Colby

CHEMISTRY

Chair, *Associate Professor Jeffrey Katz*
Associate Chair, *Professor Thomas Shattuck*
Professors Whitney King, Julie Millard, Thomas Shattuck, and Dasan Thamattoor; Associate Professors Rebecca Conry and Jeffrey Katz; Assistant Professor Kevin Rice; Postdoctoral Research Fellow Nicholas Bizier; Senior Teaching Associates Brenda Fekete and Lisa Miller; Teaching Assistants Edmund Klinkerch and Tara Kraus

Students in the Chemistry Department are provided a firm foundation in the fundamental principles of the discipline. The student major has access to a wide range of instruments for course work and research projects under supervision of a faculty that includes teaching specialists in analytical, environmental, inorganic, organic, physical chemistry, and biochemistry. Many students go on to graduate school in chemistry or biochemistry or to careers in medicine, dentistry, health-related fields, and industrial research. Other career choices in recent years have included patent law, chemical engineering, environmental science, computer science, and molecular biology.

The department offers several programs: (1) the chemistry major, (2) the chemistry-biochemistry major, (3) the chemistry major with a concentration in cell and molecular biology/biochemistry, (4) the chemistry-environmental sciences concentration, and (5) the chemistry minor. Additionally, each type of chemistry major can earn accreditation by the American Chemical Society (ACS) with additional courses selected in consultation with the advisor and with approval of the chair. More information about ACS certification can be found on the Chemistry Department website. Chemistry majors who intend to apply for admission to medical, dental, or veterinary schools must take a biology course with laboratory. For maximum flexibility, students are encouraged to take Chemistry 141 and 142 (or Chemistry 145) in their first year.

Students interested in teaching, private and public, are urged to read the “Education” section of the catalogue and to contact a member of the Education Program.

Requirements for the Major in Chemistry

Chemistry 141 and 142 (or 145), 241, 242, 331, 341, 342, 493 and 494; Mathematics 121 and 122, or 161 and 162; Physics 141 (or 143) and 145.

Requirements for the Major in Chemistry-Biochemistry

Chemistry 141 and 142 (or 145), 241, 242, 341, 367 (with laboratory), 368 (with laboratory), 493 and 494; Mathematics 121 and 122, or 161 and 162; Physics 141 (or 143) and 145; Biology 163; one course from Biology 225, 232 (with laboratory), 274 (with laboratory), 279 (with laboratory); and one course from Chemistry 331, 342, 378, 411, 444. Biology courses above the 100 level and/or biochemistry courses used to fulfill a biology major cannot count toward the major in chemistry-biochemistry.

Requirements for the Major in Chemistry with a Concentration in Cell and Molecular Biology/Biochemistry

Chemistry 141 and 142 (or 145), 241, 242, 341, 367 (with laboratory), 368 (with laboratory), 378, 493, and 494; Biology 163 and 279 (with laboratory); Mathematics 121 and 122, or 161 and 162; Physics 141 (or 143) and 145. Biochemistry 367, 368, 378, and Biology 279 cannot be double-counted toward both a biology major and the major in chemistry with a concentration in cell and molecular biology/biochemistry.

Requirements for the Concentration in Chemistry-Environmental Science

All courses required for the chemistry major; Chemistry 217, and 481 or 482; Economics 133, 231; Biology 163 and 164, or Geology 141 and 142.

Additional Requirements for All Majors in the Chemistry Department

Each major must complete a chemistry-related independent study project equivalent to two (or preferably three) credit hours. This requirement may be satisfied through independent study, internship, or summer research, and it forms the basis of the seminar presentations in Chemistry 493 and 494. An off-campus research experience must have prior approval of the chair of the Chemistry Department to satisfy this requirement.

The Seminar Program (Chemistry 493, 494) is an opportunity for students to interact with chemists from other schools. All senior chemistry majors are required to enroll in Chemistry 493 and 494. Junior chemistry majors are strongly encouraged to attend and may enroll in either Chemistry 493 or 494.

The point scale for retention of the major applies to all required courses and all elected chemistry courses. No requirement for the major may be taken satisfactory/unsatisfactory.

Honors Project in Chemistry

Majors in chemistry are encouraged to elect an honors research project with approval of a faculty sponsor in the department. Honors research normally entails eight to 10 credits across the senior year. Successful completion of the work of the honors research project, and of the major, will enable the student to graduate “With Honors in Chemistry.” Attention is also called to the Senior Scholars Program.

