Chemistry

Richard D. Broene, *Department Chair*
Jocelyn M. Lloyd, *Department Coordinator*

Professors: Richard D. Broene, Ronald L. Christensen, Jeffrey K. Nagle, Elizabeth A. Stemmler
Associate Professors: Dharni Vasudevan (Environmental Studies)
Assistant Professors: Danielle H. Dube (Biochemistry), Laura F. Voss
Visiting Faculty: Michael P. Danahy, Jennifer R. Krumper
Laboratory Instructors: Rene L. Bernier, Martha B. Black, Beverly G. DeCoster, Judith C. Foster, Colleen T. McKenna, Paulette M. Messier

Requirements for the Major in Chemistry

The required courses are **Chemistry 109**, **210**, **225**, **240**, **251**, **252**, and **205** or **226**; and any two upper-level electives, including **Chemistry 232** and courses at the 300 level or above. Students who have completed a rigorous secondary school chemistry course should begin with **Chemistry 109**. **Chemistry 101** is a course intended for students who have had limited preparation for college chemistry. First-year students must take the chemistry placement exam to ensure proper placement in **101**, **109**, or higher. In addition to these chemistry courses, chemistry majors also are required to take **Physics 103** and **104**, and **Mathematics 161** and **171**.

The chemistry major can serve as preparation for many career paths after college, including the profession of chemistry, graduate studies in the sciences, medicine, secondary school teaching, and many fields in the business world. The department offers programs based on the interests and goals of the student; therefore, a prospective major should discuss his or her plans with the department as soon as possible. Regardless of career goals, students are encouraged to develop their critical thinking and problem-solving skills by participating in a collaborative student-faculty research project (**Chemistry 291–294**, **401–404**, or summer research).

The department also offers an American Chemical Society-certified major in chemistry. The requirements for certification are met by taking advanced electives in chemistry—**Chemistry 232**, **310**, and **340**; two semesters of laboratory-based independent study; and **Mathematics 181**. Students interested in this certification program should consult with the department.

The department encourages its students to round out the chemistry major with relevant courses in other departments, depending on individual needs. These might include electives in other departments that provide extensive opportunities for writing and speaking, or courses concerned with technology and society. Students interested in providing a particular interdisciplinary emphasis to their chemistry major should consider additional courses in biology and biochemistry, computer science, economics, education, geology, mathematics, or physics.

Independent Study

Students may engage in independent study at the intermediate (**291–294**) or advanced (**401–404**) level.

Interdisciplinary Majors

The department participates in interdisciplinary programs in biochemistry, chemical physics, environmental studies, and geology and chemistry. See pages 81, 135, 209, and 212.

Requirements for the Minor in Chemistry

The minor consists of five chemistry courses at or above the 100 level. One AP chemistry credit may be counted as one of the five required chemistry courses. Biochemistry majors may not minor in chemistry.

Introductory, Intermediate, and Advanced Courses

[**50a - INS**. **Topics in Chemistry**.]

55a - INS. **Science of Food and Wine**. Fall 2009. Richard D. Broene and Barry A. Logan.

Methods of food and wine preparation and production emerged from essentially controlled scientific experiments, even if the techniques of cooking are often carried out without thought of the underlying physical processes at play. Considers the science behind food and wine using bread baking, cooking techniques, the role of microbes in our diet, and wine making and appreciation to explore the chemistry and biology that underlie our gastronomy. Molecular structures and complex interactions central to cooking and wine are examined in integrated laboratory exercises. Assumes no background in science. Not open to students who have credit for a chemistry course numbered **100** or higher. (Same as **Biology 55**.)

56a - MCSR, **INS**. **Investigations: The Chemistry of Forensic Science**. Spring 2010. Elizabeth A. Stemmler.

A study of scientific principles that underlie chemical, instrumental, and some biological techniques used in criminal investigations by forensic scientists. Focuses on understanding materials at an atomic or molecular level to learn how forensic chemistry is used to make qualitative and quantitative measurements key to forensic investigations. Makes use of case studies and the study of specific chemical, physical, and spectroscopic techniques used in forensic investigations. Assumes no background in science. Students will take part in three to four laboratory experiences. Not open to students who have credit for a chemistry course numbered **100** or higher.

57a - INS. **Chemistry of Poisons**. Fall 2009. Michael P. Danahy.

