

# CHEMISTRY

## DEPARTMENT OFFICE

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## Programs Offered

Bachelor of Science in Chemistry  
(certified by the American Chemical Society)

Bachelor of Arts in Chemistry

Bachelor of Science in Biochemistry

Minor in Chemistry

Teaching Credential Preparation

Chemistry is the study of matter, its properties, and how it changes. An understanding of chemical principles is required to fully understand most scientific disciplines such as biology, medicine, physics, environmental science, geology, materials science, pharmaceuticals, agriculture, forensic science, most branches of engineering, and even studio art. Chemists not only study molecules that nature provides but also synthesize new molecules to be used in many of these fields.

The department offers both bachelor of arts and bachelor of science degrees. Both degrees provide students with a solid chemical foundation to prepare them for graduate school, professional school, or the workforce. The B.S. degree requires more science coursework, while the B.A. allows more flexibility for other academic interests. The B.S. in Biochemistry is designed for students with an interest in the biological aspects of chemistry and the pre-health professions.

## Careers in Chemistry

Sonoma State University is fortunate to be situated within the greater Bay Area, which is rapidly becoming a leading area for research in disciplines such as biotechnology, pharmaceuticals, materials science, and proteomics. Sonoma State graduates have a high success rate for acceptance into advanced degree programs in chemistry and biochemistry; medical, dental, and veterinary schools; cell and

molecular biology; and materials science. They have also entered the job market in a variety of careers, including government agencies (FBI, forensics), technical writing, chemical and biochemical research, cosmetics and perfumes, space chemistry, teaching at all levels, medical technology, pharmaceuticals, patent law, materials research, consulting, and applications of chemistry in business.

Students seeking teaching credentials may elect chemistry as their major within the teaching credential program in science.

The small size and educational philosophy of the department encourage students to develop close relationships with other students, faculty, and staff. Course work and individual research projects place an emphasis on laboratory experiences in which students are expected to become familiar with a variety of techniques and instruments. In 2006, the department returned to the newly remodeled Darwin Hall, equipped with new lower-division teaching laboratories and facilities for advanced laboratory courses and undergraduate research. Our laboratories are equipped with many modern, computerized instruments that include ultraviolet, visible, infrared, atomic absorption, and fluorescence spectrophotometers; a nuclear magnetic resonance spectrometer; high-pressure liquid, gas, and ion exchange chromatographs; and a gas chromatograph with mass spectrometer detector.

## Bachelor of Science in Chemistry (certified by the American Chemical Society)

The B.S. degree provides thorough preparation for students who wish to pursue advanced degrees in the chemical sciences, go to professional school, or work as chemists in industry. All courses in the major core, major electives, and supporting courses must be taken in the traditional grading mode (A-F). Undergraduate research is required for the B.S. degree in Chemistry. Transcripts will be noted as approved by the American Chemical Society.

Degree Requirements	Units
General education	51
Major requirements (may include 6 units in GE)	47
Supporting courses (may include 3 units in GE)	22
Electives	0-9
<b>Total units needed for graduation</b>	<b>120</b>

### Major Core Requirements

CHEM 115AB General Chemistry (6 units may be applied to GE)	10
CHEM 255 Quantitative Analysis	4
CHEM 310AB Physical Chemistry	6
CHEM 316 Physical Chemistry Laboratory	2
CHEM 325 Inorganic Chemistry	3
CHEM 335AB Organic Chemistry	8
CHEM 336 Organic Chemistry Laboratory II	2
CHEM 401 Instrumental Analysis and Chemical Synthesis	3
CHEM 402 Advanced Synthesis and Instrumental Analysis	3
CHEM 445 Structural Biochemistry or CHEM 446 Metabolic Biochemistry	3
CHEM 494 Undergraduate Research	2
CHEM 497 Research Seminar	1

