

EXECUTIVE SUMMARY
Weber State University
College of Science
Department of Chemistry and Biochemistry
Self-Study Document, Fall 2019

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The following is a summary of the self-study document, highlighting important points. For complete information, please refer to the full, self-study document itself.

Mission Statement:

The mission of the Department of Chemistry and Biochemistry is to equip our students with the conceptual and experimental foundation to support their goals. Such a foundation is achieved through deep understanding of the chemical basis of matter, in combination with current hands-on practical laboratory skills. The Department provides a personalized and accessible learning environment to encourage critical thought, maintain safe and ethical practices, and develop the ability to communicate effectively. First, our mission is to engage chemistry majors seeking thorough technical knowledge and advanced skills that will enable them to pursue post-graduate studies or employment. Our degree programs include an Applied Associates Chemical Technician degree, ACS Certified Bachelor's degrees (Chemistry and Biochemistry), and a Chemistry Teaching Bachelor's degree. Our students take on undergraduate research opportunities under the direct mentorship of faculty members. The relationships between the faculty and local businesses allow for real-world internship opportunities. Second, our mission supports students in other scientific majors including pre-professional students by providing molecular context interdisciplinary to life science or other physical sciences. Third, our mission enables non-science majors (general education credit) to attain a basic understanding of chemistry and the scientific method, growing the community's ability to evaluate critically and make informed decisions on issues relating to science, technology, and society. We share our enthusiasm with the wider community through outreach activities, and through concurrent education opportunities.

Curriculum:

The curriculum and programs housed in the Department of Chemistry and Biochemistry have all undergone significant revision during the past five years. The Department now houses two ACS certified BS programs, one in Chemistry and one in Biochemistry, that comply with recent changes in the ACS Guidelines and Evaluation Procedures for Bachelor's Degree Programs. These changes introduce significantly increased flexibility for the student to make choices that will best serve their educational and professional interests. Significant changes have also been incorporated into the Chemical Technician

(AAS) and Chemistry Teaching (BS) programs. New courses that have been added to the curriculum include, CHEM 3610, Foundation in Inorganic Chemistry, CHEM 4150, Nuclear Magnetic Resonance, CHEM 4250, Medicinal Chemistry, and CHEM 4630, Materials Chemistry. The topics that were previously taught in CHEM 3400, Symmetry and Applied Mathematics for Physical Chemistry have been distributed across other courses that that course has been discontinued. A course in each of the central disciplines of chemistry has been identified and adjustments made to satisfy the requirements of the ACS for foundational training in the areas of Analytical Chemistry, Biochemistry, Inorganic Chemistry Organic Chemistry and Physical Chemistry. These courses, which are required for all Chemistry (BS) and Biochemistry (BS) majors ensure that our students have the breadth of training in each of these fields to create chemists that are well rounded with training in each area of chemistry and biochemistry. We continue to develop in-depth coursework offerings that will allow our students to focus on their interests and pursue their goals. Additionally, specific chemistry related courses from programs such as Physics, Earth and Environmental Sciences, Zoology, Microbiology, Botany and Mathematics, can also fulfill elective requirements.

Student Learning Outcomes and Assessment:

Program Student Learning Outcomes focus on the areas of the 1) Core Concepts of Chemistry and Biochemistry, 2) Problem Solving Skills, 3) Laboratory Skills, 4) Communications Skills, and 5) Computer Skills. Core concepts and problem solving skills are evaluated throughout the curriculum using traditional methods with specific questions on quizzes and exams and focused graded homework assignments and laboratory reports. The American Chemical Society provides exams covering the range of chemistry courses across the undergraduate curriculum. These exams are administered for the Principles of Chemistry series, the Organic Chemistry series, Quantitative Analysis, Biochemistry, Inorganic Chemistry, and Physical Chemistry. Performance varies significantly from student to student but typical class averages place our students above the national averages, with a few students placing in the 90th percentile and higher. Laboratory skills are measured based on practical and theoretical formative and summative laboratory assessments. Written and oral laboratory and project reports provide a basis to evaluate communication skills. Computer and related skills are developed and assessed through laboratory and homework assignments. Finally, graduating students meet with the department chair for an exit interview during their final semester before graduation. The feedback received during these interviews provides some of the most candid and useful information that we obtain regarding what is working within the program and where improvements need to be made.

