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Assessment of Impacts of the Biomedical Careers Program – Just-a-Start Corporation of Cambridge, MA

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JOHN W. MCCORMACK GRADUATE SCHOOL OF POLICY AND GLOBAL STUDIES
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Assessment of Impacts of the Biomedical Careers Program – Just-a-Start Corporation of Cambridge, MA

January 2016

By

Center for Social Policy

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With the assistance of Michael McCormack and Wendel Mirbel

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We also are grateful to representatives of biomedical companies and recruiters who participated in interviews; their input was essential. Finally, we thank all program graduates who provided answers to the survey as well as those who participated in interviews. Their perspectives and willingness to share their experience have mattered greatly for the relevance of the findings reported here.

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Executive Summary

In 2015, Just-a-Start (JAS) Corporation of Cambridge, MA asked the UMass Boston Center for Social Policy to conduct an assessment of the impacts of the Biomedical Careers Program on the region and the state, examining individual impacts for graduates as well as the economic contributions of program graduates to the biomedical industry.

The Biomedical Careers Program (hereafter “BioMed”) is described by JAS as an eight month program designed to enable local residents to complete “a Certificate in Biomedical Sciences to prepare them for entry level jobs at local biotechnology companies, universities, research institutions, clinical laboratories and hospitals. The program includes a comprehensive laboratory skills course, as well as career counseling and job placement assistance.” Participants of the program are eligible to apply for 8 college credits from Bunker Hill Community College

The primary questions addressed by this study concern several dimensions and vantage points:

- a) What has happened to BioMed Careers program graduates in terms of employment?
- b) What has been the impact on worker earnings and benefits over time while working in the biomedical field?
- c) What have been the fiscal impacts? That is, the impacts on state and federal income tax revenue.
- d) What has been the impact on the receipt of public assistance? This question was raised because some program participants were on public assistance at time of entry.
- e) How do employers and recruiters assess BioMed program graduates?
- f) How do graduates assess the BioMed program and its contributions to their career?
- g) What is the future of biomedical careers for graduates from the BioMed program?

To answer these questions, the Center for Social Policy research team conducted several inquiries over a 12 months period:

- An on-line survey of BioMed program graduates publicized with assistance from the BioMed program team. The survey was sent to three groups of graduates: Recent year cohorts (2011-14); graduates out for about 5-years (2008-10); and graduates out for about 10 years (2004-07). The survey was sent to 274 graduates and had a 52 percent response rate. (To answer questions a), b), f) and contribute to analysis for c)).
- Interviews with five graduates from the 10-year cohort to complete information from the survey. (For question f)).
- Interviews with six representatives of biomedical firms and recruiters. (For question e)).
- Analysis of secondary sources and survey population for the estimation of fiscal impacts of the program graduates’ earnings in biomedical industries. (For questions b) and c))
- Interviews with the program team, representatives of the Cambridge Economic Development unit, Metro North Regional Employment Board, and Skilled Careers in Life Sciences (SCILS) Initiative with the Boston Private Industry Council to gain familiarity with the history of the program.
- Analysis of occupation and industry employment projections to identify trends of most relevance to certificate holders in the state. (For question g)).

Survey of Biomedical Careers Program Graduates

CSP collected 143 responses between April and September 2015. We devised a sample stratified by cohort. The first cohort consists of recent graduates (2011-14), the second cohort are those that had graduated about five years ago (2008-10), and the third cohort are those that graduated about 10 years ago (2004-07). The survey had an overall response rate of 52%, which provides enough statistical power for estimation of the population of participants.

Overall, relative to the program graduates as a whole, survey respondents are slightly more successful: 79% got a job in the biomedical field versus 72% among graduates as a whole. They are slightly less likely to be minority: whites account for 19% of respondents versus 16% among graduates. They are significantly older than BioMed Careers graduates as a whole: 67% are aged over 30 versus 56% of all graduates (Appendix A table provides details). The differences in success after graduation and in age likely affect our assessment of economic impacts because our sample of graduates may also earn more on average. We took this into consideration in our assessment of earnings and fiscal impacts by providing more conservative estimations.

Three paths for surveyed graduates

- Path A: 79% of respondents got a job in the biomedical field upon graduation: n=95
- Path B: The graduates who have not gotten a job in the biomedical field, but are currently employed in another industry: n=16, 13% of respondents
- Path C: The graduates who have not gotten a job in the biomedical field and are currently not working: n=9, 8% of respondents

Path A: Respondents who attached to the biomedical field – the typical path for graduates

- ▶ Nearly half of the Path A respondents got their first job through a recruiter
- ▶ On average, it took 3.1 months for a Path A graduate to find a job in the biomedical field
- ▶ 61% of Path A respondents worked for drug development and manufacturing employers
- ▶ Median annual salary in respondents' first job is \$39,403 in 2015 dollars and 65% of these workers report receiving employer provided benefits
- ▶ Path A respondents worked in their first biomedical job for 3.5 years, on average (across the three cohorts surveyed, which have different seniority)

Current employment of Path A respondents

At time of survey, 52% (n=37) of Path A respondents are working for the same company as when they started; 31% (n=22) are working for a new company; and 17% (n=12) are not working (in school, at home, or unemployed). Of those working in a new company, 9 out of 10 (86%) are in still in the biomedical field.

The median annual earnings of Path A respondents currently employed have increased to \$45,550, up 16% from earnings in their first job.

Respondents who did not enter the biomedical field

Twenty-one percent, or 25, of respondents did not enter the biomed field after graduation. Among those currently working, jobs include: technicians, drivers, concierges, clerks, food service workers and supervisors in these fields. Their median annual earnings are \$35,000 (in 2015 dollars) and 67% reported receiving at least one employer-sponsored benefit. Among those not currently working —9 cases or 36%-- 3 are in school and 6 are unemployed.

Estimated compensation of all graduates who have worked in the biomedical field

The survey answers did not yield complete information for everyone over the past 10 years, but the survey provides enough information to make a reasonable estimate on how much BioMed graduates who entered the field after graduation have earned.

- ▶ Over the past ten years, BioMed Careers graduates have earned **\$42 million** (\$41,927,019) by working in the biomedical field.
- ▶ This means that *in total* these graduates earned an additional **\$16 million** (\$16,359,747) when compared to their estimated 10-year earnings based on their last job prior to the BioMed program training.
- ▶ On average, each graduate made an additional **\$14,778 per year** when compared to their previous, non-biomedical job, across the three cohorts and bearing in mind that graduates have varied seniority in the field.
- ▶ At time of survey,
 - ▶ recent graduates had increased their earnings to an average of \$42,656 a year;
 - ▶ the five year cohort had increased their earnings to \$46,087 a year; and
 - ▶ the ten year cohort had increased their earnings to \$52,712 a year.

Working in the biomedical field also had a positive impact on benefit coverage. Prior to graduating from the BioMed program, 25% of respondents (Path A) had employer provided health insurance. That grew to 62% once in the first biomedical job, and grew again to 75% in current jobs.

Impact of graduates working in biomed on state and federal income taxes

To estimate the program's fiscal impact, we extrapolated income tax contributions for all program graduates who have entered the biomedical field, based on the earnings trajectory of survey respondents (weighed by the number of cases in each group of graduates surveyed).

- ▶ Over the past ten years, BioMed Careers graduates have paid **\$4.4 million** (\$4,410,486 in 2015 dollars) in federal and state taxes combined by working in the biomedical field.

- ▶ This means they paid an additional **\$1.9 million** (\$1,920,843) in state and federal taxes when compared to their estimated 10-year tax payments based on their last job prior to BioMed Careers.
- ▶ On average, each graduate paid an additional **\$1,735 per year in taxes** when compared to their previous, non-biomedical job.

Shared perspectives of employers, recruiters and graduates

The following observations are shared by company representatives, recruiters and graduates who participated in interviews:

- The shift from direct hiring to reliance on recruiters for entry-level positions has grown apace. According to interviewed informants, 80-90% of biologics manufacturing entry-level hiring is conducted through staffing companies.
- All see the value of a certificate as providing practical preparation targeted to industry needs.
- The value of the BioMed Careers program training *per se* is reported to rest in the quality of the preparation of graduates to the work environment. It enables workers to start with limited on-the-job training relative to graduates with general degrees, even 4-year degrees. The partnership with Bunker Hill Community College is seen as valuable.
- Respondents emphasized the fact that the BioMed program selects for the right personality, meaning choosing committed and careful workers who are willing to learn. The program's emphasis on participants who have an orientation to detail and a strong sense of responsibility—because mistakes are expensive in the field—is valued.
- A particular type of soft skills, the orientation to team work, and adaptation to varied work styles is deemed important by companies and graduates. As one put it “loving science is not enough.” These skills affect the performance of production units and enable the group to avoid errors.

Interviewed respondents concur that the BioMed Careers program needs the following: continuous updating of laboratory equipment and instruction in new techniques; enhanced computer and documentation training; and more connections in industry for jobs as well as greater visibility in this growing industry. Also, all note that entry-level hiring is expected to be steady but increasingly competitive.

Program graduates have a very favorable view of the program itself; 96% of survey respondents would recommend it to a friend. Many wish the program were larger scale so that more students could benefit. Some also wish that internships were available for entry-level workers; as of now, companies only offer them to candidates from higher level degree programs.

The Future of Biomedical Jobs

In chemical manufacturing (which biologics manufacturing is a subset), there were a total of 16,740 workers employed in 2012. Of those workers, about 10% were employed in occupations for which

BioMed Careers graduates compete. These occupations include “biological technicians” and “inspectors, testers, sorters, samplers, and weighers.” Both of these occupation groups are expected to experience above average growth through 2022 (16.9% and 20.5%, respectively). In professional, scientific and technical services (which are a broad industry category but include research and development and where entry-level and mid-level biomedical jobs are present) the following occupations have above average growth rates: inspectors, tester, sorters, samplers, and weighers. In hospitals, medical and clinical laboratory technicians also have above average growth rates.

Additionally, there is evidence from our survey and our interviews with graduates and employers that BioMed graduates tend to advance their education during their career and complete an undergraduate or graduate degree. One common trajectory is to complete additional training (either employer-provided training or additional certificate or degree) and move into a production supervisor and manager position within biologics manufacturing. There is a moderate number of these positions currently and they are expected to grow at a rate of 4 to 5% between 2012 and 2022. When Biomed graduates complete a bachelor’s degree in the biomedical field, numerous opportunities open up for them. Positions in chemical manufacturing, research and development, as well as hospitals that require a Bachelor’s degree, and relate to a biomedical technicians’ work experience, include: biomedical engineers and medical and clinical laboratory technologists. Both of these occupations have a positive outlook with biomedical engineering occupations experiencing above average growth from 2012 to 2022.

Conclusions

The Biomedical Careers program significant *achievements* include: high rates of employment in biomed; positive fiscal impacts (which may be useful to compare with public investments in the program costs); and the fact that graduates and the program have good reputations *where known*. There is a high degree of satisfaction among graduates and current employers interviewed.

Expectations in the biomed field are that there is an on-going need to keep up with technique updating and new equipment in order for workers to be well prepared.

Going forward, the program will face an increasing need to adapt its outreach activities in support of graduates’ access to jobs due to the shift to recruiters (staffing firms and placement agencies) in lieu of direct hiring. Approaches to publicizing the program and its graduates may need to be amended, combining greater breadth of contacts with recruiters while maintaining strong relationships with current employers, program alumni and alumnae and being able to track the latter as they change jobs, this in order to keep a roster of active contacts over time.

Introduction

In 2015, Just-a-Start Corporation (JAS) of Cambridge, MA asked the UMass Boston Center for Social Policy to conduct an assessment of the impacts of the Biomedical Careers Program on the region and state, examining individual impacts for graduates as well as the economic contributions of program graduates to the biomedical industry.

