Fitchburg State University
Department of Biology & Chemistry

Biology Program Review
2017-2024

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i. Executive Summary

The Biology program at Fitchburg State University is committed to providing our students with a top-notch curriculum encompassing all aspects of Biology. Currently, we offer 2 degree programs: a B.S. in Biology and a B.A. in Biology. There are several concentrations within the B.S. degree program including B.S. in Biology with Initial Teacher Licensure, Health Sciences, Biotechnology, Neuroscience and Behavior, and Environmental Biology. Since our last self-study, we have graduated 316 students, and currently have approximately 170 enrolled majors, 20 students in the biology minor and 25 students in the Neuroscience, Cognition and Behavior minor that we share with Psychological Science. Our students matriculate through a series of rigorous coursework that includes 4 core courses, a capstone course and 5 biology electives. Extensive coursework in Math, Physics, and Chemistry is also required. Our department offers a range of electives such as Human Anatomy & Physiology I and II, Evolution, Conservation Biology, Neuroscience, Molecular Biology, and many others that are often cross-listed with Chemistry courses such as Biochemistry, Medicinal Chemistry, and Metals in Biology. The electives taken may vary depending on the student's concentration (eg.. a Health Sciences student takes Human A&P and Biochemistry while a BIotechnology student takes Cell Culture Techniques and Molecular Biology). Because we are a liberal arts university, all biology majors must also participate in General Education courses that include writing, the arts, history, wellness, ethical reasoning, and literature.

One of the biggest strengths of our department is our dedicated faculty and their commitment to student success. We currently have 16 full-time biology faculty and 6 full-time chemistry faculty members. The faculty of the BIology and Chemistry programs work collegially on committees to write proposals and develop programs and policies for the department, and they have often collaborated on research programs. Faculty teach a 4/4 load (12 credits per semester) and are also involved in advising, scholarship, and service. Each faculty member meets with 8-11 advisees (biology & chemistry majors) every semester and helps them with coursework and career planning. Additionally, faculty-student research projects that promote continued scholarship are readily available to interested students and offer high-impact teaching practices outside of the classroom. Many of our faculty run active research programs with collaborators from Fitchburg State and elsewhere, which helps build professional networks and opens opportunities for both faculty and students. Service is also an important component of faculty load and all of our faculty serve on a variety of departmental and university-wide committees. In addition to on-campus service, faculty also are actively involved in community outreach projects with local organizations and schools.

We have been fortunate as a department to be in a relatively new science center (2013) with updated labs equipped with state of the art equipment and safety features. In 2023, we received a $750K grant from the Massachusetts LIfe Science Center to purchase updated molecular biology, biochemistry, and cell biology equipment. Altogether, we have an impressive inventory of instruments and equipment including multiple thermocyclers, an RT-PCR, genome sequencer, 2 fluorescent microscopes, a flow cytometer, a bioreactor, multiple laminar hoods, and many DNA/RNA/Protein kits ready for use. Access to this equipment has allowed us to work with students on various research projects and present

findings in publications and at conferences. We are provided with ample departmental funds to support course and lab supplies and have opportunities to seek additional funding for instrumentation through annual extrabudgetary requests.

The biology program offers many service courses to outside departments, including Nursing, Exercise and Sports Science (EXSS), and Chemistry. Two of our primary service courses are Anatomy & Physiology (BIOL 1200 & 1300) for which we offer 9-10 sections every semester for Nursing and EXSS majors. Additionally, faculty teach non-majors courses such as Intro to Life Science (BIOL 1000) or Life Science for Educators (BIOL1050), which fulfills requirements for the Scientific Inquiry (SI) component for General Education.

One of the major challenges of our department is the decrease in enrollments in our day programs. While we will continue to explore new avenues for student recruitment, student retention once they are enrolled is also paramount. Many of our majors are from underrepresented groups which often find college difficult to navigate in the first year. Because of this, most (if not all) of our introductory majors courses, including labs, are taught by full-time faculty. We also have a policy that students must earn a 2.0 in core introductory courses to continue with the major and they are able to repeat the courses once, if necessary. This helps us identify struggling students early to either help them develop the skills they need or to encourage them to find a more suitable major. Many of our students struggle due to the math intensity that is typical of chemistry courses that are required for the biology major. Because of this, we require students to place into pre-calculus or complete a basic math course before taking Gen Chem I. We also address math skills upfront in introductory Chemistry classes and offer additional help with math skills needed to succeed. Our small class sizes and access to faculty and tutoring on campus are just some of the means that have helped our students move through the program. An encouraging point is that once graduated, our students easily find biology and biotech-related jobs in the area.

Recruiting, retention, and enrollment over the last 5 years have been university-wide concerns, and measures have been taken to address them. For example, Fitchburg State hired a new VP for Enrollment, Dr. Richard Toomey, opened up an admissions center at Fitchburg High School, started offering more open houses and department tours, and bolstered our Academic Coaching Center on campus. Recruitment and retention will continue to be one of primary priorities as we navigate the future of our biology programs. We also are encouraged by the new General Education curriculum that includes mandatory courses like the First Year Experience (FYE) to help new students navigate the intricacies of college by teaching them important executive functioning and reading skills so they can be successful doing the work that is required of them. Furthermore, we hope to continue to improve upon our new program of embedded tutors in our Anatomy & Physiology courses to help the Nursing majors remain in their rigorous course of study. We are committed to using evidence-based approaches that employ authentic and innovative ways to engage, recruit, assist, and retain students. Our students are our first priority. As a department, we are committed to our mission of providing all of our students with enriching classroom, laboratory, and research experiences that teach them important skills that will stay with them throughout their personal and professional lives.

I. Program

A. Overview

Provide an overview of the program offerings (degrees, majors, concentrations, minors, certificates). Articulate the program's mission and vision and their alignment with the institutional mission and vision. What are the distinguishing features of the program? Are there discipline-specific best practices and is the program following them? Include an evaluation of program relevancy to the field and any advancements in the specific content area(s). Include how the program has changed since its inception to meet changes in the discipline or profession. Explain the balance between breadth and depth designed in the program.

Fitchburg State University is committed to excellence in teaching and learning and blends liberal arts and sciences with professional programs within a small college environment. The Department of Biology and Chemistry is central to this mission because it contains the largest basic science major on campus, biology, Bachelor of Science (BS) or Bachelor of Art (BA), a BS degree in chemistry with a new concentration in Biochemistry added in 2019, as well as minors in both biology and chemistry, and in collaboration with Psychological Sciences, a minor in Neuroscience, Behavior and Cognition. The department is a core component of the traditional liberal arts and sciences education offered at the university and as such we have three main objectives. (1) We prepare students interested in scientific or professional careers as well as (2) provide foundational experiences for other majors on campus especially in nursing, exercise and sports science, and education. (3) For non-majors, we offer courses to fulfill the scientific component of their liberal arts and science education.

Biology & Chemistry Department Vision Statement:

The Department of Biology and Chemistry provides undergraduate students with the opportunity to immerse themselves in the physical and life sciences by focusing on processes, concepts, and critical thinking skills, and to use this foundation to actively participate in scientific inquiry and the discovery of knowledge. Our approach to education and research imparts students with a way of thinking about and understanding our natural world that will guide them throughout their professional and public lives.

The department places a high value on interdisciplinary research, collaboration, and partnerships with other educators on and off campus. A rich collaborative community is fostered through internships, independent studies, and student collaborations with active faculty research programs; an environment that mirrors the diverse world that we share. As a department we work diligently to incorporate innovations in technology, research, and education that build upon our current strengths and meet the demands of a dynamic environment.

Biology & Chemistry Department Mission Statement:

The primary mission of the Biology Department is to provide students with a working knowledge of the life sciences that is part of a larger interdisciplinary, multicultural liberal arts and sciences education. We strive to:

- Produce students who are well prepared for careers and advanced study in the biological sciences and related fields.
- Maintain a high level of scholarly activity in a variety of fields associated with biology, chemistry and science education.
- Serve the needs of the entire college and specific academic departments through our curricular offerings and involvement in the college community.
- Provide state of the art pedagogical approaches as well as utilize appropriate equipment, technology, and resources for teaching, learning and research in the sciences and science education.
- Recruit and retain qualified students for our academic programs from diverse backgrounds.

In AY 2015 the department adopted content outcomes from the BioCore Guide of the American Association for the Advancement of Science (AAAS, Brownell et al., 2014). These learning outcomes derive from the 2011 Vision and Change report from the AAAS, a national effort to revise biology teaching. The BioCore Guide lists five core areas of biology:

- Evolution
- Pathways and Transformations of Energy and Matter
- Information Flow, Exchange and Storage
- Structure and Function
- Systems

Each core area is addressed at different scales or sub-disciplines in biology including Molecular/Cellular/Developmental BIology, Physiology and Ecological/Evolutionary biology. These learning outcomes were then mapped to our curriculum with a focus on the four core courses that all biology majors take. More details of our learning outcomes can be found in Section III: Assessment.

We chose to Implement the AAAS BioCore guidelines to ensure that our program aligns with national standards for scientific literacy and competency-based learning. These guidelines emphasize core biological concepts such as evolution, structure and function, information flow, and systems biology, helping programs create a cohesive and comprehensive curriculum. By integrating these principles in our courses, we hoped to foster critical thinking, help students make interdisciplinary connections, and increase access to hands-on research experiences, ultimately preparing students for careers in science, medicine, and biotechnology. Additionally, following AAAS BioCore recommendations supports evidence-based teaching strategies, promoting active learning and inclusivity to engage a diverse student population. This alignment not only improves student outcomes but also strengthens our program's credibility, making it more competitive for funding when seeking outside grants and recruiting students.

As a department, we continue to use best practices in STEM Higher Education. Our faculty are highly trained, caring, and focused on helping students reach their full potential during their academic and professional careers. We prioritize "gold-standards" in higher education such as keeping class sizes small and personal, embedding tutors into difficult introductory courses, having lecture/labs taught by the same instructors, implementing Open Educational Resources, offering hands-on research experiences with students, and hosting on-campus social events for and with students. We work closely with student support services including the tutoring center, career services, academic coaching, student affairs, and counseling services to ensure our students' academic, physical, and mental health needs are being met.

Through the School of Graduate, Online, and Continuing Education (SGOCE), the department of Biology and Chemistry has offered a variety of graduate degrees and/or licenses under the supervision of the Graduate Chair (Dr. Lisa Grimm) and Graduate Curriculum Committee. The primary purpose of our graduate program has been to provide a pathway for high school teachers to obtain the necessary degrees and licenses mandated by Massachusetts Department of Secondary and Elementary Education (DESE). Almost all of our graduate students have been in-service teachers in biology or chemistry high school classrooms. There is high demand for high school STEM teachers, especially chemistry, so this program has fulfilled an important role in the state of Massachusetts. However, declining enrollments precipitated discussions among the members of the Graduate Curriculum Committee and the entire department about how to improve retention and enrollment numbers in our degree and licensure programs. Prior to this review period, in the 2016-2017 AY, we decided to reduce the number of degrees and licenses offered in order to provide for our students a better educational experience. Having our matriculated students spread across so many different programs resulted in low course enrollments which resulted in course cancellations. Beginning in the 2017-2018 AY, after some streamlining, the following graduate degrees and licenses were offered: MA Biology, Post-Baccalaureate Initial Licensure (8-12), and M.Ed. Science Education. When it became clear that graduate enrollment numbers were not improving in our three remaining programs, discussions were initiated with members of the Graduate Curriculum Committee, the Education Unit, and Administration. From these discussions, a decision was made to place the remaining programs under suspension. All remaining active graduate students were placed in teach-out mode. Through the cooperation and flexibility of faculty, staff, and administration, our department was able to continue to offer graduate courses and when necessary receive approval for transfer courses. Therefore, all graduate students in teach-out mode successfully earned their degrees and licenses with the last student graduating in winter 2023.

Our extensive departmental efforts to prepare students for growing careers in the region are described in **Curriculum: C. Workforce alignment**.

B. Enrollment

Summarize and evaluate the seven-year admission, enrollment, retention, and graduation data

Following dramatic growth in the number of biology majors from 2008 to 2017, the number of majors declined from 272 in AY 2018 to 153 in AY 2024, as did the number of graduates (51 and 29,

respectively). The decrease in biology majors outpaced declines in university-wide enrollments. In addition, retention rate in biology was similar to the university-wide rate prior to this period but dropped consistently below since AY 2018. However, tour retention rates significantly improved in AY23-24, possibly through our continued efforts to support students both in and out of the classroom. We continue to have a strong cohort of minors in both Biology and Neuroscience, Behavior, and Cognition (a program that we share with Psychological Sciences) with 20 and 25 students currently enrolled, respectively. Our primary goal for the next several years is to increase the enrollment and retention of students, especially those in marginalized populations, in our programs. While our major enrollment has been a challenge, we continue to support the liberal arts programs. Consistently, 10-11% of the student population has been enrolled in a biology course in any given semester.

A majority of incoming biology freshmen identified as Black or African American, Hispanic, Asian, American Indian or Alaskan Native during this period (Fall 2017 to Fall 2023 average 56%). These trends are discussed in detail in **Students: C. Significant Trends**.

Enrollment Data for the Department of Biology and Chemistry is shown in the tables below:

Biology and Chemistry Departmental Trend Data

DAY SCHOOL	AY 14	AY 15	AY 16	AY 17	AY 18	AY 19*	AY 20	AY 21	AY 22	AY23	AY24	Trend
Number of Majors2	**260**	**281**	**306**	**301**	**300**	**294**	**255**	**208**	**185**	**163**	**170**	
Overall declared majors3	3,824	3,806	3,840	3,862	3,837	3,805	3,597	3,279	2,937	2,682	2,549	
Percentage of overall declared majors	**6.80%**	**7.38%**	**7.97%**	**7.79%**	**7.82%**	**7.73%**	**7.09%**	**6.34%**	**6.30%**	**6.08%**	**6.67%**	
Biology, B.A.	1	0	0	13	16	23	0	0	0	0	5	
Biology, B.S.	96	85	93	88	89	79	85	76	53	30	37	
Biology Secondary Ed w/ initial teacher's lic	5	6	4	2	5	6	0	0	0	0	0	
Biotechnology	26	28	21	21	15	19	19	18	16	17	15	
Environmental Biology	23	28	21	17	15	11	6	8	9	14	11	
Health Sciences, B.S.	96	113	136	119	124	122	112	85	83	80	74	
Health Sciences, B.A.	0	0	0	0	1	1	0	0	0	0	0	
Neuroscience and Behavior	10	10	13	12	7	5	6	5	7	5	11	
Chemistry	3	10	18	29	27	25	23	13	12	14	11	
Chemistry Secondary Ed w/ initial teacher's lic	0	1	0	0	1	3	1	2	1	2	3	
Chemistry Biochemistry							3	1	4	1	3	
												#N/A
Incoming Freshmen												#N/A
Biology	22	12	18	16	12	12	7	6	3	37	7	
Biology Secondary Ed w/ initial teacher's lic	1	0	1	0	0	3	0	2	0	0	0	
Biotechnology	1	2	2	3	2	5	1	3	1	0	2	
Environmental Biology	3	9	4	0	3	1	0	3	2	0	1	
Health Sciences	34	32	44	20	44	29	34	25	21	0	17	
Neuroscience and Behavior	4	2	4	3	3	2	3	1	1	0	3	
Chemistry	1	3	3	6	4	4	2	1	1	3	3	
Chemistry Secondary Ed w/ initial teacher's lic	0	0	0	0	0	1	0	1	0	0	1	
Chemistry Biochemistry	0	0	0	0	0	0	1	0	1	0	1	
Number of incoming freshmen majors	66	60	76	48	68	57	48	42	30	40	35	
Percentage of incoming freshmen class4	8.63%	8.94%	10.29%	6.66%	9.54%	7.83%	7.02%	6.24%	5.16%	8.49%	6.02%	

A	B	C	D	E	F	G	H	I	J	K	L	M
Biology and Chemistry Departmental Trend Data												
Day-School												
	AY 14	**AY 15**	**AY 16**	**AY 17**	**AY 18**	**AY 19***	**AY 20**	**AY 21**	**AY 22**	**AY23**	**AY24**	**Trend**
Biology	2588	2834	2744	2702	2785	2855	2470	1998	1692	1542	1554	
Chemistry	904	1015	1187	1226	1146	1107	961	714	636	595	683	
Environmental Science	15	1	0	**0**	0	0	0	0	0	0	0	
First Year Experience	-	-	-	-	-	-	-	-	50	55	56	
General Science	-	-	-	-	-	-	-	1	1	1	1	
Honors	-	-	-	-	-	-	-	-	0	12	0	
Total Enrollment in Biology/Chemistry classes	**3,507**	**3,850**	**3,931**	**3,928**	**3,931**	**3,962**	**3,431**	**2,713**	**2,379**	**2,205**	**2,294**	
Total Enrollment in All Classes	33,952	34,081	34,062	34,169	34,257	33,695	31,983	27,491	24,227	23,044	23,252	
Percentage of total enrollment: Biology/Chemistry classes	**10.33%**	**11.30%**	**11.54%**	**11.50%**	**11.48%**	**11.76%**	**10.73%**	**9.87%**	**9.82%**	**9.57%**	**9.87%**	
Graduates in the Major	**29**	**39**	**40**	**53**	**56**	**55**	**61**	**44**	**45**	**22**	**33**	
Percentage of overall graduates	**3.61%**	**5.41%**	**5.33%**	**6.76%**	**7.43%**	**7.52%**	**7.70%**	**6.36%**	**7.09%**	**4.63%**	**7.04%**	
Biology, B.A.	0	0	0	0	3	3	7	12	5	3	2	
Biol. Secondary Ed w/ initial teacher's lic									1	0		#N/A
Biology, B.S.	16	14	19	18	19	20	19	15	12	6	9	
Biol. Secondary Ed w/ initial teacher's lic	0	1	0	0	1	0	0	1	2	0		
Biotechnology	1	7	6	4	2	2	6	2	6	3	5	
Environmental Biology	8	5	3	3	6	5	4	0	2	3	1	
Health Sciences	3	11	11	22	20	19	19	12	14	6	12	
Neuroscience and Behavior	1	1	1	4	0	2	0	0	0	1		
Chemistry, B.S.	0	0	0	2	5	4	6	2	3	0	3	
Chemistry Secondary Ed w/ initial teacher's lic											1	#N/A

A	B	C	D	E	F	G	H	I	J	K	L	M
Biology and Chemistry Departmental Trend Data												
DAY SCHOOL	**AY 14**	**AY 15**	**AY 16**	**AY 17**	**AY 18**	**AY 19***	**AY 20**	**AY 21**	**AY 22**	**AY23**	**AY24**	**Trend**
Biology	2588	2834	2744	2702	2785	2855	2470	1998	1692	1542	1554	
Chemistry	904	1015	1187	1226	1146	1107	961	714	636	595	683	
Environmental Science	15	1	0	**0**	0	0	0	0	0	0	0	
First Year Experience	-	-	-	-	-	-	-	-	50	55	56	
General Science	-	-	-	-	-	-	-	1	1	1	1	
Honors	-	-	-	-	-	-	-	-	0	12	0	
Total Enrollment in Biology/Chemistry classes	**3,507**	**3,850**	**3,931**	**3,928**	**3,931**	**3,962**	**3,431**	**2,713**	**2,379**	**2,205**	**2,294**	
Total Enrollment in All Classes	33,952	34,081	34,062	34,169	34,257	33,695	31,983	27,491	24,227	23,044	23,252	
Percentage of total enrollment: Biology/Chemistry classes	**10.33%**	**11.30%**	**11.54%**	**11.50%**	**11.48%**	**11.76%**	**10.73%**	**9.87%**	**9.82%**	**9.57%**	**9.87%**	
Graduates in the Major	**29**	**39**	**40**	**53**	**56**	**55**	**61**	**44**	**45**	**22**	**33**	
Percentage of overall graduates	**3.61%**	**5.41%**	**5.33%**	**6.76%**	**7.43%**	**7.52%**	**7.70%**	**6.36%**	**7.09%**	**4.63%**	**7.04%**	
Biology, B.A.	0	0	0	0	3	3	7	12	5	3	2	
Biol. Secondary Ed w/ initial teacher's lic									1	0		#N/A
Biology, B.S.	16	14	19	18	19	20	19	15	12	6	9	
Biol. Secondary Ed w/ initial teacher's lic	0	1	0	0	1	0	0	1	2	0		
Biotechnology	1	7	6	4	2	2	6	2	6	3	5	
Environmental Biology	8	5	3	3	6	5	4	0	2	3	1	
Health Sciences	3	11	11	22	20	19	19	12	14	6	12	
Neuroscience and Behavior	1	1	1	4	0	2	0	0	0	1		
Chemistry, B.S.	0	0	0	2	5	4	6	2	3	0	3	
Chemistry Secondary Ed w/ initial teacher's lic											1	#N/A
Graduates in the Minor												
BIOL Biology	9	8	11	13	11	14	14	10	11	4	6	
NBCM Neuroscience, Behavior and Cognition	0	0	3	8	6	7	6	8	4	7	4	
CHEM Chemistry	10	13	13	18	9	11	11	6	14	11	12	

Biology and Chemistry Departmental Trend Data												
DAY SCHOOL	AY 14	AY 15	AY 16	AY 17	AY 18	AY 19*	AY 20	AY 21	AY 22	AY23	AY24	Trend
Incoming Transfer												#N/A
Biology	5	9	15	9	9	7	8	5	5	5	5	
Biology Secondary Ed w/ initial teacher's lic	0	2	1	0	2	1	0	0	0	0	0	
Biotechnology	7	9	3	7	6	4	3	2	3	4	1	
Environmental Biology	2	3	3	6	1	4	0	1	2	2	1	
Health Sciences	22	15	12	18	16	20	12	7	8	11	11	
Neuroscience and Behavior	5	0	3	1	3	0	0	2	1	0	3	
Chemistry	0	5	1	3	1	7	3	0	2	1	1	
Chemistry Secondary Ed w/ initial teacher's lic					1	0	0	1	0	1	0	
Chemistry Biochemistry	0	0	0	0	0	0	1	1	2	0	0	
Number of incoming transfer majors	41	43	38	44	39	43	27	19	23	24	22	
Percentage of incoming transfer class4	9.45%	10.50%	9.64%	9.95%	9.24%	10.29%	8.82%	8.11%	9.80%	9.02%	6.90%	
Number of Minors												#N/A
BIOL Biology	35	38	43	44	41	51	44	34	28	25	20	
NBCM Neuroscience and Behavior	18	20	22	27	31	28	30	25	22	26	25	
CHEM Chemistry	36	40	51	36	30	31	22	23	31	32	27	
Retention Rates 5												
Retention Rate in Major - Biology/Chemistry	63.04%	66.07%	63.79%	56.00%	63.27%	33.33%	56.36%	48.94%	46.34%	40.74%	58.33%	
Biology	63.04%	66.07%	64.29%	54.17%	58.14%	33.85%	54.00%	47.73%	46.15%	44.00%	57.58%	
Chemistry	-	-	50%*	100%*	100%*	25%*	80%*	66.67%*	50%*	0%*	100%*	
Retention Rate Changed Major - Biology/Chemistry	6.52%	3.57%	12.07%	14.67%	14.29%	26.09%	16.36%	21.28%	21.95%	18.52%	2.78%	#N/A
Biology	6.52%	3.57%	12.50%	15.28%	16.28%	26.15%	16.00%	22.73%	20.51%	20.00%	0.00%	
Chemistry	-	-	0%*	0%*	0%*	25%*	20%*	0%*	50%*	0%*	33.33%*	
Retention Rate in Major Institutional	62.52%	62.15%	58.75%	62.36%	65.17%	61.38%	61.71%	62.99%	55.52%	56.89%	60.08%	#N/A
Retention Rate Changed Major Institutional	15.56%	15.19%	16.11%	12.55%	12.80%	11.98%	11.78%	13.58%	12.42%	15.03%	12.68%	

C. Recent Findings:

Summarize the recommendations and actions from the previous self-study.

Comment on any findings or recommendations specific to the department/program from the university's NECHE self-study, if applicable.

NECHE Findings

According to our recent NECHE report, the Department of Biology and Chemistry has been a model department for several efforts on campus, including recruitment, retention, and improving the campus climate for marginalized students. The Chemistry program was specifically mentioned for adding a much-needed Biochemistry concentration which will help recruit students to a program that aligns with the workforce needs of many industries in the area. Additionally, our department has made significant strides to retain Fitchburg State students at the University. In 2014, we instituted a 2.0 rule for critical introductory Biology & Chemistry courses. Students who don't get above a 2.0 in these courses by the second attempt cannot stay in the major; our data clearly show that failure to pass early courses causes students to stagnate later on in their academic career. However, our faculty have been committed to advising these students carefully and working closely with the Career Center to help those struggling in our major transition to a new area of study at the University that better matches their interests and skill sets.

The Department of Biology and Chemistry was recognized in the final NECHE report as being leaders in our efforts to improve the overall campus climate for minority and underrepresented students. For

example, as a result of the 2018 campus climate data, our department launched an effort using peer-led student focus groups and collected data to help us identify specific barriers and educational gaps for BIPOC students in our majors. According to the NECHE, our department was proactive in our approach to addressing these issues.

> *"Faculty recognized that dissatisfaction could lead to a range of outcomes, including marginalization, poor academic performance, and dropping out. The group (i.e. Dept. of Biology & Chemistry) over the years has spent time applying for funding, including a Balfour Grant, engaging in book group discussions, and engaging in campus-wide opportunities to address issues on campus."*

In a 2023 update from the NECHE Findings, the University also noted that the Bachelor of Arts Degree in Biology was a "model" for other programs. In the report, it noted that our BA in Biology vs. our Bachelor of Science (BS) in Biology are notably different. This does not seem to be the case across the university. As discussed in the program section and in the curriculum sections of this report, our BA program has a foreign language requirement in that an Intermediate II language must be taken. Students in this program do not have to take Physics II or Organic Chemistry II, but are required to complete one PHYS and one GEOG elective instead.

One key benefit of our BA program is that it relieves stress from students who are struggling in Organic Chemistry. Students in the BA are advised to enroll in either Spanish or French courses on campus. Unfortunately, these are the only 2 languages offered on campus where Intermediate I and II level courses are offered; and even these can be occasionally canceled due to low enrollments. One way we have encouraged students to complete the Intermediate language requirement is by taking the Spanish I and II CLEP exam (College Level Examination Program). This exam costs $95 to register for and can be taken online (remote proctored) or at Mount Wachusett Community College for $25. Many of our students are native Spanish speakers and thus score very well on the exam without much difficulty. If students score above a 63 out of 80 on the exam, they can transfer 12 credits of Spanish. Fewer credits (3-9) will be transferred if the student's score is lower.

Findings and Action Items Originating from the 2017 Biology Self Study

During our 2017 Self-Study, Dr. P. Boily from Western Connecticut University served as our outside reviewer. In his narrative Dr. Boily notes that there was nothing inherent in our report that he disagreed with; he merely provided ideas for improving our curricula and processes. His comments about our resources, labs, budget, and support staff were largely positive. He acknowledged the difficulty in assessing Biology programs given that there is no accrediting agency specifically for Biology and commended our adoption of Vision and Change/Bio Core learning objectives in Biology.

Suggestions of the Outside Reviewer & Actions Taken

One suggestion that Dr. Boily wrote in his report was the possibility of requiring statistics as part of our major or offering a "research course". We have very specific reasons to keep MATH 1700 (Applied Statistics) as an elective (mostly to ensure transfer students move unimpeded in the major). We recognize that having students understand the research process as well as the methods to analyze data are important. Since 2017, we have added an additional capstone course taught by Dr. Christopher Cratsely entitled "Methods, Models, and Analysis. This biostatistics course was offered in fall of 2024 and is currently in the rotation to be offered in the fall of even years.

Dr. Boily commended our commitment to experiential learning through student research opportunities and internships. He suggested that a faculty coordinator position with release time be created to support this growing need. In 2022, our department collaborated with other members of the School of Health and Natural Sciences on an AIF grant to fund this position. The responsibilities of this position are being developed and currently, Dr. Christopher Cratsley is receiving a 3-credit APR each academic year in this role. He serves multiple departments including Math, Computer Science, Biology & Chemistry, Earth & Geographic Science, and Engineering Technology. This role is university-funded as a Dean's Fellowship position due to the placement of the School of Business and Technology being under the deanship of Health and Natural Sciences. In the future, we would like to see a specific coordinator just for Biology & Chemistry, and this may require seeking additional outside or budget-level funding for our department.

Additional suggestions made by the reviewer included creating an additional full-time tenure track position for A&P, offering more 3-credit (non-lab) electives, and having a reliable regular rotation of courses. We created action items for all three of these points and in 2019, hired Dr. Liz Kilpatrick as a tenure-track member of our department with her primary teaching responsibilities being A&P. We continue to offer many 3-credit elective options and have recently finalized a predictable and clear 2-year course rotation schedule which is found in Section II: Curriculum.

Points of Disagreement

There were several suggestions made in the report which our department found incongruous to our mission and antithetical to best pedagogical practices in STEM. When we received Dr. Boily's report in the spring of 2018, we were taken aback by some of his suggestions for removing barriers to student success and graduation. For example, he suggested: adding evening classes, increasing class sizes, un-linking lectures and labs, having more faculty teach graduate courses, and having adjunct professors teach introductory courses.

In fact, several of the suggestions, use of large class sizes and adjuncts in entry level courses contradict evidence based best practices in STEM. Many studies have demonstrated that smaller class sizes result in more engaging instruction[1], better student participation [2,3], a sense of belonging[4] , and therefore much higher student success and retention [5,6] .

The department especially disagreed with the recommendations to increase class size in introductory courses and to hire more adjuncts to teach lab sections. These two suggestions contradict Fitchburg State's recent focus to increase student success, especially among minority students. Furthermore, larger classes and more adjuncts in labs would damage Fitchburg State's "brand" of offering an affordable education with individual attention. We try to have the same lecture instructor teach most, if not all, lab sections in a course. Student surveys have repeatedly supported this approach, and the strongest selling point we hear during Open Houses is when our majors tell prospective students that they will have the same professor teach lecture and labs "so professors really get to know you." Having the same instructor also improves pedagogy by integrating lecture and lab topics well. In contrast, when we have needed to use adjuncts to cover lab sections, students often complain that they feel disconnected in a lab section taught by a different instructor. Because of this we chose not to add these items to the action plan for 2017-2024.

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4. Kalinowski, S., & Taper, M. L. (2007). The effect of seat location on exam grades and student perceptions in an introductory biology class. Journal of College Science Teaching, 36, 54-57.

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7. Kokkelenberg, E. C., Dillon, M., & Christy, S. M. (2008). The effects of class size on student grades at a public university. Economics of Education Review, 27(2), 221-233.

II. Curriculum

A. Curriculum Map

Explain the rationale for the structure and sequence of the curriculum for each degree and credential, noting any distinctive experiences or expectations, and recent revisions.

The mission of the Biology & Chemistry Department is to provide undergraduate students with a top-notch education that combines scientific content knowledge with methodologies, hands-on research, as well as laboratory and field study skills that foster critical thinking and problem-solving skills that are congruent to and build upon those learned in the General Education program. An informational sheet about the General Education program is found at the in the supporting documents section (E).

The Biology Program includes both undergraduate and graduate degrees. The cornerstone of our degrees has been the Bachelor of Science degree, but in 2016 significant revisions were made to the Bachelor of Arts degree providing students with a much-improved alternative choice. Students may, but are not required to, select from among five possible concentrations: Biotechnology, Environmental Biology, Health Sciences, Neuroscience and Behavior, and Biology with Initial Teacher Licensure. The Biology major currently (Fall 2024) has 170 majors enrolled in various programs. Within the major the majority of students are in concentrations: 15 Biotechnology, 11 in Environmental Biology, 74 in Health Sciences, 11 in Neuroscience and Behavior, and none currently in Biology with Initial Teacher Licensure. Additionally, students from numerous other departments are enrolled as biology minors including 20 students in the Biology minor, 25 students in the Neuroscience, Behavior and Cognition minor as well as 27 students in the Chemistry minor.

B.S./B.A. Biology

Students can declare a B.S. or a B.A. in Biology, differentiated in part by the inclusion of a foreign language requirement in the B.A. Additionally, students in the B.A. program are not required to take Organic Chemistry II and only have to take 1 semester of any Physics class. This option gives some of our students struggling in Chemistry a reprieve. It also allows students who speak Spanish or French as their first language an opportunity Students can declare one of five concentrations within the B.S. major: Biotechnology, Environmental Biology, Health Sciences, Neuroscience and Behavior, or Biology with Initial Teacher Licensure. Regardless of concentration, every Biology student has the same basic core of four lab-based courses which are listed below. This common core provides each student with the fundamental content and skills needed in many fields of study and offers students the opportunity to develop a sense of community within a cohort of students. Beyond this core, each concentration is designed to meet the needs of a student population with a wide range of career interests through various upper-level electives, which are open to all majors.

In addition to the core courses, students must also take 6 electives including a capstone course. In the capstone course, students apply their understanding of the process of scientific inquiry to research projects. Within the Biology B.S. major students may also elect to pursue one of several tracks or concentrations to achieve a more focused course of study in contemporary, specialized fields. These

are outlined below. Electives are rotated every 2-years, which can be seen in Section E: Supporting Documents.

Required Core Courses for Biology, BS

- BIOL 1800 - General Biology I
- BIOL 1900 - General Biology II
- BIOL 2300 - Ecology
- BIOL 2800 - Genetics

Elective Courses: Biology majors also take six advanced electives at or above BIOL 2000. Independent study, directed study or internship may each count as one advanced BIOL elective in a student's program of study. Courses with a separate lecture and lab registration count as a single elective: the lab portion of a course does not constitute a distinct biology elective. One of these elective courses must be a capstone course.

Capstone Courses: One of the six electives must be a designated Capstone course. Students in the Capstone course conduct a research project to demonstrate their skills in research design and analysis. A more detailed description and purpose of the capstone course is discussed below. Capstone courses must be taken at Fitchburg State. Independent studies (BIOL 4903) require approval by the departmental curriculum committee in order to fulfill the Capstone requirement. Courses offered are:

- BIOL 3550 - Developmental Biology
- BIOL 3650 - Plant Biology (Tabled)
- BIOL 4009 – Cancer Genomics
- BIOL 4500 - Molecular Biology
- BIOL 4903 - Independent Study (requires department approval)
- BIOL/CHEM 3060- Biochemical Techniques
- BIOL 4011- Topics Models, Methods, & Analysis

Required Courses in Related Sciences Subjects: In addition to biology courses, Bachelor of Science (BS) students are required to take the following courses in related sciences and two mathematics courses at or above MATH 1300. For most biology majors, we recommend Precalculus (MATH 1300) and Applied Statistics (MATH 1700). Students applying to medical programs should meet with the pre-health advisors to discuss taking Calculus I and II. Given the rigorous chemistry requirements, students who wish to pursue a Chemistry minor only have to take 2 additional courses (Analytical Chemistry and a Chemistry elective).

- CHEM 1300 - General Chemistry I
- CHEM 1400 - General Chemistry II
- CHEM 2000 - Organic Chemistry I
- CHEM 2100 - Organic Chemistry II
- PHYS 2300 - General Physics I
- PHYS 2400 - General Physics II

Required Courses for Biology, BA

The core, electives and capstone course requirements for BA students are identical to those for the BS degree as described above.

Required Courses in Related Sciences: In addition to biology courses, Bachelor of Arts students are required to take courses in related sciences and two courses in mathematics at or above MATH 1300.

- CHEM 1300 - General Chemistry I
- CHEM 1400 - General Chemistry II
- CHEM 2000 - Organic Chemistry I
- One PHYS course
- One GEOG course

BA Language Requirement: Foreign language proficiency at the Intermediate Level II is required. This usually means 2 years of a single language unless the student can take a CLEP test to pass the first year (basic level) courses. In some cases, students have been able to pass both levels of CLEP tests and get 12 credits. Some may come in with A.P. credits as well.

Biology Concentrations/Tracks (BS only)

Students may elect to pursue a concentration within the major for a more focused course of study in contemporary, specialized fields of biology. Concentrations include all the requirements of the B.S. degree, and advanced electives include courses appropriate to each concentration. For example, students in Health Sciences must take Human Anatomy & Physiology I and II as well as Biochemistry as electives. Each concentrations' electives can be seen in detail in the four year plans in section E. The following concentrations are offered:

- Biotechnology
- Environmental Biology
- Health Sciences
- Neuroscience and Behavior
- Biology with Initial Licensure in Secondary Education (includes a minor in Middle School and Secondary Education)

Capstone Experience (Integrative High-Impact Practice, IHIP)

As a result of department assessment over the past few years, capstone courses have been improved to include specific course descriptions and learning objectives. The number of options available for the students has also doubled because of demand. Capstone courses are offered every semester and must be designated at an upper level (3000 or 4000) with prerequisites above the four core biology courses. Capstone courses fulfill the Gen Education Integrated High Impact Practice (IHIP) requirement. Students can fulfill the IHIP requirement by taking a capstone course or through an Independent Study; demonstrating the ability to:

- Form and propose a testable hypothesis
- Design an experiment
- Conduct experiments and collect data
- Analyze and interpret data
- Summarize results
- Access, analyze, and understand the scientific literature
- Demonstrate their mastery of these skills using written or verbal communication.

Student Research Projects and Internships

Our department offers the option for student research and independent studies. Students can start by taking an Introduction to Research course (1-2 credits) to engage in the research process. After completing the course, students then have the option to work with a faculty member as an Independent Study after their sophomore year. Faculty also support student research as thesis supervisors for the Honors program. During these experiences, students work with faculty one-on-one or in small groups on a project that is in the faculty's area of expertise and interest. As a small, teaching institution, our faculty have a diverse range of research areas that attract a wide variety of students. Students are able to use these research experiences as capstones or elective courses. Students can also seek internship and summer training program opportunities at off-campus sites. Our majors and minors may use these experiences as upper-level elective credits in both biology and chemistry. As stated in the rationale, we understand the strong evidence showing that these types of experiences are valuable and help to retain students and hope to expand these opportunities to students.

Student research opportunities increased when the new science facility was constructed, and again in 2016 when the Introduction to Research courses were added to the curriculum. All of our current faculty have supervised student research. Over the last five years, Biology and Chemistry Department faculty offered approximately 130 research projects, involving over 100 students. These projects are shown in more detail in **Section V:Students, D. Experiential Learning.** Briefly, the diverse topics of student research included mitochondrial diseases, myoblast repair and muscular dystrophy models in *C. elegans*, generation and action of human neutrophils, function and phylogeny of the vertebrate DNAse II genes, protein cross linking, chemical modeling of membrane permeation by nanoparticles, the synthesis of nanoparticles and their effect on plant physiology, and translational control by tRNA during infection. During their research projects, students learned different techniques that are valued as skills needed for the biotechnology, chemical, and life sciences industries such as DNA and RNA extraction, PCR, pipetting, confocal, light, and fluorescence microscopy, protein purification, cell culturing, and bioinformatics.

Articulation Agreements

We have established an Early Acceptance Program (EAP) with the Lake Erie College of Osteopathic Medicine for students wishing to pursue doctoral degrees in the areas of Osteopathic Medicine, Dentistry or Pharmacy. For the last several years, we had a Pharm D. and Physical Therapy doctoral articulation agreement with Husson University, which reduced the length of study for students by a year. Unfortunately, due to low enrollments, Husson is phasing out those programs.

Two of our alumni, Kyle Hofer and Ethan Borges were both EAP students and finished Medical School at LECOM in 2024. Another student, Aidan Ward Is a current LECOM medical student who will graduate in May of 2025. Current FSU students, Emma Duponte and Srichakri Gudimella have been accepted into the early Dental and Medical programs, respectively.

More recently (AY2024), a memorandum of Understanding for a 4+1 program has been established between Fitchburg State University and Northeastern University to provide eligible students with a pathway to directly enter the Northeastern's Masters of Biotechnology Program. One of our goals is to seek additional opportunities for our students in the form of articulation agreements or 4+1 programs.

B. Delivery Methods/Modalities

Describe program and course delivery methods/modalities and any strategic discussions or plans to make modifications. Include any supporting data.

Most courses in Biology and Chemistry are offered in-person, as is typical for lab-based sciences. However, we have made many modifications to our teaching since the previous self-study, especially in response to changes required by the COVID pandemic. For example:

- Faculty have become much more adept at recording lectures using various technologies, including ScreenPal, Doceri (which records drawings on screen), and EdPuzzle (which inserts questions into a lecture that are required before proceeding). Although "pandemic teaching" has ended, we continue to use these techniques as supplements for many in-person classes, and of course in fully online classes (see below).

- Our faculty often share techniques and strategies to use technology to improve our teaching. In addition to sharing pointers about the recording technologies listed above, we have also learned from each other how to use Socrative.com for formative "clicker questions" in lecture, and innovative uses of Google Assignments, Google Docs, and Google Forms to make learning more active. In addition, we have shared advising techniques with each other to better use the SSC and new College Scheduler platforms.

Online Course Offerings:

The Department of Biology and Chemistry currently has offered limited online courses (this excludes the pandemic when all courses went online). Many faculty in our department agree that teaching labs in an online format is not optimal. However, some classes have been taught online or in hybrid most through the use of simulation software or creative pedagogies. NECHE (our accrediting institution) has been urging departments to clearly assess these online courses to ensure their quality and rigor. One of our action items will be to Improve and seek faculty training so we can learn how to effectively design, utilize, and assess online tools for offering biology electives. In the interim, we will continue to offer online or hybrid course options using the same sound pedagogical practices and high-quality teaching materials that we currently implement in our in-person courses. Some of these classes are listed below.

