CHEMISTRY

THE FACULTY

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THE MAJORS

Learning outcomes for this program may be found at www.redlands.edu/BS-CHEM/learningoutcomes.

BACHELOR OF SCIENCE: 18 courses/ 46 credits

Core Courses

–– CHEM 131 General Chemistry (4)
–– CHEM 132 General Chemistry (4)
–– CHEM 231 Organic Chemistry (4)
–– CHEM 232 Organic Chemistry (4)
–– CHEM 330 Analytical Chemistry (4)
–– CHEM 331 Physical Chemistry (4)
–– CHEM 332 Physical Chemistry (4)
–– CHEM 445 Inorganic Chemistry (4)
–– One additional 3- or 4-credit course numbered above 300.

Capstone courses

–– CHEM 378 Chemistry Research (1-3 credits depending on degree track). Students must register for at least 1 credit of CHEM 378 no later than the May Term of the junior year.
–– CHEM 394 Chemistry Seminar (1), three semesters
–– CHEM 431 Advanced Chemistry Lab (2)
–– CHEM 476 Senior Research and Capstone Report (1) or CHEM 478 Senior Research and Thesis (1) (typically taken in the spring of the senior year)
–– CHEM 494 Communication in Chemistry (3)

RELATED FIELD REQUIREMENTS: 4 courses/ 16 credits

–– MATH 119 Integrated Calculus II (4) or MATH 121 Calculus I (4)
–– MATH 122 Calculus II (4)

Choose one of the following:

–– PHYS 220 Fundamentals of Physics I (4) and PHYS 221 Fundamentals of Physics II (4)

OR

–– PHYS 231 General Physics I (4) and PHYS 232 General Physics II (4)

RECOMMENDED:
−− MATH 221 Calculus III (4)
−− MATH 235 Differential Equations (4)
−− MATH 241 Linear Algebra (4)
−− PHYS 233 General Physics III (4)

THE ACS-APPROVED MAJOR
The Chemistry Department is accredited by the American Chemical Society (ACS). To be certified as having met the requirements for professional training in chemistry established by the Committee for Professional Training of the ACS, a student must also take CHEM 320, a minimum of three credits of CHEM 378, and 1 credit of CHEM 478 (typically taken in spring of their senior year) in addition to completing all of the Bachelor of Science requirements and related field requirements described earlier.

PROGRAM IN BIOCHEMISTRY AND MOLECULAR BIOLOGY
Please see the Biochemistry and Molecular Biology section of this Catalog.

PREMEDICAL AND OTHER HEALTH PROFESSIONS
Premedical students should refer to the Premed Program description in the Integrated Programs of Study section of this Catalog.

PURSUING A TEACHING CREDENTIAL
Students interested in a future career in teaching may pursue a teaching credential through the School of Education. Interested students should consult the School of Education section of this Catalog for information regarding admissions to the School of Education, coursework pathways, and requirements to earn a California Teaching Credential. Students should discuss their plans with their Department of Chemistry advisor and work closely with them to customize an academic plan.

MINOR PROGRAMS
Students may not pursue minors in both Chemistry and Environmental Chemistry.

CHEMISTRY MINOR

REQUIREMENTS
A. CHEMISTRY: 6 courses/ 22-24 credits
−− CHEM 131 General Chemistry I (4)
−− CHEM 132 General Chemistry II (4)
−− CHEM 231 Organic Chemistry I (4)
−− CHEM 232 Organic Chemistry II (4)
−− At least two other courses above 300 totaling at least 6 credits. One of these courses must be a laboratory course.

Acceptable laboratory courses include:
−− CHEM 301 Quantitative Chemistry and Analysis (4)
−− CHEM 312 Advanced Environmental Chemistry (4)
−− CHEM 320 Biochemistry (4)
−− CHEM 330 Analytical Chemistry (4)
−− CHEM 331 Physical Chemistry I (4)
−− CHEM 311 Environmental Chemistry Field Experience and Modeling (3)

–– CHEM 431 Advanced Laboratory (2)

Acceptable non-laboratory courses include:
–– CHEM 332 Physical Chemistry II (4)
–– CHEM 420 Advanced Biochemistry (4)
–– CHEM 425 Advanced Organic Chemistry (4)
–– CHEM 445 Inorganic Chemistry (4).

