Environmental Science, by its broad scope, includes a diverse range of disciplines in the natural and physical sciences, and mathematics. The multidisciplinary Environmental Science minor is intended to complement many majors. The minor will encourage students to better understand environmental issues and concepts from a scientific perspective. This will broaden their perception of the natural world and society by allowing them to recognize and address the challenges of the future. The minor enhances both career and graduate school opportunities for students who complete it.

- Environmental Science Minor (https://catalog.western.edu/undergraduate/programs/environmental-science/environmental-science-minor/)

## Biology Courses

**BIOL 120. Studies in Biology (GT-SC2).** (3 Credits)
An introduction to selected biological topics and the methods of science through an exploration of current topics such as evolution, bioethics and conservation biology. Students may only take this course once for credit. GT-SC2

**BIOL 130. Environmental Biology (GT-SC2).** (3 Credits)
An introduction to basic biological principles as they apply to interactions between organisms and their environment. Consideration is given to biotic and abiotic interactions, energy flow, biogeochemical cycling, population growth, biodiversity, basic cell biology, genetics, and evolution with a special emphasis on human impacts on these biological systems. This course establishes a strong foundation in applied biology from a scientific perspective. GT-SC2

**BIOL 135. Environmental Biology Laboratory (GT-SC1).** (1 Credit)
An experimental approach in both the field and laboratory to explore fundamental biological principles including biotic and abiotic interactions, energy flow, biogeochemical cycling, population growth, biodiversity, basic cell biology, genetics and evolution. Additional course fee applies. Prerequisite or corequisite: BIOL 130. GT-SC1

**BIOL 150. Biological Principles (with laboratory) (GT-SC1).** (4 Credits)
An introduction to the central unifying concepts of biology including the biochemical foundations of life, cell structure and function, cell metabolism, genetics, and evolution. Laboratories introduce students to the process and methods of science through investigative experiences. This course is designed for the science major. A year of high school biology and a year of high school chemistry are highly recommended. Additional course fee applies. Prerequisites: University Entry-Level Expectations met for mathematics and English. GT-SC1

**BIOL 151. Diversity and Patterns of Life (with laboratory).** (4 Credits)
An overview of organismal diversity and evolution. Through a taxonomic survey, students are introduced to prokaryotic and eukaryotic diversity and evolution including microorganisms, fungi, plants, and animals. Fundamentals of evolution including the history of life, evidence for common ancestry, mechanisms of evolutionary change, and speciation are covered. Organismic structure, function, and ecology are also explored. Laboratories introduce students to the process and methods of science through investigative experiences. This course is designed for the science major. A year of high school biology and a year of high school chemistry are highly recommended. Additional course fee applies. Prerequisites: University Entry-Level Expectations met for mathematics and English.

**BIOL 197. Special Topics.** (1-6 Credits)

**BIOL 200. Environmental and Public Health (GT-SC2).** (3 Credits)
An appraisal of man's surroundings which influence his health, including an introduction to the societal structure designed to cope with health problems. Of particular benefit to those who plan to major in the social sciences or enter the field of public health. GT-SC2

**BIOL 201. Introduction to Microbiology (with laboratory).** (4 Credits)
A study of the basic aspects of microbiology for allied health students that includes an introduction to the identification, physiology, growth and control of microbes. Laboratory exercises will emphasize aseptic, pure culture, and identification techniques. This course can only be used to fulfill graduation requirement for students in the allied health biology emphasis. Additional course fee applies.

**BIOL 292. Independent Study.** (1-4 Credits)

**BIOL 297. Special Topics.** (1-6 Credits)

**BIOL 300. Basic Nutrition.** (3 Credits)
An introduction to the science of human nutrition. Consideration is given to the chemical nature and functions of the major groups of nutrients, the function of the digestive system, energy metabolism and balance, weight control, and nutrition for fitness. Human nutrition during the life span is also addressed. Prerequisites: BIOL 150; and CHEM 101 or CHEM 111.