**Total units in the major core** 47

### Supporting Courses

MATH 161 Calculus I (3 units may be applied to GE)	4
MATH 211 Calculus II	4
MATH 261 Calculus (IV)	4
PHYS 114 Introduction to Physics I	4
PHYS 116 Introduction to Physics Laboratory I	1
PHYS 214 Introduction to Physics II	4
PHYS 216 Introduction to Physics Laboratory II	1
<b>Total units in supporting courses</b>	<b>22</b>
Strongly Recommended: additional units in CHEM 494, Undergraduate Research	1-6

### Sample Four-year Program for B.S. in Chemistry

FRESHMAN YEAR:: 30 Units	
<i>Fall semester (15 Units)</i>	<i>Spring semester (15 Units)</i>
CHEM 115A (5)	CHEM 115B (5)
MATH 161 (4)	MATH 211 (4)
GE (3)	GE (3)
GE (3)	GE (3)
SOPHOMORE YEAR:: 30 Units	
<i>Fall semester (14 Units)</i>	<i>Spring semester (16 Units)</i>
CHEM 335A (5)	CHEM 335B (3)
MATH 261 (4)	CHEM 336 (2)
PHYS 114 (4)	PHYS 214 (4)
PHYS 116 (1)	PHYS 216 (1)
	GE (3)
	GE (3)
JUNIOR YEAR:: 30 Units	
<i>Fall semester (16 Units)</i>	<i>Spring semester (14 Units)</i>
CHEM 255 (4)	CHEM 310B (3)
CHEM 445 (3)	CHEM 316 (2)
CHEM 310A (3)	CHEM 325 (3)
GE (3)	GE (3)
GE (3)	GE (3)
SENIOR YEAR:: 30 Units	
<i>Fall semester (14 Units)</i>	<i>Spring semester (16 Units)</i>
CHEM 401 (3)	CHEM 402 (3)
CHEM 494 (2)	CHEM 497 (1)
GE (3)	GE (3)
GE (3)	GE (3)
GE (3)	Elective (4)
<b>TOTAL UNITS:: 120</b>	

### Bachelor of Science in Biochemistry

The B.S. degree in biochemistry is appropriate for students interested in the medical fields, graduate study in chemistry or biochemistry, or employment in the biochemical, pharmaceutical, or biotechnology industries. All courses in the major core, major electives, and supporting courses must be taken in the traditional grading mode (A-F). Undergraduate research is required for the B.S. degree in biochemistry.

Degree Requirements	Units
General education	51
Major Requirements (may include 6 units in GE)	46
Biology Courses (may include 3 units in GE)	12
Supporting Courses (may include 3 units in GE)	16-18
Electives	0-7
<b>Total units needed for graduation</b>	<b>120</b>

#### Major Core Requirements

CHEM 115 AB General Chemistry (6 units may be applied to GE)	10
CHEM 255 Quantitative Analysis	4
CHEM 310 AB Physical Chemistry	6
CHEM 325 Inorganic Chemistry	3
CHEM 335AB Organic Chemistry	8
CHEM 401 Instrumental Analysis and Chemical Synthesis	3
CHEM 441 Biochemical Methods	3
CHEM 445 Structural Biochemistry	3
CHEM 446 Metabolic Biochemistry	3
CHEM 494 Undergraduate Research	2
CHEM 497 Research Seminar	1
<b>Total units in the major core</b>	<b>46</b>

#### Biology Courses

BIOL 123 Molecular and Cell Biology (3 units may be applied to GE)	4
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#### Choose 2 from the following:

BIOL 340 General Bacteriology (4)
BIOL 342 Molecular Genetics (4)
BIOL 343 Molecular Microbiology (4)
BIOL 344 Cell Biology (4)
BIOL 349 Animal Physiology (4)
BIOL 382 Parasitology (4)
BIOL 383 Virology (4)
BIOL 480 Immunology (4)
BIOL 544 Advanced Cell Biology (4)
or other courses approved by the Chemistry Department

**Total units in Biology courses 12**

#### Supporting Courses

MATH 161 Calculus I (3 units may be applied to GE)	4
MATH 211 Calculus II	4
PHYS 210A or 114 Physics I	3-4
PHYS 209A or 116 Physics Laboratory I	1
PHYS 210B or 214 Physics II	3-4
PHYS 209B or 216 Physics Laboratory II	1