Multiple sections of Nutrition (BIOL1650) have been offered nearly every semester for the past 3 years as an asynchronous online course, both through GCE and Day programs. This course is predominantly a service course required for Nursing majors. Additionally, the course can be taken by all University students, seeking to fulfill the Personal Wellness General Education requirement.

Life Science (BIOL1000) was offered through GCE as an asynchronous Biology course in the Fall of 2024. This course also serves non-majors seeking to fulfill a requirement in the General Education program; the course fulfills either the Scientific Inquiry or Procedural Logic & Thinking Gen Ed requirements. Life Science for Educators is also scheduled to be taught in an asynchronous format for the summer of 2025.

General Biology I (BIOL1800) and II (BIOL1900) have been continuously offered as a Summer online course offering, primarily to aid Biology majors who may have received a deficient grade during the regular academic year. The courses are typically recommended for these students, through advising, to keep them on track within the 4-year program of study. During the summer, Gen Bio I and II had been offered in person before COVID, but often were cancelled due to low enrollments. It was a logical transition to stay in an ONLINE format after COVID when courses were moved to format anyway.

General Biology I ONLINE (summer)
In our online Gen Bio I course, lectures are posted asynchronously, but time is scheduled for office hours. The lectures were recorded in smaller segments, with chapter materials divided into several recordings, typically 8-12 minutes per topic. Lecture recordings for each chapter were posted in separate, labeled folders on Blackboard, along with copies of the slides used in the recordings. In each recording, a PowerPoint presentation was used, followed by a switch to writing and diagramming on the whiteboard, as is typical in class lectures. The whiteboard was filled multiple times per lecture. This approach was well-received by most students, as they mentioned it provided “a classroom feel. The synchronous time was designated for office hours. The laboratory portion of the course was also conducted asynchronously online. Efforts were made to keep the laboratory content and exercises as similar as possible to those conducted in person. A pre-lab lecture recording was created, mirroring the lecture typically given in person, along with a Google document containing instructions, links to necessary videos, online tools (such as a virtual microscope or spectrophotometer), and questions for students to answer. In one lab, where students would normally work with a partner in person to time their “reaction” and provide instructions, a video was created to serve as a substitute. In this video, the instructor acted as the partner, assisting students with timing their reactions and providing the required instructions.

Gen Bio II ONLINE (summer)- This introductory course is offered in an online format over the summer months to accommodate transfer and working students. The online version of class follows the in-person objectives as closely as possible. Lectures are pre-recorded and notes are available in PDF format for students to follow along as they watch the lectures. Assignments are clearly described with deadlines for submission. Tests are done online and are timed, but not proctored. Laboratory exercises match those done in class as best as possible and have been differentiated for online or independent

instruction. Laboratory exercises include evolutionary simulations, tracking alleles in a population over time, plant identification and dissection, animal dissection (filmed), analysis of *Daphnia* heart rate and stomatal density data, and phylogenetic tree construction. Online labs were originally designed to accommodate students during the pandemic and have been continually modified and improved.

A limited number of online upper level (>2,000 level) Biology electives have also been offered to help students who have fallen behind in the 4-year program of study or have significant commitments outside of their academic responsibilities. Neuroscience (BIOL2650) has been offered in an online synchronous course each summer for since 2021. Additionally, the course has been offered online synchronously in the Spring of 2021 and online asynchronous in the Spring of 2023.

Virology (BIOL3007) was developed as an asynchronous online elective during the summers of 2020 and 2021, primarily to service students entering Fitchburg State through the Summer Starter Academy, a grant funded program to aid students transitioning from Community College into a four-year University. This course is currently scheduled to return as an online course in the summer of 2025. Lectures are delivered as prerecorded videos that students can watch at their convenience. An hour live recitation session was held every week, although the session was recorded and available for viewing if a student couldn't attend. The online course is structured similar to flipped classroom, where students receive recorded lectures and use face-to-face time to address questions and have discussions; the face-to-face time is using GoogleMeet as opposed to F2F classroom time.

Parasitology (BIOL3000) was offered as an asynchronous online course in the Fall of 2022. The course returned to be taught as a face-to-face course in the Fall of 2024. It is likely that the course will return to an online summer offering on a 2-year rotation. The Department is currently trying to offer online summer courses that are not taught during the regular academic year, to allow more of our majors to have the opportunity to take upper-level Biology electives during the summer break. The course structure followed the same model as Virology.

C. Workforce Alignment

Describe the alignment of curriculum to workforce demands including the skills that the workforce is seeking.

According to the Massachusetts 2022 Report from the Office of Labor and Development, the demand for jobs in STEM is one of the highest in the nation with 40% of all positions in the commonwealth being related to innovation or technology. Because of this and additional efforts in clean energy, biotechnology, and advanced manufacturing, the state is expected to see a further 7.8% increase in STEM-related employment until 2028. Additional reports predict increases beyond that.

The Department of Biology and Chemistry has developed our Biology curriculum to address these growing STEM workforce needs by insuring that the Core Competencies within our curriculum broadly align with the priorities identified by employers, and providing coursework that both insures students are prepared for a broad range of possible Biology careers and allows them to tailor their individual

curriculum to provide specific preparation within a high need concentration, such as Biotechnology or Health Science. Our biology core competencies were refined as part of a campus-wide Davis Foundation Grant effort in the 2020-2021 Academic Year, and ongoing workforce alignment efforts continue through outreach to local industries, facilitated in part by an ongoing partnership with the Massachusetts Biotechnology Education Foundation.

In developing Core Competencies for the Biology Curriculum, aligned with workforce priorities, the Department of Biology and Chemistry began with our existing Biology Program Learning Outcomes. These Learning Outcomes were established to align with the recommendations of Vision and Change in Undergraduate Biology Education: a call to action (AAAS 2011). The Core Competencies identified by this AAAS (American Association for the Advancement of Science) report included: 1) the ability to apply the process of science; 2) the ability to use quantitative reasoning; 3) the ability to use modeling and simulation; 4) the ability to tap into the interdisciplinary nature of science; 5) the ability to communicate and collaborate with other disciplines; and 6) the ability to understand relationships between science and society. The Biology Program Learning Outcomes focused on Competencies 1, 4 and 5 by stating that students would: Conduct original biological research, Demonstrate content knowledge of the AAAS BioCore, Communicate science orally and in writing, and Use scientific literature.

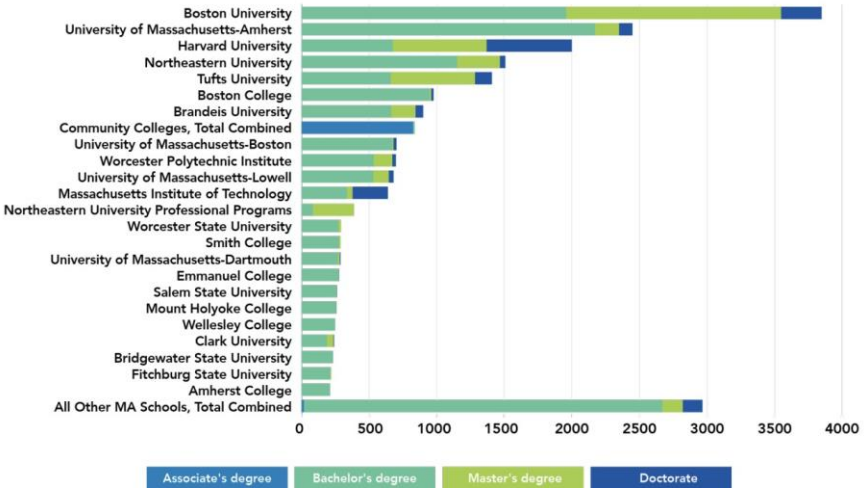
During the academic year 2020-2021, the Department of Biology and Chemistry revisited these learning outcomes and the Core Competencies identified by AAAS in order to develop a set of Biology Core Competencies that could inform students' pathways to STEMM (Science, Technology, Engineering, Mathematics and Medicine) careers. In particular, we reconsidered the importance of the Core Competencies (AAAS 2011) of quantitative reasoning and collaboration. This process also involved exploring broader patterns of Employer priorities identified by the National Association of Colleges and Employers (NACE) 2014-2015 employer survey, and the Association of American Colleges & Universities (AAC&U) 2018 employer survey, both of which identified Communication, Critical Thinking/Problem Solving, and Teamwork/Collaboration as priorities for over 80% of employers surveyed. In addition, consistent with the cross-disciplinary nature of our Department of Biology and Chemistry and the corresponding preparation Biology students receive in Chemistry, we also referenced the American Chemical Society's Guidelines for Bachelors Degree programs which include the Professional Skills and Competencies of Communication, Information Retrieval, Evaluation and Management, and Teamwork and Collaboration, as well as an emphasis on Laboratory Skills and Creating a Safety Culture. Through this process we developed the following Biology Core Competencies: Disciplinary Knowledge, Laboratory Safety skills, Scientific Inquiry and Analysis, Communication Skills, Quantitative Reasoning, Laboratory Skills, Information Literacy, Teamwork and Collaboration.

Another critical element of the process of reviewing our Core Competencies in 2020-2021 involved examining the ways in which we support co-curricular opportunities for our students including internship and other employment exploration opportunities. Since 2021, we have worked to even better identify local life sciences workforce opportunities for our students. In April of 2024, Massachusetts Biotechnology Education Foundation (MassBioEd) in partnership with Teconomy LLC, published the Massachusetts Life Sciences Employment Outlook. According to their projections, jobs in the life

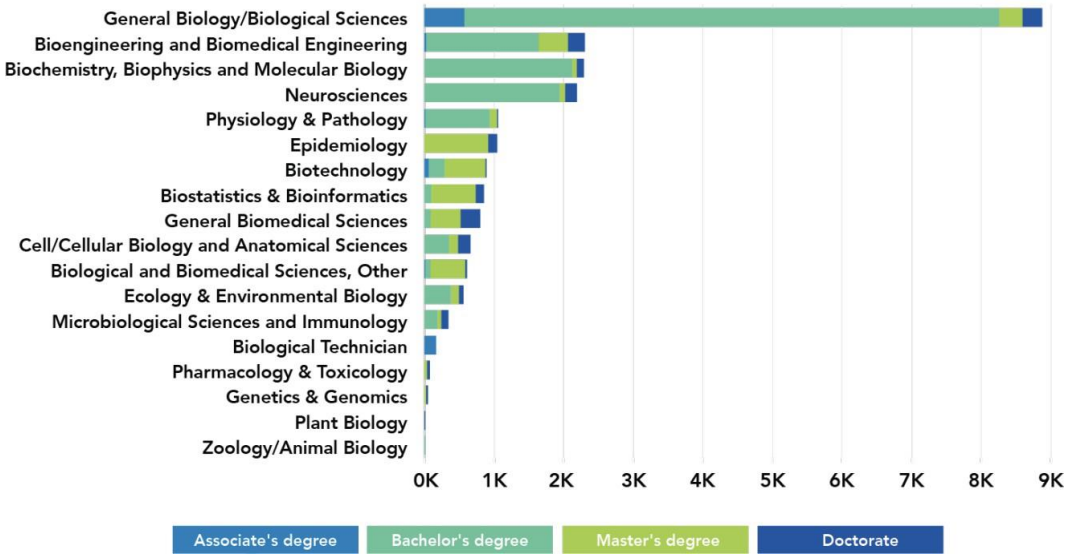
sciences are expected to increase by 32%, creating nearly 38,000 new jobs in Massachusetts. Massachusetts and the greater Boston area is one of (if not the most) concentrated areas around the globe for research and manufacturing in biological sciences, biotechnology, biotherapeutics and biopharmaceuticals (Genetic Engineering and Biotechnology News, 2023 report). Just in Worcester County alone (location of Fitchburg State University,) the workforce in the life sciences workforce grew by over 800 jobs between 2021- 2023, a 14% growth in employment. Several key companies critical for this growth were AbbVie, Bristol Myers Squibb, uBriGene, and WuXi Biologics.

Additionally, we formed a Biotechnology Advisory Board with its inaugural meeting held on February 15, 2023. Our goal going forward is to convene the board at least once per semester. This board currently consists of 14 members representing Fitchburg State faculty (2), Fitchburg State students (2), representatives from MassBioEd (2), Mass Biomedical Initiatives (1), biotechnology companies (5), Mount Wachusett Community College (1), and Monty Tech (1); we are working to add representatives from Fitchburg High School and other local high schools as well. The biotechnology companies Charles River Laboratories, Bristol Myers Squibb, Moderna, Merck, and Vincere Biosciences are represented. The goal of the Biotechnology Advisory Board is to provide more formal guidance and feedback regarding our programs, and, through participation of local high schools, a vocational school, and MWCC, it will also assist us in enhancing our enrollment process to bring in more students interested in careers in biotech. Regardless of their specific concentration of study, many of our students are able to find jobs in this growing industry. In fact, despite our smaller size, we rank high among the state universities in institutions that generate talent for the biotech industry as seen in the graph below. While we have a specific concentration in biotechnology, life science jobs mostly hire employees in degree fields of General Biology or Biological Science. We believe that our well-rounded, scaffolded biology curriculum along with math, chemistry, and physics requirements allows our students to be highly successful in landing many of these lucrative careers. Both graphs below are taken from the 2024 Massachusetts Life Sciences Employment Outlook (https://www.massbioed.org/labor-market-information/).

Leading Massachusetts Institutions Generating Life Sciences Talent, 2021-2023 Life Sciences Degree Completions



Leading Life Science Degree Fields in MA, 2021-2023 Degree Completions



D. Service and General Ed Courses

Describe what, if any, role the unit has in delivering service courses as well as courses that meet undergraduate general education requirements. Evaluate the relevant course enrollment data.

The Biology and Chemistry Department provides abundant service courses to non-majors. From AY 2017-2024 there were 5963 non-major registrations. Students who are not majors in BIO or CHEM comprise almost 26% of enrollments in all BIO classes, and 20% of all enrollment in CHEM classes. The service courses with the largest enrollments are listed below. Non-majors enroll in Biology courses to

meet major requirements (for example, Nursing and Exercise and Sports Science majors require Anatomy and Physiology I and II) and to fulfill General Education requirements. Within the General Education Curriculum, most introductory Biology classes may be used to fulfill either the Procedural and Logical Thinking (PL) Learning Outcome or the Scientific Inquiry and Analysis (SI) Learning Outcome.

In addition, Biology and Chemistry faculty have provided several First Year Experience (FYE) classes each year since AY2022, serving 50-55 new students each year. Finally, Biology faculty teach in the Honors Program, including offering the non-majors BIOL 1600 Honors Biology Issues and Inquiry annually.

Total non-majors enrollments from AY 2017-2024 and General Education designations	
Course	Total non-majors enrollments
BIOL 1200 (Anatomy & Physiology I) PL	1280
BIOL 1300 (Anatomy & Physiology II) PL	970
BIOL 1000 (Intro to Life Science) SI, PL	964
BIOL 1650 (Nutrition) PW	590
BIOL 2700 (Medical Microbiology) AIA	505
BIOL 1800 (General Biology I) SI, PL	430
BIOL 1050 (Life Science for Educators) SI, PL	385
BIOL 1010 (Environmental Science) SI, PL	174
BIOL 1900 (General Biology II) SI, PL	164
BIOL 2800 (Genetics) AIA, SI	105
BIOL 2300 (Ecology) AIA, SI	103
General Education designation codes - AIA: Integrating & Applying Learning, PL: Procedural & Logical Thinking, PW: Personal Wellness, SI: Scientific Inquiry & Analysis	

E: Supporting Documents: General Education Brochure, Biology 4 Year Plans, Updated Two-year Rotation of Courses

In the Fitchburg State General Education program, you will ...

- develop skills for personal, academic, and professional success
- increase your familiarity with campus resources
- gain knowledge about our world—past, present, and future—across many fields and through a variety of methods
- explore artistic, civic, diverse, ethical, historical, literary, and scientific perspectives while expanding your approaches to thinking and wellness
- develop skills that complement your major and prepare you to tackle more complex problems and ideas
- connect thinking with doing and apply your learning beyond the classroom walls in experiences that range from community engagement and study abroad to student/faculty collaborative research and internships

Through their complete educational experience, Fitchburg State graduates will be creative and critical thinkers who integrate and communicate their learning from a variety of disciplines and experiences in ways that enhance their civic, personal, and professional lives.

Contact:
General Education
Program Area
generaled@fitchburgstate.edu

Join us on social media
facebook.com/FSUGenEd
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FITCHBURG STATE UNIVERSITY

General Education Program

FITCHBURG STATE UNIVERSITY

General Education Program Requirements

FOUNDATION
Foundations for Lifelong Learning
15 credits minimum

- Reading/Information Literacy: First Year Experience (R&IL) ..... 3 credits
- Writing: Writing I (W) ..... 3 credits
- Writing/Information Literacy: Writing II (W&IL) ..... 3 credits
- Quantitative Reasoning: Math and Developmental Math, if required (QR) ..... 3 credits
- World Languages, Speaking and Listening (WS) ..... 3 credits

EXPLORATION
Critical and Creative Thinking Across the Disciplines
27 credits minimum

- Civic Learning (CV) ..... 3 credits
- Diverse Perspectives (DP) ..... 3 credits
- Ethical Reasoning (ER) ..... 3 credits
- Fine Arts Expression and Analysis (FA) ..... 3 credits
- Historical Inquiry and Analysis (HI) ..... 3 credits
- Literary Inquiry and Analysis (LI) ..... 3 credits
- Personal Wellness (PW) ..... 3 credits
- Procedural and Logical Thinking (PL) ..... 3 credits
- Scientific Inquiry and Analysis (SI) ..... 3 credits

All Exploration courses will also include instruction on at least one of the following skills: Creative Thinking, Critical Thinking, Digital Literacy, Information Literacy, Quantitative Reasoning, Reading, World Languages, Speaking and Listening, or Writing.

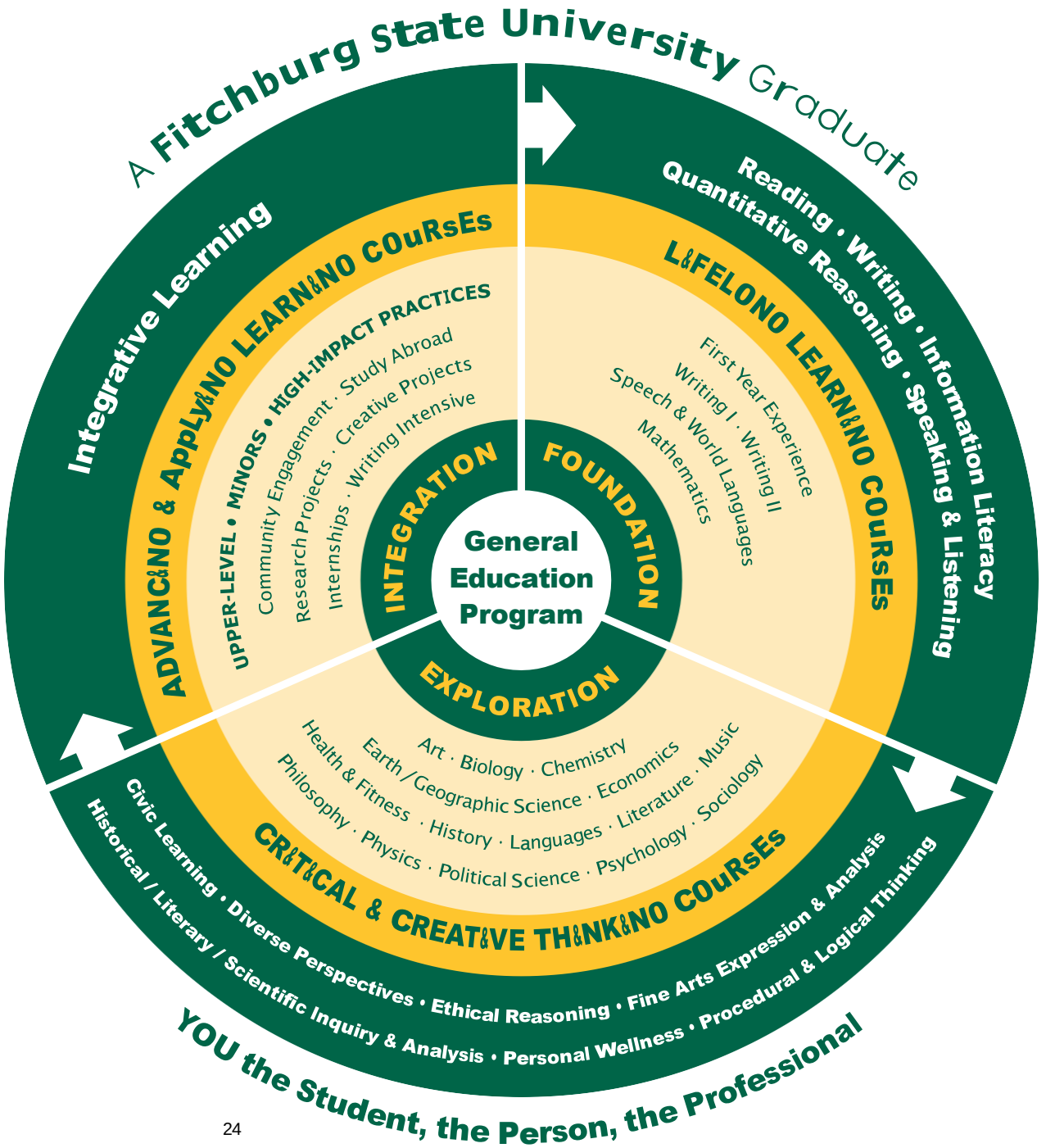
INTEGRATION
Advancing and Applying Liberal Arts & Sciences Learning
9 credits minimum

- Integrative Learning (AIA) ..... 6 credits
- Integrative High Impact Practice (IHIP) ..... 3 credits

OR

- Minor or Second Major (courses beyond the 9 credit minimum can also be applied to Foundation and Exploration requirements) ..... 9 credits

Majors may have identified up to three General Education courses from the EXPLORATION and INTEGRATION portions of the curriculum that will also meet major requirements. See your advisor and/or your major's four-year plan of study for this information.



Suggested Four-Year Plan of Study
BIOLOGY AND CHEMISTRY

FITCHBURG STATE UNIVERSITY

Biology B.S. (Bachelor of Science)

FRESHMAN YEAR

Fall Semester — 14 Credits

ENGL 1100	Writing I	3
BIOL 1800	General Biology I*	4
CHEM 1300	General Chemistry I* (SI)	4
FYE 1015	First Year Experience	3

** General Chemistry requires a 'passing' score on Advanced Algebra and Functions Accuplacer exam OR successful completion of MATH 0500 (Algebraic Preparation) prior to enrollment. To continue as a Biology Major, students must earn a grade of 2.0 in General Biology I and General Chemistry I.*

Spring Semester — 15 Credits

ENGL 1200	Writing II	3
BIOL 1900	General Biology II	4
CHEM 1400	General Chemistry II (PL)	4
MATH 1300	Precalculus	4

SOPHOMORE YEAR

Fall Semester — 17 Credits

BIOL 2300	Ecology	4
CHEM 2000	Organic Chemistry I (AIA)	4
MATH ≥1300**	Math Elective (QR)	3
	General Education (WS)	3
	General Education/Exploration	3

*** Applied Statistics (MATH 1700) is recommended to fulfill the QR requirement.*

Spring Semester — 17 Credits

BIOL 2800	Genetics	4
CHEMS 2100	Organic Chemistry II (AIA)	4
	General Education/Exploration	3
	Free Elective	3
	Free Elective	3

JUNIOR YEAR

Fall Semester — 16-17 Credits

BIOL ≥2000	Biology Elective	3-4
PHYS 2300	General Physics I	4
	General Education/Exploration	3
	General Education/Exploration	3
	Free Elective	3

Spring Semester — 13-14 Credits

BIOL ≥2000	Biology Elective	3-4
PHYS 2400	General Physics II	4
	General Education/Exploration	3
	Free Elective	3

SENIOR YEAR

Fall Semester — 15-17 Credits

BIOL ≥2000	Biology Elective	3-4
BIOL ≥2000	Biology Elective	3-4
	General Education/Exploration	3
	General Education/Exploration	3
	Free Elective	3

Spring Semester — 13-16 Credits

BIOL ≥3000	Biology Elective (Capstone) (IHIP)	4
BIOL ≥2000	Biology Elective **OR**	
	Independent Study **OR** Internship	3-6
	Free Elective	3
	Free Elective	3

General Education: Foundation

3 credits Reading and Information Literacy (R and IL): First Year Experience
3 credits Writing (W): Writing I
3 credits Writing and Information Literacy (W and IL): Writing II
3 credits Quantitative Reasoning (QR) (MATH)
3 credits World Languages, Speaking and Listening (WS)

General Education: Exploration

3 credits Civic Learning (CV)
3 credits Diverse Perspectives (DP)
3 credits Ethical Reasoning (ER)
3 credits Fine Arts Expression and Analysis (FA)
3 credits Historical Inquiry and Analysis (HI)
3 credits Literary Inquiry and Analysis (LI)
3 credits Personal Wellness (PW)
3 credits Procedural and Logical Thinking (PL)
3 credits Scientific Inquiry and Analysis (SI)

General Education: Integration

9 credits AIA (3 of which must be Integrative High Impact Practice - IHIP)

OR

Minor (professional majors completing a minor or second major must include at least 9 credits in LA&S disciplines for that minor)

General Education: MAJ

There may be major courses that have been approved to fulfill up to 3 General Education requirements (at least 9 credits). Varies by major and concentration.

Suggested 4-year plan of study. Completion of 120 credits required for graduation.

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Suggested Four-Year Plan of Study
BIOLOGY AND CHEMISTRY

FITCHBURG STATE UNIVERSITY

Biology B.A. (Bachelor of Arts)

FRESHMAN YEAR

Fall Semester — 14 Credits

ENGL 1100	Writing I	3
BIOL 1800	General Biology I*	4
CHEM 1300	General Chemistry I* (SI)	4
FYE 1015	First Year Experience	3

* General Chemistry requires a 'passing' score on Advanced Algebra and Functions Accuplacer exam OR successful completion of MATH 0500 (Algebraic Preparation) prior to enrollment. To continue as a Biology major, students must earn a grade of 2.0 or higher in General Biology I and General Chemistry I.

Spring Semester — 15 Credits

ENGL 1200	Writing II	3
BIOL 1900	General Biology II	4
CHEM 1400	General Chemistry II (PL)	4
MATH 1300	Precalculus	4

JUNIOR YEAR

Fall Semester — 15-17 Credits

BIOL ≥2000	Biology Elective	3-4
	PHYS Elective***	3-4
	Foreign Lang. Elective (Intermediate 1) (AIA)	3
	Gen Ed/Exploration	3
	Free Elective	3

*** *PHYS Elective must be one of the following: PHYS 1100, PHYS 2300, or PHYS 2600.*

Spring Semester — 15-17 Credits

BIOL ≥2000	Biology Elective	3-4
BIOL ≥2000	Biology Elective	3-4
	Foreign Language Elective (Intermediate 2)	3
	Gen Ed/Exploration	3
	Free Elective	3

SOPHOMORE YEAR

Fall Semester — 17-18 Credits

BIOL 2300	Ecology	4
CHEM 2000	Organic Chemistry I (AIA)	4
MATH ≥1300**	Math Elective (QR)	3-4
	Gen Ed/WS	3
	Foreign Lang. Elective (Beginning 1)	3

** *Applied Statistics (MATH 1700) or Calculus I (MATH 2300) is recommended to fulfill the QR requirement.*

Spring Semester — 16 Credits

Genetics 2800	Genetics	4
	GEOG Elective	3
	Foreign Language Elective (Beginning 2)	3
	Gen Ed/Exploration	3
	Gen Ed/Exploration	3

SENIOR YEAR

Fall Semester — 15-17 Credits

BIOL ≥2000	Biology Elective	3-4
BIOL ≥2000	Biology Elective	3-4
	Gen Ed/Exploration	3
	Gen Ed/Exploration	3
	Free Elective	3

Spring Semester — 13 Credits

BIOL ≥3000	Biology Elective (Capstone) (IHIP)	4
	Gen Ed/ Exploration	3
	Free Elective	3
	Free Elective	3

General Education: Foundation

3 credits Reading and Information Literacy (R and IL): First Year Experience
3 credits Writing (W): Writing I
3 credits Writing and Information Literacy (W and IL): Writing II
3 credits Quantitative Reasoning (QR) (MATH)
3 credits World Languages, Speaking and Listening (WS)

General Education: Exploration

3 credits Civic Learning (CV)
3 credits Diverse Perspectives (DP)
3 credits Ethical Reasoning (ER)
3 credits Fine Arts Expression and Analysis (FA)
3 credits Historical Inquiry and Analysis (HI)
3 credits Literary Inquiry and Analysis (LI)
3 credits Personal Wellness (PW)
3 credits Procedural and Logical Thinking (PL)
3 credits Scientific Inquiry and Analysis (SI)

General Education: Integration

9 credits AIA (3 of which must be Integrative High Impact Practice - IHIP)

OR

Minor (professional majors completing a minor or second major must include at least 9 credits in LA&S disciplines for that minor)

General Education: MAJ

There may be major courses that have been approved to fulfill up to 3 General Education requirements (at least 9 credits). Varies by major and concentration.

Suggested 4-year plan of study. Completion of 120 credits required for graduation.

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Suggested Four-Year Plan of Study
BIOLOGY AND CHEMISTRY

FITCHBURG STATE UNIVERSITY

Biotechnology B.S. (Bachelor of Science)

FRESHMAN YEAR

Fall Semester — 14 Credits

ENGL 1100	Writing I	3
BIOL 1800	General Biology I*	4
CHEM 1300	General Chemistry I* (SI)	4
FYE 1015	First Year Experience	3

** General Chemistry requires a 'passing' score on Advanced and Functions Accuplacer exam OR successful completion of MATH 0500 (Algebraic Preperation) prior to enrollment. To continue as a Biology major, students must earn a grade of 2.0 or higher in General Biology I and General Chemistry I.*

Spring Semester — 15 Credits

ENGL 1200	Writing II	3
BIOL 1900	General Biology II	4
CHEM 1400	General Chemistry II (PL)	4
MATH 1300	Precalculus	4

JUNIOR YEAR

Fall Semester — 17 Credits

BIOL 2250	Cell Biology	4
PHYS 2300	General Physics I	4
	General Education/Exploration	3
	General Education/Exploration	3
	Free Elective	3

Spring Semester — 13-14 Credits

BIOL ≥2000	Biology Elective	3-4
PHYS 2400	General Physics II	4
	General Education/Exploration	3
	Free Elective	3

SOPHOMORE YEAR

Fall Semester — 17 Credits

BIOL 2300	Ecology	4
CHEM 2000	Organic Chemistry I (AIA)	4
MATH ≥1300**	Math Elective (QR)	3
	General Education (WS)	3
	General Education/Exploration	3

*** Applied Statistics (MATH 1700) is recommended to fulfill the QR requirement.*

Spring Semester — 17 Credits

Genetics 2800	Genetics	4
CHEM 2100	Organic Chemistry II (AIA)	4
	General Education/Exploration	3
	Free Elective	3
	Free Elective	3

SENIOR YEAR

Fall Semester — 15-17 Credits

BIOL ≥2000	Biology Elective***	3-4
BIOL ≥2000	Biology Elective	3-4
	General Education/Exploration	3
	General Education/Exploration	3
	Free Elective	3

**** Three of the five Biology electives must be selected from the following courses: General Microbiology (BIOL 2150), Biochemical Techniques (BIOL 3060), Molecular Biology (BIOL 4500), Cell Culture Techniques (BIOL 3550), and Immunology (BIOL 4800). Additionally, one of the five must be designated as a Capstone course.*

Spring Semester — 13-16 Credits

BIOL ≥3000	Biology Elective (Capstone) (IHIP)	4
BIOL ≥2000	Biology Elective **OR**	
	Independent Study **OR** Internship	3-6
	Free Elective	3
	Free Elective	3

General Education: Foundation

3 credits Reading and Information Literacy (R and IL): First Year Experience
3 credits Writing (W): Writing I
3 credits Writing and Information Literacy (W and IL): Writing II
3 credits Quantitative Reasoning (QR) (MATH)
3 credits World Languages, Speaking and Listening (WS)

General Education: Exploration

3 credits Civic Learning (CV)
3 credits Diverse Perspectives (DP)
3 credits Ethical Reasoning (ER)
3 credits Fine Arts Expression and Analysis (FA)
3 credits Historical Inquiry and Analysis (HI)
3 credits Literary Inquiry and Analysis (LI)
3 credits Personal Wellness (PW)
3 credits Procedural and Logical Thinking (PL)
3 credits Scientific Inquiry and Analysis (SI)

General Education: Integration

9 credits AIA (3 of which must be Integrative High Impact Practice - IHIP)
OR
Minor (professional majors completing a minor or second major must include at least 9 credits in LA&S disciplines for that minor)

General Education: MAJ

There may be major courses that have been approved to fulfill up to 3 General Education requirements (at least 9 credits). Varies by major and concentration.

Suggested 4-year plan of study. Completion of 120 credits required for graduation.

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Suggested Four-Year Plan of Study
BIOLOGY AND CHEMISTRY

FITCHBURG STATE UNIVERSITY

Health Sciences B.S. (Bachelor of Science)

FRESHMAN YEAR

Fall Semester — 14 Credits

ENGL 1100	Writing I	3
BIOL 1800	General Biology*	4
CHEM 1300	General Chemistry I* (SI)	4
FYE 1015	First Year Experience	3

** General Chemistry requires a 'passing' score on Advanced Algebra and Functions Accuplacer exam OR successful completion of MATH 0500 (Algebraic Preparation) prior to enrollment. To continue as a Biology Major, students must earn a grade of 2.0 or higher in General Biology I and General Chemistry I.*

Spring Semester — 15 Credits

ENGL 1200	Writing II	3
BIOL 1900	General Biology II	4
CHEM 1400	General Chemistry II (PL)	4
MATH 1300	Precalculus	4

SOPHOMORE YEAR

Fall Semester — 17 Credits

BIOL 2300	Ecology	4
CHEM 2000	Organic Chemistry I (AIA)	4
MATH ≥1300**	Math Elective (QR)	3
	General Education (WS)	3
	General Education/Exploration	3

** Applied Statistics (MATH 1700) is recommended to fulfill the QR requirement.*

Spring Semester — 17 Credits

BIOL 2800	Genetics	4
CHEM 2100	Organic Chemistry II (AIA)	4
	General Education/Exploration	3
	Free Elective	3
	Free Elective	3

JUNIOR YEAR

Fall Semester — 16 Credits

BIOL 3030	Biochemistry I	3
BIOL 2004	Human Anatomy and Physiology I	4
	General Education/Exploration	3
	General Education/Exploration	3
	Free Elective	3

Spring Semester — 14-15 Credits

BIOL ≥2000***	Biology Elective	3-4
PHYS 2300	General Physics I	4
BIOL 2005	Human Anatomy and Physiology II	4
	General Education/Exploration	3

**** Developmental Biology (BIOL 3550) and a course in Microbiology (BIOL 2150) are strongly recommended as biology electives.*

SENIOR YEAR

Fall Semester — 16-17 Credits

BIOL ≥2000	Biology Elective	3-4
PHYS 2400	General Physics II	4
	General Education/Exploration	3
	General Education/Exploration	3
	Free Elective	3

Spring Semester — 13-16 Credits

BIOL ≥3000	Biology Elective (Capstone) (IHIP)	4
BIOL ≥2000	Biology Elective **OR**	
	Independent Study **OR** Internship	3-6
	Free Elective	3
	Free Elective	3

General Education: Foundation

3 credits Reading and Information Literacy (R and IL): First Year Experience
3 credits Writing (W): Writing I
3 credits Writing and Information Literacy (W and IL): Writing II
3 credits Quantitative Reasoning (QR) (MATH)
3 credits World Languages, Speaking and Listening (WS)

General Education: Exploration

3 credits Civic Learning (CV)
3 credits Diverse Perspectives (DP)
3 credits Ethical Reasoning (ER)
3 credits Fine Arts Expression and Analysis (FA)
3 credits Historical Inquiry and Analysis (HI)
3 credits Literary Inquiry and Analysis (LI)
3 credits Personal Wellness (PW)
3 credits Procedural and Logical Thinking (PL)
3 credits Scientific Inquiry and Analysis (SI)

General Education: Integration

9 credits AIA (3 of which must be Integrative High Impact Practice - IHIP)

OR

Minor (professional majors completing a minor or second major must include at least 9 credits in LA&S disciplines for that minor)

General Education: MAJ

There may be major courses that have been approved to fulfill up to 3 General Education requirements (at least 9 credits). Varies by major and concentration.

Suggested 4-year plan of study. Completion of 120 credits required for graduation.

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Suggested Four-Year Plan of Study
BIOLOGY AND CHEMISTRY

FITCHBURG STATE UNIVERSITY

Neuroscience and Behavior B.S. (Bachelor of Science)

FRESHMAN YEAR

Fall Semester — 14 Credits

ENGL 1100	Writing I	3
BIOL 1800	General Biology I*	4
CHEM 1300	General Chemistry I* (SI)	4
FYE 1015	First Year Experience	3

** General Chemistry requires a 'passing' score on Advanced Algebra and Functions Acculplacer exam OR successful completion of MATH 0500 (Algebraic Preparation) prior to enrollment. To continue as a Biology major, students must earn a grade of 2.0 or higher in General Biology I and General Chemistry I.*

Spring Semester — 15 Credits

ENGL 1200	Writing II	3
BIOL 1900	General Biology II	4
CHEM 1400	General Chemistry II (PL)	4
MATH 1300	Precalculus	4

SOPHOMORE YEAR

Fall Semester — 17 Credits

BIOL 2300	Ecology	4
CHEM 2000	Organic Chemistry I (AIA)	4
MATH ≥1300**	Math Elective (QR)	3
PSY 1100	Intro to Psychological Science	3
	General Education (WS)	3

*** Applied Statistics (MATH 1700) is recommended to fulfill the QR requirement.*

Spring Semester — 17 Credits

BIOL 2800	Genetics	4
CHEM 2100	Organic Chemistry II (AIA)	4
BIOL 2650	Neuroscience	3
	General Education/Exploration	3
	General Education/Exploration	3

JUNIOR YEAR

Fall Semester — 16-17 Credits

BIOL ≥2000	Biology Elective***	3-4
PHYS 2300	General Physics I	4
PSY 3500	Psychology of Learning **OR**	
PSY 3550	Cognition	3
	General Education/Exploration	3
	General Education/Exploration	3

**** At least two of the five biology electives must be selected from the following: Animal Behavior (BIOL 2600), Cell Biology (BIOL 2250), Developmental Biology (BIOL 3550), or Animal Physiology (BIOL 4700). Additionally, one must be designated a Capstone course.*

Spring Semester — 13-14 Credits

BIOL ≥2000	Biology Elective	3-4
PHYS 2400	General Physics II	4
	General Education/Exploration	3
	Free Elective	3

SENIOR YEAR

Fall Semester — 12-16 Credits

BIOL ≥2000	Biology Elective	3-4
BIOL ≥2000	Biology Elective **OR**	
	Independent Study **OR** Internship	3-6
	General Education/Exploration	3
	General Education/Exploration	3

Spring Semester — 13 Credits

BIOL ≥3000	Biology Elective (Capstone) (IHIP)	4
	Free Elective	3
	Free Elective	3
	Free Elective	3

General Education: Foundation

3 credits Reading and Information Literacy (R and IL): First Year Experience
3 credits Writing (W): Writing I
3 credits Writing and Information Literacy (W and IL): Writing II
3 credits Quantitative Reasoning (QR) (MATH)
3 credits World Languages, Speaking and Listening (WS)

General Education: Exploration

3 credits Civic Learning (CV)
3 credits Diverse Perspectives (DP)
3 credits Ethical Reasoning (ER)
3 credits Fine Arts Expression and Analysis (FA)
3 credits Historical Inquiry and Analysis (HI)
3 credits Literary Inquiry and Analysis (LI)
3 credits Personal Wellness (PW)
3 credits Procedural and Logical Thinking (PL)
3 credits Scientific Inquiry and Analysis (SI)

General Education: Integration

9 credits AIA (3 of which must be Integrative High Impact Practice - IHIP)

OR

Minor (professional majors completing a minor or second major must include at least 9 credits in LA&S disciplines for that minor)

General Education: MAJ

There may be major courses that have been approved to fulfill up to 3 General Education requirements (at least 9 credits). Varies by major and concentration.

Suggested 4-year plan of study.

Completion of 120 credits required for graduation.

