

Chemistry

Chair: Associate Professor M. Hagerman

Faculty: Professors J. Adrian, J. Anderson, M. Carroll (on leave winter and spring), D. Hayes (Dean of Academic Departments); Associate Professors K. Fox, J. Kehlbeck, L. Tyler; Assistant Professors L. MacManus-Spencer, M. Paulick; Visiting Assistant Professor J. Carrick; Senior Lecturer K. Lou; Lecturer S. Kohler.

Staff: K. Ryan (Stockroom Supervisor), M. Howley (Technical Secretary)

The Chemistry Department is certified by the American Chemical Society. Bachelors' degrees with a major in chemistry may be either certified by the American Chemical Society or not, according to requirements listed below. The certified degree is not necessary for the furtherance of any professional goals. For sample four-year schedules, please see the Chemistry Department website.

Requirements for the Basic Chemistry Major: Eight core courses in the department (CHM-110*, -231, -232, -240, -260, -340, -351 and -352), one course in biochemistry (selected from BCH-335, BCH-380 or BCH-382), and one chemistry-related elective (chosen from CHM-224/ESC-224, CHM-330, -332, -354, -360, -365, or GEO-302), plus mathematics through MTH-115 and two terms of introductory physics (PHY-110 or 120, and PHY-111 or 121). Chemistry majors may fulfill their WS requirement through a two- or three-term senior research thesis under the supervision of a faculty member in the Chemistry Department (CHM-491, -492, -493), through performing thesis research in another department (if a double major or ID major), or through an additional writing component added to an upper-level chemistry course (with permission of the instructor and the chair of the Chemistry Department). Knowledge of a foreign language is strongly encouraged but not required. *Students without sufficient preparation for CHM-110 may substitute the two-course CHM 101/102 sequence.

Requirements for the A.C.S. Chemistry Major: There are four different tracks that build on a common core of courses. Each track includes one Introductory Course (CHM-110*), six Foundation Courses (CHM-231, -232, -240, -260, -351 and -382), four In-Depth courses (as outlined below) in chemistry and related areas**, three terms of thesis research in chemistry (CHM-491, -492, and -493), plus mathematics through MTH-115 and two terms of introductory physics (PHY-110 or 120, and PHY-111 or 121). In-depth course requirements for each track follow:

Chemistry Track: Three required in-depth courses (CHM-340, -352, and either -360 or -365) and one elective in-depth course (chosen from CHM-330, -332, -354, -360, -365, BIO-380). Also recommended: additional courses in chemistry, physics, computer science, and/or engineering, knowledge of a foreign language and a term abroad.

Chemical Biology Track: Two required in-depth courses (BIO-380 and CHM-340) and two elective in-depth courses (chosen from CHM-330, -332, -352, -365, BIO-378, -384, PHY-200). Also recommended: additional courses in chemistry, biology, physics, computer science, and/or engineering, knowledge of a foreign language and a term abroad.

Environmental Chemistry Track: One required in-depth course (CHM-340) and three elective in-depth courses (chosen from BIO-320, -328, CHM-352, ENS-251, GEO-200, -301, -302, -304). Also recommended: additional upper-level chemistry courses, additional selections from the in-depth course electives for this track, courses in environmental ethics, history, literature and/or policy, and a term abroad.

Materials Chemistry Track: Two required in-depth courses (CHM-352 and -360) and two elective in-depth courses (chosen from CHM-224, -340, MER-213, -214, -240, -354, BNG-334, GEO-200, -302, PHY 311). Also recommended: additional courses in chemistry, biology, physics, computer science, and/or engineering and a term abroad.

*Students without sufficient preparation for CHM-110 may substitute the two-course CHM 101/102 sequence.

**Some of the elective choices for these tracks are offered by other academic departments. There is no expectation that other departments will guarantee space in their courses for chemistry students. In addition, there is no expectation that those departments will waive any prerequisites for their courses.

Requirements for Interdepartmental Majors: Students completing an 8-6 or 8-4-4 interdepartmental program in which the eight courses are in chemistry, should take the following courses: CHM-101, and -102 or -110, -231, -232, -240, -340, -351, and one of the following five courses: CHM-260, -330, -332, -352, or -382. No exceptions will be permitted unless written approval is sent from the chair to the registrar. Students completing an 8-6 or 8-4-4 interdepartmental program in which either the six courses or the four courses are in chemistry should take CHM-101 and -102 or -110, -231, -232, -240, and -260 or -340, in the former case and any four chemistry major courses in the latter. Students completing interdisciplinary majors who are seeking secondary school certification should also follow the directions noted below. Students in the Leadership in Medicine program whose science emphasis is in chemistry should take the following six courses: CHM-110*, -231, -232, -240, -382 and one additional 200-level chemistry course with lab, or any 300-level chemistry course, excluding BCH/CHM-335. *Students without sufficient preparation for CHM-110 may substitute the two-course CHM 101/102 sequence.

