2018
JOB
TRENDS
FORECAST

Life Sciences Industry Massachusetts

MassBioEd

ENGAGING EDUCATORS, INSPIRING STUDENTS, GUIDING THE LIFE SCIENCES WORKFORCE

About the Annual Report
MassBioEd produces an Annual Forecast on life sciences job trends each spring. The report provides a broad overview of supply-demand dynamics, pay, skill demand, employer sentiment, and occupational projections within the life sciences industry in Massachusetts.

About the Digest of Biotech Jobs Trends in Massachusetts
The Annual Forecast is a part of MassBioEd's ongoing Digest of Biotech Jobs Trends in Massachusetts, which also includes Briefs, a Medical Device Snapshot, and the Industry Skills Census. The Briefs present basic data and analysis on aspects of biopharma industry job trends.

The objectives in publishing the Briefs is to provide basic information about job listings trends, skills required of candidates, and prevalence of degree requirements for high trending occupations. The Annual Forecast is intended to provide greater insight based on additional study in these areas.

About the MassBioEd Foundation
MassBioEd's 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.

What Do We Mean By "Life Sciences?"
When we use the term "life sciences," we mean it to be used interchangeably with "biopharmaceutical." It excludes medical device organizations. For a full definition, please reference the Appendix.

For more MassBioEd job trends analysis, visit MassBioEd.org/job_trends.

Report At-A-Glance

The first section provides a broad overview of the job listings data, which is cut and synthesized by occupation, job type, locale, in-demand skills by degree level, employers, and educational minimums.

This information is presented against historical data, illuminating broad-based shifts occurring in the job market in the life sciences industry in Massachusetts.

This section contains 6-year projections for 350+ individual occupations, industry sectors, and occupational groups, in the hopes that decision-makers in industry, government, and academia may look forward with a reasonable expectation of what the job market landscape will look like when their decisions today are bearing fruit.

This section highlights graduation data from relevant biotech-related academic programs in order to spotlight occupations and skill-sets that potentially may see deficits in the not-too-distant future. Also, we look at supply gaps happening today and their outlook for the future.

Job Openings requiring a minimum of a Ph.D. have grown the fastest in recent years and are essential drivers of innovation and growth in the industry. This section breaks out these positions into Clinical Research and Drug Development roles to look at distinctions between skills needs and into the pipeline of future researchers.

In this section, increases in base pay for industry workers between Q2 2017 and Q2 2018 are examined. Which jobs are experiencing the fastest growth in pay? What do rapid changes in pay at different levels tell us about the workforce pipeline?

The final section looks at the results from our 3nd Annual Industry Survey, which produces previously unavailable data points on employer sentiment. Topics such as time-to-fill for openings, expected expansions by functional area, ranked importance of skills, and skill deficits are all covered.

Executive Summary

After another year of healthy employment growth, in which the industry crossed 70,000 employees for the first time, MassBioEd sees no signs of the life sciences industry slowing down in 2018. Since 2014, the life sciences industry in Massachusetts has grown at approximately double the rate of the state and U.S. economy. Industry job openings posted online exceeded 27,700 in 2017, second only to 2016.

In our annual Industry Employer Survey, 83% of respondents indicated that their organizations planned to expand workforce in the next year, in line with results from 2016 and 2017.

Looking ahead, MassBioEd projects employment growth in the industry to reach almost 12,000 new workers between May 2017 and May 2023, a 6-year growth rate of 17.4%. While impressive, it is somewhat below the six preceding years, during which the industry grew its workforce by 20.5%.

Amid such high growth, some impediments have arisen. Nearly two-thirds of those polled stated that the average time it takes to fill an opening at their organizations exceeded 2 ½ months, with 30% reporting that the average time to fill openings was longer than 3 months. The economy-wide average is about 1 month.

This slow hiring is compounded by the fact that the four areas employers report the most difficulty in onboarding qualified candidates – Research & Development, Regulatory Affairs, Quality, and Clinical Research – are also the top four functional areas in which organizations plan to expand in 2018.

To an extent, Massachusetts colleges and universities have responded to increased industry needs, as conferrals increased by at least 50% at every degree level except Ph.Ds., which increased by 16%. However, the pace of growth since 2010 in entry level openings has generally outpaced the growth of graduates from industry-related programs. This problem is especially acute at the associate and Ph.D. levels, where the difference is significant.

Finally, about 30% of life sciences organizations reported having formal diversity initiatives for either gender or race/ethnicity at either the contributor and management levels. Only 17% reported having one at the board level. A full 60% of respondents indicated a lack of a formal diversity initiative at their respective organizations.

In 2017, the total amount of job listings was **27,700,** the second-highest number ever, though 3% less than 2016.

In 2017, for the first time in history, employment in the life sciences in MA passed **70,000.**

11,976 new jobs are forecast to be created between May 2017 – May 2023.

21.5% – Projected growth rate between 2017 and 2023 at Biotechnology R&D organizations.

10.1% – Annual growth in median base pay in senior STEM/ Technical positions in 2017.

83% of respondents reported their organizations plan to expand their workforce in the next year.
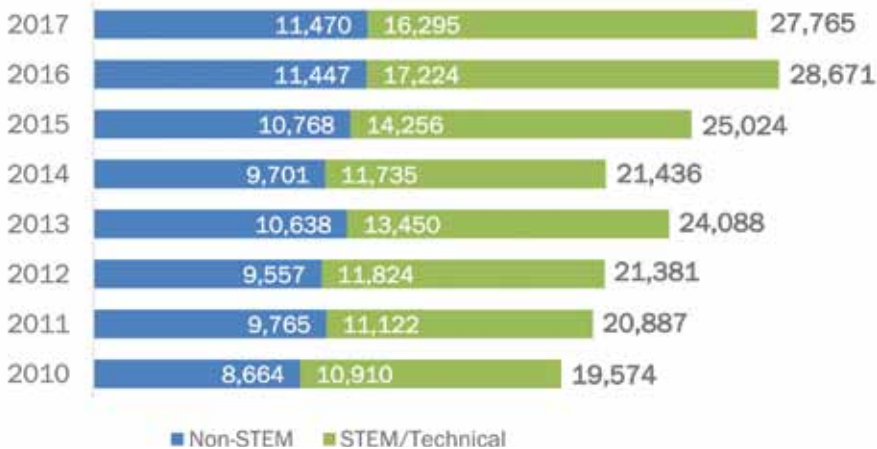
65% of organizations reported that the average time to fill openings was longer than 2 ½ months. The average US rate is 1 month.

60% of life sciences companies have no formal diversity initiatives and only 17% have such initiatives at the Board level.

To view or download the complete 2018 MassBioEd Annual Forecast please visit

MassBioEd.org/job_trends

Job Demand

Life Sciences Industry Job Listings By Year

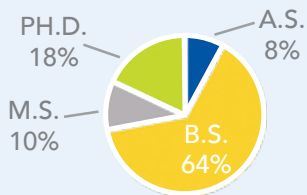| Year	Non-STEM	STEM/Technical	Total
2017	11,470	16,295	27,765
2016	11,447	17,224	28,671
2015	10,768	14,256	25,024
2014	9,701	11,735	21,436
2013	10,638	13,450	24,088
2012	9,557	11,824	21,381
2011	9,765	11,122	20,887
2010	8,664	10,910	19,574

■ Non-STEM   ■ STEM/Technical

2017 witnessed a decline (-3%) in industry job listings for the first time since 2014. The decline in job listings was limited to STEM/Technical (see Appendix for definition) positions (-5%), as non-technical listings rose slightly.

In total, there were nearly 28,000 job openings listed in 2017. This is the second-highest since 2010.

Education and Experience In STEM/Technical Openings, 2017

ALL STEM JOBS

PH.D. 18%
M.S. 10%
A.S. 8%
B.S. 64%

ENTRY LEVEL STEM JOBS

PH.D. 11%
M.S. 7%
A.S. 13%
B.S. 69%
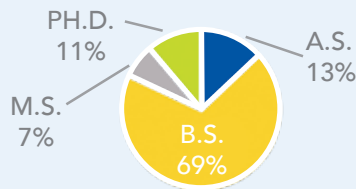
EXPERIENCE, ALL STEM JOBS

<2 yrs 33%
9+ yrs 12%
6-8 yrs 16%
3-5 yrs 39%
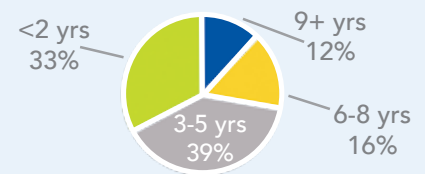
Annual Growth, Raw Total & Adjusted Total, Life Sciences Industry

Year	Total Listings	Adjusted Listings
2011	7%	-3%
2012	2%	8%
2013	13%	-25%
2014	-11%	-13%
2015	17%	20%
2016	15%	-2%
2017	-3%	-9%

■ TOTAL LISTINGS   ■ ADJUSTED LISTINGS

When accounting for factors that may be artificially influencing this total[1], the adjusted growth numbers suggest that in most years the underlying growth was lower than first appeared, which can be attributed to better detection capabilities of the Burning Glass software. Both 2016 and 2017 saw negative growth in comparison to the year prior.

[1] After accounting for growth in detection capabilities of Burning Glass Labor Insight software, as well as employer online job listing behavior, we arrive at a measure for adjusted growth.

Monthly Life Sciences Industry Job Listings, 2016 vs. 2017
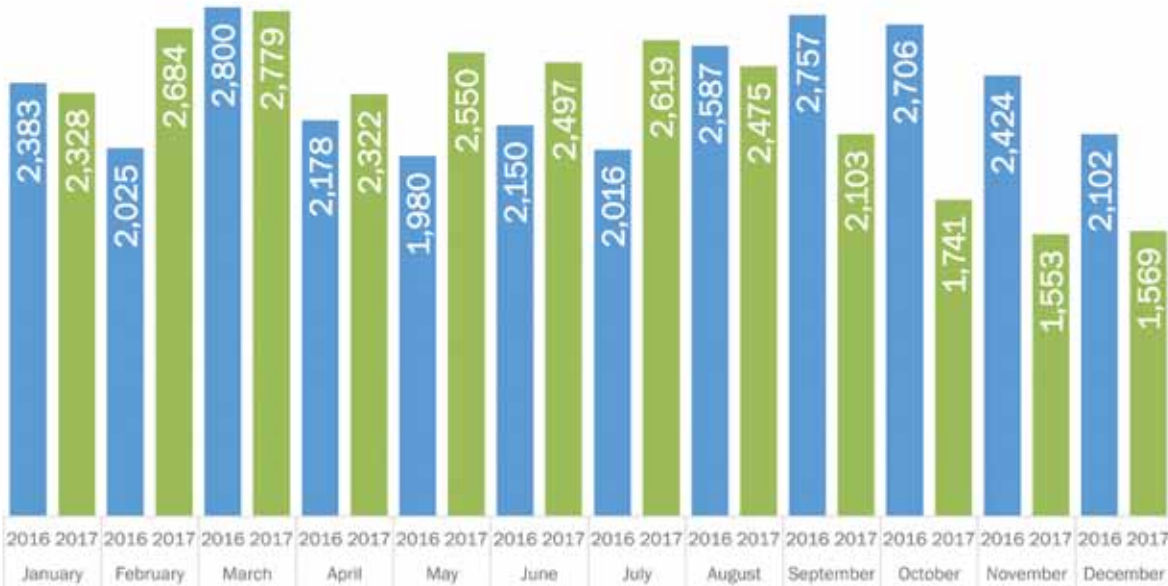
From January through July 2017, hiring either matched or significantly outperformed the industry's output in the prior year.

From August 2017 on, the trend reversed. Industry hiring went from 15% year-over-year growth in the first 7 months to a decline of 25% in the final 5 months of 2017. This is a marked decline in the rate of growth in hiring which can be potentially attributed to several factors, including slower expansion in new jobs, lower rates of job separations, and/or worker turnover. While only 5 months in, a prolonged trend of slower hiring rates can be worrisome – it indicates that companies are not increasing their headcount, and that less workers are voluntarily quitting and transferring to "better"

positions. This indicates low worker sentiment of their job market prospects.

What was driving this downward trend? Hiring among Pharmaceutical Manufacturers dropped 33% from August through December 2017, accounting for 58% of the overall decline in job listings.

STEM/Technical job openings, regardless of life sciences sector, also dropped by over 25%, year-over-year, from August through December 2017, accounting for 27% of the total decline. Together with Pharmaceutical Manufacturers, they accounted for over 85% of the total decline during this period.

Annual Employment Growth Since 2008

In the past decade, employment growth in the life sciences industry (see Appendix for definition) in Massachusetts has far surpassed the growth rate of the whole economy.

In recent years, life sciences companies have been adding to their workforce at double the rate of the economy, which typically grows at 1.5% to 2% annually, excluding recessionary periods.

Since 2014, the industry has averaged growth at a robust rate of 4% per annum, adding nearly 10,000 to its payrolls.

Industry Employment by Sector, 2016 - Present

			332	2,218		
Sep-17	10,106	41,483		2,347	9,373	4,704
Aug-17	10,244	41,844		2,148	9,447	4,670
Jul-17	10,237	41,903		2,173	9,452	4,682
Jun-17	10,217	41,391		2,184	9,429	4,642
May-17	9,967	40,263		2,297	9,320	4,613
Apr-17	9,951	39,944		2,362	9,314	4,627
Mar-17	9,990	39,695		2,336	9,314	4,631
Feb-17	9,855	39,545		2,329	9,306	4,662
Jan-17	9,934	39,099		2,167	9,341	4,676
Dec-16	10,192	41,084		2,357	9,288	4,491
Nov-16	10,113	40,364		2,357	9,288	4,465
Oct-16	10,054	40,155		2,357	9,288	4,485
Sep-16	10,460	39,220		2,296	9,297	4,467
Aug-16	10,437	39,720		2,097	9,316	4,488
Jul-16	10,450	39,792		2,124	9,329	4,495
Jun-16	10,507	38,954		2,109	9,241	4,526
May-16	10,269	38,269		2,324	9,147	4,526
Apr-16	10,188	38,063		2,377	9,120	4,517
Mar-16	10,169	37,733		2,364	9,107	4,480
Feb-16	10,140	37,477		2,346	9,080	4,441
Jan-16	10,094	37,319		2,157	9,095	4,413

■ Pharma ■ Biotech R&D ▧ Testing Labs ■ Lab Instr. Manuf. ■ Colleges ■ Hospitals ■ Med. Testing Labs

Full-time employment within the life sciences industry (excl. Medical Device Manufacturing) in Massachusetts is located predominantly at Biotech Research & Development facilities, which contain nearly 60% of all industry employment. In the past 2 years, approximately 80% industry growth has been at those same companies. Only about 1,000 of the 5,000 new workers have been in other sectors. Other large sectors, such as Pharmaceutical Manufacturers and Hospitals, have scarcely grown in that period.

Over a longer span of time—stretching back to September 2013—we see that Biotech R&D organizations have been the main source of growth in the industry. Only Biotech R&D and the Medical Testing Laboratories sector have outpaced the growth of the industry in the last 4 years for which data is available (see table at right).

Pharmaceutical Manufacturers accounted for 6% of all new industry jobs since September 2013. The sector grew 8% in that time.

Growth Rate, Last Four Years

Industry — 20%	(+11,495)
Biotech R&D —27%	(+8,927)
Med. Testing labs — 24%	(+917)
Pharma Manufacturers — 8%	(+713)
Hospitals — 4%	(+482)
Lab. Instrument Man. — 2%	(+275)
Universities/Collegs — 1%	(+151)
Testing Labs — 0.3%	(+131)

Top Non-STEM/Technical Occupations, by Job Listings, 2017

Administrative Assistant, 493	Administrative Manager, 285	Bus. / Management Analyst, 155
Healthcare Administrator, 468	HR/Labor Relations Specialists, 222	Executive Assistant, 148
B.D./ Sales Manager, 395	General Manager, 173	Customer Service Representative, 139
Marketing Manager, 369	Financial Manager, 169	Attorney, 138

Top STEM/Technical Occupations, by Job Listings, 2017

Rank, All 2017	Occupation	Year		Change	
		2016	2017	Total	Percent
1	Medical Scientist	2,304	2,410	106	5%
2	Researcher / Research Associate	2,091	1,755	-336	-16%
3	Clinical Research Coordinator / Manager	952	1,072	120	13%
4	Biologist	1,039	807	-232	-22%
5	Chemist	771	754	-17	-2%
6	Chemical / Process Engineer	638	593	-45	-7%
7	Biological Technician	500	513	13	3%
10	Quality Control Analyst	453	447	-6	-1%
11	Project Manager	431	436	5	1%
12	Medical Director	405	431	26	6%
13	Biostatistician	445	413	-32	-7%
15	Software Developer / Engineer	389	383	-6	-2%
17	Laboratory Technician	486	361	-125	-26%
18	Compliance Manager	326	321	-5	-2%
19	Science Research Manager	344	318	-26	-8%
21	Quality Control Systems Manager	268	268	0	0%
22	Sales Representative (Technical)	295	250	-45	-15%
23	Program Manager	223	250	27	12%
24	Operations Manager / Supervisor	269	236	-33	-12%
26	Laboratory Technologist	168	199	31	18%
27	Product Manager	189	182	-7	-4%
28	Chemical Technician	228	173	-55	-24%
29	Regulatory Affairs Specialist	174	173	-1	-1%
31	Mechanical Engineer	187	172	-15	-8%
33	Technical Writer	156	165	9	6%
34	Validation Engineer	193	161	-32	-17%
36	Computer Programmer	138	154	16	12%
38	Production Worker	121	143	22	18%
43	Manufacturing / Production Technician	169	133	-36	-21%
45	Engineering Manager	116	120	4	3%
46	Systems Analyst	99	120	21	21%
47	Statistician	190	117	-73	-38%
49	Quality Inspector / Technician	162	112	-50	-31%
50	Data / Data Mining Analyst	98	109	11	11%
51	Health Technician / Technologist (Other)	100	107	7	7%
54	Biochemist	103	102	-1	-1%
58	Clinical Data Systems Specialist / Manager	66	94	28	42%
60	Microbiologist	85	92	7	8%
62	Production Plant Manager	134	90	-43	-32%
63	Production Supervisor	122	88	-33	-27%
64	Industrial Engineer	76	86	10	13%
65	Data Scientist	85	80	-5	-6%

STEM/Technical occupations encompass any job or position within the industry that requires a STEM degree or in its duties and task requires a basic foundational knowledge of a STEM or technical area.

As is the case in most years, the top STEM/Technical occupations are those associated with conducting drug development research in a laboratory. **Medical Scientists, Researcher/ Research Associates, Biologists, and Chemists** all are heavily associated with this kind of work and require the incumbent to possess a scientific degree.

Many of the other top jobs were in clinical research, data-related fields, technical sales, or engineering, as shown at right.

Fastest Growing STEM/Technical Occupations, by Job Listings, 2017

Rank, All 2017	Occupation	Year		Change	
		2016	2017	Total	Percent
98	Epidemiologist	23	47	24	104%
58	Clinical Data Systems Specialist / Manager	66	94	28	42%
26	Laboratory Technologist	168	199	31	18%
38	Production Worker	121	143	22	18%
64	Industrial Engineer	76	86	10	13%
3	Clinical Research Coordinator / Manager	952	1,072	120	13%
23	Program Manager	223	250	27	12%
36	Computer Programmer	138	154	16	12%
50	Data / Data Mining Analyst	98	109	11	11%
60	Microbiologist	85	92	7	8%
104	Software QA Engineer / Tester	39	42	3	8%
51	Health Technician / Technologist (Other)	100	107	7	7%
12	Medical Director	405	431	26	6%
33	Technical Writer	156	165	9	6%
1	Medical Scientist	2,304	2,410	106	5%
45	Engineering Manager	116	120	4	3%
7	Biological Technician	500	513	13	3%
11	Project Manager	431	436	5	1%
21	Quality Control Systems Manager	268	268	0	0%

As industry STEM/Technical job listings declined by 5% in 2017, not many occupations saw significant increases.

Clinical Data Systems Managers and Clinical Research Coordinators saw large increases in openings. Other fast-growing positions include **Epidemiologists** and **Lab Technologists**.

Fastest Declining STEM/Technical Occupations, by Job Listings, 2017

Rank, All 2017	Occupation	Year		Change	
		2016	2017	Total	Percent
97	Compliance Officer / Analyst	90	48	-42	-47%
47	Statistician	190	117	-73	-38%
82	Manufacturing Engineer	98	62	-36	-37%
62	Production Plant Manager	134	90	-43	-32%
49	Quality Inspector / Technician	162	112	-50	-31%
63	Production Supervisor	122	88	-33	-27%
117	Computer Scientist	46	34	-12	-26%
17	Laboratory Technician	486	361	-125	-26%
92	Electrical Engineer	68	51	-17	-25%
28	Chemical Technician	228	173	-55	-24%
89	General Engineering Technician / Technologist	68	52	-16	-24%
4	Biologist	1,039	807	-232	-22%
34	Validation Engineer	193	161	-32	-17%
2	Researcher / Research Associate	2,091	1,755	-336	-16%
24	Operations Manager / Supervisor	269	236	-33	-12%
31	Mechanical Engineer	187	172	-15	-8%
19	Science Research Manager	344	318	-26	-8%
13	Biostatistician	445	413	-32	-7%

Job openings for **Biologists, Research Associates, and Lab Technicians** saw year-over-year declines of 16% - 26%. The largest percentage decline belonged to **Compliance Officers, where listings fell by nearly 50%.**

Top Life Sciences Organizations by Job Listings, 2017

2017 Rank	Industry For-Profits Organization	Total Listings 2016	2017	Annual Chg. Total	Pct.
1	Takeda	1,129	1,512	383	25%
2	Pfizer	1,281	1,430	149	10%
4	Biogen	1,691	1,127	-564	-50%
6	Novartis	572	693	121	17%
7	Merck KGaA*	549	634	85	13%
8	Sanofi Genzyme	2,391	611	-1780	-291%
9	Johnson & Johnson	294	582	288	49%
11	Shire	612	460	-152	-33%
13	Amgen	210	343	133	39%
14	Merck & Company	379	342	-37	-11%
16	bluebird bio	124	269	145	54%
17	Cardinal Health	205	254	49	19%
18	EMD Serono	71	250	179	72%
19	Ironwood Pharmaceuticals	200	244	44	18%
21	PerkinElmer	211	218	7	3%
22	AbbVie	164	210	46	22%
23	AstraZeneca	139	208	69	33%
24	Bristol-Myers Squibb	363	204	-159	-78%
26	Alkermes	35	199	164	82%
27	Moderna Therapeutics	212	196	-16	-8%
28	Foundation Medicine	174	179	5	3%
29	Parexel	197	175	-22	-13%
31	SAGE Therapeutics	171	158	-12	-8%
32	Alexion Pharmaceuticals	38	157	119	76%
33	Abbott Laboratories	11	155	144	93%
35	Sarepta Therapeutics	76	144	69	48%
36	MilliporeSigma	59	143	84	59%
39	Sunovion	203	139	-64	-46%
40	Thermo Fisher Scientific	117	121	5	4%
41	Astellas Pharma	69	115	46	40%
42	Danaher Corporation	173	111	-62	-56%
43	Raytheon	113	102	-11	-11%
45	Lantheus Medical Imaging	65	96	31	32%
46	Intellia Therapeutics	32	95	63	66%
47	Vertex Pharmaceuticals	634	93	-541	-582%
49	QuintilesIMS	99	92	-7	-8%
51	Celgene Corporation	139	91	-48	-53%
52	Instrumentation Lab	82	87	5	6%
53	Amag Pharmaceuticals	1	83	82	99%
54	United Therapeutics	3	78	75	96%
56	Nova Biomedical	48	67	19	29%
57	Agios Pharmaceuticals	55	65	10	15%

Top Hospitals, Universities/Colleges and Non-Profits by Job Listings Overall Rank, 2017

| Rank, Organization	Listings	Change
3. Partners Healthcare	1,407	(+121)
5. MGH	1,032	(+119)
10. Dana Farber C.I.	530	(+143)
12 Harvard University	427	(-162)
16. Boston University	328	(+2)
20. Boston Children's	227	(-105)
30. Beth Israel Medical	166	(+59)
34. MIT	150	(+54)
38. UMass Medical	139	(-83)
48. Boston Med. Center	92	(N/A)
50. Tufts University	91	(-29)
55. Tufts Med. Center	69	(+31)
65. UMass Amherst	56	(+47)

*Merck KGaA (#7) is the parent company of EMD Serono (#18) and MilliporeSigma (#36). Listings for both of those organizations may be underestimated, as Merck KGaA may be listing job openings on their behalf.

Regional Breakdown

ALL JOBS	2015	2016	2017
West	404	328	397
Central	1,429	1,647	1,352
Metrowest	3,600	4,693	4,353
North	1,908	2,734	2,860
Boston/Cambridge	14,613	15,759	14,686
South & Cape	1,108	1,032	1,400

Percentage of Statewide Industry Job Listings, 2015-2017
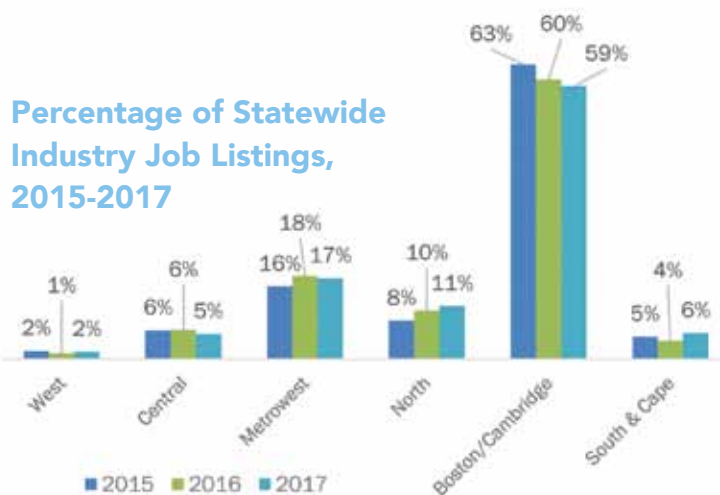
Out of the six regions throughout Massachusetts, only the **North Shore** has grown its share of statewide industry job listings by more than a percentage point since 2015, from 8% to 11%.

Boston/Cambridge remains the epicenter of the industry in Massachusetts, with ~60% of industry job listings in 2017 (64% of STEM listings).

Consistently, 40% of the industry in Massachusetts was located outside of Boston/Cambridge. **Metrowest** saw the second highest growth, from 15.6% of all listings in 2015 to 17.4% in 2017; it is also had the second highest total of job openings in each year by some margin.

Central Massachusetts – with job listings centered almost exclusively around Worcester and its surrounding towns – saw its share of job listings decrease between 2015 and 2017, along with its total job listings.

South & Cape and **Western Massachusetts** were the smallest regions by both employment totals and job listings from 2015 - 2017. Together, they accounted for only ~4% of STEM/Technical listings in each year.

