Fitchburg State University
Department of Biology & Chemistry

Chemistry Program Review
2021-2024

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i. Executive Summary

The chemistry program at Fitchburg State University is committed to providing our students with a top-notch curriculum encompassing all aspects of chemistry. Currently, we offer 2 programs: a B.S. in Chemistry, a B.S. in Chemistry with a concentration in biochemistry, and a B.S. in Chemistry with Initial Teacher Licensure. Since 2021, we have graduated 11 students, and according to Institutional Research and Planning data, we have 17 enrolled majors and 27 students in the minor, however, 3 of our students left the major since the report was issued. Our students matriculate through a series of rigorous coursework based on the guidelines of the American Chemical Society which include core coursework in General Chemistry I and II, Organic Chemistry I and II, Inorganic Chemistry, Analytical Chemistry, Biochemistry, and Physical Chemistry (with lab) as well as Calculus, Physics, and Biology. Furthermore we offer a range of chemistry electives such as Environmental Chemistry, Medicinal Chemistry, and other topics courses. Because we are a liberal arts university, all chemistry majors must also participate in a broad range of General Education courses that includes writing, the arts, history, wellness, ethical reasoning, and literature.

One of the biggest strengths of our department is our faculty and their commitment to student success. We currently have 6 full-time chemistry faculty members and 11 full-time biology faculty.. The faculty of the BIology and Chemistry programs work collegially on committees to write proposals and develop programs and policies for the department and 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 are also active participants in the regional chapter of the American Chemistry Society, 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 analytical and biochemical equipment. Altogether, we have an impressive inventory of instruments including UV-vis, NMP, IR, Vis and AA spectrophotometers, a GC-MS spectrometer, several new GC instruments, new HPLCs, UHPLC and a potentiostat/Galvanostat. 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 departmental funds to support course and lab supplies and have opportunities to seek additional funding for instrumentation through annual extrabudgetary requests.

The chemistry program offers many service courses to outside departments, including Nursing, Exercise and Sport's Science, and Biology. In fact, due to the number of required chemistry courses within the biology major, students only have to take two additional courses to attain a minor in chemistry. One of our primary service courses is Chemistry for Health Sciences (CHEM 1200); typically we offer 3-4 sections every semester for Nursing majors. Additionally, faculty teach non-majors courses such as Chemistry in a Changing World (CHEM 1000), which fulfills requirements for the Scientific Inquiry (SI) component of the General Education curriculum across campus.

One of the major challenges of our department is low enrollment, yet this is a nation-wide trend seen in many Chemistry 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 maintain a 2.0 in core introductory courses to continue with the major. Students may repeat the course, but after 2 failed attempts must meet with their advisor to identify other potential majors. This policy 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. 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 classes and offer additional help with math skills needed to succeed in chemistry. 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 are easily able to find chemistry-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, we have 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 move into the future of the chemistry program. 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 introductory courses, and widening the use of open resources like WebWorks that allow students to practice their chemistry skills with immediate feedback.

The Department of Biology and Chemistry is 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.

Historically, Fitchburg State University offered a minor and major in chemistry, but these were discontinued in the early 2000s. The department began to offer the chemistry minor again in 2008. In 2013, the new chemistry major was approved by the Massachusetts Board of Higher Education (BHE). The programs approved were a Bachelor's of Science (B.S.) in Chemistry and B.S. in Chemistry with Initial Licensure in Secondary Education. A new concentration in Biochemistry was added to the program in 2019. Currently, three bachelor of science programs in chemistry are offered: B.S. in Chemistry, B.S. in Chemistry with concentration in Biochemistry and B.S. in Chemistry with Initial Licensure in Secondary Education (which includes a minor in Middle School and Secondary Education). The department also offers a minor in chemistry, which is often very attractive to the Biology majors. The BS in Chemistry provides breadth by requiring students to take at least one upper division class in each of the five main divisions of chemistry. Additionally, students interested in biochemistry focus on depth by taking specified biochemistry electives.

1. Mission Statement of the Biology/Chemistry Department

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. In order to achieve our mission, we strive to meet the following objectives:

- 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.
- Recruit and retain qualified students for our academic programs from diverse backgrounds.

2. Vision Statement of the Biology/Chemistry Department

The Department of Biology and Chemistry provides students with the opportunity to learn in the physical and life sciences. Focusing on process, concepts, and critical thinking skills, we build the foundation students need 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.

3. Alignment Institutional Mission and Vision

Fitchburg State University is committed to excellence in teaching and learning and blends liberal arts and sciences and professional programs within a small college environment. As a community resource, we provide leadership and support for the economic, environmental, social and cultural needs of North Central Massachusetts and the commonwealth.

Chemistry is one of the fields at the forefront of the current technology revolution and, as such, it plays a crucial role in solving many of the problems faced by today's society. Chemists work in all facets of life including the development of new drugs for treatment of diseases such as cancer, AIDS, COVID-19, and heart diseases; the creation of better methods for the production of food, clothing and shelter; and the discovery of environment friendly energy sources. They also work on solving problems such as acid rain, ozone depletion, and climate change. The chemistry program at FSU, owing to its geographical location, attracts students mainly from towns in the North Central Massachusetts area and prepares them for pursuing professional careers in the chemical, pharmaceutical, biotechnology or related industry as well as secondary school teaching.

In the Chemistry Program, students take a range of General Education courses, including courses that incorporate diverse perspectives, ethical reasoning, procedural and logical thinking, civic engagement,

fine arts, and others that integrate and apply learning with high impact practices. Additionally, our students complete a rigorous curriculum in chemistry that prepares them for the aforementioned professional careers. This optimal blend of Liberal Arts and Professional courses helps meet our primary Strategic Goal of *"forging innovative paths to knowledge acquisition, career readiness, social mobility, and lifelong learning."*

The program provides students with a comprehensive foundation in all aspects of chemistry; organic, inorganic, physical, analytical and biochemistry with an emphasis on developing strong laboratory skills. Distinguishing features of our program include our dedicated and caring faculty, small class sizes and laboratory classes taught by faculty. We offer the only 4-year chemistry program in North Central Massachusetts and our students have access to well equipped laboratories with state of the art instrumentation e.g. we now have three HPLCs and a new GC/MS. Our program is based on curricular guidance from the American Chemical Society (ACS) and reflects our commitment to instituting best practices in our programs. This is discussed in depth in Curriculum: A. Our extensive departmental efforts to prepare students for growing careers in the region are described in Curriculum: C. Workforce alignment.

Our chemistry program is now 10 years old. The newly approved Chemistry major officially began in AY14/15 with two degrees in the program, the Chemistry B.S. and Chemistry Secondary Education with Initial Teacher Licensure, B.S. Over the intervening years, numerous changes have been made to the program. Additionally, In AY19/20 the Biochemistry concentration B.S. was added to meet the local demand for biochemistry graduates. In AY20/21, the education degree was revised to the Chemistry with Initial Teacher Licensure in Secondary Education (with a Minor in Middle School and Secondary Education). This coincided with the university's change to the General Education curriculum from the former LA&S curriculum.

Any significant curricular changes to courses or new course requests must be made by submitting proposals to the All University Committee (AUC). Proposals also get reviewed by the Curriculum Committee (a subcommittee of the AUC). A recommendation is made to the full AUC who forwards the proposal to the President for a final decision on approval or disapproval.
Here is a list of new courses (academic year created is listed in parentheses)

1. Biochemistry I- CHEM 3030 and cross listed as BIOL 3030 (AY14/15)
2. Introductory Research- CHEM 1600 - (AY15/16)
3. Biochemistry II- CHEM 3040 and cross listed as BIOL 3040 (AY18/19)
4. Biochemical Techniques- CHEM 3060 and cross listed as BIOL 3060 (AY18/19)
5. First Year Experience- (AY18/19)
6. Environmental Chemistry-CHEM 3003 (AY 21/22)
7. Metals in Biology - Currently still a topics course, CHEM/BIOL 4015 (AY21/22)

B. Enrollment

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

Following a higher plateau, the number of enrolled chemistry majors declined from an average of 28 in the four years prior, to an average of 17 students in AY 21-23. In this AY 21-23 review period, a total of 11 students graduated with a BS in Chemistry as determined by Crystal Reports. According to the IRP trends, we currently have 17 students in the major (11 Chem, 3 Biochem, and 3 Chem Ed), but those numbers may be lower as some of those students have switched into different programs in the fall 2024 semester. The Chemistry minor is fairly robust with 27 students enrolled based on IRP reports. SSC reports through EAB provide different counts. We have struggled with getting conflicting enrollment numbers, so as a department, we chose to report on the data given to us by the Office of Institutional Research & Planning in fall of 2024. These data can be seen in the tables below and are grouped in with data from the Biology Program because the reports are created for each department (not program area). Due to the low numbers of students in our program, it is difficult to make broad generalizations about our retention and graduation rates. For example, in 2023, it was reported that we had a 0% retention rate, while in 2024, that number jumped to 100%.

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%	

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

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%	
												#N/A
Number of Minors												
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%*	
												#N/A
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%	
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%*	
												#N/A
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%	
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.

1. New England Commission of Higher Education (NECHE) Findings

According to our recent NECHE report, the Dept. 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 2021, we instituted a 2.0 rule for critical introductory Chemistry courses. Students who don't score at least a 2.0 in these courses by the second attempt cannot stay in the major. In 2014, our department discussed some internal data that clearly showed that failure to pass early courses causes students to stagnate later on in their academic career. We are committed to advising struggling students carefully and working closely with the Career Center to help them transition to a new area of study at the University that better matches their interests and skill sets.

The Dept. of Biology and Chemistry were 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 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."*

2. Findings from the 2021 Chemistry Self-Study

While it has only been 3 years since the last Chemistry self-study, efforts have been made to address some of the acknowledged weaknesses and take advantage of potential opportunities from that study. It should be noted that as a department, we chose to bump up the Chemistry self-study timeline to be on the same schedule as Biology. Now both programs will be evaluated in the same academic years. (Typically self-studies are done every 7 years). The findings from both our departmental analysis as well as the outside reviewer, Dr. Mark Turnbull from Clark University, were congruent, and in many cases, identical. We slightly disagreed with the reviewer on the topic of student research opportunities. These are discussed below.

a. Dedicated Faculty

One of the recurring themes from both the analysis of the self-study and the reviewer's interviews with students was the strength of our program and the dedication of our faculty to ensuring the success of our students. Our well-educated and caring faculty have helped create resources and policies both in and outside of their classes that help students succeed. Student under-preparedness for Chemistry courses was thematic in our last self-study and was also intricately noted by our outside reviewer. In the past three years, we have advocated for, applied for and even received grant funding for enhanced tutoring in our Chemistry courses, specifically in the area of mathematics. Faculty have created study guides, math primers, and practice questions to address this in their courses. Dr. Mathangi Krishnamurthy, along with Dr. Daniel Welsh from Biology, have championed and instituted a "peer-tutor" program where students who have taken the class and done well, re-take it, communicate closely with the faculty, and offer tutoring and study sessions for students in the class. Our embedded tutoring program was funded by an Academic Innovation Fund that aimed at putting tutors into key gateway courses. We have now made this a continuing practice. Thus, targeted tutoring is now available for students regularly outside of our Chemistry I as well as Organic Chemistry I courses. Furthermore, as noted in the aforementioned section, we have proactively adapted policies, including a 2.0 rule, to ensure that students do not languish in the program and can quickly move to a new major before their time and money is wasted on courses they are not likely to succeed in.

b. Preparing Future Chemistry Teachers

One opportunity that our reviewer mentioned that we have not had much traction on deals with the recruitment and training of Chemistry Teachers. While we know we have a STEM teacher crisis, recruiting students who want to be teachers out of high school is challenging. However, according to a 2023 white paper by the Pioneer Institute, the STEM teacher crisis in Massachusetts is growing and the mindset of teacher training needs to shift from traditional certification programs to "experts in residence" programs (1). This requires teachers to seek alternative, on-line, and accelerated programs for licensure while teaching in a high school setting. Although we have advanced and on-line education programs at Fitchburg State, the Chemistry (and Biology) program has not focused on how to accommodate biotech, chemical, or pharmaceutical industry professionals into these degree programs. This could be a potential opportunity to recruit students into Chemistry content courses, albeit online and likely cross-listed with an undergraduate option.

c. Research Opportunities for students

Another comment from the outside reviewer was about research within the chemistry program. During his interviews with students, there was a bimodal distribution of students who either knew a lot or knew almost nothing about research opportunities in our department. He also commented that we did not have enough research space for our faculty to work if more students wanted to do research. As a department, we don't fully agree with this last statement. While faculty have smaller research areas, we have ample space and equipment to carry out experiments. This is because some research can be done in teaching labs when classes are not being held. To inform students of research opportunities, we continue to hold our Science Symposium every fall and we often recruit research students from our classes. We also have mechanisms for sharing research project openings with students via discussion groups and on-line community pages on Blackboard. Our efforts seem to be working because In our most recent student survey, most of our students are aware that research opportunities in the department are readily available.

d. Enrollment and Student Preparedness

Our outside reviewer was very honest and clear about two distinct problems that face our Chemistry program; student preparation and recruitment/enrollment. We see these two problems as incontrovertibly linked. While we have little leverage with admissions to bolster how our programs are marketed to high school students, we do see it as our responsibility to help our students remain in our programs once they are enrolled. Chemistry requires a solid background in mathematics, which many of the students applying to our programs do not have. Furthermore, the need for rigorous math training often deters students from entering STEM programs, making recruitment difficult. To overcome some of these challenges, our faculty have implemented numerous measures to "bridge the math gap" in our introductory Chemistry courses. These are described in more detail in our curriculum and program sections. Briefly, the department has been diligent in ensuring that students have the appropriate math skills before enrolling in General Chemistry I. During orientation, students take the math placement exam on campus. Those that score 243-260 are placed into precalculus while those who score above 260 are placed into Calculus. Any student scoring above a 243 is permitted to register for General Chemistry I. Those students that score below a 243 are registered for Math 050, which is a basic math

course that helps them build their algebraic and functions skills. Faculty teaching General Chemistry I have also implemented practice programs using in-house tools like WebWorks or on-line homework packages. Additionally, we have invested in an embedded tutor program for General Chemistry I and II. This gives students in the class access to a peer who can assist them with both math and chemistry issues. Students must receive a 2.0 in General Chemistry I before moving on to General Chemistry II. This prevents students from moving up in the program who may languish in upper-level classes and not succeed. Students are allowed to repeat the course once (per Academic Policy). However, if a student cannot get the prerequisite grade upon the second attempt, our faculty carefully and thoughtfully advise them to switch into a different major where they will be more successful. We have an excellent working relationship with the Career Services and Advising Center (CSAC). If our faculty can't provide the necessary information about possible majors, our colleagues in CSAC are well-equipped to assist.

It is no secret that across the country, many universities are experiencing enrollment declines. The same is true for the state universities in Massachusetts. Further in this self-study, we provide data about our programs and note that recruitment of students into the Chemistry major is challenging. In a recent (Oct. 21, 2024) article in Chemical and Engineering news about declining enrollment, the author noted:

> *"Chemistry programs are no exception. They suffer the same struggles as the education field as a whole but are faring worse in terms of enrollment and number of graduates."*

While we have no intentions of eliminating our major, we acknowledge the need to increase our enrollments and "up" our recruiting efforts. However, as faculty, we had neither the tools nor resources to do this on our own. As part of a $750K equipment grant that we received from the Mass Life Sciences Center, we discussed financial assistance "in kind" in the form of a marketing campaign for our biotechnology and biochemistry programs. Unfortunately, we are not aware if this request made it into the final version of the grant as several of the administrators on the grant have since left the university. In June of 2024, Fitchburg State University hired a new president, Dr. Donna Hodge who has brought new vision and energy to the University. Just recently, it was announced that Fitchburg State University will open a recruitment and admissions office on the campus of Fitchburg High School, one of our main feeder schools. While this is an excellent opportunity and starting point, there is much more work to be done to recruit students into our chemistry program. As a department, we discussed going into local high-performing high schools and AP courses to market our Lake Erie College of Osteopathic Medicine/Fitchburg State articulation agreement which allows students early acceptance into medical school if they meet specific criteria. We welcome outside expertise including coordination with the enrollment office and marketing department and plan to make this a high-priority action item.

References:

1. Robinson, G., & Candal, C. S. (2023). Engineering a Solution: Elevating STEM Teacher Quality.
2. Kriesch Boerner, L., (2024) Are undergraduate chemistry programs in crisis? *Chemical and Engineering News,* Volume 102, Issue 33.