Requirements for Honors: Candidates for honors in chemistry must have a cumulative index of at least 3.3 and an index of at least 3.3 in the courses of their major, excluding cognates, and must have at least three A or A- grades in such courses (not including any given in connection with the writing of their Senior Thesis). They must submit evidence of independent work in chemistry of substance and distinction in the form of a thesis which shall have been awarded a grade of at least A-. Candidates must fulfill the College-wide criteria for honors and they must be formally nominated by the Chemistry Department.

Requirements for the Minor: CHM-101 and -102 or -110, and -231 and any three other chemistry courses. Students with majors in Division I and II departments or psychology can count one chemistry GenEd course toward the minor if it is their first course in the minor.

Requirements for Secondary School Certification: PSY-246, EDS-500A, EDS-500B and at least one year of a foreign language. Chemistry requirements are identical to those of the chemistry major. All science majors are encouraged to seek certification in more than one science. To be certified in any science requires a complete major in that science. Students wishing to add certification in general science must include at least two courses each from the areas of biology (BIO-101 and -102), physics (PHY-120, -121, or -210), and earth science (any GEO course or AST-200).

Chemistry interdepartmental majors seeking secondary school certification must choose all departments from among the Departments of Biology, Chemistry, Geology, and Physics. Interdepartmental majors completing an 8-6 or 8-4-4 interdepartmental program in which the eight or six courses are in chemistry would take the chemistry courses specified for interdepartmental majors (above). Students with chemistry as a four-course minor element in an 8-4-4 interdepartmental major, would include at least CHM-101 and -102 or -110, -231, and -232.

Course Selection Guidelines

Placement: Any student interested in taking introductory chemistry is required to take a placement examination to determine the appropriate course. Exception: a student wishing to take chemistry who has scored 4 or 5 on the AP chemistry exam will be automatically placed into CHM-110 and cannot take CHM-101. Students who have scored 4 or 5 on the AP chemistry exam or who successfully complete CHM-110 will also receive AP credit for CHM-101. CHM-110 is offered only in the fall term. [Note: occasionally a student who places out of CHM-101 may find it more appropriate to take CHM-102 instead of -110. This decision must be made in consultation with the chair of the Chemistry Department.]

General Education Courses: CHM-050, -060 and -080 are designed for the general college community. They do not count toward the chemistry major nor for interdepartmental majors that include chemistry. Only students with majors in Division I and II departments or psychology can count one chemistry GenEd course toward the minor in chemistry, and only if it is their first course in the minor. CHM-101, -102, and -110 are also appropriate courses for students wishing to complete their General Education requirements.

Prerequisites: There is a strict prerequisite structure for the chemistry curriculum, so it is very important to review individual course descriptions when planning when to take the various courses. Every 200-level course has at least one 100-level chemistry course prerequisite, and some have other 200-level chemistry courses and/or cognate courses as prerequisites. Every 300-level course has at least one 200-level chemistry course prerequisite, and some have other 300-level chemistry courses and/or cognate courses as prerequisites.

Courses

CHM-050. Topics in Chemical Analysis – Forensic Chemistry (GenEd; Not offered 2011-12). Introduction to the analytical approaches used by forensic chemists. These methods of analysis, including the use of research-grade instrumentation, will be applied in the laboratory to simulated “crime scene” evidence. Not open to students who have completed CHM-101 or CHM-110, or have AP credit in chemistry.

CHM-060. Meals to Molecules (GenEd; Not offered 2011-12). What is a healthy diet? This course will discuss human nutrition from a molecular perspective. Readings from the textbook and laboratory exercises will familiarize the student with the components of foods and how these components are used by the human body. In addition, the course will examine the benefits and pitfalls of supplementation of the diet with vitamins, etc., and discuss how to interpret health claims. Not open to students who have completed CHM-101 or CHM-110, or have AP credit in chemistry.

CHM-080. Culinary Chemistry (GenEd; Spring; Kehlbeck). This culinary-themed course is an introduction to the chemistry involved in food preparation and cooking. The course will include lecture and a laboratory experience with inquiry-based exercises in both the traditional chemical laboratory setting and a typical kitchen setting. Topics include the chemical make-up of the food we eat, the relationship between structure and flavor,

and how chefs exert exquisite control over chemical reactions to create the flavor and texture of a gourmet meal. Not open to students who have completed CHM-101 or CHM-110, or have AP credit in chemistry.

