Introduction

Our objectives in the Department of Biological Sciences are to:

• prepare you for a profession in biology, botany, zoology, or microbiology
• provide you with the background necessary for admission to medical, dental, veterinary, or other professional schools
• provide a program of instruction for biology teachers in secondary schools
• provide subject matter courses appropriate for elementary teachers
• provide a knowledge of biological phenomena for cultural enlightenment and service
• provide biological insights that will be of value throughout your life

In this section, we first describe the degree programs we offer. Then we explain our pre-medical technology program and our departmental honors program.

Degrees Offered

You may pursue the following degrees in the biological sciences. (We describe these degrees in the order they are listed here.)

• B.S. in biology
  (or a B.S. in biology with an emphasis in applied plant science, aquatic biology, cellular and molecular biology, ecology, physiology and functional morphology, or wildlife management)
• extended B.S. in biology
  (or an extended B.S. in biology and secondary education)
• B.S. in botany
• B.S. in zoology
  (or a B.S. in zoology, with a health preprofessional emphasis)
• B.S. in microbiology
  (or a B.S. in microbiology with either a health preprofessional emphasis or pre-medical technology emphasis)

(NAU also offers an extended B.S. in environmental sciences, with an emphasis in either biology or microbiology. See the Environmental Sciences section of this chapter for more information.)

Please note that no minor is required for these degrees. However, you may take a departmental emphasis, an extended major, or a minor, selected with your adviser's guidance, to complement your major. If you select one of these alternatives, your general elective hours are reduced or eliminated, and
You may have to take more than 125 hours to complete your degree.

**B.S. in Biology**

To earn this degree, you must complete the three components described in the following paragraphs.

**Major Requirements**
You must complete the following 40 hours:
- BIO 184, 190, and 220; either BIO 325 or 426; the writing-intensive series (BIO 226, 240, and 245); and two laboratory courses at or above the 200 level (in addition to BIO 220)
- at least 10 hours of botany courses and 10 hours of zoology courses (which may include those listed in the above requirements)
- enough more hours of electives in the major to total 40 hours, with 8 of the remaining hours from courses numbered 300 or above

In addition, you must complete 16 to 25 hours of math and science support courses, which consist of one of three chemistry sequences, one of three math sequences, and a recommended physics sequence, chosen with your adviser’s guidance:
- CHM 130:151L and 230:230L
- or CHM 151:151L, 152:152L, and 230:230L
- or CHM 151-.151L, 152-.152L, 235:235L, and 238
- MAT 112 (or equivalent) and STA 270
- or MAT 112 (or equivalent), 119, and 131
- or MAT 135 and 136
- PHY 111:112 or 141 (recommended)

Please be aware that you may apply some of these math and science support hours to NAU’s liberal studies requirements, thereby increasing your elective hours.

**Liberal Studies Requirements**
See the General Academic Requirements chapter of this catalog for information about the 43 hours of liberal studies credit that we require.

**General Electives**
You may take the remaining hours from any area you choose to complete 125 hours.

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**B.S. in Biology (With an Emphasis)**

To earn a B.S. in biology with an emphasis in applied plant science, aquatic biology, cell and molecular biology, ecology, physiology and functional morphology, or wildlife management, you must complete the four components described in the following paragraphs:

**Major Requirements**
You must complete the following 40 hours:
- BIO 184, 190, and 220; either BIO 325 or 426; the writing-intensive series (BIO 226, 240, and 245); and two laboratory courses at or above the 200 level (in addition to BIO 220)
- at least 10 hours of botany courses and 10 hours of zoology courses (which may include those listed in the above requirements)
- enough more hours of electives in the major to total 40 hours, with 8 of the remaining hours from courses numbered 300 or above

In addition, you must complete 16 to 33 hours of math and science support courses, which consist of one of three chemistry sequences and one of three math sequences, chosen with your adviser’s guidance:
- CHM 130:151L and 230:230L
- or CHM 151:151L, 152:152L, and 230:230L
- or CHM 151-.151L, 152-.152L, 235:235L, and 238
- MAT 112 (or equivalent) and STA 270
- or MAT 112 (or equivalent), 119, and 131
- or MAT 135 and 136

Please be aware that you may apply some of these math and science support hours to NAU’s liberal studies requirements, thereby increasing your elective hours.

