



COMMUNITY COLLEGE BIOTECHNOLOGY GRADUATES:

*A PATH FORWARD TO CAREERS AND
HIGHER LEARNING*



A REPORT PREPARED FOR THE **GPSTEM**
MASSACHUSETTS COMMUNITY COLLEGE
CONSORTIUM BY **MASSBIOED FOUNDATION**

January 2018



About GPSTEM

In 2015, U.S. Department of Labor selected a consortium of 15 Massachusetts community colleges to receive the final round of federal funding from the Trade Adjustment Assistance Community College and Career Training (TAACCCT) Grant. Massasoit Community College was the project lead for the grant.

The goal of the grant was for community colleges to advance a comprehensive approach to addressing the training and educational needs of workers and employers statewide with a focus on articulated pathways to careers in high-growth STEM sectors. The project was titled *Guided Pathways to Success in STEM (GPSTEM)*. One of the fields of focus of the GPSTEM project was the life sciences. MassBioEd collaborated with the consortium to facilitate activities regarding the life sciences focus.



About the MassBioEd Foundation

A 501(c)(3) charitable nonprofit organization, MassBioEd's vision is for a talented regional workforce to sustain a world-class life sciences industry. Its mission is to build a sustainable life sciences workforce in the region through educational programs that inspire and propel students, engage and excite teachers, and illuminate the pathway from the classroom to careers.

MassBioEd produces *Briefs*, or one-off reports, on workforce issues vexing the biopharmaceutical companies in Massachusetts. The many obstacles encountered by associate degree holders in procuring employment in recent years has been a carefully

reviewed subject. This paper seeks to raise further awareness of the issue and offers solutions to remedy it.

This *Path Forward* brief is a part of MassBioEd's ongoing Digest of Biotech Jobs Trends in Massachusetts, which also includes *Quarterly Reports*, *one-off Briefs*, a *Medical Device Snapshot*, an *Entry Level Jobs Report*, and the annual *Job Trends Forecast*. The *Briefs* present basic data and analysis on aspects of biopharma industry job trends.

Acknowledgements

Mark Brusco, Manager of Labor Market Research, authored and conducted the analysis found in the *Path Forward* report under the direction of MassBioEd Foundation Executive Director, Peter Abair. Erica Dickinson, Product Support Manager at Burning Glass provided able assistance to the MassBioEd research team in effectively using data from Burning Glass Technologies. MassBio, the industry council serving the biopharmaceutical community of the Massachusetts region, provides support for MassBioEd's ongoing job trends initiative.

Lance Hartford served as MassBioEd's facilitator for the Guiding Pathways to STEM (GPSTEM) project. Dr. Kathleen Kirby, Project Director for Massasoit Community College's Trade Adjustment Assistance Community College and Career Training (TAACCCT) grant, through which the GPSTEM project activity was funded, oversaw MassBioEd's GPSTEM activities. Their commitment to the GPSTEM process and insights over the past three years on issues noted in this report were invaluable.

Benjamin Benton of Quinsigamond Community College, Lara Dowland of Mount Wachusett Community College, and Paul Patev of Middlesex Community College provided great perspective and insight for this report – much thanks to all three.

This report was 100% funded by a \$20,000,000 grant awarded by the U.S. Department of Labor's Employment and Training Administration, Grant # TC-26450-14-60-A-25. The product was created by the grantee and does not necessarily reflect the official position of the U.S. Department of Labor. The U.S. Department of Labor makes no guarantees, warranties, or assurances of any kind, express or implied, with respect to such information, including any information on linked sites and including, but not limited to, accuracy of the information or its completeness, timeliness, usefulness, adequacy, continued availability, or ownership.

TABLE OF CONTENTS

Executive Summary	5
Introduction	6
Industry-Endorsed Skills	6
Supply	8
Demand	10
Educational Pathways	12
<i>MassTransfer</i> Pathway	13
Recommendations for Biopharma Companies	15
Recommendations for Higher Education	17
Recommendations for MassBioEd	17
Appendix A	19
Appendix B	23

Executive Summary

In 2011, under the auspices of the Massachusetts Life Sciences Education Consortium (a collaboration between MassBio and MassBioEd), core competencies for community college graduates of biotechnology programs were established. The competencies were developed with substantial input from the life sciences industry and were intended to guide community colleges as they prepared students for positions in the industry. The competencies include an array of skills and knowledge areas such as laboratory practices and techniques, cell culture, and microbiology and protein purification and analysis.

- From 2011 to 2016, the growth rate in graduates from such programs has matched the growth of entry level jobs requiring such competencies.
- In the same period, employers increased the *degree requirements* for such entry level biotechnician positions. The number of biotechnology technician jobs requiring Bachelor's degree grew by 44%, those requiring an associate's degree grew 16%. Effectively, industry, having just helped establish the desired core competencies for associate's degree holders, raised the job requirements bar to the Bachelor's degree level for biotechnology technician jobs.

This report recommends that:

- Awareness be raised among industry hiring managers about the competencies of associate degree graduates of biotechnology programs.
- The industry needs to increase the availability of internships for associate degree students.
- The number of articulation agreements between two- and four-year public colleges should be increased and the state's very successful *MassTransfer* process offers a remedy for the current disconnect between community college biotechnology degree programs and four-year biology and biotechnology programs.
- Greater integration of "soft skills" training in community college programs should be pursued.
- Establishment of a statewide academic advisory group to guide life sciences program development in the state higher education system is also recommended.
- Advocacy for upgrades in campus laboratory infrastructure should be continued as training in the lab environment is a key component of a graduate's employability.

Introduction

Community Colleges have provided a critical function in the workforce development pipeline for life sciences companies in Massachusetts. Certificate programs reorient workers for basic entry-level employment within the industry and associate degree programs provide effective training for students hoping to fill technician roles at local biopharma organizations. In this report, we examine two academic programs of study: *Biotechnology* and *Biology/Biotechnology Technician*.

