Department of Chemistry and Biochemistry

Certified by the American Chemical Society

Department of Chemistry and Biochemistry

Chemical Science Building, Room CS-204
(909) 537-5318 Department of Chemistry and Biochemistry website (http://chem.csusb.edu)

Bachelor of Arts
Chemistry
  • Chemistry
  • Biochemistry Option

Bachelor of Science
Bioinformatics
  Chemistry
  • ACS Certified Option
  • Biochemistry Option

Master of Science
Earth and Environmental Sciences

Minor
Chemistry

The Department of Chemistry and Biochemistry provides:

1. Undergraduate training in chemistry and biochemistry for students planning professional careers in chemistry and allied professions such as medicine, dentistry, pharmacy, health sciences and veterinary medicine and for those contemplating graduate work for advanced degrees;
2. Appropriate courses for the teacher credential program;
3. Fundamental chemical science courses required by students majoring in related fields such as biology, physics, health science, and geology;
4. An understanding of the achievements and contributions of chemistry as a science.

The Bachelor of Science in Chemistry (ACS Certified Option) satisfies the requirements for certification by the American Chemical Society.

The Bachelor of Arts in Chemistry provides greater elective flexibility for double majors and for preprofessional, interdisciplinary or other programs involving substantial preparation in chemistry.

Preprofessional students of medicine, dentistry or other science-based fields seeking a major in chemistry should see Preprofessional Programs: Medicine, Veterinary Medicine, Dentistry, Pharmacy (http://bulletin.csusb.edu/undergraduate-degree-programs/programs/#preprofessionalprogramstext) in this catalog and contact the Health Professions Advising Cente (https://cns.csusb.edu/hpac).

Students interested in fields such as environmental science, environmental law, business, and clinical chemistry can pursue these by following the minimum requirements of the major and appropriate electives.

Departmental Honors

A graduating senior will be awarded departmental honors in chemistry after meeting the following requirements:

1. At least a 3.5 average in all chemistry course work taken at the university with a minimum being five chemistry courses;
2. At least a 3.0 (“B”) average on the comprehensive examinations;
3. An “A” in CHEM 595 or another demonstration of ability to do independent work in chemistry, for example an oral or poster presentation at a conference or symposium.

Master of Science in Earth and Environmental Sciences

• with concentrations in:
  • Professional Science Masters
  • Geology

Department of Chemistry and Biochemistry

Chemical Sciences Building, Room CS-204
(909) 537-5318 Department of Chemistry website (http://chem.csusb.edu)

Department of Geological Sciences

Biological Sciences Building, Room 113A
(909) 537-5336 Department of Geological Sciences website (http://geology.csusb.edu)

Current Faculty

Andreas Beyersdorf, Assistant Professor
B.A. 2001, Chapman University
M.S. 2007, Ph.D. 2007, UC Irvine

Kimberley R. Cousins, Professor, Chair
B.S. 1984, Duke University
Ph.D. 1991, University of Texas, Austin

Yu Jung Kim, Associate Professor
B.S. 1995, M.S. 1995, Ph.D. 2002, University of California, Riverside

Jeremy Mallari, Assistant Professor
B.A. 2000, B.S. 2003, California State University, San Francisco
Ph.D. 2008, University of California, San Francisco

David F. Maynard, Professor, Interim Chair of Geological Sciences
B.S. 1976, California State University, San Bernardino
M.S. 1988, California State University, Long Beach
Ph.D. 1992, University of California, Riverside

Larry M. Mink, Professor
B.S. 1984, Hebrew University of Jerusalem
M.S. 1986, Ph.D. 1990, University of California, Riverside

James A. Noblet, Professor
B.S. 1983, University of California, Los Angeles
M.S. 1991, California State University, Long Beach
Ph.D. 1997, University of California, Los Angeles
Department of Chemistry and Biochemistry

Lisa Shamansky, Professor
B.S. 1980, Indiana University, Bloomington
Ph.D. 1986, University of Illinois, Urbana

Douglas C. Smith, Professor
B.A. 1988, Wittenburg University, Ohio
Ph.D. 1994, Purdue University

Brett J. Stanley, Professor
B.S. 1987, University of Pittsburgh
Ph.D. 1992, Utah State University

John Tate, Associate Professor
B.Sc. 1979, Ph.D. 1982, University of Sheffield, England

Shumei Yang, Professor
B.S. 1982, Zhengzhou University, P.R. China
Ph.D. 1991, Iowa State University

Renwu Zhang, Associate Professor
B.S. 1988, Anhui Normal University
M.S. 1993, University of Science China
Ph.D. 2002, University of Missouri

Emeriti
John H. Craig, Professor
Kenneth A. Mantei, Professor
Dennis M. Pederson, Professor