**Emphasis Requirements**
You select an additional 12-18 hours in consultation with an emphasis adviser.

**Liberal Studies Requirements**
See the General Academic Requirements chapter of this catalog for information about the 43 hours of liberal studies credit that we require.

**General Electives**
You may take the remaining hours from any area you choose to complete 125 hours.
Extended B.S. in Biology

To earn this degree, you must take at least 20 credit hours beyond the 40 hours described for the B.S. in biology earlier in this section. You may choose these hours from your major field and from other natural science disciplines.

Extended B.S. in Biology and Secondary Education

If you wish to teach in the secondary schools, you may wish to consider this extended degree. To earn this degree, you must complete the three components described in the following paragraphs:

Major Requirements 63-67 hours

Professional Education Certification Sequence 31 hours

Liberal Studies Requirements 43 hours

Total 137-141* hours

*Be aware that some courses required for your degree may have prerequisites that you must also take. Check all course descriptions to find out.

Major Requirements
You must complete the 40 hours described below.

- BIO 184, 190, 220, 415, 426:426L, and 431 and the writing-intensive series (BIO 226, 240, and 245)
- 8 hours of elective credits in the major, with at least 1 of the remaining hours from courses numbered 300 or above
- enough more hours of electives in the major to total 40 hours, with 8 of the remaining hours from courses numbered 300 or above

You must also complete the following 23-27 hours of math and science support courses, chosen with your adviser’s guidance:

- either CUM 130:151L and 230:230L
- or CHM 151:151L, 152:152L, and 230:230L
- PHS 300; SCI 308, 350, 410, and 420; and STA 270
- recommended: PHY 112 and AST 180

Professional Education Certification Sequence
You must complete the following 31 hours: EOF 200; ECI 308, 322, 350, 450, 465, and 495; and EPS 325.

See the heading Certification in Secondary Education (within Instructional Leadership) in the Education section of this chapter for further details.

Liberal Studies Requirements
See the General Academic Requirements chapter of this catalog for general information about the 43 hours of liberal studies credit that we require.

For this extended major, you must include MAT 112 or 135, SC 340, GLG 101 and 103, and PHY 111 in your liberal studies coursework.

B.S. in Botany

To earn this degree, you must complete the three components described in the following paragraphs.

Major Requirements 56-65 hours
Liberal Studies Requirements 43 hours
General Electives 26-17 hours
Total 125* hours

*Be aware that some courses required for your degree may have prerequisites that you must also take. Check all course descriptions to find out.

Major Requirements
You must complete the following 40 hours:

- BIO 184, 190, 220, 415, 426:426L, and 431 and the writing-intensive series (BIO 226, 240, and 245)
- 8 hours of elective credits in the major, with at least 1 of the remaining hours from courses numbered 300 or above

In addition, you must complete 16 to 25 hours of math and science support courses, which consist of one of three chemistry sequences, one of three math sequences, and a recommended physics sequence, chosen with your adviser’s guidance:

- CHM 130:151L and 230:230L
- or CHM 151:151L, 152:152L, and 230:230L
- or CHM 151:151L, 152:152L, 235:235L, and 238
- MAT 112 (or equivalent) and STA 270
- or MAT 112 (or equivalent), 119, and 131
- or MAT 135 and 136
- or PHY 111:112 or 141 (recommended)

Please be aware that you may apply some of these math and science support hours to NAU’s liberal studies requirements, thereby increasing your elective hours.

Liberal Studies Requirements
See the General Academic Requirements chapter of this catalog for information about the 43 hours of liberal studies credit that we require.

General Electives
You may take the remaining hours from any area you choose to complete 125 hours.
B.S. in Zoology

To earn this degree, you must complete the three components described in the following paragraphs. (If you wish to earn this degree with a health preprofessional emphasis, see the following section.)

Major Requirements 56-65 hours
Liberal Studies Requirements 43 hours
General Electives 26-17 hours
Total 125* hours

*Be aware that some courses required for your degree may have prerequisites that you must also take. Check all course descriptions to find out.

