Chemistry

Faculty

Craig R. Bieler, chair, associate professor, and Herbert H. and Grace A. Dow Professor of the Sciences.
B.S., 1986, Juniata College; Ph.D., 1992, University of Pittsburgh. Appointed 1995.

Amy E. Beilstein, assistant professor.
B.A., 1996, The College of Wooster; Ph.D., 2001, Duke University. Appointed 2005.

Andrew N. French, associate professor.
B.A., 1986, Ohio Wesleyan University; Ph.D., 1992, University of Illinois, Urbana Champaign. Appointed 1997.

Clifford E. Harris, associate professor.
B.S., 1992, California State University, Chico; Ph.D., 1997, University of California, Santa Cruz. Appointed 1997.

Lisa B. Lewis, associate professor.
B.S., 1989, King's College; M.S., 1992, University of Pittsburgh; Ph.D., 1994, University of California, Irvine. Appointed 1995.

Vanessa P. McCaffrey, assistant professor.
B.S., 1996, McNeese State University; Ph.D., 2001, University of North Carolina, Chapel Hill. Appointed 2003.

Christopher E. Rohlman, associate professor.
B.S., 1984, Oakland University; Ph.D., 1989, University of Michigan. Appointed 2001.

Daniel M. Steffenson, professor.
A.B., 1962, Cornell College; M.A., 1964, Ph.D., 1967, Harvard University. Appointed 1967.

Introduction

The Chemistry Department has three major objectives: (1) To provide a strong chemistry major within a liberal arts framework for those entering the profession of chemistry or preparing for graduate work; (2) to provide cognate backgrounds in chemistry for biology majors, pre-medical and pre-dental students, medical technologists, dietitians, science educators and others who may require chemistry; (3) to provide non-science majors with sufficient background to understand advances in technology, environmental implications of new laws, drug problems and health advances.

Independent study is encouraged both as a part of formal course work and in undergraduate research projects. Faculty work closely with students in research areas of mutual interest. Cooperation with other science departments provides opportunities for interdepartmental studies. Chemistry majors are strongly encouraged to balance their science training with courses in the arts and humanities.

Chemistry Department Web site

Career Opportunities

In addition to professional work and graduate study in chemistry, a chemistry major can establish a foundation for careers in a number of fields: e.g., engineering, health-related fields, law and technically related businesses. Graduate and professional schools in the medical sciences require a strong background in chemistry.

Requirements for Major

- The specific course requirements for a chemistry major are shown below in two "tracks" plus a set of core courses that is common to both tracks. The Chemistry Track (nine units) concentrates upon the more traditional areas of chemistry and is recommended for students who intend to pursue graduate work in any area of chemistry (including biochemistry) or who expect to use their chemistry background as a basis for a laboratory-based career. The Biochemistry Track (eight and one-half units) has a biochemical orientation; it is recommended for students in the health sciences and related careers. In either track, the timing of course sequences is crucial, and students should consult with a member of the Chemistry Department as early as possible in the planning of their major.

COMMON CORE

Chem 121: Structure and Equilibrium

Chem 123: Inorganic Chemistry: Introduction
Chem 206: Chemical Analysis
Chem 211: Organic Chemistry: Structure, Stability and Mechanism
Chem 212: Organic Chemistry: Mechanism and Synthesis
Chem 301: Chemical Energetics and Kinetics

Chemistry Track
Chem 323: Advanced Laboratory: Biochemistry (1/2 unit)
OR
Chem 321: Advanced Laboratory: Synthesis (1/2 unit)
Chem 327: Advanced Physical and Analytical Laboratory (1/2 unit)
Chem 340: Physical Chemistry
Chem 350: Advanced Organic Chemistry (1/2 unit)
OR
Chem 353: Spectroscopy (1/2 unit)
Chem 356: Advanced Inorganic Chemistry (1/2 unit)
Plus:
One year of calculus (Mathematics 141, 143 or equivalent)
One year of physics, preferably Physics 167-168 (115-116 is acceptable)