An examination of the structure and biological function of selected poisons and toxins. Topics include investigating the 3-D structure of molecules, how structure and function are related, and the chemistry and policy decisions involved in labeling something a "poison." Assumes no background in science. Not open to students who have credit for a chemistry course numbered **100** or higher.

58a - INS. **Drug Discovery**. Spring 2010. Danielle H. Dube.

The process of drug discovery of medicinal compounds has evolved over millennia, from the shaman's use of medicinal herbs to the highly evolved techniques of rational design and high-throughput screening used by today's pharmaceutical industry. Examines past and present approaches to drug discovery, with an emphasis on the natural world as a source of drugs, historical examples of drug discovery, and the experiments undertaken to validate a drug. Encourages students to take initial steps to identify novel therapeutics and to directly compare conventional versus herbal remedies in integrated laboratory exercises. Assumes no background in science. Not open to students who have credit for a chemistry course numbered **100** or higher.

101a - INS. **Introductory Chemistry**. Every fall. Jeffrey K. Nagle.

A first course in a two-semester introductory college chemistry program. An introduction to the states of matter and their properties, the mole concept and stoichiometry, and selected properties of the elements. Lectures, conferences, and four hours of laboratory work per week. *To ensure proper placement, students must take the chemistry placement examination prior to registering for* ***Chemistry 101***.

105a - MCSR, **INS**. **Perspectives in Environmental Science**. Every spring. Spring 2010. John Lichter and Dharni Vasudevan.

Functioning of the earth system is defined by the complex and fascinating interaction of processes within and between four principal spheres: land, air, water, and life. Leverages key principles of environmental chemistry and ecology to unravel the intricate connectedness of natural phenomena and ecosystem function. Fundamental biological and chemical concepts are used to understand the science behind the environmental dilemmas facing societies as a consequence of human activities. Laboratory sessions consist of local field trips, laboratory experiments, group research, case study exercises, and discussions of current and classic scientific literature. (Same as **Biology 158** and **Environmental Studies 201**.)

Prerequisite: One 100-level or higher course in biology, chemistry, geology, or physics.

109a - INS. **General Chemistry**. Every fall and spring. Fall 2009. Ronald L. Christensen. Spring 2010. The Department.

Introduction to models of atomic structure, chemical bonding, and intermolecular forces; characterization of chemical systems at equilibrium and spontaneous processes; the rates of chemical reactions; and special topics. Lectures, review sessions, and four hours of laboratory work per week. *To ensure proper placement, students must take the chemistry placement examination prior to registering for* ***Chemistry 109***.

Prerequisite: One year of high school chemistry with laboratory or **Chemistry 101**.

[**205a - INS**. **Environmental Chemistry**. (Same as **Environmental Studies 205** and **Geology 205**.)]

210a - MCSR, **INS**. **Chemical Analysis**. Every fall. Elizabeth A. Stemmler.

Methods of separating and quantifying inorganic and organic compounds using volumetric, spectrophotometric, electrometric, and chromatographic techniques are covered. Chemical equilibria and the statistical analysis of data are addressed. Lectures and four hours of laboratory work per week.

Prerequisite: **Chemistry 109**.

225a. **Organic Chemistry I**. Every fall. Richard D. Broene, Michael P. Danahy, and Jennifer R. Krumper.

Introduction to the chemistry of the compounds of carbon. Describes bonding, conformations, and stereochemistry of small organic molecules. Reactions of hydrocarbons, alkyl halides, and alcohols are discussed. Kinetic and thermodynamic data are used to formulate reaction mechanisms. Lectures, conference, and four hours of laboratory work per week.

Prerequisite: **Chemistry 109**.

226a. **Organic Chemistry II**. Every spring. Richard D. Broene and Jennifer R. Krumper.

Continuation of the study of the compounds of carbon. Highlights the reactions of aromatic, carbonyl-containing, and amine functional groups. Mechanistic reasoning provides a basis for understanding these reactions. Skills for designing logical synthetic approaches to complex organic molecules are developed. **Chemistry 225** and **226** cover the material of the usual course in organic chemistry and form a foundation for further work in organic chemistry and biochemistry. Lectures, conference, and four hours of laboratory work per week.

Prerequisite: **Chemistry 225**.

