

# Chemistry

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Chemistry. It's the core science: the study of the properties, composition and changes that occur in matter. When you study chemistry, you analyze issues that influence every aspect of life on Earth.

Whether you choose the bachelor of science degree (for those targeting careers in industry or planning to pursue a graduate degree) or the bachelor of arts degree (appropriate for those seeking work in medicine, dentistry or secondary school teaching), Cal Lutheran's chemistry curriculum provides the knowledge base required of the discipline.

Because of the program's strong emphasis on laboratory experience, our advanced chemistry students are taught how to design and carry out their own experiments and encouraged to work on independent research projects. They also have the opportunity to do supported research with faculty members during the summer. Many students have been accepted to summer research programs at Ph.D.-granting institutions.

The department possesses modern instruments which students use regularly in their classes and research projects. These include:

- Fourier transform infrared and nuclear magnetic resonance spectrometers
- gas (GC) and high performance liquid chromatographs (HPLC) with several types of detectors
  - mass spectrometer
  - electron capture
  - flame ionization
  - inert atmosphere glovebox and solvent purification system
- rapid-scan UV-vis spectrometer

Cal Lutheran chemistry students are encouraged to pursue internships and REU programs during the course of their studies. Recent Cal Lutheran students have interned at Ventura County Crime Lab, Amgen and Rockwell Science Center, and have attended REU programs at Colorado State, SUNY Stonybrook, Cornell, and UCLA.

These undergraduate research opportunities translate into success for Cal Lutheran's chemistry graduates, who have been accepted into many of the nation's most respected medical, dental, and graduate programs including:

- University of California at
  - San Diego
  - Irvine
  - Santa Barbara
  - Davis
  - Berkeley
  - Los Angeles
- Yale University
- Indiana University
- University of Ohio
- University of Illinois at Urbana-Champaign
- University of Rochester
- University of Wisconsin at Madison
- The Scripps Research Institute
- Emory University

## Bachelor of Arts in Chemistry

32 credits minimum, 20 credits upper division

CHEM 151	General Chemistry	4
CHEM 151L	General Chemistry Lab	1
CHEM 152	General Chemistry II	4
CHEM 152L	General Chemistry II Lab	1
CHEM 305/305L	Quantitative Analysis and Quantitative Analysis Lab	4
CHEM 331	Organic Chemistry	4
CHEM 332	Organic Chemistry II	4
CHEM 341	Organic Chemistry Lab	1

CHEM 342	Organic Chemistry II Lab	1
CHEM 485	Capstone Seminar	2
Chemistry Elective Credits (at least 4 Upper Division)		6
Total Hours		32

### Required Supporting Courses

Select one of the following:		8-10
PHYS 201/201L/202/202L	Mechanics and Thermodynamics-Algebra and Mechanics and Thermodynamics- Lab and Electricity, Magnetism, Optics -Algebra and Electricity, Magnetism, Optics - Lab	
PHYS 211/211L/212/212L	Mechanics and Thermodynamics-Calculus and Mechanics and Thermodynamics-Lab and Electricity, Magnetism, and Optics - and Electricity, Magnetism Optics Lab	
MATH 251	Calculus I	4
Total Hours		12-14

### Recommended

MATH 252	Calculus II	4
Total Hours		4

### Bachelor of Science in Chemistry

40 Credits minimum, 28 credits upper division

CHEM 151	General Chemistry	4
CHEM 151L	General Chemistry Lab	1
CHEM 152	General Chemistry II	4
CHEM 152L	General Chemistry II Lab	1
CHEM 305/305L	Quantitative Analysis and Quantitative Analysis Lab	4
CHEM 306/306L	Chemical Instrumentation and Chemical Instrumentation Lab	4
CHEM 331	Organic Chemistry	4
CHEM 332	Organic Chemistry II	4
CHEM 341	Organic Chemistry Lab	1
CHEM 342	Organic Chemistry II Lab	1
CHEM 405/405L	Physical Chemistry and Physical Chemistry Lab	4
CHEM 406/406L	Physical Chemistry and Physical Chemistry Lab	4
CHEM 485	Capstone Seminar	2
Chemistry Elective Credits		2
Total Hours		40