Suggested Four-Year Plan of Study
BIOLOGY AND CHEMISTRY

FITCHBURG STATE UNIVERSITY

Environmental Biology B.S. (Bachelor of Science)

FRESHMAN YEAR

Fall Semester — 14 Credits

ENGL 1100	Writing I	3
BIOL 1800	General Biology I*	4
CHEM 1300	General Chemistry I* (SI)	4
FYE 1015	First Year Experience	3

** General Chemistry requires a 'passing' score on Advanced Algebra and Functions Accuplacer exam OR successful completion of MATH 0500 (Algebraic Preparation) prior to enrollment. To continue as a Biology major, students must earn a grade of 2.0 or higher in General Biology I and General Biology I.*

Spring Semester — 15 Credits

ENGL 1200	Writing II	3
BIOL 1900	General Biology II	4
CHEM 1400	General Chemistry II (PL)	4
MATH 1300	Precalculus	4

SOPHOMORE YEAR

Fall Semester — 17 Credits

BIOL 2300	Ecology	4
CHEM 2000	Organic Chemistry I (AIA)	4
MATH ≥1300**	Math Elective (QR)	3
	From Cluster 1***	3
	General Education (WS)	3

*** Applied Statistics (MATH 1700) is recommended to fulfill the QR requirement.*

Spring Semester — 17 Credits

BIOL 2800	Genetics	4
CHEM 2100	Organic Chemistry II (AIA)	4
	From Cluster 2***	3
	General Education/Exploration	3
	General Education/Exploration	3

**** At least one course must be from Cluster 1 consisting of GEOG 2100, GEOG 2500, GEOG 3110, or GEOG 4600. Another course must come from Cluster 2 consisting GEOG 2400, GEOG 3120, GEOG 3300, GEOG 4000, or GEOG 4500. (These courses may have prerequisites that must be completed prior to enrolling in them.)*

JUNIOR YEAR

Fall Semester — 16-17 Credits

BIOL ≥2000	Biology Elective	3-4
PHYS 2300	General Physics I	4
	General Education/Exploration	3
	General Education/Exploration	3
	Free Elective	3

Spring Semester — 13-14 Credits

BIOL 3100	Conservation Biology	3
PHYS 2400	General Physics II	4
	General Education/Exploration	3
	General Education/Exploration	3

SENIOR YEAR

Fall Semester — 12-16 Credits

BIOL ≥2000	Biology Elective	3-4
BIOL ≥2000	Biology Elective **OR**	
	Independent Study **OR** Internship	3-6
	General Education/Exploration	3
	Free Elective	3

Spring Semester — 13-14 Credits

BIOL ≥3000	Biology Elective (Capstone****) (IHIP)	4
BIOL ≥2000	Biology Elective	3-4
	Free Elective	3
	Free Elective	3

***** At least one of the 5 Biology electives must be designated a Capstone course.*

General Education: Foundation

3 credits Reading and Information Literacy (R and IL): First Year Experience
3 credits Writing (W): Writing I
3 credits Writing and Information Literacy (W and IL): Writing II
3 credits Quantitative Reasoning (QR) (MATH)
3 credits World Languages, Speaking and Listening (WS)

General Education: Exploration

3 credits Civic Learning (CV)
3 credits Diverse Perspectives (DP)
3 credits Ethical Reasoning (ER)
3 credits Fine Arts Expression and Analysis (FA)
3 credits Historical Inquiry and Analysis (HI)
3 credits Literary Inquiry and Analysis (LI)
3 credits Personal Wellness (PW)
3 credits Procedural and Logical Thinking (PL)
3 credits Scientific Inquiry and Analysis (SI)

General Education: Integration

9 credits AIA (3 of which must be Integrative High Impact Practice - IHIP)

OR

Minor (professional majors completing a minor or second major must include at least 9 credits in LA&S disciplines for that minor)

General Education: MAJ

There may be major courses that have been approved to fulfill up to 3 General Education requirements (at least 9 credits). Varies by major and concentration.

Suggested 4-year plan of study. Completion of 120 credits required for graduation.

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Suggested Four-Year Plan of Study
BIOLOGY AND CHEMISTRY

FITCHBURG STATE UNIVERSITY

Biology (B.S.) with Initial Licensure in Secondary Education (with Minor in Middle School and Secondary Education)

FRESHMAN YEAR

Fall Semester — 14 Credits

ENGL 1100	Writing I	3
BIOL 1800	General Biology I*	4
CHEM 1300	General Chemistry I* (SI)	4
FYE 1015	First Year Experience	3

* General Chemistry requires a 'passing' score on Advanced Algebra and Functions Accuplacer exam OR successful completion of MATH 0500 (Algebraic Preparation) prior to enrollment. To continue as a Biology major, students must earn a grade of 2.0 or higher in General Biology I and General Chemistry I.

Spring Semester — 17 Credits

ENGL 1200	Writing II	3
BIOL 1900	General Biology II	4
CHEM 1300	General Chemistry II (PL)	4
BIOL 1860	Introduction to Education (5-12)***	3
	Gen Ed/WS	3

SOPHMORE YEAR

Fall Semester — 17 Credits

BIOL 2300	Ecology	4
CHEM 2000	Organic Chemistry I	4
MATH ≥1300**	Math Elective (QR)	3
EDUC 2011	Diversity in Education (5-12)***	3
	Gen Ed/Exploration	3

*** Applied Statistics (MATH 1700) is recommended to fulfill the QR requirement.*

Spring Semester — 15 Credits

Genetics 2800	Genetics	4
CHEM 2100	Organic Chemistry II	4
EDUC 2012	Teaching the Adolescent Learner (5-12)***	3
MATH 1300	Precalculus	4

*** These courses are required for completion of the minor in Middle School and Secondary Education. Students must complete this minor for the Initial Licensure in Secondary Education. The minor fulfills the Integration requirement for the Biology major.

JUNIOR YEAR

Fall Semester — 16-17 Credits

BIOL ≥2000 §	Biology Elective	3-4
PHYS 2300	General Physics I	4
BIOL 3700	Bioethics (ER)	3
	Gen Ed/Exploration	3
SPED 3800	Inclusive Instruction (5-12)***	3

§ Human Anatomy and Physiology I and II (BIOL 2004/2005) are strongly suggested for 2 of the Biology electives.

Spring Semester — 13-14 Credits

BIOL ≥2000	Biology Elective	3-4
PHYS 2400	General Physics II	4
BIOL 3015	Methods of Teaching Biology I***	3
	Gen Ed/Exploration	3

SENIOR YEAR

Fall Semester — 16 Credits

BIOL ≥3000	Biology Elective (Capstone)	4
BIOL 4850	Methods of Teaching Biology II***	3
EDUC 3122	Sheltered English Immersion	3
	Gen Ed/Exploration	3
	Gen Ed/Exploration	3

Spring Semester — 12 Credits

BIOL 4860	Biology Practicum in Secondary Education I	4.5
BIOL 4870	Biology Practicum in Secondary Education II	4.5
BIOL 4012	Practicum Seminar	3

General Education: Foundation
3 credits Reading and Information Literacy (R and IL): First Year Experience
3 credits Writing (W): Writing I
3 credits Writing and Information Literacy (W and IL): Writing II
3 credits Quantitative Reasoning (QR) (MATH)
3 credits World Languages, Speaking and Listening (WS)

General Education: Exploration
3 credits Civic Learning (CV)
3 credits Diverse Perspectives (DP)
3 credits Ethical Reasoning (ER)
3 credits Fine Arts Expression and Analysis (FA)
3 credits Historical Inquiry and Analysis (HI)
3 credits Literary Inquiry and Analysis (LI)
3 credits Personal Wellness (PW)
3 credits Procedural and Logical Thinking (PL)
3 credits Scientific Inquiry and Analysis (SI)

General Education: Integration
9 credits AIA (3 of which must be Integrative High Impact Practice - IHIP)
OR
Minor (professional majors completing a minor or second major must include at least 9 credits in LA&S disciplines for that minor)

General Education: MAJ
There may be major courses that have been approved to fulfill up to 3 General Education requirements (at least 9 credits). Varies by major and concentration.

Suggested 4-year plan of study. Completion of 120 credits required for graduation.

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FALL SEMESTER COURSES

Non-Majors Courses				YEAR OFFERED- FALL						
BIOL	1000	Introduction to Life Science	Fall, Spring, Summer, online	21	22		24	25	26	27
BIOL	1001	Introduction to Health Professions Sem	Every other Fall				24		26	
BIOL	1010	Introduction to Environmental Sciences	Fall, Spring as needed		22		24	25	26	27
BIOL	1050	Life Science for Educators	Fall, Spring	21	22	23	24	25	26	27
BIOL	1200	Anatomy & Physiology I	Fall, Summer	21	22	23	24	25	26	27
BIOL	1650	Nutrition	Fall, Spring, Summer, online	21	22	23	24	25	26	27
BIOL	1700	Human Biology	Fall, as needed					25		
FYE	1015	First Year Experience	Every Fall	21	22	23	24	25	26	27
HON	1015	Topics: Honors Personal Genomics	Every Fall, Spring as needed			23			26	
HON	1600	Honors: Biological Issues and Inquiry	Every Fall		22		24	25		27

Biology Core										
BIOL	1800	General Biology I	Fall, Spring, Summer, online	21	22	23	24	25	26	27
BIOL	2300	Ecology	Every Fall	21	22	23	24	25	26	27
BIOL	2800	Genetics	Fall, Spring	21	22	23	24	25	26	27

Electives & Capstones										
BIOL	2004	Human Anatomy & Physiology I	Every Fall	21	22	23	24	25	26	27
BIOL	2150	General Microbiology	Every other Fall	21	22	23	24	25		27
BIOL/CHEM	3060	Biochemical Techniques (CAPSTONE)	Every other Fall		22		~~24~~	25		27
BIOL	3100	Conservation Biology	Every other Fall	21		23		25		27
BIOL	4009	Cancer Genomics (CAPSTONE)	Every other Fall		22			25		27
BIOL	3350	Cell Culture Techniques	Every other Fall					25		27
BIOL	2250	Cell Biology	Every other Fall	21	22	23	24		26	
BIOL	3102	Marine Biology	Every other Fall		S23				26	
BIOL	4011	Models, Methods, and Analysis (CAPST	Every other Fall				24		26	
BIOL/CHEM	3040	Biochemistry II (Human Metabolism)	NEW ELECTIVE- FALL						26	
BIOL/CHEM	4015	Topics: Metals in Biology	Every other Fall		22		24		26	

Chemistry Courses										
CHEM	1000	Chemistry in a Changing World	Every other Fall	21				25		27
CHEM	1200	Chemistry for the Health Sciences	Fall, Spring	21	22	23	24	25	26	27
CHEM	1300	General Chemistry I	Fall, Spring	21	22	23	24	25	26	27
CHEM	2000	Organic Chemistry I	Every Fall	21	22	23	24	25	26	27
CHEM	3600	Descriptive Inorganic Chemistry	Every other Fall	21		23		25		27
CHEM	4750	Chemistry Seminar	As Needed					25		

Not Offered/Mothballed/Unknown fate										
BIOL	3010	Invertebrate Biology	Less than every 3 years							
BIOL	3650	Plant Biology	Was every other fall, now unknow	21		23				

SPRING SEMESTER COURSES

BIology Non-Majors				YEAR OFFERED-SPRING						
BIOL	1000	Introduction to Life Science	Fall, Spring, Summer, onli	22		24	25	26	27	28
BIOL	1050	Life Science for Educators	Fall, Spring	22	23		25	26	27	28
BIOL	1300	Anatomy & Physiology II	Spring, Summer	22	23	24	25	26	27	28
BIOL	1650	Nutrition	Fall, Spring, Summer, onli	22	23	24	25	26	27	28
BIOL	2700	Medical Microbiology	Every Spring	22	23	24	25	26	27	28
BIOL	1010	Introduction to Environmental Sciences	Fall, Spring as needed		23					
BIOL	1750	Decoding Your Genome	Spring as needed		23					
HON	1015	Topics: Honors Personal Genomics	Every Fall, Spring as needed				25			

Biology Core										
BIOL	1800	General Biology I	Fall, Spring, Summer	22	23	24	25	26	27	28
BIOL	1900	General Biology II	Spring, Summer	22	23	24	25	26	27	28
BIOL	2800	Genetics	Fall, Spring	22	23	24	25	26	27	28

Electives & Capstones										
BIOL	2005	Human Anatomy & Physiology II	Every Spring	22	23	24	25	26	27	28
BIOL/CHEM	3030	Biochemistry I	Every Spring				25	26	27	28
BIOL	2650	Neuroscience	Every Spring	22	23	24	25	26	27	28
BIOL	3550	Developmental Biology (CAPSTONE)	Every Spring	22	23	24	25	26	27	28
BIOL	3700	Bioethics	Every other Spring		23		25		27	
BIOL	2600	Animal Behavior	Every other Spring		23		25		27	
BIOL	4810	Immunology	Every other Spring	22			25		27	
BIOL	2006	Tropical Ecology (Costa Rica) also non-majors	Every other Spring					26		28
BIOL	4600	Evolution	Every other Spring			24		26		28
BIOL/CHEM	4020	Medicinal Chemistry	Every other Spring		23	24		26		28
BIOL	4500	Molecular Biology (CAPSTONE)	Every other Spring	22		24		26		28

Chemistry Courses										
CHEM	1200	Chemistry for the Health Sciences	Fall, Spring	22	23	24	25	26	27	28
CHEM	1300	General Chemistry I	Fall, Spring	22	23	24	25	26	27	28
CHEM	1400	General Chemistry II	Every Spring	22	23	24	25	26	27	28
CHEM	2100	Organic Chemistry II	Every Spring	22	23	24	25	26	27	28
CHEM	2400	General Analytical Chemistry	Every Spring	22	23		25	26	27	28
CHEM	3003	Environmental Chemistry	Every other Spring		23		25		27	
CHEM	3200	Physical Chemistry I , Offered FA24	Every other Spring		23			26		28
CHEM	4750	Chemistry Seminar	As Needed		23					

SUMMER COURSES

Blology Non-Majors			Modality		YEAR OFFERED-SUMMER						
BIOL	1000	Introduction to Life Science/Educators	ONLINE	Summer II				25	26	27	28
BIOL	1300	Anatomy & Physiology I	ONLINE (SU25)	Summer I	22	~~23~~	~~24~~	25	26	27	28
BIOL	1300	Anatomy & Physiology I	ONLINE (SU25)	Summer II							
BIOL	1650	Nutrition	ONLINE	Summer I & II	22	23	24	25	26	27	28

Biology Core											
BIOL	1800	General Biology I	ONLINE	Summer I	22	23	24	25	26	27	28
BIOL	1900	General Biology II	ONLINE	Summer II	22	23	24				

Electives & Capstones											
BIOL	2650	Neuroscience	ONLINE/ONSYNCH	Summer I HOLD	22	23	24				
BIOL	3007	Virology	ONLINE	Summer II, odd				25		27	
BIOL	3000	Parasitology	ONLINE	Summer II, even					26		28

Chemistry Courses											
CHEM	1300	General Chemistry I	ONLINE	Summer I	22	23	24	25	26	27	28
CHEM	1400	General Chemistry II	ONLINE	Summer II	22	23	24	25	26	27	28
CHEM	2000	Organic Chemistry I	HYBRID	Summer I	22	23	24	25	26	27	28
CHEM	2100	Organic Chemistry II	ONLINE	Summer II	22	23	24	25	26	27	28

III. Assessment

A. Program Learning Outcomes.

Describe how your program reviews and updates PLOs

To ensure the program continues to meet program outcomes, the departmental Assessment Committee analyzes data from our course products, student surveys, and faculty feedback to make evidence-based recommendations on changes and improvements. Assessment results are regularly discussed with the full department, including at extended departmental retreats (meetings) held twice each year.

In our previous self study, two action items were tasked to the Assessment Committee:

- Continue to address challenges in our assessment plans.
- Clarify expectations and assessment in capstone courses.

Since 2018 we have made significant progress on both. First, the department continued to adapt a list of priority concepts from the AAAS BioCore that should be included in any Biology major (Brownell et al 2014) (1). In our previous Self Study we mapped those concepts onto our curriculum and noted areas with stronger or weaker coverage. We then developed and launched a set of test questions for "content knowledge" of those concepts. Results from those tests were discussed at several retreats, and the most recent data are explored below. To address the second task above, we held several discussions at department retreats to decide upon the proficiencies needed in any Capstone course, and we developed a rubric to evaluate whether students were meeting those proficiencies. Finally, in the spring semester of 2020 the Assessment Committee submitted these documents in our first official Assessment Plan. As a result, the Biology major received the highest scores possible (i.e,. "Highly Developed") in all categories that were evaluated by the UARC in 2022-2023. The full Assessment Plan, Test for Content Knowledge, and Capstone Skills Rubric are all available at the end of this section in the supporting documents.

Biology program learning outcomes (PLOs) from the Assessment Plan are:

> **PLO 1. Demonstrate content knowledge** of the American Association for the Advancement of Science BioCore (Brownell et al 2014), with topics in Evolution, Transformations of Energy and Matter, Information Flow, Exchange and Storage, Structure and Function, and Systems
>
> **PLO 2. Conduct original biological research**.
>
> - Clearly articulate testable questions and hypotheses
> - Design and execute experiments
> - Analyze data using appropriate statistical methods
> - Summarize data concisely with graphs, tables or images
> - Draw appropriate conclusions
> - Demonstrate safe practices in laboratory and field

PLO 3. Communicate science orally and in writing.

- Present information in a clear and organized manner
- Write well-organized and concise reports in a scientifically appropriate style
- Use relevant technology in communications.
- Communicate to a general audience

PLO 4. Use scientific literature.

- Retrieve information efficiently and effectively by searching the biological literature
- Cite sources appropriately

B. Measures and Results

Describe the process for collecting, analyzing and using data for program improvement.

The table below shows where we teach and assess each PLO in the courses required of Biology majors.

Assessment of Program Learning Outcomes (PLOs)				
Course	PLO 1	PLO 2	PLO 3	PLO 4
General Biology I	1A	1	1	1
General Biology 2	1-2	1	1	1
Ecology	1-2	2	2	2
Genetics	2	2	2	2
Capstone Course	2-3A	3A	3A	3A

Number codes represent assessment categories from the Assessment Report Template
0 = PLO is not addressed within the specific course
1 = Introducing; PLO is covered at an introductory level within the specific course
2 = Broadening; PLO is covered in the course so as to reinforce the students' learning of it within the specific course
3 = Fulfilling; Demonstration of proficiency of the PLO occurs within the specific course
A = Assessed for Program; There will be a Direct Assessment activity to be used in Program Level Assessment in all sections of this course

Direct Assessment

PLO 1 - Students take our Test for Content Knowledge with questions that are mapped to the AAAS BioCore content areas (Evolution, Transformations of Energy and Matter, Information Flow, Exchange and Storage, Structure and Function Systems). The assessment is given as a pre-test (early in General Biology I, 1st year) and a post-test (Capstone Course, 3rd or 4th year). For each test question and content area, we measure the % correct answers and the % change from introductory students to capstone students.

Despite the limitations of this assessment model (i.e., different students in the pre and post test sample, transfer students may not be included in pre-test, etc), it allows us to quantify progress towards meeting our learning outcome targets. The assessment was moved from a paper test to an online format using a Google Form to simplify data collection and processing.

Our aspirational, "Proficient" target is to see scores of at least 75% correct on every post-test question, OR at least 50% correct with improvement of at least 25% from the pre-test. Because some questions are designed to be challenging and address common misconceptions, we can accept "Sufficient" scores of 50-75% provided there was improvement (5-25%) compared to the pre-test. "Deficient" areas that require discussion at our annual retreat are questions that score <50% in the post-test, OR areas that score 50-75% without any improvement.

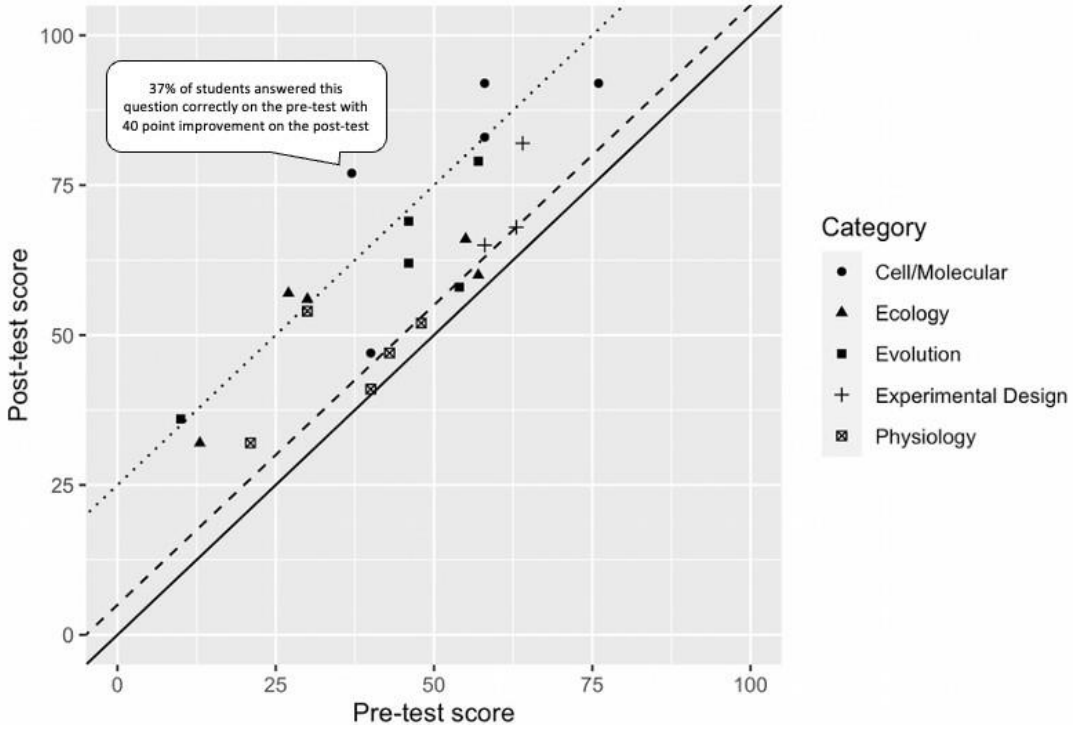

Figure III.1. Percent of students answering individual content knowledge questions correctly on pre-test (BIOL 1800 Fall 2024, n = 67) vs post-test (capstone courses 2021-2024, n = 74). Individual questions were classified into five categories (see figure legend). The 1:1 slope line (solid line) indicates no improvement in post-test over pre-test. An improvement of 5 percentage points (dashed line) and 25 percentage points (dotted line) are also depicted.

Results were most recently discussed at our spring departmental retreat (May 2024). Content knowledge assessment using pre and post testing indicated that 62.5% of questions met our criteria for sufficient or proficient, while 37.5% of questions were considered deficient (<50% in the post-test, OR areas that score 50-75% with <5% improvement, Figure III.1). Results revealed specific areas of weakness, including physiology (structure/function, surface area/volume ratios, negative feedbacks), and

a few specific concepts about evolution and energy flow. Students show strengths and significant improvement across many areas of Biology, including cell biology, genetics, phylogeny and ecology.

During this discussion, faculty wondered if there was evidence of longitudinal trends in student performance on the assessment. Some questions have been reworded or added prior to 2019 (for example, to improve clarity or address a new topic), but for stable questions, there was little evidence of trends in performance over time. We also discussed if weak areas reflect gaps in our curriculum. Human Anatomy and Physiology I and II have been added as new electives to help address gaps in physiology coverage, but these courses are currently optional and not required of all students. Some of the questions are challenging and were intentionally chosen to address misconceptions, making it difficult to compare across biology subdisciplines. One option being considered is adopting a new set of published assessment questions (2) aligned with the AAAS Vision and Change Core concepts. However, we decided to maintain the current assessment format for this program review period.

PLO 2-4 - Students complete a poster, oral presentation, or a lab report in a Capstone course. Members of the Assessment Committee evaluated criteria based on a rubric adopted by the department in 2020 (See Appendix III.3). To guide the Assessment Committee in scoring, the generic rubric is adapted for each assignment with the help of the Capstone course instructor. The criteria for success is that a majority of students (>66%) demonstrate sufficiency in one or more of the following areas: A) conducting original research; B) reporting results orally and in writing; and C) using scientific literature effectively.

Assessment of learning outcomes PLO 2-4 represents an area of substantial effort for the Assessment Committee and the department as a whole since the last self-study. Biology is a broad discipline and it has taken much discussion to find consensus and build these assessment rubrics. Cooperation between Capstone course instructors and the Assessment Committee has been key to identifying appropriate learning outcomes to assess for particular student projects, instead of applying a one-size fits all approach.

PLO 2 “Conduct original biological research” was last assessed in Spring 2024. Student oral and poster presentations were assessed by one to three faculty at the Fitchburg State University Undergraduate Conference in Spring 2024. Research was primarily conducted in the Molecular Biology capstone course or the Moderna Scholars program. Several presentations were from faculty guided independent study projects. 100% of students were assessed as sufficient or proficient for: 2A. Clearly articulate testable questions and hypotheses, 2B. Design and execute experiments, and 2C-1. Summarize results concisely with graphs, tables or images. These high scores are typical for projects assessed in earlier years, too.

The same presentations were assessed for PLO 3 “Communicate science orally and in writing”. 100% of students were assessed as sufficient or proficient for 3B. Present information in a clear and organized manner (Oral presentation or Poster). 81% of students were assessed as sufficient or proficient for 3D. Communicate to a general audience. This result is also consistent with data from Capstone assessment in 2020. Therefore, at the spring departmental retreat May 2024, faculty discussed the challenge of

presenting technical details to a general audience. The Assessment Committee plans to review and potentially revise PLO 3D based on this discussion (see Action Items below).

Department retreats and reflection on PLO2 revealed challenges students faced in making graphs or understanding statistics. One problem was that faculty were teaching different things in different courses, or had different guidelines. Therefore, in 2023 a team of five faculty (including four members of the Assessment Committee) assembled an online Graphing and Statistics Guide for Biology and Chemistry Classes. The 31-page guide includes embedded videos to show students how to do the specific steps for making graphs or running statistical tests. Anecdotally from faculty feedback, that guide has improved consistency in how we teach these concepts across courses, such as General Biology I and II, Ecology, and capstone courses. A copy of this guide is available upon request.

PLO 4 "Use scientific literature" was last assessed in Fall 2022. Summary results are included below in Table 1. 93% of students were assessed as proficient or sufficient for retrieving information, and 87% of students were assessed as proficient or sufficient for citing sources. Only 53% of students were assessed as proficient or sufficient for evaluating scientific articles.

Following those results on PLO 4 in 2022, the data were discussed at the subsequent department retreat in January of 2023. The assessment results provided a prompt for a broader discussion about using literature. Then we reflected on a survey the faculty filled out, asking 1) which skills they expect students to already know; 2) which skills are most problematic to students; and 3) specific strategies faculty use to teach those skills. Faculty members shared assignments and strategies employed in their courses that involve using scientific literature. Most faculty expected students to be able to distinguish scholarly literature and to understand and use appropriate citations. Students should have some experience with search techniques, and in pulling out key ideas from articles, but these skills take time to develop. Often this is not truly developed until several years of graduate school. Based on this discussion, it was decided that we would revise the language in our Assessment Plan from "evaluate" scientific literature to "use" scientific literature. The rationale for the change is that evaluating scientific literature is a graduate level skill and therefore not a reasonable expectation for undergraduate students.

Indirect assessment - Anonymous Student Survey - The Student Affairs Committee administers an anonymous student survey. The Assessment along with the Student Affairs Committees compile the results and report the findings to the department. Identification of strengths and challenges of the Biology program are discussed at an annual retreat. Survey results are discussed in detail in Section V. **Students** and in Section VI. **Equity**.

C. Action Items and Use of Results

Describe what changes your unit has made in response to assessment data.

Refer to **section B** above for discussion of changes made in response to assessment data.

Action Items for assessment:
1. Review content knowledge test and consider adopting Couch et al. 2019 assessment questions
2. Review and potentially revise PLO 3D "Communicate science orally and in writing: Communicate to a general audience" *Do we teach students to be able to communicate to a general audience? Should we split this learning outcome to include broader audience vs discipline specific? Perhaps revise this learning outcome to assess broader context of the research project: why are we doing this, what would you do next, and why this research matters?*

The Assessment Committee has prioritized the items above as goals for the near future. The items above are also included in Section VIII (Action Plan) along with other Assessment-related tasks.

The assessment as outlined in Couch et al. 2019 assesses student comprehension of key concepts in molecular biology, physiology, and ecology/evolution. The format is multiple-choice questions presented as scenarios with true/false statements that students need to evaluate. The assessment can be administered at different points in a biology degree, eg. at the start of introductory biology, after completing introductory courses, or near graduation to track learning progress.

D. Service Courses/Gen Ed Outcomes

Describe the assessment of student learning for service courses as they relate to the general education student learning outcomes.

The services courses offered by the Department of Biology and Chemistry are almost all designed to help students meet at least one of two General Education outcomes: Procedural and Logical Thinking and Scientific Inquiry and Analysis. Both of these outcomes are being assessed by the General Education Program Area with the support of multiple departments, including the Department of Biology and Chemistry. However, these two learning outcomes fall at different stages in the assessment plan for the General Education Program Area. The General Education Program Area has adopted an assessment plan that involves assessing a subset of its learning outcomes each year using artifacts of student work voluntarily submitted by faculty members teaching courses associated with those learning outcomes. During an "Assessment Day" held after the end of the Spring Semester, teams of volunteer faculty are trained on the use of an assessment rubric for a given outcome, run through a norming session for the rubric, and then score a subset of the artifacts submitted as evidence of student learning related to that learning outcome. The rubrics used for this scoring are developed by faculty members at least one year

prior to the academic year in which artifacts will be scored, and Biology Program faculty members have led the development of both the Scientific Inquiry and Analysis and Procedural and Logical Thinking rubrics in 2023 and 2024 respectively.

Dr. Erin Rehrig led the development of the rubric for Scientific Inquiry and Analysis, while Dr. Christopher Cratsley led the development of the rubric for Procedural and Logical Thinking. The Scientific Inquiry and Analysis (SI) rubric was used to score artifacts in the Spring of 2024, and the Procedural and Logical Thinking rubric will be used to score artifacts in the Spring of 2025. In the interest of avoiding any bias in the scoring of artifacts or the interpretation of the results, the identities of both the students whose artifacts are used and the faculty members who have submitted those artifacts from their courses are kept confidential. However, the Director of Assessment, Dr. Cate Kaluzny, confirmed that "faculty from Bio/Chem contributed significant artifacts leading to the conclusions shown in the summary report for SI for the General Education Assessment for 2023-24." Through this assessment process a total of 19 artifacts were scored by 2 assessors using the Scientific Inquiry and Analysis rubric. The Scientific Inquiry and Analysis rubric scores students on a series of 10 elements of this broader learning outcome, using ratings of 1-Emerging, 2-Developing, 3-Refining, 4-Internalizing, or NA-Not Applicable. In the Spring of 2024 two of the 10 elements of Scientific Inquiry and Analysis were rated as NA for all artifacts - "Evaluate the scientific evidence behind currently accepted explanations or solutions to determine the merits of arguments", and "Apply concepts of statistics and probability to scientific and engineering questions and problems, using digital tools when feasible." This is consistent with the nature of introductory courses for nonmajors, in which it is unlikely that they will be asked to review the broader literature on a scientific topic or conduct statistical analyses.

For the 8 elements of Scientific Inquiry and Analysis that were evaluated through the assessment process, the average score was a 3.18. The individual means for each of the 8 elements are summarized in the table below. Note that only the four means in bold were generated from at least n=15 scores (of 19 artifacts) for which the majority of the ratings were considered anything other than NA.

Criteria for General Education Scientific Inquiry Evaluation	Mean
Apply scientific reasoning to evaluate hypotheses, data, analysis, and conclusions in a science or technical text.	2
Verify data when possible by corroborating or challenging conclusions with other sources of information.	4
Construct an explanation based on valid and reliable scientific evidence obtained from a variety of sources, including students' own investigations, models, theories, simulations, or peer review.	**2.9**
Conduct a scientific research project to answer a question or solve a problem, narrow or broaden the inquiry when appropriate, and synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.	**3.5**
Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.	**2.8**

Plan and conduct a scientific investigation individually or collaboratively to produce data that serve as the basis for evidence. In the design of the investigation, decide on types, quantity, and accuracy of data needed to produce reliable measurements, and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time); refine the design accordingly.	3.9
Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.	3.7
Make and defend a claim based on evidence about the natural world that reflects scientific knowledge and student-generated evidence.	**2.7**

It is not possible to draw any meaningful conclusions about the extent to which students in the General Education Curriculum are meeting the Scientific Inquiry and Analysis Learning Outcome from such a small sample (n=19), particularly given that only 4 elements of the rubric for the learning outcome yielded a score of anything other than NA for more than half of the artifacts assessed. Nonetheless, both the leadership of Biology and Chemistry faculty in the development of this rubric and the procedural and logical thinking rubric, as well as the commitment of faculty in the department to submit artifacts for scoring, offer potential for the department to build on these initial efforts at assessing the General Education Curriculum. Once the Procedural and Logical Thinking rubric is also implemented for the first time in the Spring of 2025, this should provide an opportunity for Biology and Chemistry faculty to collaborate on a review of how both Scientific Inquiry and Analysis and Procedural and Logical Thinking are being assessed in the General Education Curriculum, and consider ways to revise assignments or the rubrics themselves. In the fall of 2024, the General Education Program implemented LODGE (the Learning Outcomes Database for General Education) and online repository of material to support teaching and learning associated with each learning outcome. The Department of Biology and Chemistry can explore ways to utilize this resource to share instructional and assessment practices related to Scientific Inquiry and Analysis and Procedural and Logical Thinking.

References:

1. Brownell, S. E., Freeman, S., Wenderoth, M. P., & Crowe, A. J. (2014). BioCore Guide: a tool for interpreting the core concepts of Vision and Change for biology majors. CBE-Life Sciences Education, 13(2), 200-211.

2. Couch, B. A., Wright, C. D., Freeman, S., Knight, J. K., Semsar, K., Smith, M. K., ... & Brownell, S. E. (2019). GenBio-MAPS: A programmatic assessment to measure student understanding of vision and change core concepts across general biology programs. CBE—Life Sciences Education, 18(1)

E: Supporting Documents:

1. Biology Assessment Plan created in 2020 (with minor amendment to PLO4 in 2023)
2. Biology Content Test given at the start of General Bio I, and again in capstone courses.
3. Biology Capstone Skills Rubric used to assess PLOs 2-4 in capstone courses and presentations.

Programmatic Assessment Plan

Program Name: ___Biology_____ Created By: ____Assessment Committee_____ Date: ___5/12/20_____

School of Health and Natural Sciences Mission

The mission of the School of Health and Natural Sciences is to help students develop the skills and habits of mind necessary for scientific inquiry and analysis in their professional, personal and civic lives. Faculty experts and engaged staff in the fields of biology, chemistry, earth and geographic sciences, exercise and sports science, mathematics, physics, psychological science, and nursing support students via foundational learning in the general education curriculum and mastery of content in a variety of majors. Our faculty offer classroom, laboratory, and clinical instruction as well as research opportunities in the sciences and health professions. Faculty and staff collaborate across the University and beyond to offer interdisciplinary learning opportunities.

Department of Biology and Chemistry Mission

The Biology and Chemistry Department believes that every student deserves a first-class education. We are educators at Fitchburg State because our personal values align with the campus values of equity and excellence. We strive to ensure that our students have the best of what we can offer them as they gain an in-depth knowledge of science that is part of a larger interdisciplinary, multicultural liberal arts and sciences education.

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In order to achieve our mission, we undertake to:

- Produce students who are well prepared for diverse careers or advanced study in the biological and chemical sciences or related disciplines as well as gain the skills necessary to successfully adapt to future changes within their disciplines.
- Build lasting relationships with students that will advance their professional growth by recognizing the unique needs of each individual and reflecting our passion for engagement in authentic learning experiences.
- Maintain a high level of scholarly activity in a variety of fields associated with biology, chemistry and science education.
- Serve the needs of the university and specific academic departments through our curricular offerings and involvement in the university community.
- Endeavor to demonstrate leadership as stewards of the environment.
- Provide state of the art pedagogical approaches as well as utilize appropriate equipment, technology, and resources for teaching, learning and research in the sciences and science education.
- Work to support the University's mission of providing leadership and support for the economic, environmental, social, and cultural needs of North Central Massachusetts and the Commonwealth.

PART I: STUDENT LEARNING OUTCOMES

University Level

ILP Code	Institutional Learning Priorities (ILPs)
ILP 1	**Graduates have a deep understanding of the world.** ***Accomplished through:*** **ILP 1A. Foundational Skills and Disciplinary Breadth** – Students will demonstrate attainment of the Learning Outcomes of the Liberal Arts and Sciences program. **ILP 1B. Mastery in a Defined Body of Knowledge** – Students will attain the specialized academic objectives of their major or program. **ILP 1C. Engagement with Campus and Community** – Students will develop personal and professional skills, goals, and ethical standards of behavior though co-curricular experiences.
ILP 2	**Graduates know how to learn and how to apply their knowledge.** ***Accomplished through:*** **ILP 2A. Creative and Critical Thinking** – Students will use evidence and context to increase knowledge, reason ethically, assess the quality of information, solve problems, and innovate in imaginative ways. **ILP 2B. Effective Communication** – Students will carefully consider and clearly articulate ideas for a range of audiences and purposes in written, spoken, technology-mediated, visual, or other forms of communication. **ILP 2C. Integrative Learning** – Students will apply their breadth and depth of knowledge, skills, and experience to address complex issues.
ILP 3	**Graduates are engaged citizens who demonstrate integrity and continuous personal growth.** ***Accomplished though:*** **ILP 3A. Respect for People and Cultures** – Students will appreciate the contributions and needs of diverse individuals and groups and understand themselves in solidarity with others locally, nationally, and globally. **ILP 3B. Civic Participation in Wider Communities** – Students will demonstrate their ability to work within and across communities, to apply their knowledge in the service of others, and to promote social justice. **ILP 3C. Continuous Learning and Personal Growth** – Students will approach the world with confidence and curiosity, appreciate the complex identities of themselves and others, and reflect critically on their experiences throughout life to make informed choices that advance their own well-being and that of the larger community.

Division Learning Outcomes (DLOs) *

LO Code	Division Student Learning Outcomes	Alignment to LA&S LOs or ELOs
DIV 1	Develop the skills and habits of mind necessary for scientific inquiry and analysis in professional, personal and civic lives.	
DIV 2	Support students via foundational learning in the general education curriculum and mastery of content in a variety of majors.	
DIV 3	Offer classroom, laboratory, and research opportunities in the sciences and health professions.	
DIV 4	Offer interdisciplinary learning opportunities.	

*** These divisional learning outcomes are unofficial. To our knowledge, the school of health and natural sciences has yet to create officially stated learning outcomes. These divisional learning outcomes are derived from the school's mission statement.**

Department Learning Outcomes

LO Code	(Biology) Learning Outcomes (LOs)	Alignment to Division/LA&S LOs or ELOs
PLO 1	*Demonstrate content knowledge of the AAAS BioCore, with topics in:* ● *Evolution* ● *Transformations of Energy and Matter* ● *Information Flow, Exchange and Storage* ● *Structure and Function* ● *Systems*	DIV 1, DIV 2,
PLO 2	***Conduct original biological research.*** · *Clearly articulate testable questions and hypotheses* · *Design and execute experiments* · *Analyze data using appropriate statistical methods* · *Summarize data concisely with graphs, tables or images* · *Draw appropriate conclusions* · *Demonstrate safe practices in laboratory and field*	DIV 1, DIV 3
PLO 3	***Communicate science orally and in writing.*** · *Present information in a clear and organized manner* · *Write well-organized and concise reports in a scientifically appropriate style* · *Use relevant technology in communications.* · *Communicate to a general audience*	DIV 2
PLO 4	***Use scientific literature.*** · *Retrieve information efficiently and effectively by searching the biological literature* · *Cite sources appropriately*	DIV 1

COMMON (Program Name) CORE

	PLO 1	PLO 2	PLO 3	PLO4
General Biology I	1A	1	1	1
General Biology 2	1-2	1	1	1
Ecology	1-2	2	2	2
Genetics	2	2	2	2
Capstone Course	2-3A	3A	3A	3A

0	1	2	3	A
Not Addressed	Introducing	Broadening	Fulfilling	Assessed for Program

Key

PLO = Program Learning Outcome
Not Addressed = PLO is not addressed within the specific course
Introducing = PLO is covered at an introductory level within the specific course
Broadening = PLO is covered in the course so as to reinforce the students' learning of it within the specific course
Fulfilling = Demonstration of proficiency of the PLO occurs within the specific course
Assessed for Program = There will be a Direct Assessment activity to be used in Program Level Assessment in all sections of this course.

PART III: ASSESSMENT MEASURES, TIMELINES AND TARGETS

Direct Assessment

PLO #	Assessment description (written project, oral presentation with rubric, etc.)	Timing of Assessment	When assessment is to be administered in student program	To which students will assessments administered	What is the target set for the PLO? (criteria for success)
1	Students take a quiz with questions that are mapped to the AAAS BioCore content areas (Evolution, Transformations of Energy and Matter, Information Flow, Exchange and Storage, Structure and Function Systems)	Annual	General Biology I (1st year) & Capstone Course (3rd or 4th year)	A subset of students will be tested. Students enrolled in General Biology I and students enrolled in a subset of capstone courses (e.g Developmental Biology).	For each test question and content area, we measure the % correct answers and the % change from introductory students to capstone students. Our aspirational, "Proficient" target is to see scores of at least 75% correct on every post-test question, OR at least 50% correct with improvement of at least 25% from the pre-test. Because some questions are designed to be challenging and address common misconceptions, we can accept "Sufficient" scores of 50-75% provided there was improvement (5-25%) compared to the pre-test. "Deficient" areas that require discussion at our annual retreat are questions that score <50% in the post-test, OR areas that score 50-75% without any improvement.
2-4	Students complete a poster, oral presentation, or a lab report. Members of the Assessment Committee will evaluate criteria based on a rubric adopted by the department in 2020. The generic rubric will be adapted for each assignment with the help of the course instructor, to guide the Assessment Committee in scoring.	Annual	Capstone Course (3rd or 4th year)	A subset of students enrolled in capstone courses (e.g. Developmental Biology)	A majority of students (>66%) demonstrate sufficiency in one or more of the following areas: A) conducting original research; B) reporting results orally and in writing; and C) using scientific literature effectively.

