

Biology

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Degrees Offered: B.S. in Biology, Biology with Environmental Science Option, and Biology with Medical Technology Option; M.S. in Biology and M.S. in Biochemistry

The mission of the Biology Department is to provide students with a relevant education for biomedical and biotechnological careers, to lead in molecular biological research, and to serve the university and the scientific community. The Biology program prepares undergraduate students for graduate education in the medically allied professions and in the specialized fields of the biological sciences. (Students who are interested in pre-medical, pre-dental, and pre-veterinary science programs should see page 193) A wide variety of career opportunities is currently available for those individuals possessing advanced knowledge and skills, particularly in the areas of biochemistry, molecular biology, microbiology, ecology, genetics, endocrinology, and immunology. Market demand in these areas will likely remain strong for the foreseeable future.

Undergraduate majors typically have diverse career goals and objectives. To accommodate these differences, the undergraduate program is very flexible; only a minimal number of technical core courses is required. Through the selection of appropriate technical electives, each student customizes their education based on personal academic needs and career objectives.

The main approach in the classroom is to stress the highly quantitative and analytical nature of modern biological inquiry, which utilizes sophisticated biochemical and biophysical techniques to answer fundamental questions about living organisms. Undergraduates are encouraged to undertake research through various directed study and special topics offerings and are often employed as technicians in the research laboratories of the faculty.

Program Educational Objectives:

Our graduates will be able to use basic principles of science to analyze, to explain, and to apply biological information and concepts.

Our graduates will be able to design and implement biological research and report findings orally and in writing.

Undergraduate Program

Bachelor of Science in Biology

Minimum credit hours required—130

In addition to the General Education Core Curriculum

Requirements (page 87), the following courses are required:

- BIOL 111 (3), 111L (1), 112 (3), 112L (1), 311 (3), 311L (1), 331 (3), 333 (3) & 333L (1) or 341 (3) & 341L, and BIOL 471 (1)
- At least 6 additional credit hours from: BIOL 341 (3) & 341L (1) or 333(3) & 333L (1), 351 (3), 352 (3), 353L (2), 354L (2), 355 (2), 355L (1), 356 (2), 356L (1), 431 (3), 437 (3)
- At least 6 additional credit hours from: BIOL 343 (3), 343L (1), 344 (3), 344L (1), 446 (3), 447 (3), 447L (1)
- Additional Biology (12). CHEM 441 and 442 (Biochemistry I and II) may be applied to biology electives.
- CHEM 333 (3); plus 6 additional hours of the following: CHEM 311 (3–4), 331 (3–4), 333L (1), 334 (3), 334L (1), 441 (3–4)
- Computer Science or Mathematics: CS 111 (4) or MATH 283 (3)
- Electives to complete 130 hours

Biology laboratory classes are required for biology lecture courses that offer an associated laboratory if credit for the lecture course is used to meet the required number of biology credits for a degree in biology. Students pursuing a B.S. in Biology must take Biology and Chemistry courses for a letter grade, except for BIOL 101 and BIOL 102. Prerequisites for a particular course may be waived only with the written permission of the course instructor and chair of the department.

Sample Curriculum for the Bachelor of Science in Biology

Semester 1

- 4 BIOL 111 & 111L (intro)
- 4 CHEM 121 & 121L (general)
- 3 ENGL 111 (college English)
- 4 MATH 131 (calculus)
- 1 Physical Recreation
- 16 Total Credit Hours

Semester 2

- 4 BIOL 112 & 112L (intro)
- 4 CHEM 122 & 122L (general)
- 3 ENGL 112 (college English)
- 4 MATH 132 (calculus)
- 1 Physical Recreation
- 16 Total Credit hours

Semester 3

- 4 BIOL 311 & 311L (genetics)
- 3 BIOL 331 (cell)
- 3 Social Science
- 5 PHYS 121 & 121L (general)
- 3 CHEM 333 (organic)
- 18 Total credit hours

Semester 4

- 4 BIOL 333 & 333L (molecular)
- 3 Social Science
- 3 Humanities
- 5 PHYS 122 & 122L (general)
- 3 Chemistry Elective
- 18 Total credit hours

Semester 5

- 4 Biology Elective
- 3 Biology Elective
- 3 Chemistry Elective
- 3 Social Science
- 3 ENGL 341 (technical writing)
- 16 Total credit hours

Semester 6

- 4 Biology Elective
- 3 Biology Elective
- 3-4 CS 111 (computer science) or
MATH 283 (statistics)
- 3 Humanities
- 3 Electives
- 16-17 Total credit hours