Major Requirements
You must complete the following 40 hours:
• BIO 184, 190, 220, and 325; the writing-intensive course series (BIO 226, 240, and 245); and two laboratory courses at or above the 200 level (in addition to BIO 220)
• enough more hours of electives in the major to total 40 hours, with 8 of the remaining hours from courses numbered 300 or above, and at least one course covering invertebrates and one covering vertebrates

In addition, you must complete 16 to 25 hours of math and science support courses, which consist of one of three chemistry sequences, one of three math sequences, and recommended physics courses, chosen with your adviser's guidance:
• CHM 130:151L and 230:230L
  or CHM 151:151L, 152:152L, and 230:230L
  or CHM 151:151L, 152:152L, 235:235L, and 238
• MAT 112 (or equivalent) and STA 270
  or MAT 112 (or equivalent), 119, and 131
  or MAT 135 and 136
• PHY 111:112 or 141 recommended

Please be aware that you may apply some of the math and science support hours to NAU’s liberal studies requirements, thereby increasing your elective hours.

Liberal Studies Requirements
See the General Academic Requirements chapter of this catalog for information about the 43 hours of liberal studies credit that we require.

General Electives
You may take the remaining hours from any area you choose to complete 125 hours.

B.S. in Zoology, (With a Health Preprofessional Emphasis)

If you wish to pursue a career in medicine, dentistry, or veterinary science, you may wish to consider this B.S. in zoology degree. (Also see the B.S. in microbiology with a health preprofessional emphasis later in this section.)

To earn this degree, you must complete the four components described in the following paragraphs:

Major Requirements 60-61 hours
Emphasis Requirements 15-19 hours
Liberal Studies Requirements 43 hours
General Electives 7-2 hours
Total 125* hours

*Be aware that some courses required for your degree may have prerequisites that you must also take. Check all course descriptions to find out.

Major Requirements
You must complete the following 40 hours:
• BIO 184, 190, and 220; the writing-intensive series (BIO 226, 240, and 245); and either BIO 325:325L or 201:202
• at least one course covering invertebrates and one covering vertebrates
• enough more hours of electives in the major to total 40 hours

In addition, you must complete 20 to 21 hours of math and science support courses, which consist of one of three chemistry sequences and one of three math sequences, chosen with your adviser's guidance:
• CHM 130:151L and 230:230L
  or CHM 151:151L, 152:152L, and 230:230L
  or CHM 151:151L, 152:152L, 235:235L, and 238
• MAT 112 (or equivalent) and STA 270
  or MAT 112 (or equivalent), 119, and 131
  or MAT 135 and 136
• PHY 111:112 or 141 recommended

Please be aware that you may apply some of the math and science support hours to NAU’s liberal studies requirements, thereby increasing your elective hours.

Emphasis Requirements
For the health preprofessional emphasis, you take BIO 331 and 424; CHM 360 or 460; and PHY 141 or 111:112 or 161:262.

Liberal Studies Requirements
See the General Academic Requirements chapter of this catalog for information about the 43 hours of liberal studies credit that we require.
General Electives
You may take the remaining hours from any area you choose to complete 125 hours.

B.S. in Microbiology
This degree is designed to provide you with the broadest preparation for a microbiology career in education, government, or private industry. (If you wish to earn this degree with a health preprofessional emphasis or a pre-medical technology emphasis, see the following two sections.)

To earn the B.S. in microbiology, you must complete the three components described in the following paragraphs:

Major Requirements
Liberal Studies Requirements
General Electives
Total

70-77 hours
43 hours
12-5 hours
125* hours

*Be aware that some courses required for your degree may have prerequisites that you must also take. Check all course descriptions to find out.

Major Requirements
You must complete the following 33 hours: BIO 184, 190, 220, 350, 369, 401, 410, 411, and 488.

In addition, you must take 27-33 hours of math and science support courses, which consist of one of two chemistry sequences and one of two math sequences, chosen with your adviser's guidance:

• MAT 112 and STA 270
  or MAT 135 and 136
  or CHM 151:151L, 152:152L, 235:235L, 238:238L, 320, and 360:360L or 460:360L

Finally, you choose 10-11 hours from the following options:

• CIS 120 or CSE 120
• CSE 121 or 122 or 123
• PHY 111:112 or 161:262

Liberal Studies Requirements
See the General Academic Requirements chapter of this catalog for information about the 43 hours of liberal studies credit that we require.

General Electives
You may take the remaining hours from any area you choose to complete 125 hours.

B.S. in Microbiology
(Emphasis in Health Preprofessional)

If you wish to pursue a career in medicine, dentistry, or veterinary science, you may wish to consider this degree. (Also see the B.S. in zoology with a health preprofessional emphasis earlier in this section.)

