Faculty Response to External Review Document

Department of Chemistry **December 18, 2020**
College of Science
Weber State University

Introduction

The Weber State University Department of Chemistry and Biochemistry is grateful to the members of the external program review team for their dedicated and professional review of the Department and its programs. The report and recommendations were formulated based on the program self-study document and site visit including interviews with students, staff, and faculty. As part of their review, the team identified the strengths, challenges, and weaknesses of the Department's programs and based their recommendations on these observations. The team's review and recommendations fall broadly in five categories: 1) faculty and staff resources, 2) program and course assessment, 3) student advising, 4) teaching pedagogies, and 5) undergraduate research. Some of these recommendations address needs that are directly related to the growth in numbers of progressing majors that has accompanied the broad revisions made to the American Chemical Society (ACS) Certified Chemistry degree program and the creation of an ACS Certified Biochemistry degree program, since the previous program review. This response provides context for the recommendations, clarifies current and future efforts related to the recommendations, and identifies departmental areas of focus for the future.

1 – Faculty and Staff

The review team was impressed with the strength of the dedicated and highly qualified Chemistry and Biochemistry faculty and staff and the major curricular changes that have been implemented since the last review. Among the challenges noted by the review time are: insufficient laboratory support personnel, insufficient resources dedicated to lower division courses and laboratories necessary for the large numbers of students in service courses; excessive faculty contact hours and loads. Recent curriculum changes and the accompanying growth in progressing majors requires additional personnel to support teaching laboratories for upper-division courses. The review team specifically noted that comparably sized programs at similar institutions have multiple laboratory managers supporting introductory, organic, and advanced chemistry labs with additional specialized staff members. Weber State's single chemistry laboratory manager divides her time between introductory and organic chemistry lab preparation while also managing the WSU Science Store. The loss of a dedicated laboratory director since the last review and the growth in majors have placed additional burdens on faculty teaching courses in the major who, in addition to designing and teaching lab, must prepare their own labs. This is a hidden load that is not part of load calculations and is not typically part of teaching responsibilities at similar institutions. Historically, the Department has employed students as laboratory teaching assistants and stockroom assistants. Prior to COVID-19, the numbers of students willing to work as teaching stockroom assistants had been dwindling and COVID-19 has now reduced these almost to zero. We have reached the point where the lab director/store manager can no longer provide the needed support and faculty are being required to prepare their own lower-division labs, significantly adding to their hidden loads. This is an unacceptable use of our highly qualified faculty, who have been hired because of their expertise to teach.

Faculty contact hours are already at the maximum and sometimes exceed those allowed by the American Chemical Society Guidelines for approved chemistry departments, which recommends

"Fifteen contact hours is an upper limit, and a significantly smaller number should be the normal teaching obligation, particularly for faculty supervising undergraduate research." The current ACS Periodic Review sets the target ideal-contact-hour threshold at eleven contact hours or less for all faculty members per week if meaningful undergraduate research is expected. High contact-hour loads threaten the Department of Chemistry and Biochemistry's standing as an ACS Approved department that can offer ACS certified degrees. Losing ACS Approved status would substantially decrease the reputation and value of the chemistry and biochemistry programs offered at Weber State. Further, supporting chemistry and biochemistry program requirements and improving undergraduate research opportunities for our students require that teaching loads are appropriate to allow faculty to mentor all our students in their research requirements. We must address teaching loads and minimize hidden loads created by insufficient support staff. While suggesting that more will be necessary, the review team recommends "The obvious point to begin is by adding another lab manager."

The review team recognizes a need for an additional faculty member to support the growth in numbers of students in the highly successful biochemistry program. Since the review team's site visit, the Department of Chemistry and Biochemistry has been approved to begin a faculty search for a new faculty line. The new faculty line will be in analytical and environmental chemistry, where the previous faculty line was lost and the Department's need for expertise is even greater than in biochemistry. The new faculty line will be shared between the chemistry department's existing teaching needs and development of courses related to the new Environmental Science (BS) program that has been implemented in the College of science. It is hoped the new faculty member's expertise will allow them to teach courses that will free up existing biochemistry faculty to focus on the Department's biochemistry program needs but they will not fully address the biochemistry program's needs. The review team's report emphasized the importance of a diverse faculty and staff in supporting the needs of a diverse student body. Every faculty search in the memory of current faculty has maintained diversity as a priority in the search but we have much improvement to make. To obtain a large and diverse applicant pool, the wording of the current job announcement was scrutinized to ensure inclusive language, the Department and College have funded posting targeted job ads in publications that serve underrepresented communities, and faculty are reaching out to colleagues to spread the word about the available position. Rating criteria will include tie-breaker credit for those identifying with underrepresented communities. The University is implementing a program to provide additional salary support to encourage candidates from underrepresented populations to accept teaching appointments at Weber State. These measures, coupled with being given the opportunity to do a faculty search during a period when many institutions of higher education are facing cut backs and limiting hiring gives us hope that we will be successful in helping make the Department a friendlier place for students of all backgrounds. The Department is committed to building an inclusive educational environment for our students.

