Annual Program Report
2022-2023

The report(s) should be inclusive of all levels, degrees (i.e. certificates, bachelor's and master's), modalities and locations.

Department: Chemistry in the Biology and Chemistry Department

Department Chair: Michael Nosek (chair)

Department Assessment Committee Contact: John Ludlam

This document is to be kept in the department and an electronic file is due to the AVP of Institutional Research and Planning by June 1, 2023.

Section I: Program Assessment (please complete this section for each program in your department)

Program: _Chemistry_____

A. Program Learning Outcomes (PLOs) (Educational Objectives)

I. List of PLOs and the timeline for assessment

PLO #	PLO – Stated in assessable terms	Where are the learning outcomes for this level/program published? (please specify) Include URLs where appropriate.	Timing of assessment (annual, semester, bi-annual, etc.)	When was the last assessment of the PLO completed?
1.	Disciplinary knowledge of topics in foundational chemistry (General Chemistry and Organic Chemistry)	Program assessment plan	At least twice every five years	Spring 2019 under the old PLOs.

2.	Demonstration of, and application of laboratory skills	Program assessment plan	At least twice every five years	Organic Chemistry II, Spring 2023
3.	Demonstration and application of the concepts of lab safety practices	Program assessment plan	At least twice every five years	Organic Chemistry I, Fall 2022 Organic Chemistry II, Spring 2023 (also Spring 2021, 2022)
4.	Presentation of scientific information in clear and organized manner through written or oral communications	Program assessment plan	At least twice every five years	Spring 2021

II. **PLO Assessment** (Please report on the PLOs assessed and/or reviewed this year. Programs should be assessing at least one each year.)

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 # (from above)	**Assessment description (exam, observation, national standardized exam, oral presentation with rubric, etc.)**	**When assessment was administered in student program (internship, 4th year, 1st year, etc.)**	**To which students were assessments administered (all, only a sample, etc.)**	**What is the target set for the PLO? (criteria for success)**	**Reflection on the results: How was the "loop closed"?**
2	Demonstration and application of laboratory skills.	2nd year	All students in the major in Organic I and II	90% of students to score > 70%	Organic Chemistry II (Spring 2023): The two students assessed exceeded 70%.

3	Lab Safety/ Chemical hygiene assignment Lab report questions Lab practical exam (direct observation of lab method)	2nd year	All students in the major in Organic I and Organic II	90% of students to score >70%	Organic Chemistry I (Fall 2022): The two students assessed exceeded 70%. Organic Chemistry II (Spring 2023): The two students assessed had a perfect score (100%) on the lab report questions submitted. Both students received full credit on the lab practical observation of lab safety. Raw data provided in Appendix B.

You may use this comment box to provide any additional information, if applicable:

The number of students assessed this year was low because only two Chemistry majors were enrolled in Organic Chemistry. No capstone seminar in AY 2022-2023 so PLO #1 (Disciplinary knowledge of topics in foundational chemistry) and PLO #4 (Presentation of scientific information in a clear and organized manner through written or oral communications) not assessed. The Chemistry Capstone Seminar will be offered in Fall 2023.

Summary of Findings: Briefly summarize the results of the PLO assessments reported in Section II above combined with other relevant evidence gathered and show how these are being reviewed/discussed. How are you "closing the loop"?

Reflection Prompt	**Narrative Response**

Other than GPA, what data/ evidence is used to determine that graduates have achieved the stated outcomes for the degree? (e.g., capstone course, portfolio review, licensure examination)	The Chemistry program revised and expanded the assessed PLOs at a department retreat in the fall 2019. The PLOs were designed to be in accordance with the learning outcomes developed by the American Chemical Society (ACS), which are delineated in Appendix A. We note that we do not undergo a formal review from the ACS. The methods of evaluation include a disciplinary knowledge capstone exam, direct observation of laboratory skills in a lab practical, the completion of lab safety and chemical hygiene written assignments, and faculty assessment of Chemistry Capstone Seminar oral presentations.
Who interprets the evidence? What is the process? (e.g. annually by the curriculum committee)	The department assessment committee evaluates all assessment related matters. The departmental student affairs committee manages the student feedback survey. The annual student feedback survey was administered this year. The results of the survey will be discussed at the Fall 2023 department retreat.
What changes have been made as a result of using the data/evidence? (close the loop)	Chemistry assessment plans were altered by Covid-19 pandemic disruptions and because the Chemistry Capstone Seminar was not offered AY 2022-2023. According to the assessment plan, PLO1 (disciplinary knowledge) and PLO4 (scientific presentations) would be evaluated in the Chemistry Capstone Seminar. The Chemistry Capstone Seminar will be offered in Fall 2023. Assessment data collected on PLO 2 (lab skills) and PLO 3 (lab safety) indicate students are exceeding expectations for these learning outcomes.