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 chemistry program was designed based on the needs of the job market and in accordance with the recommendations of American Chemical Society (ACS). Although our chemistry degree program was designed to follow ACS guidelines, it is not an ACS-accredited program and we do not envision seeking ACS accreditation in the near future. This is due in part to the small size of our program, the rigor associated with the accredited program, and our current limited ability to attract top high school talent. In addition, there is a high demand for chemistry graduates in our area who are able to secure employment without an ACS accredited degree. Expected learning outcomes include competencies in the five primary areas of chemistry - analytical, organic, inorganic, physical chemistry, and biochemistry. In addition, students will also gain competencies in the following areas - (1) laboratory safety and green chemistry (2) chemical literature and information retrieval (3) developing effective oral and written communication skills, and (4) professional ethics. Students will also receive training in related fields, such as mathematics and physics. The curriculum leaves enough room for electives, which the students can use for additional coursework in chemistry or related fields, such as biology, geophysical sciences, computer science or industrial technology. In fact, a second major in biology (or vice versa) would be relatively easy to obtain given the overlapping curricular requirements between the two majors. In addition to the major requirements, each student admitted to Fitchburg State, starting Fall 2021 is expected to complete three education designations as part of their degree requirements. The main General Education designations are: Foundation, Exploration and Integration. The 4-year plans for all Chemistry programs as well as the General Education program guidelines and our updated 2-year rotation of courses are included at the end of this section in the supporting documents section . The degree requirements for each of the Chemistry programs are listed below:

Degree Requirements B.S. in Chemistry

Core Courses in Chemistry

CHEM 1300 - General Chemistry I	4 cr.
CHEM 1400 - General Chemistry II	4 cr.
CHEM 2000 - Organic Chemistry I	4 cr.
CHEM 2100 - Organic Chemistry II	4 cr.
CHEM 2400 - General Analytical Chemistry	4 cr.
CHEM 3030 - Biochemistry I	3 cr.
CHEM 3200 - Physical Chemistry I	4 cr.
CHEM 3600 - Descriptive Inorganic Chemistry	3 cr.
CHEM 4750 - Chemistry Seminar	3 cr.
Sub-Total	**33 cr.**

Required Courses in Related Disciplines

PHYS 2300 - General Physics I	4 cr.
PHYS 2400 - General Physics II	4 cr.
MATH 1300 - Precalculus	4 cr.
MATH 2300 - Calculus I	4 cr.
MATH 2400 - Calculus II	4 cr.
BIOL 1800 - General Biology I	4 cr.
Sub-Total	**24 cr.**

Chemistry Electives

Students must choose two electives from the following list:

CHEM 3003 - Environmental Chemistry	
CHEM 3040 - Biochemistry II	
CHEM 3060 - Biochemical Techniques	
CHEM 3300 - Physical Chemistry II	
CHEM 4020 - Medicinal Chemistry	
CHEM 4015 - Metals in Biology	
CHEM 4900 - Independent Study in Chemistry	
CHEM 4940 - Internship	
Sub-Total	**6 - 8 cr.**

Total number of credit hours required in the major and related areas	63-65 cr.
General education coursework	33 cr.
Total number of credits for required coursework	96 - 98 cr.
Free electives	22 -24 cr.
Total credits required for the degree	**120 cr.**

Degree Requirements B.S. in Chemistry with Concentration in Biochemistry

Core Courses in Chemistry

CHEM 1300 - General Chemistry I	4 cr.
CHEM 1400 - General Chemistry II	4 cr.
CHEM 2000 - Organic Chemistry I	4 cr.
CHEM 2100 - Organic Chemistry II	4 cr.
CHEM 2400 - General Analytical Chemistry	4 cr.
CHEM 3030 - Biochemistry I	3 cr.
CHEM 3040 - Biochemistry II	3 cr.
CHEM 3060 - Biochemical Techniques	3 cr.
CHEM 3200 - Physical Chemistry I	4 cr.
CHEM 3600 - Descriptive Inorganic Chemistry	3 cr.
CHEM 4750 - Chemistry Seminar	3 cr.
Sub-Total	**39 cr.**

Required Courses in Related Disciplines

PHYS 2300 - General Physics I	4 cr.
PHYS 2400 - General Physics II	4 cr.
MATH 1300 - Precalculus	4 cr.
MATH 2300 - Calculus I	4 cr.
MATH 2400 - Calculus II	4 cr.
BIOL 1800 - General Biology I	4 cr.
BIOL 2800 - Genetics	4 cr.
Sub-Total	**28 cr.**

Total number of credit hours required in the major and related areas	67 cr.
General education coursework	33 cr.
Total number of credits for required coursework	100 cr.
Free electives	20 cr.
Total credits required for the degree	**120 cr.**

Degree Requirements B.S. in Chemistry with Initial Teacher Licensure (8-12) & Minor in Middle School and Secondary Education

Core Courses in Chemistry

CHEM 1300 - General Chemistry I	4 cr.
CHEM 1400 - General Chemistry II	4 cr.
CHEM 2000 - Organic Chemistry I	4 cr.
CHEM 2100 - Organic Chemistry II	4 cr.
CHEM 2400 - General Analytical Chemistry	4 cr.
CHEM 3200 - Physical Chemistry I	4 cr.
CHEM 3600 - Descriptive Inorganic Chemistry	3 cr.
CHEM 3030 - Biochemistry I	3 cr.
CHEM 4750 - Chemistry Seminar	3 cr.
Sub-Total	**33 cr.**

Required Courses in Related Disciplines

PHYS 2300 - General Physics I	4 cr.
PHYS 2400 - General Physics II	4 cr.
MATH 1300 - Precalculus	4 cr.
MATH 2300 - Calculus I	4 cr.
MATH 2400 - Calculus II	4 cr.
BIOL 1800 - General Biology I	4 cr.
Sub-Total	**24 cr.**

Minor Requirement

CHEM 1860 - Introduction to Education 5-12	3 cr.
CHEM 3015 - Methods of Teaching Chemistry (8-12) I	3 cr.
CHEM 4850 - Methods in Teaching Chemistry (8-12) II	3 cr.
EDUC 2011 - Diversity in Education (5-12)	3 cr.
EDUC 2012 - Teaching the Adolescent Learner (5-12)	3 cr.
SPED 3800 - Inclusive Instruction (5-12)	3 cr.
Sub-Total	**18 cr.**

Licensure Courses

CHEM 4012 - Practicum Seminar (5-12)	3 cr.
CHEM 4860 - Practicum in a Secondary School I	4.5 cr.
CHEM 4870 - Practicum in a Secondary School II	4.5 cr.
EDUC 3122 - Sheltered English Immersion	3 cr
Sub-Total	**15 cr.**

Total number of credit hours required in the major and related areas	90 cr.
General education coursework	30 cr.
Total number of credits for required coursework	120 cr.
Free electives	0 cr.
Total credits required for the degree	**120 cr.**

Requirements for a Chemistry Minor

CHEM 1300 - General Chemistry I (Lecture & Lab)	4 cr.
CHEM 1400 - General Chemistry II (Lecture & Lab)	4 cr.
CHEM 2000 - Organic Chemistry I (Lecture & Lab)	4 cr.
CHEM 2100 - Organic Chemistry II (Lecture & Lab)	4 cr.
CHEM 2400 - General Analytical Chemistry (Lecture & Lab)	4 cr.
One additional course selected from any 2000 level or higher CHEM course	3-4 cr.
Total	**23-24 cr**

Students in our major first take the introductory chemistry courses, General Chemistry I and General Chemistry II. These courses are taken sequentially and serve as foundational courses that introduce them to the disciplinary knowledge in Chemistry outlined in our Program Learning Objective 1 (PLO1). Chemistry majors must earn a minimum grade of 2.0 in both CHEM 1300 and CHEM 1400 to progress. Subsequently, students proceed to take Organic Chemistry I and Organic Chemistry II in sequence. To take Organic Chemistry II, students must earn a minimum grade of 1.7 in Organic I. They then proceed to take Analytical Chemistry, Biochemistry, Physical Chemistry, and Descriptive Inorganic Chemistry in no particular order. Students are expected to have fulfilled PLO1, their Lab Skills (PLO2), and demonstrated Lab Safety practices (PLO3). Chemistry majors with a Biochemistry concentration also take Biochemical Techniques, Genetics and Biochemistry II in addition to the aforementioned core courses. Biochemistry II has yet to be offered for a number of reasons. We have been giving students course substitutions and

waivers until that course is developed. Dr. O'Connor is currently seeking a Master's Degree in Nutrition and is poised to begin teaching that course with a metabolism focus starting in the fall of 2026.

The State of Massachusetts Department of Elementary and Secondary Education (DESE) has strict requirements regarding professional standards for teachers (PSTs) that must be met in the curriculum, along with specific subject matter content knowledge (SMKs). Students pursuing the B.S. in Chemistry with Initial Teacher Licensure (8-12) meet the SMKs through their chemistry coursework. To meet the state requirements for PSTs, students complete six courses (18 credits) earning a Minor in Middle School and Secondary Education, along with a state-required Sheltered English Immersion class (EDUC 3122) and lastly, a 12 credit student teaching experience (practicum and practicum seminar) Due to the requirement to meet those PSTs which are spread across 33 credits, students in this program do not have any free electives.

The Chemistry Seminar class, required for all majors, typically provides a capstone (Integrative High-Impact Practice, IHIP) experience during their senior year. It is designed to be a culminating and integrative experience. One of the major components of this course is a review paper in which students must demonstrate understanding of critical concepts and skills learned in the prerequisite courses. In this course, students also work on seminar-long projects and present their work to an audience. Communication Skills (PLO 4) is assessed in the seminar class.

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 described below.

The majority of our chemistry courses offered during the fall and spring semesters are taught in a traditional manner with face-to-face lectures and labs. In the General Chemistry sequence, all professors use the same textbook, on-line homework and do the same set of laboratory experiments. Instructors mix traditional lecture with in-class problem solving. In the Organic Chemistry sequence, instructors have switched from a traditional textbook to using the Top Hat platform and more recently the online textbook and homework system created by Joel Karty, which can be found using this link:
https://libgen.is/search.php?req=karty&lg_topic=libgen&open=0&view=simple&res=25&phrase=1&column=def

General Chemistry II (Fall 2022) and General Analytical Chemistry (Spring & Fall 2023) have been taught using a flipped classroom model. Students watch pre-recorded lectures before class and spend class time working on problem sheets in small groups or with a partner. All three of these classes were small with less than 16 students so this model worked well and the instructor was able to give the groups lots of attention. No significant improvements were seen in the average grade achieved by the students in General Analytical Chemistry. Some improvement was seen in the average grade achieved by General Chemistry II students; the class average final grade increased from 80 to 83% (2019 vs 2022).

From 2020 on, General Chemistry I and II summer courses have been taught exclusively on-line. The General Chemistry lab sequence is delivered using Beyond Labz and other lab simulators and recorded experiments. Organic Chemistry I is offered in the hybrid mode, with lectures online and in-person labs beginning summer of 2022. Organic Chemistry II was taught fully online in summers of 2022 and 2023 . The lab sequence was taught using the Beyond Labz program. It was taught as a hybrid course in summer of 2024. Environmental chemistry was taught once online in spring of 2023.

Chemistry course offerings in the hybrid or online modalities

Course	Term	Modality
General Chemistry I	Summer 2022 Summer 2023 Summer 2024	Online
General Chemistry II	Summer 2022 Summer 2023 Summer 2024	Online
Organic Chemistry I	Summer 2022 Summer 2023 Summer 2024	Hybrid
Organic Chemistry II	Summer 2022 Summer 2023	Online
	Summer 2024	Hybrid
Environmental Chemistry	Spring 2023	Online

C. Workforce Alignment

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

Entry-level job positions in the chemical and biotech industry remain the top choice for our chemistry graduates. There are two recent reports, one from Chemical and Engineering News (C&E News) and another from the American Chemistry Council (ACC) that provide nationwide job outlook information and projections for the future that are specific for chemistry related jobs. The Chemists Employment outlook report for 2022 released by C&E News indicated a return to normalcy after the hiring decline seen during the COVID pandemic (https://cen.acs.org/careers/employment/Chemistsemployment-outlook-2022/99/i45). The hiring process seemed to have "picked up steam" with the fall hiring cycle in September 2022 already at 80% of the 4-year average. According to the ACC year-end situation and outlook report released in November 2023, chemical industry employment increased significantly in 2022, with the addition of about 18,000 new jobs (https://www.americanchemistry.com/chemistry-in-america/news-trends/blog-post/2023/acc-year-end-situation-outlook-november-2023). Tighter market regulations in 2023 led to addition of only 3000 new jobs. The report predicts industry employment growth to remain stable in 2024 and then increase again in 2025.

The U.S Bureau of Labor Statistics provides state-specific jobs outlook data for chemistry jobs. According to the Occupational Employment and wages report released by the Bureau of Labor statistics (https://www.bls.gov/oes/current/oes192031.htm#st), 4340 chemists were employed in the state of

Massachusetts. The majority of the industry jobs were in Scientific research and development services and Pharmaceutical and Medicine manufacturing. Overall, there seems to be a positive trend in chemical industry employment in terms of entry level jobs in the near future.

Besides employment in the chemical and biotech industry, some of our students have also pursued graduate education in chemistry and health sciences. We also have students in our education track planning to become chemistry teachers. Our chemistry curriculum along with the associated research experience that our students gain through internships and independent studies help students gain foundational knowledge and valuable skills for a variety of careers that they may wish to pursue after graduation.

The chemistry curriculum at FSU was originally developed in 2013 after consultation with an advisory panel comprising chemists from both academia and industry. The curriculum was designed to address the growing needs of the chemistry workforce with the core curriculum aligned with the priorities highlighted by the chemists in the advisory panel and to ensure our students possess the broad skill set needed for a wide range of careers in chemistry. While we developed our curriculum following ACS guidelines, our program is not accredited by ACS. We do not seek to get ACS accreditation anytime in the near future, due to the small number of students and our limited ability to attract top high school students. Expected learning outcomes include competencies in the five primary areas of chemistry - analytical, organic, inorganic, physical chemistry and biochemistry. In addition, students will also gain competencies in the following areas:

1. Disciplinary knowledge
2. Lab skills and safety
3. Chemical literature and information retrieval
4. Communication skills - both oral and written
5. Professional ethics

We started with a smaller set of electives when our major got the Board of Higher Education (BHE) approval and have been adding newer elective courses that reflect the changing needs of the job market. A detailed list of electives is given in Section A. Besides offering new chemistry elective courses, we have also created a Biochemistry concentration to better prepare students for careers in health sciences, drug development and biotechnology.

In addition to coursework, students in our program also gain valuable research experience through independent studies and internships. While our core courses and electives help to address the disciplinary knowledge and lab skills competencies, these research experiences help to address competencies 3, 4 and 5 while bolstering competency 2. Several of our chemistry majors have worked on research projects under the guidance of our chemistry faculty to gain valuable research experience. Some of our students have worked on paid internship projects as part of the Research Scholars program sponsored by the Moderna Charitable grant. This $51K grant, which is listed in the grants table in section V: Faculty, was designed to allow students to do research on campus for both credit and pay. Many of our students can not afford to take off work to stay on campus to do research. This grant aimed to remove that barrier for some of our students who could benefit most from this high-impact research internship on campus. Two of our faculty members, Dr. Dennis Awasabisah and Dr. Aisling O'Connor supervised students in these internships. All of these independent studies and internships led to formal student

presentations, either oral or poster, at the Fitchburg State Undergraduate Research conference and the Massachusetts Undergraduate Research Conference at University of Massachusetts, Amherst. The research experiences have better prepared our students for graduate studies and careers in the industry. One of our recent graduates, Jack Gangemi, who worked on the Moderna internship with Dr. Awasabisah is currently pursuing his Masters degree in chemical engineering at Oregon State University while also working at Alnylam Pharmaceuticals. Another recent graduate, Aiden Luckey, who also worked on the Moderna internship under the guidance of Dr. Aisling O'Connor is working as a laboratory technician at Atlantic Medical Partners. Thomas Adler-Mandlie, a 2024 chemistry graduate who worked on a research project with Dr. Mathangi Krishnamurthy, while currently working as a lab assistant at Enamel Pure and Spatial Surgical at Worcester, MA is also actively applying for PhD programs in Medicinal chemistry.

Besides working on research projects via independent and internships in-house, some of our chemistry majors have also succeeded in securing summer internships as part of the Research Experience(REU) programs. One of our recent graduates, Shaniah Greene, worked on a REU summer internship and is currently working at the National Renewable Energy lab in Golden, CO. Another recent graduate, Racheal Lafevre worked on a summer internship at UMass Chan Medical School.

While our curriculum and research opportunities help students develop the skill sets required for careers in chemistry, our involvement with the local ACS section activities also provide networking opportunities for our students. Two of our faculty members, Dr. Krishnamurthy and Dr. Awasabisah are actively engaged in the activities of the Central Massachusetts Section of the American Chemical Society (CMSACS). The CMSACS events organized on campus and outside have provided the conducive environment for our students to meet several chemists from the area, representing both academia and industry, who are also prospective employers. In this review period, one of our chemistry majors participated as a student representative at the CMSACS strategic planning retreat in September 2022 along with Dr. Mathangi Krishnamurthy.

