

## Chemistry

*Professors Hess, Levy, Tortorelli; Associate Professors Price (Chair), Rutledge, Williamsen; Assistant Professors Ellison, Popescu, Laboratory Coordinator Pfenning.*

The chemistry department at Ursinus College has been approved by the American Chemical Society since 1959. The objectives of the department are (1) to offer specialized training in chemistry, beyond the basic course, that will enable a graduate to enter a career as a professional chemist; (2) to prepare the student for graduate study; (3) to provide a strong foundation for the student planning to enter medicine, dentistry, or an allied health field; (4) to prepare the student for teaching chemistry at the secondary level; (5) to provide courses which satisfy the departmental requirements for a comprehensive minor; and (6) to provide a course in general chemistry which satisfies the natural science requirements of the College.

Recognizing that students have different educational objectives, the chemistry department offers several programs leading to a major. Students wishing to combine a chemistry major with a major/minor concentration in another academic department may enroll in any one of the following programs (tracks) in accordance with their career interests.

### Requirements for Majors

Regardless of track, all majors must complete the following courses: Chemistry 105/105LQ (or 151/151LQ in place of 105/105LQ and 206/206L), 106/106L, 201W, 205/205L, 206/206L, 212, 309/309L, 310/310L, 315/315L, and 322/322L; Math 112; and Physics 111Q/112.

### Track 1. Major Specialization in Chemistry

Students planning to enter the chemical industry or planning further study in chemistry or chemically related areas (e.g. engineering, biochemistry, material science, and the like) may enroll in this program. In addition to the courses required of all majors, this specialization requires one of 405W, 409W, 415W, 422W, or 424W.

### Track 2. American Chemical Society Certified Major — Chemistry Emphasis

The American Chemical Society has adopted a set of standards for undergraduate training in chemistry. In addition to the courses required of all majors, students seeking certification must complete the following courses: Chemistry 380 or 381 or 491W, and at least two of 405W, 409W, 415W, 422W, or 424W.

### Track 3. Specialization in Chemistry for Medical School and Allied Fields

This course of study is designed for students planning admission to graduate programs in biochemistry, toxicology, pharmacology, etc., and to professional schools in the healing arts (such as medicine and dentistry) or further study in the health-related fields. In addition to the courses required of all majors, this program consists of the following courses: Chemistry 424W or BCMB 351; Biology 111WQ and 212WQ.

### Track 4. Specialization in Chemistry for Science Teaching

This program satisfies the requirements for secondary school certification in chemistry as established by the Commonwealth of Pennsylvania. In addition to the courses required of all majors, students seeking certification should complete one of 405W, 409W, 415W, 422W, or 424W. Prospective teachers should serve as laboratory assistants or participate in safety training. Prospective student teachers must have a 2.50 average in chemistry and receive a departmental recommendation which considers, in addition to academic performance, the student's interpersonal and communication skills. Students and their advisers should consult the Ursinus College Education Department.

The following courses satisfy the college capstone, oral, and writing requirements for the major: 405W, 409W, 415W, 422W, and 424W.

### Requirements for Minors

A minor concentration in chemistry consists of Chemistry 105/105LQ (or 151/151LQ in place of 105/105LQ and 206/206L), 106/106L, 205/205L, 206/206L, 309/309L or 315/315L or 322/322L, and three additional credits in chemistry.

**CHEM-100Q. Topics in Chemistry Faculty**

A study of the essential nature of chemistry, emphasizing basic chemical principles and applications. Topics may include atomic structure, bonding, the production and utilization of energy, and oxidation-reduction. Societal and historical perspectives are introduced by way of assignments from the popular literature. A knowledge of algebra is assumed. Three hours of lecture and three hours of laboratory per week. *Four semester hours. (LS.)*

*Note: A student who has received credit for CHEM-105 may not enroll in CHEM-100Q. CHEM-100Q may not be used as elective credits for chemistry majors or minors.*