Requirements for the Minor in Chemistry

Chemistry 141 and 142 (or 145), 241, and at least 10 credit hours in three or more courses selected from the following: Chemistry 217, 242, 255, 331, 332, 341, 342, 362, 367, 368, 378, 411, 413, 431, 432, 434, 444. Courses selected to fulfill the minor must include at least four courses in addition to courses taken to satisfy requirements for any major or other minor. Specifically, Chemistry/Biology 362, 367, 368, and 378 cannot be used to fulfill the requirements for both a major and the chemistry minor. Students are strongly advised to consult with a member of the chemistry faculty to select a logical grouping of courses for the minor.

Course Offerings

CH112f Chemistry for Citizens Basic chemical principles and their applications to topics of current concern to society. Topics include atomic theory, chemical bonding and reactions, properties of solutions, and the chemistry behind drugs, DNA technology, and many household products. Intended for non-science majors. Working knowledge of algebra required. Students with prior credit for Chemistry 118, 141, or 145 may not receive credit for Chemistry 112. Fulfills non-laboratory science requirement. *Three credit hours.* **N** MILLARD

[CH112J] Chemistry for Citizens Basic chemical principles and their applications to topics of current concern to society. Topics include atomic theory, chemical bonding and reactions, properties of solutions, and the chemistry behind drugs, DNA technology, and many household products. The laboratory introduces students to the scientific method and the use of both qualitative and quantitative data in decision making. Intended for non-science majors. Working knowledge of algebra required. Students with prior credit for Chemistry 118, 141, or 145 may not receive credit for Chemistry 112. **During Jan Plan Selection, choose the lab(s) only. The lecture will be added for you if you are confirmed in the course.** *Prerequisite:* Concurrent enrollment in Chemistry 112JL. *Three credit hours.* **N**

CH141f General Chemistry Fundamental principles of chemistry including atomic theory, stoichiometry, solution chemistry, gas laws, thermochemistry, chemical bonding, and intermolecular forces. Students will become proficient at using pre-calculus-level quantitative skills in a scientific context and to master the interface between narrative and mathematical problem solving. The laboratory will familiarize students with experimental techniques and the accumulation and analysis of experimental data. Students with prior credit for Chemistry 145 may not receive credit for Chemistry 141. Lecture, discussion, and laboratory. *Four credit hours.* **N,Lb** KATZ, SHATTUCK

CH142s General Chemistry Explores the fundamental principles of chemistry including chemical equilibria, thermodynamics, kinetics, electrochemistry, and radioactivity. Students will become proficient at using pre-calculus-level quantitative skills in a scientific context and will master the interface between narrative and mathematical problem solving. The laboratory will familiarize students with experimental techniques and the accumulation and analysis of experimental data. Students with prior credit for Chemistry 145 may not receive credit for Chemistry 142. Lecture and laboratory. *Prerequisite:* Chemistry 141. *Four credit hours.* **N,Lb** CONRY, RICE

CH143f Turbo Chemistry A recitation section designed to amplify the material covered in General Chemistry lecture with extra challenging homework, practice exams, and required group problem sets. *Prerequisite:* Permission of the instructor. *One credit hour.* KING

CH144s Turbo Chemistry A recitation section designed to amplify the material covered in General Chemistry lecture with extra challenging homework, practice exams, and required group problem sets. *Prerequisite:* Permission of the instructor. *One credit hour.* KING

CH145f Honors General Chemistry Introductory chemistry for students with strong pre-college chemistry preparation. An accelerated course covering similar topics as Chemistry 141 and 142 with an additional focus on modern bonding theory. Students will become proficient at using pre-calculus-level quantitative skills in a scientific context and mastering the interface between narrative and mathematical problem solving. The laboratory will familiarize students with experimental techniques and the accumulation and analysis of experimental data. Students with prior credit for Chemistry 141 or 142 may not receive credit for Chemistry 145. Lecture and laboratory. *Four credit hours.* **N,Lb** RICE

[CH151] K-8 Chemistry Outreach Activities Development of hands-on activities to fulfill physical science goals required by the Maine Learning Results. Students create age-appropriate science experiments that illustrate the relevance of chemistry to society and implement these activities in area classrooms and on campus. Communication skills are enhanced through the development of teacher kits (written) and interaction with schoolchildren (oral). Lecture only. *Prerequisite:* Chemistry 112 with laboratory or 118 with laboratory or 141. *Three credit hours.* **N**

