

**CALIFORNIA STATE UNIVERSITY, SAN BERANRDINO
OUTCOMES ASSESSMENT PLAN
DEPARTMENT OF CHEMISTRY
BACHELOR OF ARTS & BACHELOR OF SCIENCE**

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STATEMENT OF MISSION AND GOALS FOR THE
DEPARTMENT OF CHEMISTRY
CALIFORNIA STATE UNIVERSITY SAN BERNARDINO

Mission Statement

The mission of the Department of Chemistry at California State University San Bernardino is to provide our students with the modern and comprehensive chemical education required to live and work in our technologically advanced society. This mission is fulfilled through a range of educational opportunities that allow students to learn, discover and explore the major chemical concepts that contribute to their lives and the lives of others around the world. Central to our mission is providing students with an awareness of the achievements and contributions of chemistry as a science that will help them better understand their natural environment. Providing a knowledge of chemistry to the liberal arts, pre-professional and science students will help them better understand the benefits and hazards of this world and enable them to make intelligent decisions regarding their future. Chemistry majors will receive a comprehensive background in all disciplines of chemistry, including organic, inorganic, analytical, physical and biochemistry, as well as an appreciation for the related fields of Biology, Physics and Mathematics. Procedures and protocol for the safe handling of chemicals will be presented to aid students in making informed decisions about the value and consequences of handling chemicals. Educational activities outside the traditional classroom, such as internships and independent research, will provide students the opportunity to conduct individual research projects or participate as a member of a research team. Inseparable from our educational mission is the pursuit of new knowledge in the classroom and research laboratory. The Department recognizes that original research provides students and faculty with a logical approach to problem solving, critical thinking and the use of analytical and deductive reasoning skills and produces students who are creative problem solvers, skilled scientists and productive members of society.

The Goals and Objectives of the Chemistry Department

Goal 1. To provide students with accurate and relevant chemical information.

- Objective 1. All entering chemistry students will take a diagnostic test involving basic mathematical and chemical principles
- Objective 2: Students will understand the general principles of chemistry, the descriptive chemistry of the elements and molecules. They will compare and contrast reactivity based on physical properties and chemical reactivity from molecular structure.
- Objective 3: Students will know the common reactions of the elements and compounds. They will know common methods of functional group interconversions, perform retro synthetic analysis and propose multistep syntheses, evaluate and critique synthetic schemes.

Goal 2: To provide students with standard laboratory techniques to plan and safely execute basic chemical experiments.

- Objective 1: Students will perform accurate quantitative measurements, interpret experimental results, perform calculations on these results, and draw a reasonable accurate conclusion.
- Objective 2: Students will synthesize, purify and characterize a series of compounds using standard reaction protocols, laboratory equipment, and modern spectroscopic instrumentation.
- Objective 3: Students will understand the theory and use of sophisticated chemical instrumentation.
- Objective 4: Students will anticipate, recognize and respond properly to hazards of chemical handling.

Goal 3: To provide students with the opportunities to practice effective scientific computer, written and oral communication skills.

- Objective 1: Students will use computer technology to learn, gather, display, and analyze chemical information.
- Objective 2: Students will communicate effectively scientific information through written reports.
- Objective 3: Students will communicate effectively scientific information through oral presentations.

Goal 4: To provide students with a broad appreciation for chemistry as a discipline.

- Objective 1: Students will have broad and thorough knowledge of all the sub disciplines of chemistry.
- Objective 2: Students will progress through the Chemistry Degree program in a timely manner.
- Objective 3: Chemistry graduates will be educationally prepared to work in a scientific field related to chemistry.

Goal 1: Provide students with accurate and relevant chemical information.

Objective 1: Students enrolled in general chemistry will take a diagnostic test to assess their basic mathematical and chemical knowledge.

Outcome Criteria : As a way of ensuring students that are placed correctly in general chemistry courses, all students will be given a diagnostic test when entering Chemistry 215. Students who perform poorly (< 50 % correct) on this test will be advised to take Chemistry 205 before Chemistry 215. The diagnostic is mathematics as well as chemistry based, since a good grounding in mathematics is essential for Chemistry.

Assessment Method: Formative. Chemistry Diagnostic Test (Attachment 1).

Time Frame: First Laboratory Period of Chemistry 215. Curriculum committee will meet during the Spring Quarter to review students' scores and performance in chemistry courses.

Who Will Do Assessment: Laboratory instructors, grading according to departmentally approved grading schemes. Course instructor will advise students on recommended courses to remove deficiency. Chemistry chair and members of the curriculum committee will discuss test scores and recommend changes in curricula.

Type of Feedback: Lecture Instructors will discuss scores with students and recommend chemistry course. Curriculum committee will meet during the spring quarter and correlate test scores with students' course grades.

