

Faculty

Russell H. Batt
Professor Emeritus

Scott D. Cummings
Associate Professor

Simon P. Garcia
Assistant Professor

Yutan D.Y.L. Getzler
Assistant Professor

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Assistant Professor

John E. Hofferberth
Assistant Professor

Kristin Hofferberth
Visiting Instructor

Mo Hunsen
Assistant Professor (on leave)

Gordon L. Johnson
Professor Emeritus

James S. Keller
Chair, Associate Professor

John K. Lutton
Professor

Dudley G. Thomas
Director of Chemistry Labs

Owen York Jr.
Professor Emeritus

Chemistry is often called the “central science,” overlapping significantly with biology, physics, psychology, mathematics, geology, and engineering. All studies of matter at the molecular level (for example, biochemistry, molecular biology, pharmacology, neuroscience, nanoscience, computational chemistry, solid-state physics, geochemistry, the environmental sciences, and material science and engineering) depend on the theories and methodologies of chemistry.

New Students

Introductory courses are designed to respond to students’ particular backgrounds and interests. Look for the ♦ symbol, which designates those courses particularly appropriate for first-year or upperclass students new to the chemistry curriculum.

The Chemistry Curriculum

The chemistry curriculum begins with vertical series of courses covering introductory chemistry and organic chemistry in the first two years, then branches out to advanced topics in physical, inorganic, and analytical chemistry and biochemistry. Because of this vertical structure, we advise students to begin their study of chemistry as soon as possible in order to build upon their secondary-school preparation in math and science, the roots of college chemistry. Students who are considering a chemistry, biochemistry, or molecular biology major or who are planning to complete premedicine requirements should plan to take a full year of introductory lecture and lab courses (see below) in their first year.

The first semester of introductory chemistry is offered at two levels. CHEM 121 is a lecture-and-discussion course intended for students needing a thorough introduction to the fundamental concepts, theories, and methodologies of chemistry; enrollment priority is given to first- and second-year students. CHEM 122 is a lecture-and-discussion course designed for a select group of first-year students who would like to build upon a strong secondary-school preparation in chemistry and math. These two courses meet at the same time. CHEM 123 is the accompanying lab course, highly recommended for students in CHEM 121 and required for students in CHEM 122. First-year students enrolling in any introductory chemistry course must complete the chemistry readiness test and survey during orientation.

Students who have successfully completed either CHEM 121 or CHEM 122 can then choose a second-semester lecture-and-discussion course based on their particular interests. CHEM 124 continues the investigation of chemical principles as they apply to issues in biochemistry and molecular medicine, while CHEM 125 explores many of the same principles as they relate to nanoscience and materials chemistry. These two courses meet at the same time. CHEM 126 is the accompanying lab course.

Completion of a full-year sequence of introductory chemistry lecture and lab courses (1.5 units) is a prerequisite for enrolling in organic chemistry or any other advanced chemistry courses and will satisfy medical-school requirements for a course in general chemistry. Transfer students and those with advanced-placement credit or exceptionally strong secondary-school preparation in chemistry may be invited by the department, after completing the chemistry readiness test and survey, to begin their studies in organic chemistry.

The department also offers several courses designed for students who are not planning to continue beyond one or two semesters of study. These “non-majors” courses, which are numbered below 120 and have no prerequisites, serve various purposes. CHEM 109 is a required core course for the neuroscience concentration, and CHEM 108 or CHEM 110 is a required core course for the environmental studies concentration. Students wanting to complete the College requirements for 1 unit in the natural sciences can take any two of these, and CHEM 108 satisfies the college quantitative reasoning (QR) requirement. Non-majors courses do not serve as a prerequisite for any higher-numbered courses in the department.

The chemistry major is rounded out with an offering of courses and labs on the major subdisciplines of the field, along with seminar-style special topics courses. A capstone

Chemistry Research Seminar for seniors in the fall semester guides students through a self-study of an individual research topic, and the Senior Exercise in the spring semester involves preparing and presenting a thirty-minute talk on two research papers on the senior research topic. Opportunities to work on independent research projects are available at all levels of the curriculum.