**CHEM-101. Introduction to Environmental Chemistry Faculty**

This course, intended for non-science majors, will examine selected topics in environmental chemistry through an understanding of basic chemical principles. Topics may include global warming, ozone depletion, pollution, and waste management. Three hours of lecture. *Three semester hours. (LS if taken with CHEM-101LQ.)*

**CHEM-101LQ. Laboratory in Introductory Environmental Chemistry Faculty**

Laboratory work related to CHEM-101. In addition to mastering basic chemistry laboratory skills, students will analyze air, water, and soil samples using a variety of techniques. Prerequisite: CHEM-101 (or concurrently). Three hours of laboratory per week. *One semester hour.*

**CHEM-102. Introduction to Forensic Chemistry Dr. Tortorelli**

This course, intended for non-science majors, will examine selected topics in forensic science. Through an understanding of basic chemical principles, this course will investigate the role of science in solving crimes. Topics may include fingerprint analysis, fiber identification, blood typing and analysis, drug identification, and DNA profiling. Case studies will be used to explore the scientific foundation for the examination of physical, chemical, and biological evidence. Three hours of lecture. *Three semester hours. (LS, if taken with CHEM-102LQ.)*

*Note: A student who has received credit for CHEM-105 may not enroll in CHEM-102. CHEM-102 may not be used as elective credits for chemistry majors or minors.*

**CHEM-102LQ. Laboratory in Forensic Chemistry Dr. Tortorelli**

Laboratory work related to CHEM-102. This laboratory course will involve the analysis of trace evidence. Techniques utilized may include chromatography, fingerprinting, blood typing, fiber identification, glass analysis, mass spectrometry, and infrared spectroscopy. Students will work in investigative teams. Prerequisite: CHEM-102 (or concurrently). Three hours of laboratory per week. *One semester hour.*

**CHEM-105. General Chemistry I Faculty**

A study of the principles of chemistry. Topics include structure, bonding, stoichiometry, states of matter, inorganic reactions, thermochemistry, and solutions. The mathematical solution of chemical problems will be emphasized. This course must be taken concurrently with CHEM-105LQ.\* Three hours of lecture per week plus one hour of recitation per week at the discretion of the instructor. *Three semester hours. (LS, if taken with CHEM-105LQ.)*

*\*A student who repeats this need not also repeat its companion lecture or lab.*

**CHEM-105LQ. Laboratory in General Chemistry I Dr. Pfenning**

Laboratory work related to CHEM-105. Experimental work may include verification of the stoichiometric relationship between reactants and products, the preparation and characterization of compounds, titrations involving neutralization and redox reactions, measurement of enthalpies of reaction, and colorimetric analysis. The mathematical solution of chemical problems will be emphasized. This course must be taken concurrently with CHEM-105.\* Three hours per week. *One semester hour.*

*\*A student who repeats this need not also repeat its companion lecture or lab.*

**CHEM-106. Organic Chemistry I Dr. Hess, Dr. Rutledge, Dr. Tortorelli**

An introduction to the study of the physical and chemical properties of both aliphatic and aromatic

hydrocarbons within the context of modern structural theory. Areas emphasized are bonding, acidity and basicity in organic systems, stereochemistry, and reaction mechanisms. This course must be taken concurrently with CHEM-106L.\* Prerequisite: CHEM-105 or 151. Three hours per week. *Three semester hours. (LS, if taken with 106L .)*

**CHEM-106L. Laboratory in Organic Chemistry I** *Dr. Hess, Dr. Rutledge, Dr. Tortorelli*

Laboratory work related to CHEM-106. Experimental work may include measurement of physical properties, study of reaction kinetics, and synthesis. Techniques employed include chromatography, distillation, extraction, infrared and UV/vis spectroscopy, and recrystallization. Primary and secondary literature sources are introduced. This course must be taken concurrently with CHEM-106.\* Prerequisite: CHEM-105LQ or 151LQ. Three hours per week. *One semester hour.*