Addressing teaching loads is of greatest importance for newer faculty members who are striving to develop thriving research programs supported by external funding as they seek to attain tenure and establish themselves in their fields of research. Appropriate teaching loads are necessary to support newer younger faculty development and success. Recently implemented post-tenure review requirements for tenured faculty mean that appropriate teaching loads are similarly important for established faculty as they strive maintain projects that provide our students with meaningful research experiences. Providing adequate staff support and resources and sufficient faculty numbers to keep teaching loads at acceptable levels will be necessary during the coming years as we strive to improve student success. The Department is committed to student success but depends on having adequate resources available to accomplish our mission.

Acknowledging the highly successful Chemical Technician (AAS) program, the review team noted that the Department needs to plan for the continuation of that program when Dr. Walker, who has developed and promoted the program since its inception retires. While Dr. Walker has not shared plans to retire, he and all of us will one day be faced with that event. The Department had the opportunity to consider the content of CHEM 2990, Chemical Technician Seminar, and the role of the Chemical Technician (AAS) program during Dr. Walker's recent sabbatical and several ideas were generated by this experience that take advantage of the expertise of existing faculty in the Department. The Department will review the evolving local and regional needs for chemical technicians along with ideas that Dr. Walker's absence helped generate to develop a continuation plan for the highly successful Chemical Technician (AAS) program.

2 – Course Assessment

The review team recognized that adequate assessment data is being collected but they struggled to identify how the collected data was being communicated and used to systematically improve student learning within courses and across programs. The review team recommends that clearly defined thresholds be articulated for assessing student success across all sections of each course and that more evidence is needed to show that assessment tools are being used to regularly evaluate the program in a defined rigorous process to drive new changes.

The Chemistry (BS) and Biochemistry (BS) programs are both ACS certified programs. ACS approved programs provide students with comprehensive and rigorous education in the field of chemistry. The ACS defines broad learning outcomes for certified chemistry programs including problem solving skills, chemical literature and information management skills, laboratory safety skills, communication skills, team skills, and ethics. The Curriculum Map presented in the self-study identifies the degree to which the content and assessments in individual courses support specific program learning outcomes. The Curriculum Map is being updated in response to recent changes to ACS guidelines combined with changes in the ACS program evaluation process.

In addition to broad program learning outcomes, course learning outcomes include specific content knowledge. The ACS creates and makes available nationally normed ACS exams that support summative assessment of student retention of content knowledge. Midterm exams, homework assignments, classroom group assignments and other activities provide formative assessments of problem solving skills and content knowledge development throughout the semester. Laboratory activities and assignments, including written reports, lab notebook reviews, etc., provide information for laboratory skills assessment. Capstone assessments of program learning outcomes, including written reports of undergraduate research projects, posters presentations of undergraduate research or other "senior projects", and exit interviews provide completion-of-program feedback.

Currently, course learning outcomes are common among sections of a course but specific assessments vary with instructor, resulting in loss of unity and clarity, especially for course where multiple sections are taught by different instructors throughout the year. To make assessment more practical, organized, and actionable, the Department is assigning a faculty member as a "course lead" for each course to work with other faculty that teach the course and ensure unified course objectives and assessments are being used across sections. It is envisioned that course leads will manage the assessment process but decisions about changes to course content and assessment will be by made by consensus of all faculty teaching the course based on assessment data and other relevant input. Course leads will facilitate implementation and articulation of uniform assessment thresholds across all sections of their courses as recommended by the review team. Significant changes in learning

outcomes and assessment findings will be shared with all faculty across the Department on a regular basis such as every two years when biennial assessment reports are being prepared.

3 – Student Advising

The review team noted that the chemistry and biochemistry programs' current advising scheme is not adequately supporting students, especially those that fall outside of traditional power structures, in part because of the Departments weak demographic diversity. They recommend that a formalized advisor change procedure be implemented that ensures better alignment of student interests with advisor background and that advisors be given advising assignments with corresponding reassigned time for their efforts.