Indirect Assessment

- Anonymous Student Survey- The Student Affairs Committee will administer an anonymous student survey bi-anually. The Assessment along with the Student Affairs Committees will compile the results and report the findings to the department. Past surveys have not explicitly asked about student perceptions of their skills in our learning outcomes, but we should consider adding that in the future. Identification of strengths and challenges of the Biology program will be discussed at an annual retreat held before the start of the academic year.

- Other indirect methods the committee is considering for the future are (1) measures from SSC and Dashboard data around retention and completion, especially among minority students, (2) survey data from local employers for skills they seek in our majors, and (3) placement data of our graduating students with employment and graduate school.

PART IV: ASSESSMENT CYCLE TIMELINE

Explanation:

- Programmatic student learning outcomes are assessed on a five-year cycle, which means each one is to be FULLY analyzed at least once in a five-year period.

Five-Year Assessment Plan

Program Learning Outcome	Year 1	Year 2	Year 3	Year 4	Year 5
Demonstrate content knowledge of the AAAS BioCore, with topics in: ● *Evolution* ● *Transformations of Energy and Matter* ● *Information Flow, Exchange and Storage* ● *Structure and Function* ● *Systems*	X				X
Conduct original biological research.				X	
Communicate science orally and in writing.			X		
Use scientific literature.					X

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PART V: INTENDED ANALYSIS, RESPONSIBILITY, AND COMMUNICATION

The AY 2019-2020 departmental assessment committee developed this assessment plan. The data created from the assessments described above will be analyzed and evaluated by future members of the assessment committee. The chair (and other members) of the assessment committee will communicate these results at an annual retreat held before the start of the academic year. Feedback from the department at these retreats will be compiled by the assessment committee into an action plan.

Biology Program Assessment Test

This test is a way to measure how much biological knowledge students have when they start at Fitchburg State, and how much they learned when they are done. We do NOT expect you to know most of the answers when you arrive!

- Please enter all answers on a bubble sheet. Choose only one answer unless indicated otherwise.
- Please do NOT write on this test, so we can reuse this paper.

1. Are you a Biology Major? A. Yes B. No

2. Please select any courses you have already completed at Fitchburg State. You can select any number of answers, or none.

A. General Biology I (or equivalent)
B. General Biology II (or equivalent)
C. Genetics
D. Ecology

3. Please select any courses you have already completed at another college. You can select any number of answers, or none.

A. General Biology I (or equivalent)
B. General Biology II (or equivalent)
C. Genetics
D. Ecology

4. Which of the following are a source of energy used by plants? Choose ANY that are correct; there can be more than one.

A. Carbon dioxide (CO_2)
B. Phosphate (PO_4^-)
C. Sunlight
D. Water (H_2O)
E. ATP

5. A tropical rainforest is an example of an ecosystem. Which of the following statements about matter and energy in a tropical rainforest is the most accurate?

A. Energy is recycled back into the ecosystem, but most matter is released and not re-used.
B. Most matter is recycled back into the ecosystem, but most energy is eventually respired away and not re-used.
C. Both matter and energy are mostly recycled back into the ecosystem.
D. Both matter and energy are eventually respired away and not re-used.

6. The organisms at the top of a food web:

A. Accumulate all of the energy that existed in the consumed organisms that were lower in the food web.
B. Have less available energy than trophic levels below it.
C. Have the same amount of accumulated energy as each of the trophic levels below it.
D. Have available to it all of the energy of the food web.

7. If an organism has a greater evolutionary fitness than other individuals of the same population, then the organism _____. [*Choose only the ONE best answer.*]

A. Lives longer than others
B. Competes for resources more successfully than others
C. Mates more frequently than others
D. Utilizes resources more efficiently than others
E. Leaves more offspring than others

8. In an imaginary insect species, the dominant allele G codes for dark green color and the recessive allele g codes for light green color. Suppose a population of these insects moves into a habitat with light-colored leaves, such as a grassland. The lighter insects are better camouflaged and can escape predators. What changes would you expect in subsequent generations?

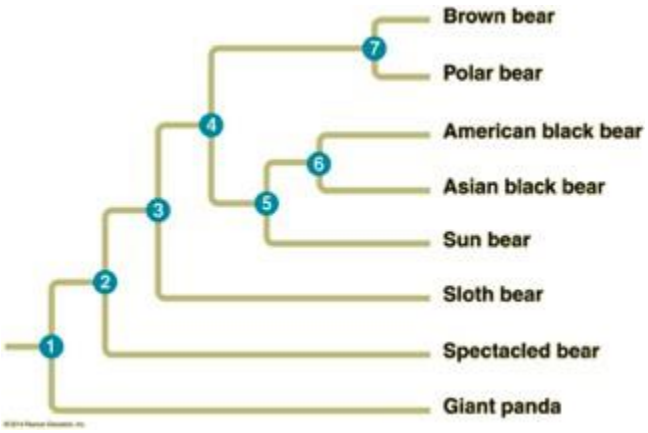
A. No change in frequencies of alleles or phenotypes.
B. Increase of the recessive allele frequency, but no change of phenotype because that allele is recessive
C. Increase of the frequency of the dominant allele and the dark color
D. Increase of the frequency of the recessive allele and light color
E. Increase of the recessive allele and eventually genetic co-dominance

The process of 9._____ generates new genetic variation, while 10._____ can act on this variation to produce adaptations to the environment.

A. Natural selection
B. Mutation
C. Genetic drift
D. Gene flow

11. This is a phylogenetic tree of the bear family, the Ursidae. Of the following pairs of species, which should have the most similar DNA to each other?

A. Giant panda and spectacled bears
B. Sun bears and black bears
C. Brown bears and polar bears
D. Brown bears and Giant panda bears
E. The answer cannot be inferred from an evolutionary tree like this.



12. Consider the following three species of mammals that are trying to stay warm.

	Species A	Species B	Species C
Surface Area =	10,200 cm^2	1728 cm^2	2400 cm^2
Volume =	63,000 cm^3	4320 cm^3	3000 cm^3
Surface Area/Volume =	0.16 cm^2/cm^3	0.4 cm^2/cm^3	0.8 cm^2/cm^3

Write the letter (A, B or C on your bubble sheet) of the species that would cool down the fastest, or have the most trouble trying to stay warm.

13. If the body is too warm, glands in the skin secrete sweat to cool the body, and then the body stops sweating. This is an example of: *[Choose ANY correct answers.]*

A. Homeostasis using negative feedback
B. Homeostasis using positive feedback
C. Thermoregulation using negative feedback
D. Thermoregulation using positive feedback

14. What does it mean for a gene to be “expressed”?
    A. It is mutated to a different form
    B. It is inserted into a bacterial plasmid
    C. It is inactivated using methyl groups
    D. It is transcribed to RNA and then translated into a protein
    E. It is quickly replicated during cell division

15. A main source of energy for immediate use inside a cell is:
    A. DNA
    B. ATP
    C. RNA
    D. Ribosome
    E. CO_2

16. Choose the process that requires an input of energy
    A. Active transport
    B. Osmosis (diffusion of water) through a plasma membrane
    C. Facilitated diffusion of glucose across a plasma membrane down a concentration gradient
    D. Diffusion of oxygen across the plasma membrane

17. Your bone cells, muscle cells, and skin cells look different because
    A. They contain different numbers of genes
    B. Each cell contains different kinds of genes
    C. Each cell has a different mutation
    D. Different genes are active in each kind of cell

18-20. You want to measure the effect of light waves on plant photosynthesis. You design an experiment that exposes corn plants to light at 4 different wavelengths and measure O_2 production as an indicator of photosynthesis. In this experiment…

18. What is the independent variable?
    A. The control
    B. Corn
    C. Wavelength of light
    D. Amount of light
    E. O_2 production

19. What is the dependent variable?
    A. The control
    B. Corn
    C. Wavelength of light
    D. Amount of light
    E. O_2 production

20. Which of the statements below best describe the hypothesis being tested in the experiment described above?
    A. There is a relationship between O2 production and the variety of corn.
    B. There is a relationship between the growth of corn plants and the amount of O2 they produce.
    C. There is a relationship between the growth of corn plants and the amount of light to which they are exposed.
    D. There is a relationship between the amount of O2 produced by corn plants and the wavelength of light to which they are exposed.
    E. There is no relationship between photosynthesis and production of O2 in corn plants.

If the forests around Fitchburg State <u>are not</u> affected by a significant disturbance over the next century, then the tree community is likely to become 21._____ diverse due to 22._____.

21.

A. More
B. Less

22.

A. Dispersal of seeds
B. Co-evolution with herbivores
C. Stress from herbivores
D. Some species out-competing others
E. Differentiation of tree niches

23. Muscle cells have the ability to change shape in response to external stimuli. Which of the following properties allows muscle cells to perform this specialized function? *Choose ANY that apply.*

A. the cytoskeletal proteins within the cell
B. the organelles within the cell
C. the receptor proteins present on the cell's membrane
D. the shape of the cell
E. the high abundance of mitochondria in each cell

24. Which of the following is an example in which structure determines function? Choose ANY that apply.

A. Neurons have receptor proteins on their membranes that respond to external stimuli
B. Herbivores have flat teeth to grind fibrous plant materials
C. Plant leaves are coated with a waxy layer perforated by tiny holes
D. Enzymes have binding pockets that are specific for their substrates

25. A young man, due to his exposure to the sun, acquired a mutation in his skin cell DNA that increases his future risk of developing skin cancer. Should he be concerned that he will pass this mutation on to his future children? Choose the BEST answer.

A. Yes because his children will inherit all of his DNA.
B. Yes but only if he develops skin cancer in his lifetime.
C. Yes, because his children will inherit half of his DNA.
D. No because only mutations present in gametes (egg, sperm) are passed to children.
E. No because his children will inherit only half of his DNA.

26. Have you have already taken this assessment in another course this year?

A. No
B. Yes

Rubric to assess skills in Biology majors (DRAFT). Developed from Learning Outcomes approved at August 2019 retreat, and merged with language from a similar Chemistry rubric and a 2014 rubric developed by Assessment Scholars from FSU/MWCC.

LO2 Conduct original biological research.

	Proficient =3	**Sufficient** =2	**Deficient** =1	**No attempt =0**
2A. Clearly articulate testable questions and hypotheses	Identifies a creative, focused, and manageable topic that addresses potentially significant yet previously less-explored aspects of the topic.	Identifies a focused and manageable/doable topic that addresses some relevant aspects of the topic.	Identifies a topic that is far too general and wide-ranging as to be manageable and doable.	
2B. Design and execute experiments	All elements of the methodology are skillfully developed and described. Experimental treatments address the question without confounding factors. Sample size is appropriate.	Critical elements of the methodology are appropriately developed and described, however, more subtle elements are ignored or unaccounted for (e.g., too few samples).	Description of design demonstrates a misunderstanding of the methodology and/or the basic question addressed.	
2C-1. Summarize results concisely with graphs, tables or images	Skillfully converts relevant information into an insightful portrayal that contributes to a further or deeper understanding.	Portrayal is only partially appropriate or accurate. For example, a graph might be missing units, or the relevance of an image may be unclear.	Portrayal is mostly inappropriate as a way to summarize results.	
2C-2. Analyze data using appropriate statistical methods	Skillfully uses statistical summaries or tests for an insightful portrayal that contributes to a further or deeper understanding.	Statistical summary or test is only partially appropriate or accurate.	Portrayal or test is inappropriate or inaccurate.	
2C-3 Describe results: Explain patterns from observations or data	Provides thorough and accurate descriptions of patterns or trends in data. Skillfully incorporates statistics into writing. For example, differences in means are quantified, with units. Or the	Provides simple and mostly accurate descriptions of patterns or trends in data. A simple description would be qualitative but not quantitative. Or there are	Draws fundamentally incorrect interpretations about what the data mean.	

	slope of a line is used to describe a pattern in a graph. Or P-values are included appropriately.	occasional, minor errors in computations, units, etc.		
2D. Draw appropriate conclusions	Uses the results as the basis for thoughtful judgments, drawing insightful, carefully qualified conclusions from this work. Connects and expands on results from different sources, and formulates a coherent argument about a topic. Relates results to appropriate mechanisms (causes). AND/OR Relates appropriate applications or implications from the study.	Uses the results for basic judgments that are correct but lack inspiration or nuance. No attempts to qualify the conclusions, nor to elaborate on mechanisms, nor to consider implications outside this study. OR Minor errors exist in the conclusions.	Conclusions are not appropriate or are clearly incorrect for the results.	May restate a pattern in data/observations, but no attempt is made to draw any conclusions or judgments.
2E. Demonstrate safe practices in laboratory and field	**???**	**???**	**???**	

LO3 **Communicate science orally and in writing.**

	Proficient =3	**Sufficient** =2	**Deficient** =1	**No attempt =0**
3A. Write well-organized and concise reports in a scientifically appropriate style	Writing is consistently well-organized, concise, professional, and coherent. Written work follows a publishable format.	Writing is mostly (but not completely) organized, professional, and coherent.	Writing lacks organization or is often not coherent. At least one section of a report is poor: e.g., an Introduction that lacks hypotheses, a Methods written like a recipe, or a missing Results description.	
3B. Present information in a clear and organized manner	Presentation is consistently well-organized, professional, and coherent. Images and text	Delivery is mostly (but not completely) organized, professional, and coherent.	Presentation lacks organization or is often not coherent. Images	

(Oral presentation or Poster)	are clearly readable by the audience.	Images and text are mostly readable.	and text are often difficult for an audience to read or understand.	
3C. Use relevant technology in communications.	Effectively uses technology to present supporting text and images to the audience.	Uses technology to present supporting text and images to the audience.	Unable to use technology to present supporting text and images to the audience.	
3D. Communicate to a general audience	Poster or presentation could be easily understood by non-experts.	Poster or presentation could be understood by most Biology majors, but non-science majors would struggle to understand the main ideas.	The main ideas of the Poster or presentation could not be understood by people outside of that course.	

LO4 **Use scientific literature**

	Proficient =3	**Sufficient** =2	**Deficient** =1	**No attempt =0**
4A. Retrieve information efficiently and effectively by searching the literature	Retrieves appropriate, focused sources from primary literature. Scholarly review papers are acceptable.	Presents information from relevant sources, but including some less-scholarly sources, or representing limited points of view/approaches.	Presents information from mostly irrelevant sources.	No resources provided when they were expected in the assignment
~~4B. Evaluate scientific articles critically~~	~~Skillfully relates results to recently published literature. Synthesizes in-depth information from a thorough range of relevant sources.~~	~~Relates results to published literature, but only enough to fulfill the requirements of the assignment, or some areas of the literature were not considered.~~	~~Results or concepts from different sources are included, but there is no (or a very weak) connection to the focus of this study.~~	
4C. Cite sources appropriately.	All sources are cited in a professional, publishable manner.	Most sources are cited in a professional, publishable manner. A rare mistake might include missing page numbers, for example, or including author initials in the in-text citations.	Most sources are not cited in a professional, publishable manner. For example, commonly missing Journal, volume, or pages. Or omitting author or year in most in-text citations.	

IV. Faculty

A. Size and Composition

Describe the faculty size and composition, and address staffing for the unit in terms of the mission and goals of the unit, along with the unit's operational metrics.

The Biology faculty members at Fitchburg State are highly qualified individuals committed to their primary mission of providing students with a working knowledge of the life sciences that is part of a larger interdisciplinary, multicultural liberal arts and sciences education. In order to achieve this overarching goal, the faculty remain committed to a strong curriculum that will prepare students for careers and advanced study, remain active in their disciplines, provide curricular offerings appropriate for other majors on campus, and are active participants in not only the university community but the larger community as well. As a group, the faculty members remain committed to student learning and willingly integrate new pedagogical approaches and technology into their teaching. The size of our program allows for close relationships with students and advisees within our program, which generates a nurturing supportive environment.

The Biology faculty currently consists of 11 full-time (FT) members. The Table below lists rank, year of appointment, and area of specialty for each faculty member. One, Dr. Kilpatrick, a FT Instructor in 2017 during our last Program Review, moved into a tenure-track position. Dr. Erin Rehrig is the current Department Chair having started her first term as chair in the fall of 2024. All faculty, therefore, are either tenured or on the tenure-track. Chemistry faculty members are listed in the table as the combined department has fostered collaboration and synergy among the disciplines. For example, Dr. Aisling O'Connor has expanded her professional development and is currently obtaining a MS in Nutrition. Nutrition was traditionally staffed by a Biologist but with her enhanced training, she has now taken over responsibility for instructing this course. Moreover, Dr. Billy Samulak with her expertise in Biochemistry and research interests bridges the two disciplines which allows her to play an important role in our Biochemistry (Chemistry), Education, and Biotechnology (Biology) concentrations. Other faculty members have demonstrated a willingness to expand their teaching expertise. Many in the department have taught the Freshman Year Experience course while others retrained in order to be able to pick up new course assignments such as anatomy and physiology labs. Collectively, the faculty members of the department demonstrate adaptability, growth, and a willingness to ensure the best possible outcomes for our students.

Faculty workload assignments are determined by area of expertise, program needs, and the necessity of balancing assignments to include electives as well as campus-wide service courses for each faculty member. The faculty operate under the Massachusetts State Colleges Association (MSCA) Collective Bargaining Agreement (CBA) which dictates workload and required office hours as well as requirements for advising, scholarship, and community service. Per the MSCA CBA, each faculty member is assigned a full-time teaching load each semester which consists of 12 contact hours (24 for the academic year) which generally includes a mixture of both lecture and laboratory assignments. Supervision of Independent

Studies or Internships are credited to faculty workload per the MSCA guidelines. Faculty may be assigned an Alternative Professional Responsibility (APR) which may result in a course release(s). Faculty workload is carefully tracked by the Chair and ultimately subject to Dean's approval to ensure that all faculty maintain a contractually required load and that overloads, when they occur, are promptly paid back to the faculty member in the form of course release. Course release for the Department Chair is calculated per the MSCA contract.

Faculty members may choose to teach courses in the evening and summers at the undergraduate and/or graduate level through the School of Graduate, Online and Continuing Education (SGOCE) in addition to teaching in the undergraduate day program. When needed, part-time faculty (adjuncts) teach introductory biology and chemistry courses. Department staffing also includes a full-time administrative assistant (shared with the Environmental, Geographic, and Public Health Sciences Department (EGPHS), and 2 technicians. One of these technicians works full-time in biology and is a 12 month employee while the second technician is assigned to chemistry but is on a 10-month schedule. A third, full time-technician who was shared with our department and Environmental, Geographic, and Public Health Science (EGPHS) has since moved into a new role at the university. The roles of the technicians include setting up labs, ordering, stocking lab supplies, and most importantly, maintaining and enforcing health and safety regulations. While assigned to different programs within the department the technicians provide back-up and coverage as well as coordination in the ordering of supplies and the monitoring of equipment and supplies.

Table of Biology and Chemistry Faculty Members.

Faculty Member	**Rank**	**Degree, Year of Appointment**	**Area of Specialty**
Biology			
Christopher Cratsley	Professor	Ph.D. 2000	General Biology, Animal Behavior, Science Education
Lisa Grimm	Associate Professor	Ph.D. 2012	General Biology, Immunology, and Science Education
Margaret Hoey	Professor	Ph.D. 1993	General Biology, Evolution, Genetics, Human Genetics, Botany
Elizabeth Kilpatrick	Assistant Professor	Ph.D. 2015	Anatomy and Physiology, Immunology

Ronald Krieser	Professor	Ph.D. 2008	Genetics and Molecular Biology
John Ludlam	Professor	Ph.D. 2011	Freshwater Ecology, Environmental Science, Invertebrate Biology, Marine Biology
Christopher Picone	Professor	Ph.D. 2004	Ecology, Environmental Biology, General Biology
Erin Rehrig Department Chair	Professor	Ph.D. 2011	Plant Biology, General Biology
Sean Rollins	Professor	Ph.D. 2012	Microbiology, Infectious Diseases
Daniel Welsh	Professor	Ph.D. 2013	Evolution, Behavior, Anatomy and Physiology
Eric Williams	Associate Professor	Ph.D. 2017	Anatomy and Physiology, Developmental Biology
Chemistry			
Dennis Awasabisah	Associate Professor	Ph.D. 2016	Organic Chemistry, General Chemistry, Organometallics
Emma Downs	Associate Professor	Ph.D. 2015	General Chemistry, Inorganic Chemistry, and Environmental Chemistry
Steven Fiedler	Associate Professor	Ph.D. 2014	Physical Chemistry, General Chemistry, Solvation Properties
Aisling O'Connor	Associate Professor	Ph.D. 2008	Analytical and Green Chemistry,
Mathangi Krishnamurthy	Associate Professor	Ph.D. 2011	Organic and Medicinal Chemistry

Billy Samulak	Associate Professor	PhD. 2013	Biochemistry and Analytical Chemistry

B. Retention

Describe retention initiatives for faculty.

The Department as a whole has fostered a supportive, collegial, and professional environment for faculty members which has resulted in staffing stability and the ability for faculty to apply and receive promotion to higher academic rank. At the time of our last self-study in 2017 we had 13 FT Biology faculty members. The reduction in total number is due to retirements over the last 7 years. There have been two retirements with an additional retirement of Dr. Meg Hoey announced for the end of AY25 which would bring the total number of faculty to 10. The loss of expertise and institutional knowledge to our program includes Animal Physiology, Anatomy and Physiology, Cell Biology, Botany, Evolution, and Genetics. The reduction to 10 faculty members will impact the department's ability to staff courses with full-time faculty members. In addition to having full time faculty retire, Mary Lou Solzek, a long-time reliable adjunct and valued colleague, retired during COVID. Mary Lou consistently taught multiple sections of our primary General Education course for non-majors, Introduction to Life Science every semester.

Due to lower enrollments, we have been able to manage these retirements by offering fewer sections of lectures/labs and having full time faculty teach introductory non-majors courses. Our department has had to carefully rethink who can teach specific courses and conduct mindful succession planning. In addition to having 170 of our own majors, we are also a key service department for Nursing, EXSS, and Education. We also teach several non-majors Scientific Inquiry (SI) and Procedural and Logical Thinking (PL) electives that are required by all students on campus. The need to offer multiple sections of service courses, esp. Anatomy and Physiology, leaves many sections needing instructors.

While we understand that scheduling needs to be flexible, our department also adheres to best practices in STEM. For example, we regularly request that lectures and linked lab sections are taught by the same full-time faculty member, especially in high-stakes or difficult gateway courses. This helps students get to know their professor and seek out opportunities for help. Faculty teaching the same courses coordinate schedules and the ordering of supplies. This ensures that the content and skills taught across multiple sections is similar, creating consistent experiences for students regardless of section. Our department also received several high-profile grants and numerous opportunities for faculty scholarship in the past 7 years, allowing us to create a vibrant undergraduate research program. Supervision of student research projects is mostly done on top of our teaching load and over time leads to banked credits for course releases. Our faculty are also very involved on campus. Some are rewarded APRs to continue their research programs while others serve Fitchburg State as Health Career Advisors, Director of the Honors Program, or Assistants to the Dean of the School of Health and Natural Sciences. All of these positions come with release time and create additional staffing needs.

In the past few years, gaps in the schedule have been managed by hiring adjuncts and asking faculty to teach multiple new preps, take on “orphan” labs, or give up their electives. While this filled shortages in the interim, it has become unsustainable and will quickly create burnout and a lack of morale in our department. With the added retirement of Dr. Hoey, we now find ourselves in the position of needing expert coverage in General Biology and Genetics. We have managed to secure a One-Year Temporary Position for AY2025-26 to cover Anatomy and Physiology I in the fall and Medical Microbiology in the spring as Dr. Sean Rollins goes on sabbatical. We are in constant need of instructors to teach Anatomy & Physiology labs, yet this is not the area of expertise for many of our faculty. In 2022, we secured an MSCA Professional Development grant of $2000 and were able to offer compensation to faculty for A&P training over the summer. Faculty who felt confident in their ability to teach the course trained with our A&P Instructors and learned the various labs. This allowed us to ask members of our existing faculty to fill some unfilled positions in A&P labs. However, with additional retirements, those faculty are now needed to teach our core set of General Biology courses, capstones, and electives. The one year temporary position gives our department some “breathing room” to identify where an additional faculty member would be the most valuable. Our plan is to request another full-time tenure track position in Biology next year with the hope that they would start in AY2026-27.

C. Research and Scholarship

Describe research and scholarship within the program.

The Biology and Chemistry Department faculty members engage in scholarly activities which not only reflect their active participation within their disciplines but more importantly, provide a variety of opportunities for our students to engage in independent research. In fact, the one core principle pervading all research activities is the importance of training the next generation of scientists. Another strength of the research is the level of collaboration among faculty members both within the department, with other faculty on campus, and with outside partners. The integration of these two principles, collaboration and student centric research, has fostered a productive and supportive environment. One outcome of this approach has been success in obtaining external funding to support student research initiatives. The lists of grants (both funded and not awarded) sought by faculty in the last 7 years is listed below.

Grant Name (Funded)	Year(s)	Amount	Description
National Science Foundation SSTEM Grant - Building Institutional Capacity to Support STEM Scholars Through Pedagogy of Real Talk	2024-2029	$1,000,000.00	Being used to support academically-talented STEM students in Biology, Chemistry, Computer Science, Engineering Technology and Mathematics with financial need by leveraging best practices including: (a) bi-weekly STEM seminars to create a community of scholars; (b) summer internships and undergraduate research experiences; and (c) a mentorship ladder model that utilizes faculty, peer, and professional mentors for each participant throughout the program.
Massachusetts Life Science Workforce Development Capital Grant	2023-2024	$746,316.33	Used to enhance biotechnology education and workforce development by acquiring advanced equipment, including new microscopes, a flow cytometer, and HPLCs. Funds also supported the establishment of a new cell culture suite.
Moderna Charitable Foundation Research Fellows Grant	2023-2024	$56,151.00	Supported the creation of a research scholars program, primarily funding student stipends to provide hands-on training in biotechnology research. The program aimed to improve student retention through active research participation.
Phase Effects on the Nanoparticle Permeation Processes	2016-2017	50,000 cpu-hours	Supported a computation study on the thermodyamics and kinetics associated with the permeation of a buckyball (C60) molecule, used as a prototypical sub-nanometer sized carbonaceous particle, through phospholipid membranes.
The Student-Faculty Collaborative Summer Research Experience	2017-2019	$240,000	Supported 15-20 students per summer studying the environmental health of the Nashua River watershed. Students gained extensive hands-on research experience

Grant Name (Not Funded)	Year Applied	Amount Requested	Description
Balfour Research Fellows Grant	2022	$168,250.00	Requested three years of funding for the formation of a research scholars program. The program goal was to improve student retention through active research participation. This grant reached the second round of application review but was ultimately not funded by the Balfour Foundation.
NIH Research Enhancement R15 Grant	2022	$427,814	Requested three years of funding to support research in muscular dystrophy. The grant would have supported 42 student stipends. This grant received favorable reviews but was ultimately not funded.
NSF SSTEM Grant- Building Institutional Capacity for Careers in STEM	2022	$750,000.00	Requested funding to support academically-talented STEM students in Biology, Chemistry, Computer Science, Engineering Technology and Mathematics with financial need through scholarships, seminars, mentorship and internship opportunities.
NSF SSTEM Grant- Building Pathway for Careers in STEM	2020	$1,000,000.00	Requested funding to support academically-talented STEM students in Biology, Chemistry, Computer Science, Engineering Technology and Mathematics with financial need through scholarships, a series of research experiences, career and academic advising, mentoring, and internship opportunities.
HHMI Inclusive Excellence Version 3 Pre-Proposal	2020	$1,000,000.00	Requested funding to support campus-wide training of faculty and staff in adopting practices that would increase success of our minority and/or first generation students. A train the trainer model was proposed in order to increase reach across the campus.
Balfour Foundation Grant	2021	$250,000.00	Requested Funding to support a three-year initiative where teams led by students and faculty, in collaboration with Anti-Racism Collaborative (ARC) consultants, identify specific equity and inclusion barriers, and train faculty and staff to remove these barriers.

The diversity of research inquiry available to students is illustrated by the contrast between the work of Drs. Sean Rollins and Elizabeth Kilpatrick, and Drs. Chris Picone and John Ludlam. Dr. Rollins had his classroom students identify microorganisms isolated from facial masks as a laboratory research project in the two years since COVID face masking. He was able to expand this project with Independent Studies and Honors thesis students where 16S rRNA sequences have been amplified by PCR and await Sanger DNA sequencing to confirm identities of these organisms. Moreover, he is in the process of applying next generation DNA sequencing techniques to further study microbial populations present on facial masks. Dr. Kilpatrick's area of research expertise involves human immune responses to viral infections and the physiological consequences when viruses cause over-activation of the immune system. She is interested in elucidating the roles that neutrophils may play in triggering excessively robust immune responses during hantavirus infections. Working with students, she is developing a model to study neutrophil responses to infected endothelial cells and whether these responses result in increased vascular permeability. Juxtaposed to this research is the carbon sequestration in the dynamic Fitchburg forests project of Drs. Picone and Ludlam. Since 2018 the Ecology classes have documented forest composition and soil characteristics at 16 permanent

forest plots near campus. They have used the data to view the past and future of these forests, and also to document changes that result from the imminent loss of a foundational species, Hemlock, as it succumbs to the invasive Hemlock Wooly Adelgid. In addition, Dr. Ludlam began studying Eastern Pearlshell mussel (*Margaritifera margaritifera*) population persistence in Massachusetts in 2018 as well as collaborating with a Mathematics faculty member to model threats to a Diamondback Terrapin population (a coastal turtle). These projects have resulted in published journal articles and have involved undergraduate students.

Collaboration with other Fitchburg State Faculty members as well as researchers at other institutions gives faculty members the opportunity to engage in larger and more impactful research projects. For example, Dr. Erin Rehrig collaborates with Dr. Emma Downs in Chemistry and Dr. Catherine Buell in Mathematics on studying the effects of silver nanoparticles (AgNPs) on plants and the environment. Over the past 10 years, students in Dr. Rehrig's capstone Plant Biology course have been researching the effects of AgNPs in *Arabidopsis thaliana* as part of a Course-Based Undergraduate Research Experience (CURE). The goal of the capstone course is to offer students opportunities to conduct novel experiments, collect and analyze data, and communicate their results to a broader audience. A number of students have worked on the project through independent studies or in Dr. Rehrig's capstone plant biology class and they have presented at the Fitchburg State Undergraduate Research Conference and the UMass Amherst Statewide Research Conference. Another collaboration among faculty members centers on the evolution of the DNaseII gene family in vertebrates. Within vertebrates, two paralogous genes encode the acid endonucleases DNase IIα and DNase IIβ. The α form is essential in mammals and expressed in all cells ubiquitously and has an important role in degrading the DNA of apoptotic cells after their engulfment by phagocytes. The β form has a limited tissue expression and has been shown in mammals to be important for the degradation of the DNA of lens cells as they mature and lose all of their organelles to become clear cells in the eye lens. Interestingly, we found that fish, amphibians, mammals, turtles and crocodilians all have both α and β forms of the gene. However, birds, lizards and snakes each have only one form of the gene. Birds and lizards have lost the α form that performs a role in development that is essential in mammals. What began as a student project has developed into a collaborative research project between Dr. Ron Krieser, Dr. Lisa Grimm, and Dr. Margaret Hoey where they hope to identify the genetic mechanism allowing the loss of an essential gene during evolution. They have had well over 50 students work on this project through Introduction to Research, Independent Study, or Course-based undergraduate research experiences. One striking feature, in fact, of all of the faculty collaborations is the level of participation by students.

The support for faculty driven interdisciplinary research with student participation has been obtained from outside funding sources. Dr. Daniel Welsh was part of an interdisciplinary group of faculty members (including Drs. John Ludlam, Emma Downs and Aisling O'Connor) who were awarded a large grant from the Balfour Foundation (in fact, the third largest private grant in the history of the university at the time it was awarded). The Foundation's educational funding, according to its website, "is generally focused on organizations or programs that provide support for underserved or under-represented populations to prepare for, access, and succeed in higher education, including

two-year and four-year institutions". Working with a group of faculty members across campus, they established a "Student-Faculty Collaborative Summer Research Experience" (often shortened to "Summer Research Collaborative" or SRC) on campus. This collaborative was designed to act like a REU (Research Experience for Undergraduates) opportunity, where several, inter-related research projects occur through the inclusion of about 15-20 students from campus in STEM majors per year. The funds were used to provide students with new opportunities to engage in research on campus during the summer months. One important outcome of this collaboration was a peer reviewed publication for the faculty members involved.

The most prominent example of the synthesis of student involvement combined with faculty productivity among the faculty is that of Dr. Eric Williams. Since joining FSU in 2017, he has provided 64 individualized research experiences for our students. On average, he mentors 4-5 students per semester. His research effort culminated in the discovery of a clinically approved drug called 4-PBA. In addition, during his time at FSU he has co-authored five manuscripts. Dr. Williams has also worked with a team of Biology and Chemistry faculty (Dennis, Aisling) to create a Research Scholars Program that targets student populations with low rates of retention. They received 1 year of funding for the program from the Moderna Charitable Foundation and were able to fund two cohorts of students. Preliminary analysis reveals an increase in cumulative GPA for participating students. Additionally, he worked with Dr. Erin Rehrig to secure a biotech equipment grant from the Massachusetts Life Science Foundation, which aims to equip the Massachusetts biotech industry with a skilled workforce. This grant has enabled us to modernize our laboratory equipment, introducing techniques like flow cytometry and next-generation sequencing, which is typically found only in major research institutions.

D. Faculty Service

Describe faculty service within the University.

The Biology and Chemistry faculty are active members of the university community as documented by the extensive active service on committees, participation in both on-campus as well as outreach programs, and appointments to active leadership roles. Details of individual participation are too numerous to detail here but may be found on the Faculty Curricula Vitae in Appendix A. The reviewer is encouraged to review their individual contributions as only a few areas will be highlighted in this narrative.

Intradepartmental committees include Curriculum, Assessment, Student Affairs, Peer Evaluation, Equipment and Facilities, and various search committees. Each fall at the first department meeting, faculty members volunteer for one or more of the standing departmental committees. As a group, the approach is one of shared responsibility which has resulted in a sense of collective ownership of curricula, space usage, and effective use of resources to support the primary mission of the department which is the education of undergraduates.

The participation and contributions of the faculty members to the University span all aspects of campus life including but not limited to NECHE reaccreditation, Strategic Planning, Promotions Committee, Institutional Biosafety Committee, Institutional Animal Care and Use Committee, Sustainability Committee, Emeritus Committee, Financial Sustainability Committee, All University Committee, Safety Committee, University-wide Academic Policies Committee, University-wide Curriculum Committee, University Assessment, Technology, Graduate Council, Leading for Change, and the Education Unit. Again, participation in the work of the campus community is considered a responsibility by all members of the faculty. Moreover, various faculty members have been willing to take on broader campus leadership roles. Currently, Dr. Daniel Welsh is acting as an assistant to the Dean and Dr. Emma Downs is a director of the Honors program. Dr. Margaret Hoey served 2.5 years as Dean of the School of Health and Natural Sciences. During her time as Dean, her second time in the role, she oversaw 8 departments.

The Pre-Health Advising Program remains an important value-added service contribution to our programs. A former colleague and Department Chair, Dr. Govindan (who retired in Spring 2020) informally served as the health professions advisor from 2006 to 2020. He developed the Pre-Medical Advising Program and created our Introduction to Health Professional Seminar Course. He also developed an advising handbook and was instrumental in the development and signing of early admission agreements for medical, pharmacy, and dental programs with the Lake Erie College of Osteopathic Medicine (LECOM) and Husson University. Pre-health advising has been taken over by Dr. Ron Krieser and Dr. Monica Maldari (EXSS). The participation of two faculty members has enabled us to maintain as well as expand the program. Currently we have between 70-80 Biology and Chemistry majors in the Health Science concentration or interested in health professions in the future.

Fitchburg State began as a state normal school and the training of future teachers remains part of its core mission. The Biology and Chemistry Department therefore work closely with the other members of the Education unit to prepare students interested in a teaching career. Dr. Lisa Grimm has served for many years as a liaison between the Departments of Education and Biology & Chemistry. She participated in activities for accreditation and DESE reviews. In addition, she reflected on and improved policies that impacted our education candidates. She was involved in developing MTEL prep modules and MTEL alternative exams to help candidates complete this requirement for teaching licensure. More recently, she has served as a Project Coordinator in PASM (Program in Secondary and Middle School Education) where she supervised all policy and curriculum decisions for middle school and secondary education candidates. More recently, Dr. Billy Samulak has also assisted in this area by becoming the Coordinator for the Initial Licensure programs for General Science (5-8), and Chemistry (8-12). Education is a time-consuming commitment which goes beyond the regular attendance at meetings and the advising of students. The requirements by DESE are ever changing and require constant updates and revisions by the participating faculty members.

E. Collaboration

Describe collaboration across campus and with external partners.

The faculty are collaborating with outside professional societies, organizations, and institutions as part of their research, scholarship, and service. Some of these partnerships are described in more detail in the previous sections (IV.C and IV.D). Details may be found in their CVs in the appendix at the end of this document. A few additional examples are listed below.

Dr. Chris Picone exemplifies the synthesis of service and collaboration in the larger community. He has served on the Nashua River Watershed Association (NRWA) Board of Directors since 2021 which is one of the largest environmental non-profits in the region. Of note is that his collaboration led to two recent internships for FSU students, one of which evolved into their full-time employment with the NRWA. One important project on which they are working is a new collaboration between NRWA, Fitchburg State, and Nue-View Communities of Fitchburg, as the NRWA received a grant to pursue "nature-based solutions" in environmental justice neighborhoods near campus. In addition, he is a long standing member of the Ashburnham Conservation Commission. This Commission regulates development, enforces the state's Wetland Protection Act, and helps to permanently protect new parcels. Case studies from this work on the Commission have been used in the Conservation Biology class. Other areas of service include Ashburnham Open Space and Recreation Committee, the Ashburnham Rail Trail Committee, the Mt. Watatic Management Committee, and the Invasive species management with North County Land Trust (NCLT). This service, aligned with his professional knowledge and ethics, provides a valuable contribution to his local town but also to the State of Massachusetts.

Daniel Welsh, Erin Rehrig, and Eric Williams worked with a group on the Life Sciences Networking event, held April 10, 2024. This required working with faculty and staff from the university plus John Brothers of MassBioEd to develop this event. In the past, this event brought industry professionals from the life science/biotech/biopharma companies in the area to campus, for students to hear about their careers and also to give students opportunities to network. We are currently planning a similar event for April 9, 2025 and hope to continue this in the future.

Drs. Lisa Grimm and Billy Samulak collaborate with faculty in other departments to maintain a unified program area of study for middle and secondary education (PASM) that meets the ever changing requirements set by DESE. These faculty maintain the curriculum needed for middle and secondary teachers in history, english, math, general science, chemistry, and biology.

Excluding 2020 and 2021, the biology and chemistry department hosts an annual science symposium where faculty present posters on their research. The goal is to inform students of the research opportunities on campus and to help them find projects of interest. Faculty in other science departments are invited to participate, including from local community colleges. We have had members of Mount Wachusett Community College and Quinsigamond Community College in previous years.

F. Advising

Describe faculty advising.

Academic advising is an important area of the faculty responsibilities. It is one of four major performance categories that faculty are evaluated on for any job actions as part of the MSCA union contract. Each student is assigned a faculty advisor when they enter the program. An effort is made by the Administrative Assistant to assign students to an advisor whose area of expertise is most closely aligned with the student's concentration or general area of interest. However, because there are more biology majors than chemistry majors, chemists are often assigned biology majors as well as some of the chemistry majors.

We try to maintain parity across the faculty members regarding numbers of advisees. In the current academic year, the department has approximately 150 biology majors, 15 chemistry majors, and 20 chemistry minors. Students in the minor are usually assigned to the department chair for advising, although sometimes a faculty member takes on one of these students because of an interest by the student in the faculty member's area of interest. The students in the biology and chemistry majors are divided up as close to equally as possible. In the current academic year, each faculty member has between 8 and 11 advisees. Differences occur as students enter and leave the program. When a faculty member goes on sabbatical, their advisees are re-assigned to the chair or other faculty members if necessary.

When assigned a new advisee, faculty reach out to students as soon as possible and encourage them to meet often during the semester. At the start of each academic year, the University provides a time for each department to meet with their new advisees in a meet-and-greet session.

One of the major responsibilities of faculty is to meet with all advisees during the 3-week advising period held in the middle of each semester. Faculty set up an advising calendar in SSC (Student Success Collaborative) platform and meet with each advisee one or more times. During these sessions, there are discussions focused on 1) student academic progress (mid-term grade warnings are available at that time), 2) setting up a schedule for the next semester, and 3) discuss other business (e.g. navigating University workings for new students, and career pathways for upperclassmen). Faculty can access student records through the Web4, DegreeWorks, and SSC platforms. Additionally, FSU recently obtained a license for College Scheduler software that allows faculty and students to look at all permutations of schedules for certain classes. Faculty can add classes for students in advance of their meeting or view classes students have selected. This has allowed for more time spent on discussion of internships, career goals, and other important matters during advising meetings. Faculty maintain notes of meetings in DegreeWorks that are available to others who have access to student records (e.g. other faculty, and administrators, especially the Registrar). Some faculty have started doing remote advising sessions and keeping Google Sheets for advising records so students can access their information and progress at any time. This also helps faculty who have been assigned a new advisee from a different department or when a faculty member has been on sabbatical.

