Chemistry

Mission

Provides preparation for professional work in chemistry or forensic science; graduate work in chemistry or forensic science; or pre-professional training in the health sciences or secondary education. Coupling the program with an appropriate minor prepares students to enter related fields such as biochemistry, oceanography, pharmacy, toxicology and the environmental or atmospheric sciences. Through the study of general, organic, analytical and physical chemistry, students gain an understanding of the world around them.

Learning Outcomes

1. Chemistry students develop critical thinking and problem solving skills through hands-on required laboratory courses as well as research and practicum opportunities, and skills for communication within both the scientific and non-scientific communities through departmental writing intensive and seminar courses.
2. The chemistry program provides service courses for other majors such as biology, geology, environmental studies, pre-health programs, as well as those interested in obtaining basic chemistry knowledge through the Liberal Arts Core Curriculum.
3. The chemistry program fosters partnerships with state, local and federal government by providing both student laboratory interns and teaching opportunities for practicing forensic scientists within the program.

Learning Outcomes Assessment: Formative and Summative

Formative Assessment

Formative assessment of Chemistry students is accomplished within the course offerings using a number of traditional methods including quizzes and exams taking the form of essays, multiple choice, true/false, and problem solving; group oral presentations and writing assignments. The program has a significant writing component through which students demonstrate mastery of concepts in both traditional and non-traditional ways. Traditional writing assignments include the laboratory notebook and formal laboratory reports. Less traditional forms include abstracts, annotated bibliographies, letters, reports in business and forensic styles, press releases, research proposals, project summaries, and web pages. Critical thinking skills are tested at different stages of the program by having students solve laboratory unknowns and develop research questions. The results of these investigations are presented in a number of ways including formal reports and poster presentations. The style and level of formative assessment varies with instructor and course content. In some courses, American Chemical Society standardized examinations are administered at the conclusion of a course to assess student knowledge relative to a national scale.

Summative Assessment

Summative assessment is accomplished in a number of ways. Chemistry majors complete two capstone courses. CH 461, 462 is a two term, inquiry-based capstone laboratory course. As a major component of this course, students design and carry out a group research project which requires integration of concepts from all the core areas of chemistry. Throughout this course, students demonstrate their level of proficiency in chemistry and their ability to use theoretical knowledge in practical applications. The second capstone course is Seminar (CH 407). In this course each student chooses a chemical topic of current interest, conducts an in-depth literature search on that topic and presents a formal public seminar on the topic. Each student is afforded a one-hour time slot for the PowerPoint presentation. These seminars are evaluated by a panel of judges on the student's ability to present the topic in a clear logical manner, the depth of the student's understanding of the topic, the quality of student's written work (slides, extended abstract and annotated bibliography), and the student's ability to answer questions. Although student seminars traditionally have been presented as part of the NSM seminar program, for the first time in 2006, student seminars will be part of a university-wide, Academic Excellence Showcase event sponsored jointly by the Phi Kappa Phi honor society and the Program for Undergraduate Research Experience. All students must complete both of these capstone course offerings to graduate from the program. In addition to these general requirements, all students in the Forensic Chemistry option must complete an internship in an external laboratory. In conjunction with assessment via capstone courses, an objective assessment tool is being implemented. The Educational Testing Services (ETS) test for chemistry has been given on a trial basis and will be implemented formally for the 2006-2007 academic year.

Program Description

The Chemistry program at Western Oregon University offers two different options, the traditional Chemistry option and the Forensic Chemistry option, both leading to a B.S./B.A. degree in Chemistry. Western's integrated Forensic Chemistry option is unique within the state of Oregon. This program melds chemistry, forensic science, and criminal justice courses into a single, integrated curriculum rather than disparate criminal justice and chemistry modules. In addition to the Forensic Chemistry major, the program provides two different Forensic Science minors, one for students pursuing majors within the sciences and one designed for those majoring in Criminal Justice or Law Enforcement.

The Chemistry program seeks to balance both the theoretical and practical aspects of chemistry with a significant laboratory component. Students complete a rigorous series of core courses in analytical, inorganic, organic and physical chemistry. In addition to the core, students choose courses from advanced offerings in biochemistry, inorganic chemistry, and instrumental analysis depending on their career goals. The program strives to provide those practical skills needed by a practicing laboratory chemist. All chemistry graduates leave the program with the ability to operate a variety of instruments and are computer literate.

We are firmly committed to developing strong communication skills in our graduates. Of the program's 49 core course hours, 22 have been approved as meeting the requirements for designation as writing intensive courses. Oral communication skills are developed through supporting course work and a required technical seminar presentation.

A. Traditional Chemistry Major

This program is designed as a preparation for professional work in chemistry, graduate work in pure or applied chemistry, or as a core for pre-professional training in the health sciences or secondary education. Coupling this program with an appropriate minor allows students to enter related sciences such as biochemistry, oceanography, and the environmental or atmospheric sciences.