Student advising in Chemistry and Biochemistry has undergone significant changes over the past ten years as we strive to improve student success. Up to about ten years ago, student advising was done entirely on an as-needed basis as requested by individual students and was primarily the responsibility of the department chair and the chemistry department administrative specialist. Approximately ten years ago the department administrative specialist was no longer allowed to do advising and all advising of chemistry majors became the sole responsibility of the department chair and students were required to meet with the department chair when declaring their major and annually or more often as needed thereafter. The department chair's familiarity with the department's programs makes them a good fit for advising responsibilities, however, advising is a time intensive process and it is not feasible for the department chair to provide all departmental advising while also attending to other department-chair and teaching responsibilities.

Following the previous program review recommendations, majors advising is distributed across the Department's faculty. This model was implemented and has been in effect since the Chemistry Program redesign and the Biochemistry Program creation in 2016. Under this model, the department chair is responsible for initial advising for newly declared majors. Initial advising is a requirement for declaring any of the Department's majors. However, it is not always enforceable with current campus major-declaration policies. After declaring a major, students are assigned an advisor from among the faculty based on their declared majors and interests (Chemistry, Biochemistry, Chemistry Teaching, Chemical Technician). Department faculty reach out to each of their assigned students at least annually to invite them to review their plans for the coming year. Only about twenty percent of students respond to the invitation for annual advising. Faculty also frequently provide informal advising for students currently taking their courses. This distributed model has provided more advising opportunities for students in the Department but continues to fall short of providing for the advising needs of all students and the Department continues to consider alternatives that might serve students better. The review team recommended that advising should be more customized to individual student needs and should specifically target at-risk students, both through better matching student needs with faculty expertise, and through more aggressive and flexible advising assignments. Placing additional advising responsibilities on faculty adversely affects their ability to attend to their primary responsibilities of teaching, supporting undergraduate research, scholarship, and service. Additionally, the Chemistry and Biochemistry programs were intentionally designed to provide students with flexible paths to completion. This flexibility has greatly increased the options students have and has made advising much more necessary and challenging. While the Department provides general advising materials, faculty often feel unqualified to provide adequate advising that addresses each student's unique interests and unique needs. We are therefore considering assigning formal advising responsibilities to only two or three faculty with associated reassigned load to offset advising burden. We need to determine the appropriate reassigned load and how to fund that reassigned load. We hope to improve advising

participation among students by introducing assignments in key courses in the curriculum that will require students to meet with program advisors. Informal advising will continue to be done by individual faculty through natural interactions with their students.

4 – Active Learning Pedagogies

The review team recommends the Department mandate increased use of active learning pedagogies to more fully engage students and improve student learning. High quality, effective teaching is the priority for all the Department's faculty. A variety of teaching approaches are used in the Department with most faculty applying multiple strategies in their teaching. All faculty in the Department apply some active learning strategies but all of us can improve. Nationally, the chemical education community takes a leading role in the development of active teaching and learning pedagogies. For example, Process Oriented Guided Inquiry Learning, POGIL, originated in the chemistry education community and boasts a thriving national and international community of practice that spans science disciplines and beyond. Several faculty regularly use POGIL in their classroom.

Talented faculty are accustomed through their training to experiment, gather data, and determine what works in their classrooms. However, limited time and uncontrollable variables and other factors mean that none of us on our own can ever do enough experimenting to exhaust all possible teaching approaches and determine what works best. Nevertheless, we can learn much from combining our experiences with those of others. There is clear evidence in the chemical education literature that active learning pedagogies produce superior results to passive learning approaches. It can seem that there are as many active learning approaches in practice as there are practitioners. This illustrates the fundamentally personal nature of teaching and the importance of individual faculty embracing the development of their own teaching style while integrating those practices that produce the best outcomes.

It has long been the Department's top priority to support faculty in developing and improving their teaching. The Department encourages participation in workshops and conferences related to teaching pedagogy and skills. Interacting with faculty from other institutions can be extremely beneficial to help our faculty develop their own teaching, regardless of how long a faculty member has been teaching. The Department and College specifically encourage the use of active learning pedagogies. The Department and College support the faculty in participating in activities that develop these teaching skills. Discussing opportunities for building connections to faculty and organizations who are focused on improved teaching are a regular element of annual review interviews. These connections create opportunities for experiencing alternative approaches for teaching and have many other benefits. All Department faculty have attended and participated in teaching workshops such as those facilitated by the POGIL community.

The course lead model described in the assessment section will also help encourage implementation of active learning pedagogies by encouraging faculty to work together to design activities and assessments that promote active student engagement in the learning process. As addressed elsewhere in this response, excessive teaching loads and especially hidden loads create burdens that make implementing active learning pedagogies challenging. Addressing these challenges has been discussed elsewhere in this response. The Department of Chemistry and Biochemistry supports and promotes the use of active learning pedagogies by its faculty throughout the curriculum but realizing all the benefits of these methods requires the support of the University.