Semester 7

- 4 Biology Elective
- 3 Biology Elective
- 1 BIOL 471 (seminar)
- 8 Electives
- 16 Total credit hours

Semester 8

- 4 Biology Elective
- 3 Biology Elective
- 3 Humanities/Social Science
- 6 Electives
- 16 Total credit hours

Bachelor of Science in Biology with Environmental Science Option

Minimum credit hours required—130

In addition to the General Degree Requirements (page 87), the following courses are required:

- BIOL 111 & 111L (4), 112 & 112L (4), 311 & 311L (4), 331 (3), 333 & 333L (4), or BIOL 343 & 343L, and BIOL 471 (1)
- At least 12 additional credit hours from: BIOL 343 (3), 343L (1), 344 (3), 344L (1), 446 (3), 493 (4); CHEM 422 (3), 422L (1), EARTH 340 (3), 390 (3), 422 (3), 440 (3)
- Additional Biology (6) CHEM 441 and 442 (Biochemistry I and II) may be applied to biology electives.
- CHEM 333 (3); plus 6 additional hours of the following: CHEM 311 (3-4), 331 (3-4), 333L (1), 334 (3), 334L (1), 422 (3-4), 441 (3-4)
- Computer Science or Mathematics: CS 111 (4) or MATH 283 (3)
- Electives to complete 130 hours

Biology laboratory classes are required for biology lecture courses that offer an associated laboratory if credit for the lecture course is used to meet the required number of biology credits for a degree in biology. Students pursuing a B.S. in Biology must take Biology and Chemistry courses for a letter grade, except for BIOL 101 and BIOL 102. Prerequisites for a particular course may be waived only with the written permission of the course instructor and chair of the department.

Bachelor of Science in Biology with Medical Technology Option

Minimum credit hours required—130

In addition to the General Education Core Curriculum (page 87), the following courses are required:

- BIOL 111 & 111L (4), 112 & 112L (4), 341 & 341L (4), 437 (3); and one of the following options:
 1. BIOL 311 & 311L (4)
 2. BIOL 331 (3) and 333 (3)
 3. BIOL 351 (3) and 352 (3)
- CHEM 311 & 311L (4), 333 & 333L (4)
- MATH 283 (3)
- Internship (30) at an approved school of medical technology

Minor in Biology

Minimum credit hours required—18

The following courses are required:

- BIOL 111 & 111L (4)
- BIOL 112 & 112L (4)
- BIOL 331 (3)
- BIOL 344 & 344L (4)
- Additional biology course numbered 300 or above (3)

Biology classes required for a minor in biology may not be taken on an S/U basis.

Graduate Program

Master of Science in Biology

The master's candidate must demonstrate competence in mathematics, chemistry, and physics comparable to New Mexico Tech's Bachelor of Science in Biology. Requirements for the Master of Science degree in Biology follow the M.S. with Thesis option (page 55). Additional requirements are the following:

- Completion of at least six credit hours of 500-level biology coursework other than thesis, directed study, or seminar.
- Completion of at least six credit hours of 500-level coursework other than thesis, directed study, or seminar in one or more disciplines outside of biology.
- *Completion of two credit hours of BIOL 501, Graduate Seminar.*

Graduate Work in Biochemistry

Biochemical studies and research are important parts of both the biology and chemistry programs at New Mexico Tech. Students interested in the application of biochemistry to research emphases in biology or chemistry should contact either department for further information.

Five Year Program: Biology B.S./Biology M.S.

Exceptionally well motivated students may earn both BS and MS degrees in Biology in five years. The student fulfills the requirements for a BS degree in four years and for an MS degree the following year. A minimum of 160 credit hours are required to complete both degrees. The MS degree requires the completion of a thesis based on the student's own research.

Students may apply for the BS/MS program at the end of their 4th semester. Admission is contingent on their having a GPA of at least 3.0, and on the acceptability of their proposed course of study. Students with upper division standing may also apply, with the same requirements for admission.

Students in the five-year program must apply for graduate standing, normally in their 6th semester. Once admitted to the graduate program, the student spends his or her 8th semester as a dually registered student. During their senior year, the student must select a graduate advisory committee and formalize his or her graduate research topic. Once admitted to the graduate program, a student may apply for financial support via research assistant or teaching assistant positions.