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.

There is significant internal demand for chemistry classes on campus. The chemistry program continues to offer a number of critical courses for many disciplines. Several of the core chemistry courses are required courses for all of the Biology majors seeking a BS. These include General Chemistry I & II (CHEM 1300 & 1400), and Organic Chemistry I & II (CHEM 2000 & 2100). All of these courses are also taken by the biology majors seeking the BA degree, except for Organic Chemistry II. Additionally, the biochemistry sequence of courses (Biochemistry I (BIOL/CHEM 3030) & II (BIOL/CHEM 3040), Biochemical Techniques (BIOL/CHEM 3060) are cross-listed as biology and chemistry courses and can be taken by both majors. Biochemistry I is a required course for students in the Biology major concentrating in Health Sciences. This concentration actually makes up over half of all biology majors. These courses are currently taught by both chemistry and biology faculty, Billy Samulak and Erin Rehrig (occasionally) respectively. Similarly, another advanced elective course, Medicinal Chemistry, is also cross-listed in both programs and is taken by both biology and chemistry majors. In 2022, Dennis Awasabisah began offering a BIOL/CHEM Metals in Biology course to both chemistry majors and minors. In addition, General Analytical

Chemistry is a chemistry elective that is taken by both chemistry majors as well as biology majors (who are pursuing a minor in chemistry). Descriptive Inorganic chemistry and environmental Chemistry are other chemistry electives that are taken by a significant number of biology majors who are pursuing a minor in chemistry. General Chemistry I and II are required courses for Environmental and Earth Science majors (Earth and Geographic Science Department), and within the Clinical Exercise Physiology major of the Exercise and Sports Sciences Department (for Pre-Physician Assistant, Pre-Physical Therapy, and Pre-Athletic Training).

General Chemistry I is required for two concentrations in the Engineering Technology Program (Electronic Engineering Technology and Manufacturing Engineering Technology), as well as Fitness Management majors in the Exercise and Sports Science program. Chemistry for Health Sciences is a course that is used by the Nursing Department, one of the largest departments in the University, and for the Environmental Public Health program in the Earth and Geographic Science Department. Chemistry for a Changing World is an introductory course that is open to all university students to be used as a General Education requirement for Scientific Inquiry. We also have faculty that teach extensively in the FYE Community of Practice (First Year Experience). This course is required for all incoming freshmen, however, we do not have update numbers or data for that course. And finally, chemistry faculty assist other departments with specific courses. The table below shows enrollment in the service courses between Fall 2021 - Spring 2025. There are two courses entitled Environmental Science and Introduction to Education 5-12 that are taught in the Honors Program and the Education Program, respectively, that chemistry faculty members share with other professors on an as needed basis.

Cumulative Enrollments in Fall and Spring General Education Courses from Fall 2021 - Spring 2024 in Service Courses Provided by Chemistry Program.

Course	FALL	SPRING	TOTALS
Chemistry in a Changing World (CHEM 1000)	15	Not offered	15
Chemistry for Health Sciences (CHEM 1200)	122	124	246
General Chemistry I (CHEM 1300)*	164	115	279
General Chemistry II (CHEM 1400)*	25	101	126
Organic Chemistry I (CHEM 2000)+	106	Not offered	106
Organic Chemistry II (CHEM 2100)+	Not offered	79	79
General Analytical Chemistry (CHEM 2400)#	13	29	42
Biochemistry I (BIOL/CHEM 3030) +	82	14	96
Medicinal Chemistry (BIOL/CHEM 4020) +	Not offered	16	16
Descriptive Inorganic Chemistry (CHEM 3600)+	22	Not offered	22

Metals in Biology (BIOL/CHEM 4015)+	8	Not offered	8
Biochemical techniques (BIOL/CHEM 3060)+	Not offered	7	7
Environmental chemistry (CHEM 3003)+	Not offered	23	23
Total Students (Contacts) in Chemistry Services Courses 2021-24			1065

* Majority of students in these classes are from majors such as Biology, Exercise and Sports Science and Engineering Technology, with Chemistry majors making up less than 10% of the class strength

+ Majority of students in these classes are Biology majors, who are pursuing a minor in chemistry

Majority of students in this class are Biology majors who are pursuing a minor in Chemistry. This course is usually taught only in the spring semester, with the exception of Fall 2023

The general educations designations for some of our chemistry courses are listed below:

Scientific Inquiry and Analysis (SI):
-CHEM 1000 (Chemistry in a Changing World)
-CHEM 1200 (Chemistry for Health Sciences)
-CHEM 1300 (General Chemistry I)
-CHEM 1400 (General Chemistry II)

Procedural and Logical Thinking (PL):
-CHEM 1300 (General Chemistry I)
-CHEM 1400 (General Chemistry II)

Advanced Integrating and Applying Learning (AIA):
-CHEM 2000 (Organic Chemistry I)
-CHEM 2100 (Organic Chemistry II)
-CHEM 3003 (Environmental Chemistry)
-CHEM 4900 (Independent study in chemistry)

Integrated High Impact Practice (IHIP):
- CHEM 4750 (Chemistry Seminar)

E: Supporting Documents: General Education Brochure and Chemistry 4 Year Plans of Study, 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
instragram.com/fsugeneraled

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.

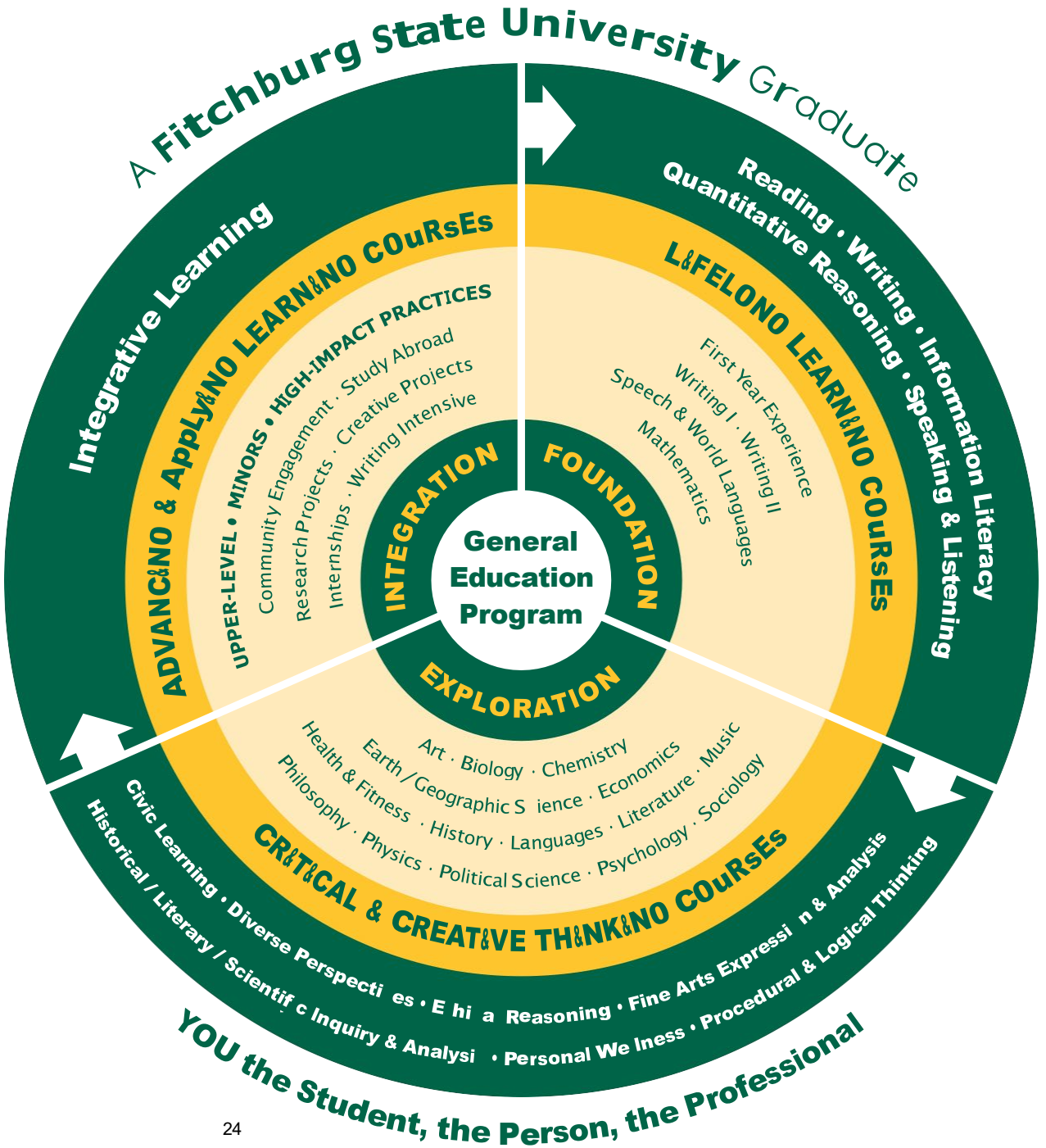
INTEGRATION
Advancing and Applying Liberal Arts & Sciences Learning
9 credits minimum

- 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

Chemistry B.S. (Bachelor of Science)

FRESHMAN YEAR

Fall Semester — 14 Credits

CHEM 1300	General Chemistry I*	4
ENGL 1100	Writing I	3
MATH 1300	Precalculus	4
FYE 1015	First Year Experience	3

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

Spring Semester — 15 Credits

CHEM 1400	General Chemistry II*	4
BIOL 1800	General Biology I (SI)	4
ENGL 1200	Writing II	3
MATH 2300	Calculus I (QR)	4

SOPHOMORE YEAR

Fall Semester — 14 Credits

CHEM 2000	Organic Chemistry I	4
MATH 2400	Calculus II (AIA)	4
	General Education (WS)	3
	General Education/Exploration	3

Spring Semester — 14 Credits

CHEM 2100	Organic Chemistry II	4
CHEM 2400	General Analytical Chemistry	4
	General Education/Exploration	3
	General Education/Exploration	3

JUNIOR YEAR

Fall Semester — 16 Credits

CHEM 3030	Biochemistry I **OR**	
CHEM 3600	Descriptive Inorganic Chemistry	3
PHYS 2300	General Physics I (PL) **OR**	
PHYS 2600	Calculus-Based Physics I (PL)	4
	General Education/Exploration	3
	General Education/Exploration	3
	Free Elective	3

Spring Semester — 17 Credits

CHEM 3200	Physical Chemistry I	4
PHYS 2400	General Physics II (AIA) **OR**	
PHYS 2700	Calculus-Based Physics II	4
	General Education/Exploration	3
	General Education/Exploration	3
	Free Elective	3

SENIOR YEAR

Fall Semester — 15-18 Credits

CHEM 3030	Biochemistry I **OR**	
CHEM 3600	Descriptive Inorganic Chemistry	3
CHEM ≥3000	Chemistry Elective **OR**	
CHEM 4900	Independent Study	3-6
	Free Elective	3
	Free Elective	3
	Free Elective	3

Spring Semester — 15-16 Credits

CHEM ≥3000	Chemistry Elective	3-4
CHEM 4750	Chemistry Seminar (Capstone) (IHIP)	3
	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.

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Suggested Four-Year Plan of Study
BIOLOGY AND CHEMISTRY

FITCHBURG STATE UNIVERSITY

Biochemistry B.S. (Bachelor of Science in Chemistry)

FRESHMAN YEAR

Fall Semester — 14 Credits

CHEM 1300	General Chemistry I*	4
ENGL 1100	Writing I	3
MATH 1300	Precalculus	4
FYE 1015	First Year Experience	3

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

Spring Semester — 15 Credits

CHEM 1400	General Chemistry II*	4
BIOL 1800	General Biology I (SI)	4
ENGL 1200	Writing II	3
MATH 2300	Calculus I (QR)	4

SOPHOMORE YEAR

Fall Semester — 14 Credits

CHEM 2000	Organic Chemistry I	4
MATH 2400	Calculus II (AIA)	4
	General Education (WS)	3
	General Education/Exploration	3

Spring Semester — 14 Credits

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

JUNIOR YEAR

Fall Semester — 16 Credits

CHEM 3030	Biochemistry I	3
PHYS 2300	General Physics I (PL)	4
	General Education/Exploration	3
	General Education/Exploration	3
	General Education/Exploration	3

Spring Semester — 16 Credits

CHEM 2400	General Analytical Chemistry	4
CHEM 3040	Biochemistry II **OR**	
CHEM 3060	Biochemical Techniques	3
	General Education/Exploration	3
	Free Elective	3
	Free Elective	3

SENIOR YEAR

Fall Semester — 16 Credits

CHEM 3600	Descriptive Inorganic Chemistry	3
PHYS 2400	General Physics II	4
	Free Elective	3
	Free Elective	3
	Free Elective	3

Spring Semester — 15 Credits

CHEM 4750	Chemistry Seminar (Capstone) (IHIP)	3
CHEM 3040	Biochemistry II **OR**	
CHEM 3060	Biochemical Techniques	3
	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.

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Suggested Four-Year Plan of Study
BIOLOGY AND CHEMISTRY

FITCHBURG STATE UNIVERSITY

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

FRESHMAN YEAR

Fall Semester — 14 Credits

CHEM 1300	General Chemistry I*	4
ENGL 1100	Writing I	3
MATH 1300	Precalculus	4
FYE 1015	First Year Experience	3

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

Spring Semester — 17 Credits

CHEM 1400	General Chemistry II*	4
ENGL 1200	Writing II	3
MATH 2300	Calculus I (QR)	4
CHEM 1860	Introduction to Education (5-12)**	3
	Gen Ed/WS	3

JUNIOR YEAR

Fall Semester — 16 Credits

CHEM 3030	Biochemistry I	3
PHYS 2300	General Physics I (PL)	4
CHEM 3600	Descriptive Inorganic Chemistry	3
SPED 3800	Inclusive Instruction (5-12)**	3
	Gen Ed/Exploration	3

Spring Semester — 17 Credits

CHEM 3200	Physical Chemistry I	4
CHEM 4750	Chemistry Seminar	3
PHYS 2400	General Physics II	4
CHEM 3015	Methods of Teaching Chemistry I**	3
	Gen Ed/Exploration	3

SOPHMORE YEAR

Fall Semester — 15 Credits

CHEM 2000	Organic Chemistry I	4
BIOL 1800	General Biology I (SI)	4
MATH 2400	Calculus II	4
EDUC 2011	Diversity in Education (5-12)**	3

Spring Semester — 14 Credits

CHEM 2100	Organic Chemistry II	4
CHEM 2400	General Analytical Chemistry	4
EDUC 2012	Teaching the Adolescent Learner (5-12)**	3
	Gen Ed/Exploration	3

** 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 Chemistry major.

SENIOR YEAR

Fall Semester — 15 Credits

CHEM 4850	Methods of Teaching Chemistry II**	3
EDUC 3122	Sheltered English Immersion	3
	Gen Ed/Exploration	3
	Gen Ed/Exploration	3
	Gen Ed/Exploration	3

Spring Semester — 12 Credits

CHEM 4012	Practicum Seminar	3
CHEM 4860	Practicum in a Secondary School I	4.5
CHEM 4870	Practicum in a Secondary School II	4.5

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.

The PLOs is a shared responsibility of members of the department. The current Assessment Plan was drafted in 2019 at a Fall Department Retreat and has been implemented in several classes since the last self study (2021). The program learning outcomes are based on the recommendations set forth by the American Chemical Society for programs in Chemistry. The department Assessment Committee composed of Chemists and Biologists is responsible for assessing the PLOs for Chemistry. The data generated by the direct assessment criteria, delineated in the Assessment Plan is analyzed and evaluated on a rolling basis. Members of the Assessment committee and the department chair then communicate these results either at an annual retreat held before the start of the academic year and/or monthly updates at department meetings. Each year the Committee submits Annual Assessment Report to the Office of Institutional Research and Planning, which is peer-reviewed by the University Assessment Research Committee (UARC). The UARC then submits their report and recommendations back to the department. The Department Assessment Committee reviews the report and creates an action plan. The assessment plan for the Chemistry Program is included at the end of this section in the supporting documents section.

PLO 1 - Disciplinary knowledge

Students should understand and be able to apply their understanding of all chemistry subdisciplines and use appropriate laboratory skills and instrumentation to solve problems. These areas of knowledge include:

- Basic chemical concepts such as stoichiometry, states of matter, atomic structure, molecular structure and bonding, thermodynamics, equilibria, and kinetics.
- Foundational knowledge and skills in analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, and physical chemistry.
- Foundational laboratory skills including synthesis of molecules, measurement of chemical properties, determination of structures, use of modern instrumentation and computational modeling.