**BIOL 301. General Ecology.** (3 Credits)
An introduction to basic ecological principles and their relationships to natural systems. Human impact on the natural systems is assessed. Prerequisites: BIOL 150 and BIOL 151. Prerequisite or corequisite: COM 202.

**BIOL 302. Ecology Laboratory and Recitation.** (2 Credits)
An experimental approach in both field and laboratory to explore fundamental ecological principles. Students gather and analyze data to address ecological hypotheses, learn practical ecological skills (performing field techniques, using statistical and graphical tools, and interpreting ecological software), and develop oral and written communication skills. Additional course fee applies. Prerequisites: BIOL 150, BIOL 151, and CHEM 113. Prerequisite or corequisite: BIOL 301.

**BIOL 310. Cell Biology.** (3 Credits)
An introduction to cellular function and structure. Prerequisites: BIOL 150 and BIOL 151. Prerequisite or corequisite: CHEM 231 or CHEM 331; and COM 202.

**BIOL 312. Genetics (with recitation).** (4 Credits)
A course in Mendelian inheritance, linkage, chromosomal aberrations, molecular genetics, gene regulation, genetic engineering, and population genetics. Prerequisites: BIOL 301, BIOL 310, CHEM 231, and CHEM 234; or CHEM 331.

**BIOL 313. Cell and Genetics Laboratory.** (2 Credits)
An introduction to experimentation and laboratory techniques used in cell biology, physiology, and genetics, including experimental design, data analysis, and presentation of research results. Additional course fee applies. Prerequisite or corequisite: BIOL 312.

**BIOL 317. Genome Analysis (with laboratory).** (3 Credits)
This course introduces students to the appropriate mathematical techniques to answer questions about information contained in genetic sequences. These techniques may include dynamic programming, motif similarity, Bayesian models, hidden Markov models, principal component analysis, and clustering. Students use standard genome query tools to annotate genomic DNA. BIOL 317 and MATH 317 cannot both be taken for credit. Prerequisites: BIOL 312 and MATH 213.
BIOL 320. Ornithology (with laboratory and recitation). (4 Credits)
An introduction to the study of bird evolution, ecology, and conservation. This course has a strong field component providing frequent opportunities to observe birds in their native environments. Additional course fee applies. Prerequisite: BIOL 301 or instructor permission.

BIOL 322. Mammalogy (with laboratory and recitation). (4 Credits)
An introduction to the study of mammal taxonomy, evolution, ecology and conservation. Additional course fee applies. Prerequisite: BIOL 301 or instructor permission.

BIOL 327. Field Entomology (with laboratory). (4 Credits)
An introduction to the world of the most diverse and abundant form of animal life on Earth through an experiential, field, and laboratory class. The course emphasizes field study, collection and preservation, identification, ecology, and natural history. Additional course fee applies. Prerequisite: BIOL 301 or instructor permission.

BIOL 342. Microbiology (with laboratory). (4 Credits)
An introduction to microbial morphology, identification, physiology, genetics, and microbiology laboratory techniques. A brief consideration is given to fungi. Additional course fee applies. Prerequisites: Biology Nucleus.

BIOL 352. Botany (with laboratory). (4 Credits)
Using field and laboratory experiences this course explores the diversity within the plant kingdom using a comparative approach to examine evolutionary trends and relationships. Students are introduced to the structure and function of plants through an investigation of plant cells, tissues, organs, and basic physiological processes. Economic importance, human uses, and significance of plants to society are emphasized. Additional course fee applies. Prerequisites: BIOL 150, BIOL 151, and ENG 102; or instructor permission.

BIOL 353. Rocky Mountain Flora. (3 Credits)
A field and laboratory course focusing on identification of flowering plants common to the Western Slope of the Colorado Rocky Mountains. This course covers methods of plant collection and preservation, field identification, natural history, and ecology as well as local plants of particular human interest, including those that are medically important, edible, and poisonous. Additional course fee applies. Prerequisites: BIOL 150 and BIOL 151; or instructor permission.