Undergraduate Degrees

Bachelor of Arts
- Chemistry- Chemistry Option (http://bulletin.csusb.edu/colleges-schools-departments/natural-sciences/chemistry-biochemistry/chemistry-option-ba)
- Chemistry - Biochemistry Option (http://bulletin.csusb.edu/colleges-schools-departments/natural-sciences/chemistry-biochemistry/chemistry-biochemistry-option-ba)

Bachelor of Science
- Bioinformatics (http://bulletin.csusb.edu/colleges-schools-departments/natural-sciences/biology/bioinformatics-bs)
- Chemistry - ACS Certified Option (http://bulletin.csusb.edu/colleges-schools-departments/natural-sciences/chemistry-biochemistry/chemistry-acs-certified-option-bs)
- Chemistry - Biochemistry Option (http://bulletin.csusb.edu/colleges-schools-departments/natural-sciences/chemistry-biochemistry/chemistry-biochemistry-option-ba)

Graduate Degree

Master of Science
- Earth and Environmental Sciences (http://bulletin.csusb.edu/colleges-schools-departments/natural-sciences/chemistry-biochemistry/earth-environmental-sciences-ms) with concentrations in:
  - Professional Science Masters
  - Geology

Minor
- Chemistry (http://bulletin.csusb.edu/colleges-schools-departments/natural-sciences/chemistry-biochemistry/chemistry-minor)

Teaching Credential Program

Teaching Credential Subject Matter Preparation Program in Science: Chemistry
Chemistry majors pursuing a single subject teaching credential in science with a chemistry specialization will need to take the CSET Exam to verify subject matter competence. To prepare for the CSET exam, the following courses are recommended as part of, or in addition to the chemistry degree.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTR 103</td>
<td>Descriptive Astronomy</td>
<td>5</td>
</tr>
<tr>
<td>ASTR 311</td>
<td>A Cosmic Perspective of Earth</td>
<td>5</td>
</tr>
<tr>
<td>or GEOL 309</td>
<td>Earth: The Blue Planet</td>
<td>5</td>
</tr>
<tr>
<td>BIOL 200</td>
<td>Biology of the Cell</td>
<td>5</td>
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<tr>
<td>BIOL 201</td>
<td>Biology of Organisms</td>
<td>5</td>
</tr>
<tr>
<td>BIOL 202</td>
<td>Biology of Populations</td>
<td>5</td>
</tr>
<tr>
<td>GEOL 101</td>
<td>Introductory Geology</td>
<td>5</td>
</tr>
<tr>
<td>GEOL 250</td>
<td>Historical Geology</td>
<td>5</td>
</tr>
<tr>
<td>NSCI 300</td>
<td>Science and Technology</td>
<td>4</td>
</tr>
</tbody>
</table>

In addition, certain prerequisites and professional education courses are required. For information about admission to the teacher education program, education courses required, or the specific requirements of the single subject teaching credential in science program, contact the Department of Science, Mathematics, and Technology Education in the College of Education.

Courses

CHEM 100. Chemistry in the Modern World. 5 Units.
Prerequisites: Eligibility to enroll in MATH 110 or MATH 115 or completion of MATH 111A or MATH 116A or MATH 12B or MATH 17B or higher (GE=B.3)
Offered: Fall, Spring and Summer
Examination of chemistry and its value to contemporary society. Topics include atomic and molecular structure, bonding, physical and chemical change, solutions and other important chemical principles related to everyday observable phenomena. In laboratory, the scientific method is employed to design experiments, test hypotheses, formulate chemical principles and interpret experiment results. Designed for those desiring a broad overview of chemistry including liberal studies majors. Four hours lecture and three hours laboratory. Materials fee required.

CHEM 105. Chemicals in Our Environment. 2 Units.
(GE=B4)
Offered: Fall and Winter
Examination of a current issue related to chemicals in our environment with focus on chemical principles and the interplay between chemical technology and society. Lecture only.
CHEM 205. Fundamentals of Chemistry I: General Chemistry. 5 Units.
Prerequisites: Eligibility to enroll in MATH 110 or MATH 115 or completion of MATH 111A or MATH 116A or MATH 112B or MATH 117B or higher (GE=B.3)
Offered: Fall, Winter and Spring
Basic introduction to the concepts of chemistry, including the composition of matter and physical and chemical changes. Designed primarily for the student with little or no chemistry background who plans to take additional chemistry or other science courses. Four hours lecture and three hours laboratory. Materials fee required.

CHEM 206. Fundamentals of Chemistry II: Organic Chemistry. 5 Units.
Prerequisites: CHEM 205 or CHEM 215
Offered: Winter
Introduction to the chemistry of organic compounds. Four hours lecture and three hours laboratory. Materials fee required.