PLO 2 - Lab skills

Students should be able to demonstrate and apply foundational laboratory skills. The areas of skills include:

- Basic laboratory skills such as keeping a notebook, use of electronic balances and volumetric glassware, preparation of solutions, chemical measurements using pH electrodes and spectrophotometers.
- Prepare solutions, record data correctly, and perform chemical synthesis and analysis of compounds, as well as use standard laboratory equipment and programs to solve problems.

PLO 3 - Safety

Students should be able to demonstrate and apply their understanding of the concepts of safe lab practices, and be able to evaluate and assess safety risks associated with laboratory experiences. Students must be able to:

- Carry out responsible disposal techniques
- Comply with safety regulations
- Properly use personal protective equipment to minimize exposure to hazards
- Recognize chemical and physical hazards in laboratories, assess the risks from these hazards, know how to minimize the risks, and prepare for emergencies.
- Understand the categories of hazards associated with chemicals (health, physical, and environmental)
- Use Safety Data Sheets (SDSs) and other standard printed and online safety reference

PLO 4 - Communication skills

Students should be able to present information in a clear and organized manner, write well-organized and concise reports in a scientifically appropriate style, and use relevant technology in their communications.

B. Measures and Results

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

As stated above, the department Assessment Committee plays an active role in analyzing and evaluating assessment data based on the Curriculum Map included in the Assessment Plan included at the end of this section.

The table below shows the 4 Program Learning Outcomes (PLOs) and which classes each outcome is assessed.

Course	Assessment Program Learning Outcomes (PLOs)			
	PLO 1	PLO 2	PLO 3	PLO 4
CHEM 1300 *General Chemistry I*	1	1	1	0
CHEM 1400 *General Chemistry II*	1	1	1	0
CHEM 2000 *Organic Chemistry I*	1	2	2A	1
CHEM 2100 *Organic Chemistry II*	1	2A	3A	1

CHEM 2400 *General Analytical Chemistry*	2	3A	3	2
CHEM 3030 *Biochemistry*	2	0	0	2
CHEM 3200 *Physical Chemistry*	3	3	3	3
CHEM 3600 *Inorganic Chemistry*	3	0	0	3
CHEM 4750 *Chemistry Seminar*	3A	0	3A	3A

KEY

PLO = Program Learning Outcome

Number codes represent assessment categories from the Assessment Report Template

0 = PLO is not addressed within the specific course

1 = 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.

The department does both direct and indirect assessments of our program to ensure we are meeting the PLOs.

Direct Assessment

PLO 1- Students in our Chemistry Seminar (Capstone class) are assessed on disciplinary knowledge of topics in foundational chemistry (General Chemistry and Organic Chemistry). All students in the Seminar class are given an exit exam as part of the course. Our criteria for success under PLO 1 is attained if 90% of students to score > 50% and 80% of students to score > 70%. These numbers were agreed upon as part of the 2019 assessment plan set forth by the Departmental Assessment Committee based on the Fitchburg State's grading criteria (70% or higher is equivalent to 2.0 GPA, which is the minimum major GPA requirement for all students).

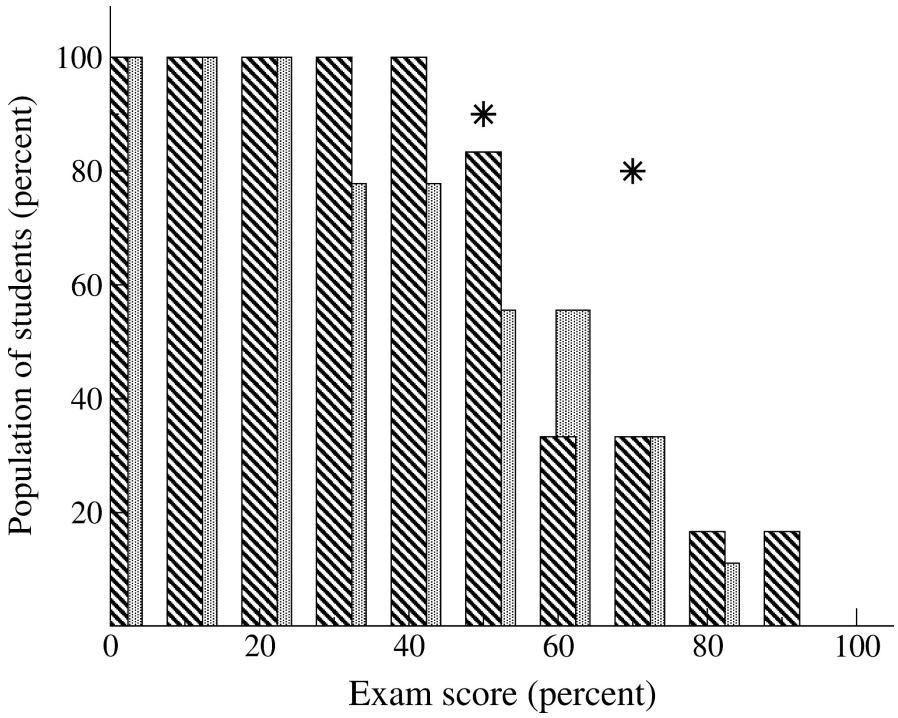

Figure 3.1 Student performance on the Chemistry exit exam. Program targets are indicated as asterisks. There were 9 and 6 students in Spring of 2019 (dot filled columns) and F23 (striped columns) respectively that took the exam. ***The target for PLO 1 was not met.***

PLO 2 - Questions are incorporated in assignments to assess students ability in demonstrating and applying foundational laboratory skills. Our PLO target is 90% of students to score > 70%. Although we had a very limited sample size we had, we met (and exceeded) expectations.

- AY21: Not assessed
- AY22: The two chemistry majors were assessed in Organic Chemistry II in S23 and scored 90% and 93%.
- AY23: Not assessed

PLO 3 - Students should be able to demonstrate and apply their understanding of the concepts of safe laboratory practices. They should be able to evaluate and assess safety risks associated with laboratory experiences. Students in their Sophomore and Junior level are assessed annually. Both Chemistry and Biology majors are assessed. Our criteria for success is attained if 90% of students score >70% and 95% of the students > 90%.

- Organic Chemistry I (Fall 2021): All students assessed (N=4) scored 100% of assignments they submitted. Organic Chemistry II (Spring 2022): All the three students that were assessed similarly had a perfect score (100%).

- Organic Chemistry I (Fall 2022): The two students both averaged 87.5%. Organic Chemistry II (Spring 2023): One student scored a perfect 100% while the second student got a score of 86.7% in the lab safety evaluation. In the lab skills assessment that was administered for the first time, one student scored 90% while the second student received a score of 93%.

- Organic Chemistry I (Fall 2023): The fours students scored 84.6%, 76.9%, 84.6% and 96.2% respectively in their safety assessment assignments.

Again, although the sample sizes are small, we are doing an excellent job of meeting the learning outcomes of safety in our chemistry courses.

PLO 4 - Oral presentations. Students in our Chemistry Seminar class are required to give oral presentations of a research topic. Students are assessed based on a criteria outlined in our oral presentation rubric where a score of 1 is deficient; 2 is sufficient and 3 is proficient. A majority of students should demonstrate proficiency on oral presentations by attaining a score > 2 (sufficient).

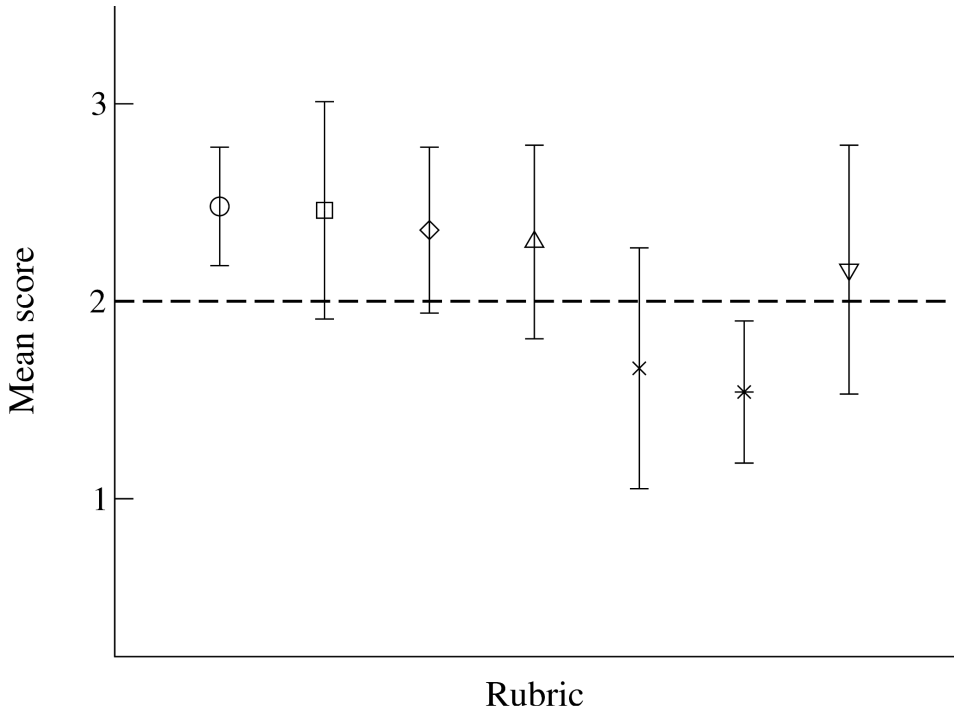

Figure 3.2: Mean scores from student oral presentations in Chemistry Seminar in F23. Presentations were evaluated by members of the Departmental Assessment Committee with respect to the following rubric categories: ○ -Define problems clearly, □ -Understanding, ◇ - Information presented in a clear and organized

manner, △ - Presents relevant data, X - Ability to retrieve information by searching the chemical literature, * - Proper citation of others' work, ▽ - Evaluate technical articles critically. The dashed horizontal line indicates the target threshold for PLO 4 as specified above. Error bars represent the standard deviation of the mean (N=5).

Analysis: On six of the seven outcomes assessed, a majority of students demonstrated sufficient or greater. A majority of students scored less than proficient on "Proper citation of others' work". Students in the course did well using sources in the written term paper, so clearly they can cite their sources. Instead, there may have been confusion about the research presentation format.

Overall, we are meeting the expectations of PLO4 regarding oral presentations, but may need to give students more guidance and clarity about how and and in what formats citations should be listed.

Indirect Assessment

In our Chemistry Capstone Seminar class, we use annual student feedback as an indirect method(s) for assessing PLO 1. The department Student Affairs Committee collects student feedback through an annual student survey. This provides a qualitative indicator of how well our program is doing. Identification of strengths and challenges of the Biology program are discussed at an annual retreat. Discussed in detail in the **Students** (V) section.

C. Action Items and Use of Results

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

The PLO1 results were discussed at our spring departmental retreat (May 2024). It was noted that interpretation of results limited by small sample sizes and high proportion of transfer students, e.g., ⅔ of the students assessed in F23 did not take at least one General Chemistry class at Fitchburg State. Greater reinforcement of introductory material in upper division chemistry classes may be needed. General Chemistry content is currently covered in Organic pre-lab questions, and this should help students review the material, though scores tend to be low. While these scores may also reflect challenges faced by the COVID cohort, results from past years such as S19 were similar.

We have also discussed the reliability of the exit exam data from the chemistry seminar. Students didn't take the exam seriously because there was little value for them personally. The students received credit for taking the exam, but not necessarily whether they got the answers correct and they did not have to study for the exam prior to taking it. Additionally, a few chemistry majors were not given the exit exam due to taking an independent study as a capstone instead of chemistry seminar which was not offered due to low enrollments and faculty teaching loads.

Assessment data collected on PLO 2 (lab skills) and PLO 3 (lab safety) indicate students are exceeding expectations for these learning outcomes.

At the spring departmental retreat (5/16/2024) there was discussion pertaining to PLO4 on adopting the American Chemical Society format in order to improve proper citation in oral presentations This format includes

a full bibliographic reference on the slide where information is referenced rather than at the end of the presentation. We are now in the process of implementing this rubric and format.

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, chair of the Department of Biology and Chemistry, led the development of the rubric for Scientific Inquiry and Analysis, while Dr. Christopher Cratsley, Biology faculty within the Department of Biology and Chemistry, 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 Assessing Scientific Inquiry (SI) in General Education Courses	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.

E: Supporting Documents: Chemistry Programmatic Assessment Plan

Programmatic Assessment Plan

Program Name: Chemistry Created By: Dept. Biology and Chemistry Assessment Committee Date: May 20, 2020

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.

School of Health and Natural Sciences Vision

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. 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.

Department of Biology and Chemistry Vision

Chemistry Program Mission

Chemistry Program Vision

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 through 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.

Liberal Arts & Science Learning Outcomes (LA&S LOs)
General Education Curriculum

LO Code	LA&S Learning Outcomes (LA&S LOs)	Alignment to ELOs
LA&S 1	LA&S LO1: Objective 1.1	

Division Learning Outcomes (DLOs)

LO Code	Division Student Learning Outcomes	Alignment to LA&S LOs or ELOs
DIV 1	DIV LO1: Objective 1.1	

Department Learning Outcomes

LO Code	(Department Name) Learning Outcomes (LOs)	Alignment to Division/LA&S LOs or ELOs

Program Learning Outcomes (PLOs)

LO Code	(Program Name) Learning Outcomes (LOs)	Alignment to Department/Division/ LA&S LOs or ELOs
PLO 1	Disciplinary knowledge Students should understand and be able to apply their understanding of all chemistry sub-disciplines and use appropriate laboratory skills and instrumentation to solve problems. These areas of knowledge include: ● Basic chemical concepts such as stoichiometry, states of matter, atomic structure, molecular structure and bonding, thermodynamics, equilibria, and kinetics. ● Foundational knowledge and skills in analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, and physical chemistry.	

- Foundational laboratory skills including synthesis of molecules, measurement of chemical properties, determination of structures, use of modern instrumentation and computational modeling.

PLO 2

Lab skills

Students should be able to demonstrate and apply foundational laboratory skills. The areas of skills include:

- Basic laboratory skills such as keeping a notebook, use of electronic balances and volumetric glassware, preparation of solutions, chemical measurements using pH electrodes and spectrophotometers.
- prepare solutions, record data correctly, and perform chemical synthesis and analysis of compounds, as well as use standard laboratory equipment and programs to solve problems.

PLO 3

Safety

Students should be able to demonstrate and apply their understanding of the concepts of safe lab practices, and be able to evaluate and assess safety risks associated with laboratory experiences.
Students must be able to:

- Carry out responsible disposal techniques
- Comply with safety regulations
- Properly use personal protective equipment to minimize exposure to hazards
- Recognize chemical and physical hazards in laboratories, assess the risks from these hazards, know how to minimize the risks, and prepare for emergencies.
- Understand the categories of hazards associated with chemicals (health, physical, and environmental)
- Use Safety Data Sheets (SDSs) and other standard printed and online safety reference

PLO 4

Communication skills

Students should be able to present information in a clear and organized manner, write well-organized and concise reports in a scientifically appropriate style, and use relevant technology in their communications.

PART II: CURRICULUM MAPPING

Instructions

Add the "required" courses in the left column starting with First Level to Upper Level.
Add Program Learning Outcomes as a header for each column
Add one number per cell to indicate the level at which the outcome is addressed in the course (see key below).
Add an "A" in cells to indicate an assessment activity from the course will be used in Program Assessment.
Focus should be only the required courses for all majors in the field of study. An additional table should be created for concentrations to map the additional learning outcomes, if necessary.

COMMON (Program Name) CORE

	PLO 1	PLO 2	PLO 3	PLO 4
CHEM 1300 ***G-Chem I***	1	1	1	0
CHEM 1400 ***G-Chem II***	1	1	1	0
CHEM 2000 ***O-Chem I***	1	2	2A	1
CHEM 2100 ***O-Chem II***	1	2A	3A	1
CHEM 2400 ***Analytical***	2	3A	3	2
CHEM 3030 ***Biochem***	2	0	0	2
CHEM 3200 ***P-Chem***	3	3	3	3
CHEM 3600 ***Inorganic***	3	0	0	3
CHEM 4750 ***Seminar***	3A	0	3A	3A

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

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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.

Direct Assessment

Using the table below, list and briefly describe the **direct method(s)** used to collect information assessing whether students are learning the core sets of knowledge (K), skills (S) and attitudes (A) identified as essential.