The Biomedical Careers Program (hereafter “BioMed”) is described by JAS as an eight month program designed to enable local residents to complete “a Certificate in Biomedical Sciences to prepare them for entry level jobs at local biotechnology companies, universities, research institutions, clinical laboratories and hospitals. The program includes a comprehensive laboratory skills course, as well as career counseling and job placement assistance. After the course, participants of the program come out with eight (8) college credits from Bunker Hill Community College.” The jobs that the program aims to train graduates for include: laboratory technician/assistant, quality control technician, biologics manufacturing assistant, and animal care technician.¹ The program offers free classroom and laboratory preparation to qualified applicants. It is targeted at students with a need for socio-economic advancement. The program is one of several workforce development programs that are part of the city of Cambridge’s economic development initiatives.

Goals

The primary questions addressed by this study concern several dimensions and vantage points:

- a) What has happened to BioMed Careers program graduates in terms of employment?
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To answer these questions, the Center for Social Policy research team conducted several inquiries over a 12 months period:

- On-line survey of BioMed program graduates publicized with the assistance from the BioMed program team. The survey was sent to three groups of graduates: Recent year cohorts (2011-14); graduates out for about 5-years (2008-10); and graduates out for about 10 years (2004-07). Each cohort arrived in the job market in slightly different economic contexts, generally for the state, but particularly for the biomedical industry. The survey was sent to 274 graduates and

¹ <http://www.cambridgema.gov/CDD/econdev/individualassistance/biomedicalcareers>

had a 52 percent response rate. (To answer questions a) and b) and contribute to analysis for c)).

- Interviews with graduates from the 10-year cohort to complete information from the survey (4 in person and 1 by telephone). (For question f)).
- Interviews with representatives of biomed firms and recruiters —4 in person and 2 by telephone. (For question e)).
- Analysis of secondary sources and survey population for the estimation of fiscal impacts of the program graduates' earnings in biomedical industries. (For questions b) and c))
- Interviews with the program team as well as representatives of the Cambridge Economic Development unit, the Metro North Regional Employment Board and the Skilled Careers in Life Sciences (SCILS) Initiative with the Boston Private Industry Council to gain familiarity with the history of the program.
- Analysis of occupation and industry employment projections to identify trends of most relevance to certificate holders in the state (for question g).

Report Structure

This report first turns to the demographic profile, trajectories and earnings of the sample of program graduates surveyed. The next section turns to estimates of the fiscal impact of earnings from *all* graduates of the program based on survey results and administrative data. Two next sections review the perspectives of employers and recruiters on program graduates and the hiring industries, as well as those of program graduates on the program and its contributions to their careers. A final section addresses what can be learned about future prospects for biomedical employment in the state.

Survey of Biomedical Careers Program Graduates

The Center for Social Policy (CSP) conducted a survey of Just-A-Start's Biomedical Careers program ("BioMed") graduates to find out about their earnings and career trajectory following their participation in the training program. CSP collected 143 responses between April and September 2015. We devised a sample stratified by cohort. The first cohort consists of recent graduates (2011-14), the second cohort are those that had graduated about five years ago (2008-10), and the third cohort are those that graduated about 10 years ago (2004-07). Table 1 provides the sample size and response rate by cohort and for the total survey. We had an overall response rate of 52%, which provides enough statistical power to estimate the population with a 95% confidence interval and a 7.5% margin of error.²

² The confidence interval and margin of error are two important statistics that measure how well the survey sample represents the population. For our survey, we can be 95% confident that a measure of the population is represented by the survey within 7.5 percentage points. For example, according to the survey of BioMed graduates, 44.8% are women. The margin of error is calculated to be between 41.5% and 48.2%. Meaning that, we are 95% confident that the true percentage of women fall within that interval.

Table 1: Sample Size and Response Rate for the CSP-Cambridge Biomedical Careers Program Survey of Graduates

	Population	Sample Size	Response Rate
Recent years cohort	79	57	72%
5-year cohort	80	40	50%
10-year cohort	115	46	40%
Total	274	143	52%

Our analysis primarily distinguishes three paths taken by graduates:

- **Path A** corresponds to graduates who got a job in the biomedical field after graduating from BioMed Careers (n=95).
- **Path B** corresponds to graduates who did not get a job in the biomedical field after graduation, but are currently employed in another industry (n=16).
- **Path C** corresponds to graduates who did not get a job in the biomedical field and are currently not working (n=9). Table 2 provides a matrix of the sample size by cohort by path which is graphed in Figure 1.

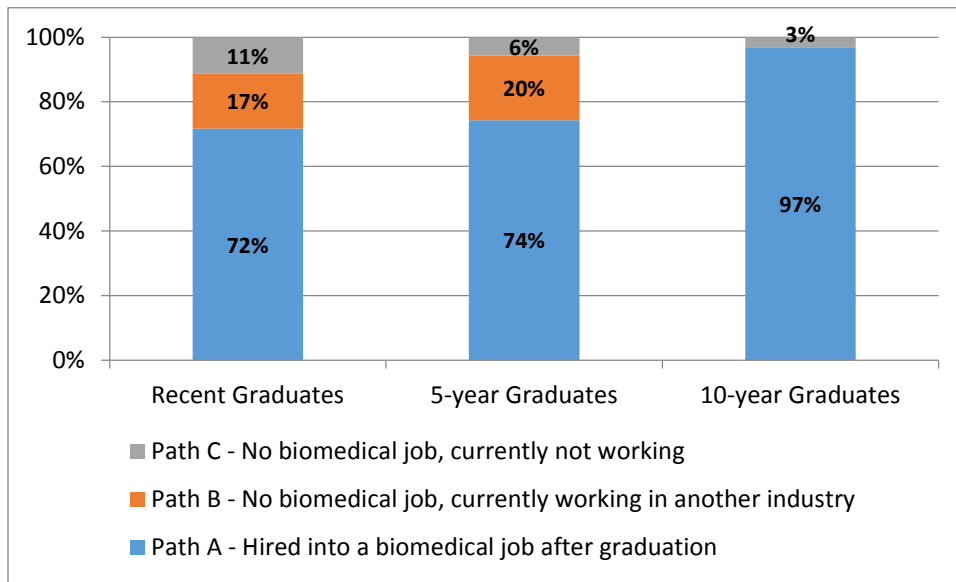
Not all respondents filled out the survey in its entirety; the valid number of cases for this analysis is 120.

Table 2: Sample Size by Graduation Cohort and Employment Path

		Recent Graduates	5-year Graduates	10-year Graduates	Total
Path A - Hired into a biomedical job after graduation	#	38	26	31	95
	%	72%	74%	97%	79%
Path B - No biomedical job, currently working in another industry	#	9	7	0	16
	%	17%	20%	0%	13%
Path C - No biomedical job, currently not working	#	6	2	1	9
	%	11%	6%	3%	8%

It is important to note that recent cohorts, particularly graduates from 2011-14, have lower employment rates in the biomedical field because they have had less time to find a job in the field.

Figure 1: Cambridge Biomedical Careers Graduates by Cohort and Employment Path (%)



Comparison of Survey Respondents to All BioMed Careers Graduates over the Past 10 Years

Out of 120 respondents with job information in our survey, almost 66% (n=80) completed the survey entirely and 32% (n= 40) of them partially completed the survey.

Since May 2005, BioMed Careers has reported a job placement rate of 72% for its graduates. For this survey, almost 79% (n=95) of the respondents reported finding a job in the biomedical field after graduation. The survey respondents were slightly more successful at finding employment in the biomedical field when compared to all graduates in the past ten years with a margin of error of 7.5% (see Appendix A for detailed table). Specifically, the 5-year cohort (who graduated in 2008-10) encountered a slack labor market due to the economic recession. During those years, the BioMed Careers program reported lower than usual job placement rates, averaging 54%. However, our survey respondents from the five year cohort were significantly more successful with an average placement rate of 74%.

Over the past ten years, 256 students graduated from BioMed Careers, based on administrative data. The majority of them are men (56%). Our survey sample represents a similar proportion of men and women. Based on the survey respondents who reported their gender, 45% are women and 55% are men. These percentages fall within a 7.5% margin of error.

The participants to the program come from a racially and ethnically diverse background. Over the past ten years, almost half of the enrolled students (49%) have been African American or Black (African-Americans, Haitians, and natives of the African continent). Asian participants are the second largest group, constituting 22%, white participants represent 16%, and other races represent 9%. At least three percent of enrolled participants are Hispanic; however ethnicity is not reported separately from

race. The survey participants represent a similar level of diversity, with the exception of white participants being just slightly over represented in the survey.

BioMed Careers administrative data show that the 18-22 year age group represents only 4% of graduates, the 23-30 year age group represents 40% of graduates, 31-39 year olds represent 35%, and the older age group (40+) represents 21% of all graduates. *Our survey over-represents older workers by a significant margin.* For example, only 21% of BioMed Careers participants are 40 years or older, whereas 32% of our survey respondents were 40 years or older when they graduated.

Overall, our survey respondents are slightly more successful, slightly less likely to be a minority, and significantly older than BioMed Careers graduates as a whole. This likely impacts our assessment of economic impacts because our sample of graduates may also earn more on average. We take this into consideration in our assessment of earnings and fiscal impacts by providing conservative estimations.

Overview of Surveyed Program Graduates – Demographics

In this survey, 45% of respondents are female and 55% are male. The average age is 35 at the time respondents graduated from the Biomedical Careers Program.

There is a significant preponderance of respondents with country of origin outside of the United States; only 24% of respondents are US-born. This is a reflection of the populations living in or near the City of Cambridge. Other countries of origin include Haiti, Ethiopia, Bangladesh, and Nepal. Figure 2 shows BioMed Careers surveyed graduates by country of origin.

