Biology BS and Minor

Biology

College of Science, Engineering & Technology
Department of Biological Sciences
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The Department of Biological Sciences offers programs for students preparing for careers in education, laboratory and field research, biotechnology, environmental sciences, medical laboratory sciences, cytotechnology, food science technology and preprofessional programs including premedicine, pre-dental, and pre-veterinary medicine. The biology major offers a core program intended to develop a common background in biology and additional upper level courses designed to provide specialized options. Students typically take a broad based general biology major or an emphasis in one of the following: general biology, cytotechnology, ecology, biomedical sciences, microbiology, plant science, toxicology, or zoology. Programs in biotechnology, environmental sciences, food science technology, medical laboratory science, and life science teaching are also offered.

Academic Map/Degree Plan at www.mnsu.edu/programs/#All

POLICIES/INFORMATION

Admission to Major granted by the department. Admission requirements are 32 earned semester hours including BIOL 105, BIOL 106, BIOL 211, and CHEM 201 with a grade of “C” or better; completed General Education Goal Area 4 (Mathematics); completed General Education Goal Area 1, Part A (English Composition); and a minimum cumulative GPA of 2.2, with a cumulative GPA in Biology courses of 2.0. For Life Science Teaching majors, the combined GPA for BIOL 105, BIOL 106, BIOL 211, and CHEM 201 must be 2.4 or better.

Residency requirement for the Major. At least 50% of courses 300 level and up that are required for the major must be taken at Minnesota State University, Mankato.

Graduation with a Biology Major requires a minimum cumulative GPA of 2.0, and a minimum cumulative GPA in Biology courses of 2.0.

P/N Grading Policy. All courses leading to a major or a minor in biology must be taken for letter grades. Any exception to this policy must be approved by the chairperson of the department.

Refer to the College regarding required advising for students on academic probation.

GPA Policy. In programs where not specifically noted, a minimum GPA of 2.0 must be maintained in biological sciences. “A minimum GPA of 2.5 in the sciences and a “C” or better in all science courses is required for graduation with a BS Life Science Teaching degree.

In addition to the specific requirements of the major, all university requirements must be met for graduation. This includes 120 credits of coursework, 40 credits of upper division courses (including those in the major), purple and gold course requirements, and two writing intensive courses.

Several biology scholarships are available for entering first year students and currently enrolled Minnesota State Mankato students who meet the requirements. Application deadline is in early February of each year.

The Department of Biological Sciences offers a well-balanced summer school program. For details concerning the courses being offered consult the summer schedule.

BIOLOGY

2017-2018 Undergraduate Catalog
Major Emphasis: Biomedical Sciences

The purpose of this option is to prepare the student for a career in biomedicine. The option fulfills the science course requirements for most medical, osteopathic, dental, and chiropractic schools as well as the science course requirements for graduate education in biomedicine. If you are interested in applying for a specific medical school, please contact that school for their specific requirements. All emphases require BIOL 105, 106, 211, CHEM 201, and ENG 271W.

Emphasis Required General Education (choose 4 credits)
MATH 211 Principles of Physics I (4)

Emphasis Required (choose 3 - 4 credits)
MATH 113 Trigonometry (3)
MATH 115 Precalculus Mathematics (4)
MATH 121 Calculus I (4)

Emphasis Unrestricted Electives: Choose 9 credits. At least one course must have a laboratory component. Choose a maximum of 4 credits from BIOL 497 or BIOL 499.

Choose from:
BIOL 324 Neurobiology (3)
BIOL 410 Global Change Biology (3)
BIOL 417 Biology of Aging and Chronic Diseases (3)
BIOL 420 Diagnostic Parasitology (3)
BIOL 430 Hematology/Introduction to Immunology (4)
BIOL 433 Cardiovascular Physiology (3)
BIOL 435 Histology (4)
BIOL 438 General Endocrinology (3)
BIOL 452 Biological Instrumentation (3)
BIOL 460 Introduction to Toxicology (3)
BIOL 466 Principles of Pharmacology (3)
BIOL 474 Immunology (4)
BIOL 475 Medical Microbiology (4)
BIOL 479 Molecular Biology (4)
BIOL 497 Internship (1-12)
BIOL 499 Individual Study (1-4)

Required Minor: None.