PLO #	Assessment description (written project, oral presentation with rubric, etc.)	Timing of Assessment (annual, semester, bi-annual, etc.)	When assessment is to be administered in student program (internship, 4th year, 1st year, etc.)	To which students will assessments administered (all, only a sample, etc.)	What is the target set for the PLO? (criteria for success)
1	Capstone exam	Annual	Junior or senior year	All students in the major	90% of students to score > 50% 80% of students to score > 70% Aggregate student performance in subject areas monitored.
2	Embedded exam questions	Annual	Sophomore and junior years	All students in the major	90% of students to score > 70%
3	I. Embedded pre-lab questions II. Chemical hygiene assignment*	Annual	Sophomore and senior year	All students in the major	I. 90% of students to score >70% II. 95% of students to score > 90%
4	Oral presentations	Annual	Junior/senior year	All students in the major	A majority of students should demonstrate a proficiency on oral presentations by attaining a score > 2 (sufficient)

*Note: I and II are independent assessments; i.e., not a pre-/post-test combination

Indirect Assessment

Using the table below, list and briefly describe the **indirect method(s)** used to supplement direct measures above.

Indirect measures include, but are not limited to: student surveys, focus groups, meetings with advisory boards, employer feedback, internship feedback, alumni surveys, etc.

PLO #	Assessment description (survey, focus group, interviews, etc.)	When assessment is to be administered	Who will give indirect feedback	Criteria for Success or Goal to be Achieved
1	Student feedback survey	Annual	Dept. Student Affairs Committee	Qualitative indicator for PLO 1

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 AY 20-21	Year 2 AY 21-22	Year 3 AY 22-23	Year 4 AY 23-24	Year 5 AY 24-25
PLO 1	x			x	
PLO 2	x		x		
PLO 3	x				
PLO 4		x			x

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Explanation:

Implementation of the assessment plan should be a shared responsibility--identify who was involved in developing the assessment plan
Identify who will be involved in the analysis and evaluation of the subsequent evidence
Identify who will be responsible for communicating results
Identify who will be responsible for creating an action plan

The AY 2019-2020 departmental assessment committee developed this assessment plan. The data generated by the direct assessment criteria, delineated above, will be analyzed and evaluated on a rolling basis by members of the assessment committee. Members of the assessment committee and the department chair will communicate these results either at an annual retreat held before the start of the academic year and/or monthly updates at department meetings. The action plan will be completed as a component of the AY2024-2025 program review by the following departmental committees: Assessment, Curriculum, and Student Affairs

Glossary of Terms

Assessment Method: The assessment instrument(s) used to assess student learning.
Direct: Linked to actual student work – i.e. written assignments, oral presentations, projects, etc.
Indirect: Not actual student work – i.e. surveys, focus groups, employer feedback, etc.

Department/Program Goals and Objectives: Usually a combination of learning outcomes and strategic outcomes, that may or may not be based on student-centered work.

Essential Learning Outcome (ELO): The University-level Learning Outcomes - should be very broad. These are the specific characteristics a student should have upon graduation from the institution. Assessment from the Course, Program, Department and Divisional levels will link upward to show achievement.

Learning Outcome (LO): Measurable statements that indicate the specific characteristics students should exhibit in order to demonstrate achievement. The levels of Learning Outcomes are LA&S, Divisional, Department, Program and Course.

Mission Statement: A concise statement that explains the purpose of the division, department, or program based on the primary functions.

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Source of Assessment: The course and student work that will provide data.

Vision Statement: A very concise (usually one sentence or partial sentence) statement that is “forward” thinking and describes what the Division, Department or Program strives to be.

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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 Chemistry faculty members at Fitchburg State are highly qualified individuals committed to their primary mission of providing students with a working knowledge of chemistry 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 Chemistry faculty currently consists of 6 full-time (FT) members. The Table below lists rank, year of appointment, and area of specialty for each faculty member. The training and expertise of the current faculty members is balanced among the chemistry subdisciplines and no additional faculty members are required at the current time. Biology faculty members are listed 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 a Biology 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. For example, faculty members have taught the Freshman Year Experience course. 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 only absolutely necessary, 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 and is on a 10-month schedule. A third, full time-technician who was shared with our department and EGPHS has since moved into a new role at the university. The description and responsibilities of this position are still being negotiated, but should be posted in the spring of 2025. The roles of the technicians include setting up labs, ordering, stocking lab supplies, and most importantly, maintaining and enforcing health and safety regulations with the guidance of our Health and Safety Office, Marco Bengrazi (a former alumni of the Biology program). While assigned to different programs within the department the technicians provide back-up and coverage to all programs 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
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
Billy Samulak	Associate Professor	Ph.D. 2014	Biochemistry, Analytical Chemistry, Science Education
Steven Fiedler	Associate Professor	Ph.D. 2014	Physical Chemistry, General Chemistry, Solvation Properties
Aisling O'Connor	Associate Professor	Ph.D. 2008	Analytical Chemistry and Nutrition

Mathangi Krishnamurthy	Associate Professor	Ph.D. 2011	Organic and Medicinal Chemistry
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, General 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

B. Retention

Describe retention initiatives for faculty.

The chemistry faculty have only had turnover due to retirement. At the time of our last self-study in 2021 we had 7 FT Chemistry faculty members. The reduction in the total number of faculty is due to the retirement of our second organic chemist and no replacement position has been requested. The Department as a whole has fostered a supportive, collegial, and professional environment for faculty which has resulted in staffing stability and the ability for faculty to apply for and receive promotion to higher academic rank.

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 overall 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 sought by faculty that have been granted (and not rewarded) are 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.

Collaboration with other Fitchburg State Faculty members as well as researchers at other institutions which gives faculty members the opportunity to engage in larger and more impactful research projects. For example, Dr. Emma Downs collaborates with Dr. Erin Rehrig in Biology and Dr. Catherine Buell in Mathematics on studying the effects of silver nanoparticles on plants and the environment. 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 URC and the UMass Amherst Statewide Research Conference. Dr. Dennis Awasabisah's research seeks to understand the hemozoin formation process during the pathogenic blood stage of the Plasmodium (malaria) parasite. He uses metalloporphyrins as synthetic heme models to understand this process. His group also studies the role antimalarials play in inhibiting the hemozoin formation process. His long-term research goal is to design effective antimalarial drugs to help curb the malaria endemic. Dr. Awasabisah has worked with several students on his projects at Fitchburg State, most recently Research Scholars Program which was funded by the Moderna Charitable Foundation, but also collaborates with researchers at Clark University and the University of Oklahoma on several projects. Recently, this collaborative work resulted in a publication with a student as co-author.

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. More recently, Dr. O'Connor was another faculty participant on the Research Scholars Program which was funded by the Moderna Charitable Foundation. The focus of her project was the GC/MS analysis on vapes/ e-cigarettes where they focused on identifying the main chemical constituents of vaping liquids contained in locally purchased e-cigarettes using NIST mass spectral libraries. Health hazards of commonly identified chemicals were also explored. The student presented our work at the FSU and UMass Amherst Undergraduate Conferences in April 2024.

The commitment to students permeates the research conducted by each faculty member. Supervising students research projects and especially Honors Program thesis projects are time-consuming and require the faculty members to act more as a Primary Investigator (PI) who must maintain an active research program attractive to students, garner the resources necessary to conduct the research, and then supervise the students in the laboratory. Dr.Mathangi Krishnamurthy has found this balance in her research in the field of medicinal chemistry. Her work involves synthesis of cannabinoid-based drugs as anticancer and anti-inflammatory agents. She is also interested in the synthesis compounds that can bind with the DNA minor groove and help in treatment of protozoal infections. Since 2017, she has supervised research projects for nine students in the form of independent studies and honors thesis projects. Her students have presented their work at our FSU Undergraduate Research conference and at UMASS Amherst Undergraduate Research conference.

The diversity of research inquiry available to students is illustrated by the contrast between the work previously described with the research completed by Drs. Fiedler and Samulak. Quantum chemical calculations completed by Dr. Steven Fiedler and his students. This work has been incorporated into a number of published studies, most recently to probe liquid helium as a prototypical dielectic media with fluorophores and chromophores. The replication of experimental absorbance and fluorescence spectra often require solute-helium Rydberg-state pair potentials and transition dipole moments calculated to a higher degree of accuracy than afforded by conventional *ab initio* approaches. To this end, very large basis sets are required to be employed by multireference approaches such as multireference configuration interaction and equation of motion coupled cluster theory. The research of Dr. Samulak is another example of how faculty research interests can be combined to expand experiences for students. Dr. Samulak joined a collaboration

with UMass-Amherst to use a protein expression system developed there - Malate Dehydrogenase and turn it into a Course-Based Undergraduate Research Experience (CURE) at FSU, combining her work with crosslinkers in the course BIOL 3060: biochemical techniques. That course has been offered once as part of the collaboration and is scheduled to be run as a CURE in 2025.

Dr. Samulak and Dr. Downs are members of a professional development program on campus known as the Faculty Academy, which is based on the "pedagogy of real talk" (PRT) authored by Paul Hernendez. This pedagogy is based around the idea that students who have a sense of belonging in college are more likely to persist and be successful in school. The defined outcomes are a reduction in course withdrawals and failure rates, improved student grades, and an increase in persistence, retention, and overall student success. In the end, the pedagogy seeks to improve the quality of our students' lives through their successful completion of higher education. The Faculty Academy reflects a commitment to the growth and development of the environment at FSU to be one where all students can achieve. There are two main components to the pedagogy - real talks and alternative lessons. Drs. Samulak and Downs have developed such talks and activities and incorporated those into their introductory classes. As a result of this pedagogy, students seem to be more successful in these classes . Dr. Samulak has obtained IRB approval to survey students about the work, along with their perceptions of science in a GOB class.

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. Dr. Emma Downs has served as the

Assistant Honors Program Coordinator since Fall 2022 and is currently the Interim Honors Program Coordinator. This position involves one course release per semester and a heavy advising load (2 course releases as Coordinator). She has also been on the Honors Advisory Committee since Fall 2022.

Dr. Krishnamurthy is passionate about science outreach and is actively involved with the science outreach activities of the Central Massachusetts Section of the American Chemical Society (CMSACS). She has been serving as the Outreach coordinator for the section since 2017 and has organized several outreach events for the National Chemistry week and Chemists Celebrate Earth week events at local schools, Boys and Girls club and museums. In this role, she also collaborates with volunteers from other local sections such as the Northeastern ACS section (NESACS). In addition, Dr. Krishnamurthy has been serving as the CMSACS Coordinator of the Chemistry Olympiad for the last four years. In her role as the olympiad coordinator, she works closely with the local high school chemistry teachers in choosing candidates for taking the national exams. Following the candidate selection, she also administers both the written and practical exams of the National Chemistry olympiad every year on the FSU campus. She has also served as the Poster session Co-Chair for the Northeastern ACS Regional Meeting (NERM) held in Boston in June 2023.

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 Appendix A. A few examples are discussed briefly here. As discussed previously, Drs. Krishnamurthy and Awasabisah are active members of our local ACS section, and all faculty help to recruit student members. With her passion for science outreach, Dr. Krishnamurthy has served in local high schools and with the Boston Museum of Science. Dr. Samulak has multiple collaborations with partners at UMass-Amherst. Dr. Awasabish and Dr. Downs both work with other faculty at Clark University. Dr. Samulak is heavily involved in the education department as the coordinator for students seeking an initial licence to teach middle school science or chemistry.

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 warnings are available at that time), 2) setting up a schedule for the next semester, and 3) 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

Recruitment:

Departmental efforts to recruit students primarily occur through the university-organized open houses and "Future Falcon Days". Every fall semester the university hosts open houses for prospective students and during the spring semester provides "Future Falcon Days" for admitted students. During these events where students and their families visit campus, 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, we also offer a smaller session for those who are more seriously considering our major where faculty and current students give a presentation on the department and talk to the attendees about the expectations and career opportunities. We give tours of our renovated labs, students complete a chemistry experiment, and families have time to get their questions answered by faculty and current students.

Several individual faculty members perform outreach events as part of their scholarly interests or their service to the broader community. Participation in these activities gives prospective students experience with our department and helps to advertise the majors that we offer. Examples of these activities are bulleted below and more details can be found in the faculty section (V) of this document.

- Multiple chemistry faculty serve as science fair judges for local or regional science fairs
- Emma Downs and Billy Samulak designed and ran sessions for a "future falcon academy" where local students performed chemistry experiments in our labs during school vacation weeks
- Erin Rehrig has offered hands-on STEM activities for local schools.
- Billy Samulak has served for multiple years in McKay Arts Academy 3rd grade classrooms doing a 5 week science experiment program, culminating in a visit to FSU.
- Mathangi Krishnamurthy has worked in collaboration with an eighth grade science teacher at McKay Arts academy as part of the "ACS Science Coaches" program sponsored by the American Chemical Society. This program involved 8-10 classroom visitations during the school year, when hands-on chemistry activities were conducted. The classroom visitations were also utilized to facilitate discussions on careers in chemistry, how to prepare for college, and help with science fair projects.

Our external reviewer from our 2021 self-study ***strongly*** encouraged the department and university to promote and market our degrees. Language from his recommendations state that "The B.S. in Chemistry with Biochemistry Concentration must also be promoted much more strongly. As such, developing separate marketing materials by Admissions to really emphasize the B.S. in chemistry with concentration in BIOCHEMISTRY is crucial." To date, this recruitment effort has not been made.

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 such as kickball games, game nights, science nights, etc 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 be fun, but put students in touch with their advisor to get any last minute questions answered
  - Billy Samulak and Emma Downs (and other biology faculty) 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 faculty and course content

- Assisting Students in the Transition from High School to College by Teaching First Year Experience (FYE) Courses :
  - Teaching FYE - Emma Downs, Billy Samulak (and other biology 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.

- Helping Students to Succeed in Their Classes
  - Supporting successful students in becoming tutors
  - Using embedded tutors in our core classes
  - Holding virtual and or open office hours

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

- 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.

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. Chemistry majors must earn a 2.0 in CHEM 1300 General Chemistry I and General Chemistry II to continue in the major and may only repeat each of these courses once. 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.

Supports:

1. **Fostering a Sense of Belonging**

Our supports begin 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 articulation 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. One of the 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.

3. Helping Students Succeed in Their Classes

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.

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)

4. Getting Students Involved in 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.

As part of efforts to support recruitment and retention for biology and chemistry 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.

5. 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.

Chemistry faculty in particular are heavily invested in the success of each student in our program. We spend extra effort in advising our majors, recommending they seek tutoring support and academic coaching as soon as any troubles emerge. Students are strongly encouraged to complete the calculus requirements as early as possible to ensure their success in physical chemistry. We double-check that students have registered for correct courses and email corrections when needed. Each semester, we review our programs and explain to students why they need to complete a specific course at a specific time.

Due to our small numbers, upper division classes for chemistry majors are typically offered every other year but have significant prerequisite courses. Faculty meet annually to discuss the progress of our students and decide on course scheduling. We have changed the scheduling of our courses so that chemistry majors do not have to take too many difficult classes at once - for example, we have separated our physical chemistry class into a spring semester while our capstone chemistry seminar is offered in the fall. We cross-list and recruit other majors into our electives as often as possible so that the courses can be offered more frequently, providing students more flexibility in scheduling. For example, CHEM 3060 - biochemical techniques is required for chemistry majors with a biochemistry concentration, but was recently approved to count as a biology capstone. Thus, chemistry majors and biology majors can take the class. Environmental chemistry can count as an elective for earth and environmental science majors. We also work with other departments to be sure that their required classes do not conflict with our major courses - for example with physics and education.

6. Career Mentoring

Every Chemistry major is required to take Chemistry Seminar (CHEM 4750). In this course, students learn to write a resume and cover letter and are encouraged to explore different careers in Chemistry. Often, professionals from industry are invited to speak via Zoom to the class. Students are encouraged if they still have questions to visit the Career and Advising Center. We encourage students to attend career fairs and sign up for a free Handshake account where they can subscribe to receive specific postings about careers, internships, graduate schools, and research opportunities in Chemistry.

C. Significant Trends

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

Due to the short review period, and the small number of chemistry majors we have, it is irresponsible to extrapolate and identify significant trends. Instead, we will highlight specific data points.

The Department of Biology and Chemistry solicits feedback from biology and chemistry majors using an online survey composed of both multiple choice and open response questions. The department typically sends out the survey every other year except during special circumstances such as COVID. In general, overall satisfaction (very satisfied and satisfied) of our majors is approximately the same when comparing the department to Fitchburg State University and most students are satisfied with their experience within our department.