Figure 2: Biomed Careers Graduates by Country of Origin

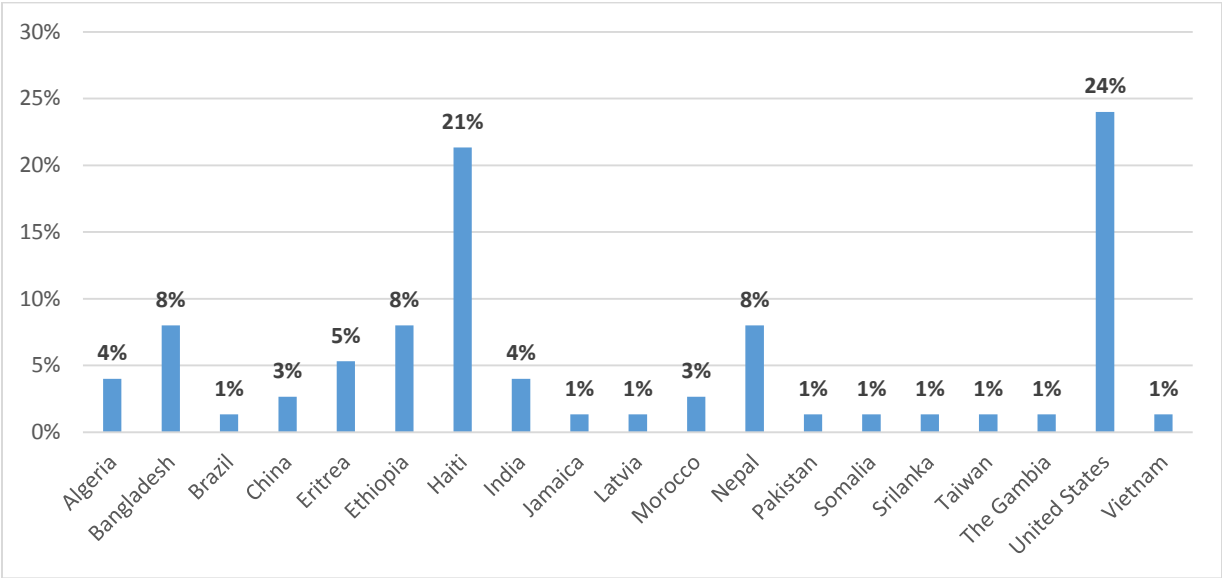
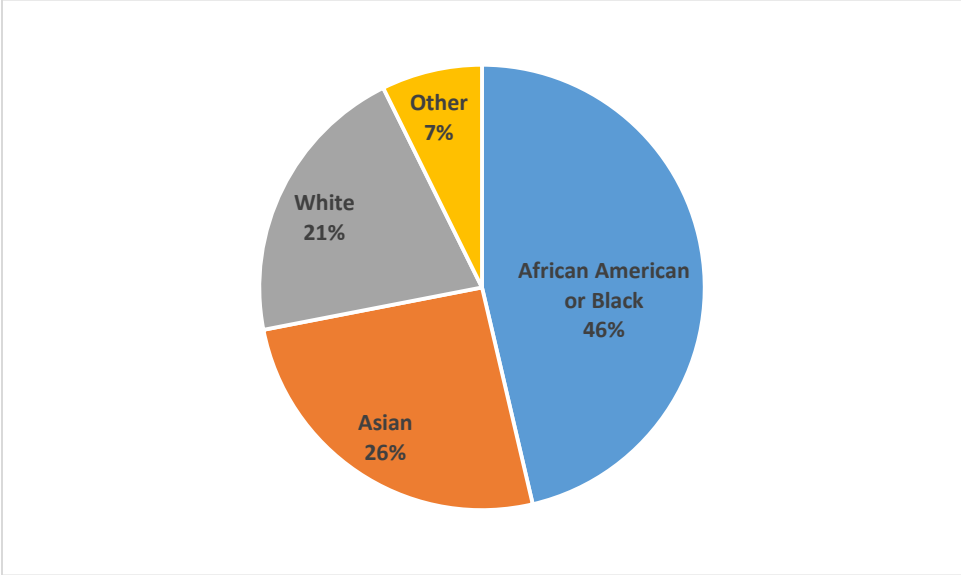


Figure 3 provides the distribution of respondents across racial categories. The largest group is African American or Black representing 46% of respondents. Asians represent 26% and whites represent 21%.

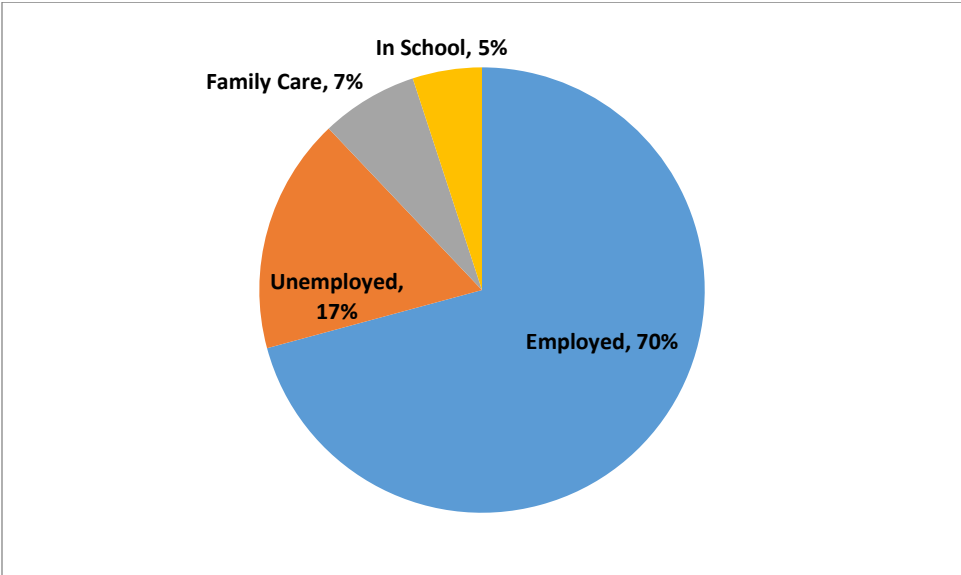
Other races include American Indian and not identified. Additionally, 8% of graduates identify their ethnicity as Hispanic (not shown in the Figure).

Figure 3: Biomed Careers Graduates by Race



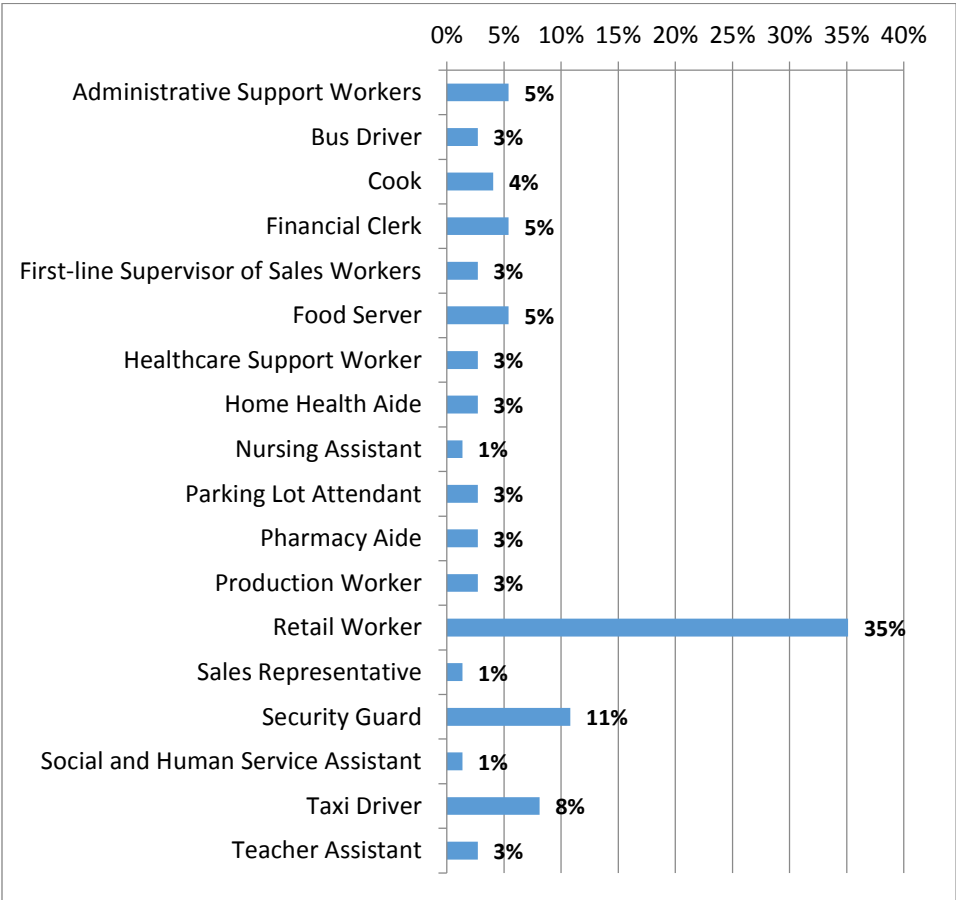
At the time surveyed graduates applied to BioMed Careers, 70% of them were employed and 17% were unemployed, but looking for work. A smaller percentage of graduates were either taking care of a family member or enrolled in school (see Figure 4).

Figure 4: Employment and Non-Labor Market Status of BioMed Careers Graduates at time of Application



Most of the BioMed Careers graduates³ who were employed at the time of application were employed in front line jobs across a range of sectors. A large percentage (35%) was employed in retail. Figure 5 lists out the different occupations that BioMed Careers graduates were originally working in and the percentage of graduates for each prior occupation.

Figure 5: Occupations Held by BioMed Careers Graduates Prior to Enrolling in the Program



Lastly, at the time of application, those graduates that were working had held their job for about 3.5 years, were working on average 34 hours per week, and had average annual earnings of \$24,265 (in 2015 dollars). Sixty-three percent reported receiving some type of employer-provided benefits in addition to their wage or salary.

³ In the remainder of this section, we refer to surveyed graduates as “BioMed graduates.”

Employment of Biomedical Careers Program Graduates

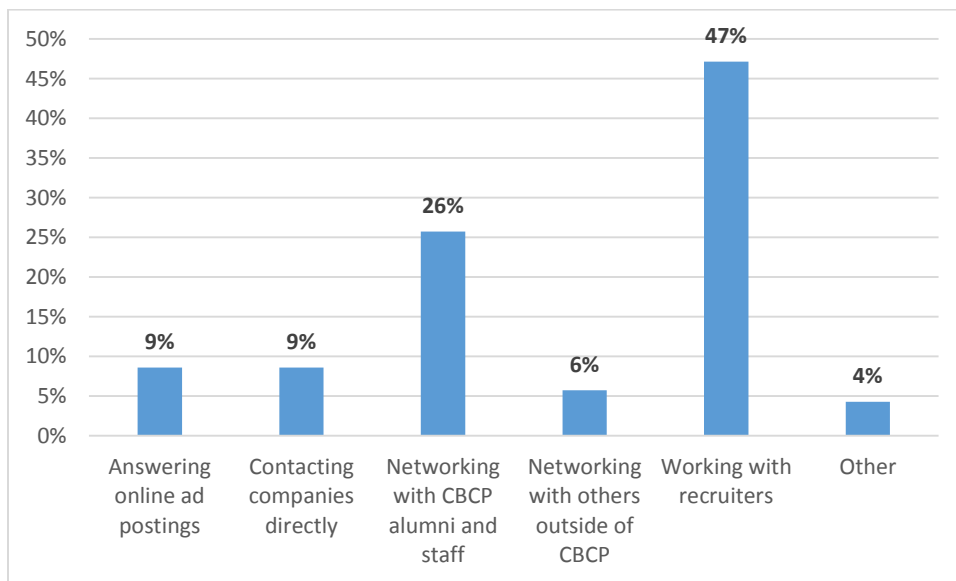
In this section we describe the typical career path of a BioMed graduate. Most program graduates get a job in the biomedical field after graduation and many advance over the years (Path A). A smaller proportion of graduates do not get a job in the biomedical field and either work in other industries (Path B) or are unemployed or enrolled in school (Path C).

The Typical Path for Graduates: Employment in the Biomedical Field (Path A)

We estimated that 79% of survey respondents got a job in the biomedical field after graduation from the training program. What is a trajectory for job access?

It took graduates in Path A anywhere from 0 to 18 months (3.1 months on average) to find their first job in the biomedical field. Graduates who find a job in the biomedical field are almost entirely hired as laboratory or manufacturing technicians. They use a variety of job search methods. In practice, they most often go through recruiters and/or use networking with BioMed alumni as well as get help from program staff. Figure 6 provides the job search methods that graduates used to successfully find their first job in the biomedical field.