CHM-101. Introductory Chemistry I (Fall, Winter, Spring; Staff). Chemistry 101 is an introductory course that focuses on atomic and molecular structure, chemical bonding, stoichiometry, the nature of chemical reactions, and the properties of gases, liquids, solids and solutions. The goal of the course is to integrate these topics in chemistry with their applications to the environment, materials, and medicine. Three lab hours each week. Not open to students who have scored 4 or 5 on the AP Chemistry Exam or who have completed CHM-110. All students who wish to enroll in an introductory chemistry course must take a placement examination to determine the appropriate course (CHM-101, CHM-102 or CHM-110).

CHM-102. Introductory Chemistry II (Winter, Spring; Staff). A continuation of CHM-101, focusing on thermodynamics, chemical kinetics, chemical equilibrium, acids and bases, electrochemistry, and an introduction to organic chemistry. As in Chemistry 101, the chemistry concepts are set within the context of relevant applications, including polymers and biomolecules, fuels, and alternative energy. Three lab hours each week. Prerequisite: Chemistry 101 or placement via the placement exam. Not open to students who have taken CHM-110.

CHM-110. Accelerated Introductory Chemistry (Fall; Anderson, Lou). A laboratory-intensive course that will deal with the main topics of Chemistry 101 and Chemistry 102 and is meant to replace those courses for students who have strong backgrounds in Introductory Chemistry. Students wishing to take chemistry who have scored 4 or 5 on the AP chemistry exam will be automatically placed into Chemistry 110. All students who have not taken an AP Chemistry course or have scored 3 on the AP Chemistry Exam are required to take a placement examination to determine whether they will enroll in CHM-101 or CHM-110. Students who have scored 4 or 5 on the AP chemistry exam or who successfully complete CHM-110 will also receive AP credit for CHM-101.

CHM-224. Frontiers of Nanotechnology and Nanomaterials (Same as ESC-224.) (Winter; Amanuel). An overview of nanotechnology and nanomaterials including interdisciplinary perspectives from engineering, materials science, chemistry, physics, and biology with emphases in sensors and actuators, nanoelectronics, alternative energy, nanocomposites, polymers, biomaterials and drug delivery. Prerequisites: PHY-111 or PHY-121 or IMP-113; MTH-115; and CHM-101 or CHM-110; or permission of instructor.

CHM-231. Organic Chemistry I (Fall, Winter; Staff). A mechanistic approach to the chemistry of carbon compounds organized around the reactions of functional groups. We cover alkanes, cycloalkanes, alcohols, alkyl halides (nucleophilic substitution and elimination), alkenes (addition and elimination), alkynes, spectroscopy (IR and NMR) and computer molecular modeling. Four lab hours each week. Prerequisite: CHM-102 or CHM-110.

CHM-232. Organic Chemistry II (Winter, Spring; Staff). A continuation of Chemistry 231 including an emphasis on synthesis, and the chemistry of conjugated and aromatic compounds, carbonyl compounds, and an introduction to important classes of biomolecules. Four lab hours each week. Prerequisite: Completion of CHM-231.

CHM-240. Analytical Chemistry (Spring; MacManus-Spencer, Lou). Introduction to chemical equilibrium, classical and instrumental methods of chemical analysis, including separations, and statistical treatment of data. Laboratory emphasis is on quantitation of analytes in sample mixtures. Six lab hours each week. Prerequisite: CHM-231.

CHM-260. Inorganic Chemistry. (Spring; Tyler). Foundations of inorganic chemistry with key focus on structure and symmetry, bonding, acid/base properties, reactivity, and physical characterization of inorganic compounds. Laboratory emphasis will focus on the synthesis and characterization of inorganic compounds and investigation of their physical properties. Four lab hours each week. Prerequisites: CHM-231 or permission of the instructor.

CHM-291, 292, 293. Research Practicum (Fall, Winter, Spring; Staff). This course is designed for students who want to gain research experience in chemistry or biochemistry under the direction of a member of the chemistry faculty. Expectations include a minimum of four hours per week of lab work, in addition to other requirements to be determined by individual research advisors. To receive Pass/Fail credit equivalent to one course, the student must earn 3 terms (normally in a row) of passing grades for the practicum experience. Not open to students currently enrolled in CHM-491, CHM-492, CHM-493 or in a sophomore scholars project in the Chemistry Department.