Biology Courses:

BIOL 101, Issues in Biological Science, 1 cr, 1 cl hr

Graded S/U

Introduction to modern topics in biotechnology, biodiversity, and biocomplexity. Discussion of career options in the biological sciences.

BIOL 102, Issues in Medical Practices, 1 cr, 1 cl hr

Graded S/U

Discussion of social, political, legal, and economic issues encountered by individuals in health care professions.

BIOL 111, 111L, General Biology, 4 cr, 3 cl hrs, 2 lab hrs

Corequisite: CHEM 121

A survey of life functions and associated structures at the cellular level. Energy fixation and utilization, growth and development through cell division, and gene action. [NMCCNS BIOL 1214: General Education Area III]

BIOL 112, 112L, General Biology II, 3-4 cr, 3 cl hrs, 3 lab hrs

Prerequisite: BIOL 111

Introduction to evolution, ecology, physiology, and development. Laboratory is a phylogenetic survey of the kingdoms of life. [NMCCNS BIOL 1224: General Education Area III]

BIOL 311, 311L, Genetics, 3-4 cr, 3 cl hrs, 3 lab hrs

Prerequisites: BIOL 111 & 111L

An overview of the storage, transmission and expression of biological information. The lab emphasizes Mendelian analysis in model organisms and fluorescent analysis of human DNA.

BIOL 331, Cell Biology, 3 cr, 3 cl hrs

Prerequisites: BIOL 111; CHEM 121

Studies of life at the cellular level. The structure and functions of eukaryotic cells and their organelles. The molecular basis for energy transfers, growth and development, and their regulation.

BIOL 333, 333L, Molecular Biology, 3-4 cr, 3 cl hr, 3 lab hrs

Prerequisites: BIOL 331; CHEM 121

Principles of modern molecular biology. Laboratory emphasizes enzyme purification and recombinant DNA techniques, organized as a gene cloning project. BIOL 333 and BIOL 333L must be taken concurrently.

BIOL 341, 341L, Introductory Microbiology, 3–4 cr, 3 cl hrs, 3 lab hrs

Prerequisite: CHEM 122

Corequisite: BIOL 331

A comparative study of reproduction, growth, and metabolism of bacteria, rickettsia, and viruses, with emphasis on the bacteria and their relation to man and their environment.

BIOL 343, 343L, Environmental Microbiology, 3–4 cr, 3 cl hrs, 3 lab hrs

Prerequisite: BIOL 111

Corequisite for Biology majors: BIOL 331; BIOL 331 recommended for other majors

A study of the relationship between microorganisms and water and soil environments with emphasis on biogeochemical cycles.

BIOL 344, 344L, Introductory Ecology, 3–4 cr, 3 cl hrs, 3 lab hrs

Prerequisites: BIOL 112; MATH 131

A study of the principles which govern the interactions between biological populations and the environment.

BIOL 351, Physiology I, 3 cr, 3 cl hrs

Prerequisite: BIOL 112; 331

Principles and mechanisms of vertebrate function, emphasizing mammalian systems. Includes homeostasis, membranes, receptors, muscle and nerve function, sensory system and the regulation and function of hormones.

BIOL 352, Physiology II, 3 cr, 3 cl hrs

Prerequisite: BIOL 351

Continuation of BIOL 351. Includes cardiovascular, respiratory, water and ion homeostasis, gastrointestinal, and reproductive physiology.

BIOL 353L, Experimental Physiology I, 2 cr, 1 cl hr, 3 lab hrs

Prerequisite: BIOL 351

Students will quantify and interpret physiologic responses in humans. Experiments will involve the nervous, sensory, and muscular systems. A portion of this course will include gross anatomy.

BIOL 354L, Experimental Physiology II, 2 cr, 1 cl hr, 3 lab hrs

Prerequisite: BIOL 351, 353L

Corequisite: BIOL 352

Continuation of BIOL 353L. Students will quantify and interpret physiologic responses in humans. Experiments will involve the cardiovascular, renal, and respiratory systems. A portion of this course will include gross anatomy.

BIOL 362, Animal Behavior, 3 cr, 3 cl hrs

Prerequisites: PSY 121; BIOL 112; or consent of instructor

General overview of ethological and physiological approaches to the study of animal behavior. (Same as PSY 362)

BIOL 411, Advanced Genetics, 3 cr, 3 cl hrs

Prerequisites: BIOL 311 and 333

A study of current topics in genetics, including the molecular basis of gene structure and action in eukaryotes and prokaryotes.

