CHEMISTRY (CHEM)

Chemistry is the study of the principles that govern matter and the chemical transformations of matter. This fundamental discipline plays a pivotal role in all of the sciences. In fact, life itself is essentially a complicated system of interrelated chemical processes. In the study of Chemistry, the student is exposed to atomic and molecular structure, properties of matter, chemical reactions, and spectroscopy.

A student who successfully completes the Chemistry Major gains basic theoretical knowledge and practical experimental skills in areas of inorganic, organic, analytical, physical, and biochemistry. Courses in the supporting areas provide a basic foundation in calculus, physics, and subjects necessary to understanding modern chemical concepts. Coordinated laboratory experiences reinforce concepts presented in lecture classes. Students also benefit from "hands-on" use of modern chemical instrumentation and from student research, a requirement of every student majoring in Chemistry.

Knowledge of chemistry is necessary for all health and allied health professional programs, geochemistry, environmental science, and molecular biology. Students seeking entrance into professional and graduate programs in these areas are well-prepared as Chemistry majors. Employment opportunities (academic and research laboratories, governmental agencies, hazardous materials management, sales, environmental testing, and remediation) remain good for students possessing undergraduate degrees in Chemistry. Opportunities expand exponentially for those students who continue their training for a masters or doctoral degree. Chemistry graduates from Western have been successful in their careers because of the theoretical and practical training received in their areas of emphasis.

The Chemistry Major at Western consists of a comprehensive program offering three areas of emphasis selected according to the interests and career goals of the student. These emphases are: general chemistry, biochemistry, and secondary licensure.

The Secondary Licensure Emphasis in Chemistry qualifies students for the State of Colorado License in Science Education. Other Chemistry emphases may also be used for licensure but may require additional classes. In addition, the student must fulfill the requirements of the Secondary Licensure Program (see description under Education).

Program Goals

- Students will develop and demonstrate knowledge of chemistry consistent with an undergraduate degree.
- Students will develop skills to solve relevant complex problems related to the field of chemistry.
- Students will develop proficiency in laboratory techniques, use of instruments, and safety awareness.
- Students will develop proficiency in writing in the discipline

- Chemistry Comprehensive Major: Biochemistry Emphasis (https://catalog.western.edu/undergraduate/programs/chemistry/chemistry-comprehensive-biochemistry/)
- Chemistry Comprehensive Major: General Chemistry Emphasis (https://catalog.western.edu/undergraduate/programs/chemistry/chemistry-comprehensive-general-chemistry/)
- Chemistry Comprehensive Major: Secondary Licensure Emphasis (https://catalog.western.edu/undergraduate/programs/chemistry/chemistry-comprehensive-secondary-licensure/)
- Chemistry Comprehensive Major: Secondary Licensure Emphasis (with a 3+2 Master of Arts in Education) (https://catalog.western.edu/undergraduate/programs/chemistry/chemistry-comprehensive-secondary-licensure-3-2/)
- Chemistry Minor (https://catalog.western.edu/undergraduate/programs/chemistry/chemistry-minor/)

Capstone Course Requirement

The following courses fulfill the capstone course requirement for the Chemistry Major: CHEM 494 Research Problem in Chemistry, or EDUC 409 Secondary Student Teaching (Secondary Licensure Emphasis).

Chemistry Courses

CHEM 100. Contemporary Chemistry (GT-SC2). (3 Credits)
An introductory course which addresses the basic facts and principles of chemistry, as well as the history of chemistry, practical aspects of chemistry, and relevance of chemistry. Topics covered in the course are dependent on the instructor and contemporary events. This course is designed for non-science majors without a background in chemistry or mathematics and may not be counted toward the Chemistry Major or Minor. GT-SC2

CHEM 101. Introduction to Inorganic Chemistry (GT-SC2). (3 Credits)
A survey of inorganic chemistry, with an emphasis on chemical principles, atomic theory, periodic law, chemical equilibrium, equations, solutions, and descriptive chemistry of the elements. This course is designed for non-majors without a background in chemistry or mathematics and may not be counted toward the Chemistry Major or Minor. GT-SC2