We find that student retention is very good when our students have progressed to taking junior level courses (>90% completion rates for the last five years) but we are concerned about our students that fail to complete introductory level courses, especially Chemistry Principles and Organic Chemistry. Completion rates for these lower division courses have hovered around 75% for the last five years. This number does not capture students that drop the course before the drop date, which would lower the completion rate still further.

While many of our students are doing very well in their studies, The Department has become aware that an apparently growing number of students are choosing to complete their lower-division chemistry coursework at other institutions then transfer those courses back to Weber State for credit toward their majors, apparently because of the perception that it is easier to obtain a higher grade in those courses elsewhere. We have not been able to determine how many students are choosing this approach but it is a significant concern as we consider how we can better serve and retain our students. While most of the upper-division majors courses that are taught in the department have smaller enrollments, usually under 24 students, introductory courses tend to have much large enrollments often of 100 or more. It is felt that smaller class sizes would allow faculty to work with students on a more individual basis, which would help improve retention and student success.

Academic Advising:

Advising of chemistry and biochemistry majors has changed significantly since the last program review was completed. The added flexibility introduced by the changes in the Chemistry (BS) program and addition of the new Biochemistry (BS) program make effective advising even more important than it was previously. Advising is a shared responsibility of the entire Chemistry and Biochemistry Department faculty. The department chair meets with each student that wishes to declare a Chemistry (BS) or Biochemistry (BS) or BIS major for initial advising answer student questions about the major and ensure the student knows what classes to take next. A member of the faculty will be assigned to advise specifically for the Chemistry Teaching (BS) major and another for the Chemical Technician (AAS). As part of the initial advising visit, each student is assigned a member of the faculty as act as their faculty advisor with the intention that the student will meet at least annually with their faculty advisor to ensure they are on-track and know what courses to enroll in during the coming year. Where possible, faculty advisors are chosen to complement each student's interests.

Faculty:

The strength of the Department of Chemistry & Biochemistry lies in the dedication and expertise of both the faculty and staff. The Department currently has eleven full-time faculty and two full-time instructors. All tenured or tenure-track faculty members within the Chemistry Department hold terminal degrees with unique talents and technical expertise. The academic preparation required of faculty in the Department generally includes an earned Ph.D. or equivalent in one of the recognized areas of chemistry (analytical, biochemistry, inorganic, organic or physical) or in a closely related area such as metallurgy, chemical engineering, material science, or geochemistry. The Department places priority on hiring and supporting qualified and experienced faculty who complement the design, goals and mission of the program. While some improvement has been made in achieving a diverse and representative faculty, this remains a challenge with improvement to be made in gender and especially race equality among the faculty.

A multidisciplinary Environmental Sciences program is being developed in the College of Science. While chemistry plays a central role in similar programs, the Department lacks faculty with expertise in field measurement and the associated analytical techniques. Specifically, the

Department and College do not have faculty trained in atmospheric chemistry and air quality, which is recognized to be an area of particular importance in northern Utah. At least one additional faculty line supporting in part the Environmental Science program is needed to help fill this void.

Faculty loads remain a significant concern. The university policy regarding faculty loads is based on antiquated teaching techniques, especially for laboratory course and undergraduate research. Modern pedagogical approaches to teaching lectures and labs require much more effort than was typical for labs ten to twenty years ago. Laboratory teaching load assignments presume that the faculty member will have half of their lab time available to grade and do other preparatory work while students work individually collecting their laboratory data. Modern active-learning pedagogies require faculty's continuously attention as students develop experimental methods and gather data. Time in lab is as all-consuming as time in lecture. Teaching load credit needs to be give faculty based on contact hours rather than the teaching load credit provided for in university policy. Similarly, faculty are increasingly involved as mentors in undergraduate research projects with students. University policy needs to be developed to better recognize the real effort that faculty are called upon to provide in these activities.

Program Support:

The number of support staff has decreased since the last program review – 7 years ago. We currently have one full-time secretary and one lab manager who also serves as manager of the science store. A full-time science store manager was cut from the department in early 2015 and was never replaced. The science store manager's responsibilities were added to those of the laboratory manager, who now functions approximately half-time as the lab manager for all chemistry teaching labs and half-time as the manager of the science store for the College of Science. Student lab assistants are used where possible but significant difficulties frequently arise in offering properly prepared labs because of the loss of the position.

The Tracy Hall Science Center provides excellent modern facilities. However, it was built for the current need and finding space for classes and research is increasingly difficult as enrollments grow. As we continue to experience growth in the number of majors and the faculty needed to teach them, we will face increasing challenges with available teaching and research space.