CHEM 207. Fundamentals of Chemistry III: Biochemistry. 5 Units.
Prerequisites: CHEM 206
Offered: Spring
Introduction to the principles of modern biological chemistry and to organic compounds of biological interest. Four hours lecture and three hours laboratory. Materials fee required.

CHEM 215. General Chemistry I: Atomic Structure and Chemical Bonding. 6 Units.
Prerequisites: Completion of, or concurrent enrollment in MATH 110, MATH 111B, MATH 112C, MATH 120, MATH 211, or MATH 212
Offered: Fall, Winter and Summer
Stoichiometry, atomic and molecular structure, chemical bonding, states of matter and solutions. Designed primarily for the student majoring in the biological or physical sciences. Four hours lecture, three hours laboratory, and one hour recitation. Materials fee required. (GE B3).

CHEM 216. General Chemistry II: Principles of Chemical Reactions. 6 Units.
Prerequisites: CHEM 215 with a grade of C or better
Offered: Winter, Spring and Summer
Chemical kinetics and equilibrium, thermodynamics, redox reactions and electrochemistry, and topics in inorganic, organic, biological and environmental chemistry. Four hours lecture and six hours laboratory. Materials fee required.

CHEM 221A. Organic Chemistry I Lecture. 3 Units.
Prerequisites: CHEM 215 with a grade of "C" or better and CHEM 216 with a grade of "C-" or better
Offered: Fall and Winter
Lecture. The chemistry of carbon compounds, including modern concepts of structure, mechanism, and reactivity. Emphasis is placed on compounds and reactions of biological interest; and includes an introduction to selected topics in biochemistry. Taking the lecture sequence (CHEM 221A, CHEM 222A, and CHEM 223A) without the lab sequence (CHEM 221B, CHEM 222B, and CHEM 223B) is inappropriate for premedical, predental and other pre-health professions students and for all majors and minors except the B.A. major in biology. Chemistry majors (except the B.A. in Chemistry, Biochemistry Option) are expected to take the Principles of Organic Chemistry sequence (CHEM 321, CHEM 322 and CHEM 323). Lecture only.

CHEM 221B. Organic Chemistry I Lab. 1 Unit.
Prerequisites: CHEM 215
Prerequisite/Corequisite: CHEM 221A
Laboratory. An introduction to experimental techniques in organic chemistry. Three hours of laboratory. Materials fee required.

CHEM 222A. Organic Chemistry II Lecture. 3 Units.
Prerequisites: CHEM 221A with a grade of "C" or better
Offered: Winter and Spring
Lecture. Continuation of CHEM 221A. Three hours lecture.

CHEM 222B. Organic Chemistry II Lab. 1 Unit.
Prerequisites: CHEM 221B
Prerequisite/Corequisite: CHEM 222A
Offered: Winter and Spring
Laboratory. Continuation of CHEM 221B. Three hours laboratory. Materials fee required.

CHEM 223A. Organic Chemistry III Lecture. 3 Units.
Prerequisites: CHEM 222A or equivalent with a grade of C- or better
Offered: Fall and Spring
Lecture. Continuation of CHEM 222A. Three hours lecture.

CHEM 223B. Organic Chemistry III Lab. 1 Unit.
Prerequisites: CHEM 222B
Prerequisite/Corequisite: CHEM 223A
Offered: Fall and Spring
Laboratory. Continuation of CHEM 222B. Three hours laboratory. Materials fee required.

CHEM 295A. Special Projects in Chemistry. 1 Unit.
Prerequisites: consent of instructor
Offered: Fall, Winter and Spring
Individual investigation, research, study or survey of selected problems. May be repeated for credit as topics change.

CHEM 295B. Special Projects in Chemistry. 2 Units.
Prerequisites: consent of instructor
Offered: Fall, Winter and Spring
Individual investigation, research, study or survey of selected problems. May be repeated for credit as topics change.
CHEM 301. Service Learning in Chemistry. 1 Unit.
Prerequisites: consent of instructor and pertinent course work
Offered: Fall, Winter and Spring
Supervised activities in chemistry or chemical education providing service to campus or community constituents. At least 30 hours required for credit. May be repeated for credit. May not be counted for credit for the chemistry major. Graded credit/no credit.

Prerequisites: CHEM 215 and CHEM 216 with grades of "C" or better in each course
Offered: Fall
Detailed study of organic molecules and their structures, reaction mechanisms, stereochemistry and synthesis. Three hours lecture and six hours laboratory. Materials fee required.

CHEM 322. Principles of Organic Chemistry II. 5 Units.
Prerequisites: CHEM 321 with a grade of C or better
Offered: Winter
Continuation of CHEM 321. Three hours lecture and six hours laboratory. Materials fee required.