BIOL 355. Spring Fungi Rocky Mountains (with laboratory). (3 Credits)
An introduction to the enigmatic kingdom of Fungi. Fungal classification, life cycles, morphology, development, symbioses, and ecological and economic significance will be explored through lecture, lab, and field experiences. Methods of fungal collection, preservation, and identification will be covered with a focus on spring and snowbank fungi of the Rocky Mountains. Prerequisites: BIOL 150 and BIOL 151.

BIOL 362. Evolution. (3 Credits)
This course provides a comprehensive overview of evolutionary processes, mechanisms, and analytical techniques. Topics include population genetics, conservation genetics, phylogenetic analysis, adaptation, behavioral evolution, sexual selection, and speciation. Evolutionary perspectives in human health and medicine, conservation biology, agriculture, natural resource management, biotechnology, global change, and emerging diseases are considered. Prerequisites: BIOL 312; or ENVS 350, ENVS 370, ENVS 390, and either BIOL 151 or Both BIOL 130 and BIOL 135; or instructor permission.

BIOL 372. Human Anatomy and Physiology I (with laboratory). (4 Credits)
An introduction to regulatory mechanisms which maintain normal body function. Specific topics include cytology, histology, integumentary system, skeletal system, muscular system, and nervous system. The course is designed for pre-nursing and exercise and sport science students. Additional course fee applies. Prerequisites: BIOL 150; CHEM 231 or CHEM 111.

BIOL 373. Human Anatomy and Physiology II (with laboratory). (4 Credits)
A continuation of BIOL 372 Human Anatomy and Physiology I. Specific topics include immunology, cardiovascular system, respiratory system, digestive system, excretory system, reproductive system, and endocrine system. Additional course fee applies. Prerequisite: BIOL 372.

BIOL 392. Independent Study in Biology. (1-4 Credits)
A study in a specific area of biology under the direction of a faculty member. May be taken for a maximum of four credits. Graded Satisfactory/Unsatisfactory only.

BIOL 397. Special Topics. (1-10 Credits)

BIOL 398. Biology Teaching Practicum. (1 Credit)
Under faculty supervision, students participate in the development of laboratory and field experience exercises, as well as in their instruction and execution. Specifically designed for students serving as teaching assistants in Biology. May be taken for a maximum of 3 credits. Graded Satisfactory/Unsatisfactory only. Prerequisite: Biol 150, Biol 151, and instructor permission.

BIOL 420. Molecular Biology (with laboratory). (4 Credits)
A study of the molecular mechanisms by which cellular processes are controlled in prokaryotic and eukaryotic cells. Topics include the biochemistry of macromolecular processes, the structure of genes and chromosomes, the genetic and molecular techniques used to study gene expression, and the transcriptional and translational control of gene expression. The laboratory includes recombinant DNA techniques to manipulate the genome of a model organism. Additional course fee applies. Prerequisites: BIOL 312 and CHEM 471.

BIOL 430. Wildlife Ecology and Management (with laboratory). (4 Credits)
Principles of ecology are applied to population and habitat management towards wildlife conservation. Tools used by wildlife biologists to restore endangered species, harvest sustainable populations, reduce overpopulated species, and to monitor and study populations are emphasized. Habitat management approaches are discussed, along with human dimensions in wildlife conservation. A field component allows students to investigate wildlife populations and habitat issues in the Gunnison Basin. Additional course fee applies. Prerequisite: BIOL 301 or instructor permission.

BIOL 431. Wildlife Techniques Workshop. (1 Credit)
A one week intensive field course focuses on wildlife conservation issues and wildlife management techniques such as trapping and marking wildlife, radio telemetry, population monitoring, GPS and GIS, and wildlife conflict resolution. The course includes a trip outside the basin; a field trip course fee is required. This course meets the week prior to the start of the fall semester. Prerequisite: BIOL 301 or instructor permission. Co-requisite: BIOL 430.