Major Emphasis: Cytotechnology

A cytotechnologist is an allied health professional and is involved in the microscopic study of cells for evidence of disease and cancer. Cytotechnologists are trained to accurately identify precancerous, malignant, and infectious conditions using cytological techniques. The “Pap test” (an evaluation of cells from the uterine cervix) is the best known test in this field. The four-year curriculum consists of three years spent at the university completing the required courses and the fourth year is a 32 credit internship spent in professional education. Agencies participating in the cytotechnology program include, but are not limited to: Mayo School of Health Sciences in Rochester, MN. Admission into the fourth-year hospital clinical internship is competitive. Therefore, admission to the program does not ensure placement into the fourth-year internship. Graduates are then eligible to take the certifying examination. Cytotechnologists are employed in hospital laboratories, universities, and private laboratories. Adjunct faculty at the clinical sites include: Kara Hansing, CT (ASCP). Students accepted into the clinical internship will be responsible for: Proof of Medical / Hospitalization / Health Insurance; Health Physical Exam; Tuberculosis (TB) testing, and Proof of Immunization which may include the following: Hepatitis B, Measles, Mumps, Rubella, Tetanus, Chickenpox (Varicella), and Influenza. Students may also be required to submit to Drug Screen Testing. Internship sites are required by law to do Background Checks on all students admitted to their cytotechnology programs. All emphases require BIOL 105, 106, 211, CHEM 201, and ENG 271W.

Emphasis Required General Education (choose 4 credits)
MATH 112 College Algebra (4)
MATH 115 Precalculus Mathematics (4)
MATH 121 Calculus I (4)

Emphasis Required Support Courses (choose 13 credits)
Choose from the following to total at least 13 additional credits in Chemistry.
CHEM 202 General Chemistry II (5)
CHEM 305 Analytical Chemistry (4)
CHEM 322 Organic Chemistry I (4)
CHEM 323 Supplemental Organic Functional Group Chemistry (1)
CHEM 324 Organic Chemistry II (3)
CHEM 325 Organic Chemistry II Lab (1)
CHEM 360 Principles of Biochemistry (4)

Emphasis Core Courses (choose 16 Credits)
BIOL 220 Human Anatomy (4)
BIOL 270 Microbiology (4)
BIOL 320 Cell Biology (4)
BIOL 330 Principles of Human Physiology (4)

Emphasis Restricted Electives (choose 3 - 4 credits)
BIOL 424 Developmental Biology (3)
BIOL 430 Hematology/Introduction to Immunology (4)
BIOL 435 Histology (4)
BIOL 479 Molecular Biology (4)

Professional Education (choose 32 credits)
BIOL 493 Cytotechnology/Cytogenetics Clinical Internship 1 (1-12)
BIOL 494 Cytotechnology/Cytogenetics Clinical Internship 2 (1-12)
BIOL 495 Cytotechnology/Cytogenetics Clinical Internship 3 (1-12)
BIOL 496 Cytotechnology/Cytogenetics Clinical Internship 4 (1-12)

Major Emphasis: Ecology

Ecology is the study of relationships between organisms and their environment. The option consists of fundamental courses in biology and related sciences, mid-level study in genetics, evolution, and statistics, and an array of upper-division electives that emphasize fieldwork, data analysis, and writing. Many students collaborate with faculty in their research or conduct independent research projects. Career titles available with this option include ecologist, naturalist, wildlife biologist, natural resource manager, fish biologist, marine biologist, conservational training or graduate school. For more information about the option and the ecology faculty, select “ecology” at the department page (see www.mnsu.edu/dept/biology). All emphases require BIOL 105, 106, 211, (5)