Figure 6: Job Search Methods Used by BioMed Careers Graduates to Find their First Job in the Biomedical Field



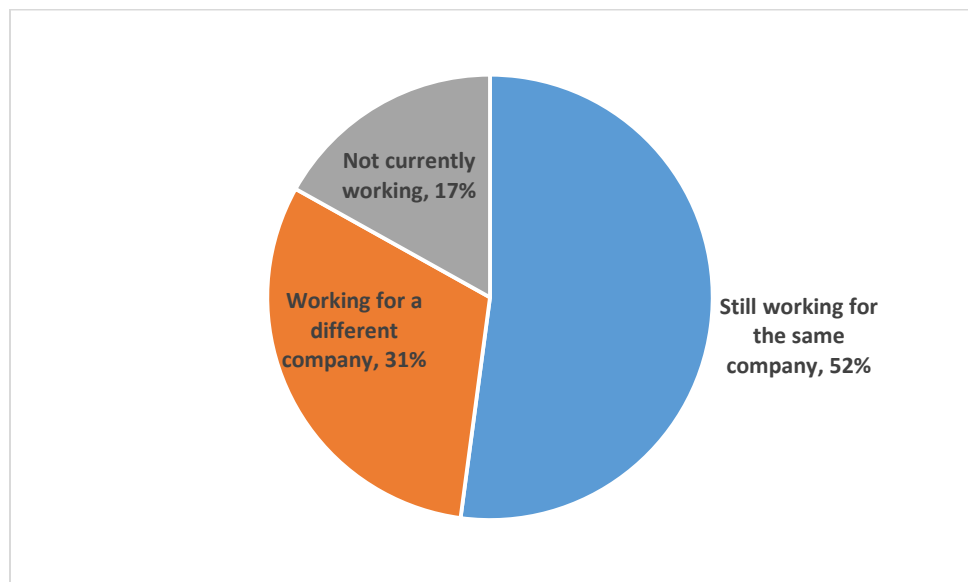
The majority of laboratory and manufacturing technician jobs obtained by graduates (61%) are with employers in the Drug Development and Manufacturing sector. Graduates also find technician jobs in other sectors as well, listed in the text box (below).

On average, graduates work about 36 hours a week and have stayed in these jobs for about 3.5 years. Over the past ten years, median annual salary for graduates in their first job is \$39,403 (in 2015 dollars). Approximately 65% of graduates received employer provided benefits in their first job. Many of the graduates who reported not receiving employer provided benefits reported that they were working in a temporary or contract position.

Graduates employment situation changes overtime. At the time of the survey (April to September, 2015), 52% of Path A graduates reported that they were still working for the same company where they had gotten their first job. Thirty-one percent reported that they were working for a different company and 17% reported that they were not currently working (see Figure 7).⁴

- Sectors that Hire
BioMed Careers Graduates**
- Drug Development and Manufacturing
 - Academic/University
 - Agricultural/Industrial Biotechnology
 - Bioinformatics
 - Contract Research & Manufacturing
 - Food Manufacturing
 - Hospitals
 - Human Diagnostic Development
 - Incubator of New Biotechnology or Start Up
 - Medical Device
 - Non-Profit Organization
 - Non-Profit Research Institution
 - Research Products & Instrumentation

Figure 7: Current Employment Status for BioMed Careers Graduates who got a First Job in the Biomedical Field



Among those graduates that are still working with the same company, 81% have received a raise and 57% have received a promotion. For those that got a raise, their median annual earnings were \$46,000 at the time of survey. For those that received a promotion, this has meant moving up the grades for technicians. For example, a graduate moves from a Manufacturing Technician I to a Manufacturing

⁴ We combine all three cohorts in the section to ensure an adequate number of observations. In later sections, we provide some analysis by cohort.

Technician II. Other graduates have changed job titles within the same company, including moving to analytical chemistry associate, patient coordinator, and quality control analyst.

Retention in the biomedical field

Among graduates that are now working for a different company, 86% are still working in the biomedical field. The majority of these graduates are working in laboratory and manufacturing technician jobs. One graduate reported working in quality assurance. For graduates currently employed, median annual earnings have increased to \$45,550 and benefit coverage is higher when compared to their first job.

Given that the response rate for 10-year graduates was expected to be lower, we also recruited a few of them for in-person interviews. Such interviews were designed to explore in greater depth the career trajectory of these graduates over time; the survey format was not suitable for such exploration whereas an interview is. Interviews were conducted with five graduates who ranged in type of current job, education level (e.g., certificate, associate's, bachelor's, master's), some still enrolled in higher education.

Most striking is that, even while employed, almost all in this small and non-random group of graduates have continued to seek additional training or higher education credentials. This is made possible by company tuition reimbursement programs, enticed by industry expansion and job openings, but also is compelled by growing job requirements and evolving techniques. The respondent who has not engaged in further higher education has benefitted from exposure to a range of production processes through position changes within a company as well as job changes across companies and, so far, has not felt the need for more formal credentials. Also, as with survey respondents overall, some respondents have higher level foreign education diplomas which are not recognized in the U.S. but, nevertheless, give them recognizable skills once they are in a position that may be conducive to promotions.

Also striking is that layoffs are part of a fairly normal experience in the industry, even for successful graduates such as those who agreed to an interview. Layoffs can be recovered from because these graduates have experienced the industry through a period of rapid growth (past 10 years).

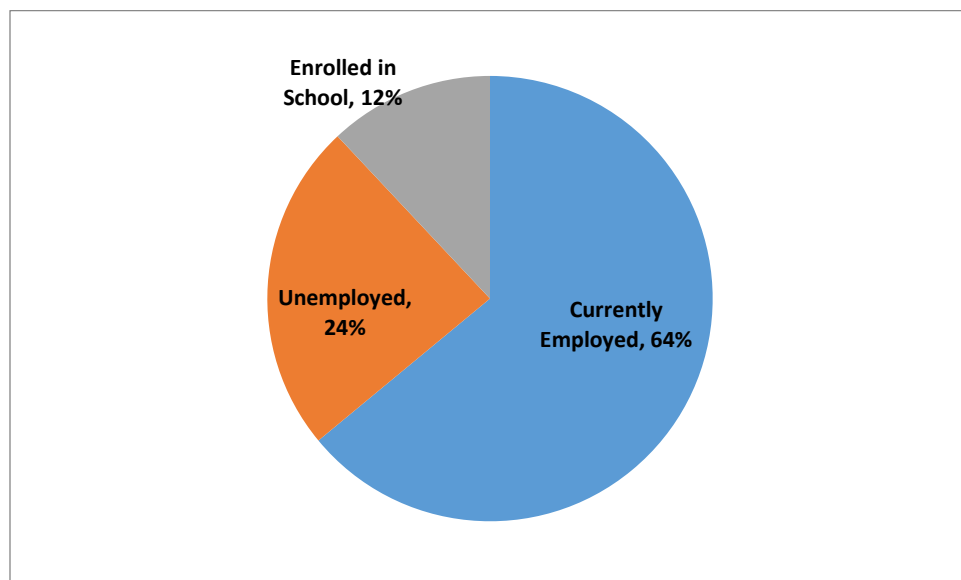
Progression paths are intricate; they may entail progression within company, or by lateral moves, but usually entail both. An example is as follows: first job as a temp lab assistant (cleaning equipment); then in a research institution preparing experiment material; then outside of biotechnology but as a technician then as a quality control technician using related skills; later in two biomedical manufacturing companies first as Technician I, then Technician II. In these technician positions, workers may be assigned to cleaning, cell culture, or purification stages. (From a manufacturing technician II, next steps may entail being lead, then senior manufacturing technician). Over 10 years, this example represents a significant number of company and job changes, with short periods of job searches (2-3 months).

Of course, the few program graduates interviewed are likely to be more successful and more satisfied with their career than average. All the same, they illustrate the amount of change and adaptation that is required of those accessing the industry through an entry-level job.

BioMed Careers Graduates Who Have Not Entered the Biomedical Field (Paths B and C)

Twenty-one percent of BioMed Careers graduates did not enter the biomedical field after graduation; some are working in other fields, while others are not working at time of survey. More than half of these graduated recently, since 2012, and are currently looking for employment in the biomedical field. Of these 25 graduates, Figure 8 shows that 64% are currently working in another industry, 24% are unemployed and 12% are enrolled in school.

Figure 8: Employment Status for Graduates Who did not Enter the Biomedical Field



Among those that are currently working in an industry outside of the biomedical field, jobs held include: technicians, drivers, concierges, clerks, food service workers and supervisors in these fields. Their median annual earnings are \$35,000 (in 2015 dollars) and 67% reported receiving employer-provided benefits.

Career and Earnings Post-graduation: Earnings Analysis for BioMed Careers Graduates

Our analysis of BioMed Careers graduates' earnings in the biomedical field shows positive results, that is, earnings improvements. Overall, graduates who moved into a biomedical job following the training program significantly increased their earnings. Furthermore, these graduates were able to advance professionally over time which led to additional increases in earnings. Table 3 provides average annual earnings in 2015 dollars prior to the training program, during their first job in the biomedical field, and for their current job.

Table 3: Average Annual Earnings (2015\$) For Graduates Over Time

Employment Path	Job previous to BioMed Careers training	First job in the biomedical field	Current job (same employer as first job)	Current job (working at a new company)
Hired into a biomedical job after graduation (Path A = 79% of graduates)	\$23,096	\$37,859	\$44,843	\$47,011
No biomedical job after graduation, currently working in another industry (Path B = 13% if graduates)	\$26,734	--	--	\$33,329
No biomedical job, currently not working (Path C = 8% of graduates)	\$24,912	--	--	--

The 79% of graduates that got a first job in the biomedical field since graduating from the BioMed program (Path A) significantly increased their earnings between the previous job they held at or before applying to the program (see Appendix B for statistical notes). Average annual earnings for these graduates increased from \$23,096 at program entry to \$37,859 at time of survey. This is a 64% increase in earnings following the training program. Furthermore, by the time of the survey, graduates that had received a promotion or gotten a job at a new company also significantly increased their earnings. Graduates who received a promotion were earning on average \$44,843 a year and those graduates that had a job with a new company were earning \$47,011 a year. This is an 18 to 24% increase in earnings following advancement in the industry.

Also of note, graduates who did not get a job in the biomedical field at graduation (Path B) but are working elsewhere significantly increased their earnings, but not to the same level as the other graduates. Average annual earnings for this smaller group of graduates were \$26,734 at or before applying to the BioMed Careers program. Average earnings grew to \$33,329 by the time of the survey. This is a 25% increase.

Combining what we know about all BioMed Careers graduates with our survey results, we are able to calculate an estimate of the total net gain in earnings for graduates that move into the biomedical field over the past ten years. According to BioMed Careers administrative data, 72% of graduates move into the biomedical field after finishing the BioMed Careers program. On average, they spend 3.5 years in their first biomedical job. After that, we know from the survey that about half (52%) receive a

promotion, one-third (31%) move to a new company, and 17% drop out of the biomedical field. We do not know about intermediary jobs or spells of not working between their first job and their current job.

Over the past ten years, BioMed graduates have earned **\$42 million** (\$41,927,019) by working in the biomedical field. This means they earned an additional **\$16 million** (\$16,359,747) when compared to their estimated 10-year earnings based on their last job prior to the BioMed training. On average, each graduate made an additional **\$14,778** a year when compared to their previous, non-biomedical job. Once in the biomedical field, we estimate that graduates increase their annual earnings by \$1,400 per year.

Changes in Earnings and Benefits for Path A BioMed Graduates

Because cohorts of graduates have spent different spans of time in the biomedical field (from 2 to 10 years), graduates' earnings increased by different amounts. Current average annual earnings are shown in Figure 9. On average, Path A graduates earn almost \$38,000 a year in their first job in the field. We know that at time of the survey, recent graduates had increased their earnings to an average of \$42,656 a year; the five year cohort had increased their earnings to \$46,087 a year; and the ten year cohort had increased their earnings to \$52,712 a year.

