Chemistry (CHEM)

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Chemistry is the science that seeks to understand the structure and composition of matter and the changes that it undergoes. The atomic/molecular perspective of chemistry provides fundamental insight into the macroscopic world of materials and organisms. Chemists apply this insight in many ways, such as the synthesis of new substances with useful technological or therapeutic properties and the discovery of new analytical methods that can be used in medicine and environmental science. Coursework in chemistry seeks to acquaint students with fundamental chemical principles, teach students to apply these principles broadly and effectively, and enable students to evaluate critically the impact of chemistry on society.

In addition to providing a working knowledge of chemical principles, a major in chemistry offers experience in critical thinking, data analysis and experimental design. Chemistry graduates pursue a variety of careers in which these skills are important. Many work as chemists in chemical or pharmaceutical companies or in government labs. Others apply their chemical skills to careers in medicine, law, business, chemical or pharmaceutical sales, biotechnology, pharmacology, toxicology or environmental science. Many chemistry graduates pursue careers in education at the secondary, college or university level.

The department emphasizes the importance of research experience. The opportunity to engage in an original research investigation, in collaboration with a faculty member, is a distinctive feature of this program.

The chemistry major may be pursued under either the bachelor of arts or the bachelor of science degree programs. Students interested in biochemistry should consider either the bachelor of science chemistry curriculum with biochemistry and biology electives or the bachelor of science program in cell biology/biochemistry offered jointly by the chemistry and biology departments.

A **bachelor of arts major** consists of eight courses in chemistry numbered 211 or above, five of which are required: CHEM 211, CHEM 212, CHEM 221, CHEM 231, and CHEM 340 or CHEM 341. In addition, one semester of calculus (MATH 201) and one semester of physics (PHYS 211) are required. MATH 202 and PHYS 212 are strongly recommended.

A **bachelor of science major** consists of 10 courses in chemistry numbered 211 or above, eight of which are required: CHEM 211, CHEM 212, CHEM 221, CHEM 231, CHEM 322, CHEM 332, CHEM 341, and CHEM 342. The sequence of chemistry courses indicated below is strongly recommended; exceptions to this sequence are rare, and each must be negotiated with the student's adviser on the merits of the particular case.

The chemistry major under the bachelor of science program also requires three courses in mathematics (MATH 201, MATH 202, and MATH 211), three courses in physics (PHYS 211, PHYS 212, and PHYS 235), and one science elective.

The recommended sequence for the bachelor of science major is as follows:

First Year	**First Semester:** CHEM 211; MATH 201 **Second Semester:** CHEM 212; MATH 202
Sophomore Year	**First Semester:** CHEM 221; MATH 211; PHYS 211 **Second Semester:** CHEM 231; PHYS 212
Junior Year	**First Semester:** CHEM 341; science elective **Second Semester:** CHEM 322; CHEM 342; PHYS 235
Senior Year	**First Semester:** CHEM 332; Elective in chemistry **Second Semester:** Elective in chemistry

During the junior year, ELEC 105 in either semester may be substituted for PHYS 235. The science elective may be selected from the following list of courses and can be taken at any time once the prerequisites for the selected course are satisfied: BIOL 205; CHEG 450; CSCI 203; GEOL 305; MATH 212; PHYS 317, 329 and 330, 332, or 333 or other courses with department approval. Electives in chemistry during the senior year may be chosen from any of the 300-level undergraduate courses in chemistry or CHEM 403. No more than two credits of research, CHEM 375-376 or CHEM 403, may be applied toward the minimum 10-course major.

Advanced placement credit accepted by the University will count as a credit toward graduation, but will not replace the number of chemistry courses above 211 that are required for a major in chemistry. The requirement for CHEM 221 is waived for students with AP credit in chemistry but these students are required to take an advanced chemistry course to meet the number required for their degree.

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Transfer students who are given at least 1.5 transfer credits toward graduation based on two semesters of general chemistry taken prior to transfer will be given an adjustment such that those two courses will replace the specific requirement for CHEM 221 and will count as one of the chemistry courses required for the chemistry degree.

Bachelor of science graduates will not automatically achieve the American Chemical Society's certification. To fulfill these requirements, bachelor of science chemistry students should take the equivalent of at least two additional laboratory or research courses, and biochemistry CHEM 351.