Top Regional Employers by STEM Job Listings, 2017

Boston/Cambridge	Listings	Metrowest	Listings
Partners Healthcare	1,056	Shire	170
Massachusetts General Hospital	850	Sanofi Genzyme	133
Takeda Pharmaceuticals	674	AstraZeneca	102
Biogen	526	Alkermes	87
Pfizer	478	Astellas Pharma	85
Novartis	377	Biogen	61
Harvard University	291	Partners Healthcare	59
Dana Farber Cancer Institute	283	Cardinal Health	55
Boston University	279	Sunovion	54
Merck & Company	230	Agenus	47
Amgen	219	PerkinElmer	45
bluebird bio	186	Quest Diagnostics	44
North	**Listings**	**South & Cape**	**Listings**
Pfizer	374	Johnson & Johnson	133
Merck KGaA	209	Merck KGaA	26
EMD Serono	128	EMD Serono	17
Abbott Laboratories	91	Cardinal Health	14
Lantheus Medical Imaging	41	Cape Cod Healthcare	11
Cell Signaling Technology	35	Oxford Immunotec	9
MilliporeSigma	31	Corbus Pharmaceuticals	7
Lahey Clinic	27	Merck & Company	7
New England Biolabs	23	Moderna Therapeutics	6
Thermo Fisher Scientific	22	Integra Lifesciences	5
Sarepta Therapeutics	20	Marine Biological Laboratory	5
Albany Molecular Research	19	Sanofi Genzyme	5
Central	**Listings**	**West**	**Listings**
AbbVie	125	UMass Amherst	35
UMass Medical School	115	Baystate Health	34
Bristol-Myers Squibb	102	Smith College	10
Pfizer	97	Cardinal Health, Inc.	8
Danaher Corporation	52	AstraZeneca	6
Sanofi Genzyme	30	Sisters Of Providence Health Systems	5
UMass Memorial Healthcare	29	Abbott Laboratories	4
IDEXX Laboratories, Inc.	27	Avista Pharma	4
Laboratory Corporation of America	22	Astellas Pharma	3
Charles River Company	11	Berkshire Medical Center	3
Karl Storz	10	Eurofins Scientific	3
Alpha Analytical	8	Johnson & Johnson	3

Top Regional
STEM Job Listings, 2017

Boston/Cambridge	Listings	Metrowest	Listings
Medical Scientist	1,744	Medical Scientist	297
Researcher / Research Associate	1207	Researcher / Research Associate	234
Clinical Research Coordinator / Manager	762	Chemist	128
Biologist	558	Quality Control Analyst	115
Biological Technician	383	Chemical / Process Engineer	113
Chemist	369	Biologist	95
Healthcare Administrator	314	Biological Technician	83
Biostatistician	309	Product Manager	78
Chemical / Process Engineer	277	Clinical Research Coordinator / Manager	76
Medical Director	267	Healthcare Administrator	66
Software Developer / Engineer	246	Software Developer / Engineer	59
Science Research Manager	195	Technical Writer	59
North	**Listings**	**South & Cape**	**Listings**
Researcher / Research Associate	171	Medical Scientist	36
Chemist	139	Laboratory Technician	32
Chemical / Process Engineer	122	Clinical Research Coordinator / Manager	29
Medical Scientist	102	Validation Engineer	28
Biologist	92	Industrial Engineer	27
Quality Control Analyst	82	Quality Control Analyst	26
Production Worker	65	Manufacturing Engineer	24
Manufacturing / Production Technician	54	Chemist	22
Validation Engineer	53	Researcher / Research Associate	20
Laboratory Technician	51	Science Research Manager	19
Microbiologist	39	Mechanical Engineer	19
Software Developer / Engineer	39	Software Developer / Engineer	16
Central	**Listings**	**West**	**Listings**
Researcher / Research Associate	72	Medical Scientist	30
Chemist	72	Sales Representative	21
Chemical / Process Engineer	65	Researcher / Research Associate	15
Biologist	58	Laboratory Technician	12
Clinical Research Coordinator / Manager	57	Medical / Pharmaceutical Sales Representative	10
Medical Scientist	48	Microbiologist	8
Laboratory Technician	41	Chemist	8
Quality Control Analyst	40	Clinical Research Coordinator / Manager	7
Manufacturing / Production Technician	30	Health Technician / Technologist (Other)	4
Laboratory Technologist	29	Biological Technician	3
Mechanical Engineer	28	Healthcare Administrator	3
Engineering Manager	17	Engineering Manager	3

Degree Requirements
STEM Openings, 2017

	West	Central	Metrowest	North	Boston/Cambridge	South & Cape
Phd	16%	8%	16%	9%	22%	7%
MS	4%	8%	10%	9%	11%	8%
BS	64%	70%	65%	66%	62%	78%
AS/Under	15%	14%	9%	16%	5%	8%

■ AS/Under ■ BS ■ MS ■ Phd
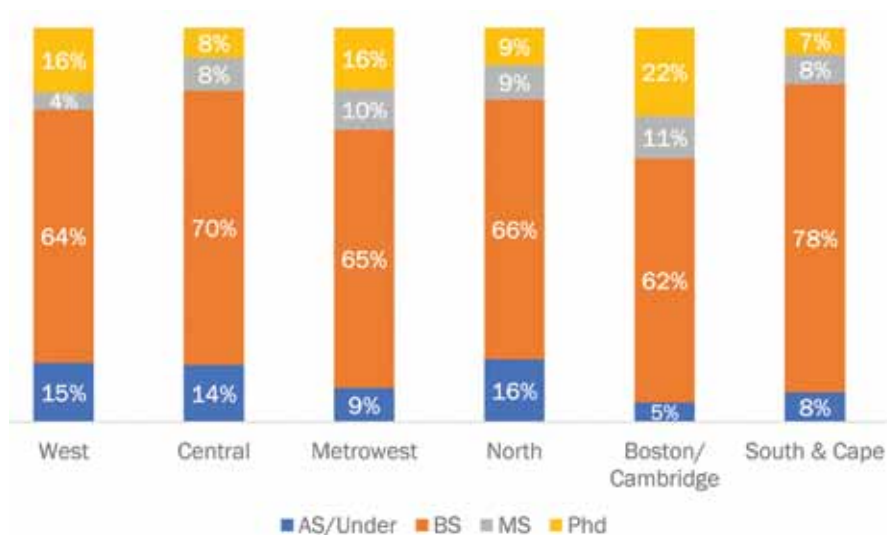
Boston/Cambridge listings required the highest levels of education, with one-third of all openings requiring a graduate degree.

Central and **North** regions had similar requirements across their open positions in 2017.

West, Central, and **North** all had the highest proportions of jobs requiring an associate degree or below, at approximately 15%.

Skill Demand by Degree Level

Demand by employers for skills in STEM/Technical positions is presented by both degree level (associate & under, bachelor's, master's, and Ph.D.), as well as experience level (entry level = 0 to 2 years' experience; midlevel = 3 to 8 years' experience) between 2014 and 2017. This section examines underlying shifts in the demand for broad skillsets for recent graduates by peering into entry level job listings data by degree minimum, as well as looking at what employers expect employees to possess as they advance throughout their careers.

We look at skill clusters, or broad groupings of similar specialized skills and techniques, as well as professional skills – most often referred to as "soft" skills. In doing so, we hope to discern which skills are broadly increasing in demand and importance for life sciences companies looking to hire, as well as highlight pockets of positions that may be experiencing abnormal increases or decreases in demand for specific skills.

Throughout 2018, MassBioEd will be releasing a series of in-depth reports on this subject, linking specific positions with academic program areas with the goal of providing granular data for program directors and students alike. The series of reports will also project out the skill needs to 2023.

First, we look at changes in skill demand between the base period of 2014-2015 and the most recent two-year period of 2016-2017, doing so to strip out any fluctuations found in any

one year. We do this for STEM/Technical openings by the degree required. We also look at top skills in 2016-2017. Lastly, we look at skills that are expected to be possessed by mid-level workers. The differences between required skills for workers in the beginning stages of their careers and mid-level workers are also examined.

Associate Degree
Entry Level - Top Skills

The blue bars in the graphs below indicate the average percentage of all entry level jobs for which a skill was required between 2014 - 2015; the orange bars indicate the same for the ensuing 2 years; 2016 - 2017.

Top 20 Skill Clusters - Entry Level STEM Jobs, Assoc. Degree or Less 2015-15 vs. 2016-17
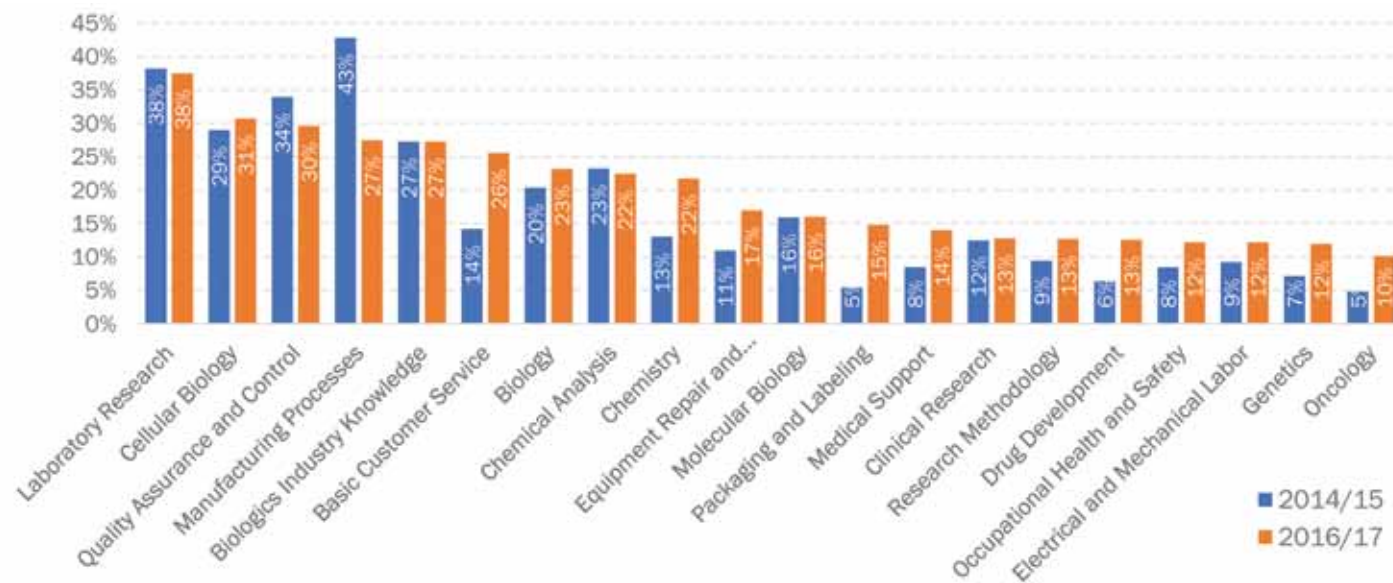
Knowledge in areas such as **Laboratory Research, Cellular Biology,** and **QA/QC** were in high demand for recent graduates of associate degree programs.

Top 10 Professional Skills - Entry Level STEM Jobs, Assoc. Degree or Less 2014-15 vs. 2016-17
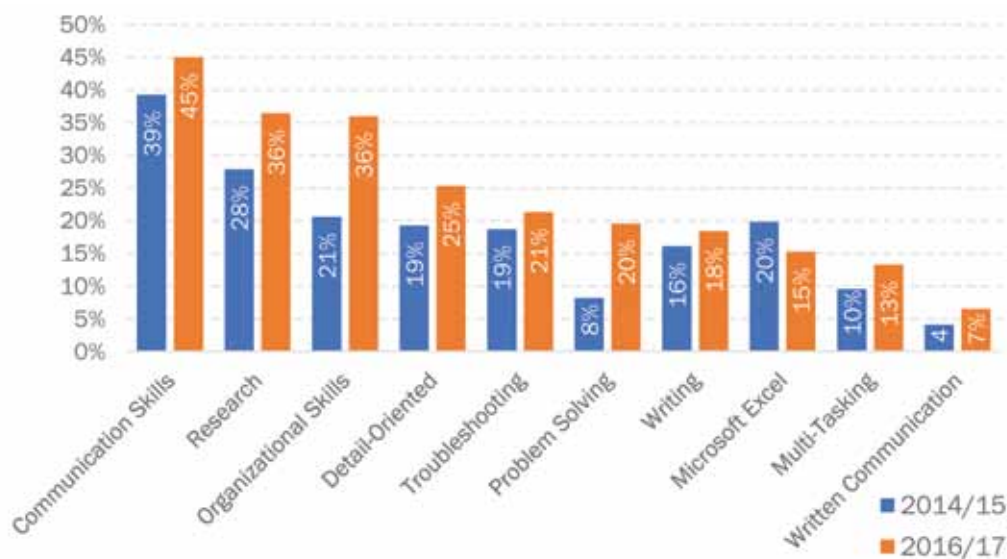
Professional skills such as **Communication, Research**, and **Organizational Skills** were all in high demand, and increased drastically in the period examined.

While many of the most common professional skills increased in demand, the same cannot be said for the broad, specialized skills. Many of the largest increases in demand were seen towards the end of the "long tail," i.e. infrequently required skillsets such as **Genetics, Oncology,** or Research **Methodologies.**

Associate Degree
Entry Level - Fastest Growing Skills

This section looks at the fastest growing skill clusters and professional skills for entry level positions requiring a STEM/Technical background by comparing the base period, 2014 - 2015, with the proceeding 2 years, 2016 - 2017. Skills were measured by their frequency of requirement in these openings. Increases are measured by percentage-point increase in appearances in these job listings between both 2-year periods.

Top Fastest Growing Skill Clusters - Entry Level STEM Jobs, Assoc. Degree or Less, 2014 - 2015
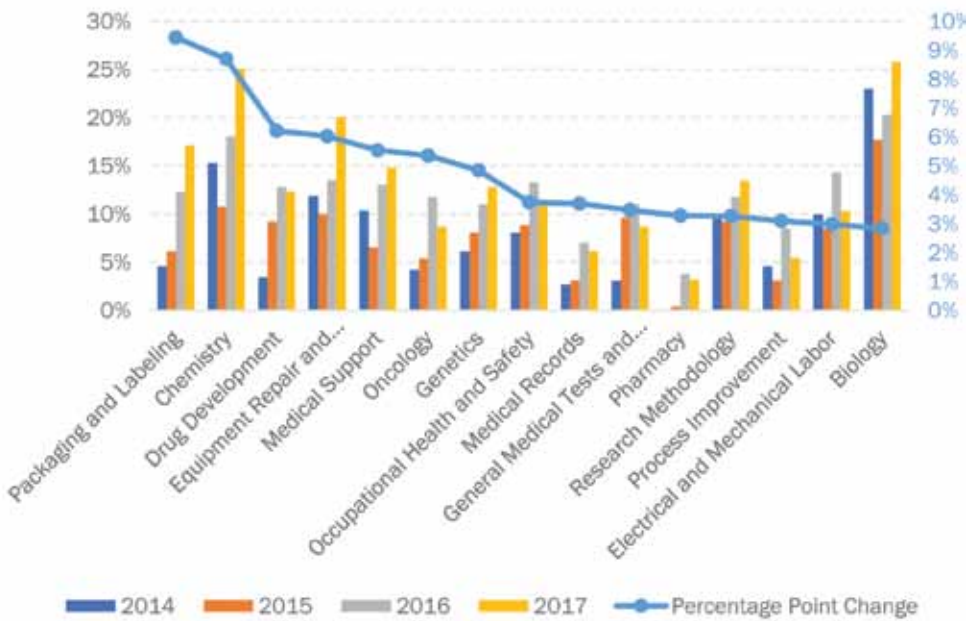
The frequency of each skill's appearance is represented each year on the left axis. The percentage point increase in appearances in job listings in that period of time, charted on the right axis. Skills such as Packaging and Labeling, Drug Development, Genetics, and Chemistry saw sharp increases in demand measured by both percentage-point increase and percent growth in job listings.

For professional skills, Problem Solving, Research, and Detail- Orientation all rapidly grew in importance over the past 4 years.

Organizational Skills saw the largest sheer increase – increasing by 15 percentage points.

Communication Skills were the most-requested professional skill, appearing in nearly 45% of all listings between 2016 and 2017.

Top 10 Fastest Growing Professional Skills - STEM Jobs, Assoc. Degree or Less, 2014-15 vs. 2016-17
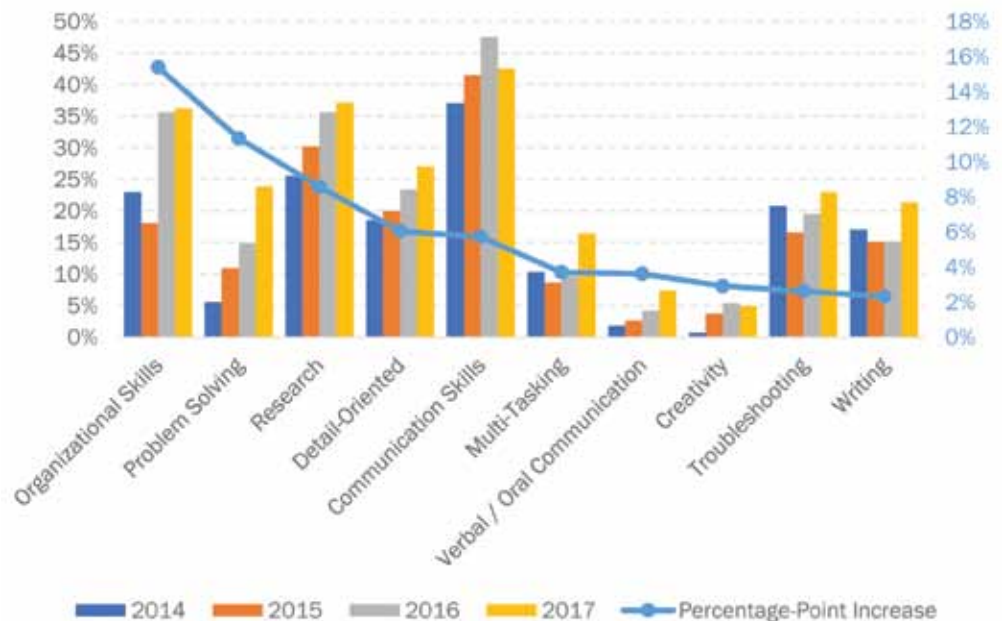
Associate Degree
Mid Level - Skill Clusters

The following section details the skill needs for mid-level life sciences professionals with an associate degree or below. These were extracted from job listings for positions requiring 3 to 8 years of experience and at most an associate degree.

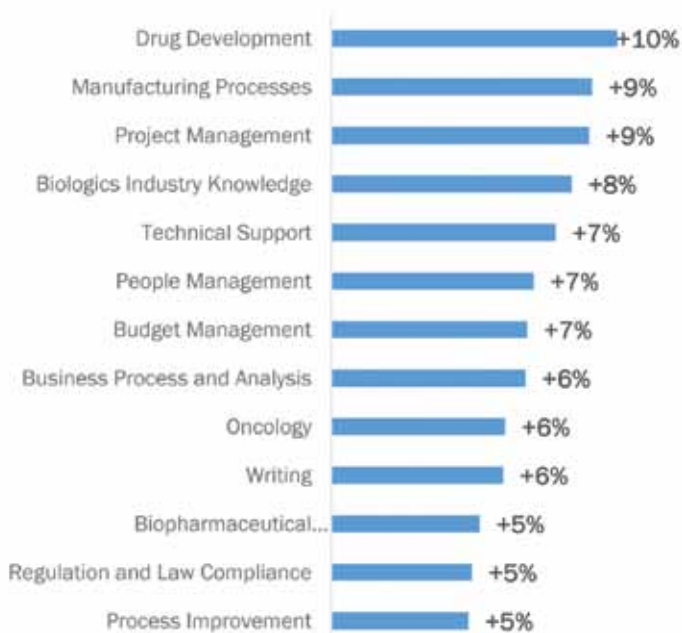### Top 12 Skill Clusters, STEM Listings, 3-8 Years' Experience 2014-15 vs. 2016-17

Legend: ■ 2014/15 ■ 2016/17
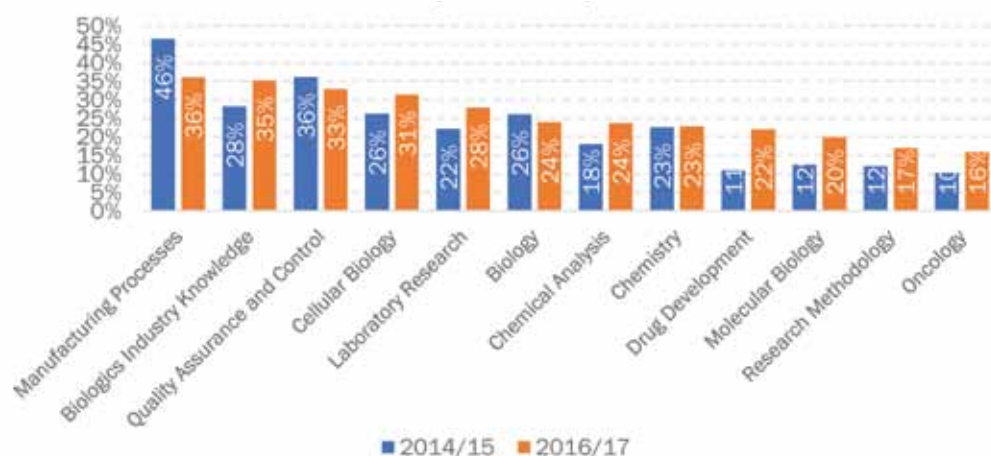
Generally speaking, the top skills required for mid-level professionals reflects that of entry-level candidates.

Skills like **QA/QC, Cellular Biology,** and **Laboratory Research** were among the top five most-requested skills at both experience levels.

However, there are drastic deviations within the skill requirements between those new to industry and incumbent professionals.

The following looks a the largest differences in skill requirements for those holding an associate's degree in the life sciences, by experience level. By comparing the different skill needs at each level, we can tease out which skills are assumed to be possessed right out of an academic program with limited industry experience, and which skills are presumed to be obtained once in the industry for a number of years.

12 Skills Seen More Often In Mid-Level Openings, 2016-2017

Skill	
Drug Development	+10%
Manufacturing Processes	+9%
Project Management	+9%
Biologics Industry Knowledge	+8%
Technical Support	+7%
People Management	+7%
Budget Management	+7%
Business Process and Analysis	+6%
Oncology	+6%
Writing	+6%
Biopharmaceutical...	+5%
Regulation and Law Compliance	+5%
Process Improvement	+5%

12 Skills Seen Less Often In Mid-Level Openings, 2016-2017

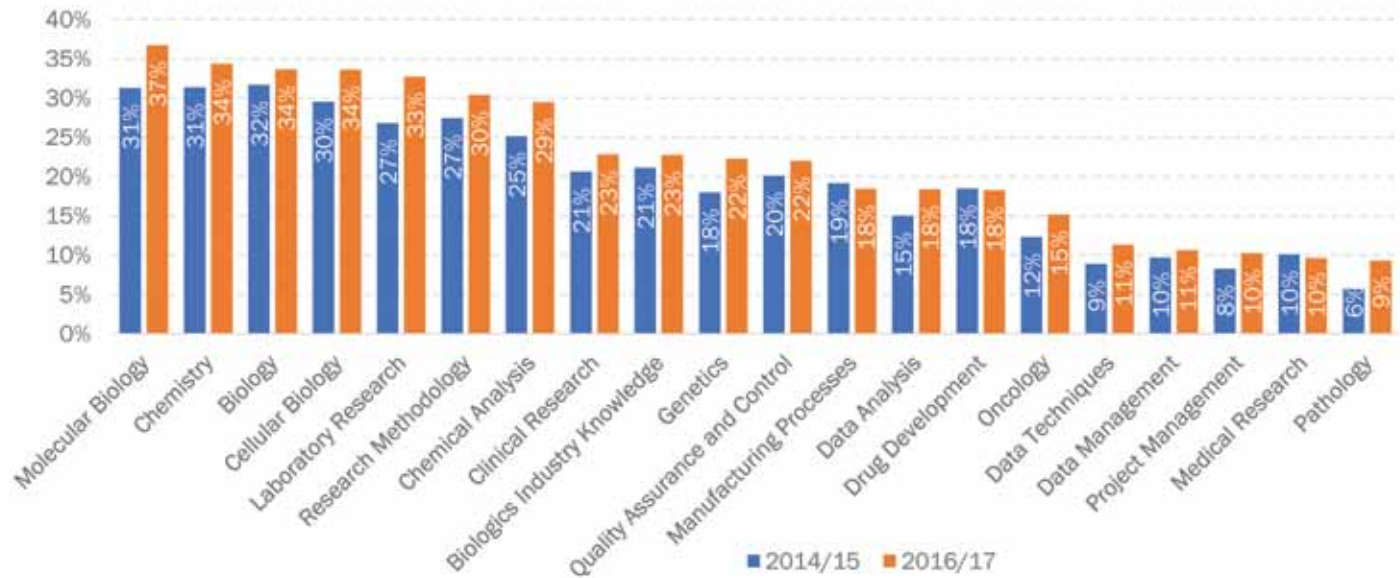| Skill	
Basic Customer Service	-13%
Laboratory Research	-10%
Packaging and Labeling	-10%
Medical Support	-8%
Occupational Health and Safety	-7%
Blood Collection	-6%
Equipment Repair and Maintenance	-5%
Machinery	-5%
Basic Patient Care	-5%
General Medical Tests and Procedures	-5%
Medical Records	-4%
Medical Research	-3%

Bachelor's Degree
## Entry Level - Top Skills

The blue bars in the graphs below indicate the average percentage of all entry level jobs for which a skill was required between 2014 - 2015; the orange bars indicate the same for the ensuing 2 years, 2016 - 2017.

Top 20 Skill Clusters - Entry Level STEM Jobs, Bachelor's Degree, 2014-15 vs. 2016-17

Many of the most commonly-requested skill sets among recent bachelor's degree candidates are areas of foundational knowledge, such as **Molecular Biology, Chemistry, Biology, Cellular Biology,** and **Genetics.**

Top 10 Skills - Entry Level STEM Jobs, Bachelor's Degree, 2014-15 vs. 2016-17
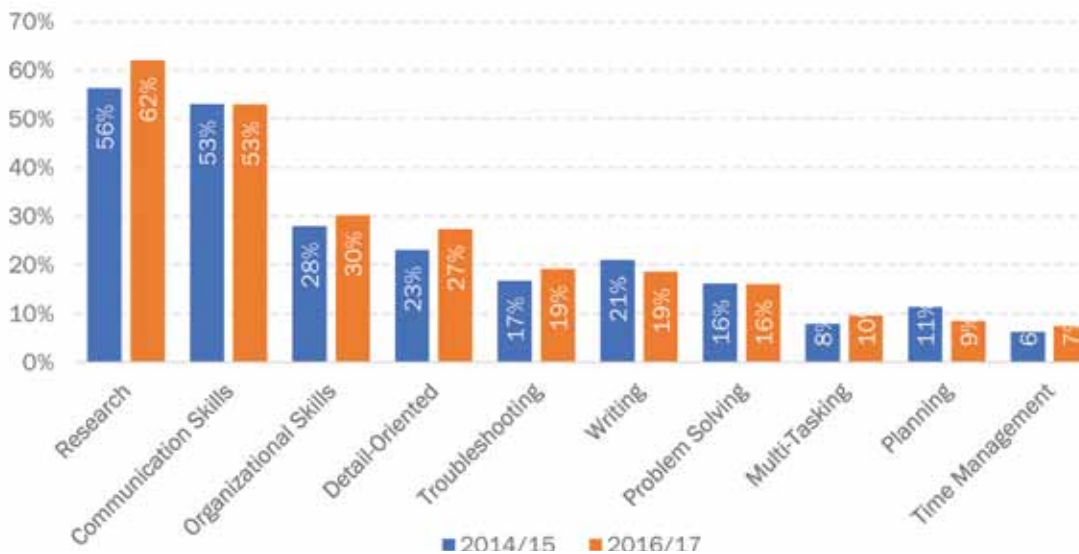
Research and **Communication Skills** were by far the most commonly required professional skills for STEM/Technical positions requiring a bachelor's degree and less than 2 years' experience.

Only **Writing** and **Planning** fell in importance between 2014 and 2017.

Bachelor's Degree
Entry Level - Fastest Growing Skills

This section looks at the fastest growing skill clusters and professional skills for entry level positions requiring a STEM/Technical background by comparing the base period, 2014 - 2015, with the proceeding 2 years, 2016 - 2017. Skills were measured by their frequency of requirement in these openings. Increases are measured by percentage-point increase in appearances in these job listings between both two-year periods.

Many of the fastest growing skills between 2014-15 and 2016-17 were also the most common skills.

Skills such as **Genetics, Pathology, Oncology, Data Analysis**, and **Data Techniques** all saw significant jumps in requirement by employers seeking entry level candidates.

Almost all these skills were in the domains of research and/or analytics. However, **Business Solutions** and **Project Management** were both non-technical skills that saw large jumps.

Top 15 Fastest Growing Skill Clusters - Entry Level STEM Jobs, Bachelor's Degree, 2014 - 17

Legend: 2014 2015 2016 2017 Percentage Point Change
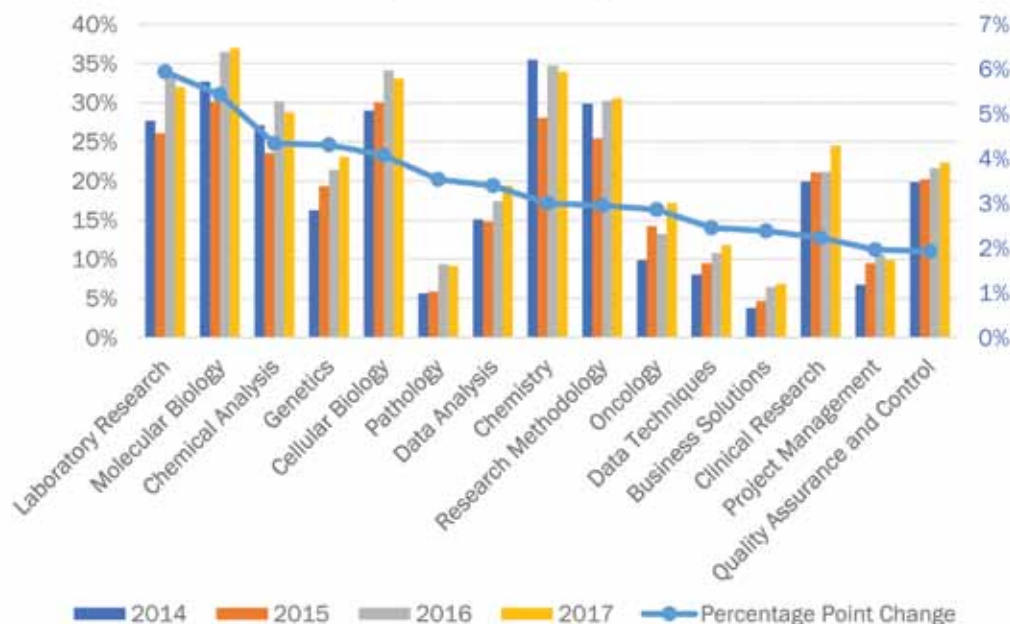
Top 10 Fastest Growing Professional Skills - STEM Jobs, Bachelor's Degree, 2014-15 vs. 2016-17

Legend: 2014 2015 2016 2017 Percentage-Point Increase
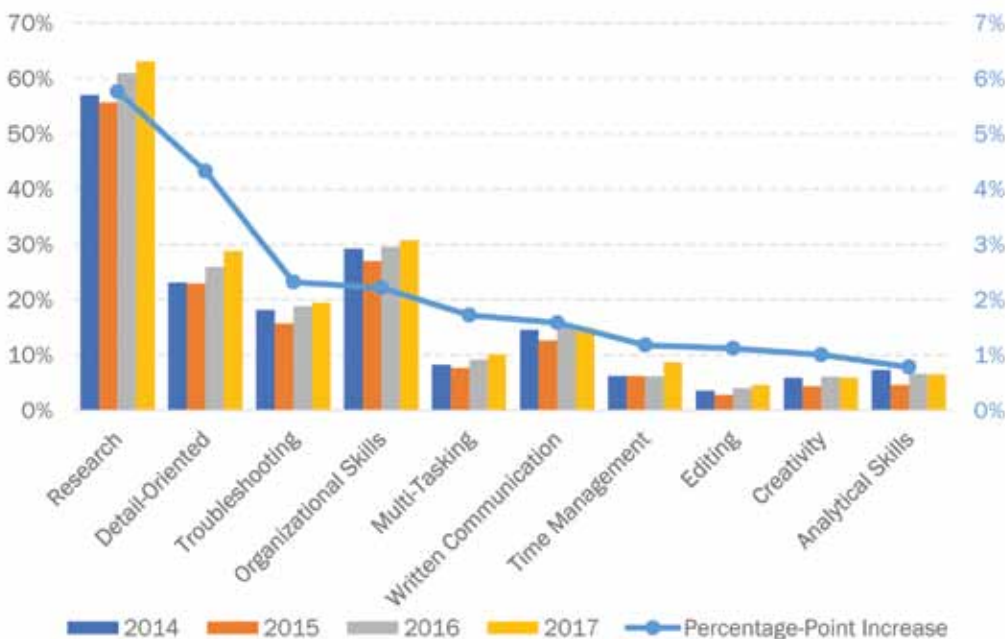
Professional skills among STEM/Technical jobs requiring a bachelor's degree remained relatively stagnant in the past 4 years.