Figure 9: Current Average Annual Earnings by Cohort for BioMed Graduates who Entered the Biomedical Field

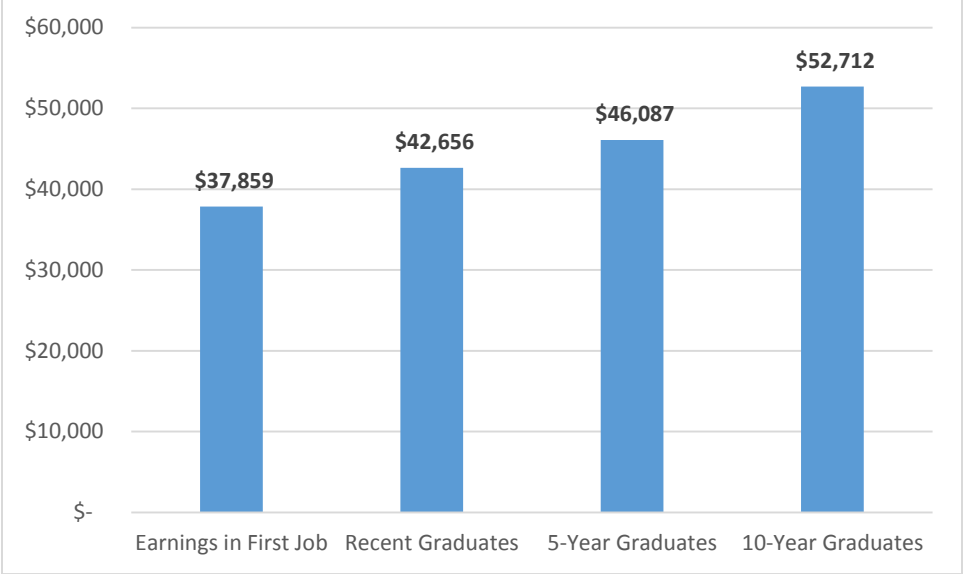


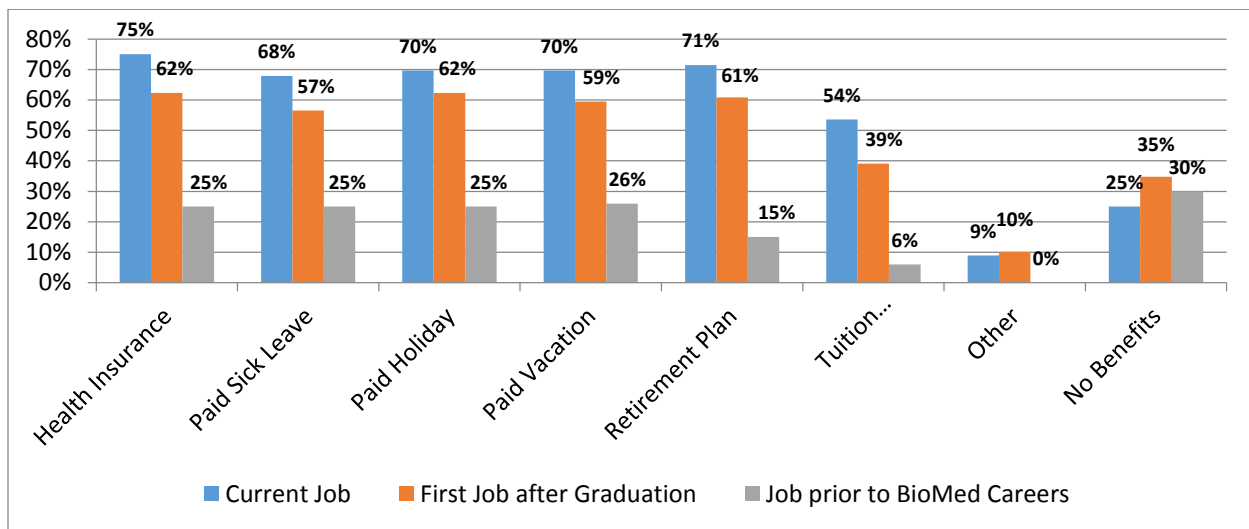
Table 4 provides average annual earnings for BioMed graduates in their current job by cohort. This table also includes the minimum and maximum annual earnings for all survey respondents current job. At minimum, program graduates reported earning at least \$25,000 in their current job. The highest earner was making \$77,000 a year.

Table 4: Average, Minimum, and Maximum Earning for BioMed Graduates Currently Employed

Years Since Graduation from BioMed Careers	Average Annual Earnings at Time of Survey	Minimum	Maximum
Recent Graduates	\$ 42,656	\$ 29,000	\$ 55,000
5-Year Graduates	\$ 46,087	\$ 25,200	\$ 70,000
10-Year Graduates	\$ 52,712	\$ 28,000	\$ 77,000

In addition to increasing earnings, moving into a job in the biomedical field increases access to employer provided benefits. We provide a comparison of the percentage of BioMed graduates that move into the biomedical field that receive employer provided benefits both before and after the training program (see Figure 10). There is a significant change in benefits before and after the BioMed Careers program. For example, only 25% of Path A survey respondents reported receiving employer-provided health insurance prior to the training program; whereas 75% of Path A respondents reported receiving it at the time of the survey.

Figure 10: Comparison of Employer Provided Benefits Before and After Graduating from BioMed Careers and Getting a Job in the Biomedical Field



Broadly speaking, the income analysis of the BioMed Careers program survey data show positive returns to graduating Just-A-Start’s Biomedical Careers Program. Income estimates and comparisons between earnings before and after graduating from the program, as well as comparisons before and after advancing in the industry, show that there are positive returns to graduating from the BioMed Careers program.

Estimated Fiscal Impacts of BioMed Careers Program Graduates

Next, we turn to the fiscal impacts of the training program. We used the Current Population Survey (CPS) to estimate income tax rates for BioMed Careers graduates. Overall, the analysis demonstrates statistically significant fiscal impacts of the training program, bearing in mind some limitations in the estimation (see Appendix C).

We calculated the mean federal and state income tax rates for biomedical and non-biomedical workers using the CPS. We used the earnings reported in the graduate survey and multiplied these by the tax rates obtained from the CPS in order to calculate a per person contribution to federal and state tax revenue over the years worked in each job.

Income Tax Contribution: What do program graduates contribute in terms of taxation?

Table 5 provides estimated annual income tax contributions at the federal and state levels for BioMed Careers graduates that work in the biomedical field. Prior to graduating, these workers paid on average \$1,311 in federal taxes each year and \$938 in state taxes each year (in 2015 dollars). After graduating and advancing in the industry, average tax contribution significantly increase to as much as \$2,952 in federal taxes and \$2,372 in state taxes each year.

The differences in average annual tax contributions as a worker progresses are statistically significant. Again, two-sample t-tests show that an individual pays more in taxes after they graduate from BioMed Careers compared to what they were paying prior to the training program. Furthermore, tax contributions increase again as the advance their careers (see Table 6).

Table 5: Estimated Average Annual Federal and State Income Taxes for BioMed Careers Graduates Working in the Biomedical Field

Graduate Cohort	Job previous to BioMed Careers training	First job in the biomedical field	Current job (same employer as first job)	Current job (working at a new company)
Federal Tax	\$ 1,311	\$ 2,197	\$ 2,749	\$ 2,952
State Tax	\$ 938	\$ 1,641	\$ 2,054	\$ 2,372

Table 6: Comparisons of Average Annual Income Tax Contributions for BioMed Careers Graduates

Tax Level	Comparison of Average Annual Income Tax Contributions	n	Two-Sample T-Test Statistic
Federal	PATH A: Job Previous to BioMed Careers vs. First Job after Graduation	53	-5.49***
	PATH A: First Job after Graduation vs. Promotion at the Same Company	25	-2.85***
	PATH A: First Job after Graduation vs. Current Job at New Employer	20	-3.26***
State	PATH A: Job Previous to BioMed Careers vs. First Job after Graduation	53	-5.91***
	PATH A: First Job after Graduation vs. Promotion at the Same Company	25	-4.16***
	PATH A: First Job after Graduation vs. Current Job at New Employer	20	-2.85***

***Two-sample t-test statistically significant, with a p-value < 0.01

Similarly to the earnings analysis (above), we combine what we know about all BioMed Careers graduates with our survey results and the income tax rates from the CPS. We are able to calculate an estimate of the total net increase in taxes paid by graduates that move into the biomedical field over the past ten years.

We used the following parameters for this estimate. Seventy-two percent of graduates move into the biomedical field after finishing the BioMed program (administrative data). On average, they spend 3.5 years in their first biomedical job. After that, 52% receive a promotion, 31% move to a new company, and 17% drop out of the biomedical field (from the survey).

Over the past ten years, BioMed Careers graduates have paid **\$4 million** (\$4,410,486) in federal and state taxes combined by working in the biomedical field. This means they paid an additional **\$2 million** (\$1,920,843) when compared to their estimated 10-year tax payments based on their last job prior to BioMed Careers. On average, each graduate paid an additional \$1,735 a year when compared to their previous, non-biomedical job.

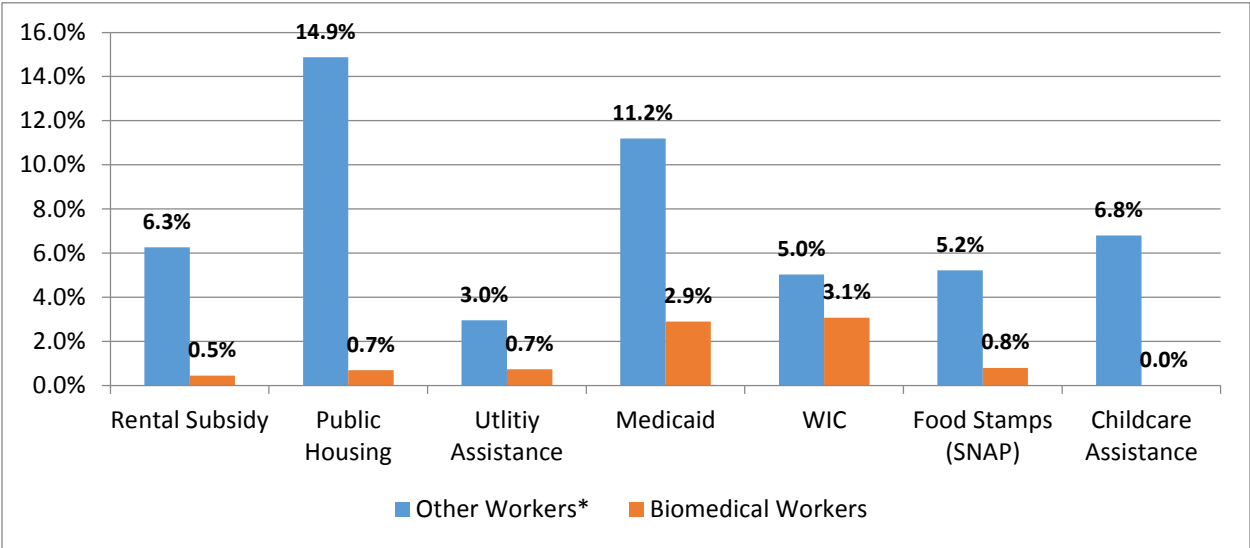
Public Assistance Receipt

Holding a job reduces the likelihood of requiring assistance or subsidies. How did program graduates (respondents) fare? The income tax analysis is the first half of the fiscal impact analysis. The second half involved calculating the percentage of people on various forms of public assistance in biomedical occupations versus non-biomedical occupations using population information from the Current Population Survey. Rates of public assistance receipt were calculated using several binary and categorical variables that indicated (1) food stamp receipt (2) public housing or rental assistance (3) heating assistance/subsidy (4) Medicaid coverage and (5) and receiving WIC. Across all of these variables, those in biomedical occupations were less likely to receive public assistance than those in non-biomedical occupations. Since this population is representative of the BioMed Career survey respondents, it can be reasonably asserted that those graduates in the biomedical field provide a fiscal benefit in the form of reduced public assistance.