The past decade has brought unprecedented growth to biomanufacturing organizations in Massachusetts, as employee headcount grew by one-third between 2006 and 2015. These establishments are the primary source of employment for workers with a certificate or associate degree in biotechnology, most of which are principally employed as manufacturing and production technicians at such facilities.

Responding to the rapid expansion of manufacturing capabilities within the life sciences sector in Massachusetts, MassBioEd & MassBio commissioned an industry endorsement process for biotechnology programs at community colleges in 2011. The Massachusetts Life Science Education Consortium (MLSEC) intended to ensure the alignment of curriculum with industry needs by identifying core competencies to be attained in the classrooms and labs of community colleges (see Appendix A for a list of the endorsed community college programs and industry endorsement requirements).

Despite these ambitious efforts, graduates of community college programs have encountered difficulties in landing positions in industry. For the past three years, all public community colleges in Massachusetts have been working on a Department of Labor grant entitled *Guided Pathways to STEM (GPSTEM)*, which sought to understand the role community college programs play in the workforce needs of industry and to find a smoother pathway for students entering industry from said programs. Eleven of the community colleges worked with MassBioEd, the selected facilitator for the life sciences discussion associated with GPSTEM. Most of the findings and recommendations of the GPSTEM activities that resulted from this multi-year effort are discussed in ensuing sections (See Appendix B for a list of campus representatives in the life sciences GPSTEM process, as well as a list of industry representatives who provided insight on industry alignment and skills needs).

Industry-Endorsed Skills

As part of the noted MLSEC process, MassBioEd convened industry and community colleges to review and validate academic programs intended to prepare students for entry-level careers within the life sciences industry. A series of core competencies were identified as necessary for inclusion in curricula to prepare students for employment in the industry.

These encompass both laboratory practices and techniques frequently seen in biomanufacturing and research and development facilities (see Appendix A for list of Core Competencies, at the end of the community college list).

In June 2017, MassBioEd compared these core competencies with the most in-demand skills and techniques listed in online job openings, aggregated through Burning Glass' *Labor Insight* software program. Our research indicates that the core competencies identified a half-decade ago remain the most in-demand skills and techniques for openings in the following occupations: *Manufacturing/Production Technicians, Laboratory Technicians, Production Workers, and Quality Technicians.*

Figure I: Comparison of MLSEC Core Competencies & In-Demand Skills

Select MLSEC Core Competencies ⁱ	Top In-Demand Skills/Techniques
Cell Culturing	1. Cell Culturing (20%)
GMP	2. GMP (19%)
Aseptic Technique	3. Aseptic Technique (17%)
Centrifugation	4. Centrifugation (17%)
Southern Blot	5. Equipment Prep (13%)
Chromatography	6. Chromatography (13%)
Solution/Buffer/Media Prep	7. Buffer Prep (13%)
Western Blot	8. Calibration (12%)
Bioreactor Use	9. Bioreactors (12%)
PCR	10. Genetic Testing (11%)
Validation	11. Validation (8%)
SOPs	12. GLP (8%)
Micro pipetting	13. Tissue Culturing (7%)
Gel Electrophoresis	14. SAP (6%)

The left half of the table above shows an unranked, non-exhaustive list of the skills and techniques listed as core competencies by the MLSEC. To the right are the top specialized skills and techniques from the past year's openings for the four occupations listed previously, but only those that required below a bachelor's degree. The left and right sides of the table match up, indicating a great deal of overlap between the skills and techniques companies requested five years ago and the subject matter presently taught in community college programs. It follows that there has not been a mismatch of curricula and job skills in demand in recent years. This finding has been further corroborated by discussions held by MassBioEd's Skills Advisory Group, consisting of representatives from industry assembled for their insight on these core competencies, as well as industry representatives who participated in GPSTEM discussions on industry alignment (See Appendix B). In summary, graduates from these academic programs are learning skills desired by industry.

Supply

Principally, these programs are designed so that graduates can utilize their training to land gainful employment at life sciences companies. Community colleges find it of utmost importance to align their curricula and learning outcomes with the expectations and requests made by employers who are filling openings for which their graduates could conceivably fill. Thus, the primary consideration must be the labor market success these students are experiencing.

While data on student placement outcomes is sporadic at best, one way to examine labor market dynamics for these students is to look at general trends over recent years. This section looks at key data points to paint a broad picture of the job market for graduates of community college biotechnology programs. We look at rates of graduation, number of entry-level openings at biopharma companies, listings by region, skill requirements, and employer survey results, among others.

Graduates of certificate or associate programs in the following fields – *biotechnology* and *biology/biotechnology technician*– are “core” academic programs for the purposes of this study. These two programs are similar in both subject matter and the types of positions their graduates fill – technician roles at biotechnology companies. The table below details the graduates from these programs between 2011 and 2016 from Massachusetts’ public, two-year colleges.

Figure II: Associate Degree Graduates in *Biotechnology & Biological Technician*, MA, 2011-2016

Grads, Associate Degree, MA	2011	2012	2013	2014	2015	2016	TOTAL	AVG
Middlesex CC	29	39	30	48	31	43	220	36.7
Mount Wachusett CC	21	18	23	10	12	9	93	15.5
Bunker Hill CC	10	9	14	12	13	8	66	11.0
Quinsigamond CC	2	2	8	18	12	16	58	9.7
Massachusetts Bay CC ¹	9	10	8	6	7	14	54	9.0
Quincy College	0	0	6	8	12	15	41	6.8
North Shore CC	2	4	7	7	5	8	33	5.5
Springfield Technical CC	3	3	4	5	1	5	21	3.5
Roxbury CC	0	0	4	0	4	6	14	2.3
Berkshire CC ²	0	2	5	1	2	1	11	1.8
YEARLY TOTALS	76	87	109	115	99	125		

As the table shows, from 2011 to 2016 the annual number of graduates increased. While 2015 saw a decrease of 16 graduates, provisional data shows that graduations rebounded

¹ Combination of graduates from *Biotechnology* (26.1201) & *Biological Technician* (41.0101) classifications

² Self-reported data from 2014 and 2017 *MLSEC* Applications

greatly in 2016, with 125 students graduating with associate degrees in these programs. Overall, there were nearly 50 more graduates in 2016 than 2011.