To earn this degree, you must complete the four components described in the following paragraphs:

Major Requirements
Emphasis Requirements
Liberal Studies Requirements
General Electives
Total

69-72 hours
6-7 hours
43 hours
7-3 hours
125* hours

*Be aware that some courses required for your degree may have prerequisites that you must also take. Check all course descriptions to find out.

Major Requirements
You must complete the following 27 hours: BIO 184, 190, 220, 350, 369, 401, 410, and 488.

In addition, you must complete the following 42-45 hours of math, computer science, and science support courses, chosen with your adviser's guidance:

• MAT 112 and STA 270
  or MAT 135 and 136
• CIS 120 or CSE 120
• CSE 121 or 122 or 123
• PHY 111:112 or 161:262

Emphasis Requirements
You must take two courses from BIO 217, 320, 331, and 440.

Liberal Studies Requirements
See the General Academic Requirements chapter of this catalog for information about the 43 hours of liberal studies credit that we require.

General Electives
You may take the remaining hours from any area you choose to complete 125 hours.

B.S. in Microbiology
(Emphasis in Pre-Medical Technology)

You may pursue this degree after completing one year in a medical technology program at another university. (For more information, see the heading Pre-Medical Technology Program later in this section.)

To earn this degree, you must complete the three components described in the following paragraphs.
Major Requirements

You must complete the following 33-40 hours: BIO 201, 202, 217, 220, 350, 401,475, and 488 and 3 hours of biology electives.

In addition, you must complete the following 25-29 hours of math, computer science, and science support courses, chosen with your adviser’s guidance.

- MAT 112
- CHM 151, 151L, 152, 152L, 230, 230L or 235, 235L, 238, 320, 320L, and 360, 360L
- recommended: CIS 120 or CSE 120; either CSE 121 or 122 or 123; and PHY 111, 112

Liberal Studies Requirements

See the General Academic Requirements chapter of this catalog for information about the 43 hours of liberal studies credit that we require.

General Electives

You may take the remaining hours from any area you choose to complete 125 hours.

Minor in Biology

To complete a minor in biology, you must take the following 18 credit hours:

- BIO 184 and 190
- 10 additional hours of nonduplicating courses (BIO 180 duplicates BIO 184 and 190; BIO 205 and 220 duplicate each other.)

Minor in Botany

To complete a minor in botany, you must take the following 18 credit hours:

- BIO 184 and 190
- 10 additional hours of nonduplicating courses (BIO 180 duplicates BIO 184 and 190; BIO 205 and 220 duplicate each other.)

Minor in Zoology

To complete a minor in zoology, you must take the following 18 credit hours:

- BIO 184 and 190
- 10 additional hours of nonduplicating courses (BIO 180 duplicates BIO 184 and 190; BIO 205 and 220 duplicate each other.)

Minor in Microbiology

To complete a minor in microbiology, you must take the following 18 credit hours:

- BIO 205 or 220, 350, and 469
- additional courses to total 18 hours

Pre-Medical Technology Program

You may earn a B.S. in microbiology at NAU while completing your fourth year of study in a medical technology program at another university. To do this, you complete the basic science courses required for admission to the other university’s program as part of your B.S. degree here. See the heading B.S. in Microbiology (With Pre-Medical Technology Emphasis) earlier in this section.

Pre-Medical Technology Program

You may earn a B.S. in microbiology at NAU while completing your fourth year of study in a medical technology program at another university. To do this, you complete the basic science courses required for admission to the other university’s program as part of your B.S. degree here. See the heading B.S. in Microbiology (With Pre-Medical Technology Emphasis) earlier in this section.

Programs

We maintain affiliation agreements with approved programs to improve the likelihood that our well-qualified students will be accepted for these clinical practicums. You are also eligible for admission to nonaffiliated medical technology programs throughout the United States; however, the program you enter should be approved by the Committee on Allied Health Education and Accreditation (CAHEA). Both Arizona State University and the University of Arizona have medical technology programs accredited by CAHEA.

Medical technology programs are competitive, and we cannot ensure that you will be accepted by another university’s selection committee. Because entrance requirements vary from one program to another, you should consult with a medical technology program adviser as soon as possible.