How Will Data Be Used To Improve Program And Revise Curricula: Students failing the diagnostic test will be advised remove deficiencies by taking CHEM 205 and appropriate math courses. Remediation of deficiencies will improve students' success in the chemistry degree program. Correlating the diagnostic test scores and student score will be noted and the diagnostic exam modified.

Objective 2: Students will understand the general principles of chemistry, name attributes and properties of elements and compounds. They will compare and contrast reactivity, physical properties and chemical reactivity from molecular structure. Perform standard chemical stoichiometry, solution, kinetic and thermodynamic calculations.

Outcome Criteria : 70% of class will be able to correctly describe the concepts of atoms, elements, compounds and mole and perform on chemical calculations on selective embedded questions. See Attachment 2

Assessment Method: Formative. Specific embedded questions on exams (see Attachment 2.)

Time Frame: Each quarter of Chemistry 215

Who Will Do Assessment: Course Instructor will select exam questions from a list of standard questions (see Attachment 2.)

Type of Feedback: Course instructor will summarize and tabulated results that will be reviewed yearly by curriculum committee. The committee will write a report describing the strengths and weaknesses of the students.

How Will Data Be Used To Improve Program And Revise Curricula: Chemistry faculty will administer, grade and rank students. Deficiencies in specific types of questions will be discussed. Significant deviation in student's performance from department norms will lead to a review of course lecture materials, textbook and laboratory notebook.

Objective 3: Students will demonstrate knowledge of the common reactions of the elements, redox outcomes, exchange and displacement reactions. Know common methods on functional group interconversions, perform retrosynthetic analysis and propose multistep syntheses, evaluate and critique synthetic schemes.

Outcome Criteria: Students will rationally address problems in synthetic chemistry such as the structure, reactivity, choice of reagents and multistep strategies for the synthesis of complex molecules. Class average in 50th percentile or better when compared with national ACS average scores.

Assessment Method: Formative and Summative: Standardized American Chemical Society (ACS) Exam in Organic Chemistry; (Attachment 3.)

Time Frame: Final Exam of Chemistry 323: Principles of Organic Chemistry III and comprehensive exams (CHEM 999) given during the students' senior year (See Goal 4 Objective 1)

Who Will Do Assessment: Course Instructor will grade exams and write summary report of findings to the curriculum committee.

Type of Feedback: At the end of CHEM, Instructor will evaluate test score and compare to national average. It is expected that the class will average in 50th percentile or better when compared with national ACS average scores.

How Will Data Be Used To Improve Program And Revise Curricula: Organic faculty will administer, grade and rank students using ACS Comprehensive Organic Exams. Deficiencies in specific types of questions will be noted. Significant deviation in student's performance from national norms will lead to a review of course lecture materials, textbook and laboratory notebook.

Goal 2: Provide students with an introduction to standard laboratory methods and an ability to plan and execute basic chemical experiments.

Objective 1: Students will perform accurate quantitative measurements, interpret experimental results, perform calculations on these results, and draw a reasonable accurate conclusion.

Outcome Criteria : Students will prepare standard chemical solutions and reagents needed to perform an analysis. Perform accurate quantitative measurements with these solutions and a standard method that is outlined for the student, demonstrating good experimental and analytical laboratory technique.

Assessment Method: Formative. Laboratory quantitative analysis of sodium carbonate. The method gives is accurate to within 0.02%. Full report of method and results is to be submitted by the student. 80% of the students will report alkalinity within 1.5% of true value. Good laboratory technique is monitored and corrected by the instructor throughout the ten weeks of the laboratory course. (Attachment 4).

Time Frame: CHEM 245: Modern Quantitative Analysis

Who Will Do Assessment: Course instructor and curriculum committee.

Type of Feedback: In student laboratory report, 80% of the students will report alkalinity within 1.5% of true value (Sample of reports will be analyzed.)

How Will Data Be Used To Improve Program And Revise Curricula: The curriculum committee analysis of students' reports will reveal three types of error. Further instruction will be given during the first two weeks of laboratory instruction in CHEM 245.

Objective 2: Students will prepare, set-up, and synthesize a series of compounds using common function group conversions and multi-step synthesis, followed by separation, purification, and identification using modern chemical and spectroscopic analysis. Reliability of results in the quantitative and qualitative analysis of chemicals.

Outcome Criteria: 90% of the students will correctly identify standard solid and liquid unknowns using solubility tests, chemical reactivity, synthesis of derivatives and instrumental analysis.

80% or better will successfully purify the two component mixtures and correctly identify the components using standard physical, chemical and instrumental techniques. (Attachment 5).

Assessment Method: Formative. Laboratory identification of solid, liquid and two-component mixture. Ten laboratory periods starting the third week of CHEM 323. (Attachment 5).