B. MATHEMATICS: 4 credits
MATH 119 Integrated Calculus II (4) or higher.

INTERDISCIPLINARY MINOR IN ENVIRONMENTAL CHEMISTRY

REQUIREMENTS

A. CORE COURSES: 4 courses/ 16 credits
–– EVST 100 Introduction to Environmental Studies (4)
–– CHEM 131 General Chemistry I (4)
–– CHEM 132 General Chemistry II (4)
–– CHEM 231 Organic Chemistry I (4)

B. ENVIRONMENTAL SYSTEMS: 2 courses/ 7-8 credits
Each of the courses includes a laboratory or fieldwork component. Select one each from Chemistry and Environmental Studies

–– CHEM 312 Advanced Environmental Chemistry (4) OR CHEM 311 Environmental Chemistry Field Experience and Modeling (3) OR CHEM 330 Analytical Chemistry (4) OR CHEM 301 Quantitative Chemistry and Analysis (4)
–– EVST 290 Environmental Geology (4) OR EVST 391 Environmental Hydrology (4) OR EVST 220 Physical Geography OR EVST 392 Oceanography (4) OR EVST 305 Ecology for Environmental Scientists (4).

C. ELECTIVE: 1 course/ 4 credits
Select one additional course from the list below.
–– CHEM 332 Physical Chemistry II, (4), CHEM 445 Inorganic Chemistry (4), CHEM 320 Biochemistry (4), EVST 245 Marine Environmental Studies (4), EVST 254 Climate Disruption: Science and Sustainability (4), EVST 242 Food and Nature, BIOL 336 Botany (4), BIOL 340 Conservation Biology (4), BIOL 331 Ecology (4), BIOL 346 Aquatic Biology (4) and MATH 231 (4).

A third course from the Environmental Systems list may be substituted for the Elective course.

ADVANCED PLACEMENT IN CHEMISTRY
Students who receive a score of four or higher on the Advanced Placement Test or a score of six or higher on the International Baccalaureate may be offered credit for CHEM 131 on the approval of the Chair.

STUDY ABROAD

Studying chemistry in another country gives a student the opportunity to experience different scientific and cultural viewpoints, as well as providing exposure to a different style of education. It can be a valuable experience, one that develops maturity and greater independence. Most international programs require junior standing and at least a 3.00 GPA. Careful advanced planning is necessary to integrate chemistry courses taken abroad with those taken at Redlands. Consult an academic advisor in the Chemistry Department and contact the Study Abroad Office for advice and information.

DEPARTMENTAL HONORS

Every chemistry major must undertake a research project and complete a senior capstone project report or thesis. The Chemistry Department seeks to recognize academic excellence and outstanding achievement in undergraduate research by nominating chemistry majors who have strong academic records and have demonstrated ownership of their research project to present their senior thesis work for honors in chemistry.

To be eligible for honors, a student must have a minimum GPA of 3.45 (cumulative or in chemistry), be on track to complete the chemistry major or the program in Biochemistry and Molecular Biology with research in chemistry, and plan to complete at least 3 credits of CHEM 378 as well as 1 credit of CHEM 478. To receive honors, a student must complete an outstanding written research thesis approved by their faculty advisor and Honors Committee and pass an oral examination on the thesis.

RESEARCH IN THE CHEMISTRY DEPARTMENT

The faculty of the Chemistry Department pursue research on a wide variety of projects. Students may choose to conduct research on computational chemistry, synthetic organic chemistry of natural products, synthesis and methodology developments, inorganic chemistry, the study of the reactions of ozone with molecular components of plant waxes, development of analytical techniques using capillary electrophoresis, separation and ultratrace detection of biologically active molecules, detecting and modeling trace pollutants in environmental systems, microbial carbon metabolism, and pharmaceutical chemistry.

COURSE DESCRIPTIONS (CHEM)

101 Mother Earth Chemistry.
Fall (4), Spring (4), May Term (3).
Designed for anyone interested in learning the chemistry and practice of simple arts like wine making, beer brewing, cloth dyeing, and the making of soap, cheese, yogurt, and high-protein foods derived from soybeans (such as tofu and tempeh). Emphasis on learning by doing. No background in chemistry is required. Recommended for non-science majors.
Offered as needed.

102 Introduction to Chemistry of the Environment.
Fall (4), Spring (4).
Introductory course for students wishing to explore the sciences or needing preparation for General Chemistry. Topics in chemistry relevant to the environment such as energy needs, pollution, and pesticides will be discussed. Three hours lecture. No background in chemistry is required. Recommended for non-science majors.
Numeric grade only.

103 Chemistry of Art.
May Term (3).
For students interested in exploring the link between chemistry and art. Students investigate topics such as color, light, the photochemistry of photography and fading, the physical and chemical properties of metals and alloys, natural and synthetic dyes, clays, ceramics, authentication of works of art, and conservation of art. Three hours lecture and laboratory. No background in chemistry is required. Recommended for non-majors.
Offered as needed.

104 Whodunit! A Course in Forensic Science.
Fall (4), Spring (4).
A course in forensic science intended to introduce the student to the role science plays in the criminal investigation process and the criminal justice system. This course will present the techniques, skills, and limitations of the modern crime laboratory for students with no background in the sciences.
Offered as needed.