Some skills did generate greater demand among employers, namely **Research** (+6%) and **Detail-Orientation** (+4%).

Most other professional skills only increased in frequency by about 1 to 2 percentage points in the past 4 years.

Bachelor's Degree
Mid-Level - Skill Clusters

The following section details the skill needs for mid-level life sciences professionals with a bachelor's degree. These were extracted from job listings for positions requiring 3 to 8 years of experience and a bachelor's degree.

Top 12 Skills Clusters STEM Listings, 3-8 Years' Experience 2014-15 vs. 2016-17
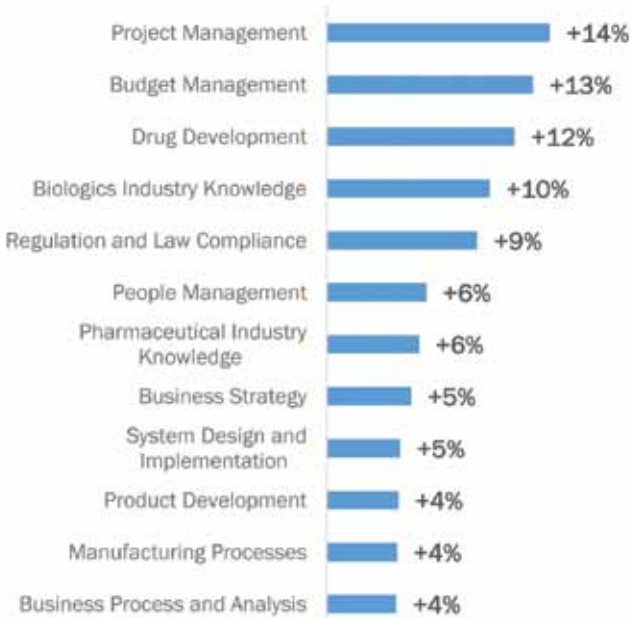

■ 2014/15 ■ 2016/17
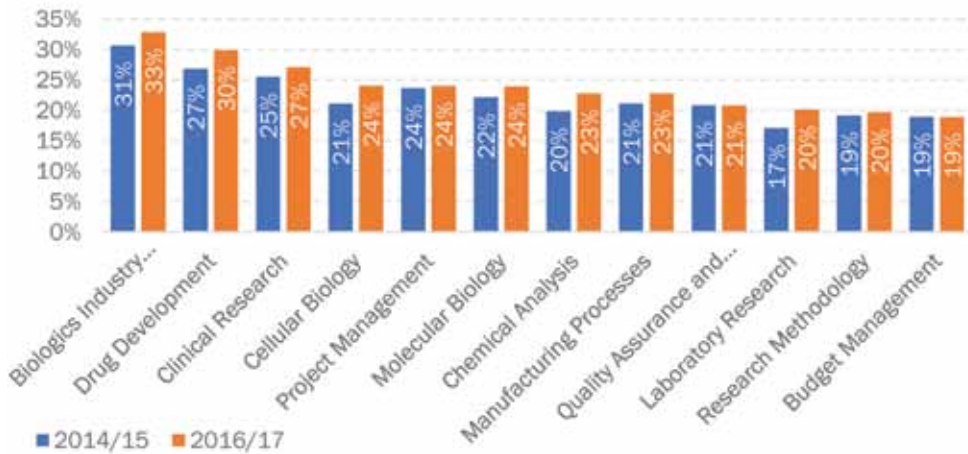
Unlike entry level openings, employers valued midlevel candidates with extensive **Biologics Industry Experience, Project Management,** and **Budget Management.**

Most of the technical duties and requirements were similar in frequency.

All of the top twelve skills shown at left did not decrease in demand in the preceding 4 years.

> The following looks a the largest differences in skill requirements for those holding a bachelor's degree in the life sciences, by experience level. By comparing the different skill needs at each level, we can tease out which skills are assumed to be possessed right out of an academic program with limited industry experience, and which skills are presumed to be obtained once in the industry for a number of years.

### 12 Skills Seen More Often In Mid-Level Openings, 2016-2017

Skill	
Project Management	+14%
Budget Management	+13%
Drug Development	+12%
Biologics Industry Knowledge	+10%
Regulation and Law Compliance	+9%
People Management	+6%
Pharmaceutical Industry Knowledge	+6%
Business Strategy	+5%
System Design and Implementation	+5%
Product Development	+4%
Manufacturing Processes	+4%
Business Process and Analysis	+4%

12 Skills Seen Less Often In Mid-Level Openings, 2016-2017

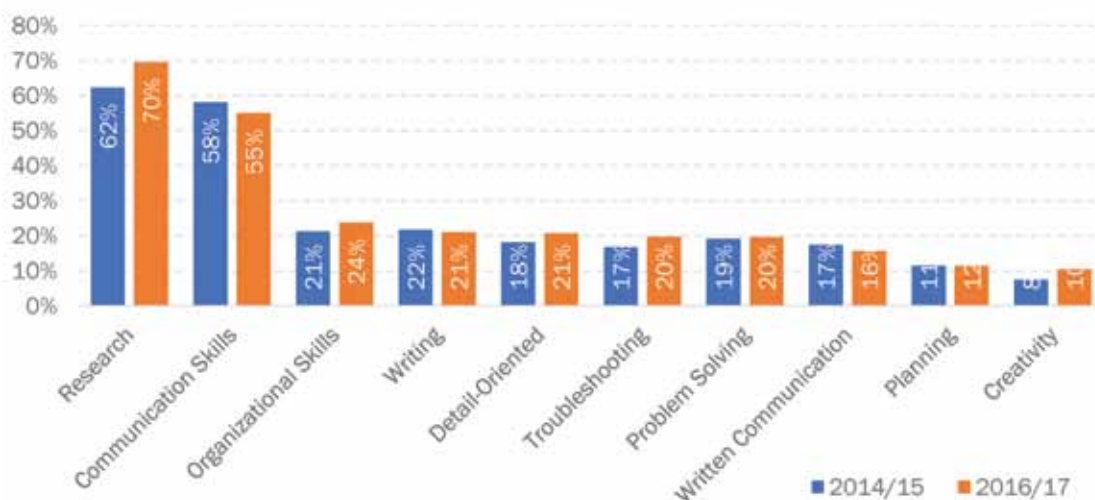| Skill	
Molecular Biology	-13%
Laboratory Research	-13%
Biology	-12%
Research Methodology	-11%
Cellular Biology	-10%
Chemistry	-9%
Chemical Analysis	-7%
Genetics	-6%
Data Techniques	-6%
Pathology	-5%
Scheduling	-3%
General Medicine	-3%

Master's Degree
Entry Level - Top Skills

The blue bars in the graphs below indicate the average percentage of all entry level jobs for which a skill was required between 2014 - 2015; the orange bars indicate the same for the ensuing 2 years, 2016 - 2017.

Top 20 Skill Clusters - STEM Jobs, M.S. Degree, 2014-15 vs. 2016-17
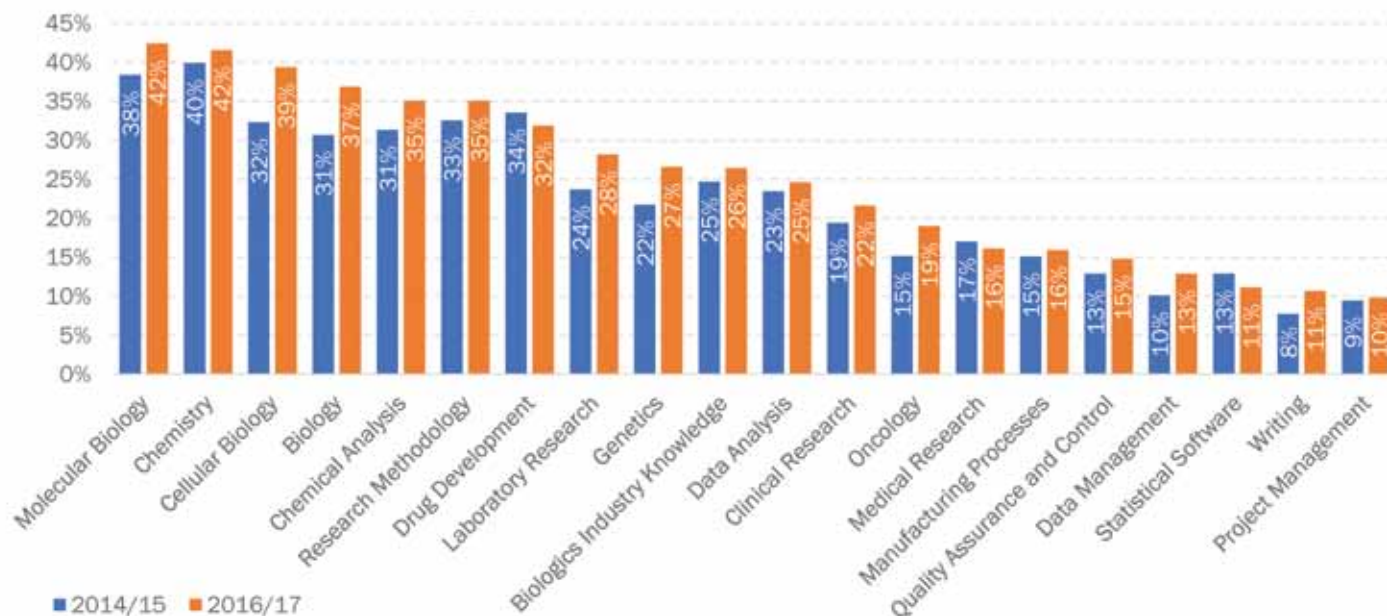
Many of the most-requested broad skillsets include foundational knowledge of scientific disciplines like **Molecular Biology, Chemistry, or Cellular Biology. Data Analysis, Data Management,** and **Statistical Software** skills were also in high demand for jobs requiring a Master's degree and less than 2 years' experience.

Top 10 Professional Skills - Entry Level STEM Jobs, M.S. Degree, 2014-15 vs. 2016-17

Much like at the bachelor's degree level, the two most important professional skills for new entrants into the life sciences industry were **Research** and **Communication Skills,** which were far and away the most commonly required of all professional skills.

Master's Degree
Entry Level - Fastest Growing Skills

This section looks at the fastest growing skill clusters and professional skills for entry level positions requiring a STEM/Technical background by comparing the base period, 2014 - 2015, with the proceeding 2 years, 2016 - 2017. Skills were measured by their frequency of requirement in these openings. Increases are measured by percentage-point increase in appearances in these job listings between both 2-year periods.

Top 15 Fastest Growing Skill Clusters - Entry Level STEM Jobs, M.S. Degree, 2014 - 17

2014   2015   2016   2017   Percentage Point Change
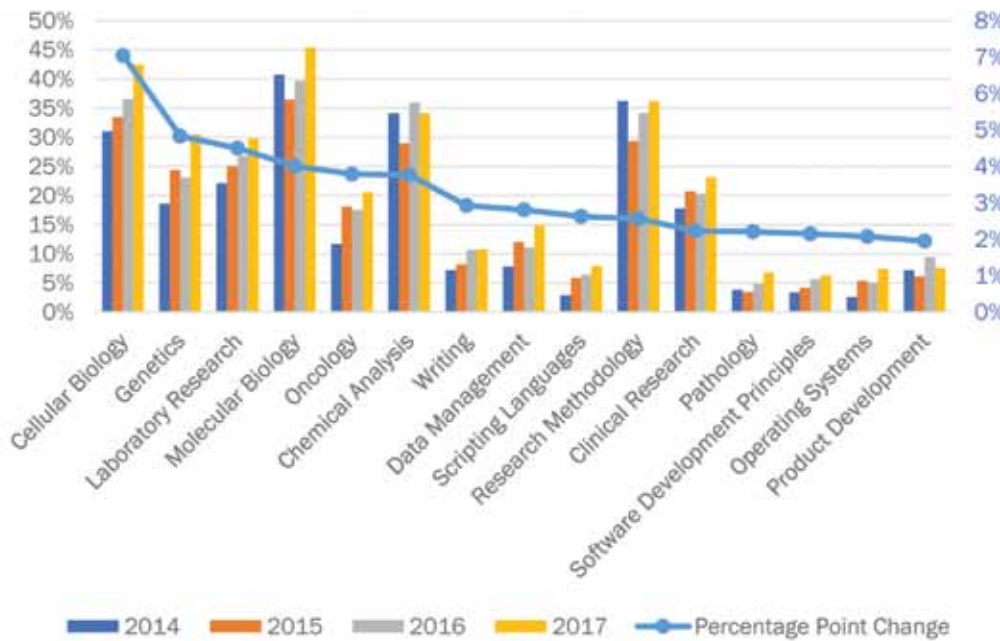
Between 2014 – 2017, **Cellular Biology, Laboratory Research, Oncology, Data Management,** and **Clinical Research** all saw steady increases in demand, year-over-year, in STEM/Technical jobs requiring a Master's degree at life sciences organizations.

Research Methodologies and **Molecular Biology** did not increase much in their frequency, but remained among the most in-demand skillsets for this subgroup.

Top Ten Professional Skills - STEM Jobs, M.S. Degree, 2014-15 vs. 2016-17

2014   2015   2016   2017   Percentage-Point Increase
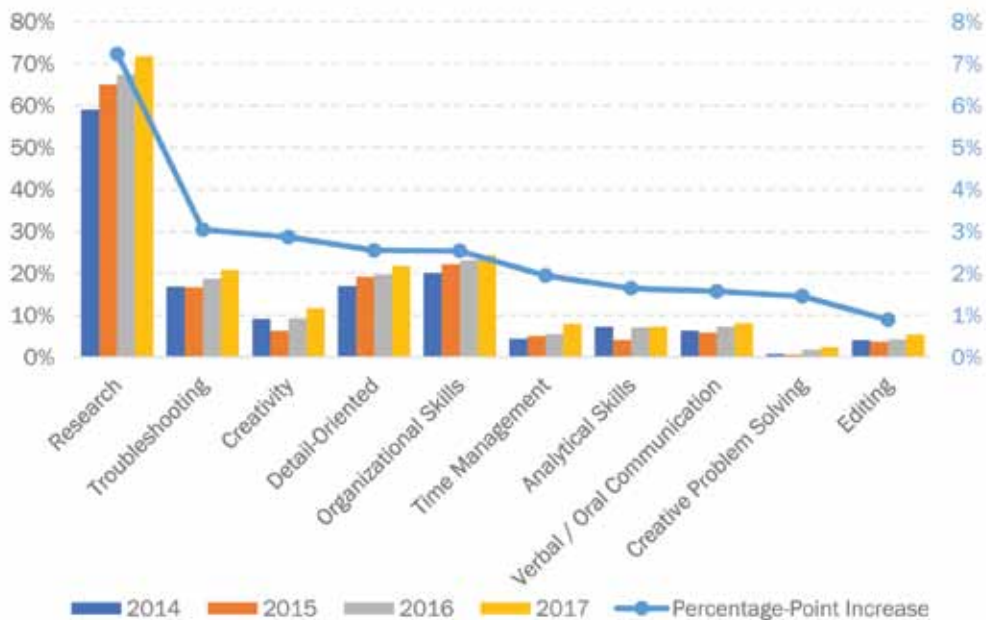
Professional skills such as **Research, Detail-Orientation** and **Organizational Skills** saw steady increases in importance over the past 4 years.

Not shown at left is **Communication Skills,** which declined by 3 percentage points in the past 4 years.

Overall, professional skills in these open positions remained remarkably steady over the period of time studied.

Master's Degree
Mid-Level - Skill Clusters

The following section details the skill needs for mid-level life sciences professionals with a master's degree.
These were extracted from job listings for positions requiring 3 to 8 years of experience and a master's degree.

Top 12 Skills Clusters STEM Listings, 3-8 Years' Experience 2014-15 vs. 2016-17
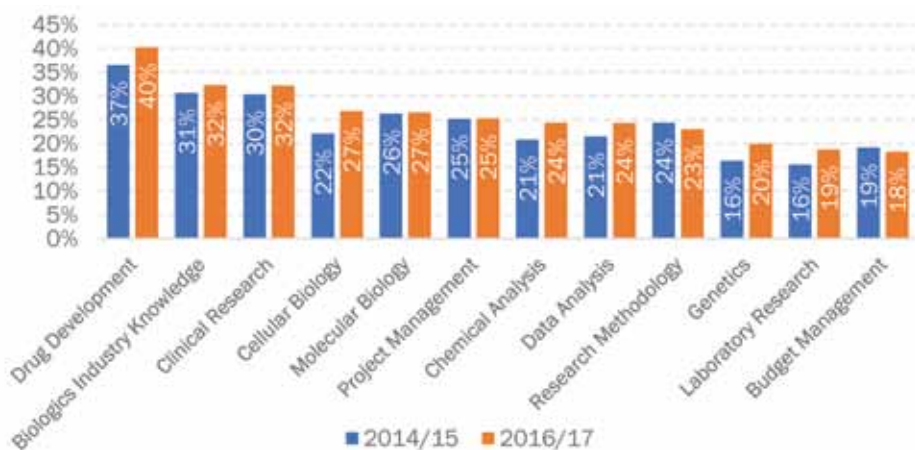
For mid-career workers with a master's degrees in the life sciences, skills like **Drug Development, Biologics Industry Knowledge,** and **Clinical Research** were the most sought-after skill sets.
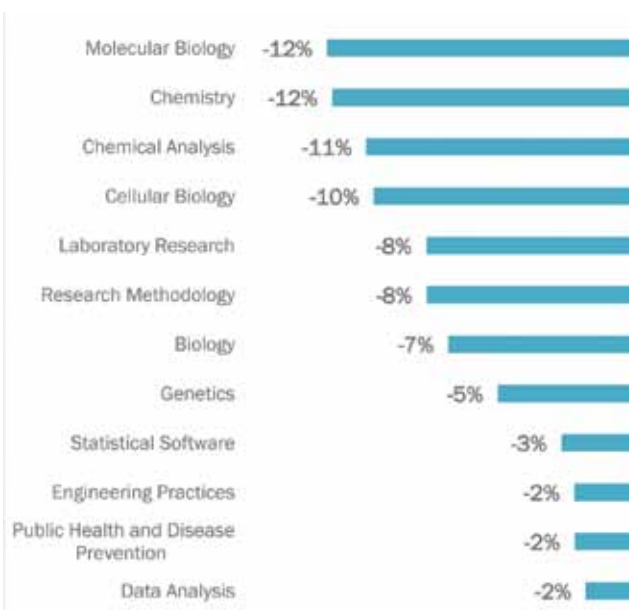
Budget Management and **Project Management** were much more prominent skills the higher the years of experience.

The following looks a the largest differences in skill requirements for those holding a master's degree in the life sciences, by experience level. By comparing the different skill needs at each level, we can tease out which skills are assumed to be possessed right out of an academic program with limited industry experience, and which skills are presumed to be obtained once in the industry for a number of years.

12 Skills Seen More Often In Mid-Level Openings, 2016-2017

Skill	%
Project Management	+16%
Budget Management	+12%
Clinical Research	+11%
Business Strategy	+7%
Regulation and Law Compliance	+7%
People Management	+6%
Biologics Industry Knowledge	+6%
Health Care Procedure and Regulation	+4%
Pharmaceutical Industry Knowledge	+4%
Business Process and Analysis	+4%
Supplier Relationship Management	+4%
Market Analysis	+4%

12 Skills Seen Less Often In Mid-Level Openings, 2016-2017

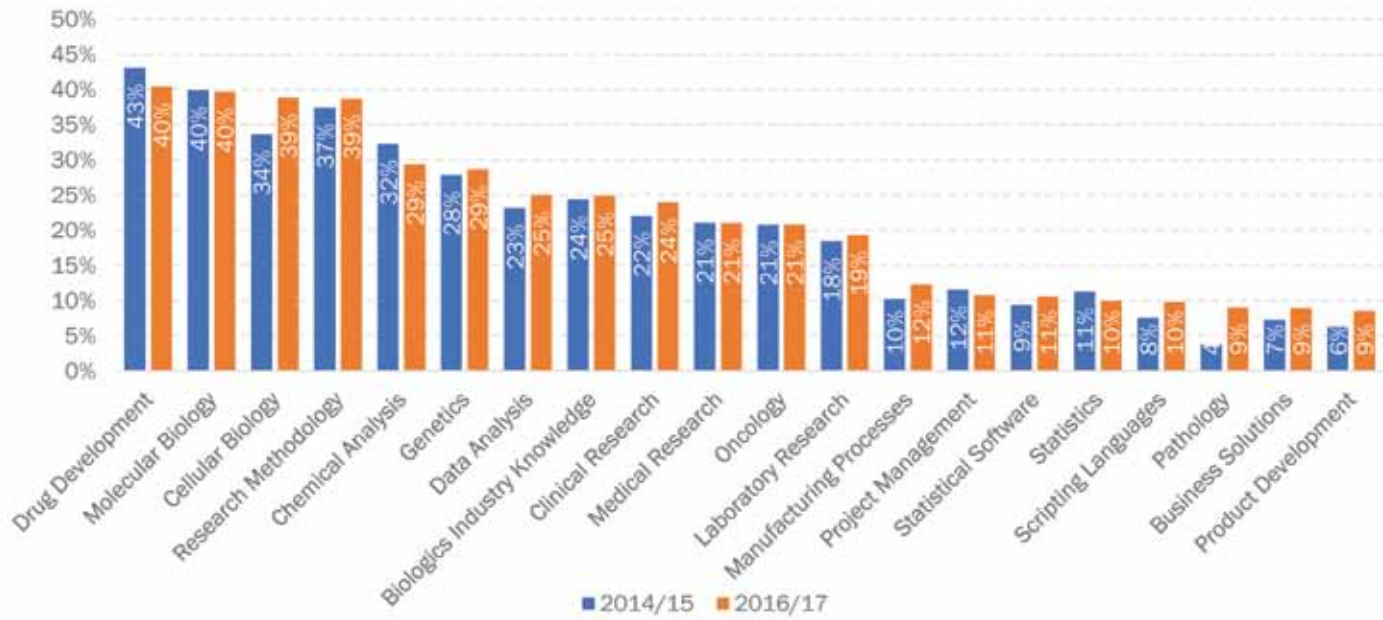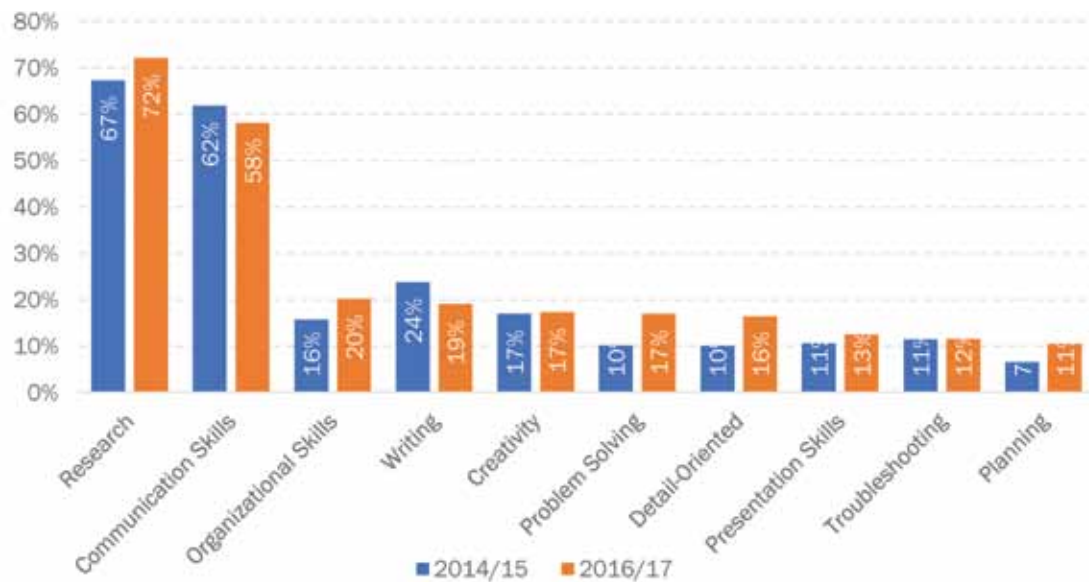| Skill	%
Molecular Biology	-12%
Chemistry	-12%
Chemical Analysis	-11%
Cellular Biology	-10%
Laboratory Research	-8%
Research Methodology	-8%
Biology	-7%
Genetics	-5%
Statistical Software	-3%
Engineering Practices	-2%
Public Health and Disease Prevention	-2%
Data Analysis	-2%

Ph.D. Degree
Entry Level - Top Skills

The blue bars in the graphs below indicate the average percentage of all entry level jobs for which a skill was required between 2014 - 2015; the orange bars indicate the same for the ensuing 2 years, 2016 - 2017.

Top 20 Skill Clusters - STEM Jobs, Ph.D. Degree, 2014-15 vs. 2016-17

More so than other degree levels, candidates for entry level positions with Ph.Ds. are required to possess skills in areas like **Genetics, Oncology, Scripting Languages,** and **Pathology.**

Top 10 Professional Skills - Entry Level STEM Jobs, Ph.D. Degree, 2014-15 vs. 2016-17

Research and **Communication Skills** are also the most sought-after professional skills at the Ph.D. level, as they have been at other levels.

Organizational Skills, Problem Solving, and **Detail-Orientation** all saw great increases in demand from life sciences organization in the past 4 years.

Ph.D. Degree
Entry Level - Fastest Growing Skills

This section looks at the fastest growing skill clusters and professional skills for entry level positions requiring a STEM/Technical background by comparing the base period, 2014 - 2015, with the proceeding 2 years, 2016 - 2017. Skills were measured by their frequency of requirement in these openings. Increases are measured by percentage-point increase in appearances in these job listings between both two-year periods.

Top 15 Fastest Growing Skill Clusters - Entry Level STEM Jobs, Ph.D. Degree, 2014 - 17

Legend: 2014, 2015, 2016, 2017, Percentage Point Change
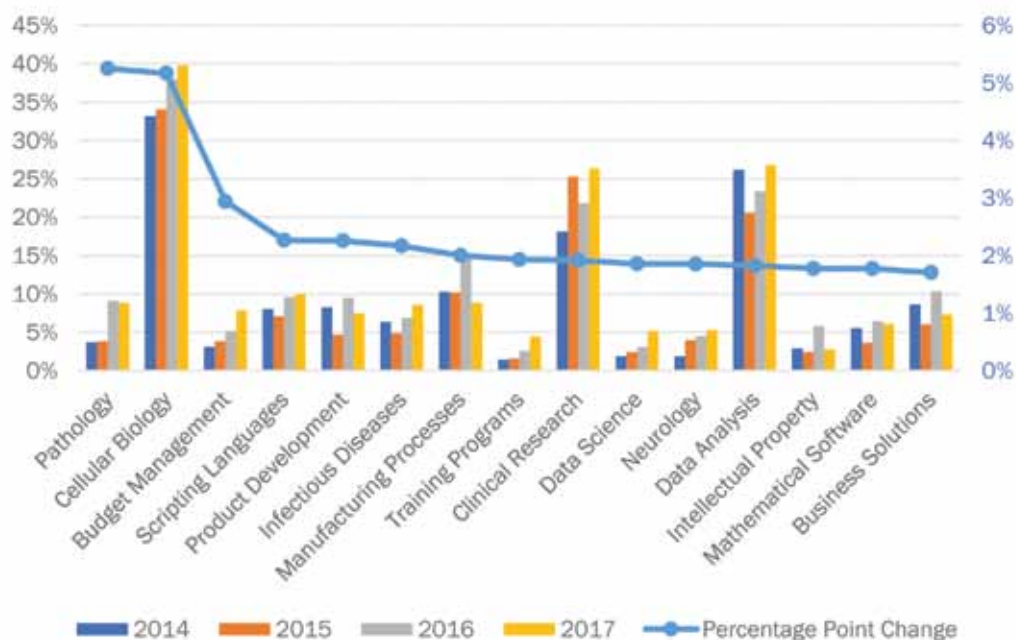
Pathology, while not required for many openings, saw the largest increase in terms of percentage points since 2014.