Measured by the sheer number of graduates produced in this period, Middlesex Community College led all community colleges, with twice as many graduates as the next institution.

Geographically, Middlesex, Bunker Hill, Quincy College, Roxbury, Mass Bay, and North Shore Community Colleges, located either within or close to the nexus of the industry in the state, produced 61 percent of graduates in these programs. As the regions in which these community colleges are located make up approximately 80-85 percent of employment within the Massachusetts industry, it is important to note that other community colleges are producing graduates at rates disproportionate to the biopharma industry employment in their regions (discussed further below).

Whereas associate degree programs generally require approximately 60 credits and take two years or more to complete, *certificate* programs are shorter and more narrowly focused on teaching practical skill sets aimed at readying students for direct entry into the workforce, without a broader emphasis on general education. The ensuing table tallies the number of graduates from certificate programs within the same period, 2011 – 2016. This table only includes graduates from two-year institutions, as UMass-Amherst also graduated students in these academic programs between 2011 and 2015.

Figure III: Certificate Recipients in *Biotechnology & Biological Technician*, MA, 2011-2016

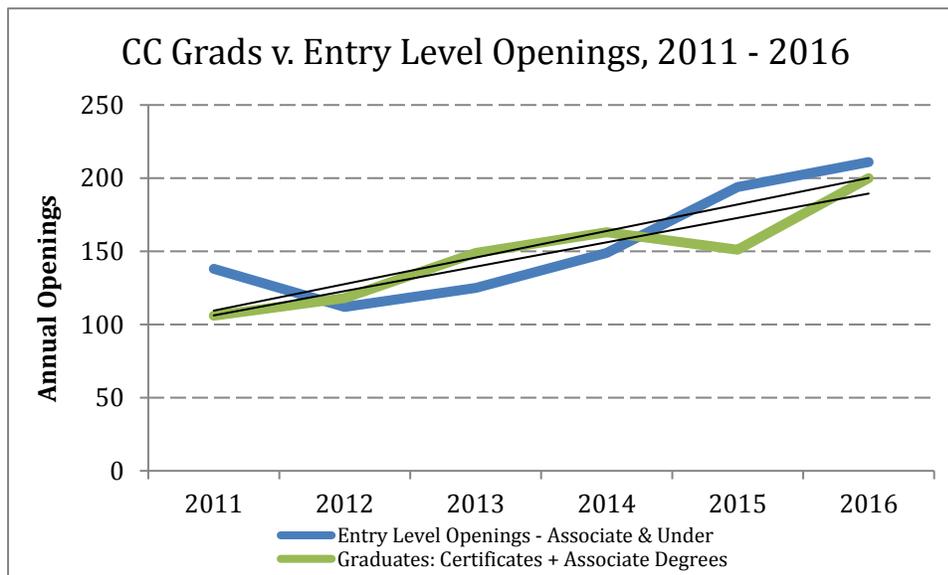
Grads, Certificates, MA, 2011-15	2011	2012	2013	2014	2015	2016	TOTAL	AVG
Middlesex Community College	18	22	30	28	35	51	184	30.7
Mount Wachusett Community College	5	5	8	6	7	4	35	5.8
Quincy College	0	0	0	0	3	14	17	2.8
Roxbury Community College	1	4	1	4	2	2	14	2.3
Massasoit Community College	0	0	1	6	3	1	11	1.8
Springfield Technical Community College	2	0	0	3	0	1	6	1.0
Bristol Community College	2	0	0	0	1	2	5	0.8
North Shore Community College	2	0	0	1	1	0	4	0.7
YEARLY TOTALS	30	31	40	48	52	75		

As was the case at the associate degree level, there was a general increase each year in the number of certificate recipients. There was an increase of 45 recipients when comparing 2016 to 2011, a growth rate of 150 percent. Middlesex Community College enjoyed a healthy edge over other institutions in awarding certificates in these fields, accounting for over two-thirds of all awarded in the five years examined.

Demand

Having established the supply of new job candidates from community college biotechnology programs, we now examine the *demand* for those workers to ascertain the relative under- or over-supply of workers. Students graduating from these programs typically find themselves in technician roles at biopharma organizations. For the purposes of this study, we have identified the Burning Glass occupations for which these graduates qualify as *Lab Technician*, *Lab Technologist*, *Manufacturing/Production Technician*, *Quality Inspector/Technician*, *Quality Control Analyst*, *Research Associate*, *Sterile Processing Technician* and *Production Worker*. These occupations have had a number of open positions in recent years that required less than a four-year degree and less than two years of experience (deemed entry level).

Figure IV: CC Grads & Entry Level Listings, MA, 2011 - 2016



Between 2011 and 2016, graduates in these select programs and the positions within industry for which they qualify have risen in tandem, as displayed in Figure IV³. Figure IV shows that the supply and demand have been growing at more or less the same rate since 2011, as their

trend lines mirror one another.

³ It is best to look at the relative rates of growth as an alternative to one-to-one comparisons of the totals, as an unknown percentage of graduates continue their studies at four-year universities (and the ability of the Burning Glass software's detection abilities may mean that job listings totals aren't 100 percent comparable year-over-year).