**Total units in supporting courses 16-18**

Strongly recommended: additional units in CHEM 494,  
Undergraduate Research 1-6

## Sample Four-year Program for Bachelor of Science in Biochemistry

### FRESHMAN YEAR:: 30 Units

<i>Fall semester (15 units)</i>	<i>Spring semester (15 units)</i>
CHEM 115A (5)	CHEM 115B (5)
MATH 161 (4)	MATH 211 (4)
GE (3)	GE (3)
GE (3)	GE (3)

### SOPHOMORE YEAR:: 30 Units

<i>Fall semester (16 units)</i>	<i>Spring semester (14 units)</i>
CHEM 335A (5)	CHEM 335B (3)
PHYS 114 (4) or 210A (3)	PHYS 214 (4) or 210B (3)
PHYS 116 (1) or 209A (1)	PHYS 216 (1) or 209B (1)
BIOL 123 (4)	GE (3)
Elective (2 or 3)	GE (3 or 4)

### JUNIOR YEAR:: 31 Units

<i>Fall semester (16 units)</i>	<i>Spring semester (15 units)</i>
CHEM 445 (3)	CHEM 441 (3)
CHEM 310A (3)	CHEM 310B (3)
CHEM 255 (4)	CHEM 446 (3)
GE (3)	GE (3)
GE (3)	GE (3)

### SENIOR YEAR:: 29 Units

<i>Fall semester (15 units)</i>	<i>Spring semester (14 units)</i>
CHEM 401 (3)	CHEM 325 (3)
CHEM 494 (2)	CHEM 497 (1)
BIOL elective (4)	BIOL elective (4)
GE (3)	GE (3)
GE (3)	Elective (3)

**TOTAL UNITS:: 120**

## Bachelor of Arts in Chemistry

The B.A. degree provides a solid foundation in chemistry so students have the same career options as those with the B.S. degree, while allowing students the flexibility to pursue other academic interests. All courses in the major core, major electives, and supporting courses must be taken in the traditional grading mode (A-F). It is highly recommended that students perform undergraduate research with a faculty member.

Degree Requirements	Units
General education	51
Major requirements (may include 6 units in GE)	38
Supporting courses (may include 3 units in GE)	16-18
Electives	13-24
<b>Total units needed for graduation</b>	<b>120</b>

### Major Core Requirements

CHEM 115AB General Chemistry (6 units may be applied to GE)	10
CHEM 255 Quantitative Analysis	4
CHEM 310AB Physical Chemistry	6
CHEM 316 Physical Chemistry Laboratory	2
CHEM 325 Inorganic Chemistry	3
CHEM 335AB Organic Chemistry	8
CHEM 401 Instrumental Analysis and Chemical Synthesis	3
CHEM 497 Research Seminar	1
Elective (upper-division chemistry)	1

**Total units in the major core 38**

### Supporting Courses

MATH 161 Calculus I (3 units may be applied to GE)	4
MATH 211 Calculus II	4
PHYS 210A or 114 Physics I	3-4
PHYS 209A or 116 Physics Laboratory I	1
PHYS 210B or 214 Physics II	3-4
PHYS 209B or 216 Physics Laboratory II	1

**Total units in supporting courses 16-18**

Strongly Recommended: CHEM 494, Undergraduate Research 1-6

## Sample Four-year Program for Bachelor of Arts in Chemistry

### FRESHMAN YEAR:: 30 Units

<i>Fall semester (15 units)</i>	<i>Spring semester (15 units)</i>
CHEM 115A (5)	CHEM 115B (5)
MATH 161 (4)	MATH 211 (4)
GE (3)	GE (3)
GE (3)	GE (3)

### SOPHOMORE YEAR:: 30 Units

<i>Fall semester (14 units)</i>	<i>Spring semester (16 units)</i>
CHEM 335A (5)	CHEM 335B (3)
MATH 261 (4)	CHEM 336 (2)
PHYS 114 (4) or 210A (3)	PHYS 214 (4) or 210B (3)
PHYS 116 (1) or 209A (1)	PHYS 216 (1) or 209B (1)
Elective (0 or 1)	GE (3)
	GE (3 or 4)