B. Assessment Plan for Program/Department

I. Insert the program or department Assessment Plan (This is an independent plan from what is reported in this document).

See Appendix C

II. Explain any changes in the assessment plan including new or revised PLOs, new assessments that the program/department plans to implement and new targets or goals set for student success.

III. If you do not have a plan, would you like help in developing one? ___Yes

C. Program Review Action Plan or External action Letter/Report

Annual Reflection/Follow-up on Action Plan from last Program Review or external accreditation (only complete the table that is appropriate for your program

I. **Programs that fall under Program Review:**

i. Date of most recent Review:

Academic Year 2021-2022

ii. Insert the Action Plan table from your last Program Review and give any progress towards completing the tasks or achieving targets set forth in the plan.

Chemistry Program Review - Action Plan for AY23-25

The Biology and Chemistry Department has identified action items to address challenges identified both in our self-study and by the external reviewer. These issues fall under two categories: Student retention and Success and Declining Enrollment

1. Student Retention and Success:
Student retention and success is one key area identified by our department as well as by the outside reviewer. This is likely in part due to entering students being under prepared for the General Chemistry sequence of courses that is fundamental to both the chemistry program as well as for students in other programs that the courses serve (e.g. Biology, Exercise and Sport Sciences, and Engineering Technology). Math is one area in which students come in ill prepared, and the use of the Algebraic Math Placement test requirement helps to minimize this area.

The policies implemented by the department such as requiring successful completion of General Chemistry I in not more than two attempts and getting a minimum grade of 2.0 to continue in the major have greatly helped students in either starting with a strong foundation in chemistry or switching to a more suitable major earlier on. However, student retention in the Chemistry major needs

improvement. To address this challenge, additional support outside the classroom for the core chemistry courses is needed. Two programs will be implemented to achieve this goal.

a. Tutor programs:
The use of student tutors has been coordinated through the Tutoring Center, but the relationship between our faculty and the staff overseeing the tutoring for our courses, is an area that needs to be strengthened and broadened.

Establishing an embedded tutoring program was identified by our department, the external reviewer, and is strongly supported by the administration. A program that will seek to provide embedded tutors for the General Chemistry I and II courses will be developed, and assessed for its success. As we implement the program in these courses, we will work with the University to seek funding sources (both external and internal) to make the program sustainable in the long term. As we assess the effectiveness of the program we will seek to increase the program to include the Organic Chemistry I and II course sequence.

The implementation of the embedded tutor program will be done in conjunction with the Advising Center and the Tutor Center. The initial plan for these tutors will includes the following: i) they will attend lecture sessions of the courses that they are going to support twice a week (approximately 2-3 hours) to better address student needs during their tutoring sessions, ii) work with instructors to coordinate their efforts (approximately 1 hour per week), iii) they will provide approximately 3 hours of group tutoring sessions per week with students, as well as iv) provide approximately 3 additional hours per week of individualized tutoring sessions. To facilitate this effort, tutors need to have flexible course schedules, and demonstrate a proficiency in the courses to be covered. The outside reviewer estimated a cost factor of about $6000/tutor/semester, and we agree that this is a reasonable cost to start the effort. It should be noted that during the Fall 2022 semester, a pilot program for this model has been funded by the University for two introductory courses (Chemistry for Health Sciences and Anatomy I and II) and will commence in the Spring 2023 semester. (**Action Item: The timeline for implementation of peer tutors in General Chemistry and Organic Chemistry courses will be in AY23-24.**)

Due to current difficulties in identifying suitable tutors with flexible schedules, an alternative approach will be adopted for an interim period before switching fully to the embedded tutor program. The alternative approach involves peer tutors conducting weekly

review sessions in addition to their regular tutoring sessions. Tutors will get weekly updates from faculty members as well as problem worksheets for content covered in the lectures during the week. Tutors will use these worksheets during their weekly review sessions. We have been successful in identifying and training two tutors, one for General Chemistry and one for Organic Chemistry for conducting these review sessions in Fall 2022 and hope to continue recruiting more student tutors in the near future. Through course release in the Fall 2022 semester, one of our faculty (Dr. Mathangi Krishnamurthy) has been working with the Advising and Tutoring Center to improve our relationship with their staff, and help us provide improved tutoring resources to our students in these courses until we are able to obtain embedded tutors. (Action Item: **Peer Tutoring program revisions will begin during Spring 2023 and continue during AY 23-24**.)

b. Student Success Initiatives:
Research opportunities in the form of independent studies and internships are critical for our majors to have successful careers after graduation. The external reviewer has commented favorably on the wide ranging research projects and opportunities available for students in our department. Based on his interactions with students, the external reviewer identified a “dichotomy in students between those who were aware of these opportunities and thought this information was readily available and those who thought it was a black box”. He has recommended taking steps to better promote available research opportunities both on campus and from outside internships.