The only other two skills to increase by more than 2 percentage points in that span of time were **Cellular Biology** and **Budget Management.**

Other top skills that saw noticeable increases were **Clinical Research** and **Data Analysis.**

Top Ten Fastest Growing Professional Skills - STEM Jobs, Ph.D. Degree, 2014-15 vs. 2016-17

Legend: 2014, 2015, 2016, 2017, Percentage-Point Increase
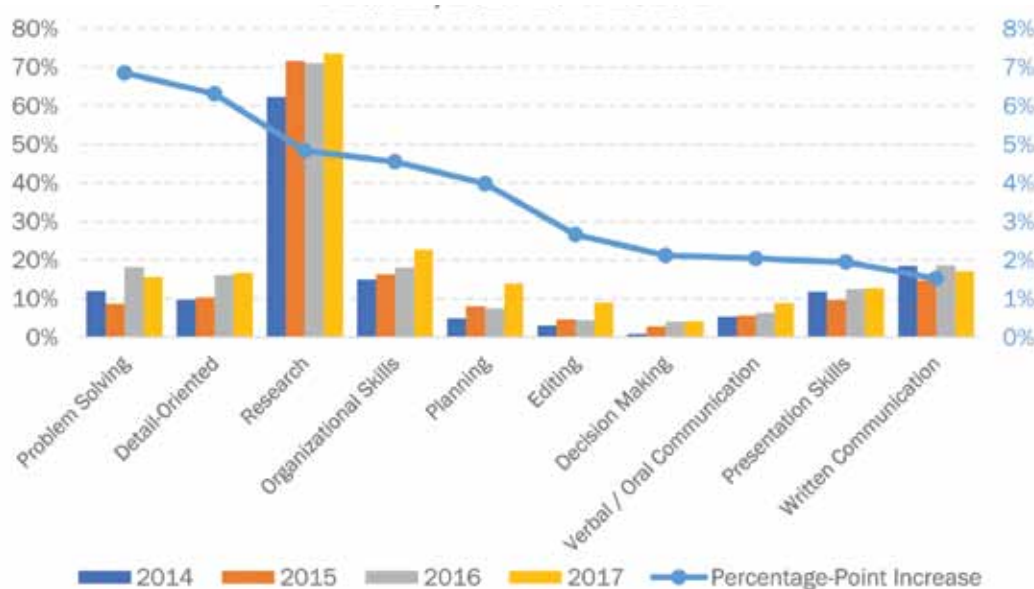
While not the most sought-after professional skills, **Problem Solving, Detail-Orientation,** and **Organizational Skills** saw large percentage point increases in demand.

Research-related skills remain far and away the most common professional skill sought of Ph.D.-holders looking for their first positions within the life sciences industry.

Ph.D. Degree
Mid-Level - Skill Clusters

The following section details the skill needs for mid-level life sciences professionals with a Ph.D. degree. These were extracted from job listings for positions requiring 3 to 8 years of experience and a Ph.D. degree.

Top 12 Skills Clusters STEM Listings, 3-8 Years' Experience 2014-15 vs. 2016-17
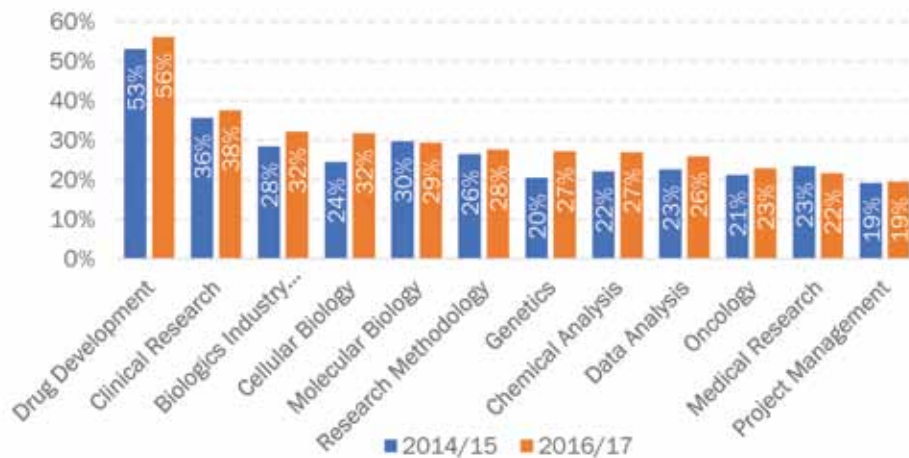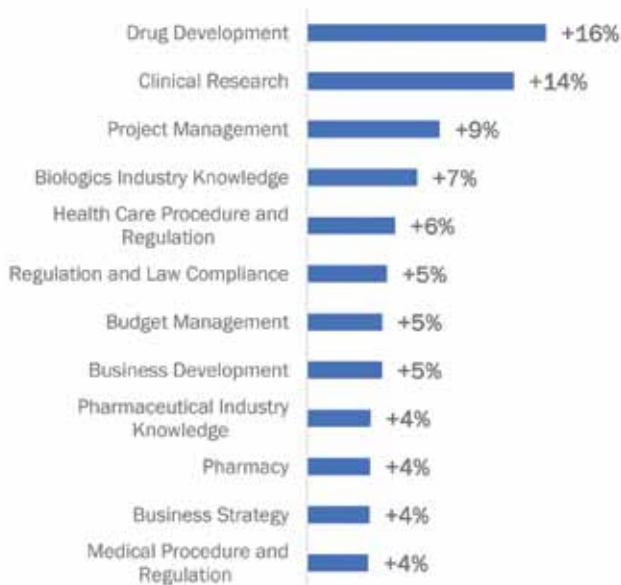

Drug Development was the most coveted skill of incumbent life sciences workers with Ph.Ds., followed by **Clinical Research** and **Biologics Experience.**

Unlike entry level positions, about one-fifth of candidates in mid-level openings required a history of **Project Management.**

The following looks a the largest differences in skill requirements for those holding a Ph.D. in the life sciences, by experience level. By comparing the different skill needs at each level, we can tease out which skills are assumed to be possessed right out of an academic program with limited industry experience, and which skills are presumed to be obtained once in the industry for a number of years.

12 Skills Seen More Often In Mid-Level Openings, 2016-2017

Skill	
Drug Development	+16%
Clinical Research	+14%
Project Management	+9%
Biologics Industry Knowledge	+7%
Health Care Procedure and Regulation	+6%
Regulation and Law Compliance	+5%
Budget Management	+5%
Business Development	+5%
Pharmaceutical Industry Knowledge	+4%
Pharmacy	+4%
Business Strategy	+4%
Medical Procedure and Regulation	+4%

12 Skills Seen Less Often In Mid-Level Openings, 2016-2017

Skill	
Research Methodology	-11%
Molecular Biology	-10%
Cellular Biology	-7%
Java	-3%
Intellectual Property	-3%
Scripting Languages	-3%
C and C++	-3%
Software Development Principles	-2%
Manufacturing Processes	-2%
Infectious Diseases	-2%
Chemical Analysis	-2%
Mathematical Software	-2%

Key Takeaways

1 Industry job listings in 2017 were the 2nd-highest on record, with nearly 28,000
job openings posted online. STEM/Technical listings accounted for over 16,200 of those.

2 Industry employment topped 70,000 for the first time in 2017. The annual growth rate of employment
in the life sciences has been approximately double that of Massachusetts as a whole since 2014.

3 The northeastern region of the state has seen the largest increases in job listings at life sciences
organizations since 2015.

4 28% of all STEM/Technical openings required possession of a graduate degree in 2017,
8% required an associate degree or less. Both are in line with historical levels.

5 Knowledge in Genetics, Oncology, and of various Research Methodologies were among the dozen
fastest-growing skill clusters at every level except for Ph.D., where all three were among the
top 11 most-requested skills by employers anyway.

Projected Growth

Since 2016, MassBioEd has released its updated annual projections for the life sciences industry as the central piece to the *Annual Forecast*. This year, we present the long-term employment outlook for the industry in Massachusetts through May 2023. These projections are intended to arm educators, policymakers, and industry decisionmakers with a reasonable expectation of industry employment needs today as they make strategic decisions for tomorrow.

In this iteration we refined our approach from the 2017 Annual Forecast. By improving upon the input data and periods of time used, as well as weighting recent events more heavily, this model better reflects the current dynamics of employment growth within the industry. For example, last year's model predicted higher growth rates of employment at Pharmaceutical Manufacturers due to high growth in the first half of the decade. This year's model takes into account recent stagnation in employment growth more so than before.

This section will provide insights on expected growth in over 300 distinct occupations, numerous sub-sectors within the life sciences industry, and total expected growth of the entire industry. By integrating low and high estimations for growth, we hope to convey a probabilistic array of expectations for employment growth between today and 2023.

> **17.4%**
> **Projected employment growth between May 2017 — May 2023**

May 2017 was the latest month available with both industry staffing patterns and up-to-date employment data, with industry employment at **68,955** workers. An explanation of the methodology used in our projection system is provided in full in the Appendix of this report.

Projected Life Sciences Industry Employment Growth MA, 2017-2023
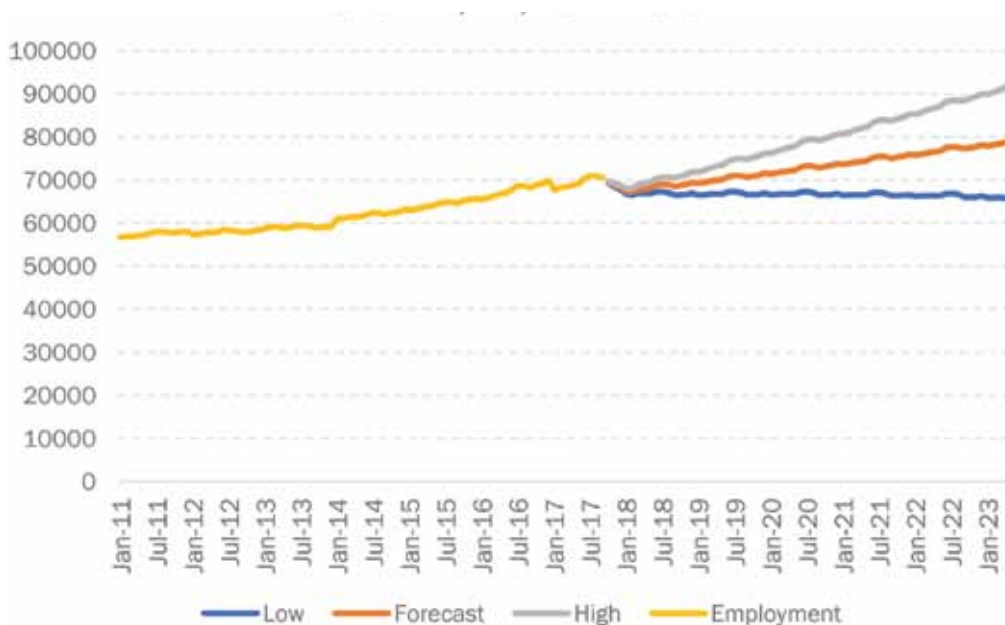
The range of predicted outcomes widens the further out you project from present times.
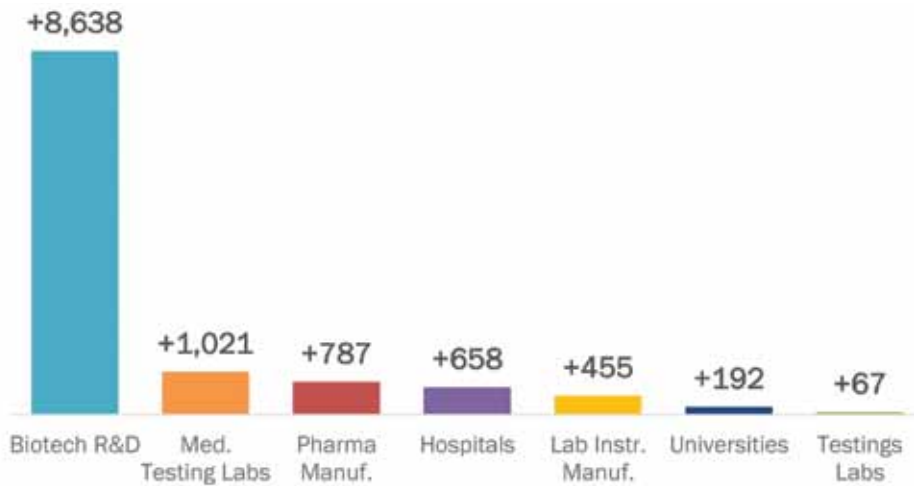
The gap represents 95% of all expected outcomes, with the orange line being the mid-point of the projections. In that, we anticipate employment to grow by **11,976** new workers in the industry between May 2017 and May 2023 to approximately **80,971** FTE workers.

Of the nearly 12,000 new jobs projected to be created between May 2017 and May 2023, over 8,600 will be created at *Biotech R&D* organizations – accounting for over 70% of the industry's growth during that time.
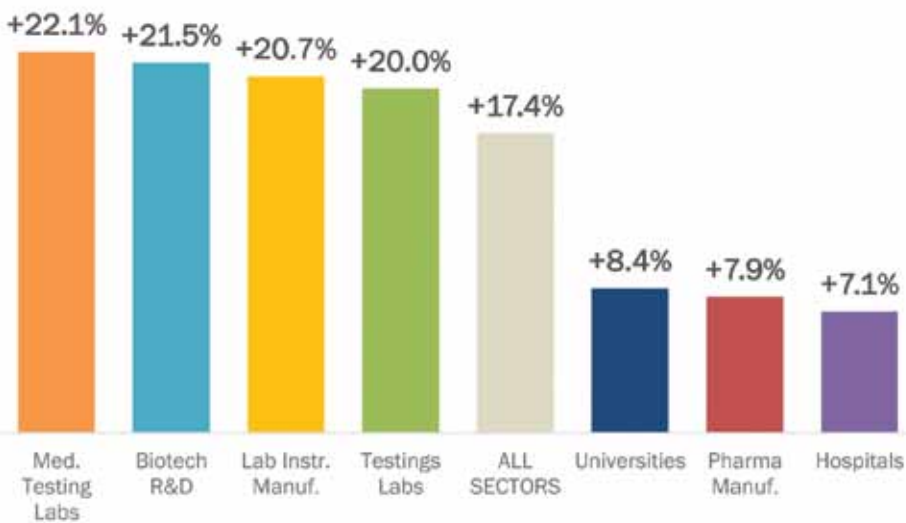
Pharmaceutical Manufacturers – the second-largest life sciences sector by employment in 2017, is expected to grow by nearly 800 workers by 2023.

Sectors where life sciences employment and output make up a small minority of total sector output, like Hospitals, Lab Instrument Manufacturers, Universities, and Testing Laboratories are expected to grow in smaller numbers.
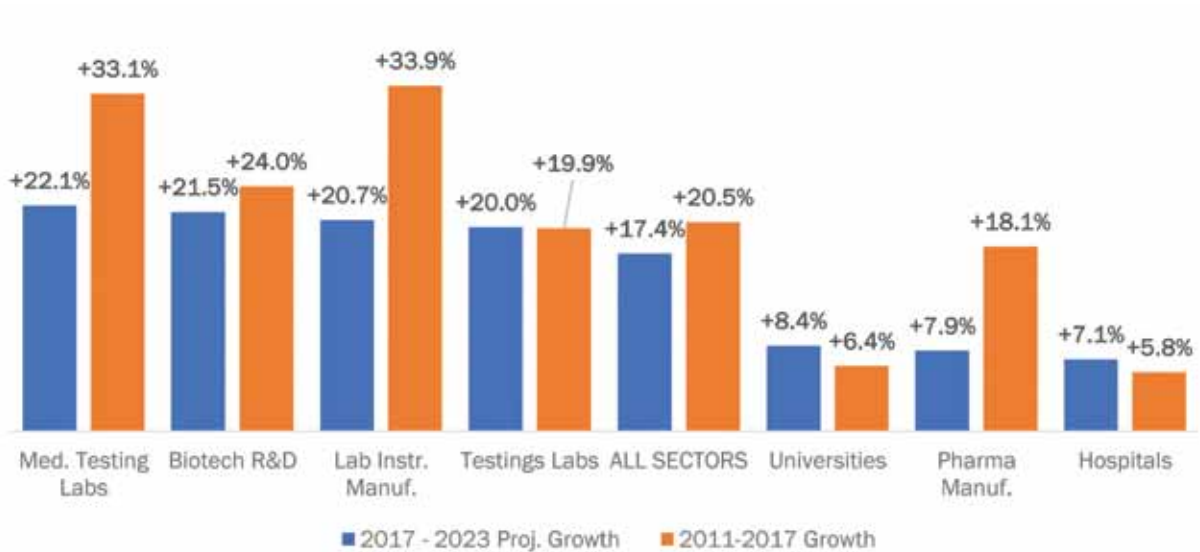
Projected Employment Growth by Sector, 2017-2023

+8,638 Biotech R&D
+1,021 Med. Testing Labs
+787 Pharma Manuf.
+658 Hospitals
+455 Lab Instr. Manuf.
+192 Universities
+67 Testings Labs

11,976
Projected number of new jobs between May 2017 — May 2023

Projected Growth Rate by Sector, 2017-2023

+22.1% Med. Testing Labs
+21.5% Biotech R&D
+20.7% Lab Instr. Manuf.
+20.0% Testings Labs
+17.4% ALL SECTORS
+8.4% Universities
+7.9% Pharma Manuf.
+7.1% Hospitals

Only three sectors are forecasted to trail in growth – *Universities, Pharmaceutical Manufacturers,* and *Hospitals.* Smaller sectors like *Medical Testing Laboratories, Laboratory Instrument Manufacturers,* and *Testing Laboratories* figure to grow by over 20%. *Biotechnology R&D* is the main driver of industry growth, with the second-highest expected rate of growth, at 21.5%.

Projected Growth Rate by Sector, Compared to 2011-2017 Actual Growth Rates

+22.1% / **+33.1%** — Med. Testing Labs
+21.5% / **+24.0%** — Biotech R&D
+20.7% / **+33.9%** — Lab Instr. Manuf.
+20.0% / **+19.9%** — Testings Labs
+17.4% / **+20.5%** — ALL SECTORS
+8.4% / **+6.4%** — Universities
+7.9% / **+18.1%** — Pharma Manuf.
+7.1% / **+5.8%** — Hospitals

■ 2017 - 2023 Proj. Growth   ■ 2011-2017 Growth

While MassBioEd projects hearty growth throughout the industry in the coming 6 years, the rate of growth is projected to slow from the rate of growth over the immediately preceding 6 years. The unprecedented growth following The Great Recession will be difficult to maintain. The potential for an economic downturn is higher, as we are now in year eight of a prolonged economic expansion.

Despite these concerns, there remain strengths in place to help avoid the flagging of employment growth in the industry. A surge in recent years in Biotech R&D employment is the result of major players in the biopharmaceutical space consolidating their efforts near the Boston/Cambridge epicenter. There has been a marked increase in research & development dollars flowing into Massachusetts as a result.

Our institutions of higher learning have increased their production of graduates who are qualified and ready to fill openings at life sciences companies. A greater share of federal research dollars has increased basic research that is continually spun out into commercializing enterprises in the state. In addition, the extension of the Massachusetts Life Sciences Initiative by 5 years, with greater emphasis on workforce development opportunities, should further bolster growth.

Employment by Occupation

As we have done in past editions, we now turn to projecting out individual occupations. The Appendix features an exhaustive table of the over 300 occupations which we forecast in this report.

For the first time, we will group positions together to show broad anticipated growth among occupations similar in functions, duties, knowledge, and skills, in order to inform our audience of the underlying currents driving employment growth and how particular pockets of jobs may fare.

The following table looks at the occupations which are forecasted to grow the fastest at life sciences organizations in Massachusetts between May 2017 and May 2023.

Projected Fastest-Growing STEM/Technical Occupations, 2017-2023, by Pct. Growth

Occupation	2017	2023	Diff	Growth
Computer and Information Research Scientists	216	284	+68	+32%
Electronics Engineers, Except Computer	840	1,099	+259	+31%
Chemical Engineers	182	238	+56	+31%
Engineering Technicians, Except Drafters, All Other	434	567	+133	+31%
Electrical Engineers	840	1,091	+251	+30%
Biological Scientists, All Other	1,022	1,326	+305	+30%
Software Developers, Systems Software	995	1,292	+296	+30%
Mechanical Engineers	766	988	+222	+29%
Mechanical Engineering Technicians	201	259	+58	+29%
Materials Scientists	143	184	+41	+29%
Statisticians	534	687	+153	+29%
Computer Systems Analysts	362	464	+103	+28%
Engineers, All Other	237	303	+66	+28%
Electrical/ Electronics Engineering Technicians	325	415	+90	+28%
Computer Programmers	118	150	+32	+27%
Sales Representatives, Technical	745	943	+198	+27%
First-Line Supervisors of Production Workers	218	276	+58	+26%
Software Developers, Applications	315	397	+82	+26%
Logisticians	211	264	+53	+25%
Industrial Engineers	1,009	1,252	+243	+24%
Medical Scientists, Except Epidemiologists [1]	5,240	6,475	+1,235	+24%
Biomedical Engineers	1,170	1,433	+263	+22%
Biochemists and Biophysicists	3,430	4,187	+757	+22%
Natural Sciences Managers	1,666	2,025	+359	+22%
Quality Control Analysts	590	716	+126	+21%
Chemists	1,356	1,629	+273	+20%
Chemical Plant and System Operators	122	145	+24	+19%
Architectural and Engineering Managers	595	706	+111	+19%
Quality Control Technicians	352	417	+65	+19%
Chemical Technicians	1,100	1,301	+201	+18%

All of the occupations numbered at least 100 full-time employees at life sciences organizations in 2017 and require a STEM background or technical expertise to function within their jobs. All are projected to outpace wider industry growth (+17.4%) over this period.

Fast-growing professions like **Computer and Information Research Scientists,** assorted **Engineer** occupations, **Statisticians,** and **Software Developers** all require high levels of numeracy and programming skills and will most likely quicken their pace of growth in the coming years.

[1]Employment at *Pharmaceutical Manufacturing* organizations in 2017 omitted from BLS published accounts

Projected Top 10 Fastest-Growing Support Occupations, 2017 - 2023, by Pct. Growth

Occupation	2017	2023	Diff	Growth
Public Relations Specialists	122	170	+48	+39%
Lawyers	298	414	+84	+28%
Market Research Analysts and Marketing Specialists	404	507	+103	+25%
Management Analysts	576	718	+141	+25%
Sales Managers	339	421	+82	+24%
Financial Analysts	252	310	+59	+23%
Training and Development Specialists	249	306	+56	+23%
Business Operations Specialists, All Other	525	642	+117	+22%
Training and Development Managers	148	181	+33	+22%
Human Resources Specialists	355	433	+79	+22%
Buyers and Purchasing Agents	363	443	+80	+22%
Medical and Health Services Managers	857	1045	+188	+22%
General and Operations Managers	1519	1846	+327	+22%
Accountants and Auditors	631	763	+132	+21%
Financial Managers	775	930	+155	+20%

Not all of the fastest growing positions at life sciences companies are in technical fields. Many are in administrative, operations, marketing, finance, or legal functions. Based on the recent trendline, these occupations will be growing as fast or at a greater rate than the industry as a whole.

Many of these fast-growing roles are in **Finance, Management,** or **Analysis.** Because of the fungibility of many of these roles with similar positions across the wider economy, workforce development bottlenecks are far less likely to occur, as their training is typically not specific to this industry.

Fastest Projected Growth, Occupational Groups, 2017 - 2023 by Pct. Growth

Occupational Groups	Pct. Growth	2017 Employment	2023 Employment	New Workers
Legal	+28%	367	501	+102
Computer and Mathematical	+27%	4,026	5,124	+1,098
Sales and Related	+27%	939	1,191	+252
Life, Physical, and Social Science	+27%	6,566	8,312	+1,746
Installation, Maintenance, and Repair	+25%	495	618	+123
Production	+24%	1,476	1,825	+350
Office and Administrative Support	+23%	6,332	7,763	+1,430
Business and Financial Operations	+21%	4,600	5,572	+972
Construction and Extraction	+20%	118	141	+23
Architecture and Engineering	+20%	19,038	22,794	+3,756
Management	+17%	10,387	12,175	+1,788
Healthcare Support	+14%	2,289	2,603	+314
Healthcare Practitioners and Technical	+13%	6,679	7,559	+879
Arts, Design, Entertainment, Sports, and Media	+12%	333	372	+39
Building and Grounds Cleaning/ Maintenance	+12%	458	511	+53
Protective Service	+10%	197	217	+19

Of the 16 distinct occupational groups within the life sciences industry, five make up three-quarters of the total industry employment in 2017 – **Architecture and Engineering** (30% of all workers), **Management** (16%), **Life, Physical, and Social Science** (10%), **Healthcare Practitioners** (10%), and **Office and Administrative Support** (10%). Of those, **Life, Physical and Social Science** occupations are projected to grow at the fastest clip, at 27% in the next 6 years.

Legal (+28%), **Computer and Mathematical** (+27%), and **Sales** (+27%) professions are the only groups of jobs forecasted to grow at an equal or greater rate than life science professions. Institutions of higher learning and training organizations will likely need to adapt to this paradigm and continue to respond to increasing demand for workers with academic backgrounds in science, engineering, and data.

Key Takeaways

1   MassBioEd projects the life sciences industry will add nearly 12,000 workers between May 2017 and May 2023.

2   Projected employment growth between 2017 and 2023 is projected to be 17.4%. This is less than the observed growth of the industry between 2011 and 2017, when it grew at 20.5%.

3   70% of the new jobs created in the industry are forecasted to be at organizations focused on biotechnology research & development.

4   **Pharmaceutical Manufacturers** are projected to grow by nearly 8%, less than half the rate the industry as a whole is projected to grow between 2017 and 2023.

5   **Legal, Computer-related, Sales,** and **Life Sciences** professions are expected to grow the fastest, all forecasted to grow by 27% or more.

6   **Public Relations Specialists** are projected to grow the fastest of all jobs in the industry, at 39%.

7   Top occupations such as **Biologists** (+30%), **Medical Scientists** (+24%), **Biochemists** (+22%), **Science Research Managers** (+22%), and **Chemists** (+20%) are all projected to grow faster than the industry as a whole between 2017 – 2023.

Labor Supply

In 2017, life sciences employers in Massachusetts listed the second-highest amount of job openings since 2010 – only 2016 had more. Employment continues to reach new highs almost every quarter.

As the industry continuously expands beyond preceding levels, higher pressure is placed upon the workforce development infrastructure in the region. Specialized work functions mean new workers cannot simply be poached from other industries or sectors.

For companies to onboard new employees to sustain their growth, there are only a few wells for which they can go. For highly specialized, experienced workers, employers may seek to recruit and relocate workers from the life sciences industry elsewhere. But for starter positions within industry, companies turn to the available pool of labor in the region, made up predominantly of recent graduates from related academic programs in Massachusetts and beyond.

Pct. Growth Since 2010

Associate **56%**

Bachelor's **51%**

Master's **100%**

Ph.D. **16%**

This section seeks to reveal underlying trends in conferrals at area institutions of higher learning in academic programs that act as feeders into STEM/Technical occupations needed by life sciences organizations. By comparing the relative growth in these entry level jobs to graduations from local universities and colleges, we hope to uncover any supply/demand imbalances that may cause life sciences organizations to look elsewhere for talent – or not expand in Massachusetts at all because of it.

Graduates of Biotech- related (see Appendix) academic programs from Massachusetts institutions of higher learning increased across the board since 2010 at each degree level.

Conferrals of Biotech-Related Degrees, MA Universities/Colleges, 2010-2017
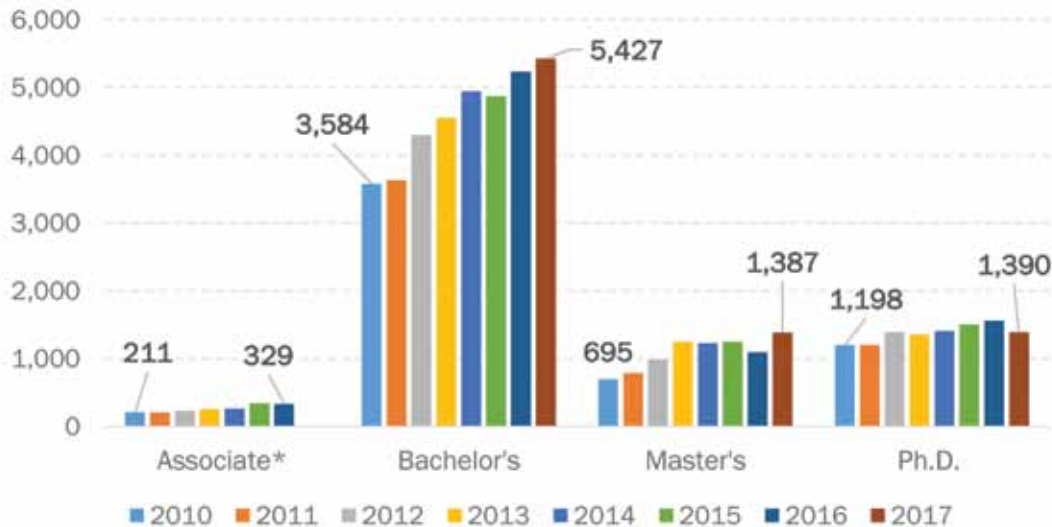
In terms of percentage growth since 2010, master's conferrals doubled, and bachelor's and associate degrees increased by over 50%. Lagging were Ph.D. conferrals, which rose by only 16%. This is due, in part, to 2017 performance, which showed the first dip in conferrals since 2013. In fact, 2017 was the lowest rate of conferrals for Ph.D.'s in biotech-related fields from all Massachusetts universities since 2011.

While overall growth in graduates, by itself, is impressive, it is important to gain a labor market context. We next look at the growth in conferrals versus the growth of entry level job openings in the life sciences industry, using this as a proxy for supply and demand for new workers.

At each degree level, and starting at the associate level, we compared each year's level of graduations and entry level openings at life sciences companies since 2010. We do this in two charts to illustrate the supply-demand dynamics at each level. One compares the sheer levels of conferrals and entry level job openings. This does not paint the whole picture – as many recent graduates leave the area or pursue career opportunities outside their academic field or do not join the local labor pool.