106 Topics in Science and Society.
Fall (4), Spring (4).
Study of the nature of scientific investigation and its relationship to societal and individual needs. Specific scientific discoveries, philosophies, and moral theories are discussed. Examination of the interactions of the scientific world communities through the analysis of current controversial areas of research and technology.

108 The Science of Drugs.
Fall (4), Spring (4).
Introductory course intended to expose students to the action of various drugs and their effects on the body with a focus on achieving a molecular-level understanding of drugs. Drugs such as caffeine, alcohol, and street drugs will be studied. Intended for non-science majors.
Offered as needed.

131 General Chemistry.
Fall (4), Spring (4).
Introduction to chemistry, including properties, structure, and reactivity of atoms and molecules, with concurrent laboratory. CHEM 131 covers fundamental concepts of atomic structure, stoichiometry, aqueous reactions, states of matter, molecular structure and bonding, and thermochemistry. Four hours lecture and three hours laboratory.
Prerequisites: Placement into MATH 100 or higher mathematics course, completion of MATH 100 or higher mathematics course, or permission of chemistry department.
Corequisite: CHEM 131L.

132 General Chemistry.
Spring (4).
Introduction to chemistry, including properties, structure, and reactivity of atoms and molecules, with concurrent laboratory. First semester covers fundamental concepts of atomic structure, stoichiometry, aqueous reactions, states of matter, molecular structure and bonding, and thermochemistry. Second semester emphasizes group projects in equilibrium, electrochemistry, thermodynamics, kinetics, inorganic synthesis, and spectroscopy. Fall: four hours lecture and three hours laboratory. Spring: seven hours laboratory and group learning.
Prerequisites: CHEM 131 with a minimum grade of 2.0 or higher or by permission. Placement into or completion of MATH 118 or higher. Mathematics course or permission of Chemistry department.

231 Organic Chemistry.
Fall (4), Spring (4).
232 Organic Chemistry.
Spring (4).
Chemistry of carbon-containing compounds; their structure, nomenclature, physical properties, spectroscopy (IR, GC-MS, NMR), stereochemistry, chemical reactivities, mechanisms of reaction, and synthesis. Four hours lecture and three hours laboratory.
Prerequisite for CHEM 231: Grade of 2.0 or higher in CHEM 132.
Prerequisite for CHEM 232: CHEM 231.

290 Mile High Chemistry.
May (3).
This course explores topics in environmental chemistry such nutrient balance, soil chemistry, and air and water quality. There is a strong emphasis placed on field and laboratory techniques. This is a May Term travel course. Course includes additional fees. May be repeated for degree credit.
Prerequisites: CHEM 131 or CHEM 102.
Recommended: CHEM 132.

301 Quantitative Chemistry and Analysis.
Spring (4).
Equilibrium and detailed acid-base chemistry specifically designed with applications in biology, clinical chemistry, or environmental analysis. Laboratory experience covers sample preparation, titrations, statistical analysis, and an overview of instrumental methods used in these applied fields, including molecular UV/ Vis and atomic absorbance spectroscopy, fluorometry, ion electrodes, gas and liquid chromatography, and electrophoresis.
Prerequisites: CHEM 132 and college algebra, or equivalent.
Offered as needed.
Numeric grade only.

311 Environmental Chemistry Field Experience.
May Term (3).
Environmental Chemistry Field Experience and Modeling takes place at the Sierra Nevada Aquatic Research Laboratory (SNARL). This course deepens understanding of natural systems, including chemical analysis of lakes, soils, and atmosphere; there is a GIS and mapping component. The final project consists of a comprehensive model of the study site.
Prerequisite: permission of instructor required.

312 Advanced Environmental Chemistry.
Spring. (4).
This course investigates environmental chemistry of local air, water, and soil systems, combined with mapping so that spatial trends can be observed. Global issues are also considered, allowing this knowledge base to be applied in multiple settings. Laboratory and fieldwork heavily based on EPA methods of sampling and chemical analysis.
Prerequisite: CHEM 232, by permission only.
Offered as needed.

320 Biochemistry.
Fall (4).
Study of the structure and function of biological molecules (including proteins, nucleic acids, carbohydrates, and lipids), enzymes, and metabolic pathways. Four hours lecture and three hours laboratory.
Prerequisite: CHEM 232 or by permission.

330 Analytical Chemistry.
Fall (4).
Principles of analytical chemistry with emphasis on precise measurements and instrumental methods, including molecular and atomic absorption spectrometry, potentiometric and electrolytic methods, separation techniques, chromatography, mass spectrometry, and other specialized instrumental techniques. Experimental design, sampling, and error reduction are studied along with statistical methods of evaluating uncertainty in laboratory results. Four hours lecture and three hours laboratory.
Prerequisites: CHEM 231 and one course from MATH119, MATH 121, MATH 122, OR MATH 221.