Completing the Program

You become eligible for the fourth-year clinical practicum when you have completed at least 93 hours of prescribed courses in NAU’s microbiology major.
Before entering a medical technology program at another university, you must obtain permission from NAU’s dean of the College of Arts and Sciences to take your senior year in absentia.

When you have completed this fourth year, you must request that a transcript and a statement of recommendation for the degree be forwarded from the other university to NAU’s Registrar.

To complete this degree, you must meet all requirements described under the heading B.S. in Microbiology (With Pre-Medical Technology Emphasis) earlier in this section. This includes meeting our liberal studies requirements, maintaining an acceptable grade point average, and earning a total of 125 hours, with not more than 32 hours transferred from the other university. In addition, you must spend three years in residence at NAU and one calendar year in the other university’s medical technology program.

Departmental Honors Program

Our department provides an opportunity for qualified students to undertake a full and comprehensive research experience, culminating in a senior research thesis. If you have demonstrated a high level of performance in the classroom and in the laboratory or in fieldwork in our department, you may apply for admission to our undergraduate research honors program.

In collaboration with a faculty research mentor, you develop an independent research prospectus, which you present along with a letter of application for admission to the program, usually in the third or fourth semester of your degree program.

Your research progress is monitored by your faculty mentor and program committee. In your final semester before graduation, you must submit a senior thesis for your program committee to evaluate. If the committee approves your final document, they recommend you for departmental research honors in biology.

For more information, contact our department office.

Biological Sciences Courses (BIO)

BIO 100 Biology Concepts (3). A one-semester introductory course covering basic principles and concepts of biology. Methods of scientific inquiry and behavior of matter and energy in biological systems are explored. Fee required. Fall, Spring, SS I and II.

BIO 100L Biology Concepts Laboratory (1). An investigation of examples of life, with focus on our understanding of evolution, environment, heredity, body form, and function. Not available for credit in the major. 1 hr. lab. Corequisite: BIO 100. Fee required. Fall, Spring, SS I and II.

BIO 184 Plant Biology (4). Principles of plant form and function, including plant structure, metabolism, growth responses, reproduction, global economics, propagation, ecology, and an evolutionary survey of the plant kingdom. 3 hrs. lecture, 3 hrs. lab. Prerequisite: Strong performance in high school biology or BIO 100 or equivalent. Fee required. Fall, Spring, SS I.

BIO 190 Animal Biology (4). Principles of animal structure and function, including characteristics and evolution or organisms, environmental relations, behavior, metabolism, and an evolutionary survey of the animal kingdom. 3 hrs. lecture, 3 hrs. lab. Prerequisite: Strong performance in high school biology or BIO 100 or equivalent. Fee required. Fall, Spring, SS I.

BIO 201 Human Anatomy and Physiology I (4). Integumentary, skeletal, muscular, nervous, sensory, and endocrine systems in health and disease. 3 hrs. lecture, 3 hrs. lab. Prerequisite: One year of high school biology, CHM 130 or 151, and 151L. Fee required. Fall, SS I.

BIO 202 Human Anatomy and Physiology II (4). Body fluid, cardiovascular, digestive, respiratory, urinary, and reproductive systems in health and disease. 3 hrs. lecture, 3 hrs. lab. Prerequisite: BIO 201 or the equivalent. Fee required. Spring, SS II.

BIO 205 Microbiology (5). Basic concepts of microbiology emphasizing the characteristics of pathogenic microorganisms, disease mechanisms, methods of control, and public health procedures. Intended for allied health pre-professional students; not intended for biological sciences majors. 4 hrs. lecture, 3 hrs. lab. Prerequisites: one semester each of college biology and chemistry. Fee required. Fall.

BIO 217 Hematology (3). Normal and abnormal blood cell morphology with current diagnostic procedures used in the clinical laboratory. 2 hrs. lecture, 3 hrs. lab. Prerequisites: BIO 202 or equivalent.

BIO 220 Biology of Microorganisms (4). Fundamental concepts of microbiology with emphasis on anatomy, metabolism, genetics, and ecology of microorganisms. 3 hrs. lecture, 3 hrs. lab. Prerequisites: one semester of college biology and one semester of college chemistry (two semesters of each preferred). Fee required. Fall, Spring.

BIO 221 Invertebrate Zoology (4). A survey of invertebrate phyla using selected taxa to illustrate concepts in evolution, ecology, and behavior. 3 hrs. lecture, 3 hrs. lab. Prerequisite: BIO 190. Field trips to nearby invertebrate habitats. Fee required. Fall.