V. Students

A. Recruitment and Retention

Describe activities and strategies related to the recruitment and retention of students. Describe Future Falcon days

Recruitment

Departmental efforts to recruit students primarily occur through the university-organized Future Falcon Days. Every fall semester, the university hosts several (usually 2-3) of these events, whereby potential students and their families visit campus to hear about the offerings at Fitchburg State University. During these events, the department has a "booth" to talk to potential students to explain the majors, minors, and concentrations we offer. This is available for anyone to visit and talk to the department, not just those considering a Biology or Chemistry major (such as undecided students). In addition, during the Future Falcon Days, we also offer a smaller session for those who are more seriously considering our major. During this smaller session, faculty and current students give a presentation on the department and talk to the attendees about the expectations and career opportunities. There is also time to answer questions and concerns that any attendees may have.

Another, smaller way that the department recruits students is through outreach events that individual faculty perform, as part of their scholarly interests or their service to the broader community. As can be found in the Faculty section of this document, many faculty give of their time to volunteer at community events or partner with other organizations to give presentations or set up demonstrations/activities. For example, Dr. Erin Rehrig has offered hands-on STEM activities for local schools. Similarly, several faculty have served as judges for local or regional science fairs. Although the objectives of these activities are not for recruitment purposes, participation in these activities still serves an ancillary purpose of "spreading the name" of the university and department and helps to advertise the majors that we offer.

Retention

Once students arrive at FSU and are assigned an advisor in the biology and chemistry department, our entire faculty work very hard to help our students be successful. While we continue to explore new avenues for student recruitment, student retention once they are enrolled is paramount. Many of our majors are from underrepresented populations or are first-generation college students, who often find college difficult to navigate in the first year. Data from our College Student Inventory (CSI) show that 50% of our incoming 2024 fall freshmen are first-generation college students. The CSI data for Fitchburg State University can be seen at the end of this section. Many of our efforts are discussed in more detail in other sections of the self-study, but our retention efforts center around :

- Fostering a sense of belonging
    - The Biology & Chemistry Club host events to help students feel welcome in the department, and occasionally include faculty

    - During the first day of classes each fall, we have a “new student meeting” designed to introduce faculty in a fun way and put students in touch with their advisor to get any last minute questions answered
    - Chris Picone, Ronald Krieser, Chris Cratsley, Billy Samulak and Emma Downs have completed professional development on the “pedagogy of real talk” (discussed more in Section VI - Equity) which aims to make connections between faculty and students, increasing their engagement with their courses

- Assisting Students in the Transition from High School to College by Teaching First Year Experience (FYE) Courses :
    - Teaching FYE - Erin Rehrig, John Ludlam, Ron Krieser and chemistry faculty have taught the universities’ first year experience class (discussed more in Section VI - Equity) to help more students successfully make the transition from high school to college. Since the deployment of FYE across campus in 2021, our department teaches 10 percent or more of the FYE sections across campus.

- Supporting Students to Succeed in Their Classes
    - Supporting successful students in becoming tutors
    - Using embedded tutors in our core classes

- Getting Students Involved in Research: Research shows that students involved in high impact practices such as independent studies in research are more likely to graduate from college, so biology and chemistry faculty try to recruit more students to do research.
    - sSTEM grant (details below)
    - Moderna Grant to fund paid student research opportunities (see details below and in the faculty section)
    - Annual Science Symposium

- Intrusive Advising: Our advising process is discussed in detail in both the faculty and program sections.

- Career Mentoring: For the past two spring semesters (2023 and 2024), we have held large Biotechnology Networking Events in collaboration with MassBioEd. We are currently planning for another event on April 9, 2025. During these events, we have invited 20+ industry professionals to come to campus and have conversations with our students about skill and career opportunities. These included representatives from Abbvie, BMS, and WuXi (mentioned above). Several professionals that have come back to campus were alumni who are now working in various industries across the state. Post-event surveys indicate that both students and industry volunteers found these experiences rewarding and helpful. We will continue to host these events moving forward as well as forge new relationships with local businesses.

As part of efforts to support recruitment and retention for Biology majors, the department of Biology and Chemistry has been a partner with the departments of Computer Science, Engineering and Technology, and Mathematics in pursuing National Science Foundation SSTEM Grant Funding in 2021, 2022, and 2023. Unsuccessful applications in 2021 and 2022 led to revision and refinement of the proposal, and successful funding in January of 2024 of a 5 year 1 million dollar NSF Grant - SSTEM: Building Institutional Capacity to Support STEM Scholars Through the Pedagogy of Real Talk. The first cohort of students supported by this grant will be admitted to the program in spring 2025 and enroll as freshman and transfer students in September 2025. As a result, the data presented below do not yet reflect any impact of these efforts. This grant is part of a recruiting effort to bring students into the STEM programs at Fitchburg State University. Emails regarding this program have been sent to accepted students with the goal of motivating them to make the commitment to attending FSU in a more timely manner.

B. Academic Expectations and Supports

Describe academic expectations and supports

Expectations

University policy is that students must earn an overall 2.0 GPA to graduate and have a 2.0 or higher in the major. The Biology and Chemistry Department follows that policy and has an additional 2.0 policy for two specific courses. Biology majors must earn a grade of 2.0 or higher in BIOL 1800 General Biology I in order to continue in the major and may only repeat it once. Biology and Chemistry majors must earn a 2.0 in CHEM 1300 General Chemistry I to continue in the major and may only repeat it once. On average, about 7 students per year earn <2.0 in BIOL 1800 (and about 3 withdrawals) and 13 students (and about 7 withdrawals) in CHEM 1300. Equity gaps related to the 2.0 policy are discussed in **Section VI. Equity**. Additionally, students must obtain a 1.7 or higher in prerequisite courses to move onto later ones. The table below shows the data related to our 2.0 rule since 2020.

Biology/Chemistry majors enrolled in Gen BioI and Gen Chem I

BIOL 1800

	Fall					Spring				
	total	**<2.0**	0-1.7	W	U	**total**	**<2.0**	0-1.7	W	U
AY20	**42**	**3**	2	1	0	**15**	**4**	2	2	0
AY21	**48**	**6**	3	3	0	**6**	**0**	0	0	0
AY22	**33**	**7**	4	3	0	**9**	**1**	1	0	0
AY23	**42**	**7**	5	2	0	**4**	**1**	1	0	0
AY24	**36**	**5**	2	3	0	**4**	**1**	0	1	0

Data from PM - sent to JPL Summer 2024
Goal, assess 2.0 minimum policy.

CHEM 1300

	Fall					Spring				
AY20	**total**	**<2.0**	0-1.7	W	U	**total**	**<2.0**	0-1.7	W	U
AY21	**51**	**8**	3	5	0	**17**	**6**	2	4	0
AY22	**38**	**9**	3	6	0	**12**	**3**	0	3	0
AY23	**32**	**8**	4	4	0	**16**	**4**	2	0	2
AY24	**32**	**6**	3	3	0	**18**	**8**	4	4	0
	28	**9**	6	3	0	**18**	**5**	3	2	0
	181	40				81	26			
		0.2209944751					0.3209876543			

Supports

1. Fostering a Sense of Belonging

Our support begins with helping students feel a sense of belonging at FSU right from day one. Studies show that students who feel like they belong are more likely to seek help and continue with their program.

At the end of the first day of fall classes, the entire biology and chemistry department meets for a "New Student Advising" session. All the faculty are introduced to the students, basic information is given about our department, including the 2.0 rule, resources such as tutoring, academic coaching, our pre-health advisor, the agreements with LECOM, etc. Students then receive BINGO cards and learn about faculty members before sitting down with their advisor to ask questions.

The biology and chemistry club is sponsored by a faculty member within the department, but is student-led. The students organize events ranging from field trips to local science museums, speakers and workshops on resume and CV building, game and trivia nights, as well as fun science nights where they make their own slime or terrariums. On occasion, faculty are invited to these events and they attend to help build connections with students.

Several faculty in the biology and chemistry department have participated in the professional development known as the pedagogy of real talk (PRT) which also helps students relate to their faculty and content. More information can be found in Section VI - Equity.

2. Assisting Students in the Transition from High School to College Through FYE

In 2021, the university began requiring all students to take a first year experience course. Key objectives of this course is to teach reading strategies to help students manage the reading requirements of college. A significant portion of the course is focused on habits of mind to help students navigate the mental and emotional challenges of university life. Lastly, the course tries to unveil the "hidden curriculum" of college and ensure students know how to navigate college life. Dr. Downs was heavily involved in the design of FYE, and three faculty members from the biology and chemistry department teach FYE each semester, which is 10% or more of the sections offered across campus.

Supporting Classroom Success

The biology and chemistry faculty collaborates with the Academic Coaching and Tutoring (ACT) Center each semester to recruit and recommend successful students who have previously taken their classes to act as paid tutors for subsequent semesters. More recently, embedded tutors have been hired and placed in key prerequisite courses.

The Embedded Tutor program is a portion of the Health Professions Meta Advising and Mentorship Program that is run out of the School of Health and Natural Sciences and is funded by an internal Academic Innovation Fund Grant. In embedded tutoring, a tutor is present in the classroom and works under the instructor's guidance to help students understand course concepts and enhance student engagement. The tutors work with the instructor to maximize their effectiveness, such as by helping during class time (answer questions, assist during group discussions, etc.) and also outside of class (by offering group and individual tutoring sessions, some of which are tailored to the particular needs of the students or covering the more challenging topics being presently discussed in class). The Embedded Tutor program is not a substitute for the tutoring offered through the ACT Center, but, rather, an additional resource for students. Research has shown that students are often more likely to seek out help if they are more comfortable doing so and by having a tutor visible in the classroom students should ideally feel more comfortable seeking help during class or outside of class. While the Embedded Tutor idea is not a new one, this program is relatively new to campus. Academic year 2023-2024 was the first time it was fully implemented on campus (there were smaller, "pilot programs" offered the year before). During that year, there were embedded tutors in eight courses: Anatomy & Physiology, General Chemistry, Chemistry for the Health Sciences, Pre-Calculus, and General Physics II, together serving about 300 students. Although many of the students this program supported were in majors other than Biology or Chemistry, the program was coordinated by one of our faculty members (Dr. Daniel Welsh). Feedback collected from students in spring 2024 indicate that those that took advantage of the embedded tutor found it to be beneficial. About 94% of respondents who went to one or more sessions offered by the tutor said that they found it helpful.

During COVID, faculty frequently provided virtual office hours. Even though we have returned to face-to-face learning, many faculty still offer virtual appointments and office hours to meet the diverse needs of students. Additionally, faculty tried holding open office hours in more prominent locations other than their offices, with multiple faculty in the same room across disciplines. We hoped that having

multiple professors and multiple students in the same room would make students feel more comfortable attending office hours and asking for help.

Providing Opportunities for Students to be Involved in Faculty Research Projects

Each fall, we hold a science symposium where faculty present posters on their research with the goal to recruit students into independent studies or introduction to research projects. Typically 10-15 faculty in the biology and chemistry department present and 50-100 students attend the symposium. Students have the opportunity to present at the university's Undergraduate Research Conference in April and they are encouraged to do so.

Students are often limited in time to participate in these research projects due to their financial need to work. Dr. Williams applied for and was awarded a Moderna Charitable Foundation Grant in 2023 "Research Scholars Program for Traditionally Underserved Undergraduates in Biology and Chemistry" to support paid opportunities for students to conduct research during the semesters that year. A description of this grant can be found in section IV: Faculty.

Co-Curricular Support Services

Although our faculty are dedicated to supporting student needs, often students require additional academic, career, and personal support outside of the classroom. Fitchburg State University, as a whole, has invested a great deal of resources into these programs including hiring additional support staff, improving marketing, and offering expanded hours. We offer targeted services for Veterans, Students with Disabilities, and International students. Our Center for Diversity and Inclusiveness delivers programs and supports designed to contribute to positive campus experiences and a culture of appreciation and respect for all students, staff, and faculty. The Academic Coaching and Tutoring Center (ACT) promotes a student-centered, supportive, nonjudgmental atmosphere. Their mission is to enhance students' ability to learn, apply knowledge, develop study habits, and be self-directed. The Career Services and Advising (CSA) Center works to support all students as they navigate their academic and career path while at FSU. All CSA services are available to current students, undergraduate and graduate, and alumni up to 5 years after graduation. We also offer Counseling Services on campus as many students (esp. since the pandemic) are experiencing high levels of anxiety and depression. Students are able to utilize many of these services by making an appointment or stopping by during drop-in hours offered each semester.

One service that faculty in our department can also use is called a "CARE" team report. CARE reports can be completed online by friends, faculty, administrators, or staff to report information about a student of concern. These reports can be on anything from missed classes, to worrisome behavior, to academic concerns. Once the form is submitted it is sent to a CARE team member in Student Affairs who triages the referrals and follows up with the student. For purely academic concerns, faculty can also submit a referral for a student for tutor or an academic coach using the SSC platform. A screenshot of the care report form can be found below.

CARE TEAM REPORT PAGE:

Please check all that apply below as to the nature of this referral. Checkboxes are not required fields. If you are unsure what to check, leave it blank and just type the narrative in the open text box. If you have any questions, please consult the Dean of Students Office for guidance.

- ☐ Academic Concerns
- ☐ Aggressive, hostile or destructive behavior
- ☐ Alcohol or substance use
- ☐ Basic needs insecurity (housing, food, clothing etc.)
- ☐ Change in appearance or hygiene
- ☐ Concerning demeanor / change in disposition
- ☐ Concerning written, visual, or virtual content
- ☐ Difficulty with college transition
- ☐ Difficult personal event or circumstance
- ☐ Difficulty with a mental health concern
- ☐ Disruptive Behavior
- ☐ Emotional distress or heightened concern
- ☐ Financial stressor or need
- ☐ Interpersonal conflict / relationship concern
- ☐ Medical concern, injury or illness
- ☐ Self-harm / self-injurious behavior
- ☐ Social difficulties or isolation
- ☐ Suicidal ideation
- ☐ Suicide attempt
- ☐ Threatening harm / intimidating others
- ☐ Unresponsive / unable to locate
- ☐ Unusual thoughts, speech or behavior
- ☐ Violence toward others
- ☐ Other (please ensure the concern is described in the narrative)

Academic Concerns (please use this if you checked "Academic Concerns" above). Check all that apply. Faculty: if your referral is solely based on academic concerns, please refer to EAB Navigate to submit a progress report for the student.

- ☐ Disruptive behavior
- ☐ Excessive absences or not attending class
- ☐ Poor performance or coursework quality
- ☐ Missed exam or critical assignment
- ☐ Time management, organization, studying concerns
- ☐ Other (please ensure the concern is described in the narrative)

Please provide a description of the incident and/or concerns (Please include specific location of the incident if applicable). Do not speculate and/or use diagnostic language. Please share observations and facts. Note: If you believe the student to be "missing" please report to University Police at 978-665-3111. (Required)

Intrusive Advising

The biology and chemistry department is invested heavily in advising. We have a designated pre-health advisor with a course release each semester to hold office hours specifically for students interested in pursuing graduate studies for health-related fields. During biannual appointments, faculty consider workload, family life, and career goals when advising students to help them be as successful as possible.

C. Significant Trends

Discuss significant trends in student enrollment, demographics, retention and graduation rates,satisfaction, post-graduation outcomes; identify pressing issues found in the data.

- The data discussed below can be accessed in the Biology Dashboard Data (which is also copied into section I.Program) provided by Institutional Research and Planning. Further data are included in this file of Bio and Chem Enrollment and Faculty Data, which spans a longer period of time than the Dashboard data.

Disproportionate decline in Biology majors

Over the period of this self-study, Fitchburg State lost students due to unavoidable demographic trends and the COVID-19 pandemic, and yet **enrollment in Biology** declined at an even greater rate. Total undergraduate enrollment at FSU fell 34% from its peak in 2017 to AY2024, while the number of Biology majors declined 43.5% over that same time period (Figure V.1). Enrollment across all Biology classes (majors and non-majors) peaked at approximately 11.5% of all Fitchburg State seats from 2017-2019, but has come down to under 9.8% of seats in the last three years.

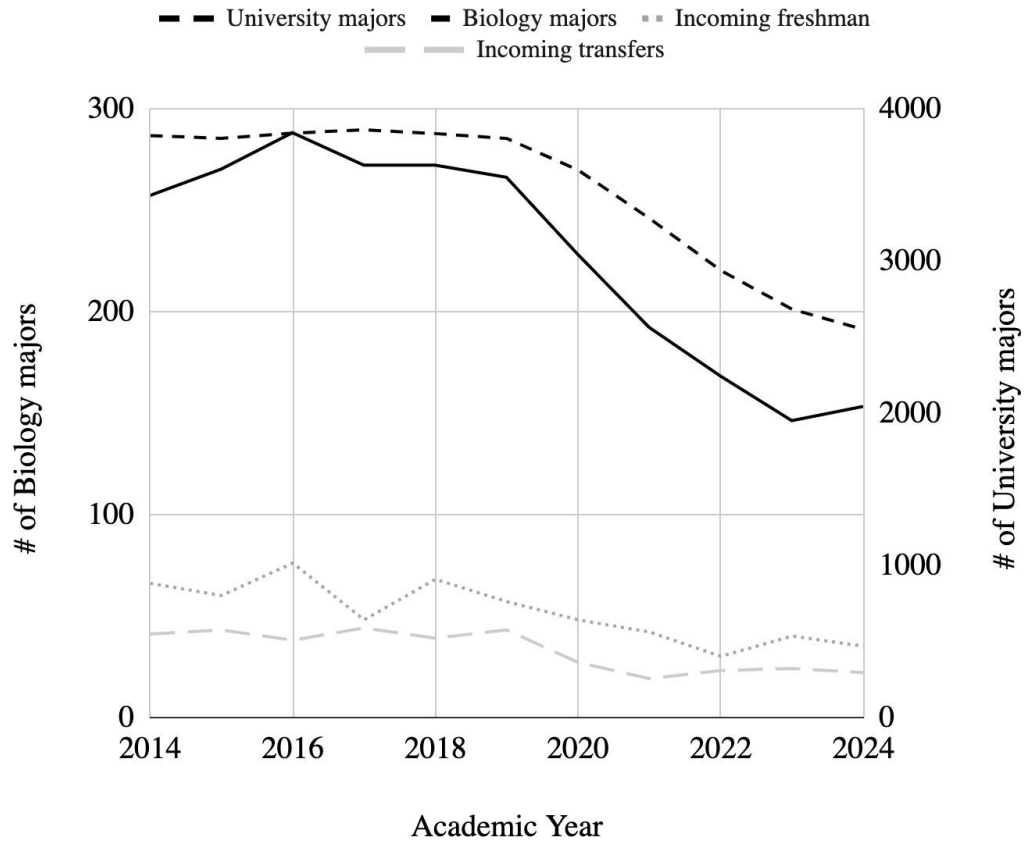


Figure V.1. Number of biology majors, incoming freshman biology majors, and incoming transfer biology majors (left axis) and number of majors university-wide (right axis) vs academic year. Note differing scales on the left and right axes.

The causes for the excess decline in the last 7 years are speculative, but may include:

- Lack of targeted marketing for the Biology and Chemistry programs.
- Our new Science Laboratory wing and building renovation were completed in 2014 and drew considerable attention and excitement that probably attracted some Biology majors to enroll here. That attention and excitement has waned in subsequent years.
- The slight decline in Biology seats may be related to offering fewer sections of Life Science, a General Education course that non-majors can use to fulfill their science requirement (SI). In the Spring of 2020 Mary Lou Soczek retired, and she had served for many years as an Adjunct Professor who taught most of sections of that non-majors course. Since then, we have offered fewer sections of Life Science, reducing our seats in Biology classes. (Note that we have continued to offer many sections of Life Science for Educators.)

Fortunately, the decline seemed to stabilize in AY2023, and we have even seen very slight gains in the number of majors and in the numbers of seats in Biology classes. We hope that trend continues while we

have recently increased the numbers of students who do research (e.g., the Moderna Scholars). For comparison, National Student Clearinghouse data for Biology and Biomedical undergraduate enrollment in Massachusetts showed a decline from 2020 to 2022 followed by a recovery in 2023 and 2024 (Figure V.2).

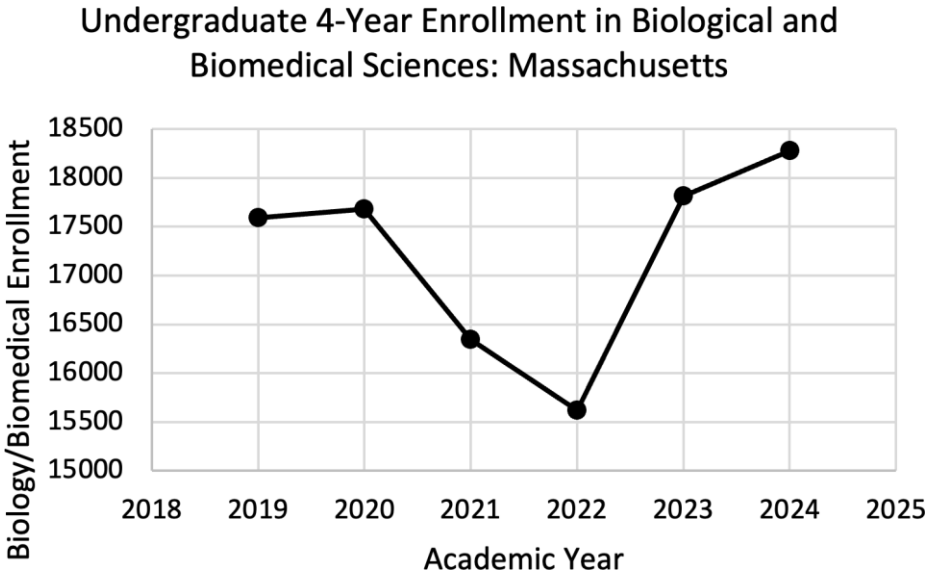


Figure V.2 Undergraduate 4-Year Enrollment in Biological and Biomedical Sciences in Massachusetts. https://nscresearchcenter.org/current-term-enrollment-estimates/

The number of majors is a function of enrollment trends (new freshman plus transfer students) and retention. Admissions "funnel" data for Fall semesters showed that the declining freshmen enrollment trend university-wide resembled declines in Biology major enrollment during the period.

A related challenge is the decline in **retention rates among Biology majors.** From AY2014-2016, retention in Biology was similar to the University as a whole. But in every year since AY2017 the **retention rates** for Biology majors has been consistently lower than the University at large (Figure V.3). The relative decline since 2017 is especially disappointing because during this same period we have increased opportunities for student research, added FYE, and implemented programs to improve DEI. Some of these changes are associated with shifting student demographics discussed in section VI. Equity.

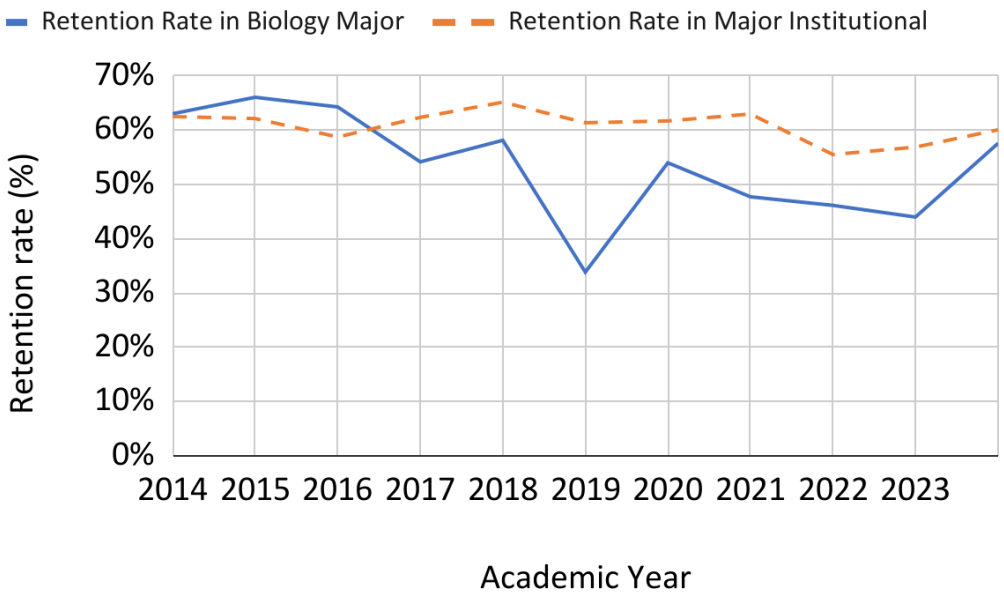


Figure V.3. Retention(full-time freshmen entering in fall and retained for the following fall semester) versus academic year. Academic year indicated for Retention Rates is the year for which students were retained.

While trends since 2019 are troublesome, it is important to note that the recent decline in Biology enrollments followed a dramatic increase over the prior decade. From 2008-2018, the number of Biology majors more than doubled. It would be unrealistic to expect the continuation of this trend given the changing and decreasing demographics of 18-24 year old applicants. Although the number of Biology majors has dropped by over 43% since 2018, the number of students obtaining a **minor** in Chemistry or the minor in Neuroscience, Behavior and Cognition has remained fairly steady. As mentioned numerous times through this document, one of our primary goals as a department is to improve both recruitment and retention of students in our program through increased wrap-around services, embedded tutoring, grants, research opportunities, and other best practices. We are beginning to see an uptick in students returning after COVID and we hope to continue with this trend.

[A separate section will address retention by different demographic groups, in Section VI: Equity.]

Graduation rates

The six-year graduation rate of first-time, full-time Biology majors (i.e., only students that graduated in the initial Biology major) averaged 34% for the last six years. Of these same Biology majors, on average 51% graduated from Fitchburg State, which includes 34% in Biology plus 17% graduating after they changed to another major.

There is an inexplicable drop in graduation rate for the 2017 cohort, down to 17% from the average of 34%. Perhaps Covid played some role, affecting these students in their third and fourth years. However,

the 2018 cohort bounced back to graduate at the typical rate, even though they would have been equally impacted by Covid. The Biology Department should continue to monitor graduation rates to verify whether 2017 was just a statistical anomaly. We are hopeful that higher retention rates since 2020, at least among Black and White students (See Section VI Equity), should lead to improved graduation rates for more recent cohorts.

First-Time Full-Time six year student graduation rate-BIOL vs University				
Entering Semester	Headcount	# Graduated in BIOL Major	% Graduated in BIOL Major*	% Graduated University any major#
Fall 2013	56	22	39%	58%
Fall 2014	56	22	39%	58%
Fall 2015	72	24	33%	57%
Fall 2016	43	16	37%	56%
Fall 2017	65	11	17%	53%
Fall 2018	50	18	36%	50%
* excludes students who changed from Biology to a different major # includes students who changed from an initial major to a different major				

D. Experiential Learning

Discuss experiential learning opportunities in the program.

Students in the department have many opportunities for experiential Learning. They take many courses with a laboratory component where they get various hands-on experiences using different instrumentation. At least one research experience is built into the curriculum as they are required to take a Capstone Course for the major. These courses must include a research component. This can range from a multi-week project for each student during the semester, to capstone courses taught as Course-Based Undergraduate Research Experiences (CUREs) where students are working on a guided novel research question during the semester. Many students also gain experience on campus by taking either BIOL 1600 Introduction to Research or BIOL 490X Independent study. The introduction to research course is a 1 credit course where students will work directly with a faculty member on their ongoing research project to get hands-on experience and see what it is like to work in a laboratory. This does not count as an upper-level biology elective. Students can get upper-level biology credit through an independent study, which, despite the name, involves students working directly under the supervision of a faculty member getting more substantial hands-on experiences as a contributor to the faculty member's ongoing research project. Both of these experiences are valuable for students and take a substantial amount of time for the faculty member that needs to be present to account for lab safety and be sure the procedures are correctly followed and documented. Biology majors that are also in the Honors Program are required to do a two-semester (6 credits) thesis project where typically they are working with a faculty member as part of their ongoing research group or on their individual project.

Examples of the number of students and types of projects of students can be found in E: Supporting Documents.

In addition to these experiences, students also find opportunities for paid and unpaid internships either at biotech companies or through NSF funded Research Experiences for Undergraduate students. In addition, students interested in careers in health care are encouraged to find shadowing experiences, or direct patient care experiences which are important or required for admission to their graduate programs of interest. To get credit for any experience taken as BIOL 4950 or 4960 Internship, students must complete the required university contractual forms and work with their advisor or faculty member who coordinates with their internship supervisor to assure that the student is progressing through the internship. The list of internships that students have taken can be seen in the supporting documents at the end of this section.

Other experiences that have been offered to our students during the review period include the Summer Research Collaborative funded by the Balfour Foundation and Student opportunities funded through the Moderna Grant. Drs. Welsh, O'Connor, Downs, and Ludlum were part of an interdisciplinary group that applied for and were awarded funding from the Balfour Foundation to support summer research by Fitchburg State students called "The Student-Faculty Collaborative Summer Research Experience" to support 15-20 FSU students per summer studying the Nashua River. Although the grant for this was awarded in the previous self-study review period, some of the research continued into this review period through encumbered funds. In addition, Dr. Williams was awarded a Moderna Charitable Foundation Grant in 2023 "Research Scholars Program for Traditionally Underserved Undergraduates in Biology and Chemistry" to support opportunities for students to conduct research during the semesters that year.

All of our majors who are seeking a biology initial license (8-12) begin field experiences in their first year and continue them throughout their education minor in middle and secondary education. In each required course within the minor, the licensure candidate is placed into a high school biology classroom where they participate in teaching and any other tasks necessary to support the in-service teacher (supervising practitioner). Each education course requires between 10-25 hours of time in the classroom and includes supervision by and feedback from the supervising practitioner. Approximately two-thirds of the required hours must be spent in a diverse setting in order to broaden the experiences of the licensure candidates. The final semester of the licensure candidate is spent in Practicum, which is the capstone teaching experience. During Practicum, the candidates work full-time in a biology high school classroom under the supervision of the Supervising Practitioner and a University Supervisor. The candidates work alongside the Supervising Practitioner and perform all outside duties required of a teacher which can include email correspondence with parents, attendance at professional development workshops, attendance at departmental meetings, and participation in parent-teacher conferences. The candidate is required to spend a minimum of two weeks in full responsibility where they take over and are in complete control of the classroom. Multiple assessments throughout the 15 week Practicum include a minimum of four observations by the supervisors, review of artifacts that demonstrate competency in essential areas, and written formative and summative assessments completed by the supervisors that are aligned with the evaluation system used by Massachusetts school districts.

Destinations of Our Graduates:

We track the post-graduation destinations of our graduates with the assistance of the Office of Institutional Research and Planning. Students are encouraged to complete a survey about their employment plans around the time of graduation and alumni are sent surveys every two years. As a department, we maintain a spreadsheet summarizing this information. Although the number of responses to these surveys each year is limited, the data show the major pathways chosen by our graduates.

Biology and chemistry research positions (e.g. laboratory technician, research associate, scientist positions) at local pharmaceutical companies and universities are the most common career paths pursued by our graduates. The destinations of our alumni who have chosen this route over the past seven years is shown below.

- AbbVie
- Affinivax Inc.
- Albany Molecular Research, Inc.
- Allotex
- Alnylam Pharmaceuticals
- Alpha Analytical Labs
- Astellas Institute for Regenerative Medicine
- Beth Israel Deaconess Medical School
- BioNTech
- BioSynth International, Inc.
- Boston Children's Hospital
- Brigham and Women's Hospital
- Bristol Myers Squibb
- Charles River Laboratories
- Discovery Diagnostic Laboratory
- Doble Engineering Company
- DuPont
- Emergent BioSolutions
- Enamel Pure and Spatial Surgical
- Environmental Testing and Research Laboratories
- Eurovia, Inc
- Ginkgo Bioworks, Inc
- Harvard University
- HyperSpectral Corp
- Johnson Matthey
- Lowell General Hospital
- Mass General Brigham
- Masy's Bioservices
- MCR Labs
- National Ecological Observatory Network
- Normandeau Associates
- Oxford Biomedica
- Pace Analytical Services
- Pfizer Inc.
- Quest Diagnostic
- Raytheon
- SciTide
- Thermo Fisher Scientific
- Umass Chan Medical School
- Veranova
- Vivetide

Another common career path for our students includes a variety of entry-level clinical positions. For example, our alumni have become medical assistants, surgical assistants, certified nursing assistants, clinical lab/research assistants, medical examiner assistants, veterinary assistants, scribes, dialysis

technicians, and pharmacy technicians. Over the past seven years, our graduates have been employed in these positions by the companies and hospitals listed below.

- Boston Children's Hospital
- Cambridge Health Alliance
- Cape Cod Dermatology
- Central Massachusetts Podiatry
- Charles Street Chiropractic
- Commonwealth of Massachusetts
- CVS
- DaVita Kidney Care
- Emerson Hospital
- New Hampshire Oral Surgery
- NuvoAir Medical
- ScribeAmerica
- Whittier Rehab Hospital

Each year, a handful of our students go on to pursue graduate degrees. We are fortunate to have early acceptance articulation agreements with Lake Erie College of Osteopathic Medicine for up to 15 students each year who are interested in Doctor of Osteopathic Medicine, Doctor of Dental Medicine, and Doctor of Pharmacy programs. In addition to these programs, we have had students pursue the graduate studies listed below.

Degree, School(s)

Doctor of Dental Medicine, University of Pittsburgh
Doctor of Nursing Practice, UMass Chan Medical School
Doctor of Pharmacy, Massachusetts College of Pharmacy and Health Science
Doctor of Philosophy in Biology, University of Alabama
Doctor of Philosophy in Mathematics, North Carolina State University
Doctor of Physical Therapy, Northeastern University
Master of Business Administration, Fitchburg State University
Master of Occupational Therapy, Johnson & Wales University
Master of Physician Assistant Studies, Massachusetts College of Pharmacy & Health Sciences
Master of Public Health, Northeastern University, UMass Lowell
Master of Science in Bioinformatics, Brandeis University
Master of Science in Nursing, Regis College
Master of Speech Language Pathology, University of St. Augustine

Finally, over the past seven years, we have trained a handful of high school teachers. These students have gone on to teach at Fitchburg High School (MA), Montachusett Regional Vocational High School (MA), and Hollis Brookline High School (NH).

E: Supporting Documents: 2024 Incoming Freshmen Student Survey/College Student Inventory (CSI), List of student independent studies, introductory research, and internships in Biology from 2017-2024

INDEPENDENT STUDIES, RESEARCH PROJECTS, HONORS THESIS & PRACTICA

Year	Semester	Full Project Title	Student(s)	Instructor	Program
2017	Spring	Mass Spectrometry Quantification of Crosslinked Proteins	Blake Phinny	Billy Samulak	Biology
2017	Fall	Mass Spectrometry Quantification of Crosslinked Proteins	Yelitza Rosario	Billy Samulak	Biology
2017	Spring	Functional Enzymatic Analysis of Crosslinked Aldolase	Mike McGrath	Billy Samulak	Biology
2018	Summer	Habitat of the Eastern Pearlshell (Margartitifera margaritifera) in	(grad)	John Ludlam	Biology
2018	Summer	and Macroinvertebrate Diversity	Chelsea Lashua	John Ludlam	Biology
2018	Summer	Paid Internship: Analysis of DYSF suppression in human cells	Anthony Manganaro	Eric Williams	Biology
2018	Summer	Paid Internship: Inhibiting fer-1 in C.elegans	and John Sanford	Eric Williams	Biology
2018	Spring	Rodent neurohistology	Ethan Borges	Thomas Schoenfeld	Biology
2018	Spring	Introduction to Research	Stephen LeBlanc	Ron Krieser	Biology
2018	Fall	Intra- and Inter-individual differences in fish scale size	Fenelon	Daniel Welsh	Biology
2018	Fall	Olfactory neurogenesis	Bryan Carlson	Thomas Schoenfeld	Biology
2018	Fall	1	Nicole Zwicker	Eric Williams	Biology
2018	Fall	Chromosomal Mapping of fer-1 suppressors in C.elegans	Benjamin McGuire	Eric Williams	Biology
2018	Fall	Honor's thesis: Apoptosis in C.elegans	Kyle Hofer	Eric Williams	Biology
2018	Fall	The Biology and Epidemiology of Influenza	Danielle Fleckner	Erin Rehrig	Biology
2018	Fall	Herbivory	Gregory Gundburg	Erin Rehrig	Biology
2018	Fall	Herbivory	Andrew Pelzer	Erin Rehrig	Biology
2018	Fall	Intra- and Inter-individual differences in fish scale size	Thibault	Daniel Welsh	Biology
2019	Spring	Intra- and Inter-individual differences in fish scale size	Bacon	Daniel Welsh	Biology
2019	Spring	Microplastics in fish	Samantha Richard	Daniel Welsh	Biology
2019	Spring	Using Macroinvertebrate Tolerances	Courtney Aulden	John Ludlam	Biology
2019	Spring	Honor's thesis: Apoptosis in C.elegans	Kyle Hofer	Eric Williams	Biology
2019	Spring	Analysis of DYSF suppression in human cells	Anthony Manganaro	Eric Williams	Biology
2019	Spring	1	Khianna Del Valle	Eric Williams	Biology
2019	Spring	Olfactory neurogenesis	Ethan Borges	Thomas Schoenfeld	Biology
2019	Summer	Plant–Bumblebee associations on organic farms	Karen DiStasio (grad)	Chris Picone	Biology
2019	Summer	River Watershed	Jordan Oberg	John Ludlam	Biology
2019	Fall	Olfactory neurogenesis	Heather Bosworth	Thomas Schoenfeld	Biology
2019	Fall	Mapping fer-1 suppressors	Amanda Montuori	Eric Williams	Biology
2019	Fall	Analysis of DYSF suppression in human cells	Jessica LoPreste	Eric Williams	Biology
2019	Fall	Paid internship: Analysis of DYSF suppression in human cells	Sarah Olson	Eric Williams	Biology
2019	Fall	Evolution of DNase II	Chelsie Clarkson	Ron Krieser	Biology
2019	Fall	Evolution of DNase II	Eric Bentil	Ron Krieser	Biology
2019	Fall	Population dynamics of freshwater mussels	Courtney Aulden	John Ludlam	Biology
2019	Spring	Intra- and Inter-individual differences in fish scale size	Kelsie Bacon, Myrca	Daniel Welsh	Biology
2019	Spring	Microplastics in Fish	Samantha Richard	Daniel Welsh	Biology
2019	Fall	Microplastics in Fish	Nicole Burdick	Gordon co-advised)	Biology
2019	Fall	Intra- and Inter-individual differences in fish scale size	Rose Kelley	Daniel Welsh	Biology
2020	Fall	Secondary Biology Practicum	Yvonne Wandless	Lisa Grimm	Biology
2020	Spring	Analysis of DYSF suppression in human cells	Lindsay Duchnowski	Eric Williams	Biology
2020	Spring	Analysis of DYSF suppression in human cells	Christina Rodriguez	Eric Williams	Biology
2020	Spring	Evolution of the DNase II Gene	Moses Gomez	Ron Krieser	Biology
2020	Spring	Line	Jumily Bourommavong	Elizabeth Kilpatrick	Biology
2020	Spring	The Effect of Silver Nanoparticles on Plants	Lindsey Smart	Erin Rehrig	Biology
2020	Spring	The Effect of Silver Nanoparticles on Plants	Erica Urlich	Erin Rehrig	Biology
2020	Spring	Silver Nanoparticles	Alexander Blinn	Emma Downs	Biology
2020	Fall	Analysis of DYSF suppression in human cells	Eli Rivera	Eric Williams	Biology
2020	Fall	Analysis of DYSF suppression in human cells	Sara Rogers	Eric Williams	Biology
2020	Fall	Analysis of dysferlin in muscle cells	Jumily Bourommavong	Eric Williams	Biology
2020	Fall	Bioinformatic analysis of aging muscle	Madison Russo	Eric Williams	Biology
2020	Fall	Duplication of Uricase Gene in turtles	Richard Taylor	Ron Krieser	Biology
2020	Fall	users	Larissa Hammamoto	Ron Krieser	Biology
2020	Fall	Intra- and Inter-individual differences in fish scale size	Xynone Cabal	Daniel Welsh	Biology
2020	Fall	A Biological Assessment of the Condition of the Nashua River	Wade Williams	Daniel Welsh	Biology
2021	Spring	Analysis of fer-1 in C. elegans muscle	Bryan Bidleman	Eric Williams	Biology
2021	Spring	Analysis of dysferlin in muscle cells	Sarah McNeil	Eric Williams	Biology
2021	Spring	Analysis of dysferlin in muscle cells	Jumily Bourommavong	Eric Williams	Biology
2021	Spring	Identifying suppressors of C.elegans fer-1	Madison Russo	Eric Williams	Biology
2021	Spring	Processes	Nicholas Sachetta	Nosek/Elizabeth	Biology
2021	Spring	thaliana	Cole Brunker	Erin Rehrig	Biology