Chemistry majors are well-prepared for professional employment or graduate study in chemistry, biochemistry, and related fields; the health sciences such as medicine, dentistry, and nursing; the veterinary sciences; secondary-school teaching; engineering; the environmental sciences; business and the law; and public service. The major emphasizes the development of independent, critical thinking as well as problem solving and communication skills. Our department is accredited by the American Chemical Society (ACS), and students may elect to receive a degree certified by the ACS (see below).

Numerous opportunities exist for students to participate in the life of the department through (1) participation in research with faculty members, (2) participation in social and outreach activities, (3) advising the department in the hiring and evaluation of faculty members and other matters, and (4) employment as stockroom assistants, laboratory proctors, paper graders, and tutors.

Requirements for the Major

The minimum requirement for a chemistry major is 6 units of credit in the department, including the following:

- One year of introductory chemistry lecture with lab (1.5 units):
 - CHEM 121 or 122, with CHEM 123
 - CHEM 124 or 125, with CHEM 126
- One year of organic chemistry with lab (1.5 units):
 - CHEM 231 with CHEM 233

- CHEM 232 with CHEM 234
- Four advanced courses (2 units):
 - CHEM 335
 - CHEM 341
 - CHEM 336 or 343
 - an additional 0.5 units at the 300-400 level
- Three advanced labs (0.75 units) from CHEM 371, 372, 373 and 374
 - 0.5 units of CHEM 375 and/or 376 may replace one advanced lab (0.25 units)
- CHEM 475 Chemistry Research Seminar (0.25 units) and the Senior Exercise

In addition, a year of introductory physics lecture (PHYS 130, 135 or 140, 145) with lab (PHYS 141, 146) —1.5 units total—is required, and Calculus B (MATH 112) is highly recommended. Those students planning to do graduate work in chemistry or related areas should take additional advanced courses in chemistry and the Natural Sciences Division and partake in research opportunities during the school year and summer. For a degree to be certified by the American Chemical Society, a student must complete the minimum chemistry major plus CHEM 256 and 1.0 credit of research in CHEM 375 and/or 376.

The chemistry and biology departments offer interdisciplinary majors in biochemistry and molecular biology. Refer to the biochemistry and molecular biology section in this catalogue for descriptions and course requirements.

Senior Exercise

During the spring semester, senior chemistry majors must prepare and present a thirty-minute talk on two research papers relating to their senior research topic. See the department chair and Web site for more information.

Honors

Departmental honors in chemistry involves demonstrating excellence in both **depth** and **breadth** of the discipline, through accomplishments on a specific research project and achievement in studying the principal areas of chemistry knowledge. Students wishing to pursue senior honors research in chemistry should apply to the chemistry department chair no later than April 15 of the spring semester of their junior year. See department chair and Web site for more information.

First-Semester Courses

Neurochemistry

CHEM 109 (0.5 unit)
Lutton

This course offers a description of the nervous system's structure and function in terms of molecular processes. Topics are developed through lectures, discussions, student presentations, class demonstrations, and computer molecular modeling. The course begins with a brief introduction to general and organic chemistry, then continues with neurocellular anatomy and the biochemistry of cell neurotransmitters and receptors and the biochemistry of psychoactive drugs and neurological disorders. This course is a required core course for the neuroscience concentration, and with CHEM 108 fulfills the science distribution requirement. No prerequisites. Enrollment limited.

Introductory Chemistry

CHEM 121 (0.5 unit)
Keller

This course provides a thorough introduction to the fundamental concepts, theories, and methodologies of chemistry. Topics may include stoichiometry, theories of molecular structure and bonding, the periodic table, acid-base chemistry, chemical equilibria, and thermodynamics. This course provides a basis for the further study of chemistry. The format is lecture and discussion. Prerequisites: for

first-year students, chemistry readiness test and survey; none for other students. Enrollment limited.

