

Program Review Report

June 2017

1. **Reporting Institution** Eastern Illinois University
2. **Program Reviewed** B.S. in Chemistry(40.0501)
3. **Date** February 20, 2017
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5. Overview

The mission of the Chemistry program is to provide a broad background of factual knowledge about chemistry while providing students with tools to effectively solve problems relating to chemistry. The Chemistry Department faculty specialize in all five traditional sub-disciplines of Chemistry (Organic, Inorganic, Physical, Analytical, Biochemistry), and several faculty have interdisciplinary interests that bridge more traditional areas. The department currently has 14 tenured/tenure-track faculty. Since the previous review in 2009, 2 annually contracted faculty (ACF) positions were lost, and 1 tenured faculty member is in administration, helping keep numbers consistent with declining EIU enrollment. The department is unique in the importance of undergraduate research participation to the development of chemistry majors; 100% of Chemistry B.S. majors from 2009-2016 participated in research. 50% of faculty have active external grants to support student research, with a total of \$1.96 million in external funding since 2009; this is an unusual level of support for a school this small. Research results are published in peer reviewed journals and presented by faculty and students at national and international conferences.

Learning objectives are that students will be able to: (1) learn fundamental principles and applications in each of the major sub-disciplines in chemistry, (2) critically analyze a breadth of chemical problems and experimental results, (3) execute chemical experiments utilizing modern methods & equipment, (4) be familiar with computer applications in chemistry, (5) be able to properly utilize chemical information sources, (6) apply the scientific method of investigation, and (7) communicate technical material effectively in speaking and writing. Because of evidence that applicants do not attend EIU or choose a different major because of lack of (clear) availability of a Biochemistry major, the department's name will be changed to "Chemistry and Biochemistry" and the Biochemistry concentration will be replaced by a Biochemistry B.S. Given our Fall 2016 university-wide program review, we are reassessing departmental long term goals. Several upper division Chemistry courses have increased enrollment of Biology majors (B.S. and M.S.), and this is enhanced by recent addition of Biochemistry to the MCAT and addition of the Biochemistry and Biotechnology M.S.

6. Major Findings and Recommendations

- a. **Description and assessment of any major changes in the program/disciplinary context, e.g., (1) changes in the overall discipline or field; (2) student demand; (3) societal needs; (4) institutional context for offering the degree; (5) other elements appropriate to the discipline in question; and (6) other.**

(1) Changes in the discipline: The Bureau of Labor Statistics projects slow growth in chemistry and materials science over the 2014-2024 period, with predicted declines in manufacturing jobs that tend to employ chemists (Occupational Outlook Handbook). On the other hand, the incoming presidential administration's seeming inclination to shun foreign manufacturing and workers could lead to an increase in demand for American-educated chemists. As EIU's overall enrollment has dropped, the number of Chemistry majors has remained relatively constant, showing steady demand for the major. Demand for high school teachers in Illinois has decreased as schools have been laying off teachers due to budgetary constraints, and this is visible in smaller numbers of students pursuing Science Teacher Certification options. At the same time, interest in biochemistry as a pre-health or stand-alone major has increased greatly. This is partly a result of the recent addition of biochemistry content to the MCAT exam, making premed students more aware of biochemistry as a separate subject and leading them to take more courses that are not housed in Biological Sciences departments. These students are interested in rigorous Biochemistry B.S. degrees, or B.A. degrees with broader coverage that allow them to take a wide range of courses in both Chemistry and Biological Sciences departments.

(2) Student demand: Overall, enrollment at EIU has declined steadily since 2009, with a drop of 29% from 2009 – 2015, but over this time Chemistry B.S enrollment has remained relatively constant. Although there was a drop of about 19% in students listing the Chemistry B.S. as their first major from 2009 – 2010, since then the number has remained essentially constant at 41 – 44 majors (with one year slightly lower). Interest in biochemistry, materials and alternative energy remains high. One retirement has allowed us to hire a new faculty member with materials science expertise, so we are well staffed in materials science. Demands for biochemistry teaching and research opportunities consistently exceed our capabilities. The recent addition of biochemistry as a subject on the MCAT medical school entrance exam has led to further increased demand in this area. Increased interest in health-related careers has also led to a proposal for a separate B.S. degree in Biochemistry (as opposed to the present concentration in Biochemistry within the B.S. in Chemistry degree). It is expected that this new major will be approved and in place by the Fall 2017 semester.