Since the start of 2016, the geographic dispersion of these job listings has not reflected the industry-wide job listings pattern. Figure V shows where entry level biotech technician positions requiring an associate degree or less were located in 2016. While the majority of all listings are in the Boston/Cambridge hub, that was not the case with regard to entry level technician positions, with Metrowest, North Shore, and Central Mass accounting for a majority of these job listings. This is a positive sign for community colleges in those regions, namely Mount Wachusett CC, Quinsigamond CC, and Middlesex CC – all of which have an outside share of graduates from related academic programs, as previously noted.

Figure V: Regional Dispersion of Job Listings, MA, 2016

Region	Biotech Technicians	Entire Industry
Boston/Cambridge	39%	60%
Metrowest	25%	17%
North	18%	11%
Central	13%	6%
South and Cape	6%	4%
West	0%	1%

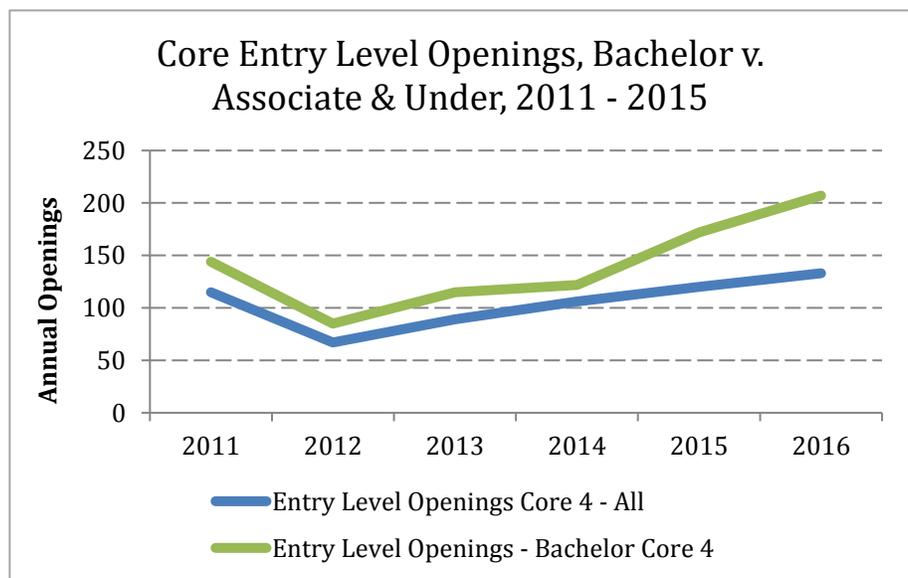
Competition for Jobs: Bachelor’s versus Associate & Certificate

The jobs that we have examined require a minimum of either a certificate or associate degree in one of the two academic programs we have discussed (*biotechnology and biology/biotechnology technician*). How do those with these credentials fare in the job market? We looked at the four “core” occupations that have a sizable share of openings for associate degree or certificate holders:

Manufacturing/ Production Technicians, Quality Inspector/Technicians, Production Workers, and Laboratory Technicians.

For these positions, we found that in every year since 2011, more openings were reserved for those with four-year degrees than those with associate degrees or below. Between 2014 and 2016, the growth rate was much more pronounced for openings requiring a four-year degree than for a two-year degree.

Figure VI: Core Entry Level Listings by Min. Degree, MA, 2011 - 2015



Between 2011 and 2016, job listings for these four core occupations that require possession of at least a four-year degree grew by 44%, while job listings requiring an associate degree or less grew by 16%. Also, the share of all listings available to those with less than a four-year degree fell from 44% of all listings in 2011 to 39% in 2016. At least in the past two years, employers seem to be *increasing* the level of educational attainment needed to fill these openings in Massachusetts. Based on discussion with industry representatives, the association of bachelor's candidates with a greater understanding of underlying science and critical thinking skills versus their associate degree counterpart is a factor in this hiring preference. However, based on the core competency requirements of the Industry Endorsement program, community college graduates from these programs must be able to “apply problem solving skills, mathematics and critical thinking to analyze problems, propose solutions and make decisions”⁴.

Biomanufacturing, as a whole, is projected to continue to grow at a faster rate than other sectors of the biopharma industry in Massachusetts in the coming years. In MassBioEd's *Annual Job Trends Forecast*, the growth rate of the sector is projected to be 32% between 2016 and 2022 – much in line with recent years and nearly double that of the rest of the industry. In our 2017 industry survey, 44 respondents indicated they expected to grow their biomanufacturing workforce in the next twelve months, 62 indicated they anticipated no net change, and only one respondent indicated a planned reduction in their biomanufacturing workforce in the next year.

Based on our review of the supply of able associate degree graduates and skill requirements for open positions, hiring managers should reassess recruitment practices to better accommodate the hiring of qualified associate degree holders for the positions noted.

Educational Pathways

Of critical importance to two-year schools with biotechnology programs are articulation agreements with area four-year universities. As employers in recent years are more likely to require a higher level of educational attainment for positions traditionally reserved for candidates with a certificate or associate degree, community colleges have been forced to reconcile their desire to maintain their programs as career-oriented with the dictates of the labor market. Our recommendation is for biotechnology programs to at once prepare their students for job placements, but allow for ease of transfer to four-year universities, bearing in mind that our research shows that the positions for which they are training their students are increasingly being listed for candidates with bachelor's degrees.

⁴ See Attachment A, Core Competencies narrative

Due in part to the results of MassBioEd’s labor market research, biotechnology programs have pivoted toward the transfer option. In doing so, they must navigate the different requirements of the state and local private universities. Our research shows that the coursework that is awarded credit upon transfer can vary from institution to institution. This was a critical issue identified through the GPSTEM grant funded study. Four-year institutions treat comparable courses from area community colleges differently, i.e. one community college’s course would be fully accepted with credit toward a four-year degree program, while others offering the same course would get only general education credit or sometimes, no credit at all.