CHEM 323. Principles of Organic Chemistry III. 5 Units.
Prerequisites: CHEM 322 with a grade of C or better
Offered: Spring
Continuation of CHEM 322, including special topics in heterocyclic compounds, fats, carbohydrates, and amino acids and proteins. Three hours lecture and six hours laboratory. Materials fee required.

CHEM 345. Modern Quantitative Analysis. 5 Units.
Prerequisites: CHEM 216 with a grade of "C" or better
Offered: Fall and Spring
Gravimetric and volumetric analysis, chemical equilibria, and modern instrumental methods. Three hours lecture and six hours laboratory. Materials fee required. Formerly CHEM 245.

CHEM 421. Intermediate Organic Chemistry. 5 Units.
Prerequisites: CHEM 223 or equivalent course work
Offered: Spring - Even numbered years
Organic reaction mechanisms, quantitative identification of organic compounds, and instrumental organic analysis. May not be counted as upper-division elective units for a chemistry degree. Three hours lecture and six hours laboratory. Materials fee required.

CHEM 436A. Biochemistry I. 4 Units.
Prerequisites: either CHEM 223 or 323 with grades of "C" or better, and BIOL 200
Offered: Fall and Winter
Lecture. Structure and function of proteins, carbohydrates, and lipids. Four hours lecture. Formerly CHEM 436.

CHEM 436B. Biochemistry I. 1 Unit.
Prerequisite/Corequisite: CHEM 436A
Offered: Fall and Winter
Laboratory. Introduction to experimental techniques in biochemistry and biotechnology. Three hours laboratory. Formerly CHEM 436.

CHEM 437A. Biochemistry II. 3 Units.
Prerequisites: CHEM 436A with a grade of C- or better
Offered: Winter and Spring
Lecture. Mechanism and kinetics of enzymes; metabolism of carbohydrates, lipids, and proteins. Three hours lecture.

CHEM 437B. Biochemistry II. 1 Unit.
Prerequisites: CHEM 436B
Prerequisite/Corequisite: CHEM 437A
Offered: Winter
Laboratory. Continuation of CHEM 436B. Three hours laboratory. Materials fee required.

CHEM 438A. Biochemistry III. 3 Units.
Prerequisites: CHEM 437A with a grade of C- or better
Offered: Spring
Lecture. Structure, function, and metabolism of nucleotides and nucleic acids with an emphasis on molecular mechanisms of nucleotide synthesis and degradation, replication, transcription, translation and regulation of gene expression. Three hours lecture.

CHEM 438B. Biochemistry III. 1 Unit.
Prerequisites: CHEM 437B
Prerequisite/Corequisite: CHEM 438A
Offered: Winter
Laboratory. Continuation of CHEM 437B. Three hours laboratory. Materials fee required.

CHEM 451. Physical Chemistry for Biochemists I. 5 Units.
Prerequisites: CHEM 345, CHEM 436A, and CHEM 436B with grades of "C" or better; MATH 213; and PHYS 123 or PHYS 223
Offered: Winter
Thermodynamics of single and multi-component systems, properties of non-electrolyte and electrolyte solutions with an emphasis on biomolecular systems. May not be counted for upper-division elective units for a B.A. in Chemistry, Chemistry Option or B.S. in Chemistry, ACS Certified Option. Four hours lecture and three hours laboratory. Materials fee required.

CHEM 452. Physical Chemistry for Biochemists II. 5 Units.
Prerequisites: CHEM 451
Offered: Spring
Phase equilibria, transport properties, electron transfer reactions, and reaction kinetics, with an emphasis on biomolecular systems. Quantum mechanical and physical principles as applied to molecular structure and spectroscopy. May not be counted for upper-division elective units for a B.A. or B.S. in Chemistry, Chemistry Option or a B.S. in Chemistry, ACS Certified Option. Four hours lecture and three hours laboratory. Materials fee required.

CHEM 455. Physical Chemistry I. 5 Units.
Prerequisites: CHEM 345 with a grade of "C" or better; MATH 213; and must have completed PHYS 123 or may take PHYS 223 as a prerequisite or corequisite. Recommended: MATH 251
Offered: Fall
Gas kinetics, thermodynamics, properties of solutions, phase equilibria, electrochemistry, and surface phenomena. Four hours lecture and three hours laboratory. Materials fee required.
CHEM 456. Physical Chemistry II. 5 Units.
Prerequisites: CHEM 455
Offered: Winter
Quantum mechanics, reaction rates and mechanisms, and crystal structure. Four hours lecture and three hours laboratory. Materials fee required.