The chemistry core curriculum consists of coursework in general, organic, analytical and physical chemistry accompanied by a significant laboratory component plus study in either inorganic, biochemistry or instrumentation via limited electives. The remainder of the program consists of career supportive electives. The elective courses offered, and their sequence, depends on resources available and student demand.

The ideal high school preparation for a prospective chemistry major includes chemistry, physics and a minimum of three years of mathematics. To enter the chemistry program, students should test into MTH 111 or higher.

B. Forensic Option

Forensic chemistry is the application of chemistry to criminal investigation. This major is recommended for individuals who wish to pursue a career in criminal investigation, in the laboratory analysis of forensic evidence, or pursue graduate study in forensic science. This course of study would also develop the analytical skills required for careers in other areas of civil law such as environmental pollution, accident investigation and product liability. Due to the nature of forensic investigations, the forensic chemist requires a strong background in chemical analysis and must be able to effectively communicate the results of laboratory analyses in reports and in the courtroom. The curriculum is designed so that the major provides a strong theoretical and experimental background in chemistry as well as written and oral communication skills. This major may only be taken in conjunction with the Forensics minor designated for chemistry majors**.** The minor provides specialized training in forensics. Students in the program will benefit from experience gained via the required practicum.

Key Changes since 1997 Report

At the time of the 1997 report, the Chemistry program consisted of only the traditional Chemistry major and minor. Since that report, the Forensic Chemistry option has been implemented along with two new Forensic Science minors. At the time of the 1997 report, the Chemistry program had 12 declared majors and approximate 20 minors. Presently, the program services 55 declared majors and a similar number of minors. In addition to the increase in the number of students enrolled in our majors and minors, the level of service provided to other programs has increased. At the time of the 1997 report, approximately 60 students enrolled in CH 104-106 (Introductory Chemistry) annually. This course services the LACC, pre-nursing students and is used by those students needing an introductory chemistry course before entering the more intense chemistry offerings. The enrollment in the CH 104-106 sequence has doubled since 1997. The CH 221-223 sequence (General Chemistry for science majors) has increased from a cap of 72 students in 1997 to its current cap of 96 students annually. CH 334-336 (Organic Chemistry) serves as both a core course in the Chemistry program as well as a service course for the Biology major. This course has increased in size from an enrollment of 30-35 students at the time of the last report to a starting enrollment of 50 in 2005-2006. It was noted in the 1997 report that the large size of General

Chemistry courses made student participation and class discussion difficult. This has been exacerbated by the continued growth of these courses. All of these courses are capped at their present levels due to the inability to service more students with the current faculty available to teach in the program. While the size of upper division course offerings has also increased, these courses are still quite intimate having student populations typically in the 8-15 range.

The addition of the Forensic Chemistry option and Forensic Science majors have necessitated the addition of six new courses and forced an increased offering frequency of other courses, an addition to the teaching loads of the Chemistry faculty. With the exception of increasing the amount of adjunct FTE from approximately 0.5 FTE to 1.25 FTE, there has been no change in the number of faculty FTE allocated to the Chemistry program since 1997.

Faculty & Staff

The program is supported by three tenured faculty members, one fixed-term adjunct faculty member, specialty course instructors who are professional scientists at the Oregon State Police crime lab and one full-time lab preparer who holds a B.S. degree in chemistry. The three full time permanent faculty members of the Chemistry faculty all hold PhD. degrees in their area of specialization. Of the two males, one holds the rank of Professor and the other Associate Professor. There is one female holding the rank of Professor. Faculty expertise covers organic and organometallic synthesis, analytical techniques including electronics, instrumentation, geochemistry, environmental chemistry and physical chemistry including nuclear chemistry. Adjuncts provide expertise in forensic science areas as well as one full-time adjunct who teaches in lower division courses. The chemical storage room is managed by a chemical preparator who holds a B.S. degree in chemistry. The preparator orders chemicals, prepares reagents for the teaching laboratories, and manages the Chemical Hygiene Plan. Due to its diversified interests, the faculty is fully capable of offering a variety of courses for its majors and minors.

Professors: Arlene Courtney, Pete Poston

Associate professor: Rahim Kazerouni

Inadequate Staffing

Although the number of degree options, number of minors and amount of service to other disciplines has increased since the 1997 report, no additional full-time faculty positions have been added. This has resulted in capping the enrollment of lower division courses to a level that can be covered by the current level of staffing. In addition, the numbers of students in these courses have been increased to sizes that are not conducive to effective student/faculty interaction in the classroom.

The report of 1997 indicated that an additional permanent faculty member was needed to ensure the future success of the program. This need has remained unfulfilled.