Biochemistry Track
Chem 321: Advanced Synthesis Laboratory (1/2 unit)
OR
Chem 327: Advanced Physical and Analytical Laboratory (1/2 unit)
Chem 323: Advanced Biochemistry Laboratory (1/2 unit)
Chem 337: Biochemistry
Chem 351: Physical Chemistry of Macromolecules (1/2 unit)
Plus:
One semester of calculus (Mathematics 141 or equivalent)
One year of physics (Physics 115-116 or 167-168)
One unit of biology selected from Biology 301, 317, 324, 332, 341, 361, 362, 363, 365 (other 300-level course by permission).

Note: Students planning to enroll in Chemistry 121 need basic algebra skills. Students who are unsure of their preparation for Chemistry 121 should consult with a member of the department.

- All chemistry courses must be taken for a numerical grade, except those offered only on a credit/no credit basis. Students who intend to apply for entrance into medical or dental schools should not take basic chemistry courses on a credit/no-credit basis, and students majoring in other sciences are strongly discouraged from doing so.

  The Chemistry Department is approved by the American Chemical Society. In order to graduate as an American Chemical Society certified chemistry major, the following courses are required beyond the common core courses of the major: Chemistry 321, 327, 337, 340, 350, 353, 356; Math 141, 143; Physics 167-168. One unit of directed study credit may be substituted for Chemistry 350. Other substitutions may be made only with prior approval of the Chemistry Department.

Requirements for Minor

- Five units in chemistry: 121, 123, 206, 211, and either 301 or 337.
- Two units in cognate areas: one semester of calculus (Mathematics 141 or equivalent), one semester of physics (Physics 115 or 167). Two semesters of physics are recommended.
- All courses for the minor must be taken for a numerical grade.

Requirements for Major With Secondary Education Certification

- Eight units in chemistry. The chemistry major has two tracks, either of which may be used as a teaching major. The majors share a common core consisting of the following: 121, 123, 206, 211, 212 and 301. In addition to these six units, the required courses are: **Chemistry Track:** 321 or 323, 340 and 1 / 2 unit chosen from 350, 353 or 356 (356 is normally recommended) or **Biochemistry Track:** 323, 337, 351 and one unit of biology numbered above 300 (except 391 and 392).
- Four units in cognate areas: Two semesters of calculus (Mathematics 141, 143 or equivalent), two semesters of physics (Physics 115-116 or 167-168).
- Completion of all other requirements for teacher certification.

Requirements for Minor With Secondary Education Certification

- Five units in chemistry: 121, 123, 211, 301, plus one unit from 200, 206, 212 or 337.
- Two units in cognate areas: One semester of calculus (Mathematics 141 or equivalent), one semester of physics (Physics 115 or 167).
- Completion of all other requirements for teacher certification.

Courses

101 Chemistry That Matters (1) Fall
As citizens and consumers, we face the question of how we can live responsibly and safely in an environment in which we are literally surrounded by synthetic chemicals. For that reason, chemistry *does* matter to all of us. This course is concerned with materials which we encounter every day, including foods and food additives, cleaning supplies, fuels, building supplies, pesticides and radioactive materials (e.g., radon). The emphasis is upon what these materials are, how they work, how they can be used safely, and what their impact is on the environment. Chemical principles are introduced as needed. Hands-on microscale demonstrations are used frequently in the classroom. Non-laboratory. Lecture and discussion. Intended for non-science majors. *Staff.*

107 Chemistry for the Non-Science Major (1) Fall
An introduction to the methodology of science and the basic principles of chemistry. General chemistry, organic chemistry and biochemistry topics are briefly surveyed. Few mathematical skills are required. Lecture and laboratory. Not intended for the chemistry or science major. *Staff.*

121 Structure and Equilibrium (1) Fall, Spring
Basic principles of stoichiometry, atomic and molecular structure, and chemical equilibria, including the study of weak acids and bases in aqueous solution. Lecture and laboratory. *Staff.*