Of the 11 electives to be taken during the four undergraduate years, an additional mathematics course is desirable. Since science is an international enterprise, chemistry majors are encouraged to take a foreign language.

Students interested in coordinating graduate with undergraduate work should consult the department chair before the end of the sophomore year. The department offers a combined B.S./M.S. program for students who desire both more research and more advanced chemistry courses than are obtainable under the bachelor of science program. The B.S./M.S. program normally is elected in the sophomore year and is completed in the summer following the senior year.

Two **minors** are available in the department of chemistry:

The minor in chemistry requires six chemistry courses. One of the courses may be CHEM 160, CHEM 201 or CHEM 202; or AP chemistry credit. The other five must be numbered 211 or above and may include a maximum of one semester of CHEM 375, CHEM 376, or CHEM 403.

The chemistry (biochemistry) minor requires six chemistry courses numbered 211 or above, including CHEM 351 and CHEM 352 and may include a maximum of one semester of CHEM 375, CHEM 376, or CHEM 403.

105 and 106. Introduction to Chemistry (I and II; 3, 3)
A terminal elementary course covering in-depth selected topics, which may vary from year to year. Satisfies laboratory science requirement for bachelor of arts students not majoring in science or engineering. Either or both semesters may be taken. CHEM 105 is not a prerequisite for CHEM 106. Not open to students who have taken CHEM 160. Prerequisite: seniors by permission only.

160. Introduction to Environmental Chemistry (II; 3, 3)
One semester terminal course in chemistry. Basic chemical concepts as they relate to chemical behavior, toxicity, and effects in the environment. Case studies are used to illustrate concepts. Satisfies laboratory science requirement for bachelor of arts students not majoring in science or engineering. Laboratory will emphasize techniques used for environmental analysis. Not open to students who have taken CHEM 201, CHEM 202 or CHEM 211. Prerequisite: high school chemistry. Seniors by permission only.

201 and 202. General Chemistry (I and II; 3, 3)
Fundamental principles in inorganic chemistry. Atomic structure, bonding, equilibrium, kinetics, etc. Laboratory experiments are both qualitative and quantitative. CHEM 201 is a prerequisite for CHEM 202. Credit not normally given for both CHEM 201 and CHEM 221 nor is credit normally given for CHEM 202 and CHEM 221 or CHEM 231.

211. Organic Chemistry I (I; 4, 4)
First-year, first-semester course for students majoring in chemistry, biochemistry, and biology. Bonding and structure in organic compounds, resonance, organic acid/base reactions, basic nomenclature, conformational analysis, stereochemistry, properties and reactions of functional groups. Prerequisite: high school chemistry or equivalent.

212. Organic Chemistry II (II; 4, 4)
A continuation of CHEM 211 with focus on properties and reactions of functional groups, synthesis, and spectroscopic analysis. Prerequisite: CHEM 211.

221. Inorganic Chemistry I (I; 3, 3)
Atomic structure and introductory quantum mechanics. Molecular structure and theories of bonding. Introductory thermodynamics and kinetics. Introduction to coordination chemistry. Laboratory: introduction to quantitative techniques. Prerequisite: CHEM 212 or permission of the instructor.

231. Analytical Chemistry I (II; 3, 3)
Chemical equilibrium and modern analysis with an emphasis on acid-base systems, solubility, metal ion determinations, electroanalytical, spectrophotometry, and separation methods. Prerequisite: CHEM 221.

304. X-ray Crystallography (I or II) Half to full course.
Independent study. Symmetry (point, plane, and space groups), diffraction (reciprocal space, precession photographs, automated data collection) and structural solution (Patterson Maps, Electron Density Maps, Refinement). Prerequisite: permission of the instructor.

313. Synthetic Organic Chemistry (I or II; 3, 0)
Modern synthetic organic chemistry, with examples involving complex natural products. Application of organic mechanism, synthetic strategy, and advanced transformations to total synthesis. Prerequisite: CHEM 212.

314. Mechanistic Organic Chemistry (I or II; 3, 0)
Thermal and kinetic aspects of organic reactions are discussed along with the effect of substituents, solvents, and stereochemistry on reaction pathways. Qualitative molecular orbit theory of organic compounds is covered in depth. Weekly problem sessions are held. Prerequisites: CHEM 211 and CHEM 212.