Students

Formal admission is required for all students seeking a chemistry or chemistry-forensic chemistry

option degree. Typically, application for admission will be made at the end of a student's sophomore year by completing a degree plan with the adviser. Prior to admission, the student should have completed the set of courses below.

Chemistry Majors Graduated in the Last 10 Years

- Amber Faw - Southwest Research Institute, San Antonio, TX
- Aleisha Rosse – Hewlett-Packard, Corvallis, OR
- Carly Sizelove – State Crime Lab, Portland, OR
- Marisa Arnold – Department of Energy Laboratory, Albany, OR
- Kristin Glander – USBank, Monmouth, OR
- David Morris – Cascade Steel, McMinnville, OR
- Rebecca Gaxiola – California Crime Lab, Yreka, CA
- Amanda Norick – Foothill Community College, Los Altos Hills, CA
- Heather Tedisch – AVI Biopharma, Corvallis, OR
- Sharon Clinton – Stockroom Preparator, WOU
- Dale Purcell – Portland Crime Lab
- Mike Nelson – LC Resources, McMinnville, OR
- Ben Clark – Hewlett-Packard, Corvallis, OR
- Jason Trigg - Forensic Scientist, Kennewick, WA
- Jason Young – polymer lab, Springfield, OR
- Les Wallace – brewery, Spokane, WA

Resources

Chemistry maintains three laboratories. All of the chemical equipment is housed in these laboratory rooms. Two of the rooms can accommodate 24 students at a time and the third which is used for upper division laboratory courses can accommodate approximately 10 students working simultaneously. The two larger rooms share two desktop PC computers, and the smaller room is outfitted with four modern PCs and four antiquated machines of limited utility. Instrumental holdings include a GC-mass spectrometer, Fourier transform infrared spectrophotometer, high pressure liquid chromatograph, atomic absorption spectrometer, bomb calorimeter, polarographic analyzer/stripping voltammeter, uv/visible spectrophotometer and fluorimeter.

Hard copy library resources are limited for Chemistry. However, the availability of electronic library resources and an efficient interlibrary loan allow sufficient access to the chemical literature.

SWOT Overview & the Future

Distinctive Value/Competitive Edge

The Chemistry program is competitive within the state system for the following reasons

- Small class size and intimate interaction with dedicated faculty members in upper division classes
- All classes taught by specialists or faculty members holding terminal degrees in their field of expertise
- A Forensic Chemistry option that integrates traditional chemistry education with specific training in forensic science
- A program of laboratory internships required for Forensic Chemistry students and encouraged for traditional Chemistry students
- A strong communication component in the major that makes our students marketable in the chemical industry

Three Primary Strengths

- The chemistry program offers close student and faculty interaction through small upper division class sizes and research opportunities
- The chemistry program affords students the opportunity to gain direct hands-on experience using specialized techniques and instrumentation
- a strong collaboration with the Oregon State Police crime lab which provides instructors for Forensic Science courses and internships allowing students to gain professional experience in a working forensic environment

Strengths: Action Plan for Maintenance

- New faculty line in Forensics to adequately cover anticipated increase in enrollments
- Renewed grant-writing activities to purchase forensic-related equipment , e.g. Raman Microscope, updated Gas Chromatograph-Mass Spectrometer
- This new equipment will facilitate continued student-professor research activities, as well as hands-on experience that will enrich their learning environment and improve their prospects for employment
- Continued progress in developing internships for students in local businesses, industry, environmental laboratories, and crime labs.

Three Primary Concerns

Three primary concerns of the Chemistry program remain unchanged since the report of 1997.

- Inadequate Staffing
- Frequency of course offerings
- Equipment holdings

Equipment Holdings

Although a goal of the Chemistry program is to produce students who are able to operate a variety of instruments, many of our instruments are aging and in need of upgrading. We also do not possess one major instrument routinely used by practicing chemists, the nuclear magnetic resonance spectrometer (NMR). Departmental budgets are insufficient for the purchase of new, modern instrumentation and are stretched to maintain aging instrumentation.

Although the faculty has integrated computer usage into the curriculum, there remains a lack of computer hardware available for use in the general and organic chemistry laboratories. Currently, there are two desktop computers that are shared by the laboratories for those courses. Any data analysis must be done away from the chemistry laboratory in a computer lab. Additional computer resources are needed for data collection and analysis in these laboratories.