123 Inorganic Chemistry: Introduction (1) Spring
Prerequisite: Chemistry 121 or permission of instructor. A systematic introduction to the chemistry of the elements; concepts include electrochemistry, solubility and complex ion equilibria. Lecture and laboratory. *Staff.*

200 Chemistry and Social Problems (1) Spring
Prerequisite: Junior/senior standing. An examination of selected, important social problems which have a technological basis. Discussions focus upon the economic, political and ethical dimensions of the problems, as well as the science and technology involved, and include problems such as the greenhouse effect and global warming, chlorofluorocarbons and the stratospheric ozone layer, chemical and radioactive waste disposal, and the use of pesticides. Risk/benefit analysis and the connection between chemical exposure and biological harm are important features of the discussions. Laboratory work involves the analysis of water samples for trace metals and organic contaminants, using state of the art instrumentation, and will include attempts to assess the validity of the analytical results. Intended for non-science majors as well as science majors. *Lewis.*

201 Chemical Thermodynamics and Kinetics (1/2) Spring
Classical thermodynamics taught using only basic algebra. A global view is used to understand spontaneous changes in chemical and physical systems. Emphasis on entropy and the Second Law of Thermodynamics. Also focuses on chemical kinetics including experimental determination of rates and the mechanisms of chemical reactions. Designed for preprofessional students and those majoring in biology and geology. Does not count toward the chemistry major. *Staff.*

206 Chemical Analysis (1) Fall, Spring
Prerequisite: Chemistry 121. Chemistry 123 is recommended. Laboratory course emphasizing the collection, analysis and interpretation of quantitative data, using both traditional and instrumental techniques. *Bieler, Green, Lewis.*

211 Organic Chemistry: Structure, Stability and Mechanism (1) Fall
Prerequisite: Chemistry 121.
An integrated two-semester introduction to the chemistry of carbon-based molecules--the molecules of life. The structure and stability of carbon compounds, including: nomenclature, physical properties, spectroscopic properties, stereoisomerism and acid-base properties. The physical and mechanistic understanding of organic chemical reactions, focusing on: substitution, addition, elimination and rearrangement reactions. Laboratory involves techniques of synthesis and purification. *French, Harris, McCaffrey.*

212 Organic Chemistry: Mechanism and Synthesis (1) Spring
Prerequisite: Chemistry 211.
A continued survey of the mechanisms and reactions of organic molecules focusing on aromatic and carbonyl compounds, and the application of organic reactions toward organic synthesis. Laboratory involves team-designed organic syntheses of biologically relevant molecules and/or synthetic methodology. *French, Harris, McCaffrey.*

288 Selected Topics (1/2) Fall or Spring
Prerequisite: Chemistry 121. *Staff.*

301 Chemical Energetics and Kinetics (1) Fall
Prerequisites: Chemistry 123 or 211 and Math 141 or equivalent.

An exploration of the basic thermodynamic and kinetic principles that govern the outcome of all chemical reactions and physical processes. Primary emphasis is placed upon macroscopic chemical thermodynamics with applications to solutions, colligative properties and phase equilibria. Additional topics include kinetic molecular theory; the experimental basis for determining reaction rates, rate laws and rate constants; the relationship of rate laws to reaction mechanisms; and the effect of temperature change on the rate constant. *Steffenson.*

321 Advanced Synthesis Laboratory (1/2) Spring
Prerequisites: Chemistry 206 and 212.
An exploration of advanced methods of chemical synthesis techniques in both organic and inorganic chemistry. Emphasis is placed on analysis of the synthetic products for purity and qualitative identification, using FT-NMR, FTIR, ultraviolet and visible spectroscopy. Further identification and analysis is done using HPLC, GC/MS, gas chromatography and LC/MS. Two four-hour laboratories per week. *Beilstein, French, Harris, McCaffrey.*