Emphasis Common Core (choose 17 credits)
BIOL 215 General Ecology (4)
BIOL 301 Evolution (2)
BIOL 408 Vertebrate Ecology (4)
BIOL 443 Plant Ecology (4)
HLTH 475 Biostatistics (3)

Chemistry Requirement (choose 5 credits)
CHEM 111 Chemistry of Life Processes (5)
CHEM 202 General Chemistry II (5)

Emphasis Required General Education courses:

Physics
PHYS 211 Principles of Physics I (4)

Math
Choose 3-4 credits from the following:
MATH 113 Trigonometry (3)
MATH 115 Precalculus Mathematics (4)
BIOLOGY CONTINUED

Emphasis Restricted Electives—Physiology Requirement.

COMPLETE ONE GROUP.

**Animal Physiology**
- **BIOL 316** Animal Diversity (3)
- **BIOL 431** Comparative Animal Physiology (3)

**Microbial Physiology**
- **BIOL 270** Microbiology (4)
- **BIOL 476** Microbial Physiology and Genetics (5)

**Plant Physiology**
- **BIOL 217** Plant Science (4)
- **BIOL 441** Plant Physiology (4)

**Emphasis Unrestricted Electives**—Choose courses to total 40 credits in biology. Courses other than those listed are allowed with consent of your advisor. A limit of 4 total credits is allowed from BIOL 492, BIOL 497, and BIOL 499 combined.

- **BIOL 320** Cell Biology (4)
- **BIOL 404** Wetlands (4)
- **BIOL 405** Fisheries Biology (3)
- **BIOL 409** Advanced Field Ecology (4)
- **BIOL 410** Global Change Biology (3)
- **BIOL 412** Soil Ecology (4)
- **BIOL 431** Comparative Animal Physiology (3)
- **BIOL 432** Lake Ecology (4)
- **BIOL 436** Animal Behavior (4)
- **BIOL 441** Plant Physiology (4)
- **BIOL 442** Flora of Minnesota (4)
- **BIOL 460** Introduction to Toxicology (3)
- **BIOL 472** Microbial Ecology and Bioremediation (4)
- **BIOL 479** Molecular Biology (4)
- **BIOL 492** Honors Research (3-12)
- **BIOL 497** Internship I (1-12)
- **BIOL 499** Individual Study (1-4)

Required Minor: None.

**Major Emphasis: Microbiology**

Microorganisms impact every area of life. The option exposes students to a variety of topics in microbiology and teaches numerous skills needed to work with microorganisms. Training in microbiology prepares students for employment in industry (e.g., quality assurance, vaccine production) and government (e.g., laboratory technicians). Currently, employment opportunities abound in applied areas of microbiology such as biological products/pharmaceuticals, food processing, environmental assessment. It also prepares a student for continuing education in microbiology, immunology, and cell and molecular biology. Students may elect to work on research projects with faculty who work in the areas of food microbiology, immunology, microbial genetics, and molecular biology. All emphases require BIOL 105, 106, 211, CHEM 201, and ENG 271W.

**Math Requirement**—Choose 3 - 4 credits.
- **MATH 112** College Algebra (4)
- **MATH 113** Trigonometry (3)
- **MATH 115** Precalculus Mathematics (4)
- **MATH 121** Calculus I (4)

**Emphasis Common Core**—Choose 18 credits.
- **BIOL 270** Microbiology (4)
- **CHEM 202** General Chemistry II (5)
- **CHEM 305** Analytical Chemistry (4)
- **CHEM 322** Organic Chemistry I (4)
- **CHEM 323** Supplemental Organic Functional Group Chemistry (1)

**Emphasis Restricted Electives**—Choose 4 - 5 credits.
- **BIOL 476** Microbial Physiology and Genetics (5)
- **CHEM 360** Principles of Biochemistry (4)
- **CHEM 460** Biochemistry I (3)
- **CHEM 465** Biochemical Techniques I (1)

**Emphasis Unrestricted Electives**—Choose 25 credits.
- **BIOL 476** Microbial Physiology and Genetics (5)
- **CHEM 360** Chemical Laboratory Techniques (1)
- **CHEM 460** Biochemistry I (3)
- **CHEM 465** Biochemical Techniques I (1)

**Recommended Support Courses**
- **IT 100** Introduction to Computing and Applications (4)
- **MATH 121** Calculus I (4)

Required Minor: None.