Honors Introductory Chemistry

CHEM 122 (0.5 unit)
Garcia

This lecture-discussion course is designed to build upon your previous study of chemistry. Chemical stoichiometry, atomic theory, and principles of molecular structure and bonding are reviewed, and acid-base chemistry, chemical equilibria, and thermodynamics are covered in more depth. Additional advanced topics and applications are included. Prerequisites: chemistry readiness test and survey. The department will recommend placement into this course, which is open only to first-year students. (All other students begin with CHEM 121.) Corequisite: CHEM 123. Enrollment limited.

Introductory Chemistry Lab

CHEM 123 (0.25 unit)
Hemkin, Garcia, Thomas

This laboratory course accompanies CHEM 121 and 122 with an introduction to modern experimental chemistry. Laboratory experiments explore inorganic synthesis, molecular structure and properties, and spectroscopy, with an emphasis on laboratory safety, computerized data acquisition and analysis, and the theory of analytical instrumentation. The laboratory work is organized around individual and team projects. Communication skills are developed through written laboratory reports and the proper use of a laboratory notebook. One three-hour laboratory is held per week. Corequisite: CHEM 121 or 122. Enrollment priority is given to first and second-year students; juniors and seniors can enroll in remaining seats during the first week of classes.

Organic Chemistry I

CHEM 231 (0.5 unit)
Hofferberth

This lecture course offers a study of the chemical and physical properties of organic compounds. Theoretical principles are developed with particu-

lar emphasis on molecular structure and reaction mechanisms. The descriptive aspects of organic chemistry include strategies for synthesis and the study of compounds of biochemical interest. Prerequisites: CHEM 126 (or 114 or 118), or permission of department chair. Enrollment is limited and requires a grade of C+ or higher in CHEM 121 or CHEM 122.

Organic Chemistry Lab I

CHEM 233 (0.25 unit)
Hofferberth, Staff

This laboratory course introduces fundamental methods of purification such as extraction, distillation, recrystallization, and column chromatography. Experiments include the isolation of a natural product, oxidation and reduction reactions, a Grignard reaction, an SN2 reaction, and a Diels-Alder reaction. Compounds are identified and assessed for purity by melting point determination, refractometry, gas chromatography, infrared spectroscopy, and proton nuclear magnetic resonance. Corequisite: CHEM 231.

Chemical Kinetics and Thermodynamics

CHEM 335 (0.5 unit)
Hemkin

This course presents a study of chemical kinetics and chemical thermodynamics. Specific topics include rate laws and reaction mechanisms, reaction-rate theories, the laws of thermodynamics, thermochemistry, properties of solutions, and equilibrium. Applications will be drawn from organic, inorganic, and biochemistry. Prerequisites: CHEM 126. MATH 112 is highly recommended.

Instrumental Analysis

CHEM 341 (0.5 unit)
Garcia

This course serves as an introduction to modern instrumental techniques available to the chemist for quantitative and qualitative analysis of organic and inorganic samples. Emphasis will be placed on theory and instrumental design for spectroscopic (UV-Vis, luminescence, IR, NMR, MS), electrochemical (ion-selective electrodes, voltammetry), and chro-

matographic (GC, HPLC) methods. Prerequisite: CHEM 234 or permission of instructor.

Advanced Lab—Biochemistry

CHEM 371 (0.25 unit)
Lutton

Students will be introduced to the theory and application of modern biochemical techniques. Experiments will emphasize amino acid, carbohydrate, and lipid chemistry; protein isolation and characterization; enzyme kinetics and mechanisms; and membrane biochemistry. The course meets for two three-hour laboratory periods per week. Prerequisite or corequisite: CHEM 256. Enrollment limited.

Advanced Lab—Inorganic

CHEM 372 (0.25 unit)
Cummings

In this laboratory course, students will engage in projects that integrate inorganic synthesis, analytical instrumentation, and physical measurement, focusing on coordination complexes. The course meets for one three-hour laboratory period per week. Prerequisite: CHEM 234 or permission of instructor.