BIO 223 Vertebrate Zoology (4). Evolution, systematics, distribution, ecology, and primary adaptations of the major vertebrate groups. 3 hrs. lecture, 3 hrs. lab. Prerequisite: BIO 190. Fee required. Spring.

BIO 226 Ecology (3). Introduction to ecological principles, including the distribution and abundance of organisms, population dynamics, community organization, energy flow, and nutrient cycling. 3 hrs. lecture. Prerequisites: BIO 184 and 190. Fall, Spring.

BIO 226L Principles of Ecology Lab (1). Introduction to the experimental analysis of plant and animal interactions within terrestrial and aquatic ecosystems, including
community dynamics, ecological processes, and biotic inventories. Prerequisite or corequisite: BIO 226. Fee required. Fall, Spring.

BIO 240 Genetics and Evolution (3). Fundamental concepts of inheritance, including genetic and chromosomal character determination, and natural selection leading to population changes and speciation. 3 hrs. lecture. Prerequisite: BIO 180 or 184 or 190. Fall, Spring.

BIO 243 Genetics Laboratory (1). An optional laboratory in the study of various modes of inheritance in plants and animals with special emphasis on humans. 3 hrs. lab. Prerequisite or Corequisite: BIO 240. Fee required. Fall, Spring.

BIO 245 Cellular and Molecular Biology (3). Organization and function of biological molecules, cell diversity, cell structure and function, and cell interaction and differentiation. 3 hrs. lecture. Prerequisites: BIO 184, 190, and 220; CHM 130:151L and 230:230L or 151:151L and 152:152L. Fall, Spring.

BIO 300 Human Biology (1:1:1:1) A series of independent minicourses dealing with aspects of biology and human conditions. Fall, Spring. SS I, SS II.

BIO 310 Scientific Concepts in Human Biology (3). Systems and processes of the human body integrated with an understanding of health and disease. 3 hrs. lecture. Prerequisites: High school biology or chemistry. Not available for credit in the major. All semesters.

BIO 320 General Pathology (3). A survey of disease processes affecting body systems; cell death, and inflammation; emphasizes altered physiological mechanisms in cells and organ systems. 3 hrs. lecture. Prerequisites: BIO 202 and 205 or 220. Spring, SS II.

BIO 322 Entomology (4). Classification, identification, ecology, physiology, and economic importance of insects. 3 hrs. lecture, 3 hrs. lab. Prerequisite: BIO 190. Fee required. Fall.

BIO 325 Animal Physiology (3). An introduction to the integration and function of animal tissues, organs, and organ systems in the maintenance of homeostasis. 3 hrs. lecture. Prerequisites: BIO 190 and CHM 130:151L or equivalent. Fall.

BIO 325L Animal Physiology Lab (1). A laboratory experience in the study of animal tissues, organs, and organ systems. 3 hrs. lab. Corequisite or prerequisite: BIO 325. Fee required. Fall, Spring.

BIO 331 Vertebrate Embryology (4). Principles of development in amphibians, birds, and mammals. 3 hrs. lecture, 3 hrs. lab. Prerequisite: BIO 424 recommended. Fee required. Spring.

BIO 332 Histology (2). The structure of tissues and organs with special emphasis on humans. 1 hr. lecture, one 3-hr. lab. Prerequisites: BIO 190 or equivalent. Fee required. Spring.

BIO 345 Plant Propagation (3). Application of plant science principles to plant propagation, including elements of pathology, physiology, entomology, landscaping, orchard, garden, and greenhouse science. 2 hrs. lecture, 3 hrs. lab. Prerequisite: BIO 184 or equivalent. Fee required.

BIO 350 Molecular Genetics (3). The study of genetics from a molecular and microbial perspective; gene structure, expression, control, mutation, and recombination; advances in genetic engineering. 3 hrs. lecture. Prerequisites: BIO 184 or 190, and 220; CHM 230:230L or 235:238. Fall.

BIO 366 Behavior of Animals (3). A survey of the theories and reasons that explain the behavior of animals. 3 hrs. lecture, Prerequisite: BIO 180 or equivalent. Fall, Spring, SS II.