(3) Societal needs: With the incoming presidential administration, it is expected that the number of highly qualified foreign scientists in the US will drop; thus, there will be a need for American scientists to fill vacant research, development, manufacturing and other technical jobs. In addition, the National Student Clearinghouse found that the number of science and engineering bachelor's degrees completed grew twice as fast as the number in non-science fields from 2009-2013, and now 40% of bachelor's degrees earned by men and 29% of women's degrees are in science, technology, engineering or math (STEM) fields (<http://www.usnews.com/news/articles/2015/01/27/more-students-earning-degrees-in-stem-fields-report-shows>). There is a clear demand for strong scientific training amongst today's college students.

(4) Institutional context for offering the degree: Chemistry is a discipline that is central to many other subjects, ranging from biology, dietetics and health-professions to physics and engineering. This leads to a significant service component to teaching within the department, with some students from other majors requiring as many as 5-6 semesters of chemistry courses. The central and interdisciplinary nature of the subject also leads many students from other majors to seek out research experiences within the Chemistry Department. Significant general education contributions are also made by the department, with an average of 578 students enrolling in general education courses in the Chemistry department each year from 2009 – 2016. The presence of a vibrant undergraduate chemistry degree is central to delivery of EIU undergraduate curriculum and to maintaining a strong group of faculty with expertise to deliver this curriculum. The recent Vitalization process at EIU listed the Chemistry B.S. degrees as stable, not requiring restructuring or other immediate changes.

(5) Other elements appropriate to the discipline: The department was recently re-approved to offer degrees certified by the American Chemical Society (ACS), and this approval is valid through 2021. Just before the last IBHE review in 2009 the department updated our B.S. Chemistry curricula so that both the Chemistry and Biochemistry concentrations met ACS certification standards. We are now in the process of separating the Biochemistry concentration into a separate B.S. in Biochemistry major, which we expect to be approved and in place by Fall 2017. With increased emphasis on Biochemistry on the MCAT exam, we feel that this will be a beneficial change for marketing our department. Within EIU's recruiting and admissions web pages, this will allow Biochemistry to be listed explicitly, which is not possible with a Biochemistry concentration within the Chemistry B.S. major. Direct student feedback has told us that we lose students to other departments and universities because of the current lack of an explicit presence of a Biochemistry degree on the university web site. Concurrently with implementation of the Biochemistry B.S., the department has had approval to change our name to "Department of Chemistry and Biochemistry" as of Fall 2017.

b. Description of major findings and recommendations, including evidence of learning outcomes and identification of opportunities for program improvement.

A variety of measures are used to assess achievement of student learning objectives. These include percentages of students achieving certain score levels on specific assignments in a variety of courses, student performance on the major Field Test that is administered to graduating seniors each year, and responses on exit surveys given to graduating students and alumni surveys that are sent 3 and 8 years after graduation. For data collected from course assignments, stated goals are generally met. The best performance is on the goal of being able to execute chemical experiments utilizing modern methods and equipment. This is arguably one of the most important aspects of the Chemistry degree since graduates in the job market will almost certainly be performing hands-on tasks. In all years evaluated the goal of 100% of students completing a series of laboratory experiments that demonstrate breadth of ability was met. Performance in critical analysis and problem solving is consistently below expectations when measured based on course grades. Additional measures of this goal include the percentage of students performing individual research projects and responses from alumni and exit surveys. Those responses overwhelmingly exceed expectations, with 60-70% of graduating seniors participating in research (criterion is 50%) and survey responses averaging 4-4.5 on a 5 point scale (criterion is ≥ 3). We continue to do reasonably well in meeting expectations that students will learn fundamental principles and applications in major sub-disciplines of chemistry. This is measured using the Major Field Test, with the expectation that a majority of students will score at or above the 50th percentile. Over the time period evaluated, typically 40-50% of students met this expectation;

however, the validity of the Major Field Test as a comparison for EIU students is questionable, since some other universities require a certain score for graduation and/or have classes aimed specifically at preparation for the test. One excellent source of feedback from graduating students has been oral exit interviews and “anecdotal” results from this have led to modifications to our degree requirements in the past. Presently, the department is working to find a way to quantify this direct student feedback and share it with faculty more effectively.

c. Description of actions taken since the last review, including instructional resources and practices, and curricular changes.