### Required Supporting Courses

MATH 251	Calculus I	4
MATH 252	Calculus II	4
Select one of the following:		8-10
PHYS 201/201L/202/202L	Mechanics and Thermodynamics-Algebra and Mechanics and Thermodynamics- Lab and Electricity, Magnetism, Optics -Algebra and Electricity, Magnetism, Optics - Lab	
PHYS 211/211L/212/212L	Mechanics and Thermodynamics-Calculus and Mechanics and Thermodynamics-Lab and Electricity, Magnetism, and Optics - and Electricity, Magnetism Optics Lab	
Total Hours		16-18

### Recommended

CHEM 411	Advanced Inorganic Chemistry	3
MATH 261	Calculus III	4
MATH 265	Differential Equations	4
Total Hours		11

## Minor in Chemistry

CHEM 151	General Chemistry	4
CHEM 151L	General Chemistry Lab	1
CHEM 152	General Chemistry II	4
CHEM 152L	General Chemistry II Lab	1
Select three courses from chemistry <sup>1</sup>		12
Total Hours		22

<sup>1</sup> Taken in at least two areas of chemistry (200 level or above). CHEM 425 cannot be used to fulfill the minor if it is also being used to fulfill a major requirement.

## Courses

### Lower Division

#### **CHEM 111. Chemistry and the Environment. (4).**

Explores the interface between chemistry and the world we live in, with particular emphasis on environmental issues such as pollution, energy depletion and global warming. The chemical principles required to understand these topics are introduced on an as-needed basis. This course is primarily intended for non-science majors and cannot be used for credit toward a chemistry degree. Lecture, 3 hours/week; Laboratory, 3 hours/week.

#### **CHEM 111L. Chemistry and the Environment Lab. (0).**

#### **CHEM 151. General Chemistry. (4).**

Covers the fundamental theories, principles and laws of chemistry, plus the properties of elements and compounds. Prerequisites: high school chemistry and a math SAT score of 540 or better or completion of MATH 110. Corequisite in Chemistry 151L.

#### **CHEM 151L. General Chemistry Lab. (1).**

Covers the laboratory techniques and apparatuses of chemistry, plus the illustrations of quantitative relationships in chemistry. Includes a systematic course in theory and techniques of inorganic qualitative analysis. Corequisite: CHEM 151.

#### **CHEM 151S. Supplemental Inst: CHEM 151. (0).**

This is the Supplemental Instruction Blackboard Platform attached to CHEM 151. As a student enrolled in this section, you are automatically enrolled in the attached Supplemental Instruction Blackboard Platform. Supplemental Instruction (SI) is an academic support program designed to improve student success in challenging foundation courses. SI is a well-researched program that has been shown to improve students' letter grades by a half to a full grade, with consistent participation. With the SI model, a SI Leader (a student who has successfully completed the course with a B+ or better in the past, and who has an overall GPA of 3.0 or higher) is embedded into the course, attending all course meetings. The SI Leader then facilitates the scheduling and running of group SI study sessions throughout the week. There will typically be three one hour SI Sessions or two 90 minute SI Sessions per week. The SI Blackboard Platform is hosted by your SI Leader, who will utilize it to take confidential attendance at SI Sessions, to make general announcements to the class members, and to share helpful resources and study materials for SI Sessions. Participation in the SI study sessions is completely optional and always free, and you may come to as many or as few sessions as you would like over the semester. Your course professor does not receive any information about attendance, so you can be certain that your participation will be kept confidential.

#### **CHEM 152. General Chemistry II. (4).**

Covers the fundamental theories, principles and laws of chemistry, plus the properties of elements and compounds. Prerequisites: CHEM 151: high school chemistry and a math SAT score of 510 or better or completion of MATH 110. Corequisite: CHEM 152L.