CH197j Chemistry of Color and Art Materials A study of the nature of light and how light interacts with matter to produce color. An exploration of the chemical properties of materials that cause color, as well as which analytical techniques probe those properties as applied to artist materials, such as pigments, dyes, paints, glasses, and ceramics. *Prerequisite:* A strong background in high school chemistry and physics or an introductory college chemistry course (Chemistry 112, 118, or 141) is strongly recommended. *Three credit hours.* **N** CONRY

CH217s Environmental Chemistry Application of chemical principles to the environment with an emphasis on the interaction among chemical, physical, geological, and biological processes. Current topics such as acid deposition, global warming, atmospheric ozone loss, and the fate and toxicity of heavy metals will be discussed in the context of natural environmental processes. *Prerequisite:* Chemistry 142. *Three credit hours.* KING

CH241f Organic Chemistry Exploration of the relationships among structure, reactivity, and synthesis of organic compounds. The lecture portion introduces atoms and molecules, orbitals and bonding, the chemistry of alkanes, alkenes, alkynes, and other functional groups, stereochemistry, ring systems, substitution and elimination reactions, and kinetics and equilibria. The laboratory involves the use of common techniques used by chemists, instrumentation, and molecular modeling. The goals are to help students think critically, solve problems, and write effectively. *Prerequisite:* Chemistry 142. *Four credit hours.* THAMATTOOR

CH242s Organic Chemistry Theories encountered in Chemistry 141, 142 are used as the basis for a detailed study of the relationships among structure, reactivity, and synthesis of organic compounds. Lecture, discussion, and laboratory. The laboratory explores the use of separation techniques, synthesis, and spectral techniques in organic chemistry. *Prerequisite:* Chemistry 241. *Four credit hours.* BIZIER, KATZ

[CH255] Nuclear Magnetic Resonance The theory and practice of one- and two-dimensional NMR, infrared spectroscopy, and mass spectrometry. Examples include complex organic species and biological macromolecules, including proteins. Laboratory exercises include sample preparation and common two-dimensional NMR experiments, including polarization transfer (DEPT), chemical shift correlation (COSY, TOCSY, HMQC, HMBC, Adequate), and nuclear Overhauser effect (NOESY) spectroscopy. Skills developed include the ability to sift through incomplete and sometimes conflicting data to reach a logical conclusion based on available evidence. Offered in alternate January Programs. Lecture and laboratory. *Prerequisite:* Chemistry 241. *Three credit hours.*

CH331f Chemical Methods of Analysis A study of the fundamentals of analytical chemistry. Students learn how to use physical measurements to make quantitative chemical measurements reported with defined uncertainties. Concepts of chemical mass and charge balance are used to calculate chemical speciation in complex acid/base and redox systems. Lectures and homework focus on problem-solving skills that provide solutions to new problems based on fundamental chemical principles and constants. The required laboratory introduces advanced volumetric, potentiometric, and spectroscopic techniques for quantitative chemical analysis. Written lab reports reinforce the technical writing style used in chemical communications. *Prerequisite:* Chemistry 142. *Four credit hours.* KING

CH332s Instrumental Methods of Analysis Instruction in instrumental methods, including modern electroanalytical methods, absorption spectroscopy, fluorescence, Raman spectroscopy, mass spectrometry, and chromatography. Lecture and laboratory. *Prerequisite:* Chemistry 331. Chemistry 342 is recommended. *Four credit hours.* KING

CH341f, 342s Physical Chemistry The laws and theories of chemical reactivity and the physical properties of matter. Emphasis is placed on chemical equilibrium, molecular bonding, and the rates of chemical reactions. Major topics in 341: thermodynamics, solutions, and reaction kinetics. In 342: quantum mechanics, spectroscopy, and statistical mechanics. Gaining facility with abstraction through building mathematical models, working through the implications of those models, and assessing the validity and inherent errors in the ability of the models to predict and explain physical phenomena is the primary goal. Lecture and laboratory. *Prerequisite:* Chemistry 142 or 145, Physics 142 or 145. Chemistry 342 may be taken before 341 with permission of the instructor. *Five credit hours.* SHATTUCK

CH362f Medical Biochemistry Listed as Biochemistry 362. *Four credit hours.* MILLARD