231a - MCSR, INS. Biochemistry and Cell Biology. Every spring. Bruce D. Kohorn.

Focuses on the structure and function of cells as we have come to know them through the interpretation of direct observations and experimental results. Emphasis is on the scientific (thought) processes that have allowed us to understand what we know today, emphasizing the use of genetic, biochemical, and optical analysis to understand fundamental biological processes. Covers details of the organization and expression of genetic information, and the biosynthesis, sorting, and function of cellular components within the cell. Concludes with examples of how cells perceive signals from other cells within cell populations, tissues, organisms, and the environment. Three hours of lab each week. **Chemistry 225** is recommended. (Same as **Biology 224**.)

Prerequisite: **Biology 102**, **104**, **105**, or **109**.

232a - MCSR. Biochemistry. Every fall. Danielle H. Dube.

Focuses on the chemistry of living organisms. Topics include structure, conformation, and properties of the major classes of biomolecules (proteins, nucleic acids, carbohydrates, and lipids); enzyme mechanisms, kinetics, and regulation; metabolic transformations; energetics and metabolic control. (Same as **Biology 232**.)

Prerequisite: **Chemistry 226**.

240a - MCSR, INS. Inorganic Chemistry. Every spring. Jeffrey K. Nagle.

An introduction to the chemistry of the elements with a focus on chemical bonding, periodic properties, and coordination compounds. Topics in solid state, bioinorganic, and environmental inorganic chemistry also are included. Provides a foundation for further work in chemistry and biochemistry. Lectures and four hours of laboratory work per week.

Prerequisite: **Chemistry 109**.

251a - MCSR, INS. Physical Chemistry I. Every fall. Laura F. Voss.

Thermodynamics and its application to chemical changes and equilibria that occur in the gaseous, solid, and liquid states. The behavior of systems at equilibrium and chemical kinetics are related to molecular properties by means of statistical mechanics and the laws of thermodynamics. Lectures and four hours of laboratory work per week. **Mathematics 181** is recommended.

Prerequisite: **Chemistry 109**, **Mathematics 171**, and **Physics 104**, or permission of the instructor.

252a - MCSR, INS. Physical Chemistry II. Every spring. Ronald L. Christensen.

Development and principles of quantum mechanics with applications to atomic structure, chemical bonding, chemical reactivity, and molecular spectroscopy. Lectures and four hours of laboratory work per week. **Mathematics 181** is recommended.

Prerequisite: **Chemistry 109**, **Mathematics 171**, and **Physics 104**, or permission of the instructor.

Note: **Chemistry 251** is not a prerequisite for **Chemistry 252**.

263a - MCSR, INS. Laboratory in Molecular Biology and Biochemistry. Every spring. Peter J. Woodruff.

Comprehensive laboratory course in molecular biology and biochemistry that reflects how research is conducted and communicated. Includes sequential weekly experiments, resulting in a cohesive, semester-long research project. Begins with genetic engineering to produce a recombinant protein, continues with its purification, and finishes with functional and structural characterization. Emphasis is on cloning strategy, controlling protein expression, and protein characterization using techniques such as polymerase chain reaction, affinity chromatography, isoelectric focusing, and high-performance liquid chromatography. Students also learn to manipulate data using structural and image analysis software. (Same as **Biology 263**.)

Prerequisite: Previous credit or concurrent registration in **Biology 224** (same as **Chemistry 231**).

291a–294a. **Intermediate Independent Study in Chemistry**. The Department.

Laboratory or literature-based investigation of a topic in chemistry. Topics are determined by the student and a supervising faculty member. Designed for students who have not completed at least four of the 200-level courses required for the chemistry major.

305a. **Environmental Fate of Organic Chemicals**. Fall 2009. Dharni Vasudevan.

More than 100,000 synthetic chemicals are currently in daily use. In order to determine the risk posed to humans and ecosystems, we need to understand and anticipate the extent and routes of chemical exposure. Addresses the fate of organic chemicals following their intentional or unintentional release into the environment. Why do these chemicals either persist or break down, and how are they distributed between surface water, ground water, soil, sediments, biota, and air? Analysis of chemical structure is used to gain insight into molecular interactions that determine the various chemical transfer and transformation processes, while emphasizing the quantitative description of these processes. (Same as **Environmental Studies 305**.)