**CHEM-151. Advanced General Chemistry** *Faculty*

A course in the foundations of chemistry and analysis of chemical systems designed for students with a strong background in chemistry. Topics in atomic structure, bonding, thermodynamics, equilibria and kinetics will be discussed in detail. The course will emphasize the integration of these topics with other areas of chemistry, having an outlook toward upper-level chemistry courses. This course must be taken concurrently with CHEM-151LQ.\* Placement in this course is by invitation of the Chemistry Department. Three hours of lecture per week plus one hour of recitation per week at the discretion of the instructor. *Three semester hours. (LS, if taken with CHEM-151LQ.)*

*Note: students who have received credit for CHEM-105 and/or CHEM-206 may not enroll in CHEM-151.*

**CHEM-151LQ. Laboratory in Advanced Chemistry** *Faculty*

Laboratory work related to CHEM-151. Experimental work may include topics in stoichiometry, chemical structure and bonding, thermodynamics, equilibrium, and kinetics. This course must be taken concurrently with CHEM-151. Three hours of laboratory per week. *One semester hour.\**

**CHEM-201W. Effective Communication for Chemists** *Faculty*

Practice in various forms of technical writing and oral communication, commonly used by chemists. Topics will include writing the scientific paper, display of experimental data, and effective presentation skills. Course work will involve bibliographic instruction and the use of primary sources. Open only to chemistry majors. Pre- or co-requisites: CHEM-205. Three hours per week. *Four semester hours.*

**CHEM-205. Organic Chemistry II** *Dr. Hess, Dr. Rutledge, Dr. Tortorelli*

A continuation of CHEM-106. Particular emphasis is placed on spectrometric methods, and on the reactivity and synthesis of a variety of organic functional groups. This course must be taken concurrently with CHEM-205L.\* Prerequisite: CHEM-106. Three hours per week. *Three semester hours.*

**CHEM-205L. Laboratory in Organic Chemistry II** *Dr. Hess, Dr. Rutledge, Dr. Tortorelli*

Laboratory work related to CHEM-205; a continuation of 106L. This course must be taken concurrently with CHEM-205.\* Prerequisite: CHEM-106L. Three hours per week. *One semester hour.*

**CHEM-206. General Chemistry II** *Faculty*

A study of properties of solutions, kinetics, equilibria, and acid-base chemistry, thermodynamics, electrochemistry, and nuclear chemistry. This course must be taken concurrently with CHEM-206L.\* Prerequisite: CHEM-105. Three hours per week. *Three semester hours.*

*Note: Students who have received credit for CHEM-151 may not enroll in CHEM-206.*

**CHEM-206L. Laboratory in General Chemistry II** *Dr. Pfenning*

Laboratory work related to CHEM-206. Special emphasis will be placed on sample manipulation, control of solution characteristics, quantitative analysis, and the development of skills in wet and instrumental analysis methods. This course must be taken concurrently with CHEM-206.\*

Prerequisite: CHEM-105LQ. Three hours per week. *One semester hour.*

**CHEM-212. Structure and Spectroscopy** *Faculty*

A study of the fundamental aspects of the various forms of spectroscopy through the structural examination of a variety of organic and inorganic compounds, either produced by students or obtained from other researchers. The course will emphasize major spectroscopic techniques, such as NMR, IR, MS, and UV-vis. In-depth analysis of the spectra and their relation to structure determination will be emphasized. Prerequisites: CHEM-205 and either 151 or 206 (or concurrently). Four hours of lecture/laboratory per week. *Three semester hours.*

**CHEM-291. Introduction to Research** *Faculty*

Laboratory and library work, under the direction of a faculty member, designed to introduce the student to fundamental research procedures and data interpretation in the context of a research project. Upon completion of the work, a formal presentation must be given to the department. This course may be taken more than once. Prerequisites: CHEM-105LQ or 151LQ and permission of the research adviser. Three hours of laboratory per week. *One semester hour.*