One prime example of this issue is the course *Cell Biology* – an equivalent course offered at Quinsigamond, Bunker Hill, and Northern Essex community colleges. This same course is treated differently at

Figure VII: Equivalent Course Credit Comparison

multiple state universities. At Fitchburg, only the Bunker Hill course receives program credit. At UMass

Community College	Course Name	Fitchburg	UMass Amherst
Northern Essex	Cell Biology	Gen. Ed.	Gen. Ed.
Quinsigamond	Cell Biology/Lab	Gen. Ed.	N/A
Bunker Hill	Cell Biology/Lab	Program Credit	Program Credit

Amherst, Northern Essex gets general credit while Bunker Hill gets full program credit. Figure VII illustrates this particular example. It is but one community college biotechnology-related course among many that is exposed to a disparate and confounding credit transfer process with public and private universities.

MassTransfer Pathway

One obvious correction would be for community college biotechnology programs to enter into a joint effort with the registrar’s offices at all public universities in the state to universally recognize similar courses and offer the same credits upon transferring. The *MassTransfer Pathway* project is a model to replicate in this regard. The Department of Higher Education’s endeavor currently only includes broad-based programs (of note to this paper are its transfer pathways for Biology, and to a lesser extent, Chemistry).

The *MassTransfer Pathway* allows for students who plan on transferring to four-year institutions the ability to transfer all sixty credits and transition seamlessly into a Chemistry or Biology B.S. degree program at any public four-year university.

At once, such an approach would solve the dual issues vexing community college biotechnology programs. The first is that biotechnology programs at community colleges often have biotech-specific coursework that does not currently transfer easily to four-year schools because the four-year colleges lack equivalent (often more technical) coursework. Secondly, it allows for students to seamlessly transfer to bachelor's degree programs, enabling them to complete a bachelor's degree in a shorter amount of time, as well as offering better job prospects.

An initial step toward better articulation is for biotechnology programs at community colleges and four-year institutions with biotechnology majors or concentrations to convene and model a transfer pathway for biotechnology, much like the one seen for general biology or chemistry.

To replicate the success of *MassTransfer*, a few actions must be taken:

1. Identify foundational courses to be taken at community colleges and their equivalents at four-year institutions.
2. Decide at which level employment-oriented technical skills should be taught.
3. Decide at which level soft-skills can be implanted into program curricula.
4. Identify ways in which biotech skills can be embedded into current general biology coursework.
5. Align curriculum with in-demand skills and techniques in entry-level occupations to which biotechnology programs act as feeders.

The preceding action items will ensure that biotechnology programs are aware of and responding to workforce needs in positions their graduates are filling. It is necessary to determine at what point students should take traditional foundational courses and when they should be exposed to technical skills that they will need to acquire gainful employment in the biopharma industry. Once the pathway is mapped out, students will be able to have two options upon completion of their associate degree in biotechnology – test the job market or transfer to a bachelor's program without fear of losing precious credits upon transferring.

Multiple biotechnology program directors with whom we spoke stressed the importance of transfer options, in light of labor market research which indicates the rising minimum educational requirements in recent years. As student labor market outcomes are a priority for these directors, a codified transfer pathway allows students to maximize the likelihood

that they will find employment in their chosen profession while also completing the proper amount of higher education.

The biotechnology options at four-year institutions of higher learning in Massachusetts are shown in Figure VIII. Currently, there is one public university and three private universities that offer a bachelor’s degree in biotechnology, while eight public universities offer a concentration, track, or minor in biotechnology. Developing transfer pathways between community colleges and these institutions presents a sensible first step in properly aligning programming to the greatest benefit of community college students.

Figure VIII: *Biotechnology* Majors, Minors, & Concentrations in MA, by 4-Year University Type

Public University - Major	Public University - Concentration/Minor
Worcester State	Bridgewater State Fitchburg State Framingham State MCLA
Private University - Major	Salem State
Bay Path Endicott Assumption	UMass Amherst UMass Boston UMass Lowell

The incentives are clear. As more and more employers require a bachelor’s degree for employment in technician roles, students, who formerly would have exited higher education for employment after two years, should have better options in pursuing a bachelor’s degree program using community college credits. These accepting four-year schools stand to gain increased student populations in biotechnology programs as higher education experiences shrinking enrollments across-the-board. By articulating a clear and smooth transition from two-year schools to their campuses, their programs stand to expand as the demand for entry-level technicians continues to rise in the industry.

Recommendations for Biopharma Companies

Biopharma companies stand to gain incredible value by looking to community college graduates to fill their entry-level technician openings. These students are ready-made to fill these positions, trained in the skills and techniques companies have explicitly asked for through the MLSEC program and in on-line job openings in recent years. Research also shows that workers are less-mobile the lower their degree level⁵. As retention remains a topic of critical importance in the industry, this fact makes hiring associate degree holders all the more appealing.

For these reasons, we recommend that companies do the following in greater frequency:

⁵ <http://blogs.lse.ac.uk/usappblog/2015/03/26/the-low-skilled-are-less-mobile-geographically-because-of-the-meagre-value-of-work/>

1. **Internships for students at two-year schools** – The key ingredient in landing employment upon graduation is exposure to industry through internships and co-ops. These hands-on experiences are most often reserved for students in programs at higher levels of education. The more internships created for two-year students, the higher the likelihood they will land gainful employment and contribute to biotech companies.

The MLSC's *Internship Challenge*, which subsidizes the cost of paid internships at small-to-midsize life sciences companies for current college students, is a prime example of a program crafted to chip away at this deficit. This highly successful program has placed thousands of students in internships since its inception in 2009, with 10% going to community college students⁶. Since it only targets companies with less than 100 employees, community college students sometimes struggle to land placements, as many opportunities available to them are at larger biomanufacturing facilities. Only 8% of the roughly 250 annual public listings of internships were targeted toward community college students⁷.