CHEM 111. General Chemistry I (GT-SC2). (3 Credits)
An introductory course designed for science majors focusing on principles and applications of chemistry. Previous experience with chemistry is expected. Topics covered are stoichiometry, bonding models, intermolecular forces, and periodic trends. Prerequisite: ACT math score of 23 or above; SAT math score of 560 or above; MATH 140 with a minimum grade of C-; or Accuplacer Advanced Algebra and Functions test score of 280 or above; or corequisite MATH 140 and ACT math score of 21 or above or SAT math score of 540 or above or Accuplacer Advanced Algebra and Functions test score of 245 or above; or instructor permission. GT-SC2

CHEM 112. General Chemistry Laboratory I (GT-SC1). (1 Credit)
An introduction to basic laboratory techniques of inorganic chemistry correlating with CHEM 111. Experiments emphasize techniques, instrumentation, and solution chemistry. Laboratory notebookkeeping and the safe handling and disposal of laboratory chemicals are also stressed. Additional course fee applies. Corequisite: CHEM 111. GT-SC1

CHEM 113. General Chemistry II. (3 Credits)
A continuation of CHEM 111. Topics covered are thermodynamics, kinetics, equilibrium, electrochemistry, and nuclear chemistry. Prerequisite: CHEM 111 with a minimum grade of C- or instructor permission.

CHEM 114. General Chemistry Laboratory II. (1 Credit)
A continuation of CHEM 112. An introduction to basic laboratory techniques of inorganic chemistry correlating with CHEM 113. Experiments emphasize techniques, instrumentation, and solution chemistry. Laboratory notebookkeeping and the safe handling and disposal of laboratory chemicals are also stressed. Additional course fee applies. Prerequisite: CHEM 112 or instructor permission. Corequisite: CHEM 113.

CHEM 121. General Chemistry for Engineers. (3 Credits)
A single semester general chemistry course designed for engineering students. Previous experience with chemistry is expected. Topics include atomic structure, bonding models, stoichiometry, states of matter, intermolecular forces, thermodynamics (including calorimetry, enthalpy, entropy and Gibbs free energy), and equilibrium. Prerequisite: ACT math score of 23 or above; SAT math score of 560 or above; MATH 140 with a minimum grade of C-; ALEKS test score of 61 or above; or Accuplacer university-level mathematics test score of 65 or above. Or instructor permission.

CHEM 197. Special Topics. (1-6 Credits)
Special Topics.

CHEM 231. Introduction to Organic Chemistry and Biochemistry. (3 Credits)
A descriptive survey course which introduces the essential topics and applications of organic chemistry and biochemistry. The course is designed for non-majors who need the second semester of a one-year chemistry core that includes general, organic, and biochemistry. This course may not be counted for credit toward the Chemistry Major or Minor. Prerequisite: CHEM 101 or CHEM 113 or instructor permission.

CHEM 234. Introductory Organic and Biochemistry Laboratory. (1 Credit)
An introductory laboratory to accompany CHEM 231. Experiments focus on reactions of organic functional groups, organic synthesis, and the chemistry of biological molecules. This course may not be counted for credit toward the Chemistry Major or Minor. Additional course fee applies. Prerequisite or corequisite: CHEM 231 or instructor permission.

CHEM 292. Independent Study. (1-6 Credits)

CHEM 297. Special Topics. (1-6 Credits)
Special topics.

CHEM 302. Chemical Information Literacy and Communication. (3 Credits)
In this course designed for chemistry majors, students learn about the organization of the chemical literature, important resources for navigating the literature of chemistry, and methods for selecting the most appropriate resources. Students will work on effective written, oral and graphical communication for chemistry and the sciences. Prerequisites: ENG 103, CHEM 113 and CHEM 114; or instructor permission.

CHEM 306. Analytical Chemistry (with laboratory). (4 Credits)
A lecture/laboratory course involving principles, techniques and calculations involved with quantitative analysis of substances. Includes solution chemistry, gravimetric, volumetric, redox, and pH determinations. Additional course fee applies. Prerequisites: CHEM 113 and CHEM 114; or instructor permission.

CHEM 331. Organic Chemistry I. (3 Credits)
First semester course of a two semester organic chemistry sequence. This course is an in depth study of saturated and unsaturated hydrocarbons. Topics include their naming, electronic structure, bonding, reactivity, stereochemistry, and reaction mechanisms Prerequisite: CHEM 113 or instructor permission.

CHEM 332. Organic Chemistry II. (3 Credits)
A continuation of CHEM 331. This course discusses spectroscopic analysis, physical, and chemical properties of organic functional groups. Emphasis includes synthesis, mechanisms, and reactions of aromatic compounds, carbonyl containing compounds, and amines. Prerequisite: CHEM 331 or instructor permission.