BIOL 435. Animal Behavior. (3 Credits)
An introduction to the study of animal behavior. This course emphasizes the importance of ecology and evolution in understanding animal behavior. Prerequisites: Biology Nucleus or instructor permission.
BIOL 440. Conservation Biology. (3 Credits)
This course addresses the reduction in biological diversity of the planet and suggested solutions to prevent further reduction. Integrating themes are drawn from scientific disciplines such as population genetics, ecology, evolutionary biology, botany, zoology, molecular biology, biochemistry, and wildlife management. Prerequisites: BIOL 312; or ENVS 350, ENVS 370, ENVS 390, and either BIOL 151 or both BIOL 130 and BIOL 135, or instructor permission.

BIOL 444. Colorado Ecoregions. (3 Credits)
A survey of the three main ecoregions of Colorado including the Great Plains, the Southern Rocky Mountains, and the Colorado Plateau. Students travel throughout Colorado and explore the ecology and natural history of the ecosystems by hiking, backpacking, and river rafting. Content includes an evolutionary perspective on ecosystem features and the adaptations of species characterizing each system, as well as applied issues in natural resources management. Additional course fee applies. Prerequisite: BIOL 301 or instructor permission.

BIOL 454. Developmental Biology (with laboratory). (4 Credits)
An examination of the embryology of vertebrates, stressing mammalian embryonic development and comparisons with amphibians, reptiles, and birds. Additional course fee applies. Prerequisites: Biology 312.

BIOL 467. Fisheries Biology. (3 Credits)
An introduction to the science underlying fisheries and their management. Topics will include the morphology, evolution, ecology, behavior and conservation of fishes, including experimental design, data analysis and communication of results focusing primarily on freshwater fisheries and common fishes of Colorado. Marine fisheries will be covered briefly. Prerequisites: BIOL 301 or instructor permission.

BIOL 474. Comparative Animal Physiology (with laboratory). (4 Credits)
An analysis of function in invertebrates and vertebrates, utilizing an environmental approach and emphasizing evolutionary trends in physiological systems. Prerequisites: Biology Nucleus and PHYS 140 or PHYS 170 or PHYS 200.

BIOL 476. Aquatic Ecology (with laboratory). (4 Credits)
A study of physical, chemical, and biological parameters of lakes and streams in the functioning of freshwater eco-systems. Additional course fee applies. Prerequisites: Biology Nucleus and SCI 202; or instructor permission.

BIOL 477. Plant Ecology (with laboratory). (3 Credits)
An introduction to plant populations and communities, including their role withinterrestrial ecosystems. Additional course fee applies. Prerequisites: BIOL 301; or instructor permission.

BIOL 481. Forest Ecology (with laboratory). (4 Credits)
Ecology of forest species, communities, landscapes, and ecosystems, with a focus on the Gunnison Basin. Topics include tree physiology, species interactions, fire and disturbance, succession, forest types, climate, forest management and restoration. Labs and field trips will provide hands-on experience and practical skills in tree identification, forest mensuration, vegetation sampling, statistics and GIS. Students will develop and conduct independent/group research projects. Additional course fee applies. Prerequisites: BIOL 301, MATH 213

BIOL 492. Independent Study. (1-4 Credits)
BIOL 495. Senior Seminar. (1 Credit)
An examination of biological subdisciplines through an investigation of the primary literature. The professional practices, procedures, and standards of the subdiscipline are discussed. This course may be repeated for credit and must be taken twice to fulfill the capstone course requirement. Prerequisites: Biology Nucleus; and MATH 151 or MATH 213.

BIOL 496. Senior Thesis. (2-4 Credits)
An advanced research experience resulting in a Senior Thesis, supervised by a thesis committee of three faculty members including at least one biologist. A proposal of the project must be approved by the thesis committee prior to project initiation. In addition to completing the written thesis, students must present the results of their work in a departmental seminar. This course satisfies the capstone course requirement. Prerequisites: Biology Nucleus; and MATH 151 or MATH 213.

BIOL 497. Special topics. (1-6 Credits)

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-.
CHEM 113. 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. 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.

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.

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.

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 and oral and graphical communication for chemistry and the sciences. Prerequisites: COM 202, CHEM 113 and CHEM 114.

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.

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.

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.

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. 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. 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.

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 201.

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.

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.

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.
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

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

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.

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