The BioMed Careers survey questions did not address public assistance receipt or household characteristics due to length limitations. However, given what we know about respondent’s income prior to the BioMed Careers program, many participants could have been eligible for public assistance. For example, if we assume that survey respondents’ total household income is equal to the earnings they reported in the survey, the vast majority would be eligible for programs like Medicaid, SNAP, and utility assistance especially if they had a family to support.

Using the Current Population Survey, we found statistically significant lower receipts of public assistance by biomedical workers compared to other workers with respect to Medicaid, SNAP (food stamps), and utility assistance. Figure 11 provides a comparison of public assistance receipt by program. The chart shows declining trends in public assistance receipt for other programs as well.

Figure 11: Comparison of Public Assistance Receipt between Biomedical Workers and Other Workers*



*Other workers are defined in Appendix C. They are used as the comparison group because they represent workers in jobs that are similar to graduates’ jobs prior to the training program.

Employer Perspectives

How do prospective employers and recruiters providing them candidates perceive and assess graduates of the Biomed Careers program? What are their views on hiring practices in biomedical fields and how do they see patterns of employment in the near future?

To address these questions, the study team conducted interviews with industry representatives and recruiters who were contacted with the assistance of program staff. Three were conducted in person, the rest by telephone at respondent request. The table below provides information on the role of respondents and the industry segment their company represents.

Table 7: Employer and Recruiter Interviews Completed

	Direct employer	Recruiter	Pharmaceuticals	Medical devices
Interview 1		X		
Interview 2		X		
Interview 3	X		X	X
Interview 4	X		X	
Interview 5	X		X	

Note: Recruiters identify candidates for firms in any segment of the biomedical field

Positions In Which Biomed Graduates And Others With Certificates Are Hired

In biotechnology and related industries, graduates from certificate programs are candidates for entry-level jobs. As the biotechnology industry in particular has matured, pharma products, medical devices, and hybrid products have gone into production, and given rise to the growth of production/manufacturing positions. Drugs in particular have a long development, trial, and FDA approval cycle; once approved, production can take place on a scale that warrants notable numbers of entry-level workers.

The type of positions for which interviewed employers and recruiters hired BioMed Careers program graduates include the following:

- Manufacturing technician
- Entry-level technician in laboratories connected to biotechnology or hospitals
- Laboratory technician (clean glassware)
- Animal care technician (mice, rats involved in pharma trials)

Shift in Hiring Practice

In the past 10 to 15 years, as biotechnology companies have developed production lines, they have followed a couple of broad practices. Some adopted human resource systems for entry-level workers that were similar to those in existence for the research and development staff as well as sales and other functions supporting product development and fundraising. In short, entry-level workers have been hired on payroll, with a probation period. Other companies developed human resource management systems for production workers that were distinct from those in existence for their research and administration personnel. Historically, biotechnology companies already used contract research organizations, for example, to conduct specific parts of the work required for product development.

In recent years, the salient change in entry-level hiring practices has been the progressive shift toward hiring through intermediaries—staffing companies and “recruiters” —and away from direct hiring. Recruiters find candidates for biotechnology companies in view of “temp-to-perm” hiring or direct hiring. “Temp-to-perm” hiring enables companies to have an extended “probation” period (from 3 to 6 months) for the worker to perform before being put on the company’s payroll and being covered by company human resources policies. While “biomed” companies have historically used such

intermediaries, recent trends appear to indicate that entry-level hiring will predominantly be conducted via staffing companies.

Contract to Hire vs. Direct Hiring

Unlike forms of externalization that address the need for specialized services, this type of externalization seems driven by the need to solve human resource management issues, that is, to have a buffer between the company and new hires, to achieve extended probation periods, and retain significant room for maneuver in hiring. It represents a “try before you hire” practice that has become generalized. In addition to these human resources considerations, biotechnology firms might use “contract/contract to hire” hiring because their project funding is constrained or not fully committed yet.

Representatives of biotechnology firms and of recruiting/staffing companies indicated that the bulk of entry-level hiring—from 80 to 90 percent—is conducted through staffing companies that payroll the worker and some of which also provide the workers with some benefits, such as health insurance. Entry-level workers are reported by respondents to convert to regular hiring; numbers given hovered around 90 percent.

This trend has implications for BioMed program graduates as well as for the program plans for supporting graduates in job search and engaging with potential employers. We noted that the fact that recruiters/staffing companies are the most likely first point of contact for entry-level candidates will have implications for how the BioMed Careers program and candidates themselves network and present their qualifications. One possible difference between direct hiring and hiring through staffing intermediaries—beyond the obvious difference in terms of employment—is that recruiters are not likely to be familiar with production processes (unless they come from the industry) and organizational arrangements of the firms for which they recruit candidates, whereas, in direct hiring, an operations manager or supervisor is likely to be involved in candidate assessment. Biotechnology firms’ respondents varied in their pattern of interaction with staffing companies: either looking at candidates that have been lined up by the staffing recruiter; or being directly contacted by candidates and directing them to the staffing company; and/or directing candidates that the firm representative has already screened to the staffing company for payrolling.

All such arrangements with a staffing intermediary entail a trial period on the staffing company payroll. The informants with whom we spoke indicated that conversion onto the biotechnology company payroll often occurs around the three-month mark, though this is not guaranteed. The arrangement, and presumably the cost of the staffing service, also vary in that some staffing companies provide the employees with benefit coverage (health insurance, paid leave) while others do not.

Boston Area Context

Entry-level hiring appears to have been steady over the past 5 to 8 years; much of it has been created by manufacturing operations. It turns out that production facilities have remained in Massachusetts

while earlier expectations had been that manufacturing, particularly on relatively large scale, could be located in areas with lower cost real estate and labor. Yet, proximity to the R&D facilities remains important for a significant number of companies because of the need for interaction with laboratory scientists, for quality control particularly but not only, for products that have an interface with surgical practice.

The product cycle affects trends in entry-level biomedical jobs. Companies with pharma products in clinical trial stages will generate jobs for animal care specialists. Also, clinical trial results have significant impacts on trends in manufacturing technician job openings; success leads to manufacturing jobs growth, conversely, failures lower expectations of job growth based on products known to be in the pipeline.

Even as the industry grows in Massachusetts, and 10 to 20 percent of current job openings are entry-level according to some industry sources, hiring for these positions is competitive. Job candidates experience difficulty getting their profile noticed and conventional advice is for them to develop and use extensive social networks, use social media platforms, avail themselves of company visits when their training program organizes them, and as a whole persevere and make repeated contacts with companies.

Possible Progression for Certificate Holders

Certificate holders may be hired in different settings: research (equipment cleaner, lab technician), trial facilities (animal care technician), and manufacturing (manufacturing technician). Importantly, over time, their experience inside biotechnology firms appears to have changed. About two decades ago, entry-level positions entailed support roles: cleaning, sanitizing, replenishing stock of materials for example. As individuals progressed and demonstrated the ability to follow protocols, they would receive cross-training into other functions (for example in steps on cell culture). Following such training, the individual might move to a higher level position such as manufacturing technician. Over time, as noted above, companies have moved to hiring through temporary intermediaries for simpler tasks. Once converted to regular hiring the worker receives cross training, which may take 6 months to know the processes that are part of manufacturing stages. Over time, individuals can also seek and obtain additional certification. In short, stages for integrating entry-level workers into a progression of jobs are more delineated than in earlier years in the industry.

In manufacturing, entry-level individuals with certificates are hired at the manufacturing technician level. A likely trajectory when successful and with access to cross-training in different stages of a process is to progress first through a few levels of “tech”, then to “lead”, then to supervisor role. To move beyond the supervisor role, for example to become manager of a unit (to whom several supervisors report), a higher education credential is usually required.

In research and development facilities, entry-level progression may go from laboratory technician I to higher grades in the same category of positions. It is also possible to move laterally to positions in

manufacturing. All certificate holders, however, will eventually encounter the need for a higher level credential in order to move beyond line supervisor role in biologics manufacturing.

The Role of Certificate Level Training

A recurring question we posed to industry respondents and recruiters concerns why they hire candidates with certificates without requiring an Associate degree and sometimes even choosing them over candidates with a bachelor's in biology. The practical preparation of candidates (regardless of their general level of education), the fact that the certificate is targeted to industry needs, and entails skills directly connected to laboratory or manufacturing procedures are reported to matter.

In pharmaceutical manufacturing for example, technicians play an extremely important role. Any mistake (failing to maintain an aseptic process for example) may destroy an entire production batch with expensive consequences because products require long and costly preparations. Therefore, practical skills are highly valued. The pressure to keep production going also leads supervisors to look for job candidates who are ready to start with minimal initial on-the-job training. Certificate graduates have had exposure and practice with laboratory environments, production processes, the necessary record keeping practices, and other conventions required. They are more valuable than candidates with higher educational credentials because of this preparation for the production or laboratory environments. One respondent noted that a major manufacturing company had shifted its job requirements in postings from bachelor degree only to bachelor/associate/certificate, an illustration of this interest in ready to work candidates.

What Biomed Careers Program Graduates Bring to Workplaces

The Biomedical Careers Program graduates have a good reputation, where the program is known. According to interviewed industry respondents, BioMed Careers program graduates bring academic and practical preparation superior to, or on a par with, all the other Boston area certificate programs. The assessment varies slightly across respondents but, on the whole, certificate graduates recruited or hired by respondents' companies were rated highly in terms of their preparation for the detail of the tasks. The partnership with Bunker Hill Community College was considered a solid asset.

BioMed program graduates are deemed to stand out among other hires by these respondents for a set of reasons having to do with their own background, their acculturation to the biomedical environment and their attitude toward work responsibilities. As was noted in the graduates' profiles, BioMed students are older; some may have higher level educational experience in their country of origin. Most, if not all, perceive the certificate as a path to upward mobility.

Respondents indicate that, beyond basic skills (e.g. cell culture, atomic weight, molarity/concentration for a solution, math skills, documentation practices), their work environments require individuals that have an orientation to detail, to responsibility and care. Importantly, though they may work alone on a specific step in a process, they must work as part of a team, coordinate with others, and document all

processes. This observation was echoed in some worker interviews, with one noting that loving science is not sufficient to do well in a manufacturing environment for example. Understanding diverse work styles and getting along with others also play an important role; soft skills do matter even in an environment driven by hard science processes.

Interviewed company representatives who have hired BioMed Careers program graduates report that these graduates show commitment (“really put out”). With very few exceptions, they are reliable, want to learn, and trustworthy (“the biggest thing”). One respondent noted that the company can train anybody to do anything if they want to do it. But cannot give “the personal integrity, character, commitment “that must come from within.” Other comments from hiring supervisors echoed similar words; there was a recognition that the program spends time on cultivating individuals’ soft skills. Some respondents also noted the fact that those workers who are recent immigrants or mid-career workers who undertook retraining after a layoff convey particular “gratitude” on the job, to use the words of one respondent.

Comments from recruiters focused almost exclusively on the job preparation of BioMed Careers candidates. Recruiters, compared to employers, conveyed far less understanding of what goes into training entry-level biomedical workers, and of the pathways through which entry-level workers might progress through a biomedical work organization. However, like biotechnology company representatives, they noted that the work ethic of BioMed graduates is salient as demonstrated by the ability of some to hold jobs while in training. Another noted that their higher age relative to graduates of other certificate programs is a “plus” in terms of related reliability, willingness to learn, and ability to work with others. A recruiter attributed the distinctive attitude of BioMed graduates to the selection process at entry, that is, the program team has a good sense of who is likely to pull through and show up consistently for training and work.