323 Advanced Biochemistry Laboratory (1/2) Fall
Prerequisite: Chemistry 206, 337.
The study of biochemical laboratory techniques, including enzyme purification and kinetics; gel exclusion, ion exchange; agarose gel electrophoresis; isolation of nucleic acids; and a special student-designed project. *Rohlman.*

327 Advanced Physical and Analytical Chemistry Laboratory (1/2) Spring
Prerequisite: Chemistry 206 and 301. Corequisite: Chemistry 340.
An exploration of various areas of physical chemistry and advanced problems in analytical chemistry including thermodynamics, kinetics, spectroscopy, x-ray diffraction and quantum mechanics. In carrying out these experiments, students use UV/Vis, fluorescence, ICP, IR, and x-ray fluorescence spectrometers and gain experience with electroanalytical methods, vacuum lines, lasers and x-ray diffraction. Two four-hour laboratories per week. *Bieler, Green, Lewis, Steffenson.*

337 Biochemistry (1) Spring
Prerequisite: Chemistry 211 or permission of instructor.
An in-depth study of biochemical structure, catalysis, metabolism and cellular regulation. Understanding living systems through molecular and chemical models. Areas of emphasis include macromolecular structure, enzyme mechanisms and kinetics, metabolic mechanisms and regulation, genomics, and proteomics. Same as Biology 337. *Rohlman.*

340 Physical Chemistry (1) Spring
Prerequisite: Permission of instructor. Normally a student is expected to have completed Chemistry 121, 123, 211, 212, 206 and 301 as well as 2 units of calculus and 2 units of physics. The microscopic or molecular basis for chemistry. Among the topics covered are the use of Schrodinger wave mechanics to examine the energies of atoms and molecules, including structure and chemical bonds; comparison of calculated energies with experimental values obtained from atomic and molecular spectroscopy; and the use of statistical mechanics to calculate thermodynamic variables and equilibrium constants. *Steffenson.*

350 Advanced Organic Chemistry (1/2) Fall
Prerequisites: Chemistry 211, 212.
Reinforces and extends the concepts introduced in Chemistry 211, 212 and introduces new concepts, reactions and molecular theories. Taught with one of two
emphases: (1) the *synthetic* course extends understanding of organic reactions,
introduces the most current synthetic organic methods and asks students to use their knowledge to propose syntheses of complex molecules; (2) the *physical/mechanistic* course includes topics such as aromaticity and models used to explain thermal and photochemical concerted reactions such as frontier orbital theory, Huckel-Mobius transition state theory and the conservation of orbital symmetry. Students in both courses are taught to read and understand the chemical literature, then write about and orally present the novel chemistry they have learned. *French, Harris, McCaffrey.*

351 Physical Chemistry of Macromolecules (1/2) Spring
Prerequisites: Chemistry 301, 337.
Examination of the physical chemistry of macromolecules in living systems. A study of thermodynamics, kinetics, ligand binding and spectroscopy related to the understanding of macromolecular structure and function. *Rohlman.*

353 Spectroscopy (1/2) Fall
Prerequisite: Chemistry 340.
General principles and theories of light absorption and emission at the molecular level, including the application of symmetry and group theory. Detailed applications to IR, Raman, microwave, UV-visible and radiofrequency spectroscopy (NMR, EPR). Additional topics chosen from X-ray crystallography, mass spectroscopy, photochemistry and Mossbauer spectroscopy. *Bieler, Green, Lewis, Steffenson.*

356 Advanced Inorganic Chemistry (1/2) Spring
Prerequisite: Permission of instructor. Normally a student is expected to have completed Chemistry 340. An advanced-level discussion of periodic properties, chemical bonding, and acidbase concepts with an emphasis upon the bonding and properties of transition metal complexes. *Beilstein.*

391, 392 Internship (1/2, 1) Fall, Spring
Offered on a credit/no credit basis. *Staff.*

401 Seminar (1/2) Fall, Spring *Staff.*

411, 412 Directed Study (1/2, 1) Fall, Spring *Staff.*