Frequency of Course Offerings

Due to an inadequate level of staffing, many chemistry courses are offered on either an alternating year or less regular schedule. The alternating schedule includes not only elective offerings but also courses that are required core courses in the program, capstone courses or courses students select as part of their programs to fulfill the required limited electives. The Ch 440-442 (Physical Chemistry required for the traditional chemistry major), Ch 340 (Elementary Physical Chemistry required for the Forensic major), Ch 420 (Forensic Chemistry required for the Forensic major) and GS 161 (Technical Photography required for the Forensic major) are offered in alternate years. Ch 461, 462 (Experimental Chemistry), one of our capstone courses required of all majors, is also only offered in alternating years. Students are required to choose two courses from a limited list of electives as part of their degree requirement. Ch 411, 412 (Advanced Inorganic Chemistry), Ch 354 (Computational Chemistry) and Ch 471 (Chemical Instrumentation), four of the six courses from which they can choose, are offered on a non-regular schedule often with 3-4 years between delivery. The only limited elective that is offered on an annual basis is Ch 430, 431 (Biochemistry) which is also a core course for the Forensic option and a service course for Biology students. A number of chemistry courses have either never been offered or have been offered on a very limited basis.

The inability to offer courses on either an annual basis or on a regular schedule places a hardship on our students. A significant portion of our student population transfers to the Chemistry program from other institutions. Completing the requirements for the Chemistry program is extremely challenging for these transfer students due to our inability to offer courses on an annual basis. In addition, the alternating year scheduling of the Experimental Chemistry capstone course requires some students to take that course during their third year of study rather than the fourth year as it is intended.

Concerns: Action Plan for Improvement

The most pressing concern is the lack of adequate staffing within the Chemistry program. One additional full-time tenure-track position in Chemistry needs to be added above the current full-time and adjunct staffing. The addition of a Chemistry faculty member would improve the frequency of chemistry courses offered.

Increasing budgets for capital equipment purchase is necessary. Developing these equipment budgets will require coming up with innovative solutions to fundraising. Several of our current instruments were obtained by funded grants. New grants will need to be written for equipment purchases. The university will need to commit significant funds to match monies obtained via funded grants. Computer holdings could be upgraded by university purchase of a group of laptop computers that would not be tied to a particular laboratory room but could meet the needs of different courses at different times.

Looking Ahead to the Future

- Since 90% of our students come from within-state, we assume enrollments will follow projected trends in high school graduations within Oregon.
- Currently we have over 55 declared majors, the majority of whom are taking the Forensics option in the Chemistry major. We expect this trend to continue.

Unit Assessment Plan

Primary assessment contact: Arlene Courtney

I. Statement of unit mission:

The chemistry program provides preparation for professional work or graduate work in chemistry or forensic chemistry or pre-professional training in the health sciences or secondary education. Through the study of general, organic, analytical and physical chemistry, students gain an understanding of the world around them.

II. Unit intended objectives/outcomes:

1. Academic Affairs Goal 2: Students develop skills for communication within both the scientific and non-scientific communities

2. Academic Affairs Goal 3: Students become proficient in each of the core areas of chemistry -- general, analytical, organic and physical chemistry

3. Academic Affairs Goal 4: Students demonstrate the ability to integrate the principles of the different core chemical areas into one body of usable knowledge

3. Academic Affairs Goal 4: Students develop critical thinking and problem solving skills

4. Academic Affairs Goal 5:

Of the objectives above, this unit will assess 2 in the current assessment year; and 2 in the next one.

III. Tactics for achieving the objectives:

1. The requirement of completion of CH 407 Seminar in which students research a current chemical or forensic topic and present a seminar on that topic

2. Close student and faculty interaction through limited enrollment upper division classes and research opportunities

3. Providing course opportunities that integrate topics from different chemical disciplines

4. Critical thinking and problem solving exercises skills will be developed through coursework and hands-on laboratory courses, as well as research and practicum opportunities. Students are required to take a capstone two term laboratory course in which students develop methods to solve practical laboratory problems. Students conduct library research and develop laboratory procedures.

IV. Basic approach for assessing our unit intended objectives/outcomes

A. BENCHMARKS FOR SUCCESS:

1. The 40-50 minute long presentation is delivered to an audience. A panel of judges assess the seminar in terms of its scientific quality as well as the quality of the student's communication skills.

2. ACS discipline specific exams will be administered at the end of core courses

2. The chemistry program will administer national exams to assess the student proficiency

a standardized assessment test available from ETS

3. Product samples will be assessed include written research proposals and written and/or oral presentations of project results.

B. RELEVANT QUANTITATIVE AND/OR QUALITATIVE EVIDENCE:

1. Evidence for Objective 1: Examination of written abstract and bibliography; seminar slides, the oral presentation and oral questioning for the seminar presentation.

2. Evidence for Objective 2: The comparison of WOU student scores versus national norms on ACS standardized exams at intervals during the student's academic program

3. Evidence for Objective 3: Comparison of student performance on the national ETS chemistry exam. The goal is an 50 percentile average across the student population.

4. Evidence for Objective 3: Evidence of critical thinking and problem-solving skills will be obtained through out the student's academic career through examinations, the solution of laboratory unknown problems and designing and conducting of research projects.