

Curricular Affairs Committee of the Faculty Senate

MEMO

To: The UVM Faculty Senate

From: Curricular Affairs Committee of the Faculty Senate, Laura Almstead, Chair

Date: April 6, 2017

Re: Item approved by the Curricular Affairs Committee that do not require a Faculty Senate vote

Request to Change Bachelor of Arts (BA) and Bachelor of Science (BS) in Chemistry

The Department of Chemistry submitted a proposal for significant revisions to the Bachelor of Arts (BA) and Bachelor of Science (BS) degrees in Chemistry. The primary objectives of the proposed changes are to provide degree options that better support students' needs, provide coursework consistent with students' interests, and promote retention in the undergraduate degrees. These objectives were met through both curricular changes as well as structural changes to the degrees. Specifically, the goals of the Department's revisions were to:

- 1) Decrease the total number of mandatory courses for Chemistry degrees, and increase the number and diversity of elective 200-level courses.
- 2) Create options for BA degree to be earned with or without American Chemical Society certification.
- 3) Re-orient the focus of first-year coursework to the practice of Chemistry by adopting an "Organic First" approach.
- 4) Increase the Chemistry content density in the first year, with an increased focus on subdiscipline-relevant content.
- 5) Create better alignment of laboratory offerings with course curricula by redistributing the Advanced Laboratory (CHEM 201, CHEM 202) credits to advanced synthetic, instrumental analysis, and physical chemistry laboratories.
- 6) Promote a greater culture of safety, environmental stewardship, and chemical intuition through discipline-specific laboratory experiences.
- 7) Provide earlier discipline-specific instruction on writing, information literacy, and presentation skills.

As a whole, the Department hopes that these changes, which engage subdiscipline-specific content sooner and afford greater choice, will prompt greater retention in the Chemistry major, a challenge in Chemistry and other STEM majors that is recognized across public universities.¹ Beginning the curricula with Organic Chemistry places students squarely in one of the active areas of the science. This creates a different experience than starting with General Chemistry, a collection of initial concepts. With the new curriculum, majors will start by learning about what chemists really do. This strategy is aimed at improving student engagement with Chemistry content from the outset. The Department conducted informal polling of current Chemistry majors to assess potential anxiety related this "organic first" approach. Responses indicated that this change is generally not viewed as a concern among current students.

¹ Chen X.; Soldner, M. *STEM Attrition: College Students' Paths into and out of STEM Fields*, U.S. Department of Education, Institute of Education Sciences, Washington, DC, 2013.

Curriculum

All existing undergraduate Chemistry courses are part of the revised program with the exception of four courses (CHEM 035, CHEM 36, CHEM 143, and CHEM 144), which will be deactivated under the revised sequence. New, required courses developed to replace the deleted courses and support the curricular revisions are indicated in the table below. All courses have been approved, and will be in the catalog for AY 2017-2018. The Department also notes that the current BS degree requires MATH 021 and 022 and PHYS 051 and 152, and those requirements remain unchanged. However, as part of the revised sequence, the BA degree will also allow for MATH 019 and 020 as well as PHYS 011/021 and 012/022. The proposed catalog descriptions and full list of courses for the new BA and BS in Chemistry curriculum that were provided in the proposal are included at the end of this report.

Number	Name
CHEM 47	Organic Chemistry for Majors 1
CHEM 48	Organic Chemistry for Majors 2
CHEM 51	Exploring Chemistry 1
CHEM 52	Exploring Chemistry 2
CHEM 114	Advanced Synthesis Techniques
CHEM 165	Introductory Physical Chemistry
CHEM 166	Physical Chemistry Lab
CHEM 181	2 nd Year Seminar: Writing
CHEM 182	2 nd Year Seminar: Presentation
CHEM 199	Professional Development
CHEM 219	Instrumental Analysis Lab
CHEM 260	Advanced Physical Chemistry