BIOL 431, Virology, 3–4 cr, 3 cl hrs, 3 lab hrs

Prerequisite: BIOL 331

Corequisite: BIOL 311

Molecular biology of viral infection, replication, and pathogenesis. Animal viruses emphasized.

BIOL 435, Bioinformatics, 3 cr, 3 cl hrs

Prerequisite: BIOL 311 or consent of instructor

Computer analysis of biological sequence data used to perform in silico experiments. Students will design and perform experiments using public domain software and databases.

BIOL 437, Immunology 3 cr, 3 cl hrs

Prerequisite: BIOL 341

Study of human infectious disease and the immune system. Pathogenic microorganisms and mechanisms of pathogenicity. Innate and acquired immune responses. Immunochimistry, cellular immunity, and immunopathology.

BIOL 444, Evolutionary Biology, 3 cr, 3 cl hrs,

Prerequisite: BIOL 311, BIOL 344

The mechanisms and implications of biological evolution. Topics include population genetics, adaptation and natural selection, fossil evidence, and evolutionary medicine.

BIOL 446, Environmental Toxicology, 3 cr, 3 cl hrs

Prerequisite: CHEM 333

The fate and behavior of toxic pollutants in terrestrial and aquatic environments, from an ecosystem perspective.

BIOL 449 Astrobiology, 3 cr, 3 cl hours

Prerequisites: CHEM 121, 122, PHYSICS 121, 122, plus one other science course and consent of instructor. Offered on demand.

An in-depth and interdisciplinary study of astrobiology, including interactions between living and non-living systems at multiple scales: stellar, planetary, meso, and microscopic. Addresses fundamental questions regarding the origin of life, and the possible extent and distribution of life in the universe. Combines principles of astrophysics, geosciences, planetary science, chemistry, and biology. Innovative interactive exercises and projects working in interdisciplinary groups and individually. (Same as GEOL 449.)

BIOL 455, Molecular Ecology, 3 cr, 3 cl hrs

Prerequisites: BIOL 311 and 344, or consent of instructor

Application of molecular biological techniques to ecological and environmental problems. Current research projects at Tech are emphasized.

BIOL 471, Life Sciences Seminar, 1 cr, 1 cl hr

Prerequisite: Upper-class standing in biology or consent of instructor

Review, discussion, and student presentations of the current literature on a single topic in biology. Topics are chosen with the aim of integrating multiple levels of biological organization and research approaches.

BIOL 486, Cytogenetics, 3 cr, 3 cl hrs

Prerequisites: BIOL 311 and 333

Principles of chromosome structure and function with an emphasis on medical diagnostics. Course includes a field trip to a cytogenetics diagnostic laboratory.

BIOL 487, 487L Advanced Virology, 3-4 cr, 3 cl hrs, 3 lab hrs

Prerequisite: BIOL 431 or 531

An in-depth study of one or two viruses, viral vectors for gene therapy, and herpes or hemorrhagic fever viruses. The laboratory section of the course will include viral propagation in tissue culture and methods to investigate the molecular biology of viral infection.

BIOL 488, Biology of Cancer, 3 cr, 3 cl hrs

Prerequisites: BIOL 331 and 333

Principles and molecular mechanisms of carcinogenesis. Involves elements of cell biology, genetics, molecular biology, immunology, biochemistry, virology, pharmacology, physiology, developmental biology, and pathology.

BIOL 489, Special Topics in Biology, cr and hrs to be arranged

Prerequisites: Two semesters of advanced courses and consent of instructor

Special readings or course in biology.

BIOL 491, Special Problems, cr and hrs to be arranged

Prerequisites: Two semesters of advanced courses and consent of instructor

An introduction to methods of research. Problems are chosen from the fields of biology and may be small independent investigations or part of a research program being directed by the advisor.

BIOL 493, Directed Study in Environmental Biology, cr and hrs to be arranged

Prerequisites: Senior student majoring in Biology—*Environmental Science Option*, and consent of instructor

A student-designed study of local problems and processes occurring during interaction between biological systems and their physico-chemical environment including literature review, field and laboratory research, and result presentation by written report and seminar.

BIOL 500, Directed Research, cr to be arranged

This course may not be used to fulfill graduate degree requirements. Research under the guidance of a faculty member.

BIOL 501, Graduate Seminar, 1 cr, 1 cl hr

Prerequisite: Graduate-level standing or consent of instructor

Special topics in biology. Readings, student presentations, and discussions will focus on a single topic within biology, with a different topic to be selected by the Biology faculty each semester.