### JUNIOR YEAR:: 30 Units

<i>Fall semester (16 units)</i>	<i>Spring semester (14 units)</i>
CHEM 255 (4)	CHEM 310B (3)
CHEM 310A (3)	CHEM 316 (2)
GE (3)	GE (3)
GE (3)	GE (3)
Elective (3)	GE (3)

### SENIOR YEAR:: 30 Units

<i>Fall semester (15 units)</i>	<i>Spring semester (15 units)</i>
CHEM 401 (3)	CHEM 497 (3)
CHEM 494 (1)	CHEM 325 (3)
GE (3)	GE (3)
GE (3)	GE (3)
Elective (5)	Elective (3)

**TOTAL UNITS:: 120**

California Commission on Teacher Credentialing. One part of the examination will test breadth of knowledge in biology, chemistry, physics, astronomy, and geology. Another part of the examination will test depth of knowledge in a particular area, such as chemistry. The B.A. or B.S. degree in chemistry is recommended to prepare for the part of the examination that tests depth of knowledge in chemistry. For more information, please contact the Chemistry Department office, Darwin Hall 300, (707) 664-2119.

## Chemistry Courses (CHEM)

Classes are offered in the semesters indicated. Please see the Schedule of Classes for most current information and faculty teaching assignments.

### 101 CHEMISTRY AND SOCIETY (3) FALL, SPRING

Lecture, 3 hours. An introductory course in chemistry for students majoring in subjects other than the sciences. This course covers many of the ideas of chemistry in a way that requires only basic algebra. An emphasis is placed on the role of chemistry in daily life and decision-making. Satisfies GE, category B1 (Physical Sciences).

### 102 CHEMISTRY AND SOCIETY (3) FALL, SPRING

Lecture, 2 hours; laboratory, 3 hours. An introductory course in chemistry for students majoring in subjects other than the sciences. This course covers many of the ideas of chemistry in a way that requires only basic algebra. An emphasis is placed on the role of chemistry in daily life and decision-making. The laboratory will consist of experiments demonstrating chemical principles and phenomena discussed in the lecture. Satisfies GE, category B1 (Physical Sciences) and GE laboratory requirement.

### 105 ELEMENTS OF GENERAL, ORGANIC, AND BIOCHEMISTRY (5) FALL

Lecture, 4 hours; laboratory, 3 hours. A survey of the principles of chemistry, with emphasis placed on the chemistry of living systems. The course is designed for students in pre-nursing and majors that do not require further courses in chemistry. This course is not a prerequisite for any other chemistry course. Satisfies GE, category B1 (Physical Science) and GE laboratory requirement.

### 107 INTRODUCTION TO PHYSICAL SCIENCE FOR TEACHERS (3) FALL, SPRING

Lecture, 3 hours. A non-mathematical course designed to introduce students to a range of topics in physics and chemistry that are required by the California Science Standards for grades K-8, including the laws of motion, energy, the structure of matter, the states of matter, electricity, magnetism, light, and optics. Lectures include many demonstrations to illustrate physical science principles, and students will be asked to think about how they would demonstrate or explain various concepts.

### 115AB GENERAL CHEMISTRY (5, 5) BOTH 115A AND 115B OFFERED FALL, SPRING

Lecture, 3 hours; lab lecture/recitation, 1 hour; laboratory, 3 hours. Principles of chemistry for students in science, pre-health and related areas of study. This course will introduce students to science and scientific thought by using problem-solving strategies in both a conceptual and mathematical manner. First semester topics include atomic and molecular structure, states of matter, chemical reactions, stoichiometry and thermodynamics. Second semester topics include kinetics, equilibrium, buffers, and electrochemistry. These courses must be taken sequentially. Prerequisite for 115A: Satisfaction of ELM requirement. Satisfies GE areas B1, B3 and laboratory requirement. CAN CHEM 2.