CHEM 470. Bioinorganic Chemistry. 3 Units.
Prerequisites: CHEM 223 or CHEM 323 and CHEM 216. Recommended: CHEM 436A and CHEM 436B
Offered: Fall
Principles of inorganic chemistry emphasizing metals in biological systems. Course will cover coordination chemistry and physical techniques used to probe activity. A survey of the types of metalloproteins and metalloenzymes and their biological functions. Detailed case studies of selected metalloproteins. May not be counted for upper division elective units for a B.A. in Chemistry, Chemistry Option or B.S. in Chemistry, ACS Certified Option.

CHEM 475. Inorganic Chemistry. 5 Units.
Prerequisite/Corequisite: CHEM 223 or CHEM 323
Offered: Spring
Inorganic compounds and reactions. Special emphasis on symmetry, structure, kinetics, and thermodynamic principles. Four hours lecture and three hours laboratory. Materials fee required.

CHEM 500. Topics in Chemistry. 2 Units.
Prerequisites: consent of instructor
Offered: Winter and Spring
Lecture course on an advanced chemistry topic such as: advanced organic chemistry, computational chemistry, environmental chemistry, literature in chemistry, medicinal chemistry, polymer chemistry, and spectroscopy. May be repeated for credit as topics change. Lecture only.

CHEM 501A. Advanced Laboratory Techniques. 1 Unit.
Prerequisites: the basic course covering the subject of the Advanced Laboratory Techniques course and consent of instructor
Offered: Fall, Winter and Spring
Advanced laboratory course on a subject relative to one of the main divisions of chemistry. May be repeated for credit, however only four units may be counted as upper division elective units for either a major or minor in chemistry. Final written report required.

CHEM 501B. Advanced Laboratory Techniques. 2 Units.
Prerequisites: the basic course covering the subject of the Advanced Laboratory Techniques course and consent of instructor
Offered: Fall, Winter and Spring
Advanced laboratory course on a subject relative to one of the main divisions of chemistry. May be repeated for credit, however only four units may be counted as upper division elective units for either a major or minor in chemistry. Final written report required. Materials fee required.

CHEM 545. Instrumental Analysis. 6 Units.
Prerequisites: CHEM 223 or CHEM 323, CHEM 345 and CHEM 452 or CHEM 456
Offered: Spring
Principles and techniques of modern instrumental analysis, including spectrophotometry, spectroscopy, chromatography, X-ray analysis, mass spectrometry and potentiometry. Four hours lecture and six hours laboratory. Materials fee required.

CHEM 575A. Internship in Chemistry. 1 Unit.
Prerequisites: course work appropriate to the specific internship and consent of department
Offered: Fall, Winter and Spring
Supervised work and study in applied chemistry in an on- or off-campus setting. Final written report may be required. May be repeated for credit with department consent. A total of four units may be applied towards obtaining a bachelors degree and a total of five units may be applied towards obtaining a masters degree. Graded credit/no credit.

CHEM 575B. Internship in Chemistry. 2 Units.
Prerequisites: course work appropriate to the specific internship and consent of department
Offered: Fall, Winter and Spring
Supervised work and study in applied chemistry in an on- or off-campus setting. Final written report may be required. May be repeated for credit with department consent. A total of four units may be applied towards obtaining a bachelors degree and a total of five units may be applied towards obtaining a masters degree. Graded credit/no credit.

CHEM 575C. Internship in Chemistry. 3 Units.
Prerequisites: course work appropriate to the specific internship and consent of department
Offered: Fall, Winter and Spring
Supervised work and study in applied chemistry in an on- or off-campus setting. Final written report may be required. May be repeated for credit with department consent. A total of four units may be applied towards obtaining a bachelors degree and a total of five units may be applied towards obtaining a masters degree. Graded credit/no credit.

CHEM 575D. Internship in Chemistry. 4 Units.
Prerequisites: course work appropriate to the specific internship and consent of department
Offered: Fall, Winter and Spring
Supervised work and study in applied chemistry in an on- or off-campus setting. Final written report may be required. May be repeated for credit with department consent. A total of four units may be applied towards obtaining a bachelors degree and a total of five units may be applied towards obtaining a masters degree. Graded credit/no credit.

CHEM 575E. Internship in Chemistry. 5 Units.
Prerequisites: course work appropriate to the specific internship and consent of department
Offered: Fall, Winter and Spring
Supervised work and study in applied chemistry in an on- or off-campus setting. Final written report may be required. May be repeated for credit with department consent. A total of four units may be applied towards obtaining a bachelors degree and a total of five units may be applied towards obtaining a masters degree. Graded credit/no credit.

CHEM 576. Chemistry of the Elements. 4 Units.
Prerequisites: CHEM 223 or 323
Offered: Fall - Even numbered years
Current developments in inorganic chemistry, including coordination chemistry, non-metals and metalloids. Lecture only.
CHEM 590A. Chemistry Seminar I. 1 Unit.
Prerequisites: twelve upper-division units in chemistry, and NSCI 306 or equivalent. Lecture only. Final written report required.
Offered: Fall, Winter and Spring
Topics of current chemical interest, presented by students, faculty and guest speakers. To be taken once for credit toward the major requirements for graduation.