**Major Emphasis: Toxicology**

Toxicology is the study of the harmful effects of chemicals, radiation, and other stressors on biological systems. This is a wide-ranging course of study, allowing students to connect their background on chemistry, biology, physics, mathematics, etc. to understand all aspects of how an exposure may or may not yield a toxic result. Then students can do elementary risk assessment and environmental or medical analyses. The purpose of this option is to train students in the theory and hands-on research techniques of an interdisciplinary biological science at the undergraduate level in a field where there are few programs in the United States.

**Emphasis Restricted Electives**—Choose at least 8 credits from the following list of electives. At least two of the courses must have laboratory components. A maximum of 4 credits may be selected from BIOL 492, BIOL 497, and BIOL 499 combined.

- **BIOL 301** Evolution (2)
- **BIOL 320** Cell Biology (4)
- **BIOL 404** Wetlands (4)
- **BIOL 409** Advanced Field Ecology (4)
- **BIOL 410** Global Change Biology (3)
- **BIOL 412** Soil Ecology (4)
- **BIOL 432** Lake Ecology (4)
- **BIOL 451** Plant Biotechnology (4)
- **BIOL 460** Introduction to Toxicology (3)
- **BIOL 479** Molecular Biology (4)
- **BIOL 492** Honors Research (3-12)
- **BIOL 499** Individual Study (1-4)

**Recommended Support Courses**
- **IT 100** Introduction to Computing and Applications (4)
- **MATH 121** Calculus I (4)

Required Minor: None.
Since toxins can be antibiotics antiviral or other chemotherapeutic medications, antidotes, agricultural chemicals, industrial chemicals, radiation, or just stressors such as poor ergonomics, graduates can and have proceeded into research and testing of pharmaceuticals, pesticides, and environmental toxicology in industry, governmental, academic institutions. Additionally, training in risk assessments leads to additional opportunities for statistical modeling, which is employed in the areas mentioned above and industrial hygiene. All emphases require BIOL 105, 106, 211, CHEM 201, and ENG 271W.

**Emphasis Required General Education (choose 8 credits)**
- MATH 121 Calculus I (4)
- PHYS 211 Principles of Physics I (4)

**Emphasis Common Core (choose 65 credits)**
- BIOL 215 General Ecology (4)
- BIOL 220 Human Anatomy (4)
- BIOL 270 Microbiology (4)
- BIOL 330 Principles of Human Physiology (4)
- BIOL 466 Introduction to Toxicology (3)
- BIOL 461 Environmental Toxicology (4)
- BIOL 462 Toxicology Seminar (1)
- BIOL 464 Methods of Applied Toxicology (3)
- BIOL 465 Applied Toxicology Project (3)
- BIOL 466 Principles of Pharmacology (3)
- BIOL 467 Industrial Hygiene (3)
- CHEM 202 General Chemistry II (5)
- CHEM 305 Analytical Chemistry (4)
- CHEM 322 Organic Chemistry I (4)
- CHEM 324 Organic Chemistry II (3)
- CHEM 460 Biochemistry I (3)
- CHEM 461 Biochemistry II (3)
- CHEM 465 Biochemical Techniques I (1)
- CHEM 466 Biochemical Techniques II (2)
- HITH 475 Biostatistics (3)

**Required Minor: None**

**Major Emphasis: Zoology**
Zoology is a major branch of the biological sciences that involves the study of animals. Study in this area focuses on organismal diversity, animal structures and functions, genetics, development, evolution, behavior, and ecological interactions. Occupations that may be available to graduates include Animal Husbandry, Museum/Zoo Guide, Animal Laboratory Technician, Animal Trainer, Pest Control Technician, Museum Curator, Entomologist, Environmental Consultant, Field Researcher, Science Writer, Physician, Veterinarian, Wildlife Rehabilitator, Zoo Keeper, and Zoologist. Advanced training in professional or graduate schools is required in many of these areas and acceptance for advanced training is competitive. Success in this career field typically requires: a thorough knowledge of general biology, the ability to work and relate with animals, proficiency in reading and writing and ability to collect and analyze data, and an interest in problem solving and decision making. All emphases require BIOL 105, 106, 211, CHEM 201, and ENG 271W.