CH367f Biochemistry of the Cell I Listed as Biochemistry 367. *Four or five credit hours.* RICE

CH368s Chemical Basis of Metabolism A focus on the chemical reactions, bioenergetics, and regulatory processes that are essential to the functioning of the cell, stressing the development of problem-solving, critical-thinking, and communication skills in both the lecture and optional laboratory. Topics include the generation and use of metabolic energy, the integrated control of cellular functions, mechanisms of transport, and special topics of particular interest to biochemists with a chemical background. The laboratory will employ a case study approach, applying biochemistry tools to real-world problems. Students cannot receive credit for both Biology 368 and Chemistry 368, nor can they earn credit for Chemistry 368 if they have previously taken Biochemistry 362 or 368. *Prerequisite:* Biochemistry 367. Biochemistry 367 laboratory is prerequisite to Chemistry 368 laboratory. *Four or five credit hours.* MILLARD

CH378s Molecular Biology Listed as Biochemistry 378. *Four credit hours.* JOHNSON

CH411f Inorganic Chemistry Current models and concepts in inorganic chemistry are discussed, with an emphasis on general trends and periodic properties of the chemical elements and their compounds. Topics include bonding and structure, acid-base theories, redox properties, molecular symmetry, and coordination compounds. Students will expand their knowledge of fundamental chemical principles as well as their ability to critically think about, communicate, and apply this knowledge in problem solving. Lecture only. *Prerequisite:* Chemistry 142 (or 145) and permission of instructor. Chemistry 342 is recommended. *Three credit hours.* CONRY

[CH413] Inorganic Laboratory Studies Synthesis and characterization of inorganic and organometallic compounds of both the representative and transition elements. Discussion and laboratory. Co-requisite: Chemistry 411. *Two credit hours.*

[CH431] Mechanistic Organic Chemistry Based on original research articles and designed to teach students to think critically about published material. The readings cover topics such as chemical bonding, molecular orbital theory, and aromaticity, the use of isotopes in determining reaction mechanisms, reactions of atomic carbon, matrix isolation spectroscopy, laser flash photolysis, the influence of structure on reactivity, the role of thermodynamics and kinetics in reactions, linear free energy relationships, and unusual molecules. Students are instructed on computational modeling of chemical reactions, structures, and spectroscopic properties and are taught to retrieve information from the chemical literature. *Four credit hours.*

CH432s Advanced Organic Chemistry The logic and methods of organic synthesis are explored. The elementary organic reactions studied in Chemistry 241, 242 are augmented and used in the synthesis of biologically and chemically important molecules. Lecture only. *Prerequisite:* Chemistry 242 or equivalent. *Four credit hours.* KATZ

CH434s Symmetry and Spectroscopy Use of principles of symmetry and group theory as an aid in understanding chemical bonding, interpreting molecular vibrational and electronic spectroscopy, and rationalizing symmetry control of reactions. Lecture only. *Prerequisite:* Chemistry 411. *Four credit hours.* CONRY

[CH444] Advanced Topics in Biochemistry A detailed look at current trends in experimental research at the interface of chemistry and biology. Critical analyses of recent literature, identification of important problems in the field, and development of proposals to address these problems will be of primary focus. Problem-solving assessments will include both written and oral communication skills. Topics will include proteomics, chemical biology, and advanced enzymology. *Prerequisite:* Biochemistry 367 and 368 (the latter may be taken concurrently.) *Four credit hours.*

CH481f, 482s Special Topics in Environmental Chemistry Primarily a laboratory course with emphasis on independent studies of environmentally related topics. A paper and oral presentation are required. *Prerequisite:* Chemistry 217 and permission of the department. *One to three credit hours.* KING

CH483f, 484s Honors in Research in Chemistry Laboratory and library work involving a senior and one or more chemistry faculty members on a clearly defined project that results in an honors thesis. *Prerequisite:* Permission of the department and recommendation of the faculty sponsor. *One to four credit hours.* FACULTY

CH491f, 492s Independent Study Laboratory work of a research nature may be arranged with the instructor. *One to four credit hours.* FACULTY

CH493f, 494s Senior Seminar Discussion of topics of current interest in all areas of chemistry. Presentations by invited speakers from other colleges, universities, and industry. Seniors give a presentation on their research each semester. *Prerequisite:* Junior or senior standing as a chemistry major. *One credit hour.* KATZ, THAMATTOOR