BIOL 511, Advanced Genetics, 3 cr, 3 cl hrs

Prerequisites: BIOL 311 and 333

A study of current topics in genetics, including the molecular basis of gene structure and action in eukaryotes and prokaryotes. Shares lecture with BIOL 411, but is graded separately and additional graduate-level work is required.

BIOL 531, Virology, 3 cr, 3 cl hrs

Prerequisite: BIOL 331

Corequisite: BIOL 311

Molecular biology of viral infection, replication, and pathogenesis. Animal viruses emphasized. Shares lecture with BIOL 431, but is graded separately and additional graduate-level work is required.

BIOL 535 Bioinformatics 3 cr, 3 cl hrs

Prerequisite: BIOL 311 or consent of instructor

Computer analysis of biological sequence data used to perform in silico experiments. Students will design and perform experiments using public domain software and databases. Shares lecture with BIOL 435, but is graded separately and additional graduate-level work is required.

BIOL 537, Immunology, 3 cr, 3 cl hrs

Prerequisite: BIOL 341

Study of human infectious disease and the immune system. Pathogenic microorganisms and mechanisms of pathogenicity. Innate and acquired immune responses. Immunochemistry, cellular immunity, and immunopathology. Shares lecture with BIOL 437, but is graded separately and additional graduate-level work is required.

BIOL 542, Advanced Microbiology, 3 cr, 3 cl hrs

Prerequisite: BIOL 341 or consent of instructor

A study of the current concepts in function and structure of microorganisms with emphasis on cellular energy, biosynthetic and ecological response.

BIOL 544, Evolutionary Biology, 3 cr, 3 cl hrs

Prerequisite: BIOL 311, BIOL 344; graduate standing or consent of instructor.

The mechanisms and implications of biological evolution. Topics include population genetics, adaptation and natural selection, fossil evidence, and evolutionary medicine. Shares lecture with BIOL 444, but is graded separately and additional graduate-level work is required.

BIOL 549 Astrobiology, 3 cr, 3 cl hours

Prerequisites: Graduate status or consent of instructor. Offered on demand.

An in-depth and interdisciplinary study of astrobiology, including interactions between living and non-living systems at multiple scales: stellar, planetary, meso, and microscopic. Addresses fundamental questions regarding the origin of life, and the possible extent and distribution of life in the universe. Combines principles of astrophysics, geosciences, planetary science, chemistry, and biology. Innovative interactive exercises and projects working in interdisciplinary groups and individually. Shares lecture with BIOL 449, but is graded separately and additional graduate-level work is required. (Same as GEOL 549.)

BIOL 560, Population and Community Ecology, 3 cr, 3 cl hrs

Prerequisites: BIOL 344; graduate standing or consent of instructor

Advanced study of demography, population dynamics, species interactions, and community structure.

BIOL 564, Molecular Ecology, 3 cr, 3 cl hrs

Prerequisite: BIOL 333 or consent of instructor

Molecular ecology is the application of molecular genetics to ecological and environmental issues. The current literature in the field is reviewed. Participants choose a topic to research and develop a research proposal as the final project. Graduate students present a public seminar.

BIOL 581, Directed Study, cr to be arranged

Study under the guidance of a member of the biology staff. In general, subject matter will supplement that available in other graduate offerings in biology.

BIOL 586 Cytogenetics, 3 cr, 3 cl hrs

Prerequisites: BIOL 311 and 333

Principles of chromosome structure and function with an emphasis on medical diagnostics. Course includes a field trip to a cytogenetics diagnostic laboratory. Shares lecture with BIOL 486, but is graded separately and additional graduate-level work is required.

BIOL 587, 587L Advanced Virology, 3–4 cr, 3 cl hrs, 3 lab hrs

Prerequisite: BIOL 431 or 531

An in-depth study of one or two viruses, viral vectors for gene therapy; and herpes or hemorrhagic fever viruses. The laboratory section of the course will include viral propagation in tissue culture and methods to investigate the molecular biology of viral infection. Shares lecture and lab with BIOL 487, 487 L, but is graded separately and additional graduate-level work is required.

BIOL 588, Biology of Cancer, 3 cr, 3 cl hrs

Prerequisites: BIOL 331 and 333

Principles and molecular mechanisms of carcinogenesis. Involves elements of cell biology, genetics, molecular biology, immunology, biochemistry, virology, pharmacology, physiology, developmental biology, and pathology. Graduate students are required to write a grant proposal.

BIOL 591, Thesis (master's program), cr to be arranged