CHEM 590B. Chemistry Seminar II. 1 Unit.
Prerequisites: twelve upper-division units in chemistry, and NSCI 306 or equivalent. Oral presentation required. Prerequisite: CHEM 590A
Offered: Fall, Winter and Spring
Topics of current chemical interest, presented by students, faculty and guest speakers. To be taken once for credit toward the major requirements for graduation.

CHEM 595A. Independent Study. 1 Unit.
Prerequisites: a minimum overall grade point average of 2.5, consent of instructor and departmental approval of a written proposal of a project submitted on a standard application filed in advance of the quarter in which the course is to be taken.
Offered: Fall, Winter and Spring
Laboratory and/or library research conducted under the direction of a faculty member. Final written report required. A total of six units in CHEM 595 may apply toward the major. Materials fee required.

CHEM 595B. Independent Study. 2 Units.
Prerequisites: a minimum overall grade point average of 2.5, consent of instructor and departmental approval of a written proposal of a project submitted on a standard application filed in advance of the quarter in which the course is to be taken.
Offered: Fall, Winter and Spring
Laboratory and/or library research conducted under the direction of a faculty member. Final written report required. A total of six units in CHEM 595 may apply toward the major. Materials fee required.

CHEM 595C. Independent Study. 3 Units.
Prerequisites: a minimum overall grade point average of 2.5, consent of instructor and departmental approval of a written proposal of a project submitted on a standard application filed in advance of the quarter in which the course is to be taken.
Offered: Fall, Winter and Spring
Laboratory and/or library research conducted under the direction of a faculty member. Final written report required. A total of six units in CHEM 595 may apply toward the major. Materials fee required.

CHEM 595D. Independent Study. 4 Units.
Prerequisites: a minimum overall grade point average of 2.5, consent of instructor and departmental approval of a written proposal of a project submitted on a standard application filed in advance of the quarter in which the course is to be taken.
Offered: Fall, Winter and Spring
Laboratory and/or library research conducted under the direction of a faculty member. Final written report required. A total of six units in CHEM 595 may apply toward the major. Materials fee required.

CHEM 595E. Independent Study. 5 Units.
Prerequisites: a minimum overall grade point average of 2.5, consent of instructor and departmental approval of a written proposal of a project submitted on a standard application filed in advance of the quarter in which the course is to be taken.
Offered: Fall, Winter and Spring
Laboratory and/or library research conducted under the direction of a faculty member. Final written report required. A total of six units in CHEM 595 may apply toward the major. Materials fee required.

CHEM 595F. Independent Study. 6 Units.
Prerequisites: a minimum overall grade point average of 2.5, consent of instructor and departmental approval of a written proposal of a project submitted on a standard application filed in advance of the quarter in which the course is to be taken.
Offered: Fall, Winter and Spring
Laboratory and/or library research conducted under the direction of a faculty member. Final written report required. A total of six units in CHEM 595 may apply toward the major. Materials fee required.

CHEM 597. Directed Study in Science Education. 1 Unit.
Prerequisites: consent of instructor and departmental approval of a written proposal.
Offered: Fall, Winter and Spring
Readings, library research or a directed project on the pedagogical content knowledge of a specific area of chemistry, conducted under the direction of a faculty member. Graded credit/no credit. May be repeated for credit. No more than four units may be applied toward degree requirements for the B.A. in Chemistry, Integrated Teaching Credential Option. May not be counted as elective units for the B.A. in Chemistry, Chemistry Option; B.A. in Chemistry, Biochemistry Option; B.S. in Chemistry, ACS Certified Option, or the B.S. in Chemistry, Biochemistry Option.

CHEM 599. Undergraduate Comprehensive Examination. 0 Units.
Prerequisites: student must be a chemistry major within three quarters of graduation.
Assessment of the student's ability to integrate the knowledge of the area, show critical and independent thinking and demonstrate mastery of the subject matter. Graded credit/no credit.

CHEM 610. Advanced Environmental Chemistry. 5 Units.
Prerequisites: one year of introductory work in chemistry including organic nomenclature e.g. CHEM 205, CHEM 206; or CHEM 215, CHEM 216, and any organic; or consent of instructor. Recommended: CHEM 345 Overview of the chemistry and properties of the natural environment, and the effects of human activities thereon. Topics include the behavior of environmental pollutants in air, water, sediments/soils and their potential biological impacts; as well as a discussion of their sources and treatment. Concurrent laboratory studies of common methods used in environmental analyses. Four hours lecture and three hours laboratory. Materials fee required.