BIO 369 Environmental Microbiology (4). Microorganisms in the air, food, soil, and water, and their interaction with the environment. 3 hrs. lecture, 3 hrs. lab. Prerequisite: BIO 220 or 205. Fee required. Fall.

BIO 371 Evolutionary Biology (3). The evolution of organisms, including variability, natural selection speciation, patterns and rates of evolution, and the importance of the fossil record. 2 hrs. lecture. Prerequisite: BIO 240. Fall.

BIO 372 Revolutionary Thought in Biology (3). Biological theories, such as those on the origin of life, evolution, and extinction; the immune response; sex; cancer; and behavior. 3 hrs. lecture.

BIO 373 Marine Biology (3). Behavior, ecology, biogeography, and evolution of marine organisms relative to the physics and geology of the ocean. 3 hrs. lecture. Prerequisites: Any two of BIO 184, 190, 205 and 220.

BIO 380 Applied Entomology (4). The effects of insects on the human economy and human welfare, including procedures for controlling insect populations emphasizing the use of insect pest management. 3 hrs. lecture, 3 hrs. lab. Prerequisite: BIO 322. Fee required.

BIO 401 Immunobiology (4). Basic and clinical aspects of immunobiology emphasizing the immune response, antibody structure, immunological specificity, antigen antibody reactions, and immunological diseases of human. 3 hrs. lecture, 3 hrs. lab. Prerequisites: BIO 205 or 220, CHM 230:230L or 235:238, and CHM 304 recommended. Fee required. Fall.

BIO 410 Phycology (3). Systematics, structure, reproduction, ecology, and methods of collecting algae; culture and experimental study of selected algae species. Field trips, 2 hrs. lecture, 3 hrs. lab. Prerequisite: BIO 184. Fee required. Spring.

BIO 411 Mycology (3). Systematics, physiology, ecology, and medical importance of fungi and related forms; field identification and experimental studies. 2 hrs. lecture, 3 hrs. lab. Prerequisite: BIO 184 or equivalent. Fee required. Fall.

BIO 414 Native Plants of Arizona (3). Field-oriented course emphasizing the recognition of much of the native and naturalized flora of Arizona. Prerequisite: BIO 184 or equivalent. Fee required.

BIO 415 Plant Taxonomy (4). Introduction to the principles of plant classification; a survey of flowering plant families in northern Arizona; collection, identification, and preservation of wild flowers and grasses. 3 hrs. lecture, 3 hrs. lab. Prerequisites: Wild flowers and grasses. BIO 184 or equivalent. Fee required. Spring.

BIO 424 Comparative Vertebrate Anatomy (4). The interpretation of vertebrate structure with emphasis on phylogeny and function. 3 hrs. lecture, 3 hrs. lab.
BIO 426 Plant Physiology (3). Analysis of plant functions, including their systems, cellular mechanisms, and integration. 3 hrs. lecture. Prerequisites: BIO 184 or CHM 230, CHM 360 recommended. Corequisite: BIO 426L. Spring.

BIO 426L Plant Physiology Laboratory (1). Laboratory exercises illustrating plant physiological functions. 3 hrs. lab. Corequisite: BIO 426. Fee required. Spring.

BIO 430 Biology Teaching Methods (2). An introduction to laboratory and classroom procedures, techniques, and curricula appropriate for the secondary school. Fall.

BIO 431 Plant Morphology (3). Comparative functional morphology, ecology, and evolutionary relationships of algae, fungi, bryophytes, and vascular plants; field and lab exercises include fossil and living plants. 2 hrs. lecture, 3 hrs. lab. Prerequisite: BIO 184. Fee required. Spring.

BIO 440 Cell Biology and Molecular Genetics (3). Cell biology including functions of macromolecules; organelle structure and function; membrane transport; and the structure, function, and action of genes. 3 hrs. lecture. Prerequisites: BIO 245, CHM 230:230L or equivalent, CHM 360 or 460, and BIO 350.

BIO 440L Cell Biology Laboratory (2). The study of cell structure and function using modern molecular and genetic techniques. 6 hrs. lab. Corequisite: BIO 440 and consent of instructor. Fee required.

BIO 444 Human Physiology (5). Physiology of major body systems studied at the metabolic, cellular, and systemic levels, emphasizing homeostatic mechanisms. 4 hrs. lecture, 3 hrs. lab. Prerequisites: BIO 202 or 325 and 424; CHM 360 or 460; and PHY 112 or 262 or 141. Fee required. Fall.