Laboratory courses are increasingly expensive to offer. Laboratory fees were introduced for chemistry labs more than ten years ago to offset the additional costs of consumables and instrument maintenance and replacement associated with labs. As costs grow, lab fees are limited and are often inadequate to cover the real costs of lab. This is especially challenging for upper-division major's courses, which have relatively few students compared with large service courses, but require more costly reagents and instrumentation. It is not reasonable to place the burden of lab fees on students for these upper-division courses but current policy requires that lab fees only be used to support the courses for which they are collected. A more sustainable model is needed to support the costs of offering upper-division laboratory courses.

The programs within the department have good access to modern instrumentation, many of which have been obtained since the opening of the Tracy Hall Science Center. However, the resources do not currently exist to support the purchase and maintenance of a modern high-field NMR instrument. This remains a priority of the department to better support undergraduate research and in-depth laboratory course work.

Relations with External Community:

The Department of Chemistry and Biochemistry enjoys excellent relationships with commercial and government laboratories in northern Utah. Each year, we take our chemistry students to visit some of the local corporate, government and university laboratories. These include the only Occupational Safety and Health Administration (OSHA) laboratory in the nation, Wasatch Labs, Balchem-Albion, Systemic Formulas, Frontier Scientific, ARUP, Nutraceutical Corp., Northrop Grumman (Orbital-ATK), Fresenius, Capstone Laboratories, Compass Minerals, Water treatment plants, Big West Oil, Purity Technologies, RJ Analytical, Western Zirconium, Utah Crime Lab, Advanced Laboratories, AMT Laboratories, Utah State University, and many others. Keeping these connections alive and nurturing them pays big dividends to the Chemistry and Biochemistry Department and to the University.

The Department of Chemistry and Biochemistry formed an advisory council in 2017 and has met annually with that body. We are working to make better use of that council. We are especially interested working with our advisory council to develop internship opportunities that will help our students as they transition from their schooling into the workforce.

Student, Faculty, Contract/Adjunct Faculty and Staff Statistics:

The Department of Chemistry and Biochemistry is currently composed of eleven tenured and tenure track faculty, two instructors, three adjunct faculty, an administrative specialist and a single lab director/Science Store manager. The Department supports a total of about 17,000 student credit hours each year. We are experiencing significant growth in numbers of progressing declared majors (+8.5% annual increase for the last five years), numbers of baccalaureate degree graduates (+15.6% annual increase for the last five years) and numbers of associate degree graduates (+56.5% annual growth for the last five years). We have over 300 declared progressing majors across each of the department's programs. We also see significant improvements in the numbers of majors from underrepresented populations (+11.5% annual growth for the last five years among students identifying as Hispanic and Latino). There are over 200 declared progressing majors in Department bachelor of science programs with about half of those declared as Biochemistry (BS) majors, half as Chemistry (BS) majors, with six Chemistry Teaching (BS) majors. We have seen remarkable growth in Chemical Technician (AAS) graduates during the last five years, with about 10 graduates per year five years ago and graduating about 60 each of the last two years. There are currently over 100 declared Chemistry Technician (AAS) majors enrolled and progressing in that program. These numbers confirm that the department is experiencing healthy growth across our programs but it also points toward challenges that lie ahead as we strive to serve increasing numbers of students with increasingly time and effort intensive teaching pedagogies. This growth has occurred while the number of

tenured and tenure-track faculty in the Department have remained constant and the number of support staff has decreased. Our ability to support our own programs and many others for which our courses provide support depends on maintaining sufficient numbers of faculty with diverse backgrounds in chemistry.

Results of Previous Program Reviews:

Specific achievements related to findings from the last program review include:

- 1) Development of an ACS Certified Biochemistry (BS) program.
- 2) Update of the ACS Certified Chemistry (BS) program.
- 3) Development and modification of foundation and in-depth courses to support the new programs.
- 4) New modern facilities housing the Department and College
- 5) Hire of a faculty member with expertise in medicinal chemistry to replace a retiring physical chemistry faculty member.
- 6) Hire of an inorganic faculty member to replace an inorganic faculty member.
- 7) Hire of two instructors to teach introductory and support courses in chemistry.
- 8) Development of new laboratory experiments across many courses within the curriculum employing more active learning pedagogical approaches.
- 9) Continue to develop and support undergraduate research options for students.

Information Regarding Current Review Team Members:

Lou Cannizzo, Northrup Gumman
Angelica Stacy, University of California Berkeley
Matt Horn, Utah Valley University
Matt Nicholaou, Weber State University