The department has previously held an annual “Science Symposium”, which provided students opportunities to know the areas in which our faculty are doing research and also identify projects on which they would like to work with faculty members. This symposium was suspended for two years due to the COVID pandemic but successfully resumed in fall 2022. The program will be continued and expanded going forward, increasing awareness of departmental research opportunities. (**Annual action item**.)

Off-campus opportunities will also be expanded. Some of our chemistry majors have been successful in pursuing summer internships both locally as well as out of state. In order to make this high-impact practice available to a wider array of students, we need to create a centralized system that will help students find, apply for and complete internships or independent studies within our department or outside.

The School of Health and Natural Sciences received an Academic Innovation Fund (AIF) for creating such a coordinated internship program. The funding allowed the work to begin in the Fall 2022 semester. The fund supports a course release for one faculty member from each participating department from the School to work in this program and assist students from their disciplines. Dr. Awasabisah is representing our department in this initiative and is working towards creating new collaborative opportunities between FSU and local employers to widen the research opportunities available for our students. He has also been involved in creation of a user-friendly internship contract and development of learning outcomes that align with career competencies. He will be working on the creation of electronic resources (Blackboard module, Google site, advising docs) that could be utilized as early as the spring 2024 advising period. (**Completion of internship materials and resources will occur during the Summer of 2023**.)

We will seek support from the administration for creating the position of an Internship Coordinator within each department to oversee the internship process and give students a point of contact in which to begin their process. The coordinator will handle paperwork and contracts, coordinate with involved faculty, generally help students and faculty navigate the internships, work to increase the partnerships we have with agencies and companies that will provide the internship opportunities, and assist students with financial resources available to students through state internship programs (e.g. the State University Internship Incentive Program, and the Massachusetts Life Sciences Center Internship Funding Program). (**Establishing an Internship Coordinator Position will be in place by Spring 2024 semester**.)

2. Initiatives to address declining enrollment:

a. The department has observed a decline in student enrollment for the last several years and this problem was only exacerbated by the COVID pandemic. Furthermore, major turnover in both the Admissions and Marketing offices in recent years has further complicated our recruiting efforts. The external reviewer is in agreement with the department that we need to strengthen our ties with the Admissions office with particular focus on the Enrollment Management Division. As suggested in the review, we plan to promote our Chemistry major using our distinctive programs including our Biochemistry Concentration and our articulation agreements with graduate programs at partner institutions. Notable partners include Lake Erie College of Osteopathic Medicine (LECOM) and Husson College (Pharm.D. program). These programs will serve as effective marketing tools in open houses and high school visits. (**Beginning in Spring 2023, and ongoing action item**.)

b. We have also initiated discussions with the Directors of Admissions and Marketing to better utilize available portals for promoting our chemistry major. In consultation with the Director of Marketing, we have chosen to use the "Tell Us Your Story" survey for reaching out to prospective students through social media sites. A sizable number of our Chemistry majors are transfer students from local community colleges such as Mt. Wachusett Community College and the Quinsigamond Community College. We have identified one current student and an alumna to share their experiences at FSU and thereby reach out to prospective transfer students. We have also identified two of our recent graduates who have participated in undergraduate summer research internship programs for showcasing their research activities as well through this forum. We have also been successful in identifying and contacting two of our recent graduates who are successfully employed in local Biotech companies to highlight success stories of our alumni. The Marketing division at FSU has also advised us to provide materials on student research presentations and posters for marketing on social media sites. We will continue our efforts in reaching out to more current students as well as alumni to actively promote our major. (**Beginning in Spring 2023, and ongoing action item**.)