2021	Fall	users	Larissa Hammamoto	Ron Krieser	Biology
2021	Fall	Analysis of membrane fusion in muscle stem cells	Skylar Worster	Eric Williams	Biology
2021	Fall	Characterization of muscle stem cells differentiation	Michaela Mancuso	Eric Williams	Biology
2021	Fall	differentiation	Cole Archambeault	Eric Williams	Biology
2021	Fall	cells	Jessica Morse	Eric Williams	Biology
2021	Fall	differentiation	Yaa Ansah	Eric Williams	Biology
2021	Fall	Neutrophils and Their Functions	Nicholas Sachetta	Nosek/Elizabeth	Biology
2021	Fall	Syndrome and Correlations with COVID-19	Michael Pawson	Elizabeth Kilpatrick	Biology
2021	Fall	Bivalves and Microplastics	Hannah Wilder	John Ludlam	Biology
2021	Fall	The Evolution of the DNaseII Gene in Vertebrates	Sarah Olson	Lisa Grimm	Biology
2021	Spring	Intra- and Inter-individual differences in fish scale size	Sierra Champagne	Daniel Welsh	Biology
2021	Fall	The effect of water clarity on fish eyes	Matt Sadowski	Daniel Welsh	Biology
2022	Spring	Syndrome and Correlations with COVID-19	Michael Pawson	Elizabeth Kilpatrick	Biology
2022	Spring	Effector Functions of a Human Neutrophil-Like Cell Line	Jordin Homes-Garton	Elizabeth Kilpatrick	Biology
2022	Spring	Biology Secondary Education Practicum	Nicholas Sachetta	Erin Rehrig	Biology
2022	Spring	Biology Secondary Education Practicum	Jamie Ruiz	Erin Rehrig	Biology
2022	Spring	Biology Secondary Education Practicum	Matt Sadowski	Erin Rehrig	Biology
2022	Fall	Dispossessed Their Land and Our Health	Maria Burnett	Chris Picone	Biology
2022	Fall	Egg Laying Behavior in Killifish	Kaya Scarela	Daniel Welsh	Biology
2023	Spring	Dispossessed Their Land and Our Health	Maria Burnett	Chris Picone	Biology
2023	Spring	AgNP-treated plants	Marissa Ladderbush	Erin Rehrig	Biology
2023	Spring	Muscular Dystrophy	Cristina Pureco	Eric Williams	Biology
2023	Spring	Dysferlinopathy	Sarah Hicks	Eric Williams	Biology
2023	Spring	Engineering in the Classroom	Justin Dediego	Billy Samulak	Biology
2023	Spring	RNA Sequencing Analysis of Dysferlinopathy	Melanie Pung	Eric Williams	Biology
2023	Spring	Dysferlinopathy	Thailee Zarycki	Eric Williams	Biology
2023	Spring	Dysferlinopathy	Jaylah Cormier	Eric Williams	Biology
2023	Fall	Response to fish lures	Brian Sweeney	Daniel Welsh	Biology
2024	Spring	AgNPs	Dylan Napoli	Erin Rehrig	Biology
2024	Spring	Muscular Dystrophy Research	Melanie Mejia	Eric Williams	Biology
2024	Spring	Muscular Dystrophy Research	Stephanie Pelletier	Eric Williams	Biology
2024	Spring	Muscular Dystrophy Research	Steven Basiastegui	Eric Williams	Biology
2024	Spring	AgNPs	Carlos Pineda	Erin Rehrig	Biology
2024	Spring	Gene Loss in Vertebrate	Barrett Richard	Ronald Krieser	Biology
2024	Spring	Muscular Dystrophy Research	Gina Vilayphone	Eric Williams	Biology
2024	Spring	Muscular Dystrophy Research	Gina Vilayphone	Eric Williams	Biology
2024	Spring	Muscular Dystrophy Research	Taja Viera	Eric Williams	Biology
2024	Spring	Muscular Dystrophy Research	Bridget Martin	Eric Willams	Biology
2024	Spring	Analysis of Putative New Exons of the DNAse II Beta Gene	Thea Wysocki	Lisa Grimm	Biology
2024	Spring	The Identification of Face Mask Microorganisms	Jason Tovar	Sean Rollins	Biology
2024	Spring	Firefly Population Analysis	Jason Ortiz	Chris Cratsley	Biology
2024	Spring	Analysis of Putative New Exons of the DNAse II Beta Gene	Lacrinia Dirtion	Lisa Grimm	Biology
2024	Spring/Fall	PFAS in Mass: Where and why water is threatened	Abigail Leahey	Downs	BIOL/CHEM

INTRODUCTION to RESEARCH (1 credit S/U) BIOL 1600				
Year	**Semester**	**Project Title**	**Student(s)**	**Instructor**
2018	Spring	GIS characteristics of local farms for bee conservation	Erica Boucher	Chris Picone
2018	Spring	Mapping fer-1 suppressors	Benjamin McGuire	Eric Williams
2018	Spring	Rodent neurohistology	Bryan Carlson and Mikaela	Thomas Schoenfeld
2018	Spring	Synthesizing Nanoparticles for Plant Experiments	Gregory Gundburg	Erin Rehrig
2019	Spring	Rodent neurohistology	Heather Bosworth	Thomas Schoenfeld
2019	Spring	Mapping fer-1 suppressors	Mitchell Richardson	Eric Williams
2019	Spring	Mass Spectrometry Quantification of Crosslinked	Justin Girard	Billy Samulak
2019	Fall	Rodent neurohistology	Ashley Hudson	Thomas Schoenfeld
2020	Spring	Characterizing suppressors of fer-1 mutants	Sara Rogers	Eric Williams
2020	Spring	Analysis of DYSF suppression in human cells	Eli Rivera	Eric Williams
2020	Spring	Characterizing suppressors of fer-1 mutants	Rebecca Landry	Eric Williams
2020	Spring	Aquatic invertebrates	Megan Divito	John Ludlam
2021	Spring	Fishes of the Nashua River Watershed	Mary Kate Moreau	Daniel Welsh
2023	Spring	ROS production in AgNP-treated plants	Maximus Ball	Erin Rehrig
2021	Fall	AgNP in Plant Biology	Linnea D'Acchille	Erin Rehrig
2022	Fall	Egg Laying Behavior in Fish	Kathleen Ben-Aroch	Daniel Welsh
2022	Fall	Development of a Functional Membrane Repair Assay in Muscle Stem Cells	Jaylah Cormier	Eric Williams
2023	Spring	Egg Laying Behavior in Fish	Jameson Dillon	Daniel Welsh
2023	Spring	Egg Laying Behavior in Fish	Olivia DeLuco	Daniel Welsh
2023	Spring	ROS in AgNP Plants	Maximus Ball	Erin Rehrig
2023	Spring	Testing Chemical Chaperones for Muscular Dystrophy	Grace Kentsa	Eric Williams
2023	Spring	Molecular Techniques	Thea Wysocki	Lisa Grimm
2023	Fall	Water Clarity and Fish	Mariah Garcia	Daniel Welsh
2023	Fall	Water Clarity Effects on Fish	Jordan Jaillet	Daniel Welsh
2024	Spring	Water Clarity and Fish	Mariah Garcia	Daniel Welsh
2024	Spring	Water Clarity Effects on Fish	Jordan Jaillet	Daniel Welsh
2024	Spring	Mitotoxicity of Resveratrol in HepG2 Cells	Erica Vogel	Michael Nosek
2024	Spring	Effects of Iron on Mitochondrial Function in a Cell Model of Friedreich's Ataxia	Samya Perez	Michael Nosek
2024	Spring	The Study of DNase II	Jocelyn Sok	Ronald Krieser

Internships in Biology (2017-2024)				
Year	**Semester**	**Student(s)**	**Full Project Title**	**Instructor**
2018	Spring	Claudia Nunez	Animal Caretaker (Animal Adventures)	Erin Rehrig
2018	Spring/Fall	Tyler Scipione	Student Development Internship	Erin Rehrig
2018	Summer	Sarah Olson	Paid Internship: Analysis of DYSF suppression in human cells	Eric Williams
2018	Summer	Anthony Manganaro	Paid Internship: Analysis of DYSF suppression in human cells	Eric Williams
2018	Summer	Reginald Sarpong	Paid Internship: Inhibiting fer-1 in C.elegans	Eric Williams
2018	Summer	John Sanford	Paid Internship: Inhibiting fer-1 in C.elegans	Eric Williams
2018	Summer	Miranda Duffany	internship in physical therapy	Ronald Krieser
2019	Fall	Sarah Olson	Paid Internship: Analysis of DYSF suppression in human cells	Eric Williams
2019	Summer	Alexandria Laderoute	MA Envir.Police Intern/ MA Dept. Cons.& Recreation	Aisling O'Connor
2019	Summer	Tiana Roman	Veterinary Wildlife (New England Wildlife Center)	Daniel Welsh
2021	Fall	Cole Archambeault	Paid Internship: Characterization of muscle stem cells	Eric Williams
2022	Summer	Kaitlyn Prentiss	Paid Internship:Use of Native Plants in Landscape Design	Erin Rehrig
2023	Summer	Abigail Leahey	Organic Agriculture	John Ludlam
2023	Summer	Alicia George	Paid Internship: Cell Signaling	Erin Rehrig
2023	Fall	Max Bollous	Effects of Smoke Water on Seed Germination	Daniel Welsh
2021	Fall	Jessica Morse	Paid Internship: Analysis of membrane fusion in muscle cells	Eric Williams

RUFFALO NOEL LEVITZ

Identification of student risk, receptivity and outreach prioritization

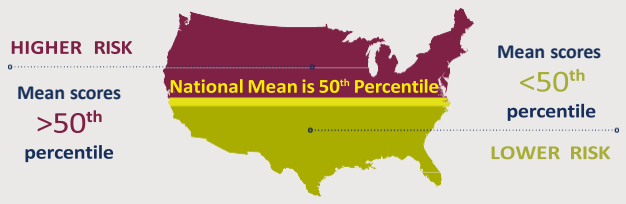
COLLEGE STUDENT INVENTORY™ SUMMARY RESULTS, FALL COHORT

N=
CSI Completion rate
incoming students

1 Are our students more or less at risk than their peers nationally?

KEY TO INTERPRETING RESULTS:

Campus results below are mean percentile scores.



Overall Risk Index

HIGH RISK >50
LOW RISK <50

TOTAL FEMALES MALES

% of students are highest risk (80th percentile or higher)

Predicted Academic Dificulty

HIGH RISK >50
LOW RISK <50

TOTAL FEMALES MALES

% of students are highest risk (80th percentile or higher)

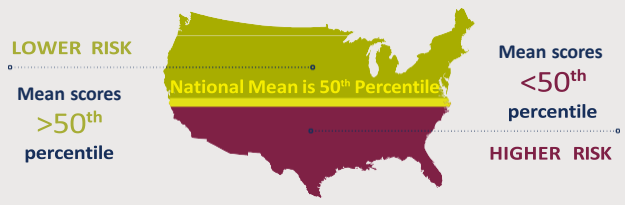
Educational Stress

HIGH RISK >50
LOW RISK <50

TOTAL FEMALES MALES

% of students are highest risk (80th percentile or higher)

2 Are our students more/less receptive to assistance?



Receptivity to Institutional Help

LOW RISK >50
HIGH RISK <50

TOTAL FEMALES MALES

%

3 What are some key characteristics of this incoming class?

Students who plan to work over 20 hours per week.

Percent and number of students

Students who plan to transfer prior to completing their program/degree.

80th percentile or above

Students who plan to earn a degree beyond a bachelor's.

Percent and number of students

Students' Top 10 Requests for Assistance (Get Help/Discuss/Get Info)

1.		%
2.		%
3.		%
4.		%
5.		%
6.		%
7.		%
8.		%
9.		%
10.		%

The percentage score is based on the number of students whose request for assistance on each item was 6 or higher (in a range of 1-10).

4 Additional information

VI. Equity

This section includes the following topics regarding our equity initiatives:

- Equity Gaps. *Identify any equity gaps in student outcomes or satisfaction and what the unit is doing, or plans to do so, to address these gaps.*
- Culturally Responsive Practices. *Describe any culturally responsive practices that you have employed to promote equity in the program.*
- Environment. *Describe any steps that have been taken to create an environment that values diversity and supports all faculty, students and staff within the department.*

Part 1. Enrollment, retention, and graduation rates across demographic groups

The Biology and Chemistry Department prioritizes service to underrepresented minorities. For over a decade, enrollment by minorities has been consistently higher among Biology majors than at Fitchburg State as a whole (Figure VI.1).

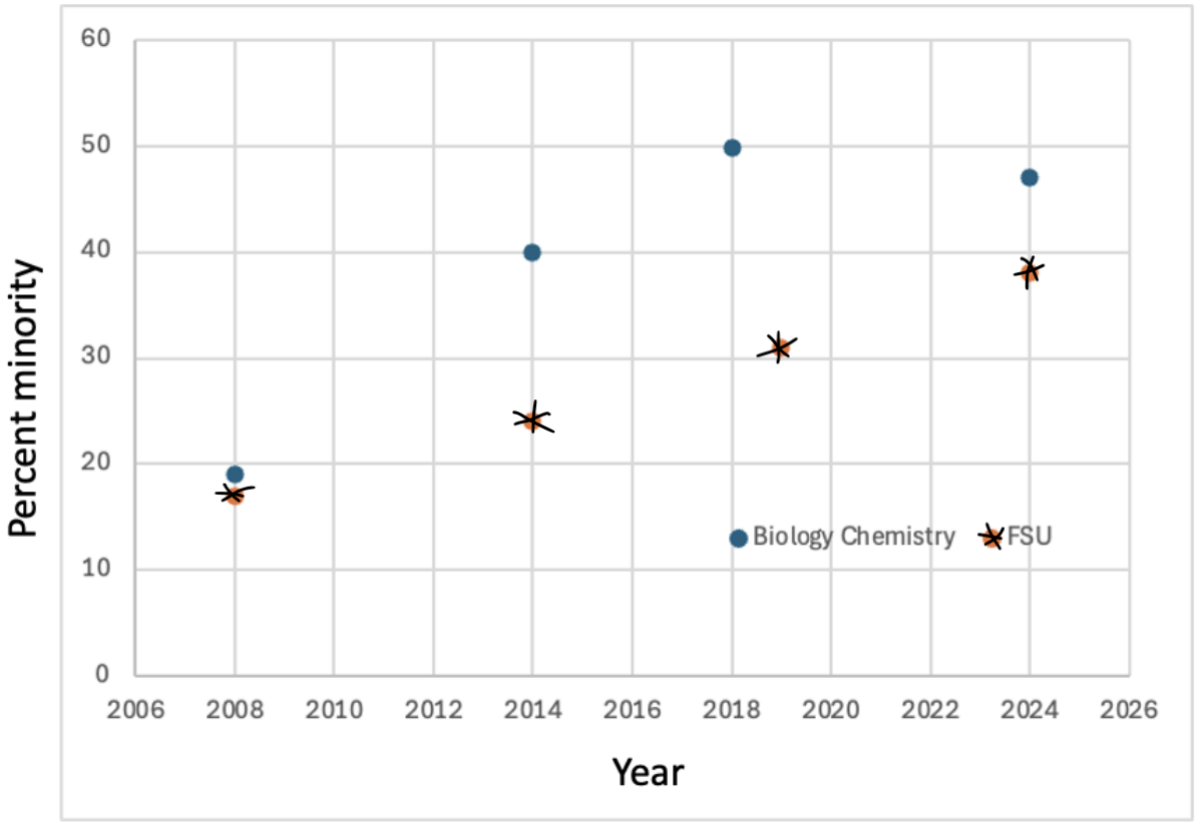


Figure VI.1. Percent of majors in Biology and/or Chemistry that identified as minority students, compared to the overall percentage of minority students at Fitchburg State from 2008-2024. The growth in minority students in the Biology and Chemistry department has increased at a faster rate than at FSU overall.

However, while % enrollments by minorities are something to celebrate, there are important demographic trends regarding the decline in total number of students, and challenges in retention, especially among Hispanic students.

First, the number of new students entering the Biology major each fall has declined, with trends varying by ethnic group (Figure VI.2). New enrollments among White students fell by 50% over the last decade, which accounts for most of the decline in total enrollments (See Section V-Students). That pattern in White students fits general demographic trends across colleges in the Northeast, and Fitchburg State in particular. In contrast, Black students exhibited a dramatic drop only since 2020. Meanwhile, the number of new Hispanic majors has shown no consistent trend. It is striking that the total of incoming, Non-white students has exceeded the number of incoming White students for most of the last decade (see counts in Table VI.1). And in both 2022 and 2023, new Hispanic majors outnumbered new Black majors (Figure VI.2).

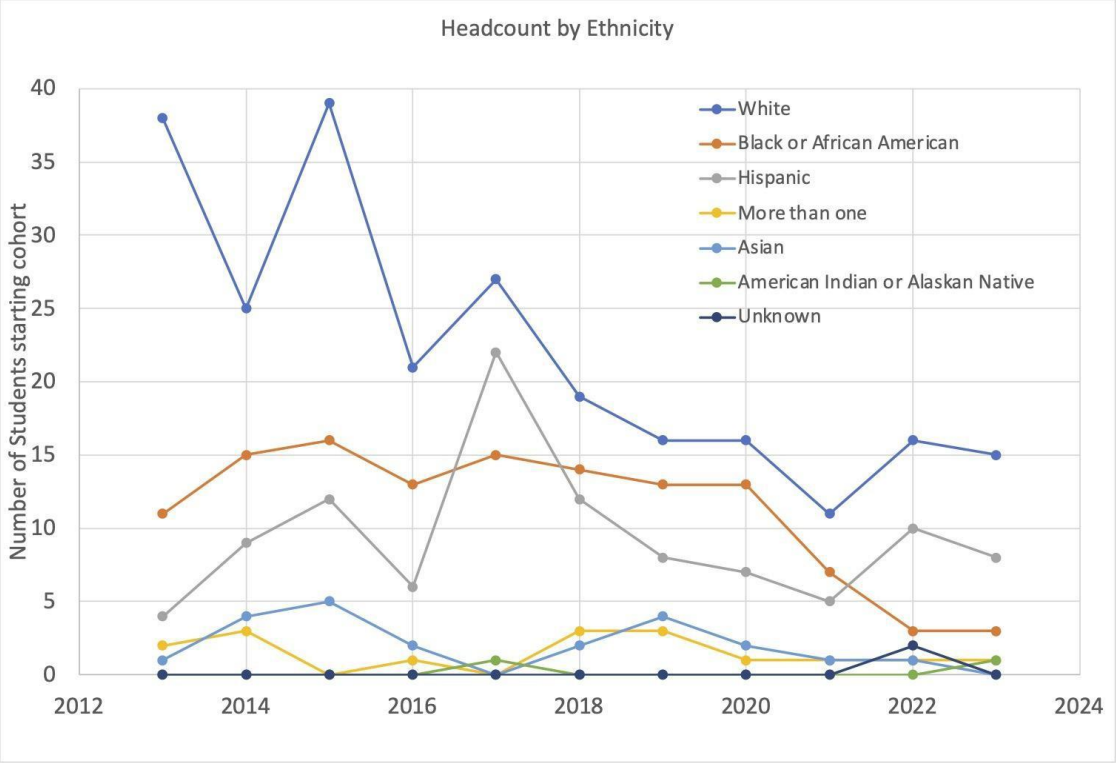


Figure VI.2. Headcount is the number of newly enrolled, full-time students each fall semester. Transfer students are not included, nor those who switch into Biology from another major.

Second, attracting students to enroll in the Biology major is only one metric: We also assessed retention and graduation rates by ethnicity (Figures VI.3-5)[1]. Because some years contain a small number of new majors in any particular ethnic group, we pooled the data by years to create larger sample sizes (Table VI.1).

Table VI.1. Pooled enrollment data of newly enrolled students. To calculate retention rates from ethnic groups, a few years were pooled in order to examine larger sample sizes. Notice that 2020-2021 and 2022-2023 include two-year pools, while prior pools included three-four years at a time. The separation of 2020-2021 was to assess impacts during the pandemic.

	Headcount (First time, full time)			
Ethnicity	2013–2015	2016-2019	2020-2021	2022-2023
White	102	83	27	31
Total Non-white	82	119	37	30
Black or African American	42	55	20	6
Hispanic	25	48	12	18
Asian	10	8	3	1
Misc (>1, Native, or Unknown)	5	8	2	5
Total	**184**	**202**	**64**	**61**

Retention data show both positive and negative trends for our Department (Figures VI-3-4).
On the positive side:

- Retention rates among Black students tend to be higher than among White students. (An exception is the most recent cohort from 2023-23, but that only included 6 Black students).
- The proportion of White and Black students who remain in the Biology major increased 10-20% since the time of our last self study (2017). This brings % retention in those two groups back up to levels seen in 2013-2015.
- All ethnicities increased as % retained in the Biology major in the last cohort (i.e., students starting in 2022 and 2023). Meanwhile, across Fitchburg State as a whole, retention in their major declined by 5% over the last 3 years compared to the prior decade (FSU Dashboard data is available here). This pattern provides some evidence that the recent equity initiatives described below may have had some effect.

[1] Full demographic data used for Figures VI.2-5 can be found in this Excel file, also in the folder of Assessment data. To view the graphs it is best to download the file and open it in Excel.

- Black and White Biology majors were retained at Fitchburg State during the height of the Covid-19 pandemic (2020-2021 cohort) at a higher rate than at other time periods during this self-study. This outcome could reflect the extra effort our department made to reach out to our students at such a difficult time.

On the negative side in Figures VI. 3-4:

- Hispanic students have had lower retention rates than other ethnic groups since 2016
- Hispanic retention declined over 20% in the last decade, both as % remaining at FSU, and as % retained in the Biology major.
- There was a significant decrease in retention in the 2016-2019 cohort across all ethnicities. The Department should explore what might have driven that decline, especially among minority students. Black and White retention in the Biology major have both recovered from that drop, but Hispanic retention has not. While the department has made a significant effort to improve the success of minority students as a whole (see below), the data in this Self Study present newly revealed patterns that we should discuss in the future.
- This is of particular concern given our new President's commitment to having Fitchburg State become a Hispinic Serving Institution

This is one of our most important action items to discuss as a department.

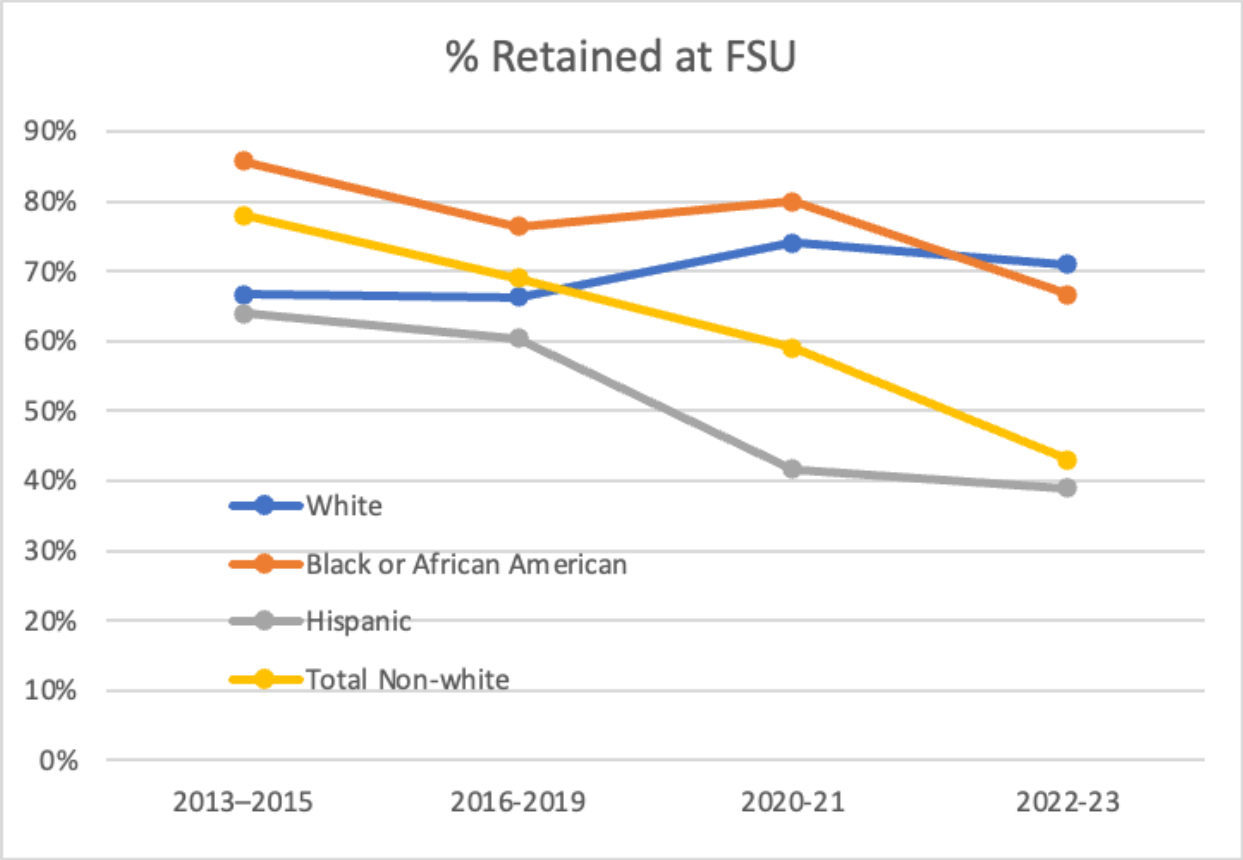


Figure VI-3. Percent retention rates in freshman Biology majors who stayed at Fitchburg State **in any major**, measured from their starting fall semester to the following fall semester. Transfer students are not included. Years are aggregated to provide a larger sample size for ethnic groups with few students (See Table X). For example, there were only 6 Black students in the 2022-23 group, while all other points assessed much larger sample sizes. "Total non-White" includes Black, Hispanic, Asian and any miscellaneous groups with few students.

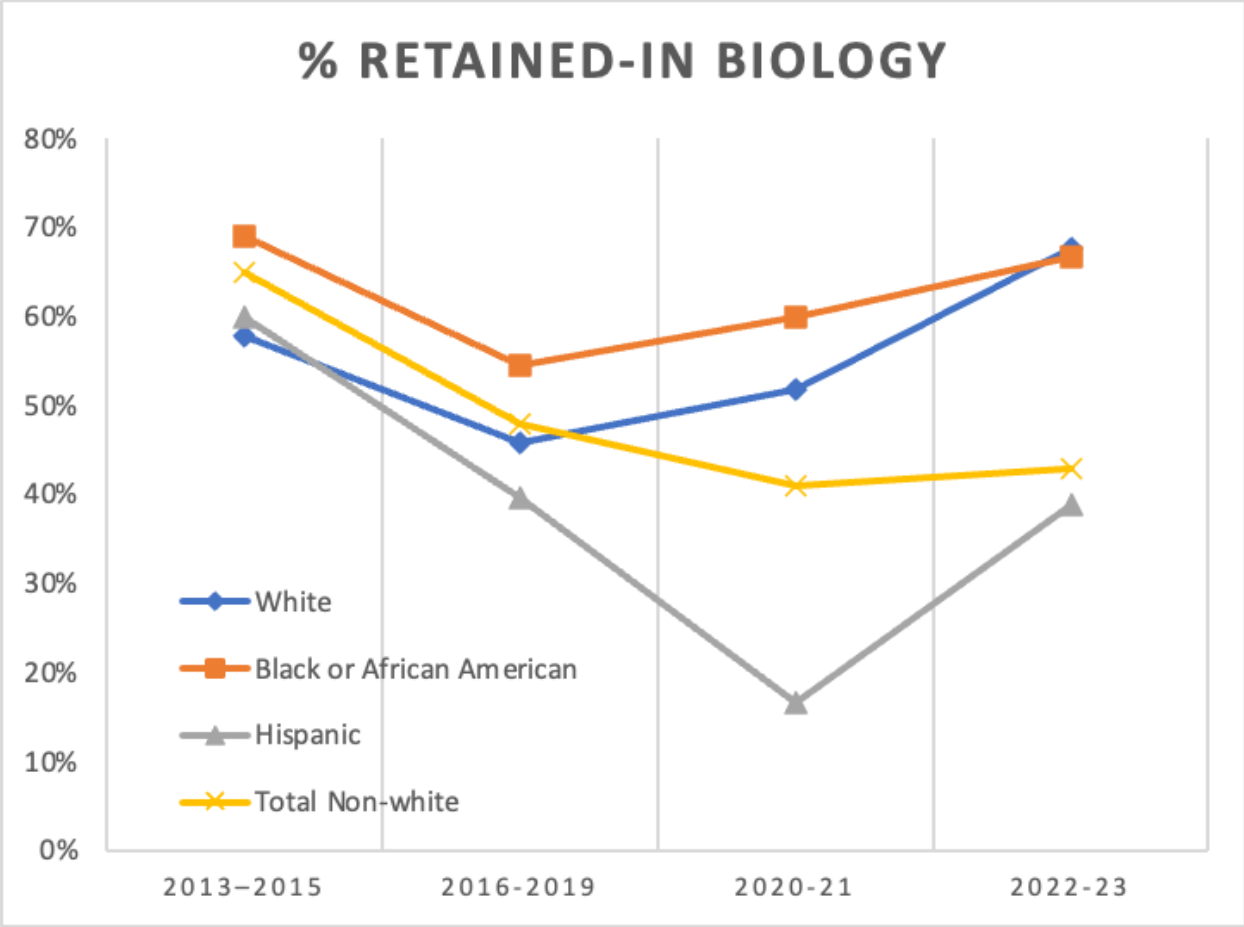


Figure VI-4. Percent of incoming majors who were retained in the Biology major in their second year. See the caption to Figure VI-3 for background. There were only 12 Hispanic students in the 2020-21 cohort, so that extreme drop may be an artifact of smaller sample size compared to other cohorts.

There was no consistent pattern of higher or lower retention rates within the major as a function of gender (Figure VI-5).

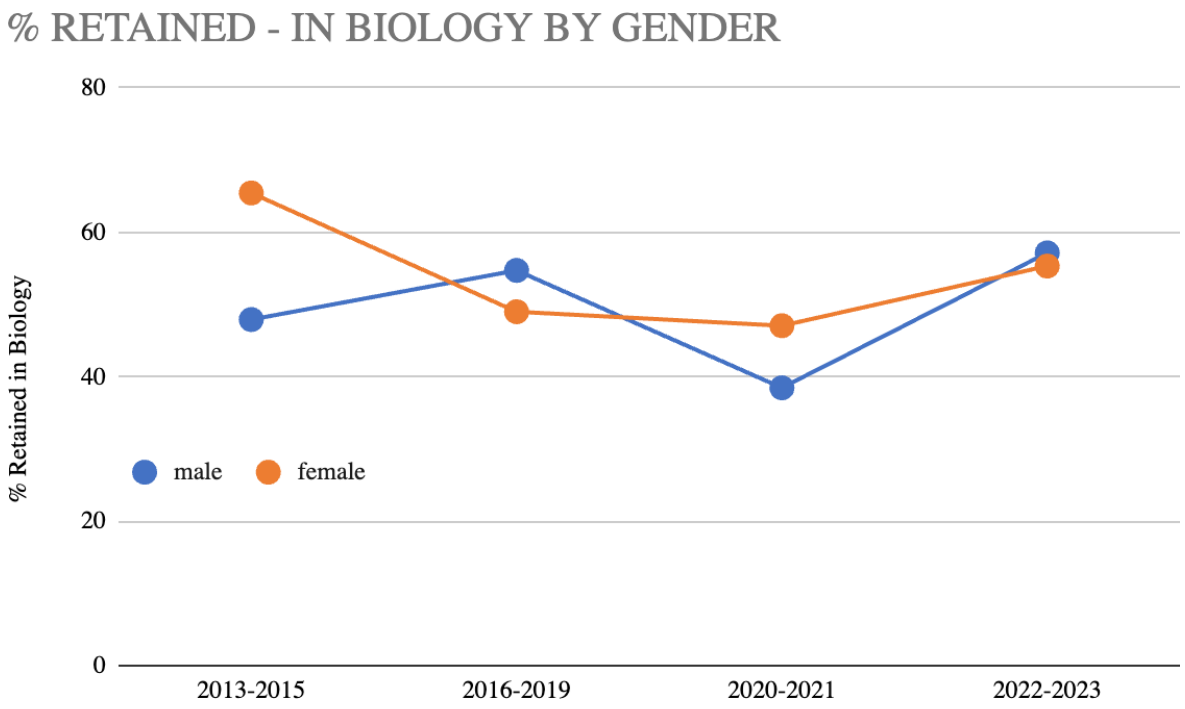


Figure VI-5. Percent of incoming majors who were retained in the Biology major in their second year as a function of gender. See the caption to Figure VI-3 for background.

Graduation rates are based on a 6-year span of following a cohort, so data are only available through the students who started in 2018 (Figure VI.5). With that caveat in mind, an important trend is that graduation rates declined across all ethnic groups. That decline is to be expected given the significant decrease in retention in the Biology major for the 2016-2018 cohort (Figure VI.4). Therefore, we expect that current and future 6-year graduation rates will benefit from recent increases in Biology major retention rates, at least across White and Black students. Second, we might expect some decrease in the 2016-2018 graduation rates because this cohort would be most impacted by the COVID-19 pandemic.

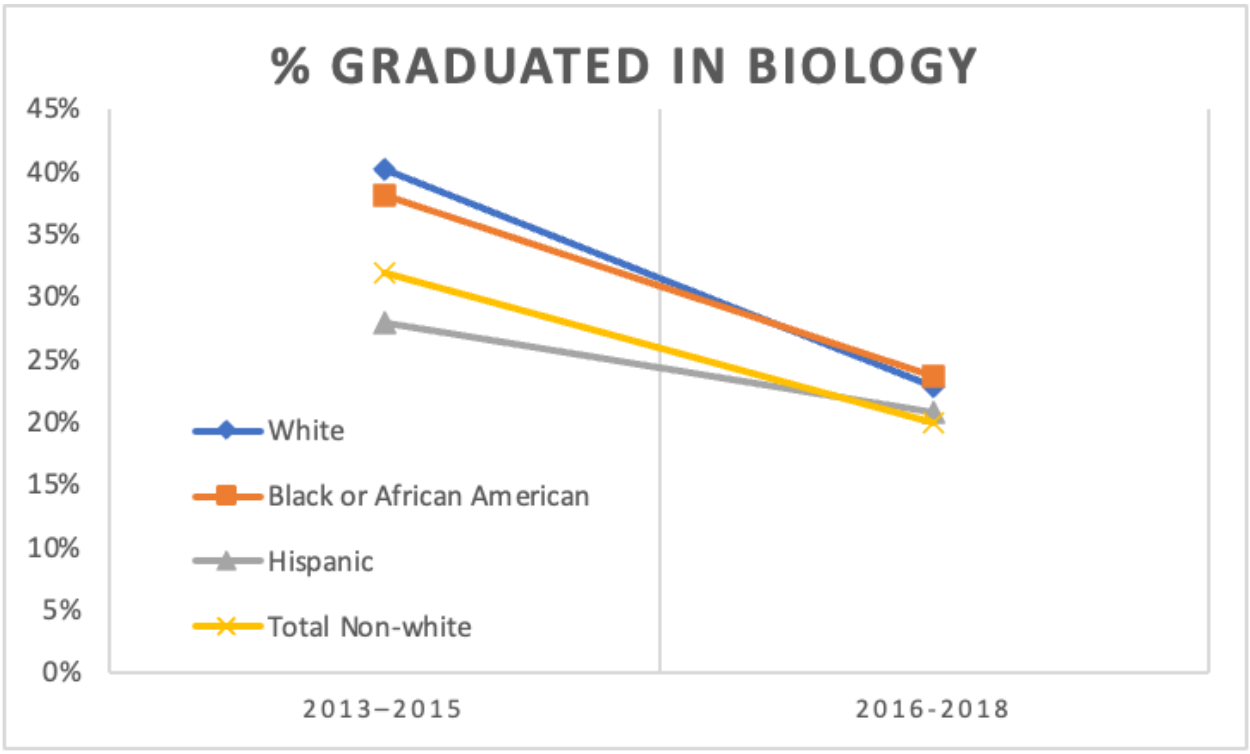


Figure VI-6. Percent of Biology majors from each starting cohort who graduated **in the major** within 6 years. See the caption to Figure VI-3 for background.

While the drop in graduation rates was relatively consistent across ethnic groups, the drop in graduation rates was exclusively a function of a drop in graduation rates for female students. From 2013-2015 to 2016-2018 male graduation rates remained very stable (Figure VI-7)

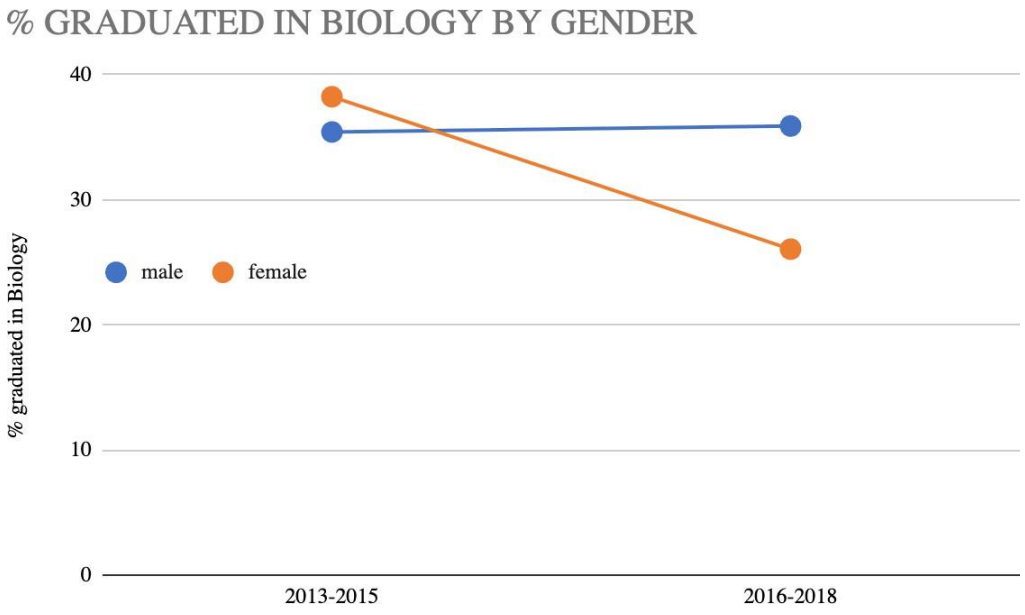


Figure VI-7. Percent of male and female Biology majors from each starting cohort who graduated **in the major** within 6 years. See the caption to Figure VI-3 for background.

Part 2: Addressing Equity Gaps

The data above show that the department has room to improve retention and graduation rates, especially among Hispanic students as well as graduation rates in particular among female students. Faculty in our department continually reflect on ways to make our teaching more effective and inclusive, and whether the Biology major presents barriers to equity. This section begins with analysis of one of our policies that could be a barrier to some students. Then this section presents results from surveys of student satisfaction, followed by a summary of strategies we have implemented to improve equity.

2.0 policy equity analysis[2]

Beginning in the fall of 2014, the department enacted a 2.0 policy for introductory courses in the major. Biology majors must earn a grade of 2.0 or higher in BIOL 1800 General Biology I and CHEM 1300 General Chemistry I in order to continue in the major and may only repeat each course once. This policy was motivated by data showing that students with poor performance in the introductory courses did not succeed in subsequent courses. In order to see if this policy was equitable, we investigated how the policy affected different student demographic groups.

For CHEM 1300, 88% of students took the course only once and 12% took the course twice. Black or African American students were over-represented in repeating the course (25% of single takers vs 48% of repeaters, Figure VI.8). Hispanics were underrepresented in repeating the course (23% single takers vs 15% of repeaters. Females were over-represented in repeating the course (68% of single takers vs 82% of repeaters). There were similar patterns for Biol 1800. Analysis of course withdrawal rates showed that Black or African American and Females were also over-represented in withdrawals (data not shown).

The department has considered whether students might benefit from reducing the 2.0 threshold down to 1.7. That change would be consistent with the transfer policy, in that anyone who earns at least 1.7 at another school can transfer in the same courses for which we require 2.0. However, our analysis suggests that such a change would be unlikely to address equity concerns because relatively few students would be affected. Lowering the threshold from 2.0 to 1.7 would have benefited only 4 of 263 students in BIOL 1800, or only 11 of 269 students in CHEM 1300. (Some ethnic groups had very small sample sizes that precluded interpretation of trends.) Furthermore, the retention data in Figures VI-3-4 show that Hispanic students seem to have more barriers to remain in Biology compared to Black students, while Black students face more barriers from the 2.0 rule. So the 2.0 policy does not seem to be exacerbating inequity.

[2] Full datasheet on the 2.0 outcomes is available with this link, and in the folder with Assessment data.

Composition of CHEM 1300 General Chemistry I and BIOL 1800 General Biology I for Fall 2018 to Spring 2024. Data provided to us combined White and Hispanic students together as "White" in the first rows of data. We could only assess Hispanic data with a separate analysis of "Hispanic" vs "non-Hispanic" counts that were provided to us.