Concerns were raised during the public comment period that allowing students pursuing the BA to take either PHYS 011/012 or PHYS 051/152 would leave students that chose the former option unprepared for their subsequent physical chemistry course, and that PHYS 011/012 are sufficient to meet the American Chemical Society (ACS) guidelines for Bachelors degrees in chemistry. The concerns were specifically related to the fact that PHYS 011/012 are not calculus-based. The Chair of the Chemistry Department responded to these concerns, stating that they recently restructured their physical chemistry sequence. Physical chemistry material had been divided into one semester of quantum mechanics (CHEM 161) and one semester of thermodynamics and kinetics (CHEM 162). Those courses are no longer being offered. Instead, students take Introduction to Physical Chemistry (CHEM 165), which covers more basic topics of quantum, thermodynamics, and kinetics, and more advanced topics are covered in the second semester (CHEM 260 Advanced Physical Chemistry). While CHEM 260 does require multivariable calculus, it is a requirement for the BS degree only, which has more rigorous physics and mathematics requirements (PHYS 51/152 and either MATH 121 or CHEM 167). Dr. Landry acknowledges that the BA degree falls below ACS standards for other reasons, which is explicitly stated in the program's catalog description. Students wishing to pursue an accredited path in the BA are directed to take specific courses from the available options. Currently, neither the Biomolecular or Environmental concentrations within the BA are

ACS-certified. Dr. Landry also indicated the Department had been in communications with the ACS Committee on Professional Training, which certifies degrees and accredits the department. The committee has expressed interest in seeing how the realignment progresses, as the committee has been discussing ways to revisit the undergraduate physical chemistry curriculum.

Admission Requirements and Process

The changes do not impact requirements for admission, though they may make the Chemistry degrees more appealing, particularly given the high degree of specialization possible within the BA degree. This programmatic change does not affect their selection process. It will ideally challenge the increasingly academically prepared students admitted to UVM, and it will provide pathways for students who arrive with less preparation as well.

Anticipated Enrollment and Impact on Current Programs

Overall, the Department does not anticipate a change in the source of candidates, or significant alterations in the number of students within the degrees. The new curriculum will, however, better support a more diverse pool of students. Increased numbers of students majoring in Chemistry due to the increased flexibility of the BA and improved retention within the major, could result in slightly increased enrollments for required courses outside the department, for example, mathematics, physics, and related science courses at the upper level. However, with the current number of graduating Chemistry majors of five to ten, even doubling the number of graduating Chemistry majors would not change enrollments in these courses more than the normal fluctuations in enrollment over the last five years.

It is important to note that the non-majors course offerings (e.g., CHEM 31/32 and 141/142) are unaffected by this proposal, and this route remains an option for students who switch to the Chemistry major after the first few years, transfer students, and students who may need more remedial preparation for the degree. In their revisions process, the Chemistry Department reached out to departments across the University requiring these courses to make them aware of the changes and seek their approval.

Assessment Plan

The Department will undertake this evaluation as part of its annual assessment practices. Specific metrics the Department indicates will be assessed are indicated below.

- 1) *Student performance through vetted assessments.* The Department collected validated assessment data on topical areas at the end of key foundational courses. They will continue this practice and compare data for students engaged in the new curriculum with those in the current to ask whether students are learning as well or better under the new curriculum.
- 2) *Enrollment in the degree programs.* They will track the number of majors by degree type, the pathways toward degrees, and enrollment in the courses. These data will address the question of whether more students are taking and completing Chemistry degrees, and whether the revised sequence is contributing to retention.
- 3) *Student experience.* The capstone course allows us to collect student experience data. They will continue to ask students what aspects of their degrees helped them to prepare for their current roles.

Staffing Plan, Resource Requirements, and Budget

There are no changes to staff assignments, faculty, space requirements, or library requirements. No additional costs are anticipated by the Department.