BIO 470 Concepts in Ecology (4). Theoretical and applied concepts in ecology, such as evolutionary ecology, population and community ecology, ecosystem ecology, and behavioral ecology. 3 hrs. lecture. 3 hrs. lab. Prerequisite: BIO 226. Fee required.

BIO 471 Microbial Ecology (3). Interaction of fungi and algae in their environment involving species diversity, population regulation, and community dynamics of aquatic and terrestrial forms. 2 hrs. lecture, 3 hrs. lab. Prerequisites: BIO 205 or 220; and BIO 410 and 411.

BIO 474 Economic Botany (3). Survey of plants used by humans including plant parts or products used, and their geographic origin and distribution. 2 hrs. lecture, 3 hrs. lab. Prerequisite: BIO 184 or equivalent.

BIO 475 Parasitology (4). Parasites and their life cycles, host injuries, treatment, means of control, and prevention of infection. 3 hrs. lecture, 3 hrs. lab. Prerequisite: Junior standing in biology.

BIO 476 Higher Aquatic Plants (3). Ecology and taxonomy of the vascular plants and bryophytes in aquatic and riparian environments. 2 hrs. lecture, 3 hrs. lab. Prerequisites: BIO 184 and 431. Fee required. Fall.

BIO 477 Fish Management (3). Introduction to theory and practice of commercial and sport fish management. Topics include evolution and management of wild and stocked populations; field, laboratory, and hatchery techniques; aquaculture; exotic species; politics and economic management. 2 hrs. lecture, 3 hrs. lab. Prerequisites: BIO 223 or 527 and 528. Fee required. Fall.

BIO 478 Wildlife Management (3). A survey of concepts and practices employed in the study and management of terrestrial wildlife. Topics include values, habitat requirements, movements, behavior, and dynamics of wildlife populations and the techniques used to ensure their continued survival. 2 hrs. lecture, 3 hrs. lab. Prerequisite: BIO 223 or 527, and 528. Fee required. Fall.

BIO 480 Virology (4). Medical aspects of host-parasite relationships in bacterial, mycotic, rickettsial, and viral diseases of human. 3 hrs. lecture, 3 hrs. lab. Prerequisites: BIO 205 or 220; CHM 230:230L or 235:238 (may be taken concurrently). Fee required. Spring.

Graduate Courses

BIO 502 Virology (4).
BIO 516 Microbial Genetics (4).
BIO 517 Agrostology (3).
BIO 522 Advanced Entomology (3).
BIO 525 Ichthyology (3).
BIO 526 Herpetology (3).
BIO 527 Ornithology (3).
BIO 528 Mammalogy (3).
BIO 535 Advanced Systemic Physiology (3).
BIO 536 Developmental Plant Anatomy (3).
BIO 540 Comparative Animal Physiology (4).
BIO 544 Applied Microbiology (4).
BIO 550 Human Genetics (3).
BIO 554 Advanced Botany (3).
BIO 570 Plant Ecology (3).
BIO 571 Field Biology (2-3).
BIO 572 Limnology (3).
BIO 573 Field Ecology (3).
BIO 574 Experimental Marine Ecology (6).
BIO 575 Plant Pathology (3).
BIO 576 Economic Botany (3).
BIO 577 Fern Mountain Field Ecology (5).
BIO 580 Population and Quantitative Genetics (3).
BIO 612 Advanced Immunology (4).
BIO 642 Applied Microbiology (4).
BIO 646 Plant Chemistry (3).
BIO 650 Advanced Cellular Biology (3).
BIO 651 Molecular and Developmental Biology (4).
BIO 652 Cytogenetics (4).
BIO 660 Organic Evolution (3).
BIO 662 Modern Microbiology for Teachers (3).
BIO 663 Biogeography (3).
BIO 665 Systematic Zoology (3).
BIO 666 Animal Behavior (3).
BIO 670 Advanced Ecology (3).
BIO 671 Paleobotany and Paleocoeology (3).
BIO 673 Physiological Ecology (3).
BIO 680 Biological Techniques (2-3).
BIO 681 Advanced Studies in Biology (2-3).
BIO 682 Quantitative Biology (3).
BIO 683 Modern Biology for Teachers (3).
BIO 698 Seminar (1).
BIO 795:796 Internship in College Teaching (1:1).