**CHEM-309. Physical Chemistry I** *Dr. Ellison, Dr. Popescu*

An in-depth study of chemical thermodynamics and kinetics, including enthalpy, entropy, and Gibbs energy changes; physical and chemical equilibria; rates of chemical reactions; and reaction mechanisms. Prerequisites: CHEM-151 or 206; MATH-112; PHYS-112. Strongly recommended: MATH-211. Three hours per week. *Three semester hours.*

*Note: Students may not receive credit for both CHEM-309 and BCMB-307*

**CHEM-309L. Laboratory in Physical Chemistry I** *Dr. Ellison, Dr. Popescu*

Laboratory work related to BCMB-307 and CHEM-309, emphasizing data analysis, computer and writing skills. Lab report writing will require use of the primary and secondary literature sources. Prerequisites: CHEM-151LQ or 206L; BCMB-307 (or concurrently) or CHEM-309 (or concurrently). Three hours per week. *One semester hour.*

**CHEM-310. Physical Chemistry II** *Dr. Ellison, Dr. Popescu*

A study of the principles of quantum mechanics applied to simple models (particle in the box, harmonic oscillator) and to atoms and molecules (quantum chemistry). The course will include statistical thermodynamics. Emphasizes the mathematical foundation and spectroscopic investigation of atomic and molecular properties. Prerequisite: CHEM-151 or 206; MATH-112; PHYS-112. Strongly recommended: MATH-211. Three hours per week. *Three semester hours. (LS if taken with CHEM-310L.)*

**CHEM-310L. Laboratory in Physical Chemistry II** *Dr. Ellison, Dr. Popescu*

Laboratory work related to CHEM-310, emphasizing spectroscopic methods of investigating atomic and molecular structure and properties. Data analysis and lab report writing will require the use of the chemistry literature. Prerequisites: CHEM-151LQ or 206L; 310 (or concurrently). Three hours per week. *One semester hour.*

**CHEM-315. Instrumental Analysis** *Dr. Williamsen*

A study of instrument-based spectroscopic, separation, and electrochemical analyses. A framework that can be used to understand new and old techniques, the theory behind a variety of specific techniques, and the current practices used in chemical analysis will be discussed. In addition to the discussion of specific techniques, basic concepts in electronics and statistics will be presented. Prerequisite: either CHEM-151 or 206. Three hours per week. *Three semester hours.*

**CHEM-315L. Laboratory in Advanced Instrumental Analysis** *Dr. Williamsen*

Laboratory work related to CHEM-315. Students will gain experience with a variety of instrumental and analysis techniques by investigating how specific instrumental settings affect output. Emphasis will be placed on statistical analysis of experimental data. This course must be taken concurrently with CHEM-315. Three hours per week. *One semester hour.*

**CHEM-322. Inorganic Chemistry** *Dr. Price*

A systematic survey of the descriptive chemistry of the main group elements with an emphasis on periodicity nomenclature, structure, and reactivity. An introduction to the chemistry of the transition metals as well as group theory and symmetry will also be discussed. Prerequisite: either CHEM-151 or 206, and 212 (or concurrently). Three hours per week. *Three semester hours.*

**CHEM-322L. Laboratory in Inorganic Chemistry** *Dr. Price*

Laboratory work related to CHEM-322. Techniques used to synthesize and characterize a variety of inorganic compounds will be introduced. This course must be taken concurrently with CHEM-322. Three hours per week. *One semester hour.*

**CHEM-350. Selected Topics in Chemistry** *Faculty*

A course focused on a topic of contemporary interest to the chemical community, such as advanced organic chemistry, nuclear magnetic resonance, medicinal chemistry, materials science, ethical issues in science, or synthesis. Prerequisites: CHEM-205 and 206, and permission of the instructor. Three hours per week. *Three semester hours.*