5 – Undergraduate Research

The review team recommended that the Department needs to build strength in research to provide research opportunities to undergraduate students. Some challenges regarding undergraduate research related to faculty and staff resources have been addressed under the Faculty and Staff section. The Chemistry and Biochemistry programs face challenges related to faculty load as well campus infrastructure.

Perhaps the biggest challenges that the Department and its faculty face related to providing undergraduate research opportunities for all our students is faculty time. Current University policy regarding undergraduate research loads awards 0.25 teaching credit hours (TCH) for each student credit hour of CHEM 4800 Research and Independent Study. CHEM 4800 students are expected to spend about three hours each week during the semester in lab for each hour of research credit. Faculty supporting student research frequently spend a similar amount of time with each student and 0.25 TCH does not begin to represent the faculty time and effort associated with supporting undergraduate research. Ideally, a predictable number of students would sign up for CHEM 4800 research with each faculty member each semester and this could be applied to their load calculation in the semester where research is being accomplished. In practice, research loads vary wildly from semester to semester and research TCH must be banked and applied in a later semester. The Department is still trying to find a good model for managing the meager research TCH that faculty generate to better support faculty in undergraduate research.

All Chemistry (BS) majors are required to complete two credits of CHEM 4800 and one credit of CHEM 4990 where they prepare a research paper and poster and present the poster. Faculty are deeply involved in these courses, which serve as a capstone experience for our majors. A capstone experience is required for all ACS certified majors. The CHEM 4800/4990 are currently elective rather than required for Biochemistry (BS) majors because the Department cannot fully support more student research than it is currently supporting with current faculty loads and the Biochemistry program is considering alternative capstone experiences that will not require as much faculty time.

In addition to research experiences that are completed with Weber State faculty, chemistry and biochemistry students have many opportunities each year to apply for and become involved in Research Experience for Undergraduates (REU) programs offered by graduate programs in Utah and across the nation. Students may substitute an REU for CHEM 4800 credit with departmental approval but must still complete CHEM 4990 to facilitate preparing a research report and poster presentation. Providing adequate support in CHEM 4990 for students that complete an REU is a challenge for the Department because our students frequently work on projects that our faculty do not have expertise in and REU mentors are often unhelpful when the student is preparing a research report. Research based internships and research for a student's employer are similar to REUs and may also be substituted, with departmental approval, for CHEM 4800 research. Students completing internships face many of the same challenges that REU students face. Additionally, research conducted by businesses is often proprietary in nature and the business will not allow a student to write a report about their work.

The Department continues to explore alternative capstone experiences that can deepen students' understanding and allow students to draw on their coursework and lab experiences to solve real-world challenges and is investigating using collaborative research projects with research cohorts to maximize educational impacts while minimizing the burden on faculty.

Campus infrastructure supporting undergraduate research is extremely limited. The Department has ten shared research spaces in the Tracy Hall Science Center and one in the Lind Lecture Hall. This provides one space per tenured or tenure track faculty member in the department. The addition of a new faculty line will require an additional research space. The Department has a fairly broad range of common laboratory instrumentation, though much of it is ageing. With no maintenance plans for most instruments, the Department does a remarkable job of keeping these instruments serviceable. Faculty are sometimes required to invest extensive amounts of time when an instrument breaks down, which often occurs at the busiest time of the semester and represents another hidden load. Unlike most programs of similar size, the Department does not have a high-field NMR instrument, nor does it have a differential scanning calorimeter, both of which are important for undergraduate research projects in multiple areas. Not only does the Department not have sufficient funding to purchase these instruments, but it lacks necessary funding for maintenance and consumables to keep the instruments serviceable. The College of Science is currently searching for an instrument technician to help address instrument maintenance needs across the College but a technician will not be able to maintain instruments without funding for consumables and specialized service.

Summary

The review team has identified a range of strengths, weaknesses, challenges, and recommendations for the Chemistry and Biochemistry programs at Weber State University. The Department agrees with much of the team's analysis and is excited to move forward with redesigning the chemistry curriculum to provide greater flexibility and more fully serve student needs. The success of the Department depends on the vision, dedication, and ingenuity of the chemistry faculty and on the support of the College and University to provide the resources necessary to implement the needed changes. We are optimistic that we can make real and substantial progress toward accomplishing our goals to improve and transform the Chemistry and Biochemistry programs at Weber State University.