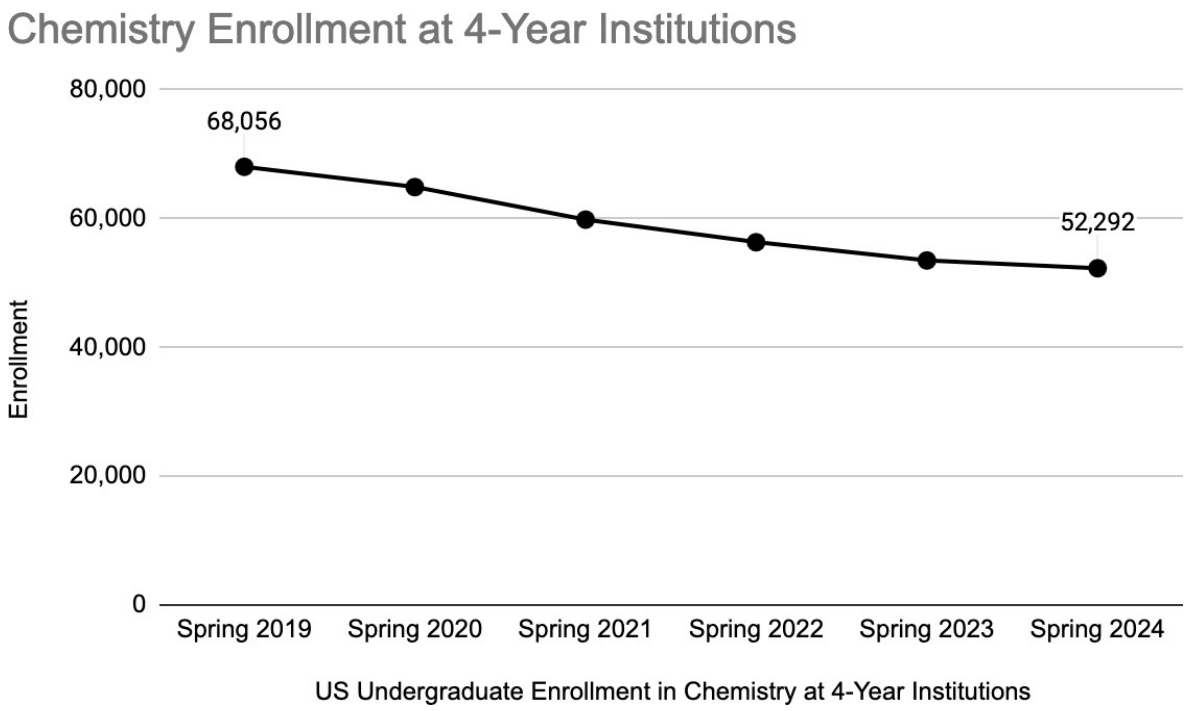
We are celebrating our first ever graduate from the chemistry in secondary education with initial teaching licensure. That student is successfully employed and teaching high school chemistry. We have two additional students who are on track to graduate in the upcoming years. To date, we have not graduated a student within our biochemistry concentration, however, in AY 24, we have 3 students enrolled, up from 1 the previous year.

The majority of our majors graduate without a concentration. Over the short review period, ten students have graduated from our program with a major in chemistry. Of those 11, 7 graduates are employed or pursuing graduate studies in chemistry or a chemistry-related field, 2 are unknown since summer 2023, 1 is unknown, and 1 is pursuing graduate work in his second major (mathematics).

The table below lists our graduates since 2021 and what we know was their last position.

2022 (3)	Student Name	Company Name	Job Title
1	Mathew Cruz Vives		
2	Shaniah Greene	National Renewable Energy Laboratory, Golden, CO	Research Technologist I
3	Gaelle Polinice	Walgreen's (last position)	Pharmacy Technician
2023 (2)			
1	Dylan Dandy	North Carolina State University, NC	PhD student (Mathematics)
2	Kaitlyn Commodore	Holy Family Academy, Gardner, MA	Substitute Teacher
2024 (6)			
1	Thomas Adler-Mandile	Enamel Pure and Spatial Surgical, Worcester, MA	
2	Jack Gangemi	Oregon State University, OR	MS student (Chemical engineering)
3	Racheal Lefevre	UMASS Chan Medical School (last position)	Clinical Fellow (Summer position)
4	Aiden Luckey	Atlantic Medical Partners, Fitchburg, MA	Lab Technician
5	Mariana Wendling	Hollis Brookline HS, NH	High School Teacher
6	Emily Pham	MCPHS, MA	Pharmacy Program

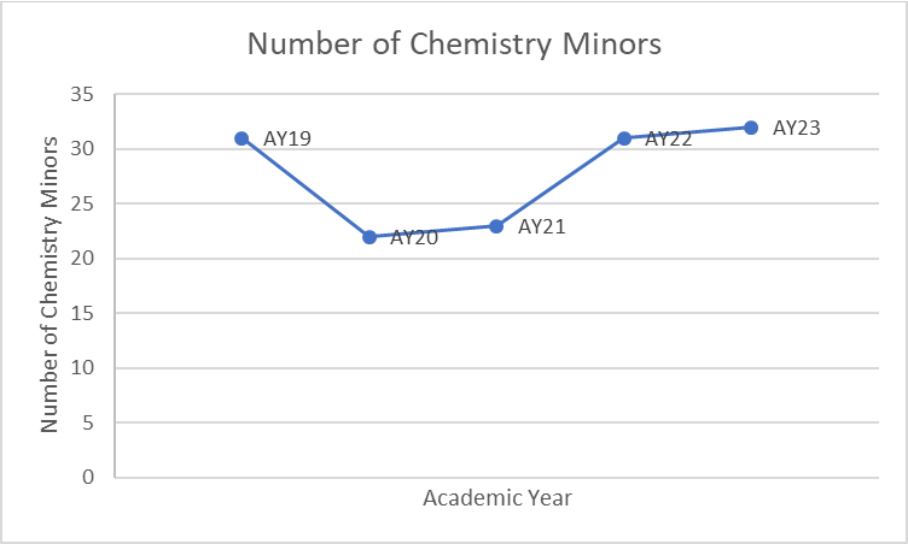
We have 34 total graduates since the first students graduated in 2016. We will note that graduation rates across the region have declined and the number of incoming freshmen are also less likely to major in chemistry as described in a recent C&EN news report in October of 2024.



https://nscresearchcenter.org/current-term-enrollment-estimates/ provides a "Data Appendix" spreadsheet.

Although our numbers of graduating majors are small, we consistently graduate an average of 10 or more students annually with a chemistry minor. In analyzing our alumni data, many biology majors who graduate with a chemistry minor are employed in a chemistry field, so the minor is preparing them well for employment. We will also note that the number of students in the chemistry minor dipped in AY20 and AY21, likely due to the pandemic, but since then has rebounded and is staying consistent at approximately 30 students.

The graph below shows Chemistry minor trends for AY 21, 22, and 23 which are in review period. Prior to the COVID pandemic, we were averaging 30 students per year in the minor. We have mostly returned to those levels.



Prior to 2020, students enrolled in chemistry classes made up 3.3% of the classes across the university. In AY21, AY22, and AY23, chemistry enrollments have been consistently at 2.6%. In AY24, the enrollment has risen to 2.9% of enrollments, suggesting we are coming back after COVID. These courses are primarily service courses to other majors, including biology, exercise and sports science, nursing, and engineering technology.

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 Chemistry Seminar course. In this course, students must use the scientific literature to research a topic of their choice. Students also have the ability to gain hands-on research experience on campus by taking either CHEM 1600 Introduction to Research or CHEM 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 setting. Students can get upper-level chemistry credit through an independent study which 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. Chemistry majors that are also in the Honors Program are required to do a two semester (6 credits) thesis project, where they are typically 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 the chart at the end of this section.

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 CHEM 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.

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. To date, four chemistry majors have participated in this program.

All of our majors who are seeking a chemistry 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 chemistry 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 chemistry high school classroom under the supervision of the Supervising Practitioner and a University Supervisor. The candidates work alongside the Supervising Practitioner and perform all 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.

The tables below list year, semester, project, student, and supervising faculty member for experiential learning projects from the last self-study.

INDEPENDENT STUDIES, RESEARCH PROJECTS, HONORS THESIS, PRACTICA					
Year	**Semester**	**Full Project Title**	**Student(s)**	**Instructor**	**Program**
2021	Fall	Honors project: Mild synthetic procedure for deoxygenation of substituted phenols and their applications in drug synthesis	Matthew Sadowski	Mathangi Krishnamurthy	Chemistry
2022	Fall	Synthesis of insect pheromones	Thomas Adler Mandile	Mathangi Krishnamurthy	Chemistry
2023	Spring	Synthesis of insect pheromones	Thomas Adler Mandile	Mathangi Krishnamurthy	Chemistry
2023	Fall	Heme Models	Zachary Desir	Dennis Awasabisah	Chemistry
2023	Fall	GC/MS Analysis of Vapes	Aiden Luckey	Aisling O'Connor	Chemistry
2023	Fall	Development of Forensic Chemistry Labs	Mariana Wendling	Aisling O'Connor	Chemistry
2024	Spring/Fall	PFAS in Mass: Where and why water is threatened	Abigail Leahey	Chris Picone and Emma Downs	Biology & Chemistry
2024	Spring	Iron(III) Porphyrin Complex and its Reactions with Quinoline-based Antimalarial Drugs	Adama Bangura	Dennis Awasabisah	Chemistry
2024	Spring	Synthetic Heme-antimalarial Adducts; Synthesis and Electrochemistry	Jack Gangemi	Dennis Awasabisah	Chemistry
2024	Spring	Synthesis and Reactions of Iron(III) μ-oxo-bridged Tetraphenylporphyrin	Zachary Desir	Dennis Awasabisah	Chemistry
2024	Spring	Honors thesis: Synthesis of combretastatin analogs	Marina Kamayou	Mathangi Krishnamurthy	Chemistry
2024	Spring	Engineering in the Classroom	Hope Freeman	Billy Samulak	Education
2024	Spring	Chemistry Secondary Education	Mariana Wendling	Billy Samulak	Chemistry Education

Introduction to Research Students (CHEM 1600)

2022	Fall	Western Blot Analysis of Malate Dehydrogenase	Stephanie Pelletier	Billy Samulak	Chemistry
2024	Spring	Malaria Research	Asher Easter	Dennis Awasabisah	Chemistry

Internships since the last self-study (CHEM

Year	Semester	Student(s)	Full Project Title	Paid	Instructor	Dept.	Location
2021	Fall	Yaa Ansah	Paid Internship: Characterization of muscle stem cells differentiation	Paid	Eric Williams	Chemistry	FSU (Special projects grant)
2021	Summer	Shaniah Greene	National Renewable Energy Laboratory, (Golden, CO)	Paid	Aisling O'Connor	Chemistry	Golden, CO
2022	Summer	Dylan Dandy	Amino Acid Analysis (Vivetide)		Aisling O'Connor	Chemistry	FSU (Special projects grant)
2023	Summer	Cynthia Laurore	REU, Protein Analysis	Paid	Aisling O'Connor	Chemistry	Ohio State University, OH
2023	Summer	Jeanie Djokotoe	Training as a PCA at St.Vincent Hospital, Worcester		Mathangi Krishnamurthy	Chemistry	St.Vincent Hospital, Worcester

E: Supporting Documents: 2024 Incoming Freshmen Student Survey/College Student Inventory (CSI)

RUFFALO NOEL LEVITZ

Identification of student risk, receptivity and outreach prioritization

COLLEGE STUDENT INVENTORY™ SUMMARY RESULTS, FALL COHORT

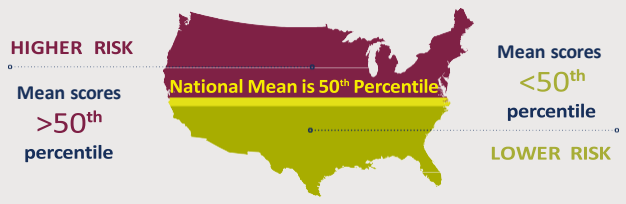
N= incoming students

CSI Completion rate

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)

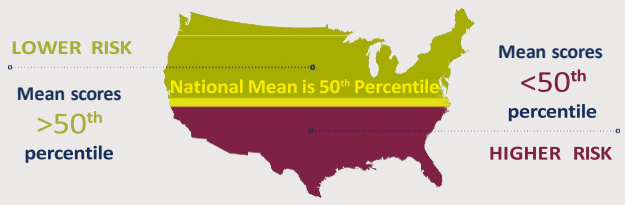
Educational Stress

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 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 or Chemistry majors than at Fitchburg State as a whole (Figure VI.1). In fact, of the 11 Chemistry majors graduated since 2011, 5 came from under-represented populations. The graph below compares the percent of students that identified as minority in the Biology and Chemistry department compared to the overall percentage of minority students at Fitchburg State University from 2008-2024. As you can see, the growth in minority students in the Biology and Chemistry department has increased at a faster rate than at FSU overall. This is why we have been devoting efforts to better understand and support these students for a number of years now. This section of our self study discusses these efforts of the department over the self study period.

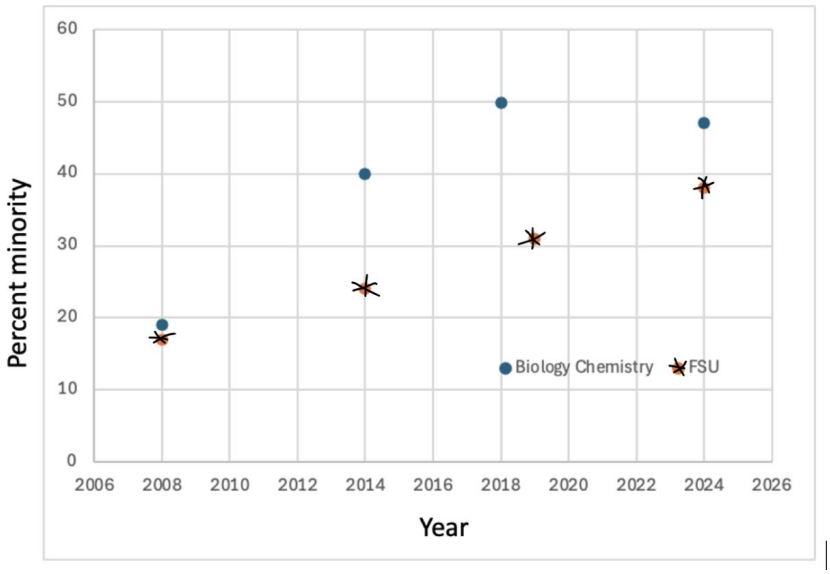


Figure VI.1. Percent of majors in Biology and/or Chemistry that identified as minority students, compared to the overall % of minority students at Fitchburg State 2008-2024.

Part 2: Student satisfaction data

The Department of Biology and Chemistry 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. The department typically sends out the survey every other year except during special circumstances such as COVID. In general, overall satisfaction (very satisfied and satisfied) of our majors is approximately the same when comparing the department to Fitchburg State University. As shown in Figure VI.2, approximately 80% of our students are very satisfied or satisfied with both the department and University in 2019 compared to 90% in 2024. In both years, the % of students that felt very satisfied was significantly higher for the department compared to the University, 42% vs. 21% in 2019 and 43% vs. 26% in 2024. Given that students spend more time within their departments than they do with other aspects of the University, it is encouraging that with a lot of points of contact with the department, students view it very favorably.

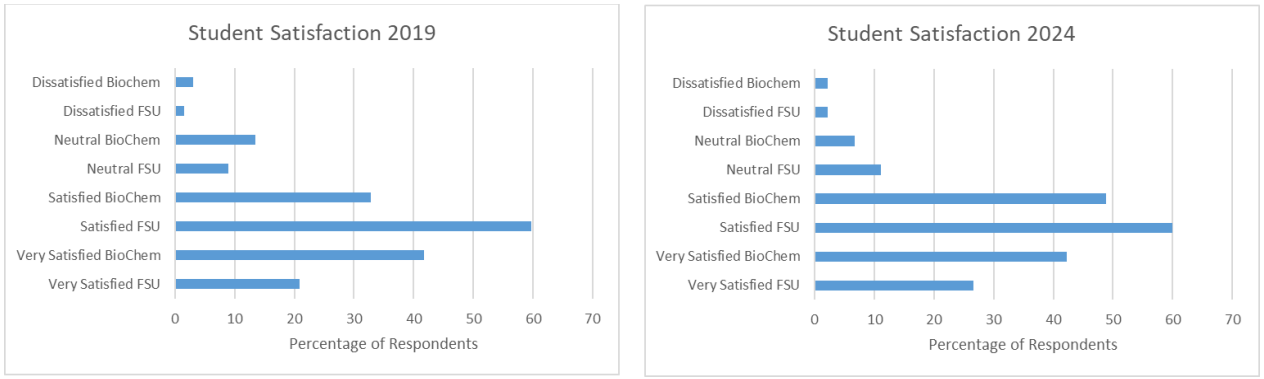
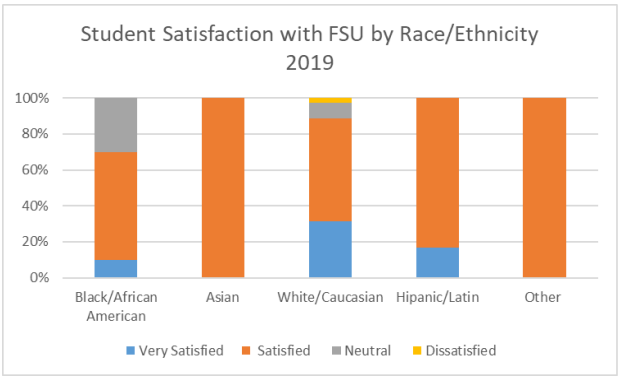


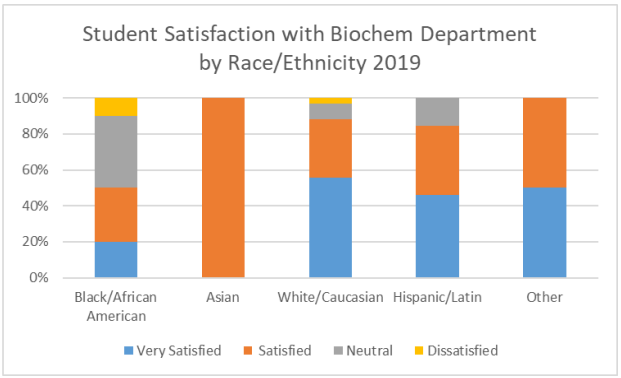
Figure VI.2. Overall satisfaction of biology and chemistry majors with the Department of Biology and Chemistry and Fitchburg State University. Data was taken from departmental student surveys distributed in 2019 and 2024.