(1) Recent faculty hires: The hiring of a faculty member with expertise in materials, and particularly with interests in solar cell development has allowed the department to build strong ties to the new CENCERE renewable energy center on campus. This faculty member was hired in 2012 and has already been successful in obtaining significant external funding for his research program, and he has an active research program involving both undergraduate and masters students. An additional hire of a biochemist in 2010 replaced a faculty member who failed to achieve tenure. This biochemist has also been successful at obtaining external funding for her research and has an active undergraduate and graduate research program.

(2) Instructional resources: The department was the victim of a major vandalism attack in November 2011. This resulted in destruction of all of the major instrumentation in the department, many computers, and significant numbers of samples and equipment in faculty research labs. The department was able to rebound from this setback relatively quickly, thanks to the support of the EIU administration for facilitating many large equipment orders very quickly. Ultimately, a few classes had to be taught differently than usual during the Spring 2012 semester, but operations were back to normal by Fall 2012. In addition to replacement equipment obtained as a result of the vandalism losses, we have continued to modernize equipment used in general chemistry and higher level lab classes. In general chemistry labs, some experiments now utilize handheld digital data collection units which have replaced old mercury-containing manual instrumentation. The department upgraded its computational resources to a 12 CPU Linux workstation running state of the art computational chemistry software in Spring 2013, and this and PC versions of the software are used at multiple curricular levels.

d. Description of actions to be taken as a result of this review, including instructional resources and practices, and curricular changes.

Two changes have been approved up through the EIU curricular bodies, which are also mentioned above. These are changing the department name to Chemistry and Biochemistry and changing the present B.S in Chemistry – Biochemistry concentration to a separate B.S. in Biochemistry major.

7. Responses to Institution-Assigned Issues

a. What strategies has the department implemented that will support the Integrative Learning Experience at EIU?

The department has several undergraduate experiences that are strongly integrative. The most obvious of these is undergraduate research, which recently has been undertaken by 60-70% on undergraduates, and 100% of students completing the B.S. in Chemistry with Chemistry or Biochemistry concentrations. Research requires students to apply knowledge and hands-on skills learned in other chemistry course-work. In addition, students write a report on their results each semester, improving their writing skills in an environment outside of the typical classroom writing assignment. We have provided extensive support, supplemented by the college and

faculty grants, for students to present research results at regional, national and international conferences. These oral and poster presentations help students integrate speaking and visual presentation skills with their specialized knowledge of chemistry. A second highly integrative experience is the Undergraduate Seminar course sequence. In this 4 semester series, students listen to and evaluate other students' oral presentation during 2 semesters, and they present a 20 minute junior seminar and 30 minute senior seminar in the other 2 semesters. This experience requires students to choose a chemical topic, search peer reviewed literature, read and assimilate papers, and present and answer questions on their topic in a way that is clear and understandable to other students and faculty.

b. What one unique, noteworthy activity is the department involved in that will enable the IBHE to distinguish its program from other similar programs in the state?

There are many activities related to research in the department that are unique, but two that stand out are the work of Dr. Kraig Wheeler and Dr. Hongshan He. Dr. Wheeler maintains an X-ray diffractometry lab that is a regional center for determining the structures of crystals. Faculty from other regional universities send crystals to Dr. Wheeler to analyze using the instrumentation at EIU. This regional X-ray diffraction center was established using funding from the National Science Foundation, and it is unusual for a school as small as EIU to operate this type of facility. Dr. He was hired in 2013 and has brought an active alternative energy research program to EIU. His work involves development of cheaper and more effective materials for manufacturing solar cells, and this has allowed the department to increase its connections to CENCERE, as discussed earlier. Dr. He has been awarded 2 external grants since being hired, and he has supported 7 graduate students and an approximately equal number of undergraduates using these funds.

8. Outcome

8.1 Decision:

- Program in Good Standing
 Program flagged for Priority Review
 Program Enrollment Suspended

8.2 Explanation:

Dean's Comments

Renaming the department as the Department as Chemistry and Biochemistry and defining biochemistry as its own degree program (rather than embedded as a concentration) should aid in the growth of health-related fields at EIU. Support and/or expansion of departmental faculty with biochemistry or related expertise also would be very helpful.

Provost's Comments

The engagement of undergraduate students in research activities has been a hallmark of the Department for a number of years and is worthy of special note. So too has been the level of research activity of the Department's faculty over the years with a successful record of attracting extramural research support. I concur with the dean that making biochemistry more visible within the Department's portfolio of offerings should help into the future, a future which sadly remains clouded by the State's fiscal impasse.