c. Building a strong student pipeline requires a connection with the local school community. Our faculty are involved in a variety of science outreach activities involving K-12 students in the Greater Fitchburg area. Many of these activities involve collaboration with local public schools, Boys and Girls Clubs, local science museums, and other after-school programs. We plan to expand these programs and use them to promote our major and our involvement in promoting science in the region. (**Ongoing action item.**)

d. Our faculty are also actively involved in science outreach as representatives of the central MA section of the American Chemical Society (ACS). Dr. Krishnamurthy is the section coordinator for the National Chemistry week and Chemists Celebrate Earth week events. Furthermore, she also serves as the ACS Chemistry Olympiad coordinator for our local ACS section. In appreciation of her efforts for science outreach, she was awarded the Outstanding Volunteer award for 2021-2022. We plan to grow our involvement in these professional societies and related activities to gain more visibility in the region and beyond and attract more students to our major. (**Ongoing action item**.)

e. In March of 2023, our Department will be working with MassBioEd and BioTeach to host a Teacher Professional Development Workshop on campus. And in July/August, we will be assisting the New England Association of Chemistry Teachers (NEACT) by

hosting their two-day annual summer conference. These events will provide exposure of our Department and its programs to high school teachers, and may provide valuable learning opportunities to our students that will help us promote our programs. (**Summer 2023, and ongoing throughout AY23, 24, and 25**.)

iii. If you do not have an action plan, would you like help in developing one based on your last program review and needs of the program? _____Yes

II. Programs with external Accreditation:

i. Professional, specialized, State, or programmatic accreditations currently held by the program/department.
ii. Date of most recent accreditation action by each listed agency.
Iii. Date and nature of next review and type of review.

List key issues for continuing accreditation identified in accreditation action letter or report.	**Key performance indicators as required by agency or selected by program (licensure, board or bar pass rates; employment rates, etc.) (If required.)**	**Update on fulfilling the action letter/report or on meeting the key performance indicators.**

Section II - Departmental Outcomes

A. Departmental Strategic Initiatives

Accomplished Initiatives AY22-23	**Corresponding Strategic Plan Goal & Strategy Goal # followed by Strategy # ex: 1.3**	**Indicate (X) if a Diversity, Equity and Inclusiveness (DEI) Goal**
Work with MassLife Sciences (focused on life sciences workforce development) to create internship pipelines, upgrade laboratory	1.2 - Forge innovative paths to career readiness	

equipment, and coordinate curriculum to fulfill demand for industry competencies. (ongoing)		
Secured funding for research fellows program (Moderna Foundation Grant). The program is a scholarship program that targets underserved populations to increase retention (through faculty mentored research). (ongoing)	1.2 Forge innovative paths to career readiness 2.1 Narrow achievement gap 6.4 Increase philanthropic support for university	X
Formation of Biotechnology Advisory Board (ongoing)	1.4 Forge deeper connections between our curriculum and community needs.	
MassBioEd networking event- 17 biotechnology industry career professionals attended a networking event on our campus in Spring 2023. Well attended by students. (ongoing)	1.2 Forge innovative paths to career readiness	
Applied for Mass Life Sciences foundation grant to upgrade and modernize equipment.	6.4 Increase philanthropic support for university	
Applied Learning: undergraduate research. Especially reaching out to minority students (Ongoing)	2.1 - Student-ready university - cultural shift for underrepresented students	X
Reverse declining enrollment. Faculty outreach to accepted students; Virtual Open Houses, etc. (Ongoing). Early enrollment data for Fall 2023 shows improvement. Held MassBioEd Teacher Workshop on campus. Created a document, "Talking Points for Admissions" and shared with Admissions Staff and departmental faculty as a Google Doc. (ongoing)	5.6 - Marketing	
Creation of a Biology & Chemistry Alumni LinkedIn page to strengthen connections with alumni	5.6- Marketing	

Open Educational Resources: now adopted in both intro Bio classes, some upper level electives, and some non-majors classes. A list of courses and faculty using OERs in our department can be found here. (ongoing initiative)	5.7-Affordability	

Planned Initiatives for AY 23-24	Associated Strategic Plan Goal & Strategy Goal # followed by Strategy # ex: 1.3	Indicate (X) if a Diversity, Equity and Inclusiveness (DEI) Goal
The department received a CTL Teaching, Learning and Innovation Grant to create an online guide to graphing and statistics. The idea arose from discussions in our Assessment Committee: It may help students to have more consistent approaches to teaching these skills across different courses. We will create a guide with embedded videos to teach basic skills, with the hopes that the skills will feel more familiar to students when they have the same resources.	1.7 Leverage institutional expertise in online education to reinforce the University's commitment to access.	
Creation of a research fellows program with Moderna grant funding	1.2 Forge innovative paths to career readiness 2.1 Narrow achievement gap 6.4 Increase philanthropic support for university	X
Focus more on enrollment strategies. Improve 4-year plans with career competencies and Alumni stories. Check our website: how inviting is it? Consider another video with a tour?	5.6 - Marketing	
See all "Ongoing" initiatives above for AY'23.		