	CHEM 1300			BIOL 1800	
Took course at least once	**269**	**% all takers**		**263**	**% all takers**
American Indian or Alaskan Native	1	0%		1	0%
Asian	10	4%		13	4%
Black or African American	74	28%		82	31%
Native Hawaiian or Pacific Islander	1	0%		1	0%
White	167	62%		150	58%
Unknown	16	6%		16	6%
Hispanic	60	22%		57	22%
non-Hispanic	208	77%		205	78%
Female	187	70%		193	73%
Male	82	30%		70	27%

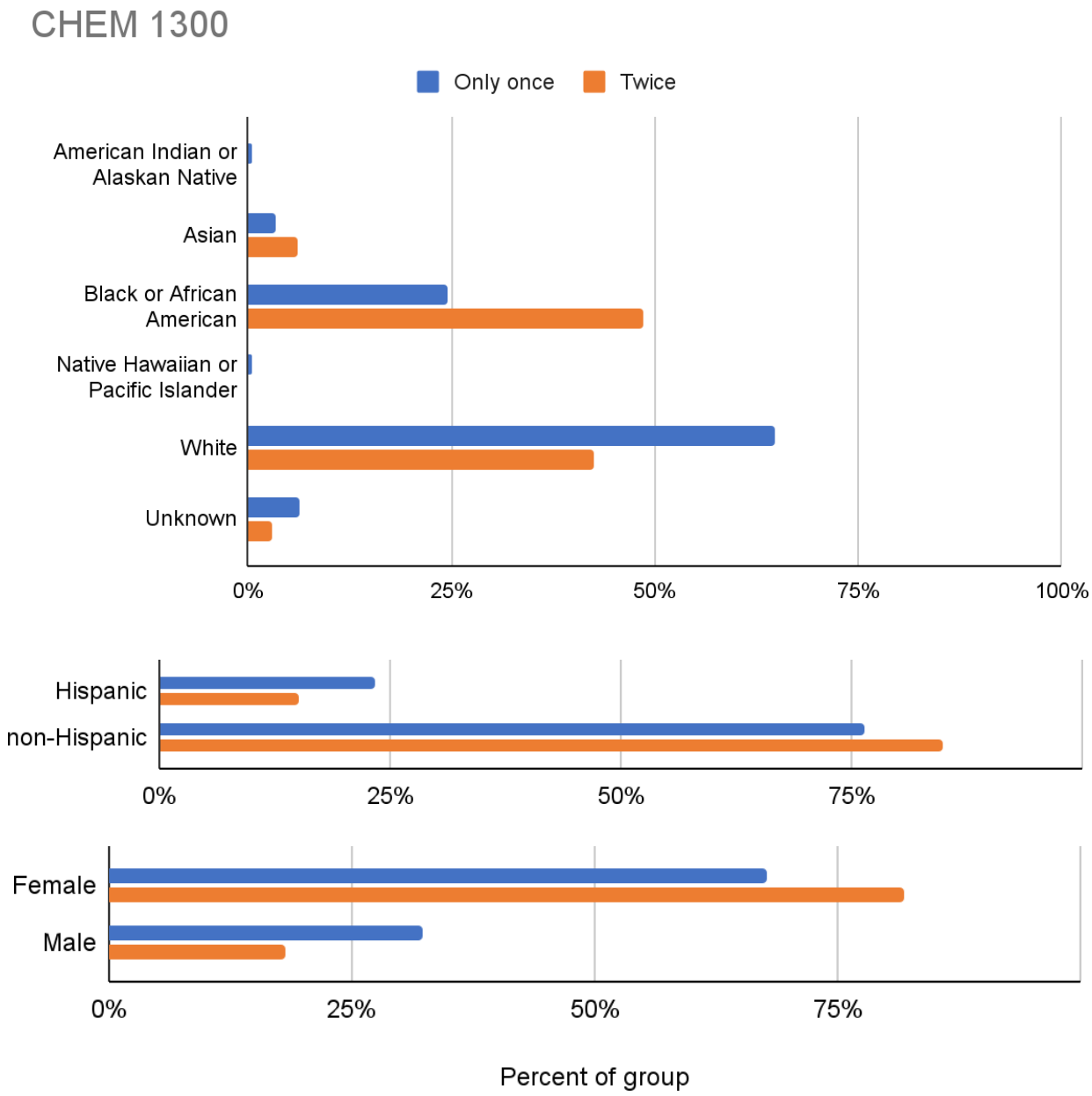


Figure VI.8 Percent of students taking CHEM 1300 General Chemistry I only once or twice by demographic group. Ethnic groupings, Hispanic/non-Hispanic, and gender each considered separately for percentages. Complete ethnic grouping names given in Table VI.1

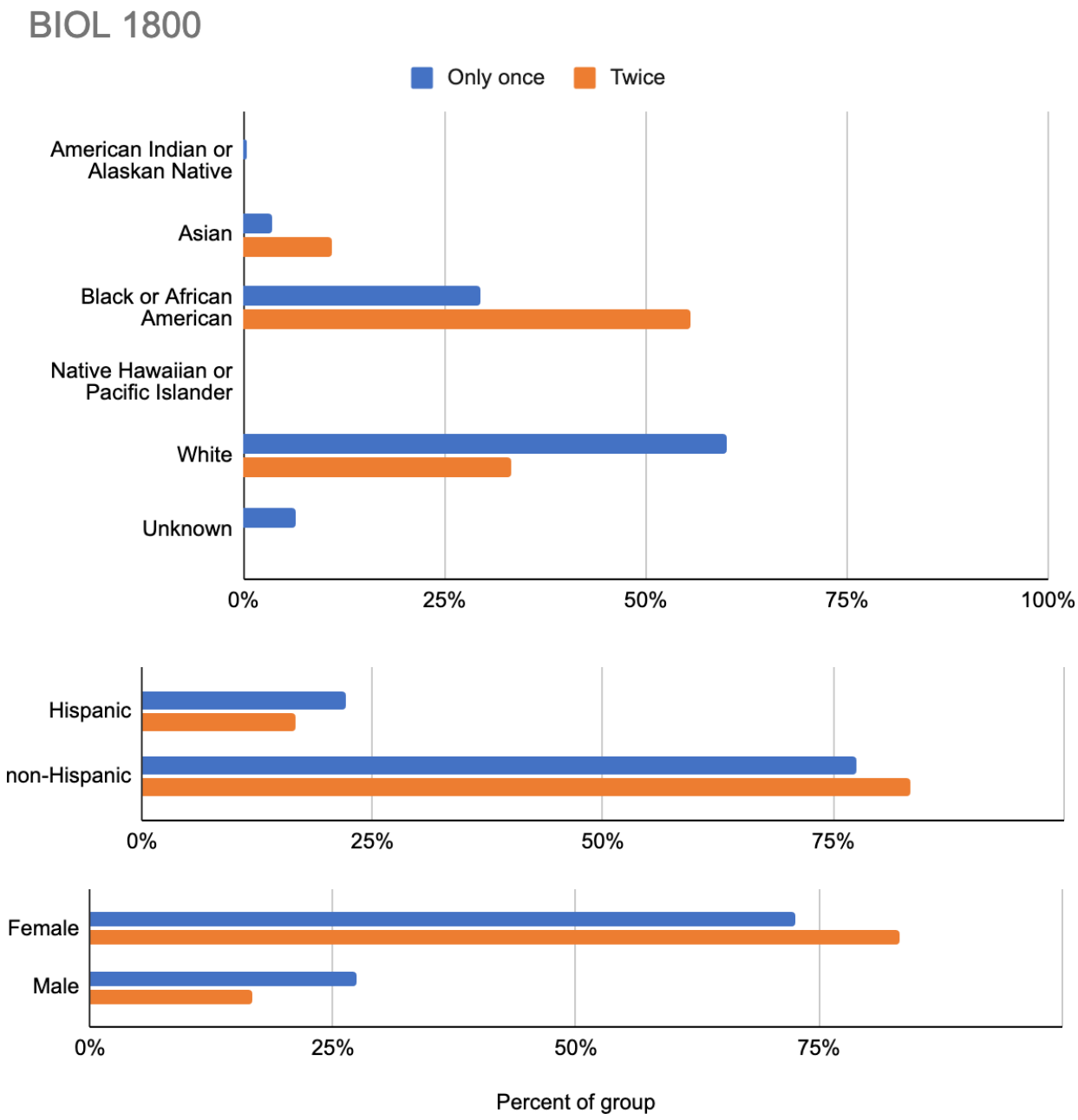
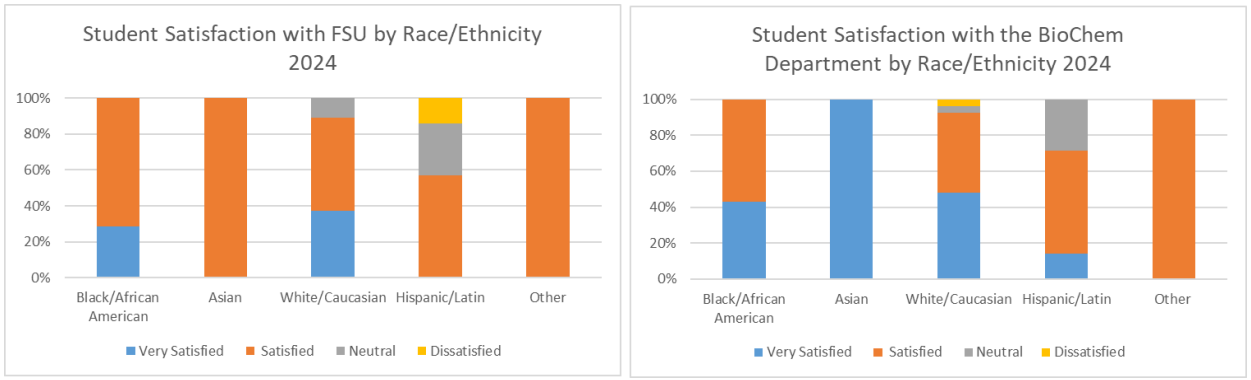


Figure VI.9 Percent of students taking BIOL 1800 General Biology only once or twice by demographic group. Ethnic groupings, Hispanic/non-Hispanic, and gender each considered separately for percentages. Complete ethnic grouping names given in Table VI.1

Survey Data on Student Satisfaction

As already mentioned in the Student Section (Section V) of this self study, the Student Affairs Committee solicits feedback from biology and chemistry majors using an online survey composed of both multiple choice and open response questions. A copy of this can be found at the end of this section. Overall student satisfaction with the department and with Fitchburg State was collected from surveys performed in 2019 and 2024 and is described in the Student Section. In order to compare student satisfaction among different races, we disaggregated the student satisfaction survey data from 2019 and 2024 by race, and the data is shown in Figure VI.10.

2024



2019

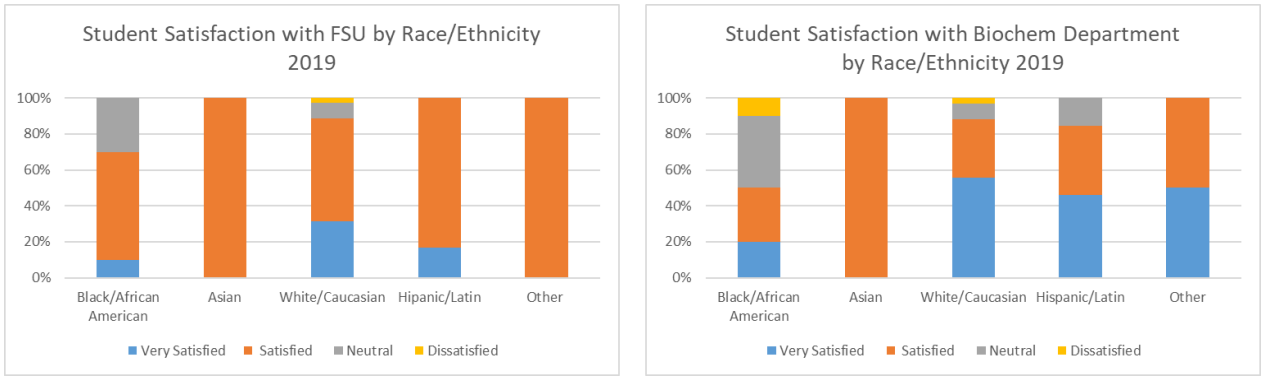


Figure VI.10. Overall satisfaction of biology and chemistry majors of different race/ethnicities with the Department of Biology and Chemistry and Fitchburg State University.

In 2019, a lower percentage of our Black students felt satisfied (very satisfied and satisfied) with the department compared with the University, 50% vs. 70% respectively. Lower satisfaction was also recorded for our Hispanic students, 82% v. 100% respectively. The data in 2024 suggest that we have made improvements with these two student populations. In 2024, 100% of our Black students reported feeling satisfied (very satisfied and satisfied) with the department and with the University. There was a 50% increase in satisfaction with our department compared to 2019. In addition, we observed an

increase in Black students who were very satisfied with our department compared to the University, 41% and 28% respectively. In contrast, both the department and University saw a decrease in satisfaction with Hispanic students in 2024. The decrease for the department was 12% and the decrease for the University was 42%. Although the decrease was smaller for our department compared to the University, work by both is required to improve these numbers. Our department and its **Inclusive Excellence Group** have gathered data to identify barriers experienced by our underrepresented minority and first generation college students. These data have been critical to initiating discussions within the department on changes in curriculum, policy, and culture that are needed to reduce or remove these barriers. The improvement in satisfaction with our department among Black students in 2024 compared to 2019 may in part be a reflection of our efforts to reduce or remove barriers.

In both 2019 and 2024, 100% of Asian students in our department reported feeling satisfied with the department and the University. In 2024, 100% of Asian students feel very satisfied with the department compared to 100% feeling satisfied (as opposed to very satisfied) with the University. This result highlights an improvement in satisfaction among Asian students (from satisfied to very satisfied) with our department from 2019 to 2024. For our White majors, there was no significant difference in satisfaction (very satisfied and satisfied) with the department and University in both 2019 and 2024. In all cases, satisfaction was around 90%. Of interest, a greater percentage of White students reported being very satisfied with the department compared to the University in both 2019 and 2024.

Figure VI.11 below shows data from the 2019 and 2024 surveys disaggregated by gender. In both years there were more female than male respondents. (41 female and 19 male in 2019, 30 female, 13 male, and 2 transgender or non-binary in 2024.) In 2019 a higher percentage of men were very satisfied with the department compared to women, 58% vs. 37%. In 2024 that difference had largely leveled out, with 40% of women being very satisfied with the department vs. 38% of men. The overall satisfaction with the department was high across genders, as stated above. It is worth noting that both transgender and non-binary students who responded to the survey in 2024 were very satisfied with the department.

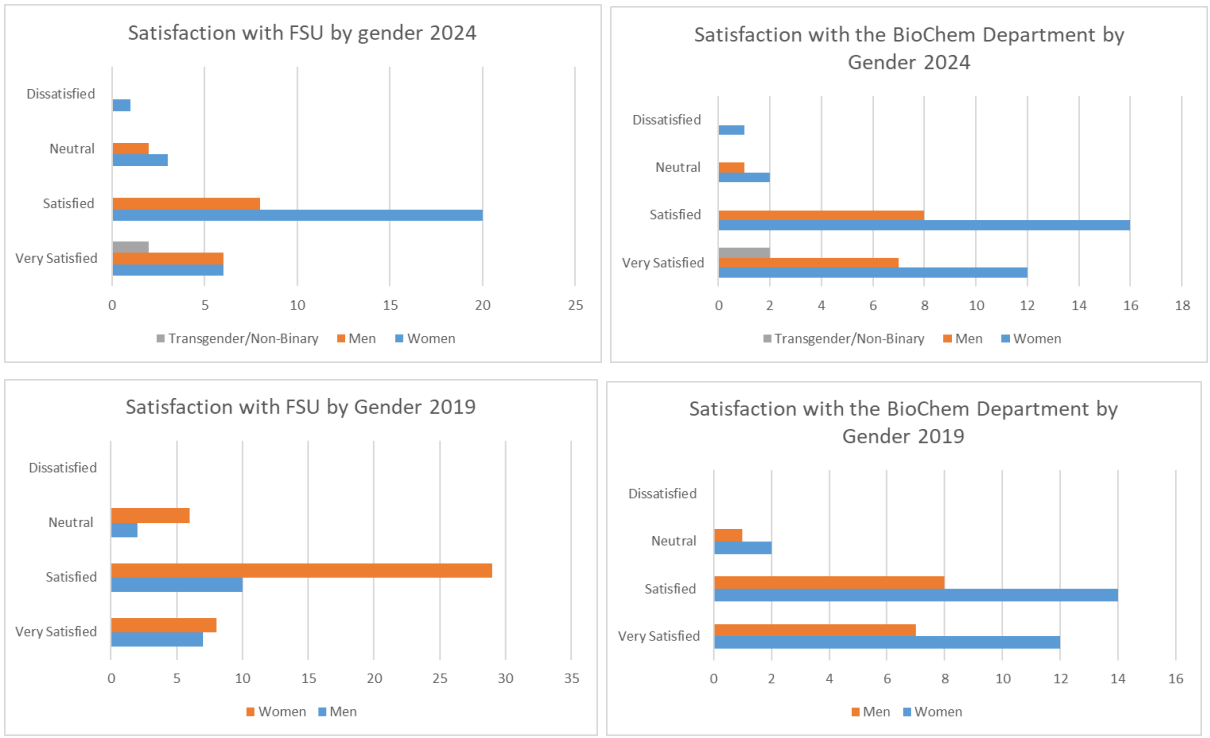


Figure VI.11: Overall satisfaction of Biology and Chemistry majors of different gender identities with Fitchburg State University and the Biology and Chemistry Department.

Part 3: Creating a More Equitable Environment and Teaching Practices

For over a decade, the Biology and Chemistry Department has recognized the need to to better understand and support our minority students. Here we summarize some of our efforts over the self study period.

Howard Hughes Medical Institute "Inclusive Excellence" 3 (HHMI IE3) pre-proposal:
Beginning in May of 2019, The department became involved in a group interested in obtaining funding from the HHMI IE3 initiative. The HHMI IE3 initiative was offering $1 million grants to colleges and universities to increase under-represented minority (URM) students' persistence in STEM by driving institutional change. In our first meetings, we discussed what campus initiatives this could support. We have seen a change in demographics in our student population at Fitchburg State, and this is more pronounced in the Biology and Chemistry department (Figure VI.1). Our proposal was not about changing students, but instead focused on the faculty, administration and staff that needed to change to be more inclusive and have all students feel like they were valued. The main priority of this proposal was to bring down barriers to inclusion and success that were being created by our department and the University. We formed an "Inclusive Excellence Group" that originally included members mostly from our department along with faculty from education and math. We then worked to design, write and edit the pre-proposal. We then had the larger HHMI group give their input on the draft and also had a consultant read and comment on the pre-proposal. We submitted the pre-proposal in January 2020. The review process was put on hold due to COVID. The original plan of HHMI was to have a first round of reviews and invite those that made it to the second round to an in-person workshop in the summer to revise and improve their proposals. We received word from HHMI in October 2020 that we did not receive the funding. This notification did include general feedback with information about what they were looking for in a strong proposal and what was missing in weaker proposals. In December we received word from HHMI that our proposal did make it to the second round of consideration and received more specific comments from reviewers but was not chosen to be funded in that round.

Inclusive Excellence Group: Dean's Anti-Racism Fund:
To move ahead with inclusive excellence training we wrote a proposal to the Dean's Antiracism Fund to start a book reading group and fund an honorarium for a seminar speaker. We invited the first speaker, Dr. Bryan Dewsbury (Professor, Biology) from University of Rhode Island who gave a talk "Equity practices in the STEM classroom" via Google meet on 4-6-2021. We also organized and began our first reading group for the book "Successful STEM Mentoring Initiatives for Underrepresented Students, A research-based guide for faculty and administrators" by Becky Wai-Ling Packard. The seminar and book reading group lead to interesting discussions among our group.

Inclusive Excellence Group: Student Working Group to identify barriers to success:
The goal of the Inclusive Excellence (IE) Group has been to identify and remove barriers to success for our students. If this is our goal, why not ask the students about their perceived barriers? In order to initiate a student-centered approach to uncovering barriers, Dean Hoey reached out to Dr. Cardelle, and

the IE group met with Jason Smith to discuss developing a student-led project. In AY 20-21, we worked with Jason Smith and Morgan Hakala in Student Success, put together a job posting, and we were successful in hiring four students to develop a project that would collect feedback from their peers in Biology and Chemistry classes about their perceived barriers at the institutional, departmental, and classroom levels. We decided that having student leaders working directly with Biology or Chemistry faculty may affect their willingness to be honest or specific. Therefore, the four student leaders held biweekly sessions with Morgan Hakala in the Academic Coaching Office to develop a set of guiding questions that would reveal barriers encountered by students who identified as minority students and/or first-generation college students. Once the guiding questions were created, volunteer biology and chemistry students met in focus group sessions with the four student leaders. The student leaders initiated and supervised conversations using the set of guiding questions they had created. Because the sessions were led by peers and not faculty, the conversations were frank and wide-ranging. The anonymous conversations were captured using an online transcription program and were facilitated by Morgan Hakala. This data was then presented to the entire department and discussed at an end of semester retreat. Our process and reporting of our equity initiatives have become a model for other departments and were highlighted as points of excellence in the University's NECHE review (our accreditation agency).

The transcripts revealed several barriers, and each barrier was put into the following categories or "buckets": academic, advising and academic policies, campus life, and emotional/personal/financial. Some of the specific barriers revealed were the following: instructors are prioritizing content over learning (academic), office hour format for seeking extra help is intimidating (academic), dreams are being crushed too early (advising and academic policies), too little time spent on career development (advising and academic policies), exclusion from peers is occurring (campus life), there is limited access to health care (emotional/financial/personal, and there is a lack of respect for emotional-based accommodations (emotional/financial/personal). Some of the barriers are not within the power of our department to resolve, but the barriers within the academic and advising buckets can be addressed within our department. The department has created a list of action items that we hope will lower some of the barriers that our students are encountering, thereby improving student success and retention of our minority and first generation students.

Inclusive Excellence Group: Balfour Foundation Proposal:

We decided to explore other mechanisms to fund the Inclusive Excellence work. A group at Fitchburg State had successfully received funds from the Balfour Foundation to support a summer research initiative. From the foundation webpage: (https://www.bankofamerica.com/philanthropic/foundation/?fnId=31) "The Foundation's educational funding is generally focused on organizations or programs that provide support for underserved or under-represented populations to prepare for, access and succeed in higher education, including 2-year and 4-year institutions." We thought our goals for an Inclusive Excellence training initiative fit this description well. We again formed a writing group, mostly from our HHMI group, to work on this project. We found an organization that we could partner with for this training initiative, The Anti-Racism Collaborative in Boston. They met with us and we described the program we were envisioning. They

provided a proposed plan and cost. We then wrote the grant to the Balfour Foundation for $285,000 to fund a 3-year program. This would begin with an assessment and student partnership to look for barriers to inclusion and success at institutional, departmental and classroom levels. From this we would work with the Anti-Racism Collaborative to develop a train-the-trainer initiative beginning with STEM and then use this model to drive institutional change. The grant proposal was submitted on June 1, 2021. Unfortunately we received notice that this was not funded.

Moderna Research Scholars Program

From 2023-2024, several faculty successfully applied to the Moderna Charitable Foundation to create a new Research Scholars Program. The focus was to involve students in original research, or course, but to target student groups who often showed lower rates of retention in the sciences. Students were paid a financial stipend to participate in the program, which was designed to reduce the financial burden that these populations often face. Faculty reached out to recruit students who had potential for success despite moderate grades, and/or students who were the first generation in college, and/or under-represented minorities. The grant provided one year of funding and supported two cohorts of "Research Scholars." Each cohort conducted independent, original research under the guidance of a faculty member (Eric Williams, Aisling O'Connor, Dennis Awasabisah, Erin Rehrig, and Sean Rollins). Students presented their research at monthly meetings to infuse a sense of community among the participants. In addition, students also presented at the Fitchburg State Undergraduate Research Conference and the UMass Undergraduate Research Conference at the end of the Spring 2024 semester. They were also highlighted at our 2024 Life Science Networking Event, giving them the opportunity to discuss their research with potential future employers. Preliminary analysis suggests an increase in cumulative GPA of ~0.5 GPA units for the students who participated. This increase in cumulative GPA persisted into subsequent semesters after the program was completed. We are currently in the process of reapplying to the Moderna Charitable for additional funding to continue the program.

The Faculty Academy: Because we desire to become more inclusive instructors, five faculty in Biology and Chemistry participated in the Faculty Academy (Ron Krieser, Chris Picone, Billy Samulak, Emma Downs, and Chris Cratsley). The goal of the Academy is to make courses more relevant and engaging to students, and to use "real talk", a pedagogical approach developed by the coordinator of the Faculty Academy, Dr. Paul Hernandez. Real talks are designed to break down barriers between students and faculty, and to create a sense of belonging for everyone in the classroom. The Academy also helps faculty to develop "alternative assignments" that are meant to promote student engagement, often based on information learned from the real talks. For three years as members of the Academy, faculty attend summer sessions and monthly meetings, develop and share "real talks" and alternative assignments with their cohorts, and then use them in their courses.

FYE training: The First Year Experience Seminar (FYE) has been a part of the general education curriculum at Fitchburg State Since 2021. This retention initiative aims to ease the transition from high school to college for all students, but first generation students in particular can benefit from this course as they might not be as aware of college culture and the "hidden curriculum". The FYE seminar prepares students for a successful college career and the world of work. The course develops students' habits of

mind, reading, and information literacy skills in a small-class setting. Almost all first-year students are required to pass an FYE course in order to graduate. (Students in the Honors Program are exempt from this requirement.)

Because the content of the FYE seminar is very different from the discipline specific material faculty are used to teaching, FYE instructors undergo extensive training before teaching the course. This training includes a summer institute and a Community of Practice, and is highly focused on reading, using a framework called Reading Apprenticeship. The Biology and Chemistry department offers the most sections of FYE of any department on campus, and a significant number of faculty in the department have taught the course and thus undergone the Reading Apprenticeship training (Erin Rehrig, Billy Samulak, John Ludlam, Ron Krieser, Emma Downs, and Chris Cratsley). This continues to benefit students beyond their first year. While the training is extremely helpful and necessary for teaching FYE, instructors have found they also use some of the reading techniques in their upper-level classes, particularly when introducing the primary scientific literature.

E: Supporting Documents: Biology & Chemistry Student Satisfaction Survey

Biology/Chemistry 2022 Student Survey

1. The Department of Biology/Chemistry at Fitchburg State University is seeking your thoughts and opinions about the department and the university. This survey will allow you to give us valuable feedback and help the department to improve upon our mission of providing a quality educaConal experience for all of our students. ALL Biology and Chemistry majors are welcome to complete this survey. This survey should only take about 12-15 minutes of your Cme. Your answers will be kept anonymous. Please provide your honest feedback. All students compleCng the survey BY FRIDAY, MARCH 25th will be entered into a drawing to win one of two $25 Amazon giT card (you will be asked to provide an e-mail address at the end of the survey so that we may contact the winner). You may only complete this survey ONCE and it must be completed in one siZng (there is no way to save it and come back to it). Thank you, again, for your Cme and though[ul input. We really appreciate it!!
    - I have read this.

2. To which gender idenCty do you most idenCfy?
    - Male
    - Female
    - Transgender Male
    - Transgender Female
    - Non-binary/non-conforming
    - Prefer not to respond

3. What is your current Year/Grade?
    - Freshman (0-1 year here)
    - Sophomore (1-2 years here)
    - Junior (2-3 years here)
    - Senior (3-4 years here)
    - "Super Senior" (>4 years here)

4. Describe your student status
    - Commuter
    - On-campus resident

5. Major/concentraCon
    - Biology
    - Biology/Biotechnology
    - Biology/Environmental Biology
    - Biology/Health Sciences
    - Biology/Neuroscience and Behavior
    - Biology/Secondary EducaCon
    - Chemistry
    - Chemistry/Biochemistry
    - Chemistry/Secondary EducaCon

6. Which category describes you? (select all that apply)
   - Caucasian/Non-Hispanic
   - Hispanic/LaCn
   - African American
   - Asian
   - NaCve American
   - NaCve Hawaiian or Pacific Islander
   - Other

7. Are you a first-generaCon college student (an individual whose parents, aunts/uncles, or grandparents did not graduate from a four-year college/university)?
   - Yes, I am a first-generaCon college student
   - No, I am not a first-generaCon college student

8. In an AVERAGE week, approximately how many hours do you work at job(s) outside of being a student (regardless of whether that job is on campus or off campus)?
   - 0-5
   - 6-10
   - 11-15
   - 16-20
   - 21-25
   - 26-30
   - 31-35
   - 36-40
   - 41+

9. Which of the following best describes how you started your college career?
   - I started as a Biology/Chemistry major HERE at Fitchburg State University
   - I started as a different major HERE at Fitchburg State University and changed majors
   - I started as a Biology/Chemistry (or similar) major at a DIFFERENT college and transferred to Fitchburg State University
   - I started as a different major (outside of Biology/Chemistry) at a DIFFERENT college, and then transferred to Fitchburg State University and changed majors, too.

10. Which factor was the MOST important in choosing to anend Fitchburg State University?
    - The academics of the university (had the major/minor you wanted, etc.)
    - The reputaCon of the university
    - The closeness of the university to home and/or work
    - The cost of anending the university
    - Other, please specify

11. The reputaCon of the Biology/Chemistry department was an important factor in my choosing this major

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

12. The approachability of the faculty in the Biology/Chemistry department was an important factor in my choosing this major

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

13. The science equipment and building were an important factor in my choosing this major

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

14. For Biology and Chemistry courses, what is your preferred course format?

- Fully in-person
- Hybrid (mix of in-person and online)
- Fully ASYNC (work is completed without class meeCngs)
- Fully ONSYNC (meet online at specific Cmes each week)

15. Why did you choose this preferred format? (select all that apply)

- This is the most convenient for me
- This is how I learn best

16. The department is considering offering more online Biology and/or Chemistry elecCves in the future. If we were to do that, what is the frequency you would prefer?

- At least one per semester
- At least one per year
- Only in the summer
- Only sporadically/occasionally
- Only as a last resort

17. What do you like about the Biology/Chemistry department? Do you consider there to be anything unique about the Biology/Chemistry major at Fitchburg State University? When answering this quesCon, please do not idenCfy any specific faculty or staff members.

18. Are there ways for the Biology/Chemistry department to improve? If so, please explain. When answering this quesCon, please do not idenCfy any specific faculty or staff members.

19. Can you describe the common obstacles you or your peers encounter when trying to complete a Biology/Chemistry degree?

20. Based on your experiences and/or what you know from your peers, which of the following are important factors that explain why students leave the Biology/Chemistry major? (Select all that apply)

- The CURRICULUM makes it difficult to finish a degree in four years
- Students are UNHAPPY with the teaching in the department
- FAMILY/PERSONAL ISSUES interfere with compleCng a degree
- A lack of MONEY for college prevents students from compleCng a degree
- Students realize that a science degree is no longer their career goal

21. What can you suggest the Biology & Chemistry department do to help students overcome the obstacles you idenCfied?

22. How saCsfied are you with your overall experience at Fitchburg State University so far?

- Very SaCsfied
- SaCsfied
- Neither SaCsfied nor DissaCsfied
- DissaCsfied
- Very DissaCsfied

23. How saCsfied are you with your overall experience with the Biology & Chemistry department so far?

- Very SaCsfied
- SaCsfied
- Neither SaCsfied nor DissaCsfied
- DissaCsfied
- Very DissaCsfied

24. If you have any other comments that you would like to share to help us bener understand what moCvates students to pursue a Biology/Chemistry degree, the challenges that students face while pursuing their degree, or ways that the department and university can bener assist students, please enter them here. (OPTIONAL)

VII. Resources and Facilities

A. Technology

Describe technology and equipment needed to support the program and its delivery.

Special equipment and facilities are needed to support the teaching of students in the Biology and Chemistry department. To achieve this we have well-equipped facilities and teaching spaces in our Science Center. The Antonucci Science Center has a laboratory wing (the Irving Wing) with 8 Biology teaching labs and 3 Chemistry teaching labs. It also houses an herbarium, an animal facility, a walk-in cold room, a microscope suite, two cell-culture facilities, several equipment and prep rooms, as well as several faculty/student research labs for faculty research and student research projects. The science building meets all OSHA guidelines and fulfills the requirements of the American with Disabilities Act, therefore all labs and research spaces are accessible to all students.

The Science Center has a second wing (in the renovated Condike Science Building) that houses 4 classrooms, all faculty offices, six laboratories for the Environmental, Geographic, and Public Health Sciences department, a computer lab, a mud room, several faculty/student research rooms, a conference room and several small meeting rooms and study spaces, a faculty/staff lunchroom, and two supply rooms with printers and faculty mailboxes. The impact of the Science Complex on the ability of the Department to carry out its mission is incalculable. Its effects are far-reaching, impacting faculty and students alike. Increased technology in the lecture and lab classrooms has enhanced teaching and learning opportunities. In addition, the new equipment has provided increased opportunities for students to conduct research with faculty members. Lastly, students can frequently be seen utilizing the lounge spaces as study areas and to interact with their peers and several faculty offices have small "common areas" outside of their office. All of this creates a more collaborative and welcoming atmosphere for all the occupants of the building.

The equipment in the Science center is well-maintained and up to date. This includes several fluorescence microscopes, electrophoresis apparati, gel imaging equipment, PCR and real-time PCR equipment, a DNA sequencer, cell counting apparati and a flow cytometer
Photosynthetic Meter, Ethylene Analyzer, Quantum Light Meter and Leaf Area Meter, which are located in our plant laboratory. We have a dedicated greenhouse facility with a growth chamber, a range of growth lamps and automated irrigation systems. Our cell culture, genetics and molecular biology labs are equipped with a vast array of equipment including high speed centrifuge, bioreactors, electrophoresis apparati, gel imaging equipment, PCR and Real-time PCR equipment, a DNA sequencer, cell counting apparati, a flow cytometer and several fluorescence microscopes.

We have a dedicated vivarium that has three holding rooms for vertebrate animals, including an aquatics room and a rodent room with ventilated caging, plus a cage washing room with automated cage washer and a procedure room with ventilated biosafety cabinet, isoflurane anesthesia system, and physiology

monitoring equipment for use during rodent surgery. Modified biosafety cabinets are available in the facility for protecting animal caretakers when handling animals and collecting waste bedding.

The anatomy and physiology labs are equipped with a ventilated storage cabinet for storing preserved specimen for dissection and numerous models and skeletons for displaying both human and infrahuman vertebrate anatomy. Also, six physiology recording workstations are available for use in teaching and research in A&P, animal physiology, and neuroscience, with specialized amplifiers for neurophysiology and a gas analyzer for small organism respirometry. The department is well appointed in terms of field equipment such as a backpack fish electroshocker and a wide-range of research-grade meters for accessing water quality e.g. Salinity Meter, pH Probe, Turbidity Meter and Dissolved Oxygen Meter. The complete list of equipment can be found here.
https://docs.google.com/spreadsheets/d/16CMorPYxA4EMlRDN4K5R14JGlmkboEt5JVRevm71mhs/edit?gid=0#gid=0

The computer access needs of students, faculty and students are continually being met. Fitchburg State University's Department of Information Technology has continued to be aggressive in introducing and supporting new technologies such as Google Meet and related suite, Hoonuit Learning (on-line technology training), Zoom Web Conferencing, and SelectSurvey. Technology has become a very important resource for us, especially during the COVID-19 lockdowns. We were provided Wacom tablets to make annotations on presentations and specialized microphones and recording devices to help with online instruction. In order to meet some course goals of providing students with practical knowledge, we had to be creative. During this period several faculty adopted a variety of virtual lab resources such as Beyond Labz, and other simulation programs. We were fortunate to receive supplemental funds from the university to purchase licences for the virtual resources. In addition, the IT department has employed an Instructional Technologist, Allison Bunnel, who provides regular training sessions for faculty and students on various technologies. She has been an invaluable resource person especially in the last two years when many of our classes were moved online due to the COVID-19 pandemic.

All faculty members are provided with a new laptop or tablet every 3 years. Students in the department now have increased access to laptops for class use as the department has 4 carts containing 8 – 10 laptops each. There is support for emergency-type problems that occur in the classroom. Faculty can call the IT helpdesk if they have a classroom emergency and a member of the IT staff will immediately come to the classroom to provide assistance. Recently, we acquired a Dell PowerEdge T560 computational workstation with 48 core, 125 GB of memory and 125 TB of disk space through the Massachusetts Life Science Center (MLSC) that will provide the data science needs of our programs. We also purchased 12 new laptops through the MLSC grant. The list of equipment purchased since the last self-study are listed below.

Equipment	Area	Users/Classes
DNA tissue DNA kits Cells	Molecular Biology Reagents	BIOL 4009, BIOL 4903, BIOL 3650, BIOL 4500
DNA tissue DNA kits Tissue/blood	Molecular Biology Reagents	BIOL 3550, BIOL 4903
RNA Easy Prep Kits (with DNase)	Molecular Biology Reagents	BIOL 3550, BIOL 4903
RNALater	Molecular Biology Reagents	BIOL 3550, BIOL 4903
QIAGEN Plasmid Plus Midi Kit (25)	Molecular Biology Reagents	BIOL 3550, BIOL 4903
Qiagen Spin Miniprep Kit (250)	Molecular Biology Reagents	BIOL 3550, BIOL 4903
PCR Cloning Kit	Molecular Biology Reagents	BIOL 3550, BIOL 4903
SYBR Green RT-PCR Master Mix	Molecular Biology Reagents	BIOL 3550, BIOL 4903
1KB DNA Ladder plus dye	Molecular Biology Reagents	BIOL 3550, BIOL 4903
Invitrogen™ SuperScript™ First-Strand Synthesis System for RT-PCR	Molecular Biology Reagents	BIOL 4009, BIOL 4903, BIOL 3650, BIOL 4500
Dream Taq PCR MasterMix	Molecular Biology Reagents	BIOL 3550, BIOL 4903
Flow Cytometer	Cell Culture	
EVOS 5000 Fluorescence system	Cell Culture	
Fluorescent Cell Counter (Red/Green)	Cell Culture	BIOL 3550, BIOL 3650, BIOL 4500, BIOL 4903
Thermo Scientific™ 15 and 50ml centrifuge	Cell Culture	
ZEISS Primovert Cell Culture Microscopes	Cell Culture	BIOL 3550, BIOL 3650, BIOL 4500, BIOL 4903
Lab Armor Beads (for dry water baths)	Cell Culture	
Liquid nitrogen tank Thermo Scientific™ Locator™ Plus Rack and Box Systems	Cell Culture	

Electronic Pipet Controller	Cell Culture	
Fisherbrand™ Nutating Mixers - Variable Speed	Cell Culture	
-80 chest freezer with CO2 backup system	Cell Culture	
Fluorescent Chemidoc	Analytical and Biochemistry	BIOL/CHEM 3060
HPLC, 1260 Infinity II LC System	Analytical and Biochemistry	CHEM 2400, BIOL/CHEM 3060, CHEM 4900
Fluorometer	Analytical and Biochemistry	
Pipetman (100-1000ul)	Analytical and Biochemistry	
Pipetman (Fixed, 1,000 uL)	Analytical and Biochemistry	BIOL 4500, BIOL 4903
Pipetman (500 - 5000 uL)	Analytical and Biochemistry	BIOL 4500, BIOL 4903
Invitrogen Protein Gel Electrophoresis Apparatus with Western blot (XCell SureLock MiniCell)	Analytical and Biochemistry	BIOL/CHEM 3060
Fisherbrand™ Electrophoresis Power Supplies	Analytical and BIochemistry	
Glovebox (Labstar Pro) with fridge	Analytical and BIochemistry	CHEM 2100, CHEM 2000, CHEM 4900, CHEM 1600
Thermo Scientific™ MaxQ™ 6000 Incubated/Refrigerated Stackable Shaker Packages	Analytical and BIochemistry	
Mettler Toledo™ ML-T Analytical Balances	Analytical and BIochemistry	
Fisherbrand™ Isotemp™ Digital Dry Baths/Block Heaters	Analytical and BIochemistry	
iSeq 100 Sequencing System	Data Science	BIOL 4009
Illumina RNA Prep kit	Data Science	
Nextera XT DNA Library Prep Kit	Data Science	

Computational Server	Data Science	BIOL 4009
Laptop computers with 2TB hard drive	Data Science	BIOL 1900, 2300, 4009, 4600, BIOL 1800
Freezer -25C	Molecular Biology	
Gilson™ PIPETMAN™ G p10, p20, p200, p1000	Molecular Biology	
Minione Gel electrophoresis machine	Molecular Biology	
Minione PCR machines	Molecular Biology	
Relative Humidity Unit	Molecular Biology	
Large Countertop Microwave	Molecular Biology	
Benchmark C2417 MC-24 High Speed Microcentrifuge w/ COMBI-Rotor	Molecular Biology	
Benchmark H2200-H MyTemp Mini Digital Incubator	Molecular Biology	
GC-MS Spectrometer*	Analytical	CHEM 2400, CHEM 2100, CHEM 2000, CHEM 4900, CHEM 1600
EFT-60 NMR Wideband Probe upgrade*	Analytical	CHEM 2400, CHEM 2100, CHEM 2000, CHEM 4900, CHEM 1600

B. Library

Describe how the Library supports the program mission and attainment of objectives.

Fitchburg State's Amelia V. Gallucci-Cirio Library offers access to over 145,000 online journals in 200 databases. Specifically, for the Biology major and classes, the focus is more on academic journals and monographs (books). The library has several core full-text journal databases for the Biology major/classes; Biological Abstracts/BIOSIS, Biological Science Collection, BioMed Central, Biomedical Reference Collection: Basic, GreenFILE, JSTOR Life Sciences, MEDLINE, ProQuest Science Database, PubMed Central, Science (Gale Interactive) and Science in Context. Database and journal subscriptions are reviewed periodically and cancelled if underutilized. This allows for subscriptions to new titles even with a flat library budget. In addition, the library has 5,572 print books with call numbers associated with Biology and access to over 3,700 videos aligned with Biology via Kanopy.