Figure VI.3 shows the data from the 2019 and 2024 surveys disaggregated by race. 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 improvement 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. 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

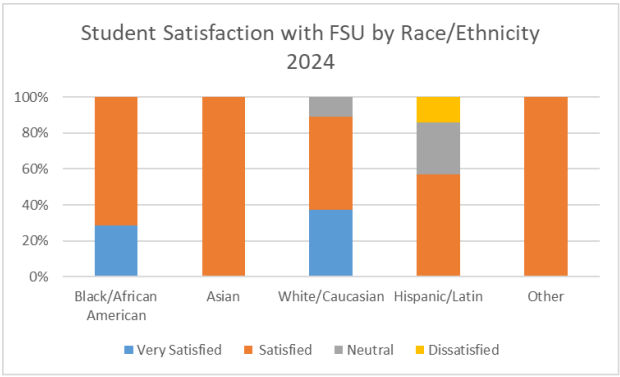
curriculum, policy, and culture that are needed to reduce or remove these barriers. The improvement in satisfaction with our department among Black students in 2024 compared to 2019 may in part be a reflection of our efforts to reduce or remove barriers.

2019





2024



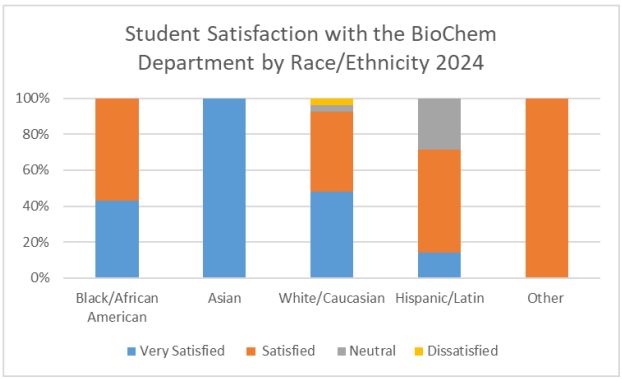


Figure VI.3. Overall satisfaction of biology and chemistry majors of different race/ethnicities with the Department of Biology and Chemistry and Fitchburg State University.

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.4 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 all transgender and non-binary students who responded to the survey in 2024 were very satisfied with the department.

Figure VI.4: Overall satisfaction of Biology and Chemistry majors of different gender identities with Fitchburg State University and the Biology and Chemistry Department.

2.0 policy equity analysis

The department has 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 as seen in the table below. Black or African American students were over-represented in repeating the course (48% of repeaters vs 25% of single takers, Figure VI.5). Hispanics were underrepresented in repeating the course (23% single takers vs 15% of repeaters. Females were over-represented in repeating the course (82% of

repeaters vs 68% of single takers). There were similar patterns for Biol 1800 (VI.6). Analysis of course withdrawal rates showed that Black or African American and Females were also over-represented in withdrawals (data not shown). Lowering the threshold from 2.0 to 1.7 benefited only 4 of 263 students (BIOL 1800) or 11 of 269 students (CHEM 1300). Some ethnic groups had very small sample sizes that precluded interpretation of trends.

This analysis suggests that minor changes to the 2.0 policy (decreasing threshold to 1.7) are unlikely to address equity concerns because relatively few students would be affected.

Composition of CHEM 1300 General Chemistry I and BIOL 1800 General Biology I for Fall 2018 to Spring 2024.

	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%

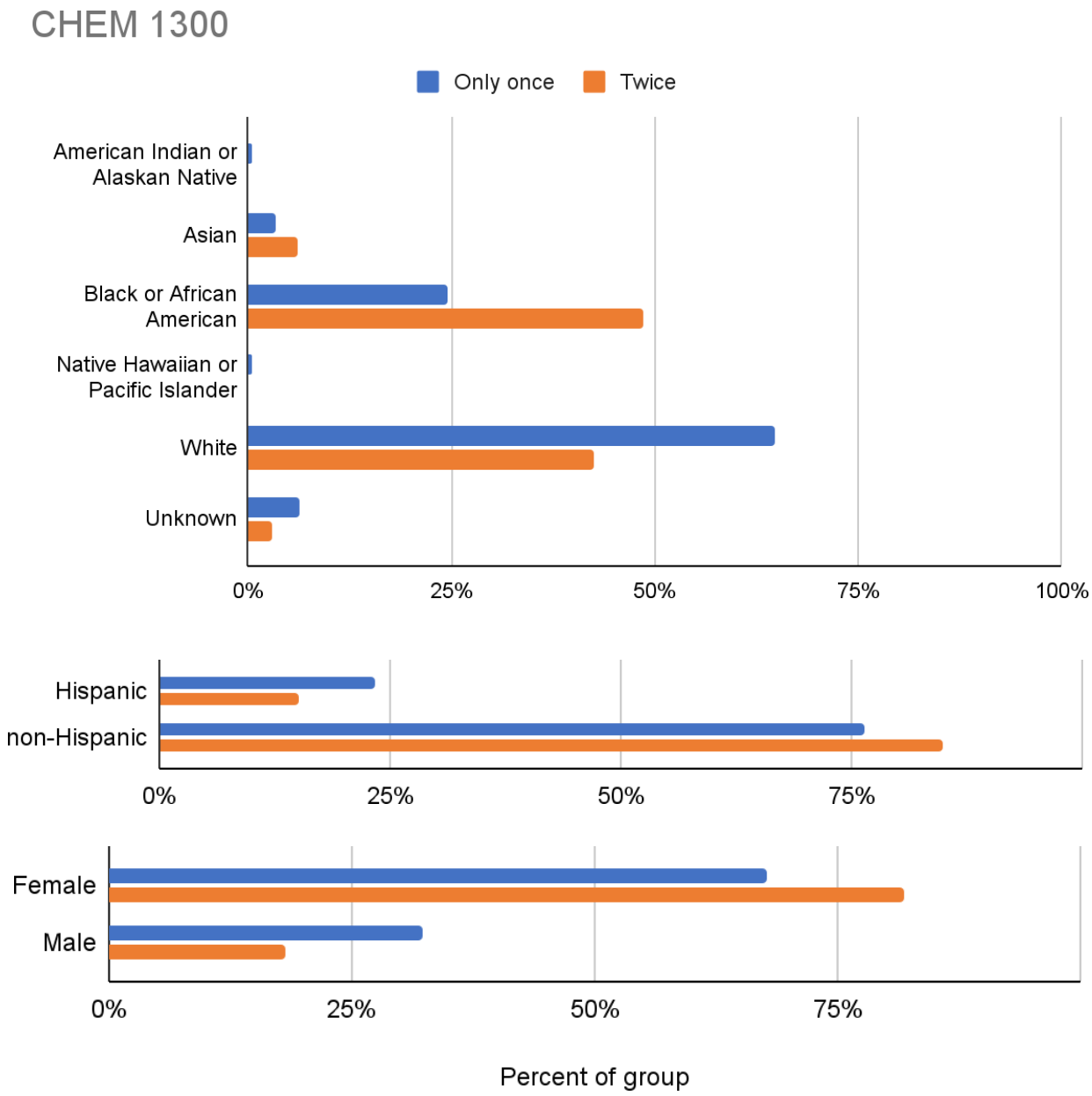


Figure VI.5 Percent of students taking CHEM 1300 General Chemistry I only once or twice by demographic group. Ethnic groupings, Hispanic/non-Hispanic, and gender each considered separately for percentages. Complete ethnic grouping names given in the table above.

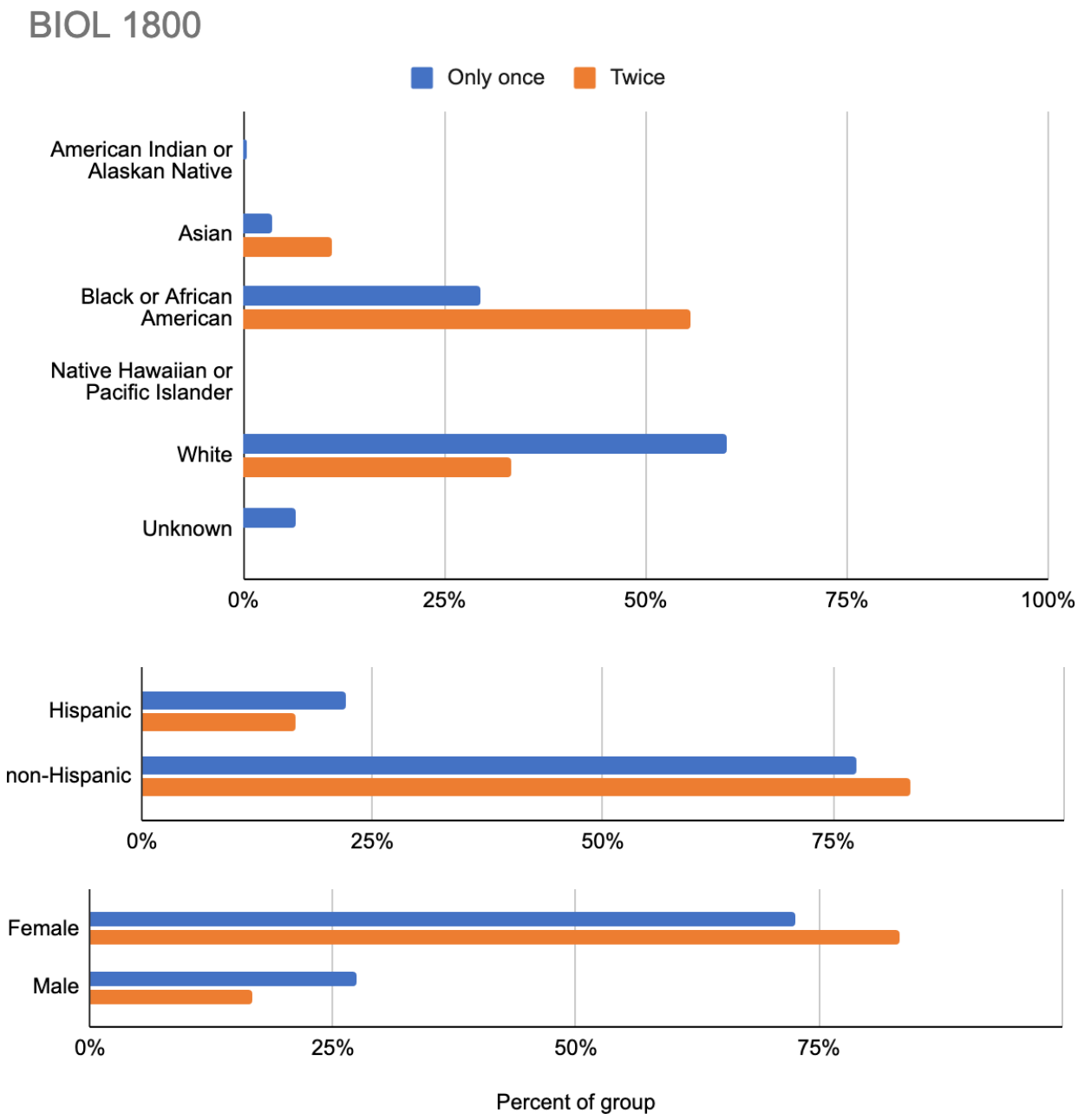


Figure VI.6 Percent of students taking BIOL 1800 General Biology only once or twice by demographic group. Ethnic groupings, Hispanic/non-Hispanic, and gender each considered separately for percentages. Complete ethnic grouping names given in the table above.

Part 3: Initiatives to Improve Diversity, Equity, and Inclusion in the Biology & Chemistry Dept.

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 URM students' persistence in STEM by driving institutional change. In our first meeting, 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. Our proposal was not about changing students, rather, it was the faculty, administration and staff that needed to change to be more inclusive and have all students feel like they were valued. This is how to bring down barriers to inclusion and success. We formed a group with members of our department and other departments including 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 upon their proposals. We received word from HHMI in October 2020 that we did not receive the funding along with general feedback about 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.

Dean's Anti-Racism Fund: To move ahead with inclusive excellence training, the Chemistry faculty 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.

Student working group to identify barriers to success: The goal of the inclusive excellence group at Fitchburg State has been to identify and remove barriers to success for our students. Why not ask the students about their perceived barriers? Therefore, our former dean, Dr. Meg Hoey reached out to the (then) Vice Provost, Dr. Cardelle and we met with the Assistant Dean of Students, Jason Smith to discuss developing a student-led project with these goals. We worked with Jason Smith and Morgan Hakala in the Student Success Center, put together a job posting, and we were successful in hiring 4 students to work to develop a project to 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 students working directly with Biology or Chemistry faculty may affect their willingness to be honest or

specific, therefore the four student leaders held biweekly meetings facilitated by Morgan Hakala in the Academic Coaching Office. They developed questions for and held student focus groups and collected the data. 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).

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 Antiracism 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 Antiracism 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.

The Faculty Academy: Because we desire to become more inclusive instructors, many faculty in Biology and Chemistry chose to participate in the Faculty academy. 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, and alternative assignments to increase the students' sense of belonging and promote success. Members of the academy attend summer sessions, learn about, develop, and share "real talks" and alternative assignments with their cohort groups, and 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, including Chemist Dr. Emma Downs, and thus undergone the Reading Apprenticeship training. 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.

The Department possesses a diverse and very extensive array of equipment. The Antonucci Science Complex has provided a lot of new or upgraded equipment. Some of the new pieces of equipment have service contracts which we deem essential for ensuring proper functioning of the equipment and extending their lifespan. In addition to equipment needed in the teaching laboratories, we have an extensive range of research grade equipment which are summarized in the paragraphs below.

In the strategic plan, Fitchburg State prioritizes a commitment to excellence in teaching and learning. This is reflected in its Vision For the Future by *[o]ffering all students the opportunity to apply their learning so that they are career-ready.* To this end, the department has sought to modernize and improve the science facilities and programs.

The approval of the chemistry major coincided with the construction of a new science building with brand new lecture areas and laboratories. Since our last self-study in 2021 we purchased a new GC/MS using extra budgetary request (EBRQ) funding and an additional UHPLC using funding from our Mass Life Science Center (MLSC) grant. We were also able to use this grant to upgrade the computer system on our oldest HPLC from Windows 2000 to the latest software! The MLSC grant was also used to purchase new Glovebox and SDS Page Electrophoresis units. Recently, we acquired a computational server through the MLSC that will provide computational work for Dr. Fielder and other data science needs of our programs. We also purchased 12 new laptops through the MLSC grant to support computer access for students, faculty and staff both in the teaching and research labs.

There are several spectrophotometers: UV-vis, NMR, IR, Vis, Atomic absorption which are generally used for teaching and research. Other research grade equipment include a GC-MS spectrometer, several GC instruments, HPLC, two UHPLCs and a potentiostat/Galvanostat. All the lab instruments are accessible by faculty and students for both classroom and independent studies. The biology teaching and research labs are equipped with several research equipment that chemistry faculty and chemistry students have used in collaborative research. Some of the equipment include: a plant growth chamber, fraction collectors, platform rocker, automated cell counters (2 different types), three research grade fluorescent microscopes, (inverted, upright, and dissecting), plate reader, plate washer and motorized cryostat. There is a microscope suite that houses three research-grade microscopes - inverted, upright, and dissecting. Each has fluorescence capabilities, with dedicated digital cameras and computer-based software for data collection and image analysis.

The department is well appointed in terms of field equipment, with a wide-range of research-grade meters for accessing water quality (e.g. Salinity Meter, pH Probe, Turbidity Meter and Dissolved Oxygen Meter).