331 Physical Chemistry I.
Spring (4).
Quantum chemistry, spectroscopy, and statistical thermodynamics applied to the study of the physical and chemical properties of matter. The laboratory involves the systematic study of the theory and practice of modern spectroscopic methods. Four hours lecture and three hours laboratory.
Prerequisites: CHEM 132 and MATH 122 or higher math course and PHYS 220 or higher physics course or by permission.

332 Physical Chemistry II.
Fall (4).
Equilibrium thermodynamics and kinetics applied to the study of the physical and chemical properties of matter. CHEM 331 need not be taken before CHEM 332.
Prerequisites: CHEM 132 and MATH 122 or higher math course and PHYS 220 or higher physics course or by permission.

378 Chemistry Research.
Fall (1–4), Spring (1–4), May Term (1–3).
Chemistry majors are required to complete 1–3 credits of research for graduation, depending upon their selection of an option for the major and agreement with their research advisor.
Prerequisite: by permission.
Credit/no credit only.

394 Chemistry Seminar.
Fall (1), Spring (1).
Required of majors during fall and spring of junior year and spring of senior year. Activities include seminars by vising speakers and discussions of current research. Juniors prepare a seminar on their proposed senior research and seniors prepare a seminar on their research.

420 Advanced Biochemistry.
Spring (4).
In-depth study of biochemical topics. Specific focus will vary and may range from bioorganic chemistry to the biochemistry of processes taking place at the level of the whole organism. Three or four hours lecture/seminar.
Prerequisite: CHEM 320 or by permission.
Offered as needed.

425 Advanced Organic Chemistry.
Spring (4).
Selected topics in organic chemistry, including physical organic chemistry, molecular orbital theory, structural and mechanistic relationships, and computational chemistry. Three hours lecture.
Prerequisite: CHEM 232 or by permission.
Offered as needed.

431 Advanced Laboratory.
Spring (2).
Integrated project-oriented lab, including computational chemistry; synthesis; characterization; reactivity studies; kinetics; thermodynamics and photochemistry; and the use of instrumental techniques such as ion chromatography, atomic spectroscopy, UV-visible, infrared, Nuclear Magnetic

Resonance, mass spectrometry, magnetic susceptibility, and electrochemical methods. As part of this course, students will take the Major Field Test, a comprehensive examination that covers analytical, inorganic, organic, and physical chemistry. Six hours laboratory.
Prerequisites: senior standing, CHEM 330, CHEM 332 or by permission.
Numeric grade only.

445 Inorganic Chemistry.
Spring (4).
Focus on understanding the fundamental concepts of transition metal chemistry, the main group elements, and bio-inorganic chemistry. Emphasis on bonding, structures, synthesis, and reactivity. Four hours lecture.
Prerequisites: CHEM 232.
Numeric grade only.

460 Special Topics.
Fall (1–4), Spring (1–4).
Special topics in chemistry studied under the guidance of faculty (4 credit hours lecture) may include the following: advanced analysis, environmental chemistry, surface science and spectroscopy, organometallic chemistry and catalysis, solid-state chemistry, polymers and surfactants in solution, colloids and macromolecules, application of molecular assembly, diffusion, or other approved topics.
Prerequisite: by permission.
Numeric and Evaluation grade only.

476 Senior Research and Capstone Report.
Fall (1), Spring (1).
This course is required as part of the capstone requirement for the BS in chemistry and taken as the last semester of the capstone research project. The student completes his or her research, writes a capstone research report on the project, and presents a seminar during the Chemistry Seminar. All aspects of the student's capstone project must be acceptable to the research mentor(s) for the student and the Chemistry Department.
Prerequisite: by permission and at least 1 credit of CHEM 378.

478 Senior Research and Thesis.
Fall (1), Spring (1).
This course is taken in a student's final semester of the capstone research project for the BS with ACS certification or BS with Honors. The student completes his or her research, writes a thesis on the project, and presents a seminar during Chemistry Seminar. The research mentor for the student evaluates him or her on research effort and progress, the capstone research report or honors thesis, and any presentations the student has given.
Prerequisites: by permission and at least 2 credits of CHEM 378.
Evaluation grade only.

494 Communication in Chemistry.
Fall (3).
This course focuses on important concepts in effective written and oral communication in chemistry. Students will write multiple drafts of the introduction to their capstone report and review the work of their peers. Students will receive instruction in effective presentation techniques and give two presentations with feedback.
Prerequisite: senior standing and at least one credit of CHEM 378 (can be co-requisite).