CHM-295H/296H. Chemistry Honors Independent Project 1 and 2 (Fall, Winter, Spring; Staff). Two-term sophomore independent study project on a chemistry- or biochemistry-related project under the direction of a member of the chemistry faculty, for students in the Union Scholars Program. Expectations include a minimum of six hours per week of lab work, in addition to other requirements to be determined by individual research advisors. Student receives a Pass/Fail grade in the first term of the project, and a letter grade and one course credit upon completion of the second term of the project. Not open to students currently enrolled in CHM-491, CHM-492, or CHM-493.

CHM-330. Medicinal Chemistry (Not offered 2011-12). This course focuses on medicinal chemistry and the underlying principles of organic chemistry. Topics to be covered might include drug discovery, lead modification, drug-receptor interactions, structure-activity relationships (SAR), pro-drugs and biomimetics. Physicochemical properties and synthetic approaches to drug families will be especially emphasized. Prerequisite: CHM-232.

CHM-332. Synthetic Methods (Fall; Adrian). This course focuses on developing the common laboratory techniques used in modern synthetic organic chemistry and the underlying principles of organic chemistry covered. Topics to be covered will be in the form of three synthetic projects. Six lab hours each week plus additional instrumentation time outside of lab. Prerequisite: CHM-232.

CHM-335. Survey of Biochemistry (Same as BIO-335 and BCH-335) (Winter; Cohen). A survey of topics in biochemistry including buffers, protein structure, lipid structure, carbohydrate structure, enzyme mechanism, and enzyme kinetics. The pathways by which biomolecules are synthesized and degraded will be investigated. Specifically we will look at carbohydrate, lipid and nitrogen metabolism. Medical applications will be emphasized throughout the course. Prerequisites: BIO-225 and CHM-231. Not open to students who have completed either BIO/BCH 380 or BCH/BIO/CHM 382 or students in the 8-year medical program whose science emphasis is in chemistry.

CHM-340. Chemical Instrumentation (Fall; Carroll, MacManus-Spencer). Theory and practice of modern methods of analysis with emphasis on spectroscopic, chromatographic, electrochemical, and surface science techniques, as well as electronic measurements. Four lab hours each week. Prerequisite: CHM-231, CHM-240, and one course in physics or permission of the instructor.

CHM-351. Kinetics and Thermodynamics (Winter; Anderson, Kohler). Properties of gases; chemical kinetics; fundamentals of thermodynamics including heats of reactions and phase and chemical equilibria. Four lab hours each week. Prerequisites: CHM-240, PHY-110 or PHY-120 and MTH-115

CHM-352. Quantum Chemistry (Spring; Anderson, Kohler). Fundamentals of quantum mechanics and its application to chemical bonding and spectroscopy. Four lab hours each week. Prerequisites: CHM-351 and PHY-111 or PHY-121.

CHM-354. Chemical Applications of Group Theory (Not offered 2011-12). A course on the role of molecular symmetry in chemistry. Topics include symmetry point groups, bonding in organic, inorganic, and organometallic compounds, orbital symmetry control of chemical reactions, and spectroscopy. Prerequisites: CHM-232 and CHM-352, MTH-115, and PHY-111 or PHY-121. CHM-352 may be taken concurrently.

CHM-360. Advanced Inorganic Chemistry: Materials (Winter; Hagerman). Structure/property relationships in solids, organometallics, homogeneous and heterogeneous catalysis, materials chemistry and inorganic nanomaterials. Prerequisites: CHM-260 and CHM-351 or permission of the instructor.

CHM-365. Advanced Inorganic Chemistry: Bioinorganic Chemistry (Not offered 2011-12). Introduces and emphasizes the importance of metals in biological systems such as metalloproteins and enzymes. Important metal containing synthetic compounds, including drugs and biomimetic complexes, will also be presented. Prerequisites: CHM-260 and CHM-351 or permission of the instructor.

CHM-382. Biochemistry: Structure and Catalysis (Same as BCH-382 and BIO-382) (Winter; Fox, Anderson). Structure and function of proteins/enzymes including purification, mechanism, kinetics, regulation, metabolism and a detailed analysis of several classic protein systems. Four lab hours each week. Prerequisite: CHM-232. Not open to students who have completed CHM-335, BIO-335 or BCH-335.

CHM-491, -492, -493. Chemical Research (Fall, Winter, Spring; Staff). Chemical research under the direction of a member of the faculty. Thesis required. Expectations include a minimum of twelve hours per week of lab work, in addition to other requirements to be determined by individual research advisors. Prerequisites: CHM-232, CHM-240 (CHM-340 and CHM-351 are recommended), third-term junior standing, and/or permission of the department chair.