### 195 LOWER-DIVISION SPECIAL STUDIES (1-3)

May be repeated.

## Minor in Chemistry

Completion of the following SSU courses (or their equivalent): General Chemistry 115A and B (10 units), Quantitative Analysis 255 (4 units), Organic Chemistry: either 232 (5 units) or 335A (5 units), plus at least two additional upper-division classes for a total of 6 units. These additional upper-division classes must be taken in residence at SSU. Up to six units in chemistry 115A/B may count toward the general Education requirements in area B including the laboratory requirement.

## Secondary Education Teaching Credential Preparation

Chemistry students must demonstrate competence in the natural sciences by passing the subject matter examination required by the

**232 SURVEY OF ORGANIC CHEMISTRY (5) FALL**

Lecture, 3 hours; laboratory lecture, 1 hour; laboratory, 3 hours. An introduction to the important principles, compounds, and reactions of organic chemistry. Particular emphasis on compounds of biological significance. Laboratory includes an introduction to basic techniques of organic chemistry, with emphasis on their application to natural products. Designed for students who are not chemistry majors. Prerequisite: CHEM 115B or consent of instructor.

**255 QUANTITATIVE ANALYSIS (4) FALL**

Lecture, 2 hours; laboratory, 6 hours. Theory and practice of methods of analysis, including volumetric, gravimetric, and selected instrumental techniques. Prerequisite: CHEM 115B, CAN CHEM 12.

**310AB FUNDAMENTALS OF PHYSICAL CHEMISTRY (3, 3) A, FALL; B, SPRING**

Lecture, 3 hours. Development and applications of the concepts of thermodynamics, equilibrium, kinetics, quantum mechanics, and spectroscopy to chemical systems. Prerequisites: CHEM 255; MATH 211; PHYS 210AB or 214 and 216; or consent of instructor.

**316 FUNDAMENTALS OF PHYSICAL CHEMISTRY LABORATORY (2) SPRING**

Lecture, 1 hour; laboratory, 3 hours. Physicochemical measurements, with an emphasis on error analysis, instrumental techniques, report writing, and presentation. Prerequisites: CHEM 310A; concurrent enrollment in CHEM 310B.

**325 INORGANIC CHEMISTRY (3) SPRING**

Lecture, 3 hours. Topics include atomic structure, symmetry, and group theory of small molecules and the relationship of these concepts to bonding theory and molecular spectroscopy. Applications of symmetry and group theory to coordination chemistry of transition metal complexes in organometallic, environmental, bioinorganic, and materials chemistry. Other topics include kinetics and mechanisms of inorganic and organometallic reactions including electron transfer.

**335A ORGANIC CHEMISTRY (5) FALL, SPRING**

Lecture, 3 hours; laboratory lecture, 1 hour; laboratory, 3 hours. Basic course in the general theory and reactions of organic chemistry. Emphasis on basic principles. Recommended for science and pre-professional majors. Prerequisite: CHEM 115B or consent of instructor.

**335B ORGANIC CHEMISTRY II (3) FALL, SPRING**

Lecture, 3 hours. Continuation of CHEM 335A. Prerequisite: CHEM 335A.

**336 ORGANIC CHEMISTRY LABORATORY II (2) FALL, SPRING**

Laboratory lecture, 1 hour; laboratory, 3 hours. Fundamental techniques of organic chemistry, emphasizing synthetic organic chemistry, modern instrumental methods, and qualitative organic analysis. Designed to complement CHEM 335B. Prerequisite: CHEM 335A.

**397 CHEMISTRY PRACTICUM (1-6) FALL, SPRING**

Supervised chemistry work experiences that involve practical application of previously studied theory. Intended for professional growth and/or collection of data for future theoretical interpretation. Not applicable toward the chemistry major or minor. May be repeated for up to a total of 6 units. Two hours of work per week for each unit of credit. Cr/NC only. Prerequisite: junior standing or consent of instructor.