CHEM 334. Organic Chemistry Laboratory I. (1 Credit)
An accompanying laboratory course for CHEM 331, serving as an introduction to basic macro-and micro- scale organic techniques used to separate, isolate, and characterize organic compounds. Methods utilized include distillation, extraction, chromatography, Infrared (IR) spectroscopy. Additional course fee applies. Prerequisite: CHEM 114 or instructor permission. Corequisite: CHEM 331.

CHEM 335. Organic Chemistry Laboratory II. (1 Credit)
This lab is a continuation of CHEM 334, with an expansion in scope that allows incorporation of more complex synthetic problems. The lab will employ the use of thin layer chromatography (TLC) to follow reaction progress along with NMR spectroscopy to determine reaction outcomes. Additional course fee applies. Prerequisite: CHEM 334 or instructor permission. Corequisite: CHEM 332.

CHEM 397. Special Topics. (1-6 Credits)
Special Topics

CHEM 406. Instrumental Analysis (with laboratory). (4 Credits)
A lecture/laboratory course examining the theory and techniques of instrumental methods of quantitative analysis, including spectrophotometric methods, electrochemical methods, and chromatography. Additional course fee applies. Prerequisite: CHEM 306 or instructor permission.

CHEM 451. Physical Chemistry I. (3 Credits)
A detailed study of thermodynamics, phase equilibria, kinetic theory and chemical kinetics. Prerequisites: CHEM 113, MATH 251, and PHYS 191 & PHYS 186; or instructor permission.

CHEM 452. Physical Chemistry II. (3 Credits)
A continuation of CHEM 451, which examines quantum chemistry, atomic, and molecular structure and spectra, photochemistry, and statistical mechanics. Offered in alternate years. Prerequisites: CHEM 451, or instructor permission.

CHEM 454. Physical Chemistry Laboratory. (2 Credits)
An experimental-techniques course in physical chemistry (including computer-assisted instruction), with emphasis on thermodynamics, chemical kinetics, quantum chemistry, statistical mechanics, and spectroscopy. Offered in alternate years. Additional course fee applies. Corequisite: CHEM 452 or PHYS 452.

CHEM 461. Advanced Inorganic Chemistry. (3 Credits)
Inorganic chemistry based on principles of bonding, structure, and reaction mechanisms. Chemistry of representative and transition elements and their compounds are covered. Offered in alternate years. Prerequisites: CHEM 113, CHEM 302, and MATH 251; or instructor permission.

CHEM 471. Biochemistry I. (3 Credits)
Overview of the aqueous environment and its effects on solutes, including biomolecules. Other subject matters include the chemistry of proteins, carbohydrates, and lipids; the mechanisms and kinetics of enzymes; and the stoichiometry and chemistry underlying core metabolic processes, energy production, cellular respiration and the regulation of these processes. Prerequisites: BIOL 150 and CHEM 332; or instructor permission.

CHEM 472. Biochemistry II. (3 Credits)
A continuation of CHEM 471. The course integrates the study of metabolic processes and regulation to the synthesis of lipids and other biologically important molecules. Topics include membranes and molecular transport, biosignaling and receptors, hormonal regulation of metabolism, amino acid and nucleic acid synthesis, and nitrogen metabolism. Plant biochemistry, including photosynthesis and carbohydrate production are introduced as well. Prerequisite: CHEM 471 or instructor permission.

CHEM 474. Biochemistry Laboratory. (2 Credits)
Biochemical techniques laboratory course involving analytical experiments with proteins, nucleic acids and other biological molecules. Basic spectrophotometric techniques are introduced and utilized in biochemical research applications. Molecular separations using a variety of chromatographic techniques to purify and characterize enzymes from both native tissues and recombinant enzymes produced from bacterial systems are performed. Additional course fees apply. Prerequisite/Corequisite: CHEM 471 or instructor permission.

CHEM 494. Research Problem in Chemistry. (1-4 Credits)
An advanced, supervised laboratory or literature research experience involving methods of chemical research in an area of analytical, physical, organic, or biochemistry. A research paper and oral presentation of research results is required. Prerequisite: CHEM 302 or instructor permission.

CHEM 497. Special Topics. (1-6 Credits)
Special Topics