CHEM 690. Graduate Seminar in Environmental Sciences. 2 Units.
Selected topics and reviews of current investigations in the fields of environmental chemistry. Two hours seminar.
CHEM 691B. Graduate Independent Study. 2 Units.
Prerequisites: classified standing in master's program and consent of instructor
Independent study of an advanced topic in chemistry or environmental science.

CHEM 691C. Graduate Independent Study. 3 Units.
Prerequisites: classified standing in master's program and consent of instructor
Independent study of an advanced topic in chemistry or environmental science.

CHEM 691D. Graduate Independent Study. 4 Units.
Prerequisites: classified standing in master's program and consent of instructor
Independent study of an advanced topic in chemistry or environmental science.

CHEM 695D. Supervised Graduate Study in Chemistry. 4 Units.
Prerequisites: classified standing in masters program and consent of advisor
Original individual research in environmental chemistry; to be conducted under the direct supervision of a faculty member of the students committee, and if desired in collaboration with other members of the students masters committee. Materials fee required.

CHEM 695E. Supervised Graduate Study in Chemistry. 5 Units.
Prerequisites: classified standing in masters program and consent of advisor
Original individual research in environmental chemistry; to be conducted under the direct supervision of a faculty member of the students committee, and if desired in collaboration with other members of the students masters committee. Materials fee required.

CHEM 696A. Graduate Project. 1 Unit.
Prerequisites: classified standing and consent of instructor
Original individual research in chemistry, to be conducted under the guidance of the student's graduate advisor, and if desired, in collaboration with other members of the student's master's committee. May be repeated for credit for a maximum of 12 units. Materials fee required. Graded credit/no credit.

CHEM 696B. Graduate Project. 2 Units.
Prerequisites: classified standing and consent of instructor
Original individual research in chemistry, to be conducted under the guidance of the student's graduate advisor, and if desired, in collaboration with other members of the student's master's committee. May be repeated for credit for a maximum of 12 units. Materials fee required. Graded credit/no credit.

CHEM 696C. Graduate Project. 3 Units.
Prerequisites: classified standing and consent of instructor
Original individual research in chemistry, to be conducted under the guidance of the student's graduate advisor, and if desired, in collaboration with other members of the student's master's committee. May be repeated for credit for a maximum of 12 units. Materials fee required. Graded credit/no credit.

CHEM 696D. Graduate Project. 4 Units.
Prerequisites: classified standing and consent of instructor
Original individual research in chemistry, to be conducted under the guidance of the student's graduate advisor, and if desired, in collaboration with other members of the student's master's committee. May be repeated for credit for a maximum of 12 units. Materials fee required. Graded credit/no credit.

CHEM 696E. Graduate Project. 5 Units.
Prerequisites: classified standing and consent of instructor
Original individual research in chemistry, to be conducted under the guidance of the student's graduate advisor, and if desired, in collaboration with other members of the student's master's committee. May be repeated for credit for a maximum of 12 units. Graded credit/no credit.

CHEM 696F. Graduate Project. 6 Units.
Prerequisites: classified standing and consent of instructor
Original individual research in chemistry, to be conducted under the guidance of the student's graduate advisor, and if desired, in collaboration with other members of the student's master's committee. May be repeated for credit for a maximum of 12 units. Graded credit/no credit.

CHEM 697. Advanced Internship. 4 Units.
Prerequisites: CHEM 575 or GEOL 575 and consent of advisor
Supervised work or study in private or public organizations. May be repeated for credit with consent of Environmental Science Graduate Committee.

CHEM 698A. Continuous Enrollment for Graduate Candidacy Standing. 1 Unit.
Prerequisites: advancement to candidacy and approval of program graduate coordinator or, if an interdisciplinary studies major, consent of the Dean of Graduate Studies
Independent study leading to completion of requirements (other than course work) for the master's degree. To retain classified standing in the master's program, a student must enroll in 698 each quarter until the project or thesis is accepted or the comprehensive examination passed. Students who enroll in 698 through the university have full use of all university facilities. See Culminating Experience: Exam, Thesis, or Project in Graduate Degree and Program Requirements section of the Bulletin of Courses. 698 is a variable unit course, see fee schedule in the Financial Information section of the Bulletin of Courses. Earned units are not degree-applicable nor will they qualify for financial aid.