Faculty and students are able to utilize their robust InterLibrary Loan Services. The library also offers in-person biology instruction sessions, and more recently, embedded biology courses. They offer a one-to-one research service for students and faculty. An online chat service is available 24/7 for students to receive research assistance. The library now offers both traditional print and digital course reserves which are well utilized by students. The full library analysis is presented in the appendix at the end of this section.

C. Budgetary and Personnel Support

Describe budgetary and personnel support needed to deliver the program.

The operating budgets of our department are administered through the Department Chair. In addition to the operating budgets, the University supports the administrative costs of the Department. These items include administrative support, departmental technicians, office supplies, postage, phone usage, faculty computers and technical support, duplicating costs, and faculty salaries. A breakdown of the department's budgets since the last self study is shown in the tables below. Overall, we have had a level funded operating budget over the last five years. Faculty travel funds are allocated per faculty member from the University and have remained around $400 per year per full-time member as stipulated in the MSCA Contract; faculty must apply for these funds. We note that due to travel restrictions in FY-21, no funds were made available for travel. The Department has always maintained a policy of assigning funds according to need thereby covering the majority of costs when faculty travel. If travel requests exceed available funding, priority is given to junior faculty or to those faculty who are presenting at meetings. Faculty also have an annual professional development stipend that may be used for travel.

The department receives additional funding through the Strategic Funding Requests or EBRQ. These University-wide funds are made available for one-time expenses that focus on items that are necessary in order to maintain our academic programs and support services. The Department's Equipment and Facilities Committee solicits input from the faculty and compiles a list of equipment needs based upon curricular needs that are driven by the Department's mission. The request is submitted to the University during the normal budget process.

In AY 2022/2023, our immediate past dean, Dr. Jennifer Hanselman supported our 2017 proposal for funding to increase retention and success rates in chemistry courses by hiring and training embedded tutors into our courses. Our proposal was funded, which allowed us to pay student embedded tutors. In Spring 2023, we engaged in a pilot program that provided embedded tutors for two of our service courses, Anatomy and Physiology and Chemistry for Health Sciences. The program was subsequently expanded to include General Chemistry I, and Organic Chemistry. The program has served as a model for other departments, with precalculus, Calculus, Physics, Business Statistics, and a number of Nursing courses being added to the list of courses that provided embedded tutoring services. As part of the grant, Dr. Daniel Welsh was given a course release to help administer the program and to serve as mentor for the embedded tutors.

Approved Budget for Biology

Biology	FY-25	FY-24	FY-23	FY-22	FY-21	FY-20	FY-19	FY-18
Travel Budget	$3531	$3804	$3528	$2189	$0	$4,940	$5,200	$5,200
Operating Budget	$90,708	$90,708	$90,708	$90,459	$90,459[a]	$91,214	$98,610	$103,610
Strategic Funds/ EBRQ[b]	$18,250	$32,969	$79,196	$61,012	$6,000	$6,100	$22,315	$5,834

[a]Originally awarded $91,214, but was reduced mid-year by Finance.

[b]EBRQ funds are for both Biology and Chemistry programs.

Approved Budget for Chemistry

Chemistry	FY-25	FY-24	FY-23	FY-22	FY-21	FY-20	FY-19	FY-18
Travel Budget	$1926	$1902	$1764	$1194	$0	$2,660	$2,800	$2,800
Operating Budget	$37,041	$37,041	$37,041	$37,041	$37,041[a]	$39,275	$42,275	$42,175
Strategic Funds/ EBRQ[b]								$1,500

*Originally awarded $39,275, but was reduced mid-year by Finance

The Biology/Chemistry department has three full-time support staff and one part-time that assist in the daily operation of the department. Our administrative assistant, Lindsey Babineau is a full time employee, but also serves the Biology/Chemistry & Environmental, Geographic and Public Health Sciences Departments. The duties of the department administrative assistant include providing administrative support to all members of both departments, organizing schedules, coordinating meetings, assigning advisees, monitoring and processing department budgets, evaluations, scheduled appointments and other duties as assigned by the chairs. The administrative assistant's duties also include assisting students with concerns such as registrations, add/drop processes and assisting advisors

and students with academic forms. The Administrative Assistant also works with the Graduate and Continuing Education evening, summer, intersession, fall, and spring scheduling.

Melissa Legare is our 12-month lab technician in biology. Until recently (Fall 2021), there was one 10-month technician (Karen Kowlzan) in chemistry and (Ian Murray) who split his time between Biology/Chemistry and the Environmental, Geographic and Public Health Sciences Departments. Since 2014, Ian also worked with the university's Environmental Safety office while he served as the half-time chemistry technician. He was recently reassigned by the Dean of Health and Natural Sciences to the Nursing Department to support their Simulation (SIM) Center. We are looking to hire another person to replace Ian that can serve as summer support for Chemistry and also overlap with Karen before she retires in fall of 2025. We have requested that Karen's replacement be hired before she leaves so that she can provide training and support, however, that type of overlap is unprecedented. Currently, Karen currently serves as the only technician for chemistry.

Support staff for the Biology/Chemistry Department.

Staff	Title	Status
Lindsey Babineau	Administrative Assistant (12 month shared with the Environmental, Geographic and Public Health Sciences Department	Current
Karen Kowlzan	Lab Technician (10 month)	Current. Retires in Sept. 2025
Melissa Legare	Lab Technician (12 month)	Current
Ian Murray	Lab Technician (~10%) until Fall 2021. Assists with chemical waste pickup	Reassigned to the Nursing Department in 2021.

The duties of the lab technicians include setting up labs, checking safety equipment, stocking lab supplies, ordering chemicals, inventorying, and arranging for yearly maintenance of lab equipment. Our technicians have collaborated together and provided first-class lab support for both chemistry and biology programs. Melissa Legare, who is the only full-time Biology technician, has similar duties as those of the chemistry technicians. Her major duties are related to the biology part of our department. The contributions of the three technicians extend beyond their roles in the department. They are all engaged in university wide committees. For example, Karen and Ian have been active members of the University's Safety Community. Melissa Legare also contributes significantly to the University's Institutional Biosafety Committee (IBC). Our talented support staff significantly contributed to our program and they played significant roles during the COVID-19 pandemic. They assisted faculty in creative ways that far exceeded expectations and have continued to deliver fantastic services post COVID-19 pandemic. Together they help provide safe working conditions both in the labs and in the classrooms.

After several years of providing lab support services to the chemistry program and beyond, our full-time chemistry technician, Karen will be retiring in Fall 2025. The role of the chemistry lab technician is very critical for our chemistry program. Karen has been playing a vital role in ordering and stocking lab supplies, maintaining chemical inventories, upkeep of laboratory equipment and managing annual maintenance and servicing needs, and maintenance of safety equipment. Overall, the technician ensures our labs are safe working environments. They do this by maintaining and enforcing health and safety regulations. We cannot safely hold any teaching labs or faculty-student research collaboratives without an in-house lab technician. In addition, Karen has consistently assisted our chemistry faculty members in successfully carrying out science outreach activities and olympiad practical exams for professional organizations like the American Chemical Society. Consequently we will need to hire another technician to replace Karen so we can continue to offer classes to our students. Having provided us with advanced notice, we hope to be able to do a search and hire Karen's replacement so that there will not be interruptions in lab services in chemistry. We recommend that the new hire's start time overlaps with Karen's tenure so they can get trained to ensure a smooth transition. We are working with our new Dean of the School of Health and Natural Science, Dr. Jannette McMenamy on the details.

To ensure a safe working environment and a safe campus community as a whole, a University-wide Biosafety Policy and an Exposure Control Plan was written. The policy, which was supported by our past dean, Dr. Meg Hoey was written to ensure that the materials and equipment used for research are biosafety levels 1 or 2 certified. The University-wide Biosafety committee was established and its role was to ensure that the policy is enforced. Additionally, the University IACUC committee of both staff, faculty and a licensed veterinarian provide guidance for our animal care facility. Established safety procedures are now routinely followed and faculty receive yearly training on topics such as chemical safety and blood-borne pathogens. We also have a fully effective Chemical Hygiene Plan, an online chemical inventory system, and a full-time Environmental Safety Officer.

D. Supporting Documents- List of Library Resources for Biology

FITCHBURG STATE UNIVERSITY
AMELIA V. GALLUCCI-CIRIO LIBRARY

To: Biology Faculty
CC: Erin Rehrig, Chair
Jannette McMenamy, Dean of Health & Natural Sciences
From: Jacalyn Kremer, Dean of Amelia V. Gallucci-Cirio Library
Lori Steckervetz, Outreach Librarian for Student Success
Date: November 20, 2024
Re: **DRAFT** Library resources and services to support the program review of the Biology program

The New England Commission on Higher Education's Standard 7.22 calls for "access to Library and information resources, services, facilities, and qualified staff sufficient to support its teaching and learning environments and its research and public service mission as appropriate." The purpose of this report is to outline the current Amelia V. Gallucci-Cirio Library's resources, services and facilities that support the undergraduate in-person and remote programs in Biology at Fitchburg State University. The material presented in this report will be discussed in a December, 10, 2024 meeting with the Biology faculty. Specific items we hope to discuss include:

- Partnering to develop Biology students' information literacy skills
- Increase participation in the Library's course materials reserve service, especially the digital controlled lending service which provides digital access to course texts.
- Exploring opportunities to support the creation and use of Open Educational Resources within Biology courses
- Identifying opportunities to increase Biology focused scholarly resources, such as monographs and journals, and their usage

The last full library analysis for the Biology program came in AY17.

ABOUT Biology at Fitchburg State University

Undergraduate Students with (first) major as Biology enrolled in Fall 2023	**140**

An analysis of the Library support needed for the Biology undergraduate major as well as undergraduates taking Biology courses as non-majors is classified into three categories: resources, services and facilities.

RESOURCES for Biology

Researchers in Biology generally focus on the use of academic journals and monographs (books).

Journals and Databases

The Library collection development policy has been, and continues to be, to provide the core journals and databases appropriate for each discipline. Reviews of databases and journals are consulted, peer comparisons are conducted, and faculty input on the effectiveness of the resource is critical when considering new databases. The Library budget is relatively flat. Funds for new databases and/or journals come from reallocation of funds from canceled journals and databases with low usage.

The Amelia V. Gallucci-Cirio Library offers access to over 145,000 online journals in over 200 databases. Specifically, for the Biology major and classes, we have the following core databases:

1. Biological Abstracts/BIOSIS
2. Biological Science Collection
3. BioMed Central
4. Biomedical Reference Collection: Basic
5. GreenFILE
6. JSTOR Life Sciences
7. MEDLINE
8. ProQuest Science Database
9. PubMed Central
10. Science (Gale Interactive)
11. Science in Context

Biology related journal titles in the following sub-categories may be viewed online by subject using the Library's "Journal Locator" tool (items in parenthesis are # of journals):

- Bioengineering (95)
- Biomedical Engineering (132)
- Animal Biochemistry (131)
- Biology – General (402)
- Biophysics (103)
- Cytology (115)
- Economic Biology (1)
- Evolution (40)
- Genetics (174)
- Microbiology & Immunology (258)
- Microscopy (19)
- Biochemistry (34)
- Botany (339)
- Human Anatomy & Physiology (558)
- Zoology (551)

See Library Table 1: Full-text Journal Databases by Disciplines related to Biology**.** Usage statistics show the overall usage numbers are good.

The librarians conduct an annual review of journal subscriptions examining data on both print and online journals to which the Library directly subscribes (outside of the journals available through the databases). The annual cost per usage is determined by dividing the annual cost for the journal title by the number of times the journal was used in a year. Criteria have been established and applied that allowed the Library to cancel journals that are not being effectively used.

This journal review process allows the Library to increase journal offerings in needed areas as determined by interlibrary loan data, as well as to purchase large, multi-disciplinary eBook collections and new databases. More information about the new eBook collection is below.

Since the previous program review we have canceled 1 database and 2 journals that were not being utilized:

- BioOne Database (canceled in AY22)
- JOVE Database (canceled in AY23)
- Annual Review of Plant Biology (canceled in AY23)
- Journal of Heredity (canceled in AY23)

Books

A review of our print collection in the Library of Congress call number ranges specifically associated with Biology shows 5,752 **print** books in our collection. See Library Table 2: Monograph Collection Description and Analysis.

In order to better meet the needs of both undergraduate, graduate, and faculty researchers, the Library sought to expand the available eBooks in our collection with eBook packages that include Biology books. Effective in AY19, the Library subscribed to both the EBSCO Academic Complete eBook package and JSTOR EBA and DDA eBook collections. In AY21 we subscribed to the ProQuest eBook Central DDA Collection utilizing a demand driven acquisition model. Through these 4 eBook packages we have added approximately 9,132 titles in Biology and related areas (1,902 of these titles were published in the last 5 years and 2,187 were published in the last 10 years). This increases the number of books associated with Biology in total to **14,884** books while providing on and off-campus access. This number of books is considered appropriate to support undergraduate level research and course work in Biology.

Films and other Media

In 2018, the Library purchased a subscription to the academic streaming film database Kanopy. Over 3,700 videos are available in AY24 with subjects aligned with Biology (this does include some

duplicates). See Library Table 3: Films and Other Media Collection for a breakdown by category.

SERVICES for Biology

Technology

Starting in Fall 2020, the Library offers a robust Technology Lending Library to ensure that all students, regardless of their financial means, are able to access the technology needed to do their course work, including digital cameras and podcasting equipment. The technology is available for checkout. Students also have access to a range of technology available in the Library building. We welcome a conversation about the addition of Biology-related technology.

Library Instruction

For all academic departments in AY24, faculty librarians taught 176 synchronous research sessions and were embedded into 51 courses. Through these efforts, we reached over 4,100 students during the last academic year. With only 7 faculty librarians on staff, 4 of whom conduct the majority of instruction, the number of classes with research sessions and/or an embedded librarian is impressive and requests continue to increase.

Since AY22, librarians have collaborated with Biology faculty members a total of 35 times to provide information/research literacy instruction as part of a Biology course. Librarians have taught Biology research sessions and were embedded in sections of the Biology's First Year Experience course and in a section of the Biology Senior Seminar.

Library Instruction	AY22	AY23	AY24
Total Embedded Courses	78	83	51
Embedded Biology Courses	0	6	2
Total In-person/Onsync Sessions	140	171	176
In-person Biology Sessions	7	11	9

See Library Table 4: Research Instruction for more information.

We welcome the opportunity to discuss how the Library can support your department's information literacy and research goals.

Library Research Guides

The Library offers 43 subject research guides plus 289 course specific guides, covering all disciplines at Fitchburg State. For Biology, librarians have created 1 subject research guide and 10 course specific research guides.

The usage statistics in the Biology research subject guide shows that the guide was accessed a total of 374 times in AY24. This is about 63% less than the usage the average subject guide receives (998 views/guide avg.). The Library's Biology Research Guide is available within the Blackboard course management system in all Biology courses.

The Library is interested in working with Biology faculty to increase course-specific use of specialized databases via our embedded research guides.

Research Help

The Library offers one-on-one research help services in a variety of modes, including drop-in help at the Research Help Desk, making a research appointment with a librarian, email, and the online, chat messaging service. During the academic year, Fitchburg State librarians provide over 50 hours of research help per week. In AY24, librarians answered 1,449 research questions.

Additionally, the Library provides access to a 24/7 online chat service, which allows students to receive research help 24 hours per day, 7 days per week. The aggregate trends in research help appear in Library Table 5: Research Help. Please note that data on the use of the research help services specifically by Biology are not available.

Course Reserves

The Library's Course Reserve system is well-used by the Fitchburg State community. The Library now offers traditional print, as well as online, digital course reserves through our controlled digital lending program. In AY24, Fitchburg State professors placed a total of 522 items (physical and digital) on reserve. Students checked out a total of 2,566 of reserve materials during the same period.

In Fall 2024, 14 Biology professors put a total of 40 physical and 3 digital items on reserve. We hope to discuss with the Biology faculty further opportunities to utilize the controlled digital lending program for digital reserves. In addition, the Library is currently exploring ways to increase access to materials by students, including the insertion of digital library resources into courses, and the adoption of Open Educational Resources, which would increase student access to no or low-cost textbooks and other course materials.

InterLibrary Loan Services Request

Interlibrary Loan data is not disaggregated by department or user type. In AY24, the University as a whole borrowed a total of 1,629 items (both physical and digital) through interlibrary loan. As mentioned above, this data is used to help determine acquisition decisions, such as subscribing to a new journal. In reviewing the most frequently requested journal and book titles, currently no

titles related to Biology were recommended to be purchased based on interlibrary loan requests.

FACILITIES for Biology

With the Library's recent renovation, students have access to welcoming spaces designed to support individual and group work, and is more than adequate to meet the needs of students, faculty and administration. Building information is in Library Table 7: Facilities

Library Table 1:

Full-text Journal Databases by Disciplines related to Biology

The full complement of databases supporting Biology can be found on the Library website (https://Library.fitchburgstate.edu/research/databases). Whereas there are 11 directly applicable full-text databases, another 8 full-text databases supplement this core collection. In addition, individual titles stretching across disciplines number in the thousands. Journals are either embedded within databases or are available through individual subscriptions, accessible through Serials Solutions.

Core Full-text Journal Databases
1. Biological Abstracts/BIOSIS 2. Biological Science Collection 3. BioMed Central 4. Biomedical Reference Collection: Basic 5. GreenFILE 6. JSTOR Life Sciences 7. MEDLINE 8. ProQuest Science Database 9. PubMed Central 10. Science (Gale Interactive) 11. Science in Context
Supplemental Full-text Journal Databases
1. CINAHL 2. Cochrane Collection Plus 3. Environmental Studies and Policy Collection 4. Health and Wellness (Gale) 5. Health and Medicine (Gale OneFile) 6. Health Source: Consumer Edition 7. Health Source: Nursing/Academic Edition 8. PsycINFO

Database	AY24 Usage	AY23 Usage	AY22 Usage
Biological Abstracts/BIOSIS	4716	3514	5590
Biomedical Reference Collection: Basic	4308	3456	5317
GreenFILE	4093	3347	4981
JSTOR Life Sciences	859	942	1540
MEDLINE	6524	8029	11251
ProQuest Science Database	2681	2601	4565

Notes:

Database usage data disaggregated by discipline does not exist, therefore it is not possible to determine how many articles were accessed only by Biology faculty and students. In total for the Fitchburg State community, over 124,000 articles were accessed through the Library's 203 databases in AY24.

- **Biological Science Collection** – Part of ProQuest Central - no statistics available
- **BioMed Central** - Open Access - no statistics available
- **JSTOR Life Sciences** – Item requests are used for usage, no search stats available.
- **PubMed Central** - free full-text archive of biomedical and life sciences journal literature at the U.S. National Institutes of Health's National Library of Medicine (NIH/NLM) - no statistics available
- **Science (Gale Interactive)** -No search stats available (only 2 years of item request data available)
- **Science in Context -** Usage is extremely low.

Library Table 2:

Biology Book Collection

		Electronic			Physical			
LC	**Subject Area**	**Published 2019-2024**	**Published 2014-2018**	**Published Prior to 2014**	**Published 2019-2024**	**Published 2014-2018**	**Published Prior to 2014**	**Total**
QD415-436	Biochemistry	19	20	15	0	0	6	60
QH201-278.5	Microscopy	9	18	30	0	0	16	73
QH301-705.5	Biology (General) – (Evolution, Genetics, Reproduction, Life, Ecology, Cytology, Economic Biology)	540	606	1476	32	76	1207	3937
QK	Botany	226	215	535	16	14	555	1561
QL	Zoology	555	567	1400	25	52	2049	4648
QM	Human Anatomy	41	64	82	1	4	73	265
QP	Physiology	350	511	1188	42	84	1182	3357
QR	Microbiology	162	186	317	6	33	279	983
Totals		**1902**	**2187**	**5043**	**122**	**263**	**5367**	**14884**
		9132			**5752**			

Library Table 3:

Film and Other Media Collection

# of Streaming Films by Subject in Kanopy Database	
Biology	487
Chemistry	268
Environmental Sciences	1162
Medicine	535
Science, Nature, and Technology	1305
Total (includes duplicates)	**3,757**

Library Table 4:

Research Instruction

	AY22	AY23	AY24
Total Instruction Sessions Conducted:	218	254	227
Biology Sessions Conducted:	7	17	11
Percentage:	3.2%	6.7%	4.8%
Total Embedded:	78	83	51
No. of Biology Embedded:	0	6	2
Total In-person/Onsync classes:	140	171	176
No. of Biology In-person/Onsync classes:	7	11	9

Note: The Library offers both discipline-specific and general information literacy instruction sessions.

Library Table 5:

Research Help

Library Research Guides

For Biology, we have created one subject research guide and ten course specific research guides. The usage statistics in the Biology research guides show that the subject guide was accessed a total of 374 times in AY24. Additionally, 10 course-specific research guides have been created for Biology courses (BIOL 1650, BIOL 2003, BIOL 2650, BIOL 3004, BIOL 3100, BIOL 4007, BIOL 4011, BIOL 4700, BIOL 9011, FYE 1015).

Reference Statistics

	AY20	AY21	AY22	AY23	AY24
Total Interactions	**2409**	**2534**	**3469**	**3338**	**3092**
Mode of Access					
In Person	1547	838	1989	2226	2061
Chat	416	1002	634	393	393
Phone/Email	420	455	395	285	254
Video Call	42	252	144	154	111
Library FAQ Tickets		26	25	15	20
Questions by Patron					
Student	2091	2286	2829	2729	2434
Faculty	165	147	140	118	119
Extended Campus/DL	169	129	152	91	139
Public/Alumni/Other	134	69	108	96	165
Staff	29	21	57	40	28
Duration					
0-2 minutes	844	666	1205	1326	1381
3-5 minutes	644	710	941	905	625
6-15 minutes	433	551	529	383	433
16-30 minutes	265	319	287	225	250
More than 30 minutes	223	288	197	201	130

Library Table 7:

Facilities

Space	Specifications
Total Number of Seats in Library	• 596
Information Commons	• Research Help Desk • Circulation Desk • 49 public computer stations (now distributed on 4 floors) • 2 multi-function printers • KIC Scanner
Study Rooms	• 10 large (up to 8 people) containing conference table, white board, media viewing equipment, and Apple TV. • 8 small (2 people) containing a conference table, computer, and whiteboard.
Media Production Room	• Seating up to 7 people containing a computer, Apple TV, ceiling mounted projector, DVD player, and document projector.
Quiet Space	• 2 floors (3rd and 4th)
Archives	• 28,937 items used from the institutional repository in AY24 • 38 Special Collections totaling 322 boxes. • 13 record groups totaling 480 boxes • 20 digital collections containing 14,600 items • 2,500 rare books Art collection • Available 20 hours per week for walk ins (available by appointment as well)

Study Room Statistics	AY22	AY23	AY24
Unique Users	1,594	1,225	1,520
Total Bookings	6,079	8,241	8,789
Hours Booked	10,956	14,868	15,631

VIII. Action Plan

A. Findings

Discuss the comparative strengths and distinctiveness of the program, and challenges/areas of improvement, identified in the self-study.

Strengths

The biggest strength of the biology program is its highly qualified and caring faculty who focus on teaching and student success. All faculty members have a terminal degree and experience doing professional activities and research. Additionally, our small class sizes help foster effective communication between the faculty and students. Close faculty-student interactions have resulted in many students pursuing research opportunities in the form of independent studies and internships. Our departmental surveys tell us that students are well-aware of our research opportunities, and we have been strategic and ambitious with funds and grants to ensure we can continue supporting undergraduate research. Our introductory research course allows students to get engaged with research beginning in their freshmen year and become more involved with independent studies later on in their academic careers. The biology program is well funded by the administration, supported by excellent technicians, and has state-of-the art equipment in dedicated instrumentation rooms and several teaching and research lab spaces. With the recent $750K Massachusetts Life Sciences Center equipment grant, we have been able to update our instrumentation so that every student gets hands-on experience in laboratories using equipment on par with industry. Additionally, we were able to secure a one-year $51K Moderna grant that allowed 8 biology majors (and 4 chemistry majors) to work with our faculty on novel independent projects for both pay and academic credit. Often our students have to work upwards of 20 hours per week at jobs off campus, which may prevent them from seeking research opportunities on campus. This grant was designed to remove that barrier and make research more accessible to all majors and we will continue to seek additional funding through grants moving forward.

As a department, we pride ourselves with our small class sizes and approachable faculty who teach both introductory and advanced courses in the major as well as service courses for Nursing, EXSS, Chemistry, and the entire campus by offering SI courses. Because the departments of Biology and Chemistry are in one department and share office space (and an Administrative Assistant) with the Environmental, Geographic, and Public Health Science department , faculty are very collegial and work together to help students navigate the science curricula. We serve as advisors to our students and often get to know them personally. This relationship allows us to help them when it comes time for students to look for jobs, internships, or graduate school.

One major strength of our department is our excellent Assessment Committee which allows our program to make data-driven, evidence-based decisions and policies that are in the best interests of our students. We also have an active Student Affairs committee that administers a student satisfaction survey every two years. It is not surprising that scientists would be good at data analysis! We have been recognized by NECHE in our ability to predict the needs of our diverse student population and create assessment plans

to make continuous and strategic improvements to our programs. Moving forward, we hope to create an annual working document for our committees to note their important work and decisions.

Distinctiveness

Items of distinction in our department are both our Health Sciences Advising Programs and our articulation agreement with Lake Erie College of Osteopathic Medicine (LECOM). This program was developed to allow students that meet specific requirements to get into early acceptance programs into Medical School. We have 2 Health Sciences Advisors, Dr. Ron Krieser from Biology and Dr. Monica Maldari from Exercise and Sports Science. Our advisors hold specific office hours to help students navigate and prepare for careers in medicine and human health. We offer a 1-credit Introductions to Health Professions Seminar that invites speakers from Medical, Dental, Physician Assistant, Physical Therapy, and post-bac Nursing programs to talk to our students about how to prepare for and what to expect in advanced programs. We are currently negotiating an articulation agreement with Northeastern University for a 4+1 program, where students can get a Bachelor of Science in Biology and a Masters in Science in Biotechnology in 5 years. These are top-notch programs but are under-utilized and under-marketed. It will be a top priority in the next few academic years to work with Admissions to market these programs to local schools and target high-achieving students who may have misconceptions that they must attend a prestigious private (and expensive) college in order to get into post-baccalaureate programs.

Challenges & Threats to the Program

Despite the attractive career choices available for biology graduates, there has been a steady fall in the number of new students being admitted to our program. This is an issue that needs to be addressed immediately and requires targeted and sustained recruitment efforts. Recruitment of new students into the program is by far the biggest challenge we face. We are fortunate to have Tyler Scippione, a Biology major alumnus, as our new Assistant Director of Admissions. We have already had conversations about bolstering our efforts and marketing our STEM programs with Tyler and look forward to having an excellent partnership with Admissions in the future.

Decreasing Enrollments

Our enrollment numbers have been further complicated by lower retention rates among existing students. While the recruitment issue can be addressed through effective marketing of the program, the low retention rates are often reflective of deficient math skills coming out of high school that are needed to succeed in chemistry courses required for a biology major. To address this problem, faculty members teaching the general chemistry sequence review basic mathematical concepts with incoming freshmen in the first two weeks of the fall semester and also provide practice problems on Webworks (an open-source, in-house application for students to get instant feedback on problems). We encourage students to work with our Tutoring Center, and we have instituted an embedded tutor program (often called Supplemental Instruction at other institutions). Resources for programs such as embedded tutors have largely been secured through grants. Our administration understands their value and we are working towards making this a line item in the budget for the School of Health and Natural Sciences. Our new dean, Dr. Jannette McMenamy is a strong advocate for our department and we are encouraged

by her support and pragmatic approach to solving some of these issues. We will also continue to work with our partnering Community Colleges (Mount Wachusett & Quinsigamond) to recruit transfer students as we have robust Mass transfer agreements with numerous programs so credits transfer seamlessly into our programs.

Faculty Retirements

As explained in Section IV. Faculty, since 2020 our department has lost 2 full-time biologists, a full-time chemist (who served as our chair) and a long-time reliable adjunct due to retirement. Additionally, Dr. Meg Hoey just announced her retirement at the end of Spring 2025. We lose a tremendous amount of institutional knowledge and content expertise as our retirees leave our department. In the past few years, gaps in the schedule have been managed by hiring adjuncts and asking faculty to teach multiple new preps, take on "orphan" labs, or give up their electives. While this filled shortages in the interim, it has become unsustainable and will quickly create burnout and a lack of morale in our department. We have managed to secure a One-Year Temporary (OYT) Position for AY2025-26 to cover Anatomy and Physiology I in the fall and Medical Microbiology in the spring when Dr. Sean Rollins goes on sabbatical. We are in constant need of instructors to teach Anatomy & Physiology labs, yet this is not the area of expertise for many of our faculty. Those that are qualified can fill positions in A&P labs–often as an extra prep. However, with additional retirements, those faculty are now needed to teach our core set of General Biology courses, capstones, and electives. The OYT position gives our department some "breathing room" to identify where an additional faculty member would be the most valuable. Our plan is to request another full-time tenure track position in Biology next year with the hope that they would start in AY2026-27. Our department will be asking the administration for funds to recruit and advertise in places most likely to increase the pool of Hispanic candidates. As our University moves towards becoming a Hispanic Serving Institution (HSI), having representation on our faculty will be essential.

Requirements of the B.A. Program

As reported in Section I:Program, our department has been given "kudos" by NECHE for having a clear distinction between our B.S. and our B.A. program. While our B.S. in biology students must take 2 semesters of each Organic Chemistry and Physics, our Bachelor of Arts students take only 1 semester of Organic Chemistry, any PHYS course, and one GEOG elective, along with 12 credits of foreign language (6 credits must be at the intermediate level). While this program is excellent for our students who are multi-language learners and can often score high enough on the CLEP exam to get 12 credits or jump into an intermediate course, it is often not feasible for some students. Besides French and Spanish, other foreign language courses are not offered at the intermediate level on a regular basis. Our department would like to explore other options for our B.A. students such as taking upper-level electives in Fine Arts or Humanities. Our department would like to research how we can remove these barriers.

B. Opportunities for Improvement

Discuss opportunities to leverage or extend existing strengths. Discuss how any challenges/areas of improvement may be addressed.

While reading our self-study, our department identified several areas where we need to make improvements, including improving our assessment tools for content knowledge in the first Program Learning Outcome (#1), continuing Inclusive Excellence initiatives to better serve the needs of our Hispanic students, and improving the tracking of our graduates and alumni.

Address Program Learning Objective 1

Our assessments indicated that our learning objective of specific disciplinary knowledge was not meeting targets, specifically PLO1-disciplinary knowledge. Results revealed specific areas of weakness, including physiology (structure/function, surface area/volume ratios, negative feedbacks), and a few specific concepts about evolution and energy flow. Students show strengths and significant improvement across many areas of Biology, including cell biology, genetics, phylogeny and ecology. We discussed if weak areas reflect gaps in our curriculum. Although Human A&P for majors is offered as an elective, not all students take it. Many of our majors interested in organismal or environmental Biology switch into the Environmental and Geographic Sciences major due to the lack of career prep and options our program offers. While there are many biotech-related positions available in the area, other jobs that are environmental or ecology-based are harder to find. Furthermore, some of the questions on the assessment for PLO-1 are challenging and were intentionally chosen to address misconceptions, making it difficult to compare across biology subdisciplines. One option being considered is adopting a new set of published assessment questions[1] aligned with the AAAS Vision and Change Core concepts. However, we decided to maintain the current assessment format for this program review period.

Explore Ways to better Serve the Needs of our Hispanic Students

Every other year, our Student Affairs committee administers a student survey to our majors. The analysis of those surveys indicated that Hispanic students are more dissatisfied with our program than are students who identify as Black, White, or Asian. As an emerging Hispanic Serving Institution, it is imperative that we address this issue and learn strategies to better engage and serve the needs of our Hispanic students. Opportunities for professional development or tapping into our campus expertise are necessary to address this concern.

Improve Tracking of our Alumni

One of our objectives as a department is to improve our ability to track and stay connected with our alumni. Currently, there isn't a dedicated office on campus tasked with alumni tracking, so we rely on methods like the first destination survey administered at graduation. However, the response rate for this survey is about 60%, but the data are disaggregated, so overall Biology responses may be low. To address this, we should explore strategies to increase response rates, such as better communication or incentives for completing the survey. In addition, we maintain connections through LinkedIn and email, but these methods are not always comprehensive or consistent. Developing a more structured process for tracking and engaging alumni is essential, especially as their participation can play a crucial role in departmental

and networking events, student mentoring, and even recruitment efforts. Establishing a reliable system to keep alumni involved could greatly benefit both our department and current (and graduated) students.

C. Future Positioning

Discuss positioning of the program to address the future direction of the discipline in the next seven years.

To effectively position our biology program to address the evolving demands of the discipline over the next seven years, the department has identified four key areas for strategic development: micro-credentialing and improving career-readiness, exploring 4+1 programs, increasing online elective offerings, and expanding co-op and internship opportunities. These initiatives aim to align our program with emerging trends in education and the workforce, ensuring that we remain forward-looking and competitive.

Explore and Evaluate the Benefits of Micro-Credentialing

Micro-credentialing is all about recognizing the specific skills students pick up in courses, so they can earn credentials that show off their abilities in skills like information literacy, lab techniques, or data analysis. This approach meets the rising demand for skills-based education and gives students solid proof of their expertise. According to the National Association of Colleges and Employers (NACE), nearly two-thirds (64.8%) of employers are now hiring based on skills instead of traditional metrics like GPA[2]. We would like to explore whether adding micro-credentialing to our biology (and possibly, chemistry) lab courses would give our students additional clear proof of their skills, making them more attractive to employers and giving them an edge in the job market.

Consider Career Readiness as an Assessment Objective

What's the point of micro-credentials if students don't know how to show them off on a cover letter or resume? Our department could improve support for students to prepare for jobs—such as writing cover letters, resumes, and preparing for interviews. Our department discussed adding career readiness as a fifth learning objective for our assessment reports. If students feel prepared for the workforce, it will make them more confident and competitive when applying for jobs. In the long run, having career-ready graduates could strengthen our alumni network and boost the reputation of our program.

Discuss the Expansion of 4+1 Programs

Expanding our 4+1 programs—where students can earn both a bachelor's and a master's degree in five years—can benefit both students and our department. These programs give students a faster, more affordable way to get an advanced degree and help them stand out in fields where having a master's is expected. Additionally, 4+1 options may attract high-achieving students who want to accelerate their education and save time and money on a graduate degree.

Explore Strategies to Best Offer Online Elective Classes

While our department has offered many courses online, we are reluctant to offer additional courses without assessing the quality of the online vs. in-person content and analyzing the student success data

from modalities. Furthermore, student use of AI is a major concern. We are aware that online elective courses give students more flexibility and lets our department reach a wider range of students, including non-traditional students and working professionals. Online learning is commonplace, with over 60% of college students using some form of online education by 2022[3]. Online courses also make it easier for students facing challenges such as transportation, childcare, or illness to graduate. However, many of our students are challenged by the discipline required for in-person classes where faculty are continuously coaching/reviewing concepts and reminding students of deadlines, thus we question their abilities to be successful in an online format. While online courses can be interactive and engaging, many of us are not trained in or aware of the technology needed to do this effectively.

Expand Co-op and Internship Opportunities

Expanding co-op and internship opportunities is key to helping students succeed after graduation. Real-world experience lets students apply what they've learned in class, build their professional network, and explore potential career paths. Since 2018, 18 students have taken part in internships, either on or off-campus, while over 100 students have done research projects. Moving forward, our department will continue to advocate for support for a departmental internship coordinator who will help us keep and build relationships with industry and research partners. Strengthening these opportunities will make our students more competitive in the job market, where employers are placing more value on hands-on experience, alongside academic qualifications.

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2. Gatta, M, (2024) *Nearly two-thirds of employers use skills-based hiring practices for new entry-level hires.* National Association of Colleges and Employers Online Newsletter

3. National Center for Education Statistics. (2023). Undergraduate Enrollment. *Condition of Education.* U.S. Department of Education, Institute of Education Sciences. Retrieved July 20, 2023, from https://nces.ed.gov/programs/coe/indicator/cha.

D. Action Plan for next seven years

1. Key objectives, and strategies actions to achieve each objective
2. Timeline, with milestones and measurable outcomes to determine progress and measure success
3. Method of achieving objectives
    a. Internal improvements
    b. Improvements achieved only with additional resources and plans to obtain these resources
4. Resources necessary to achieve the plan
    a. Faculty/staff
    b. Budgetary

In early January of 2025, our department met to discuss this self study and identify not only the strengths and threats to both our biology and chemistry programs, but also produced several action items that arose from synthesizing the information presented in our reports. Some of those action items are overtly woven into the narrative of this document, while others are more pragmatic in nature. We present the items required in D. Action Plan for the next seven years in the table below. We look forward to hearing back from our outside reviewer and our Dean before prioritizing or thoroughly seeking strategies and resources needed to address each action item.

	Self Study Action Items AY 2024-2025						
	Tasks Identified	**Program(s)**	**Resources Needed**	**Performed by**	**Rank**	**Budget**	**Timeline**
1	Hold a retreat to digest comments from outside reviewer & prioritize action items	Biology & Chemistry	Time, budget for catering	Department	1	$500	May 2025
2	Ensure our Chemistry Technician's retirement allows for overlap and no lapse in support services, investigate 1-credit releases for faculty to prep if no candidate is found in a timely manner	Chemistry	HR to allow for hiring of EGPHS position and training, possible overlap of Karen with new hire, Dean of HNS support	Dean of HNS, Dept. Chair	1		By Summer 2025
3	Improve recruitment of students to our majors	Biology & Chemistry	Faculty time to go to High Schools, Admissions Officer support	Department	1	TBD	AY25-26
4	Identify and discuss gaps in teaching expertise created by retirements, champion for full-time tenure track position	Biology	Dean, VP approval, HR coordination, funds to advertise to increase Hispanic candidate pool	Dept., Chair, Search Committe	1		AY25-26
5	Continue to improve upon and explore retention strategies for difficult introductory courses	Biology & Chemistry	Funds for embedded tutors, release time for Webworks	APR faculty			
6	Continue to explore opportutnies for funding (eg. grants) to support retention and recruitment initiatives	Biology & Chemistry	Faculty release time to write/administer grants, Grants Center Support, Administrative Support	Faculty, Grants Center			
7	Continue to provide opportunities for networking with community colleges	Biology & Chemistry	Faculty time	Department			
8	Explore options for certificate programs (Build off of Dr. Samulak's initial report)	Biology & Chemistry	Faculty time	Appointed faculty member or subcommittee			
9	Evaluate the 2.0 rule. For example, see whether the 2.0 rule affected DFW rates. Re-assess the correlation of grades in intro classes vs. % graduation rates.	Biology & Chemistry	Student data, IRP	Assessment Committee			
10	Offer additional appealing/catchy SI service courses for non-majors	Biology & Chemistry	Department Meetings	Department			
11	Improvement in meeting the needs of Hispanic Students in our majors	Biology & Chemistry	Professional Development funds, Administrative support	Outside trainer, campus expert			
12	Develop an annual working online document for all committees to report on action items	Biology & Chemistry	Google Doc	Chairs of each committee			
13	Work with the libary in sophomore and junior level courses to scaffold information literacy	Biology & Chemistry	Content Librarians	Equipment Committee			
14	Brainstorm strategies for improving the Biology & Chemistry Secondary Education Programs	Biology & Chemistry	Department, Program Area for Secondary & Middle School Education, SGOCE, DESE or BHE support	Billy Samulak, Lisa Grimm, Chair			
15	Seek additional training to understand the strengths, opportunities, and challenges of AI in our classrooms	Chemistry	Professional Development	Outside trainer, campus expert			
16	Strategize ways to improve PLO1-disciplinary knowledge among majors and improve content test	Chemistry	Department Meetings	Assessment			
17	Explore options for partnerships or programs with the Business Dept. (Expand up on the work that Dr. Samulak has done).	Chemistry	Buy in from Business Dept. Administration, Faculty release time	Sub-committee			
18	Discuss options to expand or streamline Chemistry minor	Chemistry	Dept. meeting agenda item	Curriculum Committee			
19	Explore options for removing barriers in the BA program	Biology	Curriculum Committee, AUC	Curriculum			
20	Improve PLO 3D to include communication to both scientific and general audiences	Biology	Meeting time	Assessment Committee			
21	Coordinate capstone career-readiness efforts, explore PLO5-career readiness	Biology	Meeiing time	Assessment Committee			
22	Improve and build process to keep track of our alumni	Biology	Alumni Office, Career Service (survey), LinkedIn Professional Account, Faculty compensation	Appointed Dept. Alumni Liaison (precedent from Student affairs)			
23	Explore opportunties for Microcredentialling	Biology	Faculty time, guidance from outside trainers	Department			
24	Explore opportunties for developing 4+1 programs	Biology	Meeting time, possible release time	Department			
25	Increase and market internships & coops, bullt industry partner network	Biology	Faculty release time	Internship Coordinator			
26	Improve & offer training to best design and utilize online elective options	Biology	Department meeting time, faculty training, software	Department			