2. **Raise awareness among hiring managers of the competency of associate degree candidates** – Many times we have heard from human resources professionals that the preference of their hiring managers is to consider, then hire, candidates with closely matching skills sets *and* the highest level of educational attainment. Our conclusion is that associate degree candidates' skills sets are a direct match to what is requested in technician openings. Despite such candidates having a lower degree, hiring managers should be made aware of their competencies, so as to enhance the prospects for employment for these candidates.
3. **Maintain relationships with community colleges** – Whether it is serving on an academic advisory board, offering internships, participating in career exploration, or advocating for additional funding for campus laboratory facilities (a significant issue for some campuses), companies stand to gain much by considering community colleges as sources for talented workers.

Following these recommendations should result in graduates from two-year schools being considered in greater numbers for technician openings. The general trend has been credential inflation, even as the learning outcomes of associate degree programs continually match what is requested by employers to fill these openings. Solving this disconnect involves awareness on the part of companies, as well as a willingness to extend opportunity to these skillful graduates.

⁶ <http://www.masslifesciences.com/wp-content/uploads/Internship-Challenge-Program-at-a-Glance.pdf>, page 2

⁷ http://snip.ly/uvdhj#https://www.massbioed.org/writable/files/jobTrends/2017_entry_level_report_final.pdf, page 30

Recommendations for Higher Education

While we recommend that companies change their current hiring behavior, community colleges must adapt as well to ensure their viability in this environment.

We recommend that biotechnology programs across the state follow these suggestions in order to best serve their student populations and thrive in this ever-changing environment:

- 1. Two-year biotechnology programs must clarify pathway to four-year schools –** As companies increase their reliance on bachelor’s degree holders to fill openings in technician roles, community colleges must recognize this preference and ensure that they best position their students for gainful employment post-graduation. Enhancements may include additional coursework in foundational courses in biology or augmenting existing courses to enable students to effectively attain and demonstrate problem solving skills, mathematics and critical thinking to analyze problems, propose solutions and make decisions. Articulation agreements should be designed to give students the option of entering the job market after two years, or transferring to a four-year institution while keeping most or all of their program credits. *Four-year institutions must be engaged partners in this process.* In doing so, they will ultimately be improving the alignment of their degree programs to industry needs.
- 2. Greater soft-skill integration is needed –** Biotechnology programs have continuously adapted to meet employer needs, specifically technical requirements for technician openings. However, our research indicates a shortfall of soft skills possessed by entry level candidates.⁸ Collaboration, communication, and writing skills are high on employers’ wish lists and can be acquired through carefully-crafted curricula, or by exposure to industry labs through internships.
- 3. Better alignment with industry –** This recommendation is dual-pronged. For one, biotechnology programs must monitor the latest labor market information regarding in-demand skills and emphasize these skills as they move forward. Secondly, colleges must build and maintain relationships with industry – whether through adjunct faculty, internship partnerships, or more robust academic advisory boards. MassBioEd previously proposed a supplemental, statewide advisory group for all two-year biotechnology programs as a way to stay abreast of industry happenings on a continual basis.

⁸ 91.3% deemed them “very important” in our 2016 Industry Survey.

The end goal, as always, is to best prepare students interested in biotechnology for success in the job market. Recognizing that countervailing market forces have put some associate degree holders at a disadvantage in recent years, community colleges should emphasize the transfer pathway to four-year schools with biotechnology majors or concentrations as the best way for students to acquire gainful employment.

This goal can be accomplished through modeling a pathway after the *MassTransfer* agreement and on-going interaction and collaboration with industry. Graduates are still able to land technician roles after two years of schooling, but the option of seamlessly transferring to a four-year program must be provided.

Recommendations for MassBioEd

MassBioEd sees itself as the facilitator of the recommendations put forth to companies and higher education. Uniquely situated between industry and the education & training communities, MassBioEd can convene these groups on a semi-regular basis to increase alignment through validation of industry-endorsed skills and advocate for increased consideration of community college graduates. It can also remain an advocate for continued state funding to support the construction of adequate lab facilities on community college campuses.

Most, if not all, biotechnology programs at community colleges maintain an academic advisory board, made up in part by industry representatives, to stay current on trends within the biopharma space. While many are populated with representatives from local biotech employers with whom they have developed fruitful relationships, some programs have difficulty getting adequate involvement, due to a dearth of local industry employers or scheduling and attrition issues with members.

MassBioEd proposes a *complementary, statewide academic advisory* board that will provide guidance to community college biotechnology programs twice per year. The goal of this body would be to convene all biotechnology programs and provide them with a supplemental group of industry professionals who, by representing a wider swath of the industry in Massachusetts, provide insight in substantive detail regarding the skills and hiring trends within the industry. Since skill requirements are *not* localized, it makes sense to create such a body to disseminate insights across all biotechnology programs in the Commonwealth. Such a board will ensure curriculum alignment with industry needs.

With buy-in from community colleges, MassBioEd will lead the effort to recruit members from the life sciences industry. Topics will be sourced from biotechnology program coordinators, so that vexing issues felt by these programs and their students are responded to in a timely manner.

Appendix A – MassBioEd Industry Endorsed Community College Programs

Berkshire Community College: Associate in Arts - Biotechnology Concentration

The biotechnology concentration offers skills and knowledge in medical, agricultural, environmental and chemical biotechnology, providing a strong foundation in subject matter, applications and methodology of the field. The curriculum prepares for employment as well as transfer into baccalaureate programs. Berkshire Community College's biotechnology program is closely linked to baccalaureate programs in the region and coordinated with academic institutions and biotechnological industry in the Commonwealth. The College's variety of science courses provides a solid foundation and allows students to add special focus. Individually tailored internships help prepare students for their chosen career.