Time Frame: Third to seventh week of CHEM 323. Who Will Do Assessment: Organic faculty members Type of Feedback: If achievement level is lower than department norms, extra synthetic laboratories will be scheduled using the basic chemical techniques required for this type of chemical analysis.

How Will Data Be Used To Improve Program And Revise Curricula: If achievement level is lower than standard, extra synthetic laboratories will be scheduled using the basic chemical techniques.

Objective 3: Understand the theory and use of sophisticated chemical instrumentation.

Outcome Criteria: Operate and collect data on the Fourier Transform Infrared (FTIR) Spectroscopy, write a report on the experiment including a procedure section on instrument operation. Students (80%) will describe absorption bands, interferometer operation, Fourier analysis and quantitative analysis procedure.

Assessment Method: Formative. The student report will include the principles of IR analysis, a schematic diagram of the FTIR spectrometer and details of a quantitative analysis of a mixture of xylenes isomers. (Attachment 6).

Time Frame: CHEM 545: Instrumental Analysis laboratory.

Who Will Do Assessment: Analytical faculty members will grade reports and summarize findings.

Type of Feedback: Instructor and assessment committee will review and discuss students performance, and if necessary modify instruction.

How Will Data Be Used To Improve Program And Revise Curricula: Upon committee review of students' reports, incorrect description of FTIR analysis and instrument operation by a significant segment (ca. 20 %) will result in increased instruction in the lecture component of this course on the principles of IR spectroscopy and Fourier Transform.

Objective 4: Anticipate, recognize and respond properly to hazards of chemical handling.

Outcome Criteria: Know locations and uses of personal protective equipment (gloves, aprons, goggles, fume hood). Understand standard laboratory safety rules, standard emergency procedures, and Material Safety Data Sheets. Master routines for storing, handling, and disposing of chemicals with the ability to anticipate obvious hazards such as the caustic nature of acid and the flammability of organic solvents. Since handling chemicals safety is crucial for student's health, it is expected that at least 100% of the students will score 90% or better on the safety exam.

Assessment Methods: While safety procedures are taught in each laboratory course, and evaluated by individual instructors (often expressed as part of the student's "discretionary grade" in lab), for the purpose of program evaluation a formal course in chemical safety in our first "majors" course, CHEM 321 will conclude with a written safety examination, approved by members of the curriculum committee. (Attachment 7)

Time Frame: Exam will be given each fall quarter when Chem. 321 is offered.

Who Will Do Assessment: Laboratory Instructor.

Type of Feedback: Since handling chemicals safety is crucial for student's health, it is expected that at least 100% of the students will score 90% or better on the safety exam. Questions answered incorrectly will be discussed with the student until it is correctly understood.

How Will Data Be Used To Improve Program And Revise Curricula:

Copies of these will be included in the curriculum committee's files for annual review. Any major accident will immediately be reported to the department and corrective action taken at that time.

GOAL 3: To provide students with the opportunities to practice effective scientific computer, written and oral communications skills.

Objective 1: Students will use computer technology to learn, gather, display and analyze chemical information.

Outcome Criteria: Students will use data processing, spreadsheet and graphing tools to display and analyze experimental data. Develop mathematical model to explain observation, experiment data, especially one that can be confirmed or predict phenomena in laboratory. Use computer models to describe the behavior of individual molecules and chemical systems. 70 % of class passing with a grade of C or better in course.

Assessment Method: Formative: Use computers to modify simple BASIC programs, use quantum mechanics software, employ spread sheet, perform non-linear curve fitting of experimental data and the quality and timely submission of laboratory reports. (Attachment 8).

Time Frame: CHEM 456: Physical Chemistry II. Solubility and Ionic Strength Laboratory.

Who Will Do Assessment: Course Instructor and curriculum committee.

Type of Feedback: 70 % of class passing with a grade of C or better in course.

How Will Data Be Used To Improve Program And Revise Curricula: Course instructor will evaluate students' progress by one or more of the above assessment methods. Department curriculum committee will analyze grades and progress of students.

Objective 2: Students will communicate effectively scientific information through written reports.

Assessment Method: Students will maintain a legible and complete laboratory notebook of a quality that would allow another person to repeat the experimental work. Experimental records and written reports will be submitted in a timely manner. 90% of class following standard ACS writing protocol.

Assessment Method: Formative. Laboratory notebook will be reviewed by organic faculty.

Time Frame: CHEM 321: Principles of Organic Chemistry I. Evaluate of students laboratory notebooks is based upon key components of a laboratory experiment write-up as outlined in "Writing the Laboratory Notebook", H. M. Kanare, American Chemical Society, Washington, D.C., 1985. (Attachment 9).

Use of Information for Program Improvement:

Organic Faculty will evaluate students' notebooks by criteria outlined by ACS .

Objective 3: Students will communicate effectively scientific information through oral presentations.