**Emphasis Core Courses (choose 22 credits)**
- BIOL 215 General Ecology (4)
- BIOL 301 Evolution (2)
- BIOL 316 Animal Diversity (3)
- BIOL 408 Vertebrate Ecology (4)
- BIOL 424 Developmental Biology (3)
- BIOL 431 Comparative Animal Physiology (3)
- HITH 475 Biostatistics (3)

**Emphasis Restricted Electives (choose 6 - 7 credits)**
- BIOL 420 Diagnostic Parasitology (3)
- BIOL 421 Entomology (3)
- BIOL 436 Animal Behavior (4)
- BIOL 438 General Endocrinology (3)

**Emphasis Unrestricted Electives (choose 6 credits)**
- BIOL 420 Cell Biology (4)
- BIOL 424 Neurobiology (3)
- BIOL 403 Conservation Biology (3)
- BIOL 409 Advanced Field Ecology (4)
- BIOL 419 Global Change Biology (3)
- BIOL 412 Soil Ecology (4)
- BIOL 420 Diagnostic Parasitology (3)
- BIOL 435 Histology (4)
- BIOL 438 General Endocrinology (3)
- BIOL 460 Introduction to Toxicology (3)
- BIOL 472 Microbial Ecology and Bioremediation (4)
- BIOL 479 Molecular Biology (4)
- BIOL 492 Honors Research (1-3)
- BIOL 497 Internship I (1-12)
- BIOL 499 Individual Study (1-4)

**Recommended Support Courses**
- CHEM 111 Chemistry of Life Processes (5)
- CHEM 202 General Chemistry II (5)

**Recommended Support Courses**
- PHYS 211 Principles of Physics I (4)
- MATH 121 Calculus I (4)

**Emphasis Required General Education Courses**
- CHEM 111 Chemistry of Life Processes (5)
- MATH 121 Calculus I (4)

**Emphasis Required General Education Courses**
- PHYS 211 Principles of Physics I (4)
- MATH 121 Calculus I (4)

**Minor Required General Education Courses**
- PHYS 211 Principles of Physics I (4)
- MATH 121 Calculus I (4)

**Minor Electives**
In addition to the course chosen from the list below add any 200-level or above biology course to total 17 credits in the minor.

**Major: Zoology**
See the **LIFE SCIENCE TEACHING BS**

**Biology Minor**

- BIOL 105 General Biology I (4)
- BIOL 211 Genetics (4)
- BIOL 106 General Biology II (4)

**Minor Core**
- BIOL 105 General Biology I (4)
- BIOL 106 General Biology II (4)
- BIOL 211 Genetics (4)

**Minor Electives**
- BIOL 215 General Ecology (4)
- BIOL 217 Plant Science (4)
- BIOL 220 Human Anatomy (4)
- BIOL 270 Microbiology (4)

**Course Descriptions**

**BIOLOGY 100 (4) Our Natural World**
Introductory course designed for students not majoring in science. Focuses on basic biological principles with special emphasis on the human species. Includes scientific problem solving, biodiversity, human and social aspects of biology, ecology, cellular processes and organ function, human reproduction, prenatal development, and heredity. Lecture, laboratory, and small group discussions.

Fall, Spring
GE-3

**BIOLOGY 101 (2-4) Biological Perspectives**
Students focus on specific biological perspectives, including environmental science, biology of women, biotechnology, human heredity, etc. May be repeated for credit under different subtitles.