The second graphic conveys the rates of growth for both conferrals and entry level jobs by comparing each year to the base year levels of 2010. Thus, if in 2016 a job index is 2.03, it means that 103% more jobs were listed in that year than in 2010. Likewise, if a conferral index is 0.95, it means that there are 5% fewer graduates in that given year compared with 2010. Taken together, these graphics provide insights into whether the demand exceeds supply at each degree level.

Supply - Associate Degree

Associate Degree Conferrals vs. Entry Level Job Listings, 2010 - 2016

In most years between 2010 – 2016, local community colleges produced graduates at a near-parity with their associated entry level openings.

In 2015, graduates appreciably exceeded entry level listings, while 2016 saw the inverse, with listings exceeding conferrals.

The growth of entry level STEM/Technical job openings requiring an associate degree or less (which includes jobs requiring a certificate or H.S. education) generally matched that of conferrals in most years.

Between 2010 and 2016 (the last year with graduation data available) the growth rate of jobs for which recent graduates were qualified grew nearly 50% more. This means that the relative growth of demand exceeds supply. If this trend were to continue unabated, there will be a structural imbalance between supply and demand, with employers forced to either list these jobs with different educational requirements or seek talent from new sources.

However, it appears as if the supply-demand dynamic at the associate degree level is experiencing a brief fluctuation. For over 6 years the supply has nearly matched demand, and unless employers dramatically increase the number of entry level openings in the coming years, this parity should hold.

Growth in Associate Degree Graduations and Entry Level Job Openings, vs. 2010 Levels (2010 = 100)

Supply - Bachelor's Degree

Bachelor's Degree Conferrals vs. Entry Level Job Listings, 2010 - 2017

Since 2010, universities and colleges throughout the state have produced graduates of biotech-related programs at much higher numbers than entry level jobs. This makes sense – as fields like Biology (46% of entry level jobs outside of life sciences), **Chemistry** (62%), and **Biochemistry** (52%) have plenty of entry level job opportunities outside of life sciences companies – meaning that only a sub-set of these graduates seek employment in the industry, if they stay local at all.

Using LinkedIn's Alumni Network tool to estimate the percentage of students from each university that stays in Massachusetts post-graduation, we have a clearer estimate of the number of graduates who stay in Massachusetts after they receive their STEM degrees.

At the bachelor degree level, the relationship between conferrals and industry opportunities for them in Massachusetts is much closer when estimating the pool of recent graduates who stay local. While the number of graduates outpaces the number of life sciences opportunities for which they qualify, the gap has closed in recent years, meaning more open jobs for each potential new entrant into the life sciences workforce.

True Supply of Recent Conferrals vs. Entry Level Job Listings, 2012 - 2017

Annual Bachelor's Graduate Per Entry Level Job Openings - All vs. Local
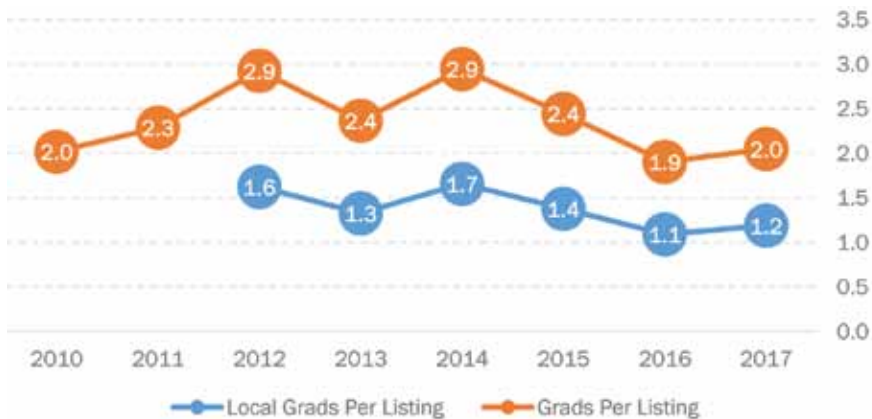
When taking into account those leaving the area after graduation, the number of graduates per entry level opening in the life sciences industry has been between 1.1 and 1.7, meaning a relative oversupply of graduates. This measure does not account for graduates who may seek employment in other industries, or those who go on to continue their studies. It is best used to show a trend over time. In this case, there have been a relative increase in entry level openings per graduate, which could portend a more difficult time for employers.

Growth in Bachelor's Degree Graduations and Entry Level Job Openings, vs. 2010 Levels (2010 = 100)

Growth in bachelor's degree graduates far outpaced the growth in the openings for which they qualified between 2010 and 2015. Only in 2016 and 2017, after a surge in entry level openings, did growth in entry level jobs catch up.

Basically, using growth since 2010 as a measure, the annual number of job listings and graduates had the same rate of growth in 2016 and 2017, meaning that over the long-term, both have grown at about the same rate.

Supply - Master's Degree

Master's Degree Conferrals vs. Mid-Level and Entry Level Job Listings, 2010 - 2017

Entry Level Listings: 628 (2010), 531 (2011), 555 (2012), 767 (2013), 562 (2014), 781 (2015), 1,044 (2016), 1,027 (2017)

Midlevel Listings: 1,445 (2010), 1,429 (2011), 1,784 (2012), 2,015 (2013), 2,000 (2014), 2,746 (2015), 2,891 (2016), 2,520 (2017)

Legend: Entry Level Listings — Midlevel Listings — Conferrals

Unlike at the associate or bachelor's degree levels, to measure supply and demand dynamics at the master's degree level requires inclusion of listings outside of jobs for new industry entrants, as many recipients of these professional degrees are already incumbent workers and are leveraging their master's degrees to advance within life sciences organizations.

There has been a dramatic increase in the total number of STEM/Technical jobs requiring a master's degree since 2014. 2015 – 2017, on average, saw a 35% increase in job openings against the 2013 – 2014 years. A large increase in openings requiring possession of a master's degree drove growth in conferrals in related fields, from 695 in 2010 to 1,387 in 2017, a **99%** increase.

Between 2010 and 2014, there was a creep towards more graduates per openings, perhaps due to workers looking to upskill during the Great Recession.

Since 2014, for both entry level and midlevel openings, the trend has somewhat reversed, as it has moved back towards more openings available per graduate. This can be explained partly by a surge in STEM/technical job listings requiring a master's degree at both entry level and the mid-career level at local life sciences organizations. Regardless, over the course of seven-plus years, there were consistently more graduates than entry level positions to fill, before accounting for graduates who left the area or sought employment elsewhere.

Between 2010 and 2017, growth in graduates from related master's academic programs grew at a faster rate than entry level or midlevel openings for those graduates, indicating a slight relative increase in supply over demand. Yet, in that same time, growth in midlevel and entry level listings grew by 74% and 66%, respectively. However, when using 2015 or 2016 as the cutoff date, the picture changes, as growth rates since 2010 in listings outpaced graduates. In all, it looks as if the growth in listings and graduates generally kept pace with one another, but with graduate growth slightly outperforming listings in most years.

Annual Master's Graduate Per Mid-Level + Entry Level Job Openings - All

Conferrals Per Entry Level Listings: 1.1 (2010), 1.5 (2011), 1.8 (2012), 1.6 (2013), 1.9 (2014), 1.6 (2015), 1.0 (2016), 1.4 (2017)

Conferrals Per Midlevel Listings: 0.5 (2010), 0.5 (2011), 0.6 (2012), 0.6 (2013), 0.6 (2014), 0.5 (2015), 0.4 (2016), 0.6 (2017)

Legend: Conferrals Per Entry Level Listings — Conferrals Per Midlevel Listings
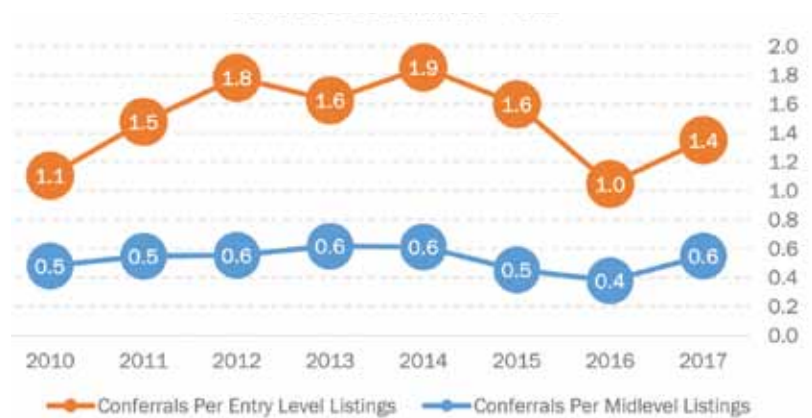
Growth in Master's Degree Graduations and Mid-Level / Entry Level Job Openings, vs. 2010 Levels (2010 = 100)

Legend: Graduate Index — Entry Level Job Index — Midlevel Job Index
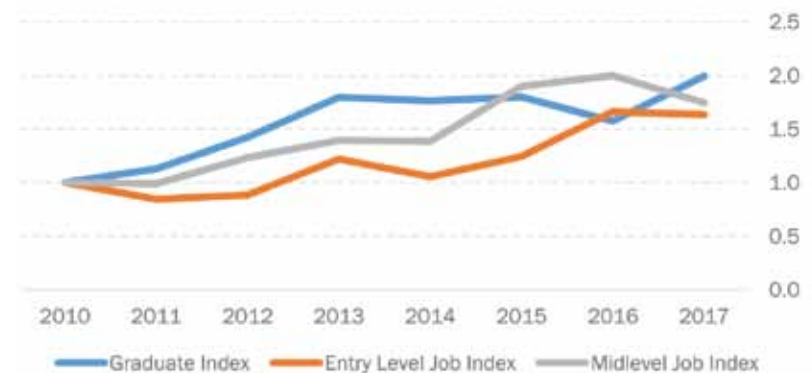
Supply - Ph.D.

Ph.D. Conferrals vs. Entry Level Job Listings, 2010 - 2017

Obviously, conferrals of biotech industry related Ph.D.'s far outpaced local demand for those recipients. That must be taken with a grain of salt, however. Many of our Ph.D.-granting institutions are world-renowned are preparing their Ph.D.'s not only for academic careers, but for industry opportunities flung across the globe. It is less instructive at the Ph.D. level to directly compare supply and demand in this way.

The trend over time shows that the number of Ph.D. conferrals per related entry level opening (requiring less than 2 years' experience) has closed in recent years, with 2016 and 2017 being the best years in the labor market for workers with biotech-industry relevant Ph.D.'s and less than 2 years' experience.

These trends in recent years portend good things for those exiting local Ph.D. programs that are also interested in pursuing careers within industry. If the trend continues, it means that the growth of entry level job openings is increasing at a faster rate than graduates of relevant programs. Inversely, local companies are requiring Ph.D.'s at ever-greater levels, but will have greater difficulties finding their talent locally, unless local universities produce more graduates.

Annual Ph.D. Per Entry Level Job Openings - All

Overall, the growth trendline for both Ph.D. graduates and entry level jobs for which they qualify follow a similar path. Since 2010, the annual number of job openings requiring a Ph.D. and less than 2 years' experience in Massachusetts has grown 43%, while the annual number of graduates in Ph.D. programs grew by 16%. So, while the gap between rates of graduates and jobs moved closer to 1:1, the job growth outstripped that of graduates capable of filling them by 27 percentage points.

Growth in Ph.D. Graduates and Entry Level Job Openings, vs. 2010 Levels (2010 = 100)

As is the case nationally, there are far more Ph.D. graduates than there are openings for them at life sciences companies. But the situation has improved in Massachusetts since 2010, as job growth has far out-paced growth in graduates. Job growth would have to reach yet-unsurpassed heights to achieve anything close to parity between graduates and industry openings.

Key Takeaways

1   At the associate degree level, supply of new workers and demand for new workers has essentially been even since 2010. The growth rates of both has remained even since 2010.

2   While Massachusetts universities and colleges produce far more biotech industry related 4-year graduates than there are positions. When accounting for who stays local, the ratio becomes much closer. In recent years there has been about 1.2 graduates to fill relevant entry level industry openings.

3   Master's graduates in biotech industry related fields have doubled since 2010, the most of any degree level. When including openings for midlevel positions demand has outgrown supply.

4   Growth in "starter" positions for Ph.D. candidates in industry has grown at double the rate than local universities have produced relevant Ph.D.'s since 2010.

5   In comparing 2017 to 2010, growth in annual entry level job listings approximately doubled the growth rate in conferrals at the associate and Ph.D. levels; at the bachelor's degree level growth rates were even; at the master's level high growth in conferrals meant it exceeded demand growth by approximately 33%.

Short-Term Supply Gaps

The Commonwealth of Massachusetts's Workforce Skills Cabinet, a collaborative effort between the Executive Offices of Education, Labor and Workforce Development, and Housing and Economic Development, has created a fantastic Regional Workforce Planning Initiative which includes a Supply and Demand Data Tool to locate pressure points in the labor market. Using this, MassBioEd, identified a few key industry occupations that are seeing contemporaneous demand exceed supply.

Below are 31 occupations with more than 100 incumbents within the life sciences industry in Massachusetts that currently have more statewide openings than workers able to fill them.

Occupation Title	Employment	New Demand Measure	Total Supply (Short Term)	Supply Gap
Medical Scientists, Except Epidemiologists	5,240	8,783	535	-8,248
Biological Technicians	5,120	7	0	-7
Biochemists and Biophysicists	3,430	21	20	-1
General and Operations Managers	1,519	2,903	1754	-1,149
Chemical Technicians	1,100	168	86	-82
Compliance Officers	820	10	3	-8
Industrial Production Managers	819	434	162	-272
Financial Managers	775	4,747	2395	-2,353
Mechanical Engineers	766	1,222	1123	-99
Marketing Managers	660	9,902	2067	-7,835
Accountants and Auditors	631	9,324	2255	-7,069
Architectural and Engineering Managers	595	942	330	-612
Computer and Information Systems Managers	579	2,835	978	-1,857
Management Analysts	576	6,078	1386	-4,692
Industrial Engineering Technicians	401	817	109	-708
Computer Systems Analysts	362	7,602	1590	-6,013
Human Resources Specialists	355	3,467	931	-2,536
Sales Managers	339	3,592	1096	-2,496
Human Resources Managers	307	2,738	707	-2,031
Lawyers	298	2,133	503	-1,631
Information Security Analysts	270	2,128	582	-1,546
Financial Analysts	252	2,633	1449	-1,184
Training and Development Specialists	249	1,622	360	-1,262
Purchasing Managers	227	1,032	252	-780
Computer and Information Research Scientists	216	726	86	-640
Logisticians	211	498	143	-355
Mechanical Engineering Technicians	201	113	43	-70
Public Relations and Fundraising Managers	161	1,997	292	-1,705
Training and Development Managers	148	190	77	-113
Public Relations Specialists	122	2,907	205	-2,703
Computer Programmers	118	2,409	675	-1,734

The larger the number, the larger the shortfall in the workers needed now versus the supply of workers available to fill them, which includes unemployment insurance claimants and recent graduates. Large numbers for positions with high employment totals at life sciences organizations, like **Medical Scientists, General Operations Managers, Financial Managers, Marketing Managers,** and **Accountants and Auditors,** could suggest the need for high salaries as companies compete for limited available talent or bid up and "poach" workers from other firms.

Long-Term Supply Gaps

Long-term supply gaps are more difficult than short-term gaps to measure, for myriad reasons. Here, we utilize data we developed on forecasted growth in employment, supply of graduates, and pay trends to come up with an idea of which occupations could pose issues in the workforce development pipeline in the coming years.

We grade key occupations on their projected growth, the trendline of supply of relevant graduates, recent growth in pay, projected growth in demand in competing sectors, and the size of the current supply gap to spotlight areas in which the supply of local candidates for positions will likely be exceeded by demand by a significant margin.

We scaled each metric 1-10 by percentile rank. A 1 being the least amount of labor market pressure and 10 being the highest pressure. For example, if an occupation is projected to grow in the highest decile of growth, it receives a 10; if it were exactly in the middle in terms of growth, it would receive a 5 for that category.

Also, if a given occupation's supply gap as a percentage of demand is negative (meaning more workers than openings), it would receive a very low score. We average the five metrics (when available) and rank these occupations by their average scores.

Occupations that consistently were graded difficult (scores of 5 or more in most categories) will appear at the top of the list, as they are projected to grow a great deal in the life sciences industry and across Massachusetts, have experienced sustained supply gaps and increased compensation in recent months, and the trendline of the pace of growth of relevant academic programs is less than that of projected job growth.

The following table has 36 occupations with more than 50 current workers at life sciences companies, ranked by their long-term supply gap outlook. Occupations with grades of 5 or more are projected to be difficult for supply to meet demand; under 5 is considered the inverse of that.

Long-Term Supply Gap Outlook, Key Occupations, Life Sciences Industry

Occupation	2017 Employment	MBEF Proj.	BLS Proj.	Short-Term Supply	YoY Pay Chg.	Long-Term Supply	AVG GRADE
Computer and Information Research Scientists	216	9	10	5	--	--	8.0
Biological Scientists, All Other	1,022	9	5	--	5	10	7.2
Medical Scientists, Except Epidemiologists	5,240	6	6	9	6	8	7.0
Software Developers, Applications	315	7	9	4	--	--	6.6
Information Security Analysts	270	7	9	1	--	--	5.9
Mechanical Engineers	766	8	4	1	10	--	5.6
Engineering Technicians, Except Drafters, All Other	434	9	2	--	6	--	5.6
Management Analysts	576	6	9	1	--	--	5.4
Biomedical Engineers	1,170	6	10	1	8	3	5.4
Quality Control Analysts	590	4	7	--	2	7	5.2
Statisticians	534	8	10	1	5	2	5.2
Lawyers	298	8	3	2	8	--	5.2
Industrial Engineers	1,009	6	4	1	10	--	5.1
Biochemists and Biophysicists	3,430	5	6	1	8	6	5.1
Medical and Health Services Managers	857	5	9	3	2	--	4.7
Training and Development Specialists	249	6	6	2	--	--	4.6
Chemical Engineers	182	2	3	1	9	9	4.6
Operations Research Analysts	75	2	10	1	6	--	4.5
Financial Analysts	252	6	7	1	--	--	4.5
Administrative Services Managers	527	4	6	1	7	--	4.5
Chemists	1,356	4	5	1	8	5	4.4
Natural Sciences Managers	1,666	5	4	1	--	7	4.2
Sales Representatives (Technical)	745	7	5	--	0	--	4.2
Technical Writers	97	2	6	1	8	--	4.2
Human Resources Specialists	355	5	5	2	--	--	3.9
Human Resources Managers	307	3	7	2	--	--	3.9
Sales Managers	339	6	4	1	--	--	3.8
Mechanical Engineering Technicians	201	8	2	1	--	--	3.8
Financial Managers	775	4	5	1	--	--	3.3
Compliance Officers	820	3	5	1	4	--	3.2
Machinists	86	2	7	1	--	--	3.2
Industrial Engineering Technicians	401	3	2	4	4	--	3.1
Chemical Technicians	1,100	3	4	1	4	4	3.1
Biological Technicians	5,120	2	7	1	2	4	3.1
Microbiologists	500	0	4	1	5	1	2.4
Quality Control Technicians	352	3	2	--	1	--	2.1

Metrics were not available for each category for each occupation, but for those that were, a picture is created of the supply gap outlook.

Key Takeaways

1   **Computer and Information Research Scientists** retained the highest grade, due to its high projected growth rate and current supply gap issues.

2   **Medical Scientists,** the occupation with the highest industry employment, graded 3rd highest, indicating a substantial supply gap outlook. It grades high in every category, from high projected growth rates to short- and long-term supply issues.

3   Other critical occupations that graded worse than average were **Biological Scientists, Biomedical Engineers, Quality Control Analysts, Biochemists,** and **Statisticians**. As stated above, their poor grades were due to a confluence of factors, mainly due to projected growth rates and current supply issues.

4   **Quality Control Technicians** (2.1), **Microbiologists** (2.4), **Biological Technicians** (3.1), **and Chemical Technicians** (3.1), each a key occupation, have scores below 5. With 5 being average, these grade as considerably easy to fill now and moving forward, as their projected growth rates are relatively low, with low supply and pay pressures and high growth rates forecasted in related academic programs. Life sciences organizations will likely not need to worry about the long-term viability of the local labor pool for these positions in the coming years.

5   Broadly speaking, a forthcoming tightening in the labor market for engineers appears to be in the offing. The job market for technician positions looks like it will favor employers with a strong supply of available workers.

Growth in Academic Programs

At all degree levels, biotech industry relevant academic programs experienced significant increases in the aftermath of The Great Recession, as adults in and out of the workforce were looking to upskill in the face of a historically-tight labor market. In recent years, the growth rate has flagged (while still increasing the sheer number of graduates).

Since 2010, annual growth has been high at each degree level except for the Ph.D. level. Annual growth of job listings has exceeded that of conferral growth at the associate and Ph.D. levels.

Growth has not been linear, as some years were flat or negative, followed by years with staggeringly high growth. The following chart shows the year-over-year growth of conferrals in biotech-industry related programs between 2011 and 2017.

> **Compound Annual Growth Since 2010**
> Associate **9.3%**
> Bachelor's **7.2%**
> Master's **12.2%**
> Ph.D. **2.5%**

Annual Growth in Biotech Industry Related Academic Fields, 2011 - 2017

One theme that's apparent in the accompanying graphs is that growth rates tended to be higher in the first half than the latter half of the preceding 6 years.

At the associate degree level, growth was steady, with a large jump in 2015 and slight declines in 2011 and 2016.

At the bachelor's degree level, growth was positive in most years, but has remained at about 5% since 2015.

The master's degree level has seen the most substantial growth, driven mostly by incredibly high rates of growth between 2011-2013 and 2017, with declining rates in between.

Lastly, Ph.D. conferrals have ebbed and flowed, with its largest 1-year decline occurring in 2017.

Biological Sciences Graduates, MA, 2010 - 2017

Conferrals within biological sciences programs across Massachusetts' colleges and universities rose across three levels, sharply at the bachelor's level (+38%) and the master's degree level (+50%), but hardly budging upwards at the Ph.D. level.

Public institutions within the state in 2017 accounted for 37% of bachelor's conferrals in this category, 13% of master's, and 18% of Ph.D.'s.

Biochemistry Graduates, MA, 2010 - 2017
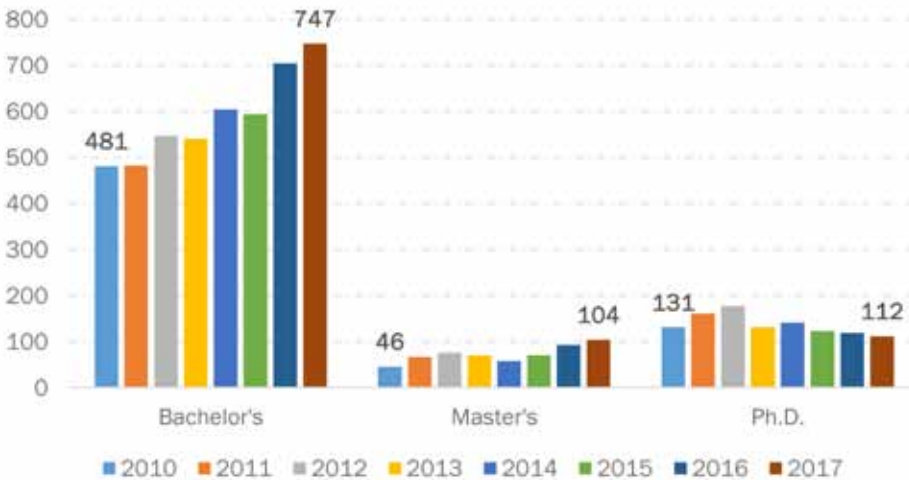
Growth within biochemistry programs rose by 55% at the 4-year level, doubled at the master's level, yet declined slightly at the Ph.D. level at Massachusetts institutes of higher learning since 2010.

31% of bachelor's degrees in biochemistry fields were at public colleges and universities in 2017; 24% of master's and 7% of Ph.D. conferrals were also at public universities this past year.

Chemistry Graduates, MA, 2010 - 2017
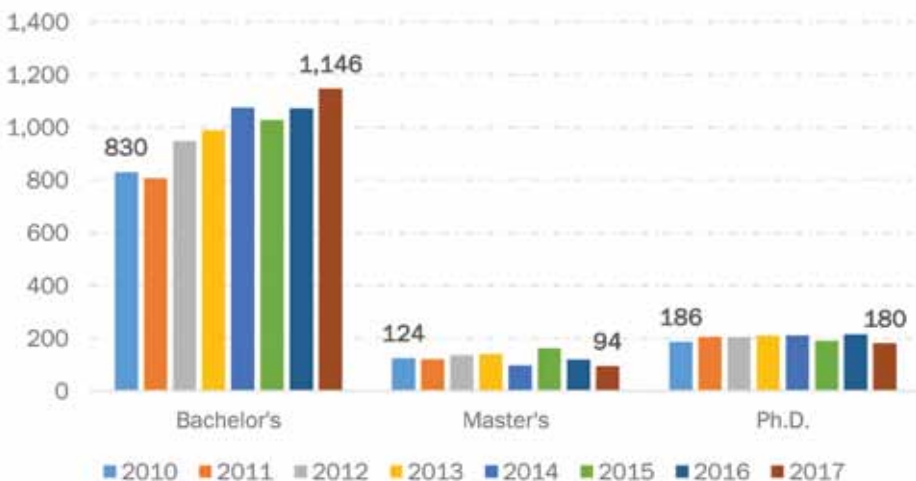
Bachelor's conferrals in chemistry rose 38% between 2010 and 2018. Master's conferrals fell by 30 between those two years, while Ph.D. conferrals remained remarkably consistent between 2010 and 2017, hovering between 180 and 210 in every year.

Chemical Engineering Graduates, MA, 2010 - 2017
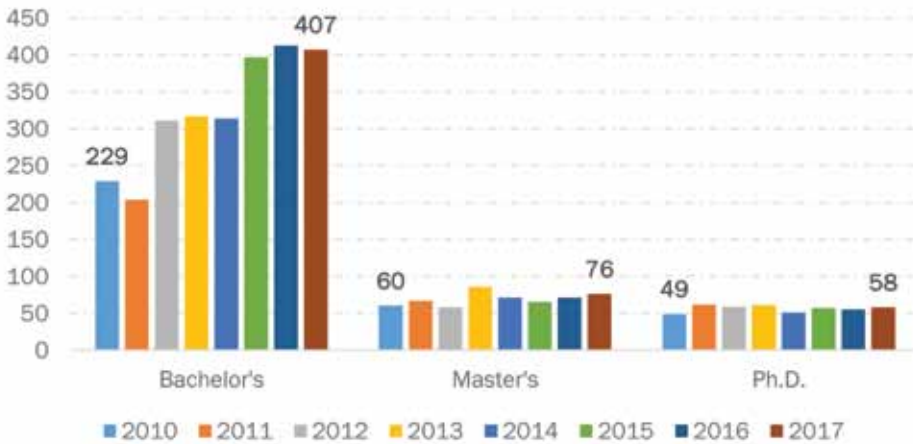
Mirroring the trend within the state's chemistry programs, chemical engineering conferrals at both graduate levels remained relatively stagnant between 2010 and 2017.

At the 4-year level, graduations rose by 78% between 2010 and 2017, among the highest rates for biotech industry-related fields.

Bioengineering Graduates, MA, 2010 - 2017
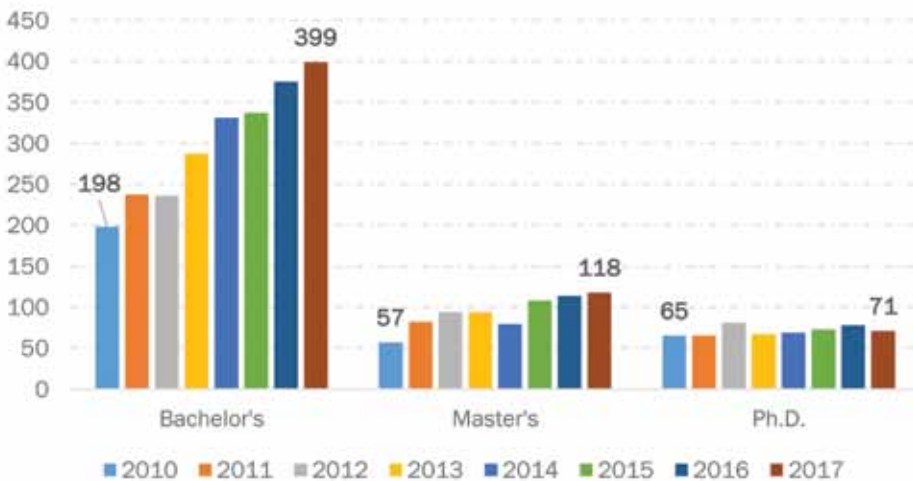
Bioengineering conferrals doubled at both the bachelor's (+102%) and master's degree (+107%) levels, rising in a linear fashion at the 4-year level.

Ph.D. conferral rose slightly, from 65 to 71 within that span of time.

Key Takeaways

1   Supply from the five program types (Biological Sciences, Biochemistry, Chemistry, Chemical Engineering, and Bioengineering) rose sharply at the bachelor's degree level between 2010 and 2017, from 38% to 102%.

2   Bioengineering and Chemical Engineering experienced the sharpest growth in supply since 2010.

3   Ph.D. conferrals in Biochemistry was the only subset to experience steady declines.

4   Across all levels, Chemistry had the lowest increases in conferrals, as the industry shifts from small molecule to large molecule therapies.

5   Growth rates in supply were higher in 2010 – 2013 and have lagged from 2014 – 2017.

Ph.D. Spotlight

In the Massachusetts Life Sciences industry, STEM/Technical job openings requiring a Ph.D. have risen steadily in recent years, as ever-greater levels of complex drug discovery, drug development, and clinical trials are conducted in the Commonwealth. About one-in-five technical openings in the industry require a Ph.D. – a staggeringly high number not seen in other industries.