#### **CHEM 152L. General Chemistry II Lab. (1).**

Covers the laboratory techniques and apparatuses of chemistry, plus the illustrations of quantitative relationships in chemistry. Includes a systematic course in theory and techniques of inorganic qualitative analysis. Corequisite: CHEM 152.

#### **CHEM 152S. Supplemental Instr: Chem 152S. (0).**

This is the Supplemental Instruction Blackboard Platform attached to CHEM 152. As a student enrolled in this section, you are automatically enrolled in the attached Supplemental Instruction Blackboard Platform. Supplemental Instruction (SI) is an academic support program designed to improve student success in challenging foundation courses. SI is a well-researched program that has been shown to improve students' letter grades by a half to a full grade, with consistent participation. With the SI model, a SI Leader (a student who has successfully completed the course with a B+ or better in the past, and who has an overall GPA of 3.0 or higher) is embedded into the course, attending all course meetings. The SI Leader then facilitates the scheduling and running of group SI study sessions throughout the week. There will typically be three one hour SI Sessions or two 90 minute SI Sessions per week. The SI Blackboard Platform is hosted by your SI Leader, who will utilize it to take confidential attendance at SI Sessions, to make general announcements to the class members, and to share helpful resources and study materials for SI Sessions. Participation in the SI study sessions is completely optional and always free, and you may come to as many or as few sessions as you would like over the semester. Your course professor does not receive any information about attendance, so you can be certain that your participation will be kept confidential.

#### **CHEM 282C. ST: Select Topic (core). (1-4).**

Select Topic approved for core requirement.

## Upper Division

### **CHEM 301. Environmental Chemistry. (4).**

In this course, principles of chemistry will be applied to environmental problems including water, air and soil chemistry and toxicology. Lecture, 3 hours/week; Lab, 3 hours/week. Prerequisite: Chem 201.

### **CHEM 305. Quantitative Analysis. (4).**

Covers the principles and techniques of gravimetric and volumetric analysis. Lecture, 3 hours/week; Laboratory, 3 hours/week.

### **CHEM 305L. Quantitative Analysis Lab. (0).**

### **CHEM 306. Chemical Instrumentation. (4).**

Covers the theories and application of instrumentation in chemistry. Lecture, 2 hours/week; Laboratory, 6 hours/week. Prerequisite: CHEM 305.

### **CHEM 306L. Chemical Instrumentation Lab. (0).**

### **CHEM 331. Organic Chemistry. (4).**

Covers the structure, nomenclature, reactions and synthesis of organic compounds, plus the theory and mechanism of organic reactions. Lecture, 4 hours/week.

### **CHEM 331S. Supplemental Inst: Chem 331. (0).**

This is the Supplemental Instruction Blackboard Platform attached to CHEM 331. As a student enrolled in this section, you are automatically enrolled in the attached Supplemental Instruction Blackboard Platform. Supplemental Instruction (SI) is an academic support program designed to improve student success in challenging foundation courses. SI is a well-researched program that has been shown to improve students' letter grades by a half to a full grade, with consistent participation. With the SI model, a SI Leader (a student who has successfully completed the course with a B+ or better in the past, and who has an overall GPA of 3.0 or higher) is embedded into the course, attending all course meetings. The SI Leader then facilitates the scheduling and running of group SI study sessions throughout the week. There will typically be three one hour SI Sessions or two 90 minute SI Sessions per week. The SI Blackboard Platform is hosted by your SI Leader, who will utilize it to take confidential attendance at SI Sessions, to make general announcements to the class members, and to share helpful resources and study materials for SI Sessions. Participation in the SI study sessions is completely optional and always free, and you may come to as many or as few sessions as you would like over the semester. Your course professor does not receive any information about attendance, so you can be certain that your participation will be kept confidential.

### **CHEM 332. Organic Chemistry II. (4).**

Covers the structure, nomenclature, reactions and synthesis of organic compounds, plus the theory and mechanism of organic reactions. Lecture, 4 hours/week. Prerequisite CHEM 331.