Bunker Hill Community College: Associate in Science - Biotechnology Option

Bunker Hill Community College's Biotechnology program is an option within the Associate in Science Degree, Biological Sciences Program. The Biotechnology option provides students with a rigorous academic background that covers the concepts, methodology and techniques of cell biology, genetics, cell culture, molecular biology, microbiology, biochemistry and bioinformatics. Laboratory courses emphasize key subjects through inquiry-based investigations, experimental design, optimization of experimental procedures and data interpretation. Students use research quality laboratory equipment to master the laboratory techniques commonly used in biotechnology, cell culture, protein purification and recombinant DNA technology. Students receive extensive hands-on, industry-specific laboratory skills, including aseptic technique, media preparation, quality control/GMP, documentation and validation. The program highlights "job readiness" and reinforces the importance of communication, organization, teamwork and time management. Graduates of this program may transfer to four-year colleges and universities to pursue their studies in biotechnology or other life sciences. Students also qualify for entry-level positions in a wide range of biotechnology disciplines.

Middlesex Community College Biotechnology Program: Associate in Science - Biotechnology Technician Biotechnology Technician Certificate

The Middlesex CC Biotechnology Technician program provides students with the education and training in skills required for entry-level employment as technicians in manufacturing, research, media preparation, validation, quality control, documentation, and process operations. The program emphasizes hands-on practical lab work and includes on-site work experience at a local biotechnology company. In addition to biotechnology-specific science, students take classes in chemistry, biology, microbiology, English composition, mathematics for technology, computers for technology, and quality control/GMP. The day certificate program is full-time for ten months; the evening certificate is part-time for 16 months. Credits earned in the certificate program can be applied to the Biotechnology Technician associate degree.

Mt. Wachusett Community College: Associate of Science in Biotechnology/Biomanufacturing Biotechnology/Biomanufacturing Certificate

Biotechnology uses living organisms, usually microscopic, to manufacture drugs or other chemicals for the purpose of enhancing medical care or altering a process which improves living conditions for the general population. Careers in biotechnology/biomanufacturing will continue to advance. The biotechnology/biomanufacturing curriculum will offer excellent academic and skill development for anticipated positions in the biotechnology industry. This program is a sequential set of courses that requires preparation in science, chemistry, writing, mathematics, and biotech/biomanufacturing.

North Shore Community College: Associate in Arts: Biotechnology, Biotechnology Certificate

The **Biotechnology Transfer Option of Liberal Arts** is designed to provide a basic understanding of the principles of biotechnology, preparing the students for employment in entry-level positions in the industry. The program has been developed with the assistance and guidance of biotechnology firms throughout the area to assure that students acquire skills that can be applied in a wide variety of biotechnology industries, from manufacturing to research.

In addition, students receive hands-on training by carrying out specific and extensive biotechnological applications in the laboratory. The program is enhanced by combining the scientific aspects of biotechnology with a strong liberal arts foundation, thus providing transfer credits to four-year programs.

The Biotechnology Certificate is a one-year laboratory science intensive program which is designed to prepare students and retrain professionals for entry into the field of biotechnology. The curriculum provides both the theoretical and practical hands-on laboratory training needed for entry-level positions in the biotechnology industry.

Northern Essex Community College: Associate in Applied Science in Laboratory Science

The associate in applied science degree program in Laboratory Science is a two-year program designed to build the essential skills and knowledge required for entry-level employment and/or transfer to a four-year college or university. The curriculum allows students with minimal science and mathematics backgrounds to enter the program and develop the skills needed to successfully complete upper level science courses. The program focus areas are: Biotechnology, Environmental Sciences, and Chemical Analysis. A minimum of 60 credit hours are required for graduation. The first year of the program focuses on developing science, computer and math skills, in addition to training in good laboratory practices (GLP), and the “soft skills” deemed desirable by employers such as communication, teamwork, and analytical reasoning. The second year focuses on further developing analytical skills, training in the use of specialized equipment such as HPLC (high performance liquid chromatography) and GC (gas chromatography), and becoming familiar with cell culture techniques. In addition, in the second year, students spend time in externships to acquire work experience in the field. Externships might take place at: Biotechnology companies, universities, the Department of Environmental Protection and other state or wildlife agencies, crime labs, or biopharmaceutical companies. In addition, the program provides the foundation to pursue a career as a medical lab technician.

Quinsigamond Community College: Biotechnology Certificate

The Quinsigamond Community College Biotechnology Certificate Program provides students with an overview of the science of biotechnology as well as the technical skills required for entry-level employment in manufacturing or research. The program emphasizes hands-on technical skills and includes on-site instruction and technical skill application at a local biotechnology company. Additionally, students take courses in cell biology, molecular biology, chemistry, microbiology and computer science. The certificate is a part time program for 10 months. Credits earned in the certificate program can be applied to the General Studies -Biotechnology Option associates degree program.

Roxbury Community College: Associate in Science Degree in Biotechnology (AS) and Biotechnology/Bio-manufacturing Certificate (C)

The purpose of the Biotechnology Associate in Science Degree is two-fold. All students will obtain a broad-based science background focusing on the courses in the life and chemical sciences. In addition, students will develop specific laboratory skills applicable to procedures commonly performed in research hospitals and research industrial laboratories all over the United States. Students successfully completing the programs

will be able to transfer to a four-year university to further their studies in the sciences at the baccalaureate level or, if they prefer, join the workforce as entry-level research or laboratory assistants. The Biotechnology/Bio-manufacturing certificate program is designed for the student who wishes to learn about the field of biotechnology or who may already have a scientific background but desires to study the details of this burgeoning field in the hope of gaining an entry level position at one of the many biotechnology companies, hospitals, clinics, or laboratories in the greater Boston area. Research assistants, lab technicians, manufacturing technicians, quality control technicians, documentation coordinator, and instrumentation calibration are examples of such careers.