In the previous section, we saw that growth in entry-level "starter" positions for Ph.D.'s in Massachusetts rose faster than that of conferrals from institutions across the state – job openings grew by 43% between 2010 and 2017 while related conferral rose by only 16%. In this environment, it is prudent to reveal the skill needs for these positions, as Ph.D.'s flock to life sciences companies in larger numbers than ever before.

In this section, we break out the "starter" job openings that have required a Ph.D. at life sciences organizations in Massachusetts into two buckets: those in drug development functions and those in clinical research. We then examine the differing skills needs of these jobs.

Life Sciences Openings Requiring a Ph.D < 2 Yrs., Exp. 2010 - 2017

2010 2011 2012 2013 2014 2015 2016 2017
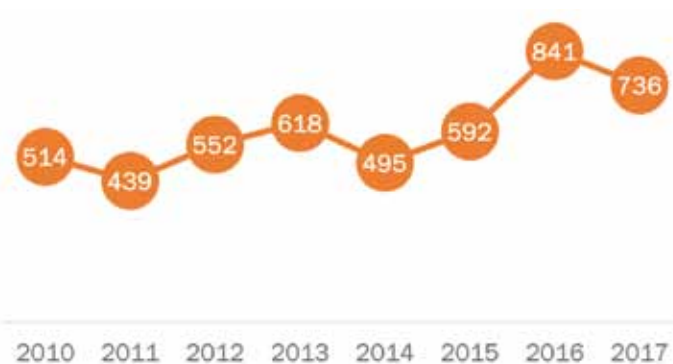
Drug Development

In roles requiring a doctorate and less than 2 years' experience, drug development was the largest subset. Nearly 45% of these positions were in drug development in 2017. These scientists are targeting assays, designing experiments, and driving innovation forward in the industry – they are the closest thing to essential employees that exist in the life sciences industry.

Drug Development Openings	2010	2011	2012	2013	2014	2015	2016	2017
Researcher / Research Associate	58	43	90	55	44	62	98	79
Chemical / Process Engineer	9	17	34	32	21	14	46	75
Medical Scientist	19	38	44	46	52	53	67	63
Biologist	38	17	27	33	45	42	54	40
Chemist	43	33	28	33	57	30	53	33
Biochemist	5	10	8	10	3	1	7	7
Biological Technician	1	2	1	0	0	0	2	5
Natural Science Research Manager	0	0	1	0	0	0	1	5
Biostatistician	6	6	10	10	12	14	8	2
Laboratory Technician	0	0	0	0	0	0	0	1
Biomedical Engineer	1	0	1	0	0	0	2	0
Microbiologist	1	2	0	0	0	2	0	0
Quality Control Analyst	0	0	0	1	0	0	1	0
Chemical Technician	0	0	0	0	0	1	1	0

Many of these positions are categorized into different scientific fields – general researchers like **Research Associates** and **Medical Scientists; Biologists, Microbiologists,** and **Biological Technicians;** and **Chemical Engineers** and **Chemists.**

Drug Dev. Openings Requiring a Ph.D. and <2 Yrs. Exp., 2010 - 2017

181	168	244	220	234	219	340	310
2010	2011	2012	2013	2014	2015	2016	2017
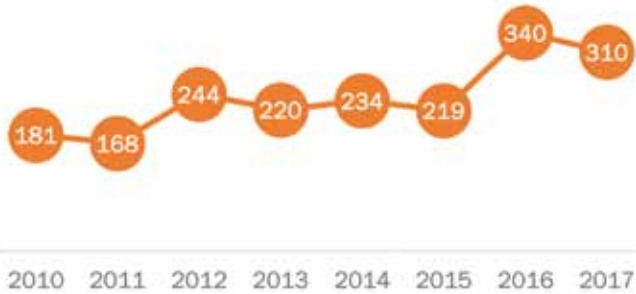
Overall, these openings have grown – especially so since 2015. Prior to 2016 the average annual number of job listings was 211. In 2016 and 2017, that average number increased to 325 (an increase of 54% percent).

As area companies expand their research and development expenditures, it only makes sense that these "entry level" positions increase dramatically. There are only so many experienced Ph.D.'s to go around in the industry.

## Top Skills - Entry Level Drug Dev. Positions, 2011 - 2017
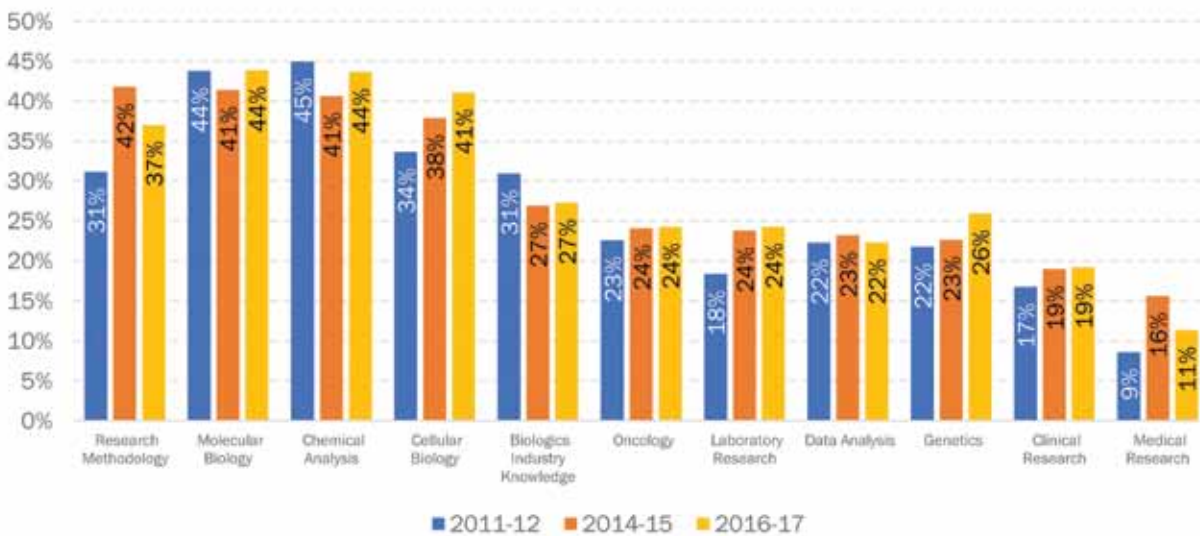
Across three separate 2-year periods since 2011 (2011-12, 2014-15, & 2016-17) we examine the top groupings of broad skills, or skill clusters, for entry level drug development roles requiring a Ph.D. Backgrounds in **Chemical Analysis** and **Cellular Biology** were required in near-equal numbers while the need for candidates with knowledge in **Data Analysis, Genetics,** and **Oncology** were all requested nearly 25% of the time.

Some skills have been growing in demand faster than others, as the drug development spaces grows and evolves with new technologies and therapeutic target areas.

Among the top skills shown above, **Laboratory Research** experience, **Cellular Biology** expertise, and knowledge in **Research Methodologies** have grown the most since the base period of 2011 – 2012.

Fast Growing Skills - Entry Level Drug Dev. Positions
Over the Long-Term
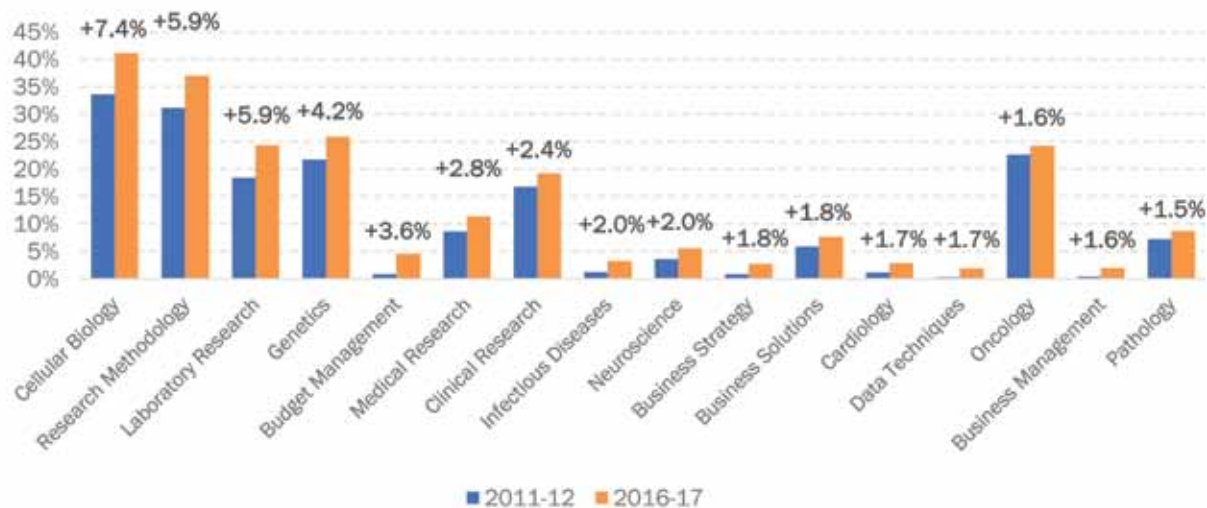
Over the long-term (since 2011-2012) many skills have grown sizably in terms of percentage-point increases. Demand for candidates with a background in **Cellular Biology** has grown by over 7 percentage points. Demand for candidates versed in various **Research Methodologies** and **Laboratory Research** experience have both increased by nearly 6 percentage points.

Emerging skills like **Budget Management, Business Strategy, Business Management** and **Data Techniques** have all grown from virtually no demand in 2011 – 2012 to about 2 – 3% of all job listings in this space.

Fast Growing Skills - Entry Level Drug Dev. Positions
Over the Short-Term
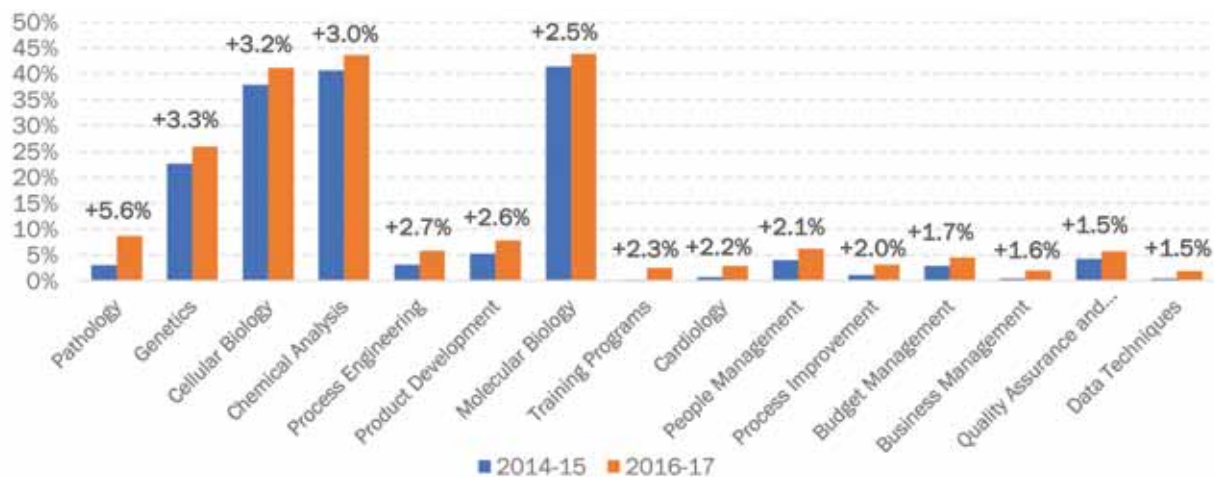
In the short-term, since 2014-2015, other skills have grown tremendously. **Pathology** (+5.6 percentage points), **Genetics** (+3.3), **Cellular Biology** (+3.2), and **Chemical Analysis** (+3) have all grown by at least 3 percentage points over the course of 4 years.

Top Professional Skills, Entry Level Drug Dev. Openings, 2011 - 2017
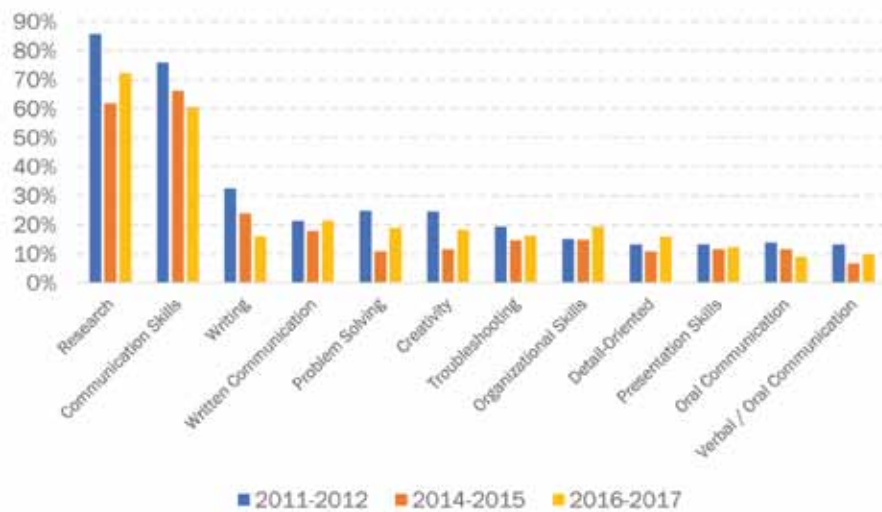
Top professional skills in these openings were **Research, Communication,** and **Writing,** with the former two appearing in over 60% of job openings since 2011.

Many of the remaining "soft" skills were in approximately 10% - 20% of job listings in a given year.
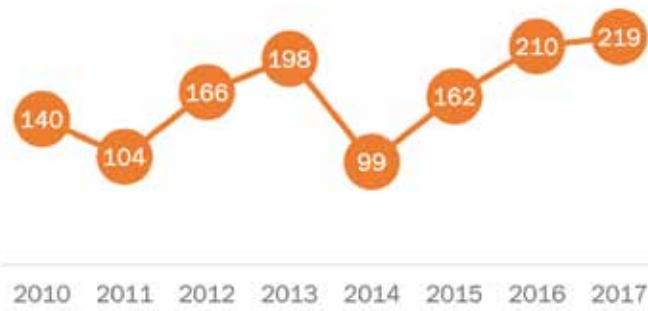
Clinical Research

In roles requiring a doctorate and less than two years' experience, the second largest subset were roles that were in some capacity involved in clinical research and clinical trials. These openings number anywhere between 100 – 200 in any given year.

Clinical Research Openings	2010	2011	2012	2013	2014	2015	2016	2017
Medical Scientist	20	17	28	33	29	50	57	74
Medical Director	40	11	25	55	14	12	21	20
Chemical / Process Engineer	4	3	8	3	6	1	10	20
Healthcare Administrator	6	5	20	19	5	13	9	16
Researcher / Research Associate	21	11	27	13	5	15	39	16
Biologist	4	7	11	13	12	14	13	12
Technical Writer	4	4	5	12	0	2	1	11
Biostatistician	15	17	17	18	13	19	13	9
Clinical Research Coordinator / Manager	7	10	9	4	5	5	17	9
Regulatory Affairs Specialist	2	4	5	7	2	1	2	6
Natural Science Research Manager	0	0	1	1	0	4	5	5
Data Scientist	0	1	0	0	0	0	0	4
Sales Representative	0	1	3	8	0	5	5	3
Computer Programmer	1	0	1	2	1	1	1	2

Clinician openings are concentrated in medical-adjacent professions, such as **Medical Scientists, Medical Directors, Healthcare Administrators,** and **Clinical Research Managers.**

Clinical Research Openings Requiring a Ph.D. and <2 Yrs. Exp., 2010 - 2017

While on an upward trajectory since 2010, there has been some annual blips, like in 2011 and 2014.

Since a nadir in job listings in 2014, the annual number of openings for these clinical research entry positions for Ph.D.'s has crept up each year, culminating in 219 in 2017, a 121% increase over the 2014 total.

## Top Skills - Entry Level Clinical Research Positions, 2011 - 2017
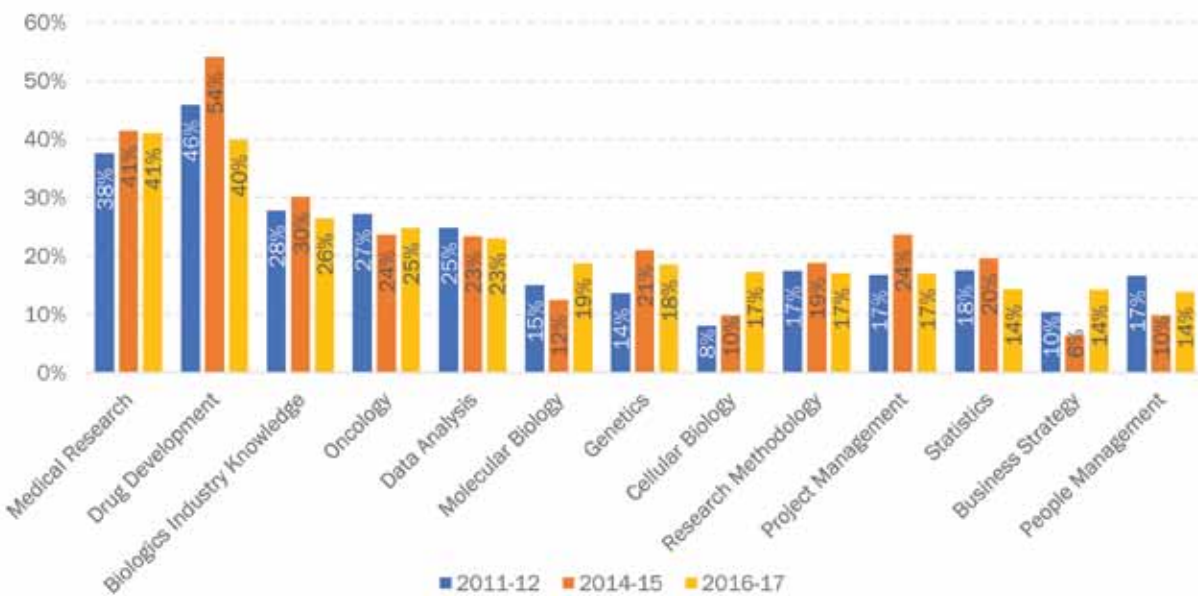
Medical Research and **Drug Development** skills are in the highest demand among these openings, followed closely by **Biologics Industry Knowledge, Oncology,** and assorted other skills.

Unlike in Drug Development openings, **Project Management, People Management,** and **Business Strategy** appear as top in-demand skills for these openings.
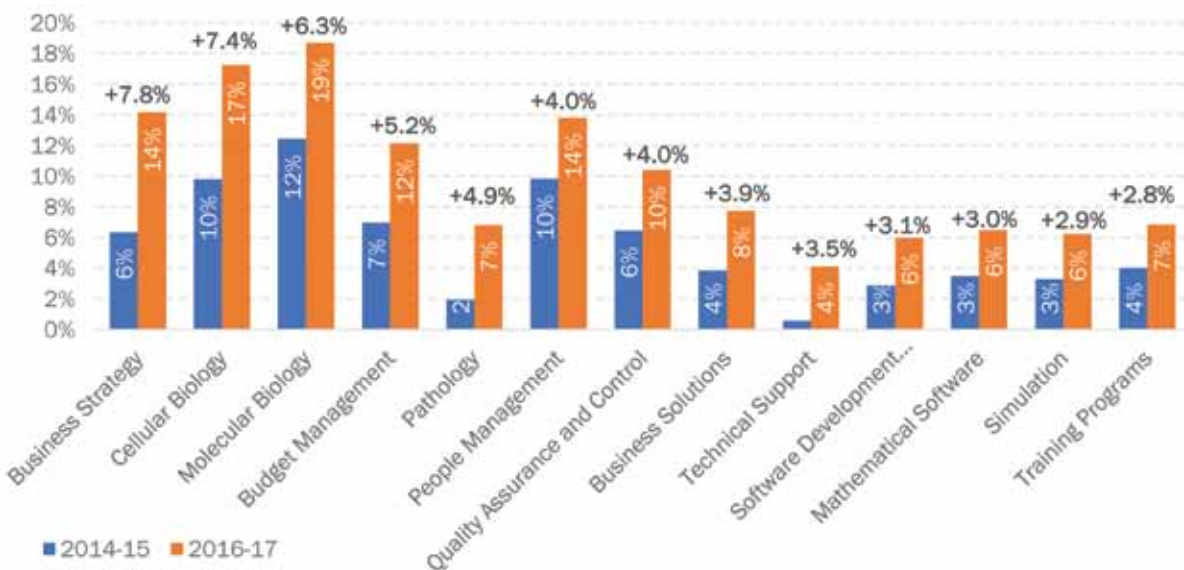
Scientific disciplines such as **Molecular Biology, Genetics,** and **Cellular Biology** all appear in the top 10 most frequently required skills.

Fast Growing Skills - Entry Level Clinical Research Positions Over the Long-Term
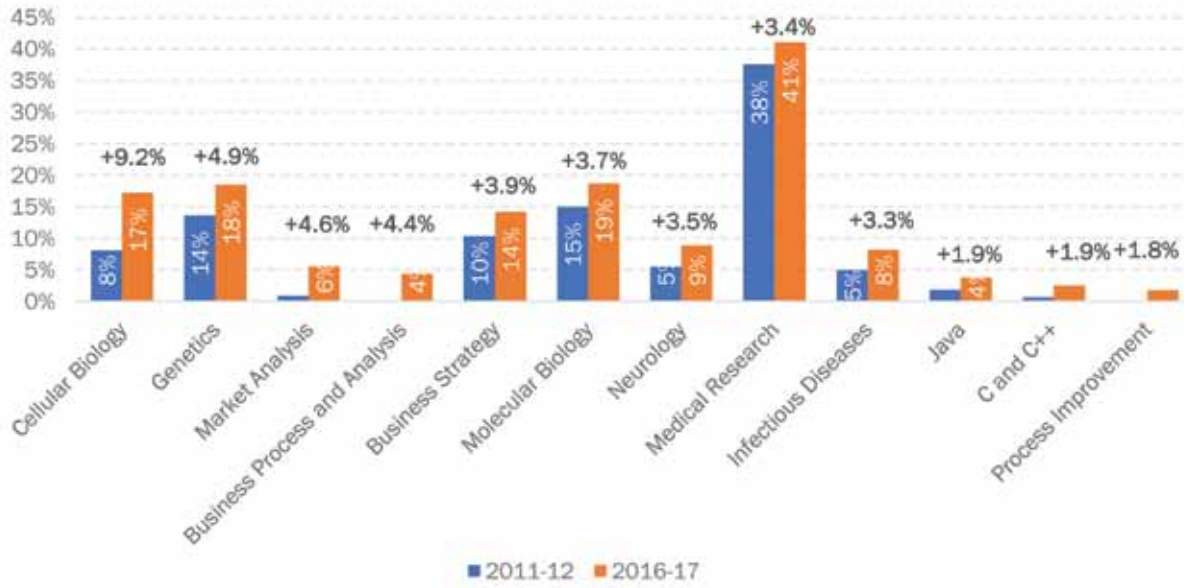
Clinical research openings skill demands have remained remarkably stable since 2011, with the exception of a few skills. Among the largest increases were in business-related skill clusters, such as **Market Analysis** (+4.6 percentage points since 20122-2012), **Business Process & Analysis** (+4.4), and **Business Strategy** (+3.9).

Fast Growing Skills - Entry Level Clinical Research Positions Over the Short-Term

Over the short-term, **Business Strategy** (+7.8) grew the most, while **Cell Biology** (+7.4), **Molecular Biology** (+6.3), and **Pathology** (+4.9) were the fastest growing scientific disciplines by requests.

Top Professional Skills, Entry Level
Clinical Research Openings, 2011 - 2017

Legend: ■ 2011-2012 ■ 2014-2015 ■ 2016-2017

Research and Communication skills were once again the most in-demand professional skills in starter positions for Ph.D.'s looking to work in Clinical research-related functions.

Writing and **Building Effective Relationships** came in closely thereafter.

Key Takeaways

1 Starter positions for Ph.D.'s have grown dramatically since 2011, annual **Drug Development** openings grew from 181 to 310, while **Clinical Research** positions grew from 140 to 219.

2 **Writing, Communication,** and **Research** skills were the most prevalent professional skills in openings for Ph.D.'s.

3 Business skills were required in much higher numbers for positions dealing with clinical research than they were for drug development ones.

4 The scientific disciplines of **Pathology, Genetics,** and **Cell Biology** have all grown significantly in demand in these openings since 2014.

5 **Data Analytics and Statistics** knowledge was far more prevalent in **Drug Development** openings that it was for **Clinical Research.**

Pay Growth

In 2017, MassBioEd started tracking quarter-by-quarter changes in industry pay by occupation and experience level with the hopes of better gauging pockets of job market pressure points for life sciences organizations. This data, in conjunction with data previously seen within this report on supply gaps, long-term supply trends, and employer demand, paint a near-complete picture of demand versus supply.

This section provides base salary growth by occupation type and within each occupation by experience level (entry, intermediate, and senior). Generally speaking, pay has risen across the board, save for a select few occupations.

The median growth rate for pay for entry level STEM/Technical positions was 7.9% in Q2 2018. Intermediate openings grew by 9.1%. At the senior-most positions at life sciences organizations, the median pay rate of growth was 10.1%. The escalation of the rates of base pay growth by the level of experience indicates that life sciences companies are finding it harder to onboard highly specialized and experienced talent without outbidding other suitors. The assumption can be made that at higher experience levels demand outstrips supply, where there is only a limited pool of qualified candidates ready to fill industry positions at the highest levels.

Annual Base Pay Growth in STEM/Technical Positions, Q2 2018

Entry **7.9%**

Immediate **9.1%**

Senior **10.1%**

Annual change in pay was measured as the difference between median base salary in Q2 2018 versus Q2 2017. These measures of pay increase do not include incentive pay – either short-term (like bonuses) or long-term (equities, stock option, etc.), which are also used often within the life sciences industry as part of a broader package to entice new workers or retain current ones.

In the positions tracked, **Engineering** had the highest levels of growth in base pay at each level, presumably driven by economy-wide demand for engineers, for which the life sciences industry plays a small role.

Management positions experienced the second-highest rates of growth in pay, at a rate of nearly 10% at all levels. **Life Sciences** and **Mathematical/ Computational** occupations grew at about the same rates at each level of experience.

In all, these positions grew at remarkably high rates, which were much higher than pay increases seen in other sectors in other parts of the country.

Occupation Type	Median Pay Growth		
	Entry	Mid	Senior
Management	+9.0%	+9.9%	+10.4%
Mathematical and Computational	+7.6%	+8.7%	+9.7%
Engineering	+11.7%	+12.1%	+12.5%
Life Sciences	+7.1%	+8.7%	+10.0%

For an extended look at industry compensation data, MassBioEd will be releasing the 1st Edition of its *Life Sciences Industry Wage & Compensation Report* this July, replete with pay by sector, region, years of experience, organization size, as well as non-technical positions.

Please contact Mark Bruso (Mark.Bruso@MassBio.org) for more information on how to receive this report.

Entry Level Median Pay Growth

STEM/Technical Occupations, ranked by year-over-year growth in median base salaries.

Fastest Growing Ocupations by Base Salary
Entry Level STEM/Technical Jobs, Q2 2018 vs. Q2 2017

Occupation	SOC Code	Median Entry Pay- Q2 2018	Q2 2017 Employment - All Levels	Entry Median
Mechanical Engineer	172141	$94,815	766	+16.2%
Quality Control Engineer	172112	$81,768	1,009	+15.2%
Manufacturing Engineer	172112	$82,948	1,009	+14.2%
Scientific Researcher	192032	$70,548	143	+13.0%
Biochemical Engineer	172041	$88,729	182	+12.6%
Biotechnology Engineer	191023	$90,308	–	+12.1%
Chemical Engineer	172041	$99,923	182	+12.1%
Pharmacist Consulting	291051	$133,225	97	+12.0%
Bioprocess Engineer	172031	$90,752	1,170	+11.7%
Chemical Test Engineer	172041	$94,879	182	+11.6%
Biomedical Engineer	172031	$88,048	1,170	+11.2%
Process Design Analyst	172112	$82,013	1,009	+11.1%
Toxicologist	191042	$66,911	5,240	+11.0%
Quality Assurance Analyst	151121	$62,369	362	+10.7%
Compliance Officer	131041	$119,594	820	+10.2%
Pharmacist Clinical	291051	$117,467	97	+10.1%
Biochemist	191021	$88,276	3,430	+9.8%
Medical Writer	273042	$71,817	97	+9.2%
Analytical Chemist	192031	$68,754	1,356	+9.0%
Clinical Research Manager	119111	$102,689	857	+9.0%
Regulatory Affairs Analyst	131041	$72,131	820	+8.9%
Clinical Research Scientist	191042	$87,274	5,240	+8.7%
Chemist	192031	$71,368	1,356	+8.6%
Regulatory Affairs Specialist	131041	$71,095	820	+8.6%
Compliance Manager	131041	$88,442	820	+8.6%
Clinical Research Coordinator	191042	$84,162	5,240	+8.5%
Regulatory Administrator	131041	$81,566	820	+8.4%
Biomedical Research Scientist	191042	$80,332	5,240	+8.1%

Of the entry level occupations that are experiencing the greatest growth in pay within the industry, 10 of the top 12 occupations by their year-over-year growth in base pay were in engineering positions – all of which grew by over 11% with entry pay north of $80,000.

Other entry level positions experiencing rocketing growth in pay are Scientific Researchers and Consulting Pharmacists, which both saw increases of 13% and 12%, respectively.

The vast majority of other fast-growing occupations by pay were in bench scientist roles or within the regulatory and/or compliance department.