### **CHEM 332S. Supplemental Instr: Chem-332s. (0).**

This is the Supplemental Instruction Blackboard Platform attached to CHEM 332. As a student enrolled in this section, you are automatically enrolled in the attached Supplemental Instruction Blackboard Platform. Supplemental Instruction (SI) is an academic support program designed to improve student success in challenging foundation courses. SI is a well-researched program that has been shown to improve students' letter grades by a half to a full grade, with consistent participation. With the SI model, a SI Leader (a student who has successfully completed the course with a B+ or better in the past, and who has an overall GPA of 3.0 or higher) is embedded into the course, attending all course meetings. The SI Leader then facilitates the scheduling and running of group SI study sessions throughout the week. There will typically be three one hour SI Sessions or two 90 minute SI Sessions per week. The SI Blackboard Platform is hosted by your SI Leader, who will utilize it to take confidential attendance at SI Sessions, to make general announcements to the class members, and to share helpful resources and study materials for SI Sessions. Participation in the SI study sessions is completely optional and always free, and you may come to as many or as few sessions as you would like over the semester. Your course professor does not receive any information about attendance, so you can be certain that your participation will be kept confidential.

### **CHEM 341. Organic Chemistry Lab. (1).**

Laboratory work in isolation, characterization and synthesis of organic compounds. Laboratory, 3 hours/week. Corequisite: CHEM 331.

### **CHEM 342. Organic Chemistry II Lab. (1).**

Laboratory work in isolation, characterization and synthesis of organic compounds. Laboratory, 3 hours/week. Corequisite: CHEM 332.

### **CHEM 405. Physical Chemistry. (4).**

The study of kinetic theory, structure of condensed phases, thermodynamics, equilibria, electrochemistry, quantum chemistry and chemical kinetics. Lecture, 3 hours/week; Laboratory, 3 hours/week. Prerequisites: one year each of calculus and physics or consent of instructor.

### **CHEM 405L. Physical Chemistry Lab. (0).**

### **CHEM 406. Physical Chemistry. (4).**

The study of kinetic theory, structure of condensed phases, thermodynamics, equilibria, electrochemistry, quantum chemistry and chemical kinetics. Lecture, 3 hours/week; Laboratory, 3 hours/week. Prerequisites: one year each of calculus and physics or consent of instructor.

### **CHEM 406L. Physical Chemistry Lab. (0).**

### **CHEM 411. Advanced Inorganic Chemistry. (3).**

The advanced treatment of special topics in inorganic chemistry, including atomic structure, classification of elements and inorganic reactions in aqueous and non-aqueous solutions. Lecture, 3 hours/week. Prerequisite: consent of instructor. (on demand).

**CHEM 412. Advanced Organic Chemistry. (3).**

Further study in organic chemistry, emphasizing synthesis, reaction mechanisms and stereoisomerism. Lecture, 3 hours/week. Prerequisite: CHEM 332 or consent of instructor. (on demand).

**CHEM 425. Biochemistry. (4).**

The structure and function of proteins is covered, along with the structure, function, and metabolism of carbohydrates, lipids, and amino acids. Regulation of proteins and metabolism is emphasized. Lecture, 3 hours; Laboratory, 3 hours/week. Prerequisites: CHEM 331 and CHEM 332. Recommended: BIOL 122 and BIOL 124L. (cross-listed with BIOL 425).

**CHEM 425L. Biochemistry Lab. (0).**

Prerequisite: Concurrent enrollment in BIOL 425 / CHEM 425. (cross-listed with BIOL 425L).

**CHEM 482. Selected Topics. (1-4).****CHEM 482C. ST: Select Topic (CORE). (1-4).**

Select Topic approved for core.

**CHEM 485. Capstone Seminar. (2).**

Introduces students to the skills and practices required of professional scientists. Students will gain experience with conducting literature searches, conducting and presenting scientific work, reviewing the work of others and writing research proposals. Prerequisite: senior standing.

**CHEM 490. Independent Study. (1-4).****CHEM 492. Internship. (1-4).****CHEM 496. Directed Research. (1-3).**