**401 INSTRUMENTAL ANALYSIS AND CHEMICAL SYNTHESIS (3) FALL**

Lecture, 1 hour; laboratory, 6 hours. An integrated inquiry and project-based upper-division course for B.S. and B.A. chemistry majors. Capstone course for B.A. chemistry degree. The projects will cover the synthesis of organic and inorganic molecules and characterization of student-prepared molecules. Lecture will focus on analysis of spectroscopic data, an overview of the instrumental hardware, and principles of chromatography. Topics include basic electronics, optics, signal to noise, detectors, IR, optical, NMR and fluorescence spectroscopy, mass spectrometry, and chromatography. Prerequisites: CHEM 255. Highly recommended: CHEM 336.

**402 ADVANCED SYNTHESIS AND INSTRUMENTAL ANALYSIS (3) SPRING**

Lecture, 1 hour; laboratory, 6 hours. Project-based synthesis, purification, and characterization of inorganic, organic, and organometallic molecules. Capstone course for B.S. chemistry degree. Topics will include air-sensitive syntheses, standard Schlenk line techniques, characterization through IR, optical and NMR spectroscopy, mass spectrometry, and electrochemistry. Prerequisite: CHEM 401. Highly recommended: CHEM 325.

**441 BIOCHEMICAL METHODS (3) SPRING**

Lecture, 1 hour; laboratory, 6 hours. Project-based laboratory course involving isolation, purification, and characterization of proteins from natural sources. Capstone course for BS biochemistry degree. The course provides an introduction to biochemical methods, instrumentation, and experimental design techniques common in biotechnology and research. Prerequisites: CHEM 445 or BIO 123, and a foundation in spectroscopy, kinetics, and thermodynamics, or consent of instructor. Strongly recommended: CHEM 255.

**445 STRUCTURAL BIOCHEMISTRY (3) FALL**

Lecture, 3 hour. A study of the structure: function relationships of amino acids, proteins and enzymes, carbohydrates, lipids, and nucleic acids. Also includes topics such as enzyme kinetics, membrane transport, and signaling. Prerequisites: CHEM 335B or CHEM 232 and a foundation in spectroscopy, kinetics, and thermodynamics, or consent of instructor.

**446 METABOLIC CHEMISTRY (3) SPRING**

Lecture, 3 hours. A study of bioenergetics and metabolism of carbohydrates, lipids, and proteins. Includes a brief review of enzyme kinetics. Prerequisites: CHEM 335B or CHEM 232, CHEM 445 or BIOL 123, and a foundation in spectroscopy, kinetics, and thermodynamics, or consent of instructor.

**494 UNDERGRADUATE RESEARCH (1-6) FALL, SPRING**

Individual investigation of either student- or faculty-initiated experimental or theoretical chemical problems under the supervision of a member of the chemistry faculty. May be repeated. Prerequisites: CHEM 335B; previous or concurrent enrollment in CHEM 310B; or consent of instructor.

**495 SPECIAL STUDIES (1-3) FALL, SPRING**

Investigation of existing information in the chemical literature on a specific or general topic of interest to the student. May be repeated. Prerequisite: consent of instructor; upper-division standing in chemistry or closely related science.

**496 SELECTED TOPICS IN CHEMISTRY (1-3)**

A study of an advanced topic in chemistry. May be repeated for credit with new subject matter.

**497 RESEARCH SEMINAR (1) SPRING**

Laboratory, 3 hours. The course will focus on techniques involved in the preparation and delivery of technical seminars. The final project will be a formal oral presentation to the chemistry department on a research paper from the chemical literature or the student's undergraduate research project. Instruction includes the appropriate coverage of the selected topic, use of the chemical literature, and the preparation and use of PowerPoint, graphic, and Web-based applications to create an informative talk. Prerequisites: Senior standing or consent of instructor.

**499 INTERNSHIP (1-4) FALL, SPRING**

Chemistry field experience in industrial, hospital, or similar laboratory settings. Enrollment by prior arrangement with supervising faculty member and community sponsor. Please see department advisor for details. Three hours of work per week for each unit of credit. Internship assignments may be paid. Cr/NC only. May be repeated.