Slowest Growing Occupations by Base Salary
Entry Level STEM/Technical Jobs, Q2 2018 vs. Q2 2017

Occupation	SOC Code	Median Entry Pay- Q2 2018	Q2 2017 Employment - All Levels	Entry Median
Pharmaceutical Sales Representative	414011	$77,627	745	-4.3%
Biotech Sales Representative	414011	$61,537	745	-3.2%
Manufacturing Worker	519199	$28,702	–	+0.7%
Medical Technologist	292010	$62,567	1,985	+1.1%
Quality Control Technician	519061	$42,781	352	+1.6%
Biology Aide	194021	$44,562	5,120	+1.9%
Research Technician	194031	$47,844	1,100	+2.0%
Technician Research	194031	$47,844	1,100	+2.0%
Medical Laboratory Technician	292010	$43,403	1,985	+2.0%
Quality Control Inspector	519061	$41,993	352	+2.4%
Quality Inspector	519061	$41,993	352	+2.4%
Clinical Research Technician	292010	$46,020	1,985	+2.7%
Laboratory Technician	194031	$45,918	1,100	+3.2%
Compliance Coordinator	131041	$44,372	820	+4.1%
Science Technologist	292010	$57,924	1,985	+4.2%
Technician Chemical Engineering	173029	$65,306	434	+4.8%
Physiologist	191029	$61,549	1,022	+5.0%
Laboratory Assistant	194099	$39,157	590	+5.1%
Clinical Research Associate	191042	$61,458	5,240	+5.2%
Biomedical Engineering Director	119111	$95,923	857	+5.3%
Chemical Laboratory Technician	194031	$52,956	1,100	+5.3%
Laboratory Technician Chemical	194031	$52,956	1,100	+5.3%
Quality Control Test Technician	173026	$60,456	401	+5.3%
Pharmacologist	191042	$93,387	5,240	+5.4%
Microbiology Technologist	194021	$63,003	5,120	+5.5%
Biologist	191029	$63,367	1,022	+5.8%
Statistician	152041	$82,506	534	+5.9%

Many of the "slower" growing occupations were in fact rising in pay but rated as such because their growth in pay was less than the median rate for entry level occupations this past year, which was 7.9%.

At the entry level, only Sales Representative occupations fell in pay this past year, with both occupations falling by more than 3%.

Many of the other occupations with pay growth lagging behind the industry-wide rate were in **Technician** positions, such as **Quality Control Technician, Research Technician,** and **Lab Technician**. Many of these occupations experienced rates of growth in entry pay of 3% or under, just enough to keep up with the rise of inflation.

Perhaps the most surprising inclusion in this table was **Statistician** due to the widely-held assumption that with the advent of big data and a shortage of professionals to match the growth in demand, pay would be expected to increase dramatically. While it did increase by 5.9%, this was actually 2 percentage points below the industry average in 2018.

Intermediate Level Median Pay Growth

STEM/Technical Occupations, ranked by year-over-year growth in median base salaries.

Intermediate is defined as positions which require a handful of years of experience, require greater knowledge/training than entry level, require less supervision, and allow for more autonomy.

Fastest Growing Occupations by Base Salary
Intermediate STEM/Technical Jobs, Q2 2018 vs. Q2 2017

Occupation	SOC Code	Median Entry Pay- Q2 2018	Q2 2017 Employment - All Levels	*Entry Median*
Mechanical Engineer	172141	$111,837	766	+16.5%
Quality Control Engineer	172112	$97,570	1,009	+16.1%
Manufacturing Engineer	172112	$99,766	1,009	+14.8%
Manufacturing Engineering Supervisor	172112	$116,504	1,009	+14.0%
Scientific Researcher	192032	$89,887	143	+13.8%
Research Manager	119041	$133,753	595	+13.7%
Toxicologist	191042	$84,021	5,240	+13.2%
Biochemical Engineer	172041	$106,574	182	+12.8%
Biotechnology Engineer	191023	$108,810	–	+12.8%
Quality Assurance Analyst	151121	$75,248	362	+12.4%
Manufacturing Engineering Manager	119041	$127,656	595	+12.4%
Chemical Engineer	172041	$114,345	182	+12.3%
Chemical Test Engineer	172041	$116,317	182	+12.2%
Bioprocess Engineer	172031	$108,921	1,170	+12.0%
Pharmacist Consulting	291051	$157,222	97	+11.9%
Process Design Analyst	172112	$101,087	1,009	+11.9%
Biomedical Engineer	172031	$105,782	1,170	+11.5%
Intellectual Property Director	231011	$179,243	298	+11.3%
Manufacturing Manager	113051	$112,062	819	+10.9%
Biochemist	191021	$105,509	3,430	+10.8%
Chemist Clinical	191021	$105,509	3,430	+10.8%
Chemical Engineering Supervisor	172041	$125,530	182	+10.8%
Compliance Officer	131041	$142,387	820	+10.8%
Analytical Chemist	192031	$84,514	1,356	+10.8%
Pharmacist Clinical	291051	$139,702	97	+10.7%
Medical Writer	273042	$86,127	97	+10.2%
Regulatory Affairs Manager	112031	$130,703	161	+10.0%
Clinical Research Scientist	191042	$104,350	5,240	+9.8%

The occupations with the greatest year-over-year rise in base pay at the intermediate level were in assorted Engineering professions, a few bench scientist roles, as well as management positions and regulatory/compliance roles.

The median pay raise for this group was even higher than at the entry level, at 9.1%, meaning exactly half of occupations grew faster and half slower than that rate. This indicates fierce competition for midlevel talent among life sciences companies, much more so than at the entry level.

The occupations with the biggest difference in the growth rates of their pay at the intermediate level versus the entry level were **Toxicologist** (median growth 2.2 percentage points higher at the intermediate level), **Biologist** (+2.1%), **Compliance Coordinator** (+1.9%), and **Microbiologist** (+1.8%).

Slowest Growing Occupations by Base Salary
Intermediate STEM/Technical Jobs, Q2 2018 vs. Q2 2017

Occupation	SOC Code	Median Entry Pay- Q2 2018	Q2 2017 Employment - All Levels	Intermediate Median
Pharmaceutical Sales Representative	414011	$90,874	745	-5.4%
Biotech Sales Representative	414011	$66,397	745	-4.1%
Laboratory Head	292010	$94,462	1,985	-1.5%
Medical Technologist	292010	$70,299	1,985	-0.2%
Manufacturing Worker	519199	$32,356	–	+0.8%
Quality Control Technician	519061	$48,372	352	+1.8%
Biomedical Engineering Manager	119111	$88,201	857	+2.0%
Quality Control Inspector	519061	$47,872	352	+2.5%
Medical Laboratory Technician	292010	$49,104	1,985	+2.7%
Research Technician	194031	$54,704	1,100	+3.5%
Technician Research	194031	$54,704	1,100	+3.5%
Biology Aide	194021	$50,922	5,120	+3.5%
Clinical Research Technician	292010	$52,701	1,985	+4.4%
Technician Clinical Research	292010	$52,701	1,985	+4.4%
Laboratory Technician	194031	$51,681	1,100	+4.6%
Laboratory Assistant	194099	$44,218	590	+4.8%
Biomedical Engineering Director	119111	$113,872	857	+5.1%
Pharmacologist	191042	$109,513	5,240	+5.2%
Physiologist	191029	$75,393	1,022	+5.4%
Science Technologist	292010	$66,611	1,985	+5.4%
Technician Chemical Engineering	173029	$73,822	434	+5.6%
Compliance Coordinator	131041	$51,996	820	+5.9%
Laboratory Analyst	194031	$42,854	1,100	+6.2%
Quality Control Test Technician	173026	$69,438	401	+6.3%
Microbiology Technologist	194021	$71,713	5,120	+6.4%
Chemical Laboratory Technician	194031	$60,716	1,100	+6.7%

With intermediate base salaries rising about 9%, all the of occupations in the "slowest growing" table grew slower than the industry average, despite in some cases growing as fast as 6.7%.

Many **Technician** positions reappear on this table and can be considered "intermediate" due to the number of years required for these positions, along with their greater levels of autonomy and skills and knowledge requirements.

As was the case at the entry level, **Sales Representatives** experienced the lowest growth, with each position falling by over 4%. This is in part due to falling demand (-15%) last year for all **Sales Representatives.**

Only two other intermediate positions experienced a drop in pay – **Laboratory Head** (-1.5%) and **Medical Technologist** (-0.2%). The rest of the above occupations experiences increases in pay acrossthe board, with only a handful falling short of cost-of-living increases – **Manufacturing Worker** (+0.8%), **Quality Control Technician** (+1.8%), **Biomedical Engineering Manager** (+2%), **Quality Control Inspector** (+2.5%), and **Medical Laboratory Technician** (+2.7%).

Senior Level Median Pay Growth

STEM/Technical Occupations, ranked by year-over-year growth in median base salaries.

Finally, we look at base salary increases for senior positions, or those that allow a greater deal of autonomy and complexity, with many managing or directly overseeing large departments or teams.

Fastest Growing Occupations by Base Salary
Senior STEM/Technical Jobs, Q2 2018 vs. Q2 2017

Occupation	SOC Code	Median Entry Pay- Q2 2018	Q2 2017 Employment - All Levels	*Senior Median*
Mechanical Engineer	172141	$133,670	766	+17.0%
Quality Control Engineer	172112	$116,786	1,009	+16.8%
Manufacturing Engineer	172112	$119,724	1,009	+15.4%
Manufacturing Engineering Manager	119041	$153,328	595	+15.2%
Toxicologist	191042	$104,517	5,240	+14.9%
Scientific Researcher	192032	$113,260	143	+14.7%
Manufacturing Engineering Supervisor	172112	$137,469	1,009	+14.6%
Research Manager	119041	$155,508	595	+14.3%
Quality Assurance Analyst	151121	$91,160	362	+13.9%
Biotechnology Engineer	191023	$131,921	–	+13.3%
Biochemical Engineer	172041	$128,909	182	+13.0%
Chemical Test Engineer	172041	$141,550	182	+12.7%
Process Design Analyst	172112	$123,763	1,009	+12.6%
Chemical Engineer	172041	$133,223	182	+12.5%
Bioprocess Engineer	172031	$131,672	1,170	+12.3%
Analytical Chemist	192031	$103,724	1,356	+12.2%
Pharmacist Consulting	291051	$184,296	97	+12.1%
Biochemist	191021	$126,502	3,430	+11.8%
Chemist Clinical	191021	$126,502	3,430	+11.8%
Intellectual Property Director	231011	$214,587	298	+11.7%
Biomedical Engineer	172031	$127,968	1,170	+11.6%
Compliance Officer	131041	$171,233	820	+11.5%
Manufacturing Manager	113051	$131,926	819	+11.5%
Pharmacist Clinical	291051	$164,876	97	+11.4%
Medical Writer	273042	$103,652	97	+11.3%
Chemical Engineering Supervisor	172041	$146,387	182	+11.3%

The median base pay year-over-year increase within senior-level STEM/Technical positions was 10.1%, 1 percentage point higher than at the intermediate level and 2.2 percentage points higher than at the entry level, once again confirming that there are increased pay pressures at higher experience levels.

Occupations exhibiting even higher rates of growth at the senior level as opposed to the intermediate level were **Manufacturing Engineering Manager** (growth rate was 2.8 percentage points higher at senior level), **Compliance Coordinator** (+1.8%), Biologist (+1.7%), and **Toxicologist** (+1.7%).

Many **Engineering** professions dominate this list, with a smattering of research and engineering managers, and some chemistry-based occupations filling out the rest of the list.

Slowest Growing Occupations by Base Salary
Senior STEM/Technical Jobs, Q2 2018 vs. Q2 2017

Occupation	SOC Code	Median Entry Pay- Q2 2018	Q2 2017 Employment - All Levels	Senior Median
Pharmaceutical Sales Representative	414011	$106,666	745	-6.3%
Biotech Sales Representative	414011	$73,662	745	-4.9%
Laboratory Head	292010	$108,748	1,985	-1.6%
Medical Technologist	292010	$80,284	1,985	-1.3%
Biomedical Engineering Manager	119111	$105,426	857	+1.8%
Biomedical Engineering Director	119111	$135,555	857	+5.0%
Pharmacologist	191042	$129,398	5,240	+5.1%
Physiologist	191029	$92,203	1,022	+5.6%

Not many occupations at the senior-most levels of biopharmaceutical organizations experienced slow growth or negative growth. In fact, only seasoned Sales Representatives, Laboratory Heads, and Medical Technologists experienced drops in pay. Outside of those occupations, only Biomedical Engineering Managers did not keep up with the increase in cost-of-living.

By and large, senior level professionals were immune to pay stagnation in 2018, signifying intense competition among life sciences organizations – start-ups through established pharmaceutical conglomerates – trying to outbid each other for a small pool of specialized workers ready to fill ever-growing openings at the highest levels.

Key Takeaways

After peering into the differences in pay increases across experience levels and occupation type, a few takeaways emerge, which link to some obvious conclusions about the life sciences job market in Massachusetts.

1   Engineering professions experienced the highest rates of base pay increases across all levels, likely driven by economy-wide demand for such positions. To compete, life sciences organizations must simply match these increases to stay competitive.

2   Sales and Technician positions were among the occupations with the lowest rates of pay growth. Sales Representative pay fell across the board, while Technician positions, like those in quality, lab, or manufacturing functions, failed to keep up with inflation in many cases.

3   Rates of growth in pay were much higher the more senior the position. The median rates of growth for senior positions was 1 percentage point higher than at the intermediate level, while the growth in pay at the intermediate level was 2 percentage points higher than for entry level positions.

4   Bench scientist roles were more likely than not to experience relatively higher rates of growth at higher experience levels than other positions, meaning higher relative competition among employers for those workers.

5   Regulatory, Compliance, and Medical Writing were more concentrated among the highest growing professions by pay at the entry level, but less so at higher levels.

2018 Industry Survey

2018 marks the third consecutive year in which MassBioEd/MassBio has conducted a survey of industry decision-makers about the state of hiring within the life sciences. The 25+ questions answered by 128 respondents give us insights into pressing workforce development issues vexing many organizations in the state. They also reveal preferences and expectations of those involved in hiring, allowing for inferences moving forward on what skills will be needed by workers. This survey was conducted in March and April 2018.

The vast majority of respondents come from companies defined as Drugs and Pharmaceuticals (63%), Research, Testing, & Medical Laboratories (11%), or Industrial Biotech (10%). Over 60% are intimately involved with the hiring process at their companies, with the remaining 40% aware of the hiring processes and issues within their organizations.

Respondent Company Type
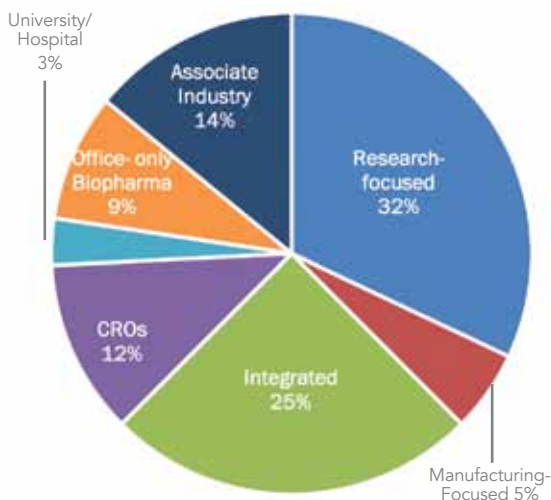
A satisfactory cross-section of the industry was represented in this year's survey. Nearly one-third of respondents were from research-focused establishments. One quarter were from organizations doing both research and manufacturing.

Associate Industries, such as contingent staffing (14%), CROs (12%), Office-only Biopharma (9%), Manufacturing-focused (5%), and Universities/ Hospitals (3%) round out the rest of the survey's respondents.

43% of respondents hailed from organizations with less than 50 employees in 2018.

34% reported being from organizations with 150 or more employees.

23% were from companies between 51 and 150 full-time employees.

Due to the high number of small, start-up firms in the space, it may be that this sample is underrepresented by those companies and skewed towards larger, more established firms.

Respondent Company Employees Size
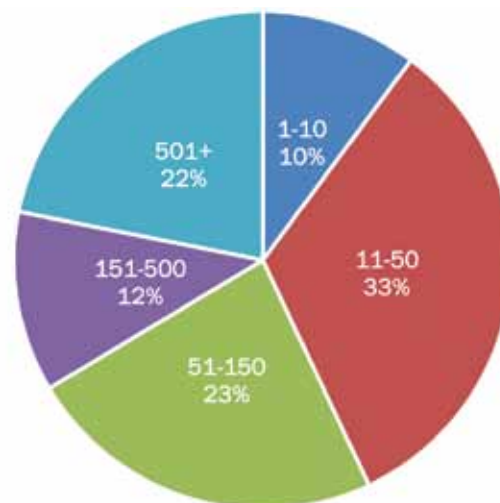
Significant Digits

83% of companies in this year's survey anticipate expanding employment at their respective sites in Massachusetts in the next 12 months. This is statistically the same as the past two surveys, where in 2017 82% and in 2016 87% of respondents indicated the same.

72% of respondents reported that their company increased their full-time equivalent (FTE) headcount in the past year, as employment reached record-highs.

65% of respondents reported the average time it took to fill openings at their company was 10 weeks or longer. This is 9 percentage points lower than in the 2017 survey, where 74% of respondents reported it being that long. In 2016, 52% of respondents indicated as much. 30% in 2018's survey indicated it took much longer – 13-plus weeks – to fill an opening.

55% of those polled indicated they expected to expand headcount within their Research and Development departments within the next 12 months, the most of any functional area. The next highest two were Clinical Research (41% of companies expecting to expand) and Regulatory Affairs/ Compliance (39%).

41% of companies with under 50 FTEs reported adding six or more full-time hires this past year. 16% of these small companies reported hiring more than 11 and as many as 25 full-time employees.

31% of respondents listed Clinical Research openings as more difficult or much more difficult to fill than other openings, the most of any category, followed by Regulatory Affairs/Compliance and Research & Development roles.

29% of companies reported having formal diversity initiatives (for either gender or race/ethnicity) at the contributor/non-management level. It was essentially the same rate at the management level. At the board level, the percentage of organizations reporting to have either form of diversity initiatives was just 17%.

18% of respondents indicated that compensation demands by experienced workers was the most detrimental effect on their bottom line, the 4th most chosen response after length of time to fill opening, worker turnover, and training/onboarding cost/length.

13% of the industry's workforce has required relocation expenses during onboarding, according to the 2018 survey.

Survey Particulars

Company Size sample sizes:

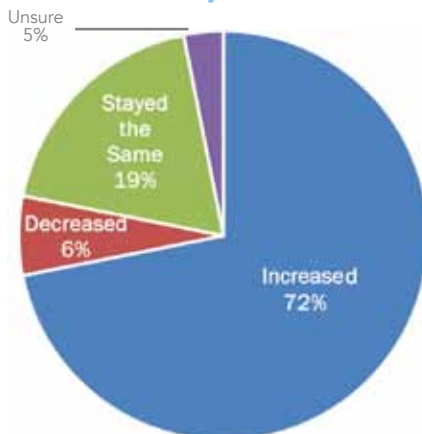Small (1-50 employees): n=55   Medium (51-150): n=30   Large (151+): n=43

Organizational Type sample sizes:

Research (R&D, Unis/Hospitals, CROs): n=60

Manufacturing-inclusive (Biomanuf., CMOs, Integrated ops): n=39

All Respondents

- Unsure 5%
- Stayed the Same 19%
- Decreased 6%
- Increased 72%

In the Past Year, Has Your FTE Headcount:

Reported increase in FTE by company size:

Large – 68%
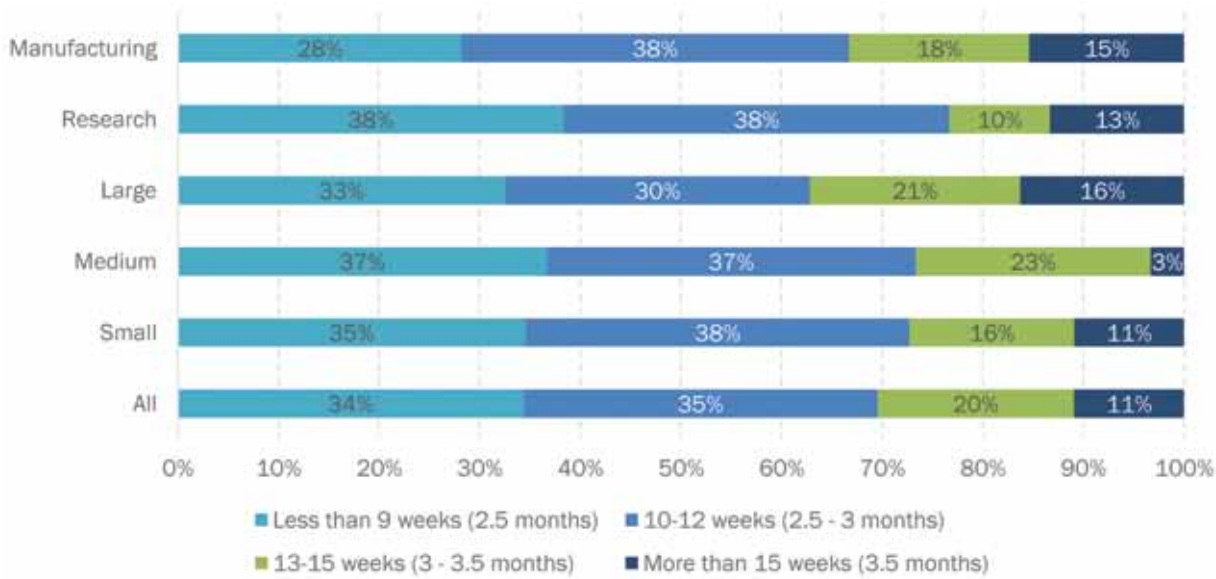
Medium – 83%

Small – 65%

Reported increase in FTE by company type:

Research – 75%

Manufacturing – 74%

What is The Average Length of Time it Takes to Fill an Opening at Your Company?

Average Time-To-Fill by Company Type Size

Legend:
- Less than 9 weeks (2.5 months)
- 10-12 weeks (2.5 - 3 months)
- 13-15 weeks (3 - 3.5 months)
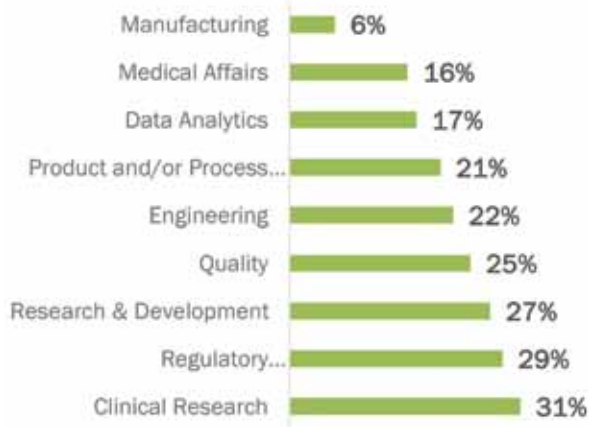- More than 15 weeks (3.5 months)

Identify the Functional Areas in Which You Expect to Expand Headcount in the Next 12 Months. Please Check All That Apply:

Functional Areas Expected to Expand in 2018

Legend: All, Small, Medium, Large, Research, Manufacturing
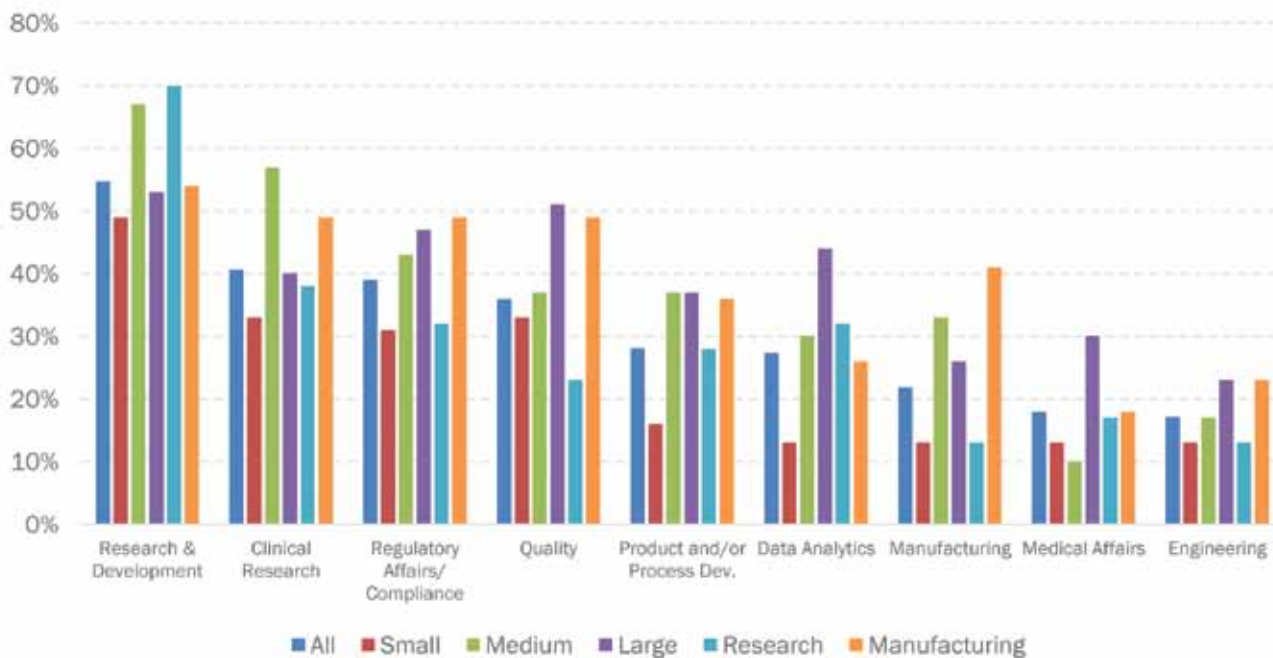
How Difficult has it Been to Fill Openings in the Following Functional Areas?
and Your Organization's Plans for Expansion by Functional Area

More Difficult/Much More Difficult Than Most Openings

Functional Area	Percent
Manufacturing	6%
Medical Affairs	16%
Data Analytics	17%
Product and/or Process…	21%
Engineering	22%
Quality	25%
Research & Development	27%
Regulatory…	29%
Clinical Research	31%

Planned Expansion by Functional Areas

Greatly Increase
Slightly Increase

Medical Affairs
Engineering
Manufacturing
Data Analytics
Lab Technicians
Product and/or Process…
Regulatory…
Quality
Clinical Research
Research & Development

0% 10% 20% 30% 40%

The top four functional areas ranked by industry professionals as most difficult to fill are, not coincidentally, the four areas in which most life sciences employers plan to expand in the next 12 months.

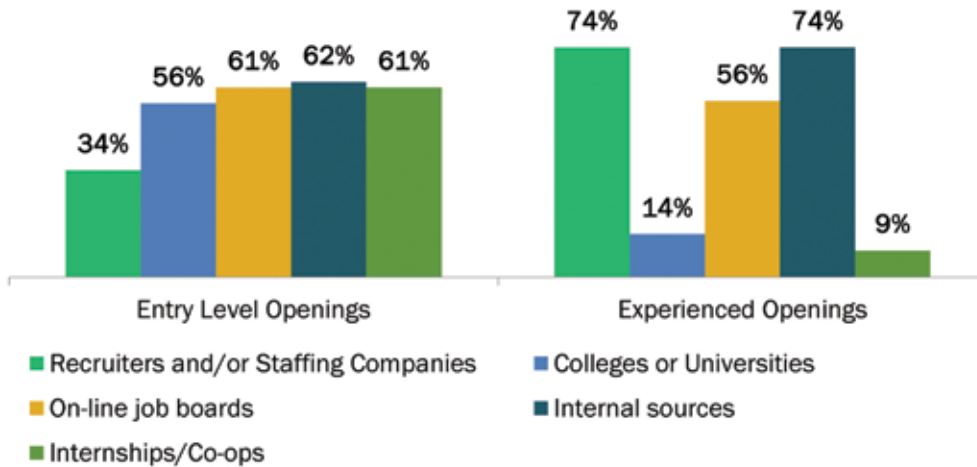## Approximately What Percentage of Your Workforce is Comprised of…

Composition of Workforce

	Percent
H1-B Visa Workers	8%
Required Relocation Expenses	13%
Contract Employees	16%

105 respondents (H1-B and Relocation) and 114 respondents (Contract Employees) answered three questions on the composition of their organization's workforce in these three realms.

In 2017's survey, 50% of companies stated they hire contract workers. The results from this year's survey reveal that about one-in-six industry employees are contract employees.

Do You Partner with or Use Any of the Following Organizations for Sourcing Talent?

Entry Level Openings: 34%, 56%, 61%, 62%, 61%
Experienced Openings: 74%, 14%, 56%, 74%, 9%

- ■ Recruiters and/or Staffing Companies
- ■ Colleges or Universities
- ■ On-line job boards
- ■ Internal sources
- ■ Internships/Co-ops

For entry level positions, life sciences organizations are far more likely to look to contacts at colleges or universities or candidates with work-based learning experiences when sourcing new hires.

For openings for experienced professionals, recruiters and internal sources (like informal networks) are likely to play an outsized role in finding talent. Online job boards are used by approximately 60% of organizations as a channel for finding talent at both entry and experienced levels.

Of the 82 survey respondents who answered this question, approximately 60% reported a lack of formal diversity initiatives in the hiring process at their respective organizations.

The rates for formal initiatives were essentially equal across gender and race/ethnicity across all job types: non-management (individual contributors), management, and board.

About 30% of organizations have set up formal diversity programs for non-management and management positions. For board positions, the number drops to 17%, or approximately one-in-six companies.