All respondents noted that the BioMed program graduates, like those of other programs, could use even more exposure to “work-like” biomedical environments and to cutting edge equipment and processes. A number of comments alluded to the expansion of computerized processes to coordinate the work of teams, to greater demand for documentation of work processes, and to the anticipated need for additional training emphasis on accuracy and consistency in this regard. As a whole, these comments hint at growing requirements in worker responsibilities and to the evident need, and desire, of companies to have hires that are “ready-to-go” and to absolutely minimize, if not eliminate, a start-up phase of on-the-job training for new recruits, be they “contracted” or direct hires.

Revisiting Job Access and The Growing Role of Recruiters

The shift to a heavy role for temporary staffing through recruiter outfits has repercussions for the program graduates and for the program staff activities in job search support. In addition to biomedical career preparation, BioMed program graduates are known for, and appreciated, for their attitude in the workplace, orientation to learning, reliability and stability. These personal characteristics, which are enhanced by the program, are more readily conveyed in situations of direct hiring by biotechnology employers. Relationships can be established with the hiring personnel and the track record of BioMed

Careers program graduates can be referred to. With recruiting intermediaries such as staffing firms, the program staff and graduates deal with recruiters who have multiple company needs and types of jobs for which to recruit. Their primary concern is with matching skill to positions and their “window of attention” to individual candidate characteristics is limited, where entry-level position recruitment is concerned. Networking and maintaining relationships with recruiters thus requires amending approaches to publicizing the program and networking on the part of both program representatives and graduates. Importantly and as the program team has also noted, BioMed program alums are a key resource for building the reputation of the program –which is small scale relative to industry hiring volumes—and making its graduates’ specific assets visible.

Graduates’ Perspectives

The survey of BioMed Careers graduates asked several questions about how respondents related to the training that they received through the program. This included satisfaction with different program elements and possible areas for improvement for the program. Additionally, we interviewed five program graduates to learn about their career trajectories and their perspectives on the training.

Survey Respondents

Responses to the online survey indicate a high degree of satisfaction with the BioMed Careers program; 96 percent would recommend the program to a friend. Even considering that graduates who are satisfied are more likely to respond to the survey, this is indication of a considerable degree of satisfaction.

Elements of the program which were considered most beneficial were the classroom and laboratory instructions. In spite of the challenges that program staff and graduates report with the job search process, the job search support services is also considered beneficial.

Table 8: What aspects of the Biomedical Careers Program are most beneficial?

	Number	Percent (n=83)
Laboratory instruction	73	88%
Classroom instruction	56	67%
Job Search Support Services	33	40%
Job Readiness Seminar	24	29%
Industry Speakers/Tours	20	24%
Computer instruction	17	20%

Note: Respondents checked no more than 2

When asked what elements of the BioMed Careers program respondents might want to see change, open-ended comments were also provided by 53 survey respondents. Some comments were enthusiastic and recommended no change (n=12). A much larger number of positive comments

addressed a number of concerns. Some wished that the program had larger scale and were offered to larger numbers of trainees, again an indication of generally positive experience.

In terms of wished-for improvements, a good number of surveyed graduates (n=13) mentioned the need for expanded laboratory space, updated equipment, and a wish for increased laboratory experience. This set of issues is not unfamiliar to the program staff and is very much tied with increases in knowledge requirements in biomedical workplaces as well as access to resources to make enhanced laboratory preparation possible for students. An example of graduate's comment is *"More hands-on experience with the latest instruments would be much...better [for] go[ing] [in]to the biotech field."* We see this set of concerns about enhanced laboratory preparation as shared across all education programs for biomedical jobs; the BioMed program gets positive reviews from employers about its graduates' preparation even as graduates feel pressure to familiarize themselves with lab procedures when they start out.

Job search support and assistance with opening doors was also a concern mentioned, again probably not surprisingly. Entry-level biomedical positions have become more competitive; even while graduates surveyed for the most part have been able to find jobs in the industry, they report having need for additional help with the job search. A couple of respondents have found that they encountered the requirement for a four-year college degree. A handful of respondents further identify the usefulness of company tours. Networking among program alums was mentioned as a source of potential job contacts. Some indicated the wish for access to internship experience. (We note that an employer representative also noted that entry-level workers could benefit from internship programs but that companies usually reserve these programs for higher level workers.)

We also heard from different quarters that biomedical entry-level jobs increasingly require computer skills, often for documentation and record keeping. A few respondents either noted that the computer instruction was not needed because they were already familiar while others reported needing more instruction in general skills such as Word and Excel. The range of concerns expressed illustrates the complexity of dealing with general skills in a short-term, targeted, program such as the BioMed program. While these skills are not core to the training, they are mentioned by employers as well as becoming more important to job performance.

Finally, the breadth of skill levels of program participants at time of entry also means that some with higher level skill sets wish for a "fast track" option to the program enabling them to place out of some of the instruction components or to access higher level instruction modules.

Overall, the relationship with Bunker Hill Community College is seen as mostly an asset, with only one comment noting difficulty in interacting with their records system.

Perspective on the Program From the "10-Year" Cohort of Graduates

A few graduates from the 10-year cohort agreed to be interviewed in person. Their perspective on the program is essentially similarly positive as that of all survey respondents but more detailed. Their perspective on the biomedical industry overall is also instructive. This is a professionally successful group that spans a range from exclusive reliance on the certificate to expanded education (associate's,

bachelor's or master's degree from outside the U.S.) with a few currently enrolled in such programs while working.

The insight of these experienced graduates, all of whom have done well in terms of biomedical employment over the years, is that scientific preparation or love of science matter, yet they are necessary but not sufficient for success in hiring and retention in the field. At hiring time, personal networks matter, and a personable interview persona enhances chances of hiring.

Over time, the ability to get along with team members as well as the commitment to quality are essential. Thus, a number of respondents note that training can be provided, and standard operating procedures and processes can be drilled. However, orientation to working in a team, and understanding different workstyles matter not only for the smooth running of the facility but for accuracy and ultimate commercial success. As one graduate said "trust but verify"; she sees the role of peers to verify her work, even if she is a stellar worker, and certainly to notice if she is tired and more likely to make errors which "cost the company millions" in a manufacturing process. Reliance on each other is important for success. Interviewed company representatives made similar comments.

These experienced graduates see that value of the BioMed Careers program as being tuition free, entailing practice with biotech lab environment. They appreciate the selection of program candidates (which some rate as exacting) and the thoroughness of their preparation (e.g. "they give you the tools to succeed"), and dedication of the staff and instructors. Clearly, those still relying on their certification as primary credential value this preparation more than those who have moved onto higher positions and gained more varied experience. The contacts of the BioMed program with employers were valued by some and less by others, depending on their own individual paths into the industry.

These graduates wish that the BioMed Careers program could be expanded to accept a greater number of applicants; they see the need in their personal network as well as the industry need. One person's insight is that the program is small relative to the size of the Boston area industry and insufficiently visible. Hence, the role of program alums in opening doors for recent graduates is key.

A number noted that hiring requirements have risen for entry-level positions. We are not willing to draw conclusions from these comments on this point because graduates range on their assessment and their view is very much colored by whether their company is expanding. Among entry-level positions, the least prized are those entailing dealing with animal care in trials.

The Future of Biomedical Jobs

What trends are likely to affect the hiring of certificate holders in Massachusetts in coming years? And what opportunities for promotion might open up in the state from the positions into which BioMed certificate holders are likely to be hired?

We used two sources of government employment projections to derive estimated answers to these questions. We rely on these sources to provide a picture of the future of biomedical jobs that BioMed

Careers graduates likely move into at graduation and as their career evolves. The Massachusetts Executive Office of Labor and Workforce Development (EOLWD) has published employment projections for 2012-22, the most recent of its periodic releases. Industry or occupation projections are available statewide and by workforce investment area and are available on the web.⁵ In addition, the U.S. Department of Labor sponsors a website, O*NET Online, that provides detailed descriptions of occupations based on Standard Occupational Codes (SOCs).⁶

First, BioMed Careers graduates can compete for a series of occupations in manufacturing, research and development, hospital and educational environments. We take a statewide look at these occupations in Table 9. Based on a review of O*NET job descriptions, as well as results from the survey of BioMed program graduates, the occupations listed below represent the jobs that BioMed Careers graduates are most likely to obtain. According to our survey, the jobs graduates get are most likely to be located in biologics manufacturing, but can also be found in research and development firms, hospitals and universities.

Table 9 provides occupations (based on the SOC title), average annual wages in 2014 dollars, and the most common level of educational attainment for the occupation. It is important to note that the “common level” of education is different than the “required” level; it represents what current job holders are likely to have and, importantly for this study, does not specify degrees above high school but below the Bachelor level. The fourth column in the table estimates average *annual* openings from 2012 to 2022. This estimate is based on projected employment growth as well as replacements over time as people turn over in their jobs. The table also provides a list of industries where these occupations are located and the detailed job description provided by O*NET.

The estimates of average annual job openings by occupation spans *all* manufacturing sectors—not only chemical manufacturing where biologics manufacturing is a subset—as well as all research and development activity, not just biotechnology. Therefore, it represents a wide net of occupations in which certificate holders might be hired in coming years.

⁵ Commonwealth of Massachusetts, Executive Office of Labor and Workforce Development. (2015). “Massachusetts Occupation and Industry Projections.” <http://www.mass.gov/lwd/economic-data/projections/>, accessed December 26, 2015.

⁶ O*NET Online. <https://www.onetonline.org/>, accessed December 26, 2015.

Table 9: Description of Occupations where BioMed Careers Graduates are Likely to Be Hired

Occupation	“Common” Educational Level	Average Annual Wage (2014)	Estimated Annual Openings (Statewide)	Industries	O*NET Definition
Biological Technicians	Bachelor's degree	\$47,610	260	Professional, scientific and technical services, educational services and chemical manufacturing	Assist biological and medical scientists in laboratories. Set up, operate, and maintain laboratory instruments and equipment, monitor experiments, make observations, and calculate and record results. May analyze organic substances, such as blood, food, and drugs.
Medical and Clinical Laboratory Technicians	Associate's degree	\$43,880	266	Hospitals, professional, scientific and technical services and educational services	Perform routine medical laboratory tests for the diagnosis, treatment, and prevention of disease. May work under the supervision of a medical technologist.
Inspectors, Testers, Sorters, Samplers, and Weighers	High school diploma or equivalent	\$44,470	196	Across ALL manufacturing sectors and in professional, scientific, and technical services, as well as wholesale and warehousing	Inspect, test, sort, sample, or weigh nonagricultural raw materials or processed, machined, fabricated, or assembled parts or products for defects, wear, and deviations from specifications. May use precision measuring instruments and complex test equipment.
Weighers, Measurers, Checkers, and Samplers, Recordkeeping	High school diploma or equivalent	\$36,830	31	Across ALL manufacturing sectors and in professional, scientific, and technical services, as well as wholesale and warehousing	Weigh, measure, and check materials, supplies, and equipment for the purpose of keeping relevant records. Duties are primarily clerical by nature. Includes workers who collect and keep record of samples of products or materials.
Packaging and Filling	High school	\$29,110	223	Across ALL	Operate or tend machines to prepare industrial or

Occupation	“Common” Educational Level	Average Annual Wage (2014)	Estimated Annual Openings (Statewide)	Industries	O*NET Definition
Machine Operators and Tenders	diploma or equivalent			manufacturing sectors	consumer products for storage or shipment. Includes cannery workers who pack food products.
Veterinary Assistants and Laboratory Animal Caretakers	High school diploma or equivalent	\$32,280	66	Professional, scientific and technical services and educational services	Feed, water, and examine pets and other nonfarm animals for signs of illness, disease, or injury in laboratories and animal hospitals and clinics. Clean and disinfect cages and work areas, and sterilize laboratory and surgical equipment. May provide routine post-operative care, administer medication orally or topically, or prepare samples for laboratory examination under the supervision of veterinary or laboratory animal technologists or technicians, veterinarians, or scientists.
Helpers--Production Workers	Less than high school	\$26,630	117	Across ALL manufacturing sectors and waste management	Help production workers by performing duties requiring less skill. Duties include supplying or holding materials or tools, and cleaning work area and equipment.
Laborers and Freight, Stock, and Material Movers, Hand	Less than high school	\$30,730	1,144	Warehousing, retail, wholesale, manufacturing, and transportation	Manually move freight, stock, or other materials or perform other general labor. Includes all manual laborers not elsewhere classified.
Packers and Packagers, Hand	Less than high school	\$23,390	410	Retail, manufacturing, and waste management	Pack or package by hand a wide variety of products and materials.
Production Workers, All Other	Information Not Available	\$34,340	64	Across ALL manufacturing sectors and waste management	All production workers not listed separately.