Although we have access to the equipment, many of our instruments are not under service contract or and are getting old and unreliable. For example, the only pieces of equipment that are currently under contract are our GC/MS, FTIR and our NMR machine was used (demo model) when we purchased it in November of 2008. The software for our EFT Spectrometer has not been updated since 2016.

As stated above, extra budgetary requests (EBRQs) can be used to purchase supplies and equipment to support teaching and research activities. These "open up" yearly around mid-February and typically require departments to prioritize large purchases. Our department has sent numerous requests through the EBRQ/ Strategic Funding pipeline over the last few years. In AY 2023/2024 Dr. Awasabisah resubmitted a proposal for funding to purchase an Anasazi EFT-60 NMR Wideband Probe. The purpose was to upgrade the department's EFT-60 NMR instrument to allow analysis of other nuclei such as F-19, P-31 and Si-29. The upgrade includes a new PNMR data acquisition software and the SNAP data processing software. The proposal was funded, thus, expanding the usage and applications of our NMR instrument. The department continues to explore more future Strategic Funding requests and other grant opportunities to purchase these and upgrade other research equipment.

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), ScreenPal, and SelectSurvey. In addition, the IT department has employed an Instructional Technologist, Allison Bunnel, who provides regular training sessions for faculty and students on various technologies.

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 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.

List of major equipment purchased/upgraded since the last self-study. Many of the equipment were purchased with funds from the MLSC grant. *Purchased through EBRQ grants.

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	Cell Culture	

Box Systems		
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 Chemistry major and classes, the focus is more on academic journals and monographs. The library has several core databases for the Chemistry major/classes; Applied Science & Technology Source, PubChem, Science & Technology Collection, Science Full Text Select, SciFinder, SciTech Premium and Springer Nature Link Package. Faculty and students are able to utilize their robust InterLibrary Loan Services.

The library also offers in-person chemistry instruction sessions, and more recently, embedded chemistry 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. Additionally, the library has several print books in call numbers

associated with chemistry. 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 supporting documents section (D).

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 Table X and XX. 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 provide 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 Chemistry

Chemistry	FY-25	FY-24	FY-23	FY-22	FY-21
Travel Budget	$1926	$1902	$1764	$1194	$0
Operating Budget	$37,041	$37,041	$37,041	$37,041	$37,041[a]
Strategic Funds/ EBRQ[b]					

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

Approved Budget for Biology

Biology	FY-25	FY-24	FY-23	FY-22	FY-21
Travel Budget	$3531	$3804	$3528	$2189	$0
Operating Budget	$90,708	$90,708	$90,708	$90,459	$90,459[a]
Strategic Funds/ EBRQ[b]	$18,250	$32,969	$79,196	$61,012	$6,000

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

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

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.

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. Currently, Karen currently serves as the only technician for chemistry. Melissa Legare is our 12-month lab technician in biology.

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. Assists with chemical waste pickup	Role ended in 2021. Reassigned to the Nursing Department.

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 is an active member 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 only full-time chemistry technician, Karen will be retiring in the 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 also 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. While it is unlikely, 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 also hope to hire Ian's replacement soon so they can be trained by Karen. This person will take care of inventories, chemical hazards, and supporting Chemistry faculty in the summer, so overlap will be critical.

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: Library Report for Chemistry

FITCHBURG STATE UNIVERSITY
AMELIA V. GALLUCCI-CIRIO LIBRARY

To: Chemistry 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 7, 2024
Re: **DRAFT** Library resources and services to support the program review of the Chemistry 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 Chemistry at Fitchburg State University. The material presented in this report will be discussed in a November 19, 2024 meeting with the Chemistry faculty. Specific items we hope to discuss include:

- Partnering to develop your Chemistry 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.
- Inclusion of chemistry equipment in the Technology Lending Library
- Exploring opportunities to support the creation and use of Open Educational Resources within chemistry courses
- Identifying opportunities to increase chemistry focused scholarly resources, such as monographs and journals, and their usage

The last full library analysis for the Chemistry program came in AY21.

ABOUT Chemistry at Fitchburg State University

Undergraduate Students with (first) major as Chemistry enrolled in Fall 2023	**16**

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

RESOURCES for Chemistry

Researchers in Chemistry 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 Chemistry major and classes, we have the following core databases:

1. Applied Science & Technology Source (EBSCO)
2. PubChem (National Library of Medicine)
3. Science & Technology Collection (EBSCO)
4. Science Full Text Select (H.W. Wilson)
5. SciFinder (American Chemical Society)
6. SciTech Premium (ProQuest)
7. Springer Nature Link Package

Chemistry 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):

- Chemical Engineering (351)
- Analytical Chemistry (53)
- Biochemistry (34)
- Chemistry - General (182)
- Crystallography (2)
- Inorganic Chemistry (23)
- Organic Chemistry (60)
- Photochemistry (5)
- Physical & Theoretical Chemistry (76)

See Library Table 1: Full-text Journal Databases by Disciplines related to Chemistry. 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.

At the time of this report, no chemistry related journals were canceled since the previous program review.

Books

A review of our print collection in the Library of Congress call number ranges specifically associated with Chemistry shows 355 **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 Chemistry 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 3,038 titles in Chemistry and related areas (563 of these titles were published in the last 5 years and 1,384 were published in the last 10 years). This increases the number of books associated with Chemistry in total to **3,393** books while providing on and off-campus access. While this number of books is less than other disciplines, we feel it is adequate to support undergraduate level research and course work, especially since Chemistry students and faculty tend to focus on other resources, such as databases and journals.

Films and other Media

In 2018, the Library purchased a subscription to the academic streaming film database Kanopy. Over 4,000 videos are available in AY24 with subjects aligned with Chemistry (this does include some duplicates). See Library Table 3: Films and Other Media Collection for a breakdown by category.

SERVICES for Chemistry

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 chemistry-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 Chemistry faculty members a total of 10 times to provide information/research literacy instruction as part of a Chemistry course. Librarians have also taught Chemistry research sessions and were embedded in sections of the Chemistry's First Year Experience course and in a section of the Chemistry Senior Seminar.

Library Instruction	AY22	AY23	AY24
Total Embedded Courses	78	83	51
Embedded Chemistry Courses	1	2	1
Total In-person/Onsync Sessions	140	171	176
In-person Chemistry Sessions	2	1	3

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 Chemistry, librarians have created 1 subject research guide and 3 course specific research guides.

The usage statistics in the Chemistry research subject guide shows that the guide was accessed a total of 164 times in AY24. This is about 84% less than the usage the average subject guide receives (998 views/guide avg.). The Library's Chemistry Research Guide is available within the Blackboard course management system in all Chemistry courses.

The Library is interested in working with Chemistry 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.

Did you know the Library has 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 Chemistry 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, 8 Chemistry professors put a total of 4 digital items on reserve. We hope to discuss with the Chemistry 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 Chemistry were recommended to be purchased based on interlibrary loan requests.

FACILITIES for Chemistry

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: Facilitie

Library Table 1:

Full-text Journal Databases by Disciplines related to Chemistry

The full complement of databases supporting Chemistry can be found on the Library website (https://Library.fitchburgstate.edu/research/databases). Whereas there are 7 directly applicable full-text databases, another 6 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. Applied Science & Technology Source 2. PubChem (National library of Medicine) 3. Science & Technology Collection (EBSCO) 4. Science Full Text Select (H.W. Wilson) 5. SciFinder (American Chemical Society) 6. SciTech Premium (ProQuest) 7. Springer Nature Link Package
Supplemental Full-text Journal Databases
1. Academic OneFile (Gale) 2. Academic OneFile Select (Gale) 3. Academic Search Ultimate (EBSCO) 4. Energy & Power Source 5. JSTOR, including JSTOR Life Sciences 6. Science In Context (Gale)

Database	AY24 Usage	AY23 Usage	AY22 Usage
Applied Science & Technology Source	4713	3504	5218
SciTech Premium (ProQuest)	2162	2356	3935
Science & Technology Collection (EBSCO)	4656	3462	5235
Science Full Text Select (H.W. Wilson)	4331	3365	5093
SciFinder (American Chemical Society)	188	152	133
Springer Nature Link Package	4937	5264	7432

Notes:

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

Library Table 2:

Chemistry 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**
QD 1-65	General Chemistry	49	76	165	4	18	60	372
QD 71-142	Analytical Chemistry	44	54	99	0	4	11	212
QD 146-197	Inorganic Chemistry	35	46	95	3	8	7	194
QD 241-441	Organic (Includes Biochemistry)	84	92	172	1	10	53	412
QD 450-801	Physical and Theoretical Chemistry	66	85	267	2	21	36	477
QD 901-999	Crystallography	21	22	66	0	3	3	115
TP 1-1185	Chemical Technology (Includes Chemical Engineering and Manufacture)	264	446	790	4	13	94	1611
Totals		**563**	**821**	**1654**	**14**	**77**	**264**	**3393**
		3038			**355**			

Library Table 3:

Film and Other Media Collection

# of Streaming Films by Subject in Kanopy Database	
Applied Science	788
Biology	487
Chemistry	268
Engineering	349
Mathematics	343
Medicine	535
Science, Nature, and Technology	1305
Total (includes duplicates)	**4,075**

Library Table 4:

Research Instruction

	AY22	AY23	AY24
Total Instruction Sessions Conducted:	218	254	227
Chemistry Sessions Conducted:	3	3	4
Percentage:	1.4%	1.2%	1.8%
Total Embedded:	78	83	51
No. of Chemistry Embedded:	1	2	1
Total In-person/Onsync classes:	140	171	176
No. of Chemistry In-person/Onsync classes:	2	1	3

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

Library Table 5:

Research Help

Library Research Guides

For Chemistry, we have created one subject research guide and three course specific research guides. The usage statistics in the Chemistry research guides show that the subject guide was accessed a total of 164 times in AY24. Additionally, 3 course-specific research guides have been created for chemistry courses (CHEM 3003, CHEM 4750, and BIOL/CHEM 9011).

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 & Distinctiveness

The biggest strength of the chemistry program is its highly qualified and caring faculty whose main focus is 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 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 student 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. The chemistry program is well funded by the administration, and despite its small size 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 afforded 8 biology and 4 chemistry majors the opportunity 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 off campus jobs, which may prevent them from seeking out research opportunities on campus. This grant was designed to remove that barrier and make research more accessible to all Biology and Chemistry majors. In fact, one of our majors, Jack G. went back to work full time during COVID without finishing his degree, but this grant opportunity motivated him to return to campus and complete his final classwork to graduate. We will continue to seek additional funding for student research 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, Biology, and Engineering Technology. Because we are one department, faculty are very collegial and work together to help students navigate both the Biology and Chemistry curricula. We serve as academic 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.

Another distinction of our program is the integrated high-impact practice (IHIP) course our majors receive by taking Chemistry Seminar. This capstone course, taken by upperclassmen, is a unique experience. The main objectives of the course are to hone academic research skills and raise career awareness. Students create resumes and cover letters and also have many opportunities to meet with industry professionals during class time. Although our program is small, our graduates are able to secure jobs in central Massachusetts and Greater Boston area without issue. We even have a graduate working in the National Renewable Energy Laboratory in Colorado, and some students have gone on to graduate school.

Challenges & Threats to the Program

In October of 2024, Chemical & Engineering News published an article that explained that Chemistry majors across the country are seeing a decrease in enrollments[1]. We are not immune to this trend. Despite the attractive career choices available for chemistry graduates, there has been a steady fall in the number of new students being admitted to our chemistry program. This is an issue that needs to be addressed immediately and requires targeted and sustained recruitment efforts. Recruitment of new students to the program is by far the biggest challenge. We are fortunate to have Tyler Scippione, a Biology major alumni, 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.

Our enrollment numbers have been further complicated by lower retention rates amongst 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. 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 been secured through grants, however, 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.

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 assessing our first Program Learning Objective (#1) regarding disciplinary knowledge, better serving the needs of our Hispanic students, and helping our secondary education students progress expeditiously, which may improve retention and recruitment of that program.

Address Program Learning Objective 1

Our assessments indicated that upper-level students being tested on disciplinary knowledge were not meeting targets, specifically on our PLO1-disciplinary knowledge. This may be due to time lapsed between the time they learned the content and their more advanced courses or the way in which the

questions are administered or worded. Our assessment committee, in conjunction with input from our entire department, will need time and resources to tackle this issue.

Explore Options 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 a soon-to-be 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 Faculty Academy members may be necessary to address this concern.

Strategize Ways to Streamline the Secondary Chemistry Education Program

Since the pandemic, there is a nationwide need for science teachers. The chemistry program with its teacher preparation concentration, is well positioned to address this need for school teachers, however, very few incoming freshmen are interested in teaching high school (or major in chemistry). We graduated 1 student in 7 years with a BS and initial teaching license in Chemistry. This warrants a reevaluation or redesign of our Chemistry Secondary Education program given the faculty resources needed to support the program. One possible solution to this problem is to conduct a needs and sustainability assessment for a 4+1 program for Chemistry Education majors. Within this period, students would receive a B.S. in Chemistry, a Masters in Education, and an initial license to teach in the state of Massachusetts. The Masters of Education program with initial licensure already exists at Fitchburg State for Biology, but not for Chemistry, so this would be something our department would have to explore. The upper level (graduate) chemistry content courses needed for such a program could be offered in an on-line format and given the low cost of our courses, may attract other non-traditional students, such as industry professionals or current teachers seeking professional licensure.

C. Future Positioning

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

Chemistry programs at small public universities are at a pivotal moment, and our department is poised to meet emerging trends in education and industry while still maintaining our role as a service department in General Education. As the field of Chemistry continues to evolve, incorporating interdisciplinary approaches and cutting-edge technology into our curriculum is critical to ensuring that our program remains relevant and impactful. During our self-study discussion meetings, our department has identified 3 focus areas to better position us moving forward. These include integrating business education, leveraging artificial intelligence (AI), and expanding the appeal of chemistry to students across all disciplines, possibly through expanding and streamlining our minor.

Explore Opportunities for our Students to Engage with Business

Incorporating business courses or encouraging a business minor into the chemistry curricula is increasingly important as the global economy demands scientists who understand commercialization,

marketing, and innovation. From developing pharmaceuticals to advancing sustainable materials, chemists in industry navigate product development, quality and compliance, and marketing strategies for their products. With additional coursework in business, our students could connect what they do in our laboratories with real-world applications. These courses may include entrepreneurship, marketing, and management and can provide them with the knowledge to enter careers in startups, collaborate with industry leaders, or advocate for funding more effectively. Fitchburg State University proudly supports interdisciplinary education. Collaboration between the Chemistry and Business departments can position our graduates as versatile professionals ready to lead in both scientific and corporate environments. The work to develop a business/chemistry partnership was started by Dr. Billy Samulak in 2023. Her findings can serve as the starting point for our discussions.

Understand the Strengths, Opportunities, and Challenges of AI

Whether we appreciate the technology or not, Artificial Intelligence (AI) is here to stay. While AI misuse by students violates academic integrity policies, there are also countless opportunities to use AI to advance the field of Chemistry. The rise of AI can accelerate research, optimize processes, and expedite breakthrough discoveries. A recent edition of the Journal of Chemical Education focuses entirely on the transformative power of AI in the chemistry classroom and laboratory[2]. As faculty, we know we must actively engage with AI tools and methodologies to stay at the forefront of our discipline (and stay ahead of our students). Our goal is to understand and incorporate these technologies into our research and teaching that will not only enhance student learning but also make significant contributions to the broader chemistry community. In order to achieve this, we will need professional development opportunities and time to engage with this ubiquitous technology.

Expand and Market the Chemistry Minor

Because chemistry is a foundational science with applications in a wide range of fields, it is an ideal minor for students pursuing diverse disciplines. For our biology majors, a chemistry minor deepens their understanding of biochemical processes critical for healthcare and biotechnology. A minor also makes them very competitive when applying for jobs. Engineering Technology and Environmental & Geographical Science majors benefit from knowledge of chemical principles in materials science and environmental systems. Even business majors gain valuable insights into sustainability and industrial processes, equipping them to make informed decisions in roles that intersect with science and technology. By promoting the accessibility and versatility of a chemistry minor, we could attract a broader pool of students and highlight the universal relevance of the field.

References

1. Kriesch Boerner, L., (2024) Are undergraduate chemistry programs in crisis? *Chemical and Engineering News,* Volume 102, Issue 33.
2. Yuriev, E., Wink, D. J., & Holme, T. A. (2024). The Dawn of Generative Artificial Intelligence in Chemistry Education. *Journal of Chemical Education*, *101*(8), 2957-2959.

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 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			
27	Identify ways to help our Environmental Biology majors with job positions (ie. additional job site subscriptions, expand internship opportunities etc.)	Biology	Department meeting time	Department			

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