Evidence of Support

Communication of support was provided by Dr. Sara Cahan, Chair of Department of Biology; Faith Rushford, Pre-Health Program Director; Dr. Margaret Eppstein, Chair of Computer Science; Dr. Charlotte Mehrrens, Director of Geology Department; Dr. Jeff Buzas, Chair of Department of Mathematics & Statistics; Dr. David Barrington, Acting Chair of Department of Plant Biology; and Dr. George Wellman, Department of Pharmacology. It was also approved by the CAS Curriculum Committee and CAS faculty.

Summary

Overall, changes to the BA and BS in Chemistry are meant to improve student engagement early in the program and deploy more high impact practices. Both are demonstrated means to promote retention within STEM majors. The Department also believes that the revised degrees will better serve students interested in chemical science, and provide choices in curriculum that allow them to explore a range of related interests.

Chemistry – Curricular changes 2016-17

Course	Title	Action
CHEM 035	General Chemistry for Majors 1	Deactivated
CHEM 036	General Chemistry for Majors 2	Deactivated
CHEM 039	Introduction to Research	Deactivated
CHEM 040	Introduction to Research	Deactivated
CHEM 042	Intro Organic Chemistry	Edited description to include new course, CHEM 047
CHEM 044	Intro Organic Chemistry	Edited description to include new course, CHEM 047
CHEM 047	Organic Chemistry for Majors 1	New course
CHEM 048	Organic Chemistry for Majors 2	New course
CHEM 051	Exploring Chemistry 1	New course
CHEM 052	Exploring Chemistry 2	New course
CHEM 071	Contemporary Chemical Topics	New course
CHEM 114	Advanced Synthesis Techniques	New course
CHEM 121	Quantitative Analysis	Edited description to include new course, CHEM 052
CHEM 131	Inorganic Chemistry	Edited description to include new course, CHEM 047
CHEM 141	Organic Chemistry 1	Edited description to include new course, CHEM 047
CHEM 142	Organic Chemistry 2	Edited prerequisites to include new course, CHEM 047; edited description to include new course, CHEM 048
CHEM 143	Organic Chemistry for Majors 1	Edited description to reflect introduction of new course, CHEM 047
CHEM 144	Organic Chemistry for Majors 2	Edited description to reflect introduction of new course, CHEM 048
CHEM 146	Advanced Organic Laboratory	Edited prerequisites to include new course, CHEM 048; edited typo in description
CHEM 165	Intro Physical Chemistry	Edited prerequisites to include new course, CHEM 052
CHEM 166	Physical Chemistry Lab	New course
CHEM 181	2 nd Year Seminar: Writing	New course
CHEM 182	2 nd Year Seminar: Presentation	New course
CHEM 199	Professional Development	New course
CHEM 201	Advanced Chemistry Laboratory	Deactivated
CHEM 202	Advanced Chemistry Laboratory	Deactivated
CHEM 205	Biochemistry I	Edited prerequisites to include new course, CHEM 048

CHEM 214	Polymer Chemistry	Edited prerequisites to include new course, CHEM 048, and a current course, CHEM 165
CHEM 219	Instrumental Analysis Lab	New course
CHEM 221	Instrumental Analysis	Edited description to include a current course, CHEM 165
CHEM 223	Mass Spectrometry	Edited prerequisites to include new course, CHEM 048
CHEM 231	Advanced Inorganic Chemistry	Edited prerequisites to include new course, CHEM 048
CHEM 237	Special Topics: Inorganic	Edited description
CHEM 238	Special Topics: Inorganic	Edited description
CHEM 241	Advanced Organic Chemistry 1	Edited prerequisites to include new course, CHEM 048
CHEM 251	Physical Organic Chemistry	Edited prerequisites to include new course, CHEM 048, and a current course, CHEM 165
CHEM 262	Chemical Thermodynamics	Edited prerequisites to include a current course, CHEM 260
CHEM 264	Adv Quantum & Spectroscopy	Edited prerequisites to include a current course, CHEM 260
CHEM 282	Senior Seminar	Moved prerequisite to pre/co-requisites to account for current practice
CHEM 284	Biochemistry Senior Seminar	Deactivated
CHEM 285	Special Topics	Edited description
CHEM 286	Special Topics	Edited description