317. Special Topics in Organic Chemistry (I or II; R; 4, 0)
Available by independent study. Prerequisites: CHEM 212 and permission of the instructor.

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322. Inorganic Chemistry II (II; 3, 4)
Survey course in modern inorganic chemistry covering transition metal, coordination, organometallic, and bioinorganic chemistry. Laboratory will consist of synthetic and physical measurements as well as the manipulation of air-sensitive materials. Prerequisite: CHEM 231.

327. Special Topics in Inorganic Chemistry (I or II; 4, 0)
Available by independent study. Prerequisites: CHEM 322 and permission of the instructor.

332. Analytical Chemistry II (I; 3, 4)
Theory and practice of techniques of instrumental analysis including spectrophotometry, fluorescence, mass spectrometry, atomic absorption, chromatography, capillary electrophoresis, dynamic electrochemistry, and specific ion electrodes. Prerequisite: CHEM 231.

337. Special Topics in Analytical Chemistry (I or II; 4, 0)
Available by independent study. Prerequisites: CHEM 231 and permission of the instructor.

340. Biological Physical Chemistry (II; 3, 4)
Introduction to physical chemistry for life science students, with emphasis on thermodynamics, colligative properties and spectroscopy. Not open to BS chemistry majors. Prerequisites: CHEM 231, MATH 201, and PHYS 211. MATH 202 and PHYS 212 are recommended.

341. Physical Chemistry I (I; 3, 4)
Introductory physical chemistry with emphasis on thermodynamics, kinetics, and electrochemistry. Prerequisites: CHEM 231, MATH 211, and PHYS 212. Not open to engineering majors.

342. Physical Chemistry II (II; 3, 4)
Introductory physical chemistry with emphasis on quantum mechanics, molecular spectroscopy and statistical mechanics. Prerequisite: CHEM 341.

343. Physical Chemistry for Engineers (I; 3, 1)
Introductory physical chemistry for engineers with emphasis on thermodynamics, kinetics, and electrochemistry. Prerequisites: CHEM 231, MATH 211, PHYS 211. Only open to engineering majors.

347. Special Topics in Physical Chemistry (I or II; 4, 0)
Available by independent study. Prerequisites: CHEM 231 and permission of the instructor.

351. Biochemistry I (I; 4, 0)
Introduction to biological chemistry with emphasis on the structure and function of proteins, lipids, carbohydrates and nucleic acids, kinetics and mechanisms of enzymes, bioenergetics, and metabolism. Prerequisite: CHEM 231 or permission of the instructor.

352. Biochemistry II (II; 4, 0)
Advanced topics in protein structure and function, protein folding, enzyme mechanisms, electron transport and free-energy coupling mechanisms, biosynthesis, metabolic regulation, and supramolecular assemblies. Prerequisite: CHEM 351 or permission of the instructor.

357. Special Topics in Biochemistry (I or II; 3, 1)
Structure/function relationships and dynamics of biomolecules. Prerequisite: permission of the instructor.

358. Biochemical Methods (II; 2, 6)
A course in laboratory techniques including cell fractionation, protein, and nucleic acid analysis. Spectrophotometry, chromatography, centrifugation, electrophoresis, and mass spectrometry are emphasized. Prerequisite: permission of the instructor. Crosslisted as BIOL 340.

360. Advanced Environmental Chemistry (I; 4, 0)
Environmental chemodynamics, transport, abiotic transformation, biotransformation, environmental toxicology, pollutants, the environmental fate/effects of chemicals will be discussed. Prerequisite: CHEM 231 or permission of the instructor.

375 and 376. Undergraduate Research (I and II; R; 0, 6-24) Half to two courses.
Original investigations in analytical, biological, organic, physical, environmental, or inorganic chemistry.

385 and 386. Seminar (I and II; R; 2, 0) Half course.

403. Research in Chemistry Capstone (II; 2, 10)
Students conduct a research project under the guidance of a faculty member in the sciences. In weekly meetings, they share reports from the literature, report on their own work, and consider other issues and topics important in the conduct of research. Prerequisite: permission of the instructor.