**CHEM-380. Off-Campus Research** *Faculty*

An approved, off-campus laboratory research experience supervised by an on-site adviser and faculty liaison involving a minimum of 10 hours per week for one semester or four weeks of full-time work. Before beginning the project, the student must submit a proposal to be approved by both the chemistry faculty and the on-site adviser. Upon completion of the work, written and oral reports must be presented to the department. Prerequisites: CHEM-205L and either 151LQ or 206L. Graded S/U. *Three semester hours. (I.)*

**CHEM-381. Internship** *Faculty*

A laboratory project in cooperation with industry at an industrial site involving a minimum of 10 hours per week for one semester or four weeks of full-time work. Before beginning the internship, the student must submit a proposal to be approved by both the chemistry faculty and the on-site supervisor. Upon completion of the work, written and oral reports must be presented to the department. Prerequisites: CHEM-205L and either 151LQ or 206L. Graded S/U. *Three semester hours. (I.)*

**CHEM-391. Research/Focused Inquiry** *Faculty*

Laboratory and library work, under the direction of a faculty member, and designed to introduce the student to fundamental research procedures and data interpretation in the context of a research project. Upon completion of the work, a formal presentation must be given to the department. This course may be taken more than once. Prerequisites: CHEM-205L or 291, and permission of the research adviser. Six hours of laboratory per week. *Two semester hours.*

**CHEM-405W. Advanced Organic Chemistry** *Dr. Hess, Dr. Rutledge, Dr. Tortorelli*

A study of structure, reactivity, reaction mechanisms, and synthetic methodology in organic systems. Written and oral exercises are required, as well as a major paper. Offered spring of even-numbered years. Prerequisites: CHEM-205, and either 151 or 206. Three hours per week. *Three semester hours.*

**CHEM-409W. Advanced Physical Chemistry** *Dr. Ellison, Dr. Popescu*

A course that explores topics in physical chemistry in depth. Topics may include advanced methods in spectroscopy, reaction kinetics, molecular reaction dynamics, quantum mechanical calculations, and nanoscience. Written and oral exercises are required, as well as a major paper. Offered spring of odd-numbered years. Prerequisites: CHEM-309 and 310. Three hours per week. *Three semester hours.*

**CHEM-415W. Advanced Analytical Chemistry** *Dr. Williamsen*

A study of an application in analytical chemistry or a specific analytical technique. Written and oral exercises are required, as well as a major paper. Offered spring of even-numbered years. Prerequisite: CHEM-315. Three hours per week. *Three semester hours.*

**CHEM-422W. Advanced Inorganic Chemistry** *Dr. Price*

A study of bonding theories, point groups, structure, stereochemistry, and reactivity of inorganic and organometallic materials with an emphasis on transition-metal compounds. Other topics include superconductivity, catalysis, and bioinorganic chemistry. Written and oral exercises are required, as well as a major paper. Offered fall of odd-numbered years. Prerequisites: CHEM-322. Three hours per week. *Three semester hours.*

**CHEM-424W. Advanced Biological Chemistry** *Dr. Rutledge*

A detailed exploration of the structures, properties, and reactions of biological molecules, cycles, and systems. Written and oral exercises are required, as well as a major paper. Offered fall of even-numbered years. Prerequisites: CHEM-205 and either 151 or 206. Three hours per week. *Three semester hours.*

**CHEM-491W. Research/Independent Work** *Faculty*

Independent laboratory and library investigation in chemistry. A final research paper and oral presentation will be presented to the department faculty. At the time of registration, written consent of the research adviser and the department is required. Prerequisites (or concurrently): CHEM-201W. Twelve hours per week. *Four semester hours. (I.)*

**CHEM-492W. Research/Independent Work** *Faculty*

A continuation of CHEM-491W, with a final seminar and thesis describing the research work. Prerequisites: CHEM-491W. Twelve hours per week. *Four semester hours. (I.)*

**Departmental Honors in Chemistry**

Students successfully completing CHEM-491W and CHEM-492W may be awarded honors in chemistry, but no additional credit will be granted. Description of the honors program, including qualifications, is detailed in this catalog. *(I.)*