Formal Diversity/Inculsion Initiatives, PCT of Respondents Reporting Yes (You May Select Multiple)

Non-Management Hires: 29%, 28%
Management: 33%, 29%
Board: 17%, 17%
None: 61%, 59%

- ■ Gender
- ■ Race/Ethnicity
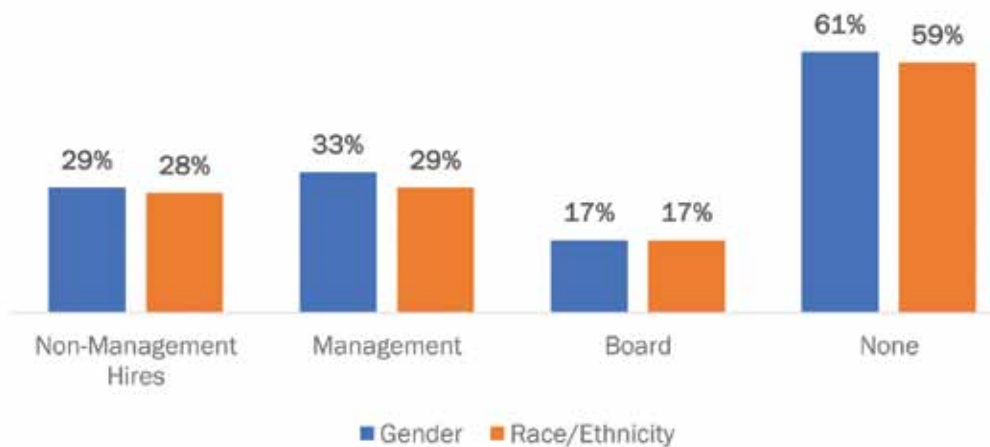
Which Soft Skills Are the Most Important for a Job Candidate to Demonstrate During the Interview Process?

Percentage of Respondents Including Soft Skill in Top 3 Most Important
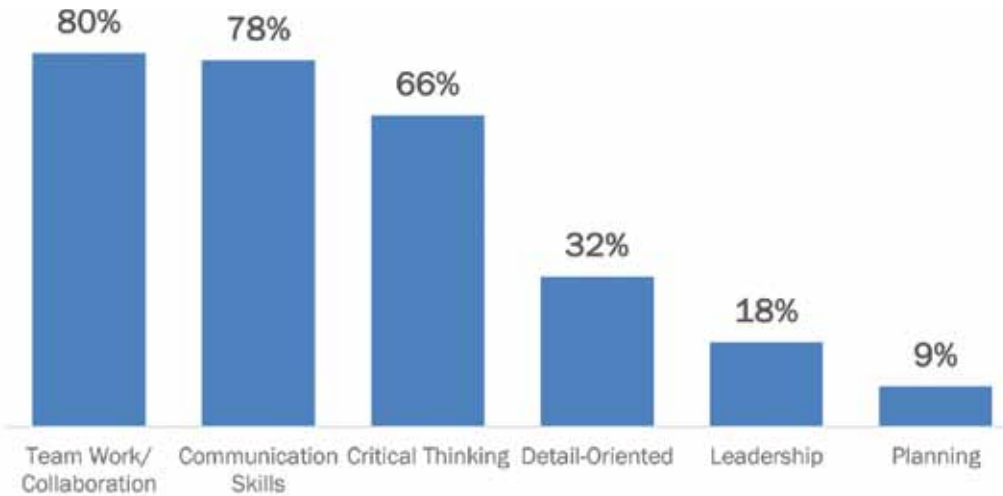

According to industry professionals, **Collaboration** and **Communication Skills** are the two top professional ("soft") skills to demonstrate during a job interview, at approximately 80% each.

Critical Thinking also appears on the top lists of respondents two-thirds of the time.

Of the Following, Which Has the Most Detrimental Affect on Your Organizations Bottom Line?

All Respondents
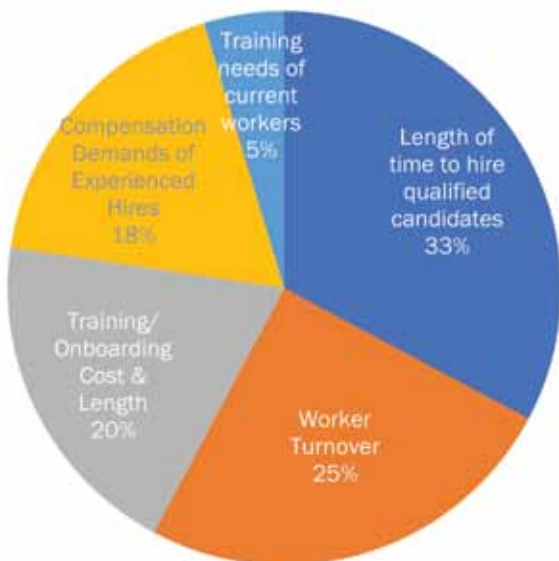
Among all respondents, the length of time to hire qualified candidates (33%), worker turnover (25%), and training/on boarding costs (20%) accounted for the biggest headaches and detriments to bottom lines.

Compensation demands of candidates for experienced roles was listed as the most detrimental effect on the bottom line by 18% of survey respondents, although we saw in a previous section how quickly worker compensation was growing for experienced workers throughout the industry.
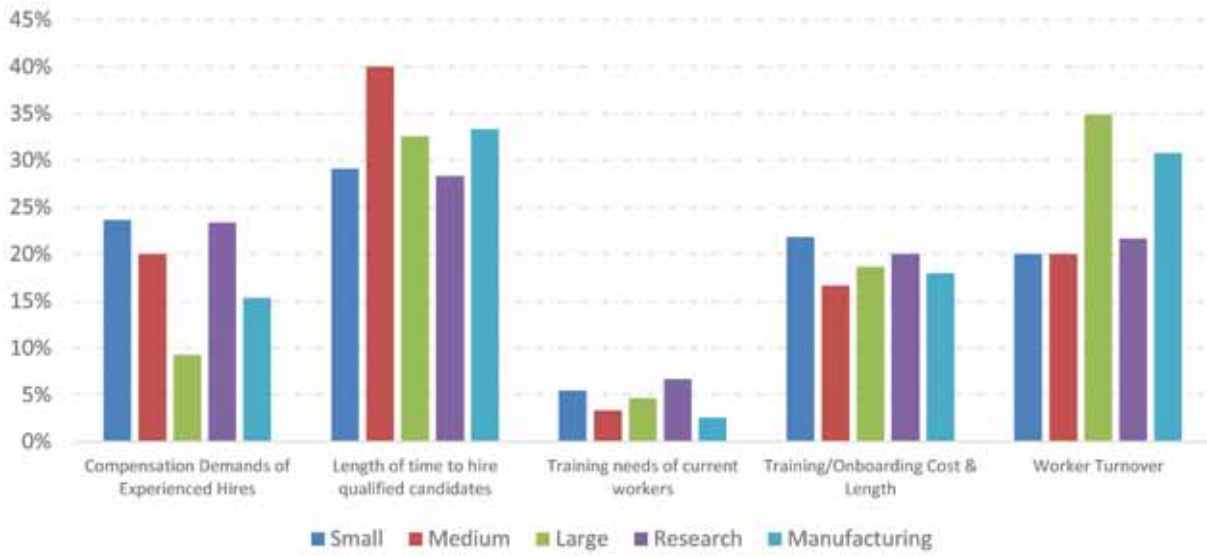
Larger companies are more likely to identify worker turnover and time-to-fill as detrimental organizational issues. Smaller organizations (especially R&D-focused ones) feel the pinch of paying experienced worker salaries much more so than larger organizations. Onboarding costs also affect these companies at a much greater rate. Manufacturing companies disproportionately report worker turnover as affecting their bottom lines.

Key Takeaways

1 Nearly three-quarters of respondents indicated net expansion of employment at their work sites in 2017, with 82% stating their anticipation of further expansion in 2018.

2 There is considerable room for life sciences companies to establish formal diversity initiatives in their hiring practices. Only about one-third of companies have them at any given level (non-management, management, or board).

3 **Clinical Research, R&D, Quality Control,** and **Regulatory Affairs** are primed for the largest expansions in 2018. All were listed as functional areas that are the toughest to find quality candidates, relative to other positions.

4 Larger companies report worker turnover and time-to-fill openings as the biggest workforce issue, while smaller companies feel the compensation demands of experienced workers more acutely.

5 The average time to fill open positions at life sciences organizations was essentially the same across company size and type. Larger companies do report a longer time waiting for the "right" candidate.

Appendix

Data Sources

- Burning Glass Labor Insight (2011 – 2016 Graduation Data, All Job Listings Data)
- University of Massachusetts President's Office, Neena Verma & Adam Collins
  (2017 Graduation data via IPEDS Data Center)
- Annual Industry Survey, SurveyMonkey
- BLS' QCEW Data Files (Employment Data)
- BLS' QCEW Multi-Screen Tool (Employment Data)
- BLS' OES Research Estimates by State and Industry (Staffing Composition of Industry)
- BLS' Consumer Expenditure Survey (Consumer Spending on products, by year)
- iShares by BlackRock (Biotech Stock Data)
- PwC MoneyTree (Venture Capital Funding Data)
- Bureau of Economic Analysis' GDP-by-Industry Data (final demand for sectors)
- NIH's RePORT ("NIH Awards by Location & Organization," NIH awards by sector)
- ERI's Salary Assessor portal (All Pay Data)
- Massachusetts Workforce Skills Cabinet: Regional Workforce Planning Initiative's Supply and
  Demand Data Tool, accessed on May 2nd – May 3rd (Current Skills Gap Analysis)
- LinkedIn Alumni Network Tool (Geographic destinations of recent university/college attendees)
- Massachusetts Executive Office of Labor and Workforce Development's Occupational Projections
  (all jobs), 2014 – 2024 (MA economy-wide projections)

"Life Sciences" Definition

Throughout this report we use the term "life sciences" to describe the industry in Massachusetts. It can be used interchangeably with the term "Biopharmaceutical" to describe organizations within the state engaged in either pharmaceutical/biologic manufacturing and/or biotechnology research & development. It does not encompass Medical Device companies (MassBioEd released a report on the Medical Device job market in 2016, and will include job market data from those companies in our Annual Forecasts starting in 2019).

Portions of additional sectors are categorized as "life sciences." They are Medical Testing Laboratories (100%), Analytical Lab Equipment Manufacturing (30%), Testing Laboratories (9%), Hospitals (4.5%), and Universities (1.9%).

Adjusted Listings Growth

Burning Glass's Labor Insight tool measures total, de-duplicated job listings. But, due to changing employer job posting habits and improvements in detection of Burning Glass's technology, comparing total job listings may not be the best way to measure industry growth year-over-year.

To adjust for this, we measured total industry listings as a percentage of all job listings in a given year within all industries in Massachusetts. Thus, growth is measured as the percentage change in the percent of industry job listings in Massachusetts from year-to-year. This measure should be taken in conjunction with the raw growth in job listings to illustrate true listings growth.

Biotech-Related Academic Programs

Biotech-related programs are academic majors filed under certain CIP codes (the federal academic program classification system) that teach core competencies used by occupations at biopharma companies.
The following table is the exhaustive list of what MassBioEd has deemed "biotech-related."

Bioengineering and Biomedical Engineering	Chemical Engineering
Industrial Engineering	Engineering Technology, General
Biomedical Technology/ Technician	Electromechanical Technology/ Electromechanical Engineering Technology
Instrumentation Technology/ Technician	Electromechanical and Instrumentation and Maintenance Technologies/Technicians, Other
Water Quality and Wastewater Treatment Management and Recycling Technology/ Technician	Hazardous Materials Management and Waste Technology/ Technician
Environmental Control Technologies/ Technicians, Other	Manufacturing Engineering Technology/ Technician
Industrial Production Technologies/Technicians, Other	Occupational Safety and Health Technology/Technician
Quality Control Technology/ Technician.	Industrial Safety Technology/ Technician
Hazardous Materials Information Systems Technology/ Technician	Quality Control and Safety Technologies/Technicians, Other
Biology/ Biological Sciences, General	Biomedical Sciences, General
Biochemistry	Biophysics
Molecular Biology	Radiation Biology/ Radiobiology
Biochemistry and Molecular Biology	Biochemistry, Biophysics and Molecular Biology, Other
Cell/ Cellular Biology and Histology	Anatomy
Cell/ Cellular and Molecular Biology	Cell/ Cellular Biology and Anatomical Sciences, Other
Microbiology, General	Medical Microbiology and Bacteriology
Virology	Immunology
Physiology, General	Pathology/Experimental Pathology
Pharmacology	Molecular Pharmacology
Neuropharmacology	Toxicology
Molecular Toxicology	Environmental Toxicology
Pharmacology and Toxicology	Pharmacology and Toxicology, Other
Biostatistics	Bioinformatics
Biomathematics, Bioinformatics, and Computational Biology, Other	Biotechnology
Ecology	Evolutionary Biology
Epidemiology	Neurobiology and Anatomy
Chemistry, General	Analytical Chemistry
Inorganic Chemistry	Organic Chemistry
Biology Technician/ Biotechnology Laboratory Technician	Chemical Technology/ Technician
Clinical/ Medical Laboratory Assistant	Pharmacy Technician/Assistant
Clinical/ Medical Laboratory Technician	Clinical Laboratory Science/ Medical Technology/ Technologist
Pharmacy	Pharmacy Administration and Pharmacy Policy and Regulatory Affairs
Pharmaceutics and Drug Design	Medicinal and Pharmaceutical Chemistry
Industrial and Physical Pharmacy and Cosmetic Sciences	Pharmacy, Pharmaceutical Sciences, and Administration, Other

STEM/Technical Occupations Definition

In the report, when STEM/Technical occupations were referenced, we used the following job filters within Burning Glass Labor Insight to extract the data:

By SOC Code		By BGTOCC Code	
Life Scientists, All Other	Computer Programmers	Medical Assistant	Manufacturing / Production Technician
Natural Sciences Managers	Architectural and Engineering Managers	Quality Inspector / Technician	Quality Control Analyst
Chemists	Economists	Assembler / Fabricator	Radiologic Technician / Technologist
Biological Scientists, All Other	Computer Systems Analysts	Production Worker	Data / Data Mining Analyst
Industrial Engineering Technicians	Database Administrators	Program Manager	Cytogenetic Technologist / Cytotechnologist
Statisticians	Social Science Research Assistants	Manufacturing Machine Operator	Computer Systems Engineer / Architect
Electronics Engineers, Except Computer	Materials Scientists	Regulatory Affairs Specialist	Cardiovascular Technician / Technologist
Mechanical Engineering Technicians	Computer User Support Specialists	Product Manager	Clinical Data Manager
Chemical Engineers	Computer and Information Research Scientists	Chemical Operator	General Engineering Technician / Technologist
Medical and Clinical Laboratory Technicians	Magnetic Resonance Imaging Technologists	Technical Writer	Network / Systems Administrator
Electro-Mechanical Technicians	Diagnostic Medical Sonographers	Production Manager	Computer Programmer
Mechanical Engineers	Materials Engineers	Medical Director	Chemist
Medical and Clinical Laboratory Technologists	Operations Research Analysts	Quality Manager	Biochemist
Industrial Engineers	Computer Hardware Engineers	Operations Manager / Supervisor	Biologist
Electrical Engineers	Microbiologists	Compliance Manager	Sterile Processing Technician
Software Developers, Systems Software	Life, Physical, and Social Science Technicians, All Other	Researcher / Research Associate	Compliance Analyst
Network and Computer Systems Administrators	Chemical Technicians	Health Technician / Technologist (Other)	Product Development Engineer / Manager
Software Developers, Applications	Medical Scientists, Except Epidemiologists	Non-Farm Animal Caretaker	Epidemiologist
Computer and Information Systems Managers	Biological Technicians	Sales Representative	Healthcare Administrator
Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	Biomedical Engineers	Medical Laboratory Technician	Civil Engineer
Engineers, All Other	Biochemists and Biophysicists	Medical Laboratory Technologist	Physicist
		Database Administrator	Robotics Technician
		Electrical and Electronics Technician	Radio Technician

Industry Protection Methodology

MassBioEd conducted its 3rd annual forecast of industry growth in May 2018. With a base month and year of May 2017 (latest available employment data with staffing patterns), we were able to forecast out through May 2023, both by industry size and individual occupations.

The first step was to estimate the size of the industry in May 2023. Each individual sector (3254, 54171, 54138, 3345, 622, 61131, and 6215) was broken out into the highest-digit NAICS code with available OES industry staffing patterns for May 2017 in order to isolate historical trends and contributing factors unique to each sector.

A multivariate ARIMA regression model was run for each sector. Differing from last year's model was the time periods used for the inputs, as well as the manner in which we forecasted growth among significant inputs to the regression model – in which we forecasted using the Exponential Triple Smoothing method.

For **Pharmaceutical Manufacturers** (NAICS 3254), additional independent variables are the previous 3-month rolling average of industry job listings (p-value = 0.0042), the Pharmaceutical Index Level from the previous six months (p-value = 1.23^{-17}), and the average monthly real output for all Pharmaceutical Manufacturers (p-value = 0.0058). The inputs to the model were weighted more heavily towards recent years. The resulting Adjusted R-Square, a measure of the total amount of variance of the dependent variable explained by the independent variables in the equation, was 0.83.

For **Biotechnology R&D** (NAICS 54171), the additional independent variable was the centered 12-month moving average of Venture Capital funding in the Massachusetts Biotech industry (sourced from PwC's MoneyTree tool) with a p-value of 0.016. The inputs to the model were weighted more heavily towards recent years. Following the same methodology as described above, the resulting Adjusted R-Square value was 0.94.

For **Testing Laboratories** (NAICS 54138), one additional independent variable was used: the real average monthly output of the NAICS code 5413, where 54138 resides. The p-value for this variable was 0.001. Following the same methodology as described above, the resulting Adjusted R-Square value was 0.93.

For **Analytical Laboratory** and **Instrument Manufacturin**g (NAICS 334516), one additional independent variable was used: the real average monthly output of the NAICS code 334516. The p-value for this variable was 0.003. Following the same methodology as described above, the resulting Adjusted R-Square value was 0.96.

For **Hospitals** (NAICS 622), one additional independent variable was used: the 12-month centered moving average of NIH funding of Independent hospitals in Massachusetts. The p-value for this variable was 3.9^{-9}. Following the same methodology as described above, the resulting Adjusted R-Square value was 0.90.

For **Medical Testing Laboratories** (NAICS 621511), one additional independent variable was used: the real average monthly output of the NAICS code 6215. The p-value for this variable was 0.003, and the Adjusted R-Square value for the model was 0.95.

For **Universities** (NAICS 61131), an autoregressive equation was utilized, which is essentially a "business-as-usual" approach. The Adjusted R-Square values was 0.16, meaning that the model could do a much better job at explaining the reasons behind the employment growth.

The resulting estimates of industry populations were completed by applying seasonality to the trend. All industries were then summed to complete the total industry growth projections.

After projecting total industry growth, we then looked to trends in staffing patterns within each sector – i.e. the share of each sector that occupational "families" had from May 2014 through May 2017. These occupational families are best seen as clusters of similar occupations, e.g. Life Sciences, Management, Engineering, etc. that are sources from the Bureau of Labor Statistics Standard Occupational Code system.

Next, in order to best predict industrial occupational composition in May 2023, we weighted the average share of each occupational family within each sector of the previous 5 years (60% of the 2017 rate, 30% of 2016, and 5% each of 2015 and 2014) to derive the estimate of each occupational family within each sector in May 2023.

Next, we applied the percentage change of each occupational family's sector share to each occupation within each occupational family, which resulted in a 2023 share for each occupation in each of the seven sectors of the industry, applied to the May 2023 total sector employment projections. They were then summed across sectors and compared against the May 2017 employment totals to come up with the projected growth or decline for all occupations between 2017 and 2023.

All Occupational Projections *(30 or More Employees in 2017)*

SOC CODE	OCCUPATION	2017 TOTALS	2023 PROJ.	PROJ. CHG.	PROJ. GROWTH
19-1042	Medical Scientists, Except Epidemiologists	5,240	6,475	1235	24%
19-4021	Biological Technicians	5,120	5,785	665	13%
19-1021	Biochemists and Biophysicists	3,430	4,187	757	22%
29-2010	Clinical Laboratory Technologists and Technicians	1,985	2,315	330	17%
11-9121	Natural Sciences Managers	1,666	2,025	359	22%
11-1021	General and Operations Managers	1,519	1,846	327	22%
19-2031	Chemists	1,356	1,629	273	20%
31-9097	Phlebotomists	1,230	1,363	133	11%
17-2031	Biomedical Engineers	1,170	1,433	263	22%
19-4031	Chemical Technicians	1,100	1,301	201	18%
19-1029	Biological Scientists, All Other	1,022	1,326	305	30%
17-2112	Industrial Engineers	1,009	1,252	243	24%
43-6011	Executive Secretaries and Administrative Assistants	1,002	1,250	247	25%
15-1133	Software Developers, Systems Software	995	1,292	296	30%
11-9111	Medical and Health Services Managers	857	1,045	188	22%
17-2071	Electrical Engineers	840	1,091	251	30%
17-2072	Electronics Engineers, Except Computer	840	1,099	259	31%
13-1041	Compliance Officers	820	969	148	18%
11-3051	Industrial Production Managers	819	914	95	12%
11-3031	Financial Managers	775	930	155	20%
17-2141	Mechanical Engineers	766	988	222	29%
43-6014	Secretaries and Administrative Assistants	762	929	166	22%
41-4011	Sales Representatives (Technical)	745	943	198	27%
43-9061	Office Clerks, General	720	888	168	23%
43-6013	Medical Secretaries	677	787	110	16%
11-2021	Marketing Managers	660	782	122	19%
43-1011	First-Line Supervisors of Office and Administrative Support Workers	643	794	151	23%
13-2011	Accountants and Auditors	631	763	132	21%
11-9041	Architectural and Engineering Managers	595	706	111	19%
19-4099	Life, Physical, and Social Science Technicians, All Other	590	716	126	21%
11-9199	Managers, All Other	583	681	98	17%
11-3021	Computer and Information Systems Managers	579	693	115	20%
13-1111	Management Analysts	576	718	141	25%
43-4051	Customer Service Representatives	547	673	126	23%
15-2041	Statisticians	534	687	153	29%
43-3031	Bookkeeping, Accounting, and Auditing Clerks	531	663	132	25%
11-3011	Administrative Services Managers	527	629	102	19%
13-1199	Business Operations Specialists, All Other	525	642	117	22%
19-1022	Microbiologists	500	529	29	6%
29-1069	Physicians and Surgeons, All Other	483	546	63	13%

SOC CODE	OCCUPATION	2017 TOTALS	2023 PROJ.	PROJ. CHG.	PROJ. GROWTH
31-1014	Nursing Assistants	455	531	76	17%
17-3029	Engineering Technicians, Except Drafters, All Other	434	567	133	31%
13-1161	Market Research Analysts and Marketing Specialists	404	507	103	25%
17-3026	Industrial Engineering Technicians	401	468	67	17%
15-1199	Computer Occupations, All Other	371	464	93	25%
13-1020	Buyers and Purchasing Agents	363	443	80	22%
15-1121	Computer Systems Analysts	362	464	103	28%
13-1071	Human Resources Specialists	355	433	79	22%
51-9061	Quality Control Inspectors	352	417	65	19%
11-2022	Sales Managers	339	421	82	24%
15-1142	Network and Computer Systems Administrators	330	418	88	27%
17-3023	Electrical and Electronics Engineering Technicians	325	415	90	28%
43-5021	Couriers and Messengers	317	424	107	34%
15-1132	Software Developers, Applications	315	397	82	26%
11-1011	Chief Executives	314	376	62	20%
11-3121	Human Resources Managers	307	362	56	18%
23-1011	Lawyers	298	414	84	28%
31-9092	Medical Assistants	289	330	41	14%
15-1122	Information Security Analysts	270	340	70	26%
15-1151	Computer User Support Specialists	258	310	52	20%
13-2051	Financial Analysts	252	310	59	23%
13-1151	Training and Development Specialists	249	306	56	23%
29-2032	Diagnostic Medical Sonographers	239	276	37	15%
37-2011	Janitors and Cleaners	237	288	51	22%
17-2199	Engineers, All Other	237	303	66	28%
43-5071	Shipping, Receiving, and Traffic Clerks	235	291	56	24%
11-3061	Purchasing Managers	227	270	43	19%
51-2098	Assemblers and Fabricators, All Other, Including Team Assemblers	225	271	46	20%
19-2021	Atmospheric and Space Scientists	223	288	65	29%
51-9011	Chemical Equipment Operators and Tenders	220	250	30	14%
51-1011	First-Line Supervisors of Production and Operating Workers	218	276	58	26%
15-1111	Computer and Information Research Scientists	216	284	68	32%
13-1081	Logisticians	211	264	53	25%
49-9071	Maintenance and Repair Workers, General	205	254	49	24%
29-2071	Medical Records and Health Information Technicians	203	229	26	13%
17-3027	Mechanical Engineering Technicians	201	259	58	29%
51-2028	Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	195	281	86	44%
37-2012	Maids and Housekeeping Cleaners	191	205	14	7%

SOC CODE	OCCUPATION	2017 TOTALS	2023 PROJ.	PROJ. CHG.	PROJ. GROWTH
17-2041	Chemical Engineers	182	238	56	31%
43-3021	Billing and Posting Clerks	180	234	53	29%
43-5061	Production, Planning, and Expediting Clerks	177	215	38	21%
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	177	181	4	2%
33-9032	Security Guards	168	207	39	23%
11-2031	Public Relations and Fundraising Managers	161	176	15	9%
11-3131	Training and Development Managers	148	181	33	22%
29-2034	Radiologic Technologists	148	165	17	12%
21-1022	Healthcare Social Workers	147	170	23	15%
19-2032	Materials Scientists	143	184	41	29%
29-2035	Magnetic Resonance Imaging Technologists	141	163	22	16%
49-9043	Maintenance Workers, Machinery	130	171	41	32%
27-3031	Public Relations Specialists	122	170	48	39%
19-2041	Environmental Scientists and Specialists, Including Health	122	164	42	35%
51-8091	Chemical Plant and System Operators	122	145	24	19%
41-3099	Sales Representatives, Services, All Other	119	159	40	33%
15-1131	Computer Programmers	118	150	32	27%
29-1123	Physical Therapists	110	123	13	12%
43-5081	Stock Clerks and Order Fillers	110	137	28	25%
39-9021	Personal Care Aides	104	90	-13	-13%
29-2055	Surgical Technologists	103	115	12	11%
43-4171	Receptionists and Information Clerks	98	116	18	18%
29-1051	Pharmacists	97	108	10	10%
27-3042	Technical Writers	97	140	43	44%
29-1171	Nurse Practitioners	97	104	8	8%
15-1141	Database Administrators	95	115	19	20%
29-1126	Respiratory Therapists	93	104	11	12%
31-1015	Orderlies	90	105	15	16%
29-2052	Pharmacy Technicians	87	96	10	11%
51-4041	Machinists	86	111	25	29%
21-1018	Substance Abuse, Behavioral Disorder, and Mental Health Counselors	83	92	9	11%
19-4061	Social Science Research Assistants	82	94	13	15%
31-9093	Medical Equipment Preparers	81	103	23	28%
29-2061	Licensed Practical and Licensed Vocational Nurses	77	86	9	11%
15-2031	Operations Research Analysts	75	100	25	33%
19-3011	Economists	74	94	20	27%
13-2031	Budget Analysts	73	85	12	17%
23-2011	Paralegals and Legal Assistants	69	86	18	26%
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers	68	86	18	26%
17-3024	Electro-Mechanical Technicians	64	78	14	22%

SOC CODE	OCCUPATION	2017 TOTALS	2023 PROJ.	PROJ. CHG.	PROJ. GROWTH
29-1071	Physician Assistants	63	70	7	12%
21-1091	Health Educators	57	67	10	17%
43-9021	Data Entry Keyers	56	76	20	36%
17-2061	Computer Hardware Engineers	54	70	16	30%
21-1023	Mental Health and Substance Abuse Social Workers	52	61	9	17%
35-2012	Cooks, Institution and Cafeteria	52	44	-7	-14%
29-2031	Cardiovascular Technologists and Technicians	51	57	6	12%
29-2051	Dietetic Technicians	50	57	6	13%
25-4021	Librarians	50	65	15	31%
11-3071	Transportation, Storage, and Distribution Managers	50	61	11	21%
11-3111	Compensation and Benefits Managers	50	64	14	28%
31-9096	Veterinary Assistants and Laboratory Animal Caretakers	48	64	16	33%
29-9011	Occupational Health and Safety Specialists	48	54	6	12%
13-1141	Compensation, Benefits, and Job Analysis Specialists	47	53	6	12%
29-1122	Occupational Therapists	47	53	5	12%
49-9041	Industrial Machinery Mechanics	47	65	18	37%
13-1121	Meeting, Convention, and Event Planners	46	53	7	15%
35-3041	Food Servers, Nonrestaurant	46	50	3	7%
43-4111	Interviewers, Except Eligibility and Loan	45	42	-3	-7%
15-1143	Computer Network Architects	45	59	14	31%
29-2099	Health Technologists and Technicians, All Other	44	49	5	12%
27-3091	Interpreters and Translators	43	47	4	10%
47-2111	Electricians	43	46	4	9%
43-3051	Payroll and Timekeeping Clerks	39	50	11	27%
43-9199	Office and Administrative Support Workers, All Other	38	41	3	9%
29-1127	Speech-Language Pathologists	37	42	4	11%
43-3011	Bill and Account Collectors	37	41	4	10%
15-1134	Web Developers	36	40	4	11%
29-2041	Emergency Medical Technicians and Paramedics	33	37	4	11%
47-2031	Carpenters	31	41	10	34%

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