Prerequisite: **Chemistry 225**.

310a. **Instrumental Analysis**. Spring 2010. Elizabeth A. Stemmler.

Theoretical and practical aspects of instrumental techniques, including nuclear magnetic resonance spectroscopy, infrared spectroscopy, Raman spectroscopy, and mass spectrometry are covered, in conjunction with advanced chromatographic methods. Applications of instrumental techniques to the analysis of biological and environmental samples are covered. Lectures and two hours of laboratory work per week.

Prerequisite: **Chemistry 210** or permission of the instructor.

[**325a**. **Structure Determination in Organic Chemistry**.]

331a. **Chemical Biology**. Spring 2010. Danielle H. Dube.

The power of organic synthesis has had a tremendous impact on our understanding of biological systems. Examines case studies in which synthetically derived small molecules have been used as tools to tease out answers to questions of biological significance. Topics include synthetic strategies that have been used to make derivatives of the major classes of biomolecules (nucleic acids, proteins, carbohydrates, and lipids), and the experimental breakthroughs these molecules have enabled (e.g., polymerase-chain reaction, DNA sequencing, microarray technology). Emphasis is on current literature, experimental design, and critical review of manuscripts.

Prerequisite: **Chemistry 232** (same as **Biology 232**).

340a. **Advanced Inorganic Chemistry**. Fall 2009. Jeffrey K. Nagle.

Inorganic chemistry is incredibly diverse and wide-ranging in scope. Symmetry, spectroscopy, and quantum-based theories and computational methods are employed to gain insight into the molecular and electronic structures and reaction mechanisms of inorganic compounds. Examples from the current literature emphasized, including topics in inorganic photochemistry and biochemistry. **Chemistry 252** is recommended.

Prerequisite: **Chemistry 240** or permission of the instructor.

350a. **Atmospheric Chemistry**. Spring 2010. Laura Voss.

An in-depth study in the chemistry that affects atmospheric composition and global climate change. Topics include ozone depletion, tropospheric pollution, understanding past climates, and modern research techniques. (Same as **Environmental Studies 350**.)

Prerequisite: **Chemistry 109** and **Chemistry 251** or **Physics 229**, or permission of the instructor.

401a–404a. **Advanced Independent Study and Honors in Chemistry**. The Department.

Advanced version of **Chemistry 291–294**. Students are expected to demonstrate a higher level of ownership of their research problem and to have completed at least four of the 200-level courses required for the major.

Classics

Jennifer Clarke Kosak, *Department Chair*
Tammis L. Lareau, *Department Coordinator*

Professor: Barbara Weiden Boyd
Associate Professors: James A. Higginbotham, Jennifer Clarke Kosak
Assistant Professor: Robert B. Sobak
Visiting Faculty: Ryan Ricciardi

The Department of Classics offers three major programs: one with a focus on language and literature (Classics), one with a focus on classical archaeology (Classical Archaeology), and one that looks at the ancient world from multiple perspectives (Classical Studies). Students pursuing these majors are encouraged to study not only the languages and literatures but also the physical monuments of Greece and Rome. This approach is reflected in the requirements for the three major programs: for all, requirements in Greek and/or Latin and in classical culture must be fulfilled. Courses in which a grade below C- is earned may not be used to fulfill the requirements for any of the programs offered by the department. Courses taken with the Credit/D/Fail grading option also may not be used to fulfill the requirements for any of the programs offered by the department.

Classics

The classics program is arranged to accommodate both those students who have studied no classical languages and those who have had extensive training in Latin and Greek. The objective of Greek and Latin courses is to study the ancient languages and literatures in the original. By their very nature, these courses involve students in the politics, history, and philosophies of antiquity. Advanced language courses focus on the analysis of textual material and on literary criticism.

Requirements for the Major in Classics

The major in classics consists of ten courses. At least six of the ten courses are to be chosen from offerings in Greek and Latin and should include at least two courses in Greek or Latin at the 300 level. Of the remaining courses, one should be chosen from **Archaeology 101** or **102**, one should be chosen from **Classics 101** or **102**, and one should be chosen from **Classics 211** or **212**. Of the courses a student wishes to count towards the major, at least one at the 300 level should be taken during the senior year. Students concentrating in one of the languages are encouraged to take at least two courses in the other. As a capstone to this