Outcome Criteria : Give an oral presentation to peers and faculty on a chemical topic of current interest. (Students will perform a systematic search of the scientific literature using chemical abstracts, electronic resources, and the primary literature. A paper and abstract are required). Achievement outcome Presentations will be evaluated by assessment committee members.

Assessment Method: Summative: The oral presentation will be evaluated by students and faculty on using "Seminar Evaluation Form" Attachment 10. Presentation will be reviewed by the curriculum committee and evaluated using standard outlined in "The ACS Style Guide" James Dodd, Editor, American Chemical Society, Washington, D.C. 1985. (Attachment 10).

Time Frame: Chem. 590, Chemistry Seminar, which is required two quarters for credit: the first quarter students will be required to attend and to prepare a written report; the second an oral presentation.

Who Will Do Assessment: Faculty, members of the curriculum and students.

Type of Feedback: Curriculum committee will meet in the spring and review thins. All students attaining grades of C⁻ or better in seminar; both oral and written reports considered "acceptable" technically and professionally by committee members.

How Will Data Be Used To Improve Program And Revise Curricula: The objective of the course exactly coincides with this evaluation objective. Student reports and at least two written faculty evaluations of oral presentations will be compiled. After review, these items will be added to student files

Use of Information for Program Improvement:

Annual review of faculty evaluations and written student reports by curriculum committee. If significant deficiencies are found, recommend additional opportunities for literature research and reporting throughout the curriculum, and "coaching" sessions during the student's first quarter of seminar.

Goal 4. To provide students with a broad understanding and appreciation for chemistry and related scientific disciplines.

Objective 1: Provide Students a broad and thorough foundation in all the sub-disciplines of chemistry.

Outcome Criteria: Students will complete four comprehensive exams in major field of study from the following sub-disciplines; organic, inorganic, physical, analytical or biochemistry based on ACS area comprehensive exams and score in the 30th percentile or better.

Assessment Method: Summative, Standardized ACS Time Frame: Chemistry 999: Comprehensive Exams are administered during the student's senior year. Students are give three change to pass each individual exam.

Who Will Do Assessment: Faculty member in each field of specialty. 90% of students will pass in the 30th percentile or better.

Type of Feedback: Faculty will administer, grade and rank students using ACS Comprehensive. At the end of the year, the faculty will write a report summarizing the results of the exams and submit it to the curriculum committee.

How Will Data Be Used To Improve Program And Revise Curricula: Curriculum committee will review and tabulate scores. Grades on the comprehensive exam will be compiled each year. Recommendations for further training at all levels will be developed at that time. Significant deviation in student's performance will lead to a review of course lecture materials, textbook, laboratory notebook and course syllabi.

Note: for BS Chemistry ACS Certified, student must successfully passed four exams. Students who fail to pass the four chosen subject area exams will earn BA Chemistry degree.

Objective 2: Students will progress through the Chemistry degree Program in a timely manner.

Outcome Criteria : 90% of students starting the chemistry degree program will graduate in 5 years or less. Students transferring into the chemistry program from other programs or institutions will complete their degree in an timely manner bases on types and number of units transferred.

Assessment Method: Formative/summative. Faculty, during academic advisement, will help student plan their academic program. (Attachment 12.)

Time Frame: Students will confer with their chemistry advisor each quarter. Students will not be permitted to enroll in Chemistry 321 and Chem 455 without advisor's permission to assure that students are informed on department and university requirements for graduation.

Who Will Do Assessment: Faculty will advise students, collect data and summarize findings. Faculty will recommend a course of study for students who are not completing degree in a reasonable time frame.

Type of Feedback: Students will receive a copy of academic program. Faculty will flag and students not progressing in the program in a timely manner. All flagged student folders will be reviewed by the assessment committee.

How Will Data Be Used To Improve Program And Revise Curricula: Assessment committee will meet in the spring quarter to review advisors summaries and flagged students' folders. Appropriate remediation in course scheduling/chemistry program will be discussed and action recommended.

Objective 3: Chemistry graduates will be educationally prepared to work in a scientific field related to chemistry.

Outcome Criteria: Students will have the skills needed to be gainfully employed.

Assessment Method: Summative, exit interview Alumni Evaluation Form. Attachment 13.

Time Frame: Exit interview and 1 years after graduation

Who Will Do Assessment: Assessment Committee will review and summarize Alumni Evaluation forms.

Type of Feedback: Assessment committee will meet in the Spring quarter to review students exit interviews and Alumni Evaluation forms.

How Will Data Be Used To Improve Program And Revise Curricula: At the end of the each academic year, the assessment will write a report describing the strengths and weaknesses which students discussed. The assessment committee will present its finding to the department and discuss findings and will recommend methods improving departmental procedures and curricula.