CHEM 698B. Continuous Enrollment for Graduate Candidacy Standing. 2 Units.
Prerequisites: advancement to candidacy and approval of program graduate coordinator or, if an interdisciplinary studies major, consent of the Dean of Graduate Studies
Independent study leading to completion of requirements (other than course work) for the master's degree. To retain classified standing in the master's program, a student must enroll in 698 each quarter until the project or thesis is accepted or the comprehensive examination passed. Students who enroll in 698 through the university have full use of all university facilities. See Culminating Experience: Exam, Thesis, or Project in Graduate Degree and Program Requirements section of the Bulletin of Courses. 698 is a variable unit course, see fee schedule in the Financial Information section of the Bulletin of Courses. Earned units are not degree-applicable nor will they qualify for financial aid.
CHEM 698C. Continuous Enrollment for Graduate Candidacy Standing. 3 Units.
Prerequisites: advancement to candidacy and approval of program graduate coordinator or, if an interdisciplinary studies major, consent of the Dean of Graduate Studies
Independent study leading to completion of requirements (other than course work) for the master's degree. To retain classified standing in the master's program, a student must enroll in 698 each quarter until the project or thesis is accepted or the comprehensive examination passed. Students who enroll in 698 through the university have full use of all university facilities. See Culminating Experience: Exam, Thesis, or Project in Graduate Degree and Program Requirements section of the Bulletin of Courses. 698 is a variable unit course, see fee schedule in the Financial Information section of the Bulletin of Courses. Earned units are not degree-applicable nor will they qualify for financial aid.

CHEM 698D. Continuous Enrollment for Graduate Candidacy Standing. 4 Units.
Prerequisites: advancement to candidacy and approval of program graduate coordinator or, if an interdisciplinary studies major, consent of the Dean of Graduate Studies
Independent study leading to completion of requirements (other than course work) for the master's degree. To retain classified standing in the master's program, a student must enroll in 698 each quarter until the project or thesis is accepted or the comprehensive examination passed. Students who enroll in 698 through the university have full use of all university facilities. See Culminating Experience: Exam, Thesis, or Project in Graduate Degree and Program Requirements section of the Bulletin of Courses. 698 is a variable unit course, see fee schedule in the Financial Information section of the Bulletin of Courses. Earned units are not degree-applicable nor will they qualify for financial aid.

CHEM 698E. Continuous Enrollment for Graduate Candidacy Standing. 5 Units.
Prerequisites: advancement to candidacy and approval of program graduate coordinator or, if an interdisciplinary studies major, consent of the Dean of Graduate Studies
Independent study leading to completion of requirements (other than course work) for the master's degree. To retain classified standing in the master's program, a student must enroll in 698 each quarter until the project or thesis is accepted or the comprehensive examination passed. Students who enroll in 698 through the university have full use of all university facilities. See Culminating Experience: Exam, Thesis, or Project in Graduate Degree and Program Requirements section of the Bulletin of Courses. 698 is a variable unit course, see fee schedule in the Financial Information section of the Bulletin of Courses. Earned units are not degree-applicable nor will they qualify for financial aid.

CHEM 698F. Continuous Enrollment for Graduate Candidacy Standing. 6 Units.
Prerequisites: advancement to candidacy and approval of program graduate coordinator or, if an interdisciplinary studies major, consent of the Dean of Graduate Studies
Independent study leading to completion of requirements (other than course work) for the master's degree. To retain classified standing in the master's program, a student must enroll in 698 each quarter until the project or thesis is accepted or the comprehensive examination passed. Students who enroll in 698 through the university have full use of all university facilities. See Culminating Experience: Exam, Thesis, or Project in Graduate Degree and Program Requirements section of the Bulletin of Courses. 698 is a variable unit course, see fee schedule in the Financial Information section of the Bulletin of Courses. Earned units are not degree-applicable nor will they qualify for financial aid.

CHEM 698Z. Continuous Enrollment for Graduate Candidacy Standing. 0 Units.
Prerequisites: advancement to candidacy and approval of program graduate coordinator or, if an interdisciplinary studies major, consent of the Dean of Graduate Studies
Independent study leading to completion of requirements (other than course work) for the master's degree. To retain classified standing in the master's program, a student must enroll in 698 each quarter until the project or thesis is accepted or the comprehensive examination passed. Students who enroll in 698 through the university have full use of all university facilities. See Culminating Experience: Exam, Thesis, or Project in Graduate Degree and Program Requirements section of the Bulletin of Courses. 698 is a variable unit course, see fee schedule in the Financial Information section of the Bulletin of Courses. Earned units are not degree-applicable nor will they qualify for financial aid.

CHEM 699. Graduate Thesis. 4 Units.
Prerequisites: CHEM 695 or GEOL 695
Independent graduate research conducted under guidance of the major advisor culminating in a written thesis option of the degree requirements. Materials fee required.

CHEM 999. Comprehensive Examination. 0 Units.
Prerequisites: advancement to candidacy, approval of department, completion of course work in the masters program, and good academic standing
Assessment of the students ability to integrate the knowledge of the area, show critical and independent thinking and demonstrate mastery of the subject matter.