Chemical Research

CHEM 375 (0.25 unit)
Cummings

Section 01 (.25 unit). This section is open to first-year and sophomore students only. Students engage in independent research under the direction of a faculty mentor. The time requirement is at least three hours in lab per week. Students will learn to search the literature and give professional presentations. This course also provides an introduction to scientific writing. More details can be obtained from the department chair. Prerequisite: permission of instructor.

Section 02 (.5 unit). This section is open to all students and is a prerequisite to Chemistry 497-498 (Senior Honors). The time commitment is six to eight hours per week in lab (instructor-dependent). Students will learn to search the literature and give professional scientific presentations as well as to write scientifically.

More details can be obtained from the department chair. Prerequisite: permission of instructor.

Chemistry and Biochemistry Seminar I

CHEM 401 (0.5 unit)
Cummings

This seminar course covers selected topics in advanced chemistry and biochemistry, with an emphasis on reading and discussing current scientific research and literature. Topics vary by semester, but may include structural biochemistry, computational chemistry, photochemistry, biophysical chemistry, spectroscopy, or organometallic chemistry. Prerequisite: permission of instructor.

Chemistry Research Seminar

CHEM 475 (0.25 unit)
Hemkin

This is a required course for all chemistry majors, including those involved in independent research. The course covers topics relating to chemistry research. Weekly meetings will involve (1) searching chemistry literature, (2) analyzing primary research articles, and (3) discussing ethics, trends, funding, and other issues relating to chemistry research. During the semester, students will give written and oral presentations of primary research articles. Prerequisite: senior standing.

Individual Study

CHEM 493 (0.25 unit)
Staff

This course provides the student with an opportunity for independent investigation of a topic not covered in the curriculum or a topic related to a faculty member's research. Prerequisite: permission of department chair.

Senior Honors

CHEM 497 (0.5 unit)
Keller

The emphasis is on independent research in collaboration with a faculty mentor, culminating with a thesis that is defended orally to an outside examiner. Prerequisites: GPA of at least 3.2, enrollment in Section 02 of CHEM 375 or CHEM 376, and permission of department chair. See department chair or Web site for full description.

Second-Semester Courses

Solar Energy

CHEM 108 (0.5 unit)
Cummings

Many scientists believe that the world will soon run out of cheap oil, resulting in profound changes in the way our society functions. This course will explore the chemistry behind fossil fuels and potential solar-energy alternatives, ranging from hydrogen fuel cells to solar panels. Chemical principles such as reaction stoichiometry, molecular structure, thermochemistry, catalysis, energy quantization, and electrochemistry will be learned in the context of investigating solar radiation, greenhouse gases, photovoltaics, artificial photosynthesis, fuel cells, and the production and storage of hydrogen. This course or CHEM 110 is a required core course for the environmental studies concentration; this course plus either CHEM 109 or CHEM 110 fulfills the 1 unit natural science distribution requirement. No prerequisites.

Biophysical and Medicinal Chemistry

CHEM 124 (0.5 unit)
Hofferberth

This lecture-discussion course is one of two paths to continue the introductory chemistry sequence started in CHEM 121 or 122. Chemical principles of molecular structure and bonding, reactivity, kinetics, and intermolecular forces will be explored in the context of biomolecules and molecular approaches to medicine. Prerequisite: CHEM 121 or 122.

Nanoscience and Materials Chemistry

CHEM 125 (0.5 unit)
Cummings

This lecture-discussion course is one of two paths to continue the introductory chemistry sequence started in CHEM 121 or 122. Chemical principles of molecular structure and bonding, reactivity, electrochemistry, kinetics, and intermolecular forces will be explored in the context of nanoscience and materials chemistry. Prerequisite: CHEM 121 or 122.

Biophysical and Medicinal Chemistry Lab

CHEM 126 (0.25 unit)
Garcia, Lutton

This lab is an experimental course to accompany CHEM 124. One three-hour laboratory session will be held per week. Prerequisite: CHEM 123. Corequisite: CHEM 124 or 125. Enrollment limited. Juniors and seniors may enroll with permission of department chair.