Fall, Spring

**BIOLOGY 102 (3) Biology of Women**
An introduction to biological topics of special interest to women with emphasis on anatomic and physiologic changes over the course of a woman's lifetime. Designed for students not majoring in science. Presents fundamental biologic concepts within this specialized context and provides opportunity to collect, evaluate, and analyze data.

Fall, Spring
GE-3
BIOL 105 (4) General Biology I
Study of biological processes at the suborganismal level including cell chemistry, metabolism, reproduction, genetics, and complex tissue physiology. Laboratory and discussion sessions stress problem solving and experimental design. Fall, Spring
GE-3

BIOL 105W (4) General Biology I
Study of biological processes at the suborganismal level including cell chemistry, metabolism, reproduction, genetics, and complex tissue physiology. Laboratory and discussion sessions stress problem solving and experimental design. Fall, Spring
GE-3

BIOL 106 (4) General Biology II
Study of biological processes at the organismal level including a survey of life forms (viruses, bacteria, protists, fungi, plants, and animals), their evolution, and ecology. Laboratory and discussion sessions stress problem solving and experimental design. Prerequisite: BIOL 105 Fall, Spring

BIOL 175 (1) Orientation to Clinical Laboratory Science
An introduction to the health care profession with special emphasis on clinical laboratory personnel. Course includes presentations by professionals in some of the major health care fields, especially medical technology. Includes lectures, discussion, and field observations. Spring

BIOL 211 (4) Genetics
Introduction to genetic analysis. Topics covered include those both classical and modern genetics: population genetics, molecular genetics, genetic manipulation of organisms and selection. Central to this course will be the primacy of the trait as the object of genetics and the development/refinement of the concept of the gene. Lab included. Prerequisite: BIOL 105, BIOL 106, and MATH 112 Fall, Spring, Summer

BIOL 215 (4) General Ecology
Principles of the study of relationships between organisms and the environment. Topics include flow of energy and materials, organism-level interactions, growth and evolution of populations, and community ecology. Field trips to prairie, lake, stream, and forest communities, training in data collection and analysis, use of equipment, and report writing. Lab included. Prerequisite: BIOL 105 and BIOL 106 or consent Fall

BIOL 217 (4) Plant Science
Biology of plants including unique features of plant cells, life histories, metabolism, anatomy, physiology, and ecology. The course emphasizes plants' remarkable adaptations to their environments, their diversity, and the vital roles they play in ecological interactions. For biology and environmental science majors and minors. Lab included. Prerequisite: BIOL 105 and BIOL 106 or consent Spring

BIOL 220 (4) Human Anatomy
Systems approach to the structure of the human body. The course is designed for students majoring in biology or health related programs. Lab included. Fall, Spring

BIOL 220 (4) Human Anatomy
Systems approach to the structure of the human body. The course is designed for students majoring in biology or health related programs. Lab included. Fall, Spring

BIOL 220 (4) Human Anatomy
Systems approach to the structure of the human body. The course is designed for students majoring in biology or health related programs. Lab included. Fall, Spring

BIOL 227 (4) Microbiology
An introduction to the general principles and methods used in the study of microorganisms. Lab included. Prerequisite: One BIOL course and one semester of chemistry from among CHEM 104, CHEM 106, CHEM 111, or CHEM 201 Fall, Spring, Summer

BIOL 283 (1) MAX Scholar Seminar
This class provides MAX scholars with an opportunity to explore a set of topics related to achieving success in academic, professional and personal realms. Speakers will include faculty, graduate students, visiting researchers and industry members as well as student participants. NOTE: Credit does not apply to any major. Prerequisite: Recipient of a MAX scholarship or instructor consent. Fall, Spring

BIOL 301 (2) Evolution
Evolution is a unifying theory of biology. Students are provided the history of evolutionary thought and the Darwinian revolution, evidence for evolution, mechanics of evolution, and an array of special topics such as speciation, molecular evolution, conservation, and extinction. Readings will include book chapters and journal articles. Lecture/discussion. Prerequisite: BIOL 105, BIOL 106, BIOL 211 