B. Departmental Accomplishments and Reflection:

Take this section to reflect on--

1. *22-23 Accomplishments not captured above*
2. *Initiatives that you may be considering for 23-24 academic year that you did not already capture above*
3. *Any other thoughts or information that you would like to share*

Please see the sections above.

Appendices

A. Program Learning Objectives (PLOs)
B. Lab Safety Assessment
C. Assessment Plan

Appendix A: Program Learning Objectives (PLOs)

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.

Appendix B - Lab Safety Assessment – Fall 2022 and Spring 2023

Students are required to submit lab reports for each experiment that they perform during the term for both Organic Chemistry I and II courses. Each lab report comprises several sections such as prelab assignment, experimental procedure, calculations, results and discussion and post lab questions. All lab reports are treated equally and worth 25 points each, even though the depth of analysis and calculations varies from one report to another. The prelab assignment for most lab reports will have at least one question that deals with lab safety. In order to answer this lab safety question, students need to look up Safety Data sheets (SDS) for all the chemicals that they will be handling for each experiment and report their safety hazards.

In the tables shown below, the grades obtained by our chemistry majors for the safety question in each lab report are indicated along with the experiment number.

Fall 2022- Organic Chemistry I lab safety grades

Student	Expt-2 Safety points: 2	Expt-3 Safety points: 2	Expt-4 Safety points: 2	Expt-5 Safety points: 2	Expt-6 Safety points: 2	Expt-7 Safety points: 2	Average %
A	1.5	1.5	2	1.5	2	2	87.5
B	1.5	2	1.5	1.5	2	2	87.5

Spring 2023- Organic Chemistry II lab safety grades

Student	Expt-1 Safety points: 5	Expt-2 Safety points: 1	Expt-3 Safety points: 3	Expt-4 Safety points: 2	Expt-6 Safety points: 2	Expt-7 Safety points: 2	Average %
A	5	1	3	2	2	2	100

B	5	1	3	2	2	0*	100

*-did not submit prelab assignment for this lab report, missed assignments not included in average

Outcome of assessment: In Fall 2022 and Spring 2023, our chemistry majors performed better than the benchmark (>70%) score established for assessment of PLO 3.

Lab skills assessment in Spring 2023

Students in the Organic Chemistry II course were administered a lab practical exam at the end of the spring semester to evaluate their lab skills. The lab skills that were assessed in this exam included the following:

1. Skill 1- vacuum filtration
2. Skill 2- Setting up a reaction at room temperature
3. Skill 3 – Setting up a reaction that involves reflux using air condenser
4. Skill 4- Setting up a reaction involving reflux using condenser with coolant
5. Skill 5- Set up for distillation
6. Skill 6- Determination of melting point of an unknown compound
7. Skill 7- Using the analytical balance to accurately weigh 0.16g of an unknown compound
8. Skill 8- Measurement of four different volumes (37 ml, 18 ml, 2 ml and 0.4 ml) of an unknown liquid using appropriate measuring glassware
9. Skill 9- Measurement of pH of three different solutions
10. Skill 10 – Safe disposal of chemical waste

The table shown below shows the points obtained by our Chemistry majors for each assessed skill. The maximum points allotted for each skill assessment was 5.

Student	Skill-1	Skill-2	Skill-3	Skill-4	Skill-5	Skill-6	Skill-7	Skill-8	Skill-9	Skill-10	Average %
A	5	5	5	3.5	3.5	3	5	5	5	5	90

B	5	5	5	5	3.5	3	5	5	5	5	93

Skills 1-9 helped in assessing PLO 2, while skill 10 helped in assessing PLO 3.

Outcome of assessment: Our chemistry majors obtained scores that were higher than the benchmark (>70%) established for assessment of PLO 2.

Appendix C – Assessment Plan

Programmatic Assessment Plan

Program Name: Chemistry Created By: 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.

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.

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	3	3	3	3

P-Chem				
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

Key

PLO = Program Learning Outcome

Not Addressed = PLO is not addressed within the specific course

Introducing = PLO is covered at an introductory level within the specific course

Broadening = PLO is covered in the course so as to reinforce the students' learning of it within the specific course

Fulfilling = Demonstration of proficiency of the PLO occurs within the specific course

Assessed for Program = There will be a Direct Assessment activity to be used in Program Level Assessment in all sections of this course.

Part III: Assessment Measures, Timelines and Targets

Direct Assessment

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

Part V: Intended Analysis, Responsibility, and Communication

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