Nanoscience Lab

CHEM 126 (0.25 unit)
Garcia

This lab is an experimental course to accompany CHEM 125. One three-hour laboratory session will be held per week. Prerequisite: CHEM 123. Corequisite: CHEM 124 or 125. Enrollment limited. Juniors and seniors may enroll with permission of department chair.

Organic Chemistry II

CHEM 232 (0.5 unit)
Hofferberth

This course is a continuation of CHEM 231. This lecture course offers a study of the chemical and physical properties of organic compounds. Theoretical principles are developed with particular emphasis on molecular structure and reaction mechanisms. The descriptive aspects of organic chemistry include strategies for synthesis and the study of compounds of biochemical interest. Prerequisite: CHEM 231.

Organic Chemistry Lab II

CHEM 234 (0.25 unit)
Getzler, Staff

This laboratory course focuses on the chemistry of dienes, carbonyl compounds, and aromatic compounds, and carbohydrates. New techniques and instrumentation include thin-layer chromatography, Fourier transform nuclear magnetic resonance spectroscopy, and ¹³C magnetic resonance. The focus of the semester is a seven-step convergent synthesis to be conducted in a research-like manner.

Biochemistry

CHEM 256 (0.5 unit)

Lutton

This course is a study of the structure and function of biologically important compounds. Topics include proteins, enzymes, intermediary metabolism, and electron transport with emphasis on thermodynamic and kinetic analysis of biochemical systems. Prerequisite or corequisite: CHEM 231 and 232. Enrollment limited.

Quantum Chemistry

CHEM 336 (0.5 unit)

Keller

This course presents a study of quantum mechanics as applied to chemistry. Specific topics include general quantum theory; the time-independent Schrodinger equation applied to electronic, vibrational, and rotational energy states; valence bond and molecular orbital theory; and molecular symmetry. Prerequisites: CHEM 114, 118, or 126. Corequisite: one year of physics. Two semesters of calculus are recommended.

Advanced Lab—Spectroscopy

CHEM 374 (0.25 unit)

Keller

This advanced laboratory course focuses on spectroscopy instrumentation and data analysis. UV-vis, fluorescence, and laser spectroscopies are used to solve research questions involving kinetics, thermodynamics, and molecular structure. Experiments are intended to complement course work in Instrumental Analysis (CHEM 341), Chemical Kinetics and Thermodynamics (CHEM 335), and Quantum Chemistry (CHEM 336), but these courses may be taken in any order. This course meets for one three-hour laboratory period per week. Prerequisite: CHEM 234.

Chemical Research

CHEM 376 (0.25 unit)

Keller

Section 01 (.25 unit). This section is open to first-year and sophomore students only. Students engage in independent research under the direction of a faculty mentor. The time

requirement is at least three hours in lab per week. Students will learn to search the literature and give professional presentations. This course also provides an introduction to scientific writing. More details can be obtained from the department chair. Prerequisite: permission of instructor.

Section 02 (.5 unit). This section is open to all students and is a prerequisite to Chemistry 497-498 (Senior Honors). The time commitment is six to eight hours per week in lab (instructor-dependent). Students will learn to search the literature and give professional scientific presentations as well as to write scientifically. More details can be obtained from the department chair. Prerequisite: permission of instructor.

Special Topic: Advanced Lab—Computation

CHEM 392 (0.25 unit)

Hemkin

This advanced laboratory course focuses on computational chemistry methods and experiments. This course meets for one three-hour laboratory period per week. Prerequisite: CHEM 234.

Individual Study

CHEM 494 (0.25 unit)

Staff

This course provides the student with an opportunity for independent investigation of a topic not covered in the curriculum or a topic related to a faculty member's research. Prerequisite: permission of department chair.

Senior Honors

CHEM 498 (0.5 unit)

Keller

The emphasis is on independent research in collaboration with a faculty mentor, culminating with a thesis that is defended orally to an outside examiner. Prerequisites: GPA of at least 3.2, enrollment in Section 02 of CHEM 375 or CHEM 376, and permission of department chair. See department chair or Web site for full description.