Springfield Technical Community College: Associate of Science in Biotechnology

Springfield Technical Community College (STCC) offers a Biotechnology Associate Degree Program with two options with curriculum designed in concert with academic partners and local industry. Students completing the transfer option of the AS degree will transfer to a four-year program to complete a degree in any of the biological sciences. The career option concentrates on the methodology and techniques of microbiology, biochemistry, cell biology, genetics, microbial testing and cell culture. Graduates completing the career option are qualified to secure employment as a laboratory assistant, laboratory technician, or manufacturing technician. Hands-on lab work emphasizes important skills such as data analysis, laboratory calculations, sterile technique, proper processing of materials, and proper record keeping and documentation.

Industry Endorsements are based on attainment of these Core Competencies:

I. Laboratory Practices and Workplace Functions

1. Communicate using scientific vocabulary common to the biotechnology industry.
2. Apply scientific knowledge and technical expertise to common biotechnological laboratory techniques.
3. Follow safety procedures and use laboratory equipment properly.
4. Follow standard operating procedure (SOP) protocol.
5. Follow Good Manufacturing Practices (GMP), including complete and proper documentation of all procedures.
6. Maintain a clean environment and equipment.
7. Use computers to gather and process data and use computerized instrumentation.
8. Apply problem solving skills, mathematics and critical thinking to analyze problems, propose solutions and make decisions.
9. Exhibit appropriate workplace behaviors, including teamwork, time management, effective communication (written and verbal) and presentation skills, and integrity in work.

II. Laboratory Techniques (Biomanufacturing and Research and Development)

1. General Laboratory Techniques

- Follow Good Manufacturing Practices (GMP).
- Validate equipment and processes routinely.
- Assess temperatures accurately.
- Use proper Microscopy Techniques.
- Use a spectrophotometer to measure light absorbance of a solution.
- Perform chromatographic techniques (gel filtration, ion exchange, etc).
- Use Aseptic Technique.

- Homogenize cells and perform cell fractionation by centrifugation and identify components of sub-cellular fractions.

2. Solution, Buffer and Media Prep

- Prepare percent, molar, and molal solutions correctly
- Weigh materials accurately.
- Measure volumes accurately.
- Dilute solutions for use in different assays as calculated.
- Obtain the correct pH of a solution.
- Use proper micro-pipetting techniques.
- Prepare sterile media for animal cell culture by sterile filtration.
- Maintain biological stock cultures.

3. Mammalian, plant or insect Cell Culture (Tissue)

- Culture cells
- Perform sub-culturing of eukaryotic cell cultures from original flask of cells.
- Enumerate the number of cells and viability in a solution.
- Maintain cultures of mammalian, plant or insect cells with sterile techniques.
- Using a bioreactor, grow cells in suspension.
- Preserve cells

4. Microbiology Techniques

- Prepare sterile agar and broth media for growing microorganisms
- Isolate and grow pure cultures of bacteria.
- Using a key, identify bacteria based on growth pattern, morphology and differential staining.
- Prepare plasmids from bacterial cells.
- Transform bacterial cells and calculates the transformation efficiency.
- Determine growth rate of bacteria or yeast by direct and indirect methods.

5. Protein Chemistry

- Harvest and purify protein products using precipitation, filtration and chromatographic techniques.
- Characterize and quantify protein products by spectrophotometry and electrophoresis.
- Use immunologic techniques including ELISA to detect proteins and/or other antigens.
- Perform Western blot transfers.
- Perform SDS/PAGE electrophoresis.

6. Nucleic Acid Chemistry

- Harvest DNA and characterize it by agarose gel electrophoresis.
- Perform polymerase chain reactions (PCR).
- Perform Southern blot transfers

Appendix B: Participants in GPSTEM discussions on industry alignment and skills requirements

GPSTEM Community College Participants

Shelly Armstrong, Berkshire CC
Gina Foley, Berkshire CC
Beth Lapiere, Berkshire CC
Fayette Reynolds, Berkshire CC
Katie Lefebve, Bristol CC
Mary Rapien, Bristol CC
Paul Kasili, Bunker Hill CC
Laurie Kelly McCorry, Bunker Hill CC
Emily Chambers, GPSTEM
Kathleen Kirby, GPSTEM
Phara Boyer, Mass Bay CC
Patricia Eisenhauer, Mass Bay CC
Bonnie Stevenson, Mass Bay CC
Elizabeth Watson, Mass Bay CC
Doug Brown, Massasoit CC
Silvia Coviello, Massasoit CC
Jean Higginson, Massasoit CC
Mary Anne Dean, Middlesex CC
Paul Patev, Middlesex CC

Patricia Richard, Middlesex CC
Kathleen Sweeney, Middlesex CC
Lara Dowland, Mount Wachusett CC
Young Bae Kim, North Shore CC
Laura Rubin, North Shore CC
Korynn Stoyanoff, North Shore CC
Michael Cross, Northern Essex CC
Carolyn Knoepfler, Northern Essex CC
Brienne McDonald, Northern Essex CC
Brienne McDonough, Northern Essex CC
Benjamin Benton, Quinsigamond CC
Leslie Horton, Quinsigamond CC
Carol King, Quinsigamond CC
Marissa Gaskin, Roxbury CC
Kristin Laird, Roxbury CC
Stacy Olson, Roxbury CC
Kimberly Stieglitz, Roxbury CC
Nikolaus Sucher, Roxbury CC

Industry and Other Participants

Gale Cohen, Bristol-Myers Squibb
Judith Taylor, Commonwealth Corporation
Sarah Larson, Foundation Medicine
Ryan MacLean, GE Healthcare Life Sciences
Ryan Mudawar, Mass Life Sciences Center
Peter Abair, MassBioEd Foundation
Mark Bruso, MassBioEd Foundation
Lance Hartford, MassBioEd Foundation
Paula O'Donnell, Sanofi Genzyme
Aron Clarke, Shire Pharmaceuticals

PAGE INTENTIONALLY LEFT BLANK