Source: Commonwealth of Massachusetts, Executive Office of Labor and Workforce Development. (2015). “Massachusetts Occupation and Industry Projections.” <http://www.mass.gov/lwd/economic-data/projections/>, accessed December 26, 2015

To put the above table in context, we look more closely at each of these occupations within several industrial subsectors statewide: chemical manufacturing; professional, scientific and technical services (of which biotechnology research and development is a subset); and hospitals.⁷ In chemical manufacturing, there were a total of 16,740 workers employed in 2012 (see Table 10). Of those workers, about 10% are employed in occupations for which BioMed Careers graduates compete. These occupations include “biological technicians” and “inspectors, testers, sorters, samplers, and weighers.” Both of these occupation groups are expected to experience above average growth through 2022 (16.9% and 20.5%, respectively). In professional, scientific and technical services (which are a broad industry category but include research and development and where entry-level and mid-level biomedical jobs are present) the following occupations have above average growth rates: inspectors, tester, sorters, samplers, and weighers. In hospitals, medical and clinical laboratory technicians also have above average growth rates.

Chemical manufacturing is almost exclusively located in the Metro North, North Shore and Central Massachusetts Workforce Investment Areas (WIAs). Research and development and hospitals are more widely spread out across the state. Based on our survey results, BioMed Careers graduates have been successful in obtaining jobs in biologics manufacturing (a subset of chemical manufacturing). There may be untapped opportunities to explore for graduates as medical and clinical laboratory technicians in the Boston and Cambridge area hospitals and research and development firms as well.

⁷ University employment projections by occupation are not available through the EOLWD.

Table 10: Statewide Growth in Occupations for BioMed Careers Graduates by Industry

Industry	Occupation	2012 Employment	Projected 2022 Employment	Change 2012-2022 Number	Change 2012-2022 Percent
Chemical Manufacturing	Total employment, all workers	16,740	17,830	1,090	6.5%
	Biological Technicians	410	480	70	16.9%
	Inspectors, Testers, Sorters, Samplers, and Weighers	430	520	90	20.5%
	Packaging and Filling Machine Operators and Tenders	460	460	0	1.8%
	Helpers--Production Workers	360	380	20	3.9%
	Laborers and Freight, Stock, and Material Movers, Hand	60	70	10	3.2%
	Packers and Packagers, Hand	60	70	10	3.2%
Professional, Scientific and Technical Services	Total employment, all workers	266,080	321,180	55,100	20.7%
	Biological Technicians	1,860	2,070	210	11.3%
	Medical and Clinical Laboratory Technicians	350	410	60	17.9%
	Inspectors, Testers, Sorters, Samplers, and Weighers	660	810	150	22.7%
	Production Workers, All Other	90	110	20	14.0%
	Veterinary Assistants and Laboratory Animal Caretakers	1,160	1,230	70	5.6%
	Weighers, Measurers, Checkers, and Samplers, Recordkeeping	60	80	20	27.0%
Hospitals	Total employment, all workers	183,510	216,180	32,670	17.8%
	Medical and Clinical Laboratory Technicians	3,410	4,210	800	23.7%

Source: US Department of Labor, O*NET Online. <https://www.onetonline.org/>, accessed December 26, 2015.

Additionally, there is evidence from our survey and our interviews with graduates and employers that BioMed graduates tend to advance their education over their career and complete an undergraduate or graduate degree. One common trajectory is to complete additional training (either employer-provided training or additional certificate or degree) and

move into a production supervisor and manager position within biologics manufacturing. There is a moderate number of these positions currently and they are projected to grow by 4 to 5% between 2012 and 2022. When Biomed graduates complete a bachelor's degree in the biomedical field, numerous opportunities open up for them. Positions in chemical manufacturing, research and development, and hospitals that require a Bachelor's degree and relate to a biomedical technicians' work experience include biomedical engineers and medical and clinical laboratory technologists. Both of these occupations have a positive outlook. Table 11 provides the estimated projections for these two occupations.

Table 11: Statewide Employment Projections for Biomedical Engineers and Medical and Clinical Laboratory Technologists (2012-2022)

Occupation	"Common" Educational Level	Average Annual Wage (2014)	Estimated Employment Growth (2012-2022)	Estimated Annual Openings (Statewide)
Biomedical Engineers	Bachelor's degree	\$92,530	27%	92
Medical and Clinical Laboratory Technologists	Bachelor's degree	\$70,090	12%	247

Conclusions

The Biomedical Careers program *achievements* include: high rates of employment in biomed; positive fiscal impacts (which may be useful to compare with public investments in the program costs); and the fact that graduates and program have good reputation *where known*. The level of satisfaction with the program is high among interviewed employers and surveyed graduates.

Expectations in the biomed field are that there is an on-going need to keep up with technique updating and new equipment.

Going forward, the program will face an increasing need to adapt its outreach activities in order to support graduates' access to jobs due to the shift to using recruiters (staffing firms and placement agencies) in lieu of direct hiring. Depth of contact with a few employers might need to be supplemented with ways to maintain relationships with recruiters. Recruiters serve various sectors in biomed and jobs; they may have less specific knowledge about workplaces which can be helpful for orienting job candidates. They may perceive higher rewards for candidates for higher level positions; it may be a challenge to maintain contact with them. Thus, approaches to publicizing program and its graduates may need to be amended, combining greater breadth of contacts with recruiters while maintaining strong relationships with program alumni and alumnae and being able to track the latter as they change jobs, this in order to keep a roster of active contacts over time.

Appendix A – Population and survey sample

Table 12: Comparison of BioMed Careers Survey Respondents with all Participants

Characteristic	Population (%)	Survey Sample (%)	Survey Sample 95% CI – Lower Bound	Survey Sample 95% CI – Upper Bound
Got a job in the biomedical field*	71.9	78.7	72.8	84.6
Sex				
Female	42.9	44.8	41.5	48.2
Male	56.4	55.2	51.0	59.3
Race				
African American or Black*	50.9	46.3	42.9	49.8
Asian*	22.6	25.6	23.7	27.5
White*	17.0	20.7	19.2	22.3
Other race*	9.4	7.3	6.8	7.9
Ethnicity				
Hispanic†	2.9	7.9	7.3	8.5
Age				
18-22*	4.4	2.5	2.3	2.7
23-30*	39.6	30.8	28.5	33.1
31-39	34.8	34.6	32.0	37.2
40+*	21.2	32.0	29.6	34.4

*Statistically significant difference between the survey sample and all participants in the past ten years.

†In the survey, Hispanic ethnicity was asked separately from race whereas it was one of the “race/ethnicity” categories in the administrative data (for the total graduate population). For this reason we do not provide a statistical comparison for Hispanic graduates. We do not deem that this difference in survey administration impacts the comparison of racial categories between the population and the survey sample.

Appendix B – Earnings information

Several steps were taken to clean the original survey of BioMed graduates in order to turn it into a workable dataset to analyze the earnings information. The survey file was examined for errors in responses and duplicate responses. Reported earnings for each individual in each job they currently or previously hold/held were converted to yearly earnings based on how respondents described their pay type (hourly or yearly). Some discrepancies between reported hourly and yearly pay amounts were resolved to improve income information. All earnings were converted to 2015 dollars to allow for comparison between earnings across time. Not all survey respondents reported their earnings information, as is common; some people may prefer to decline to provide this information. We have information for 107 respondents in total. Two-sample t-tests were conducted to compare earnings across employment paths. Table 13 provides the number of observations and the p-value for each statistical test.

Table 13: Statistical Results from Two-Sample T-Tests on Earnings Data for BioMed Graduates

Comparison of Mean Annual Earnings	n	Two-Sample T-Test Statistic
PATH A: Job Previous to BioMed vs. First Job after Graduation	53	-5.85***
PATH A: First Job after Graduation vs. Promotion at the Same Company	25	-2.15**
PATH A: First Job after Graduation vs. Current Job at New Employer	20	-2.42**
PATH B: Job Previous to BioMed vs. Current Job	9	-1.89*

*Two-sample t-test statistically significant, with a p-value < 0.10

**Two-sample t-test statistically significant, with a p-value < 0.05

***Two-sample t-test statistically significant, with a p-value < 0.01

Appendix C – Estimating fiscal impact

We used an appended version of several Integrated Public Use Microdata Series (IPUMS) for the Current Population Survey March surveys from the years 1990-2014 available from the Minnesota Population Center at the University of Minnesota. We restricted this data to workers from Massachusetts in the Boston metropolitan area. We excluded all observations with incomes higher than \$57,000 (in nominal terms), which marks the 75th percentile of the BioMed program survey earnings data. All income values were converted to 2015 dollars. Then we restricted occupations to two broad groups – biomedical and non-biomedical occupations that match as closely as possible to the occupations reported in the BioMed Careers survey.*

Once the data was restricted to a population that was representative of the respondents to the BioMed survey, we constructed federal tax rates and state tax rates. Comparisons between biomedical and non-biomedical workers' contributions to tax revenues on the federal and state and level could then be made, with the added advantage of imputing the average tax rates over to the actual survey respondents. By multiplying the tax rates obtained via the CPS with the income estimates of the survey respondents, and after extrapolation to the population of all graduates, we derived an estimate of the fiscal impacts of the BioMed Careers program in terms of increased tax revenue.

Tax rate estimates for federal taxes and state taxes were calculated using the tax data imputed by the U.S. Census. Survey respondents of the CPS do not directly report tax information, so these tax rates should be considered approximate estimates only. The CPS imputes taxes per individual for federal and state income taxes. In order to get tax rates, we divided total taxes in each category by each individual's income from wages or salaries.

***Note:** The biomedical jobs included in the CPS fiscal analysis were (1) managers of medicine and health occupations, (2) clinical laboratory technologies, (3) health record technical specialists, (4) biological technicians, (5) chemical technicians, (6) other science technicians and (7) technicians not elsewhere specified. The non-biomedical jobs included were (1) inspectors and compliance officers, (2) management support, (3) insurance sales, (4) real estate sales, (5) salespersons, (6) retail sales clerks, (7) cashiers, (8) office supervisors, (9) hotel clerks, (10) receptionists, (11) bank tellers, (12) teacher's aides, (13) supervisors by guards, (14) guards, watchmen and doorkeepers, (15) protective services, (16) waiters/waitresses, (17) cooks, (18) kitchen workers, (19) waiter's assistants, (20) miscellaneous food prep workers, (21) health aides, except nursing, (22) nursing aides, attendants and orderlies, (23) automobile mechanics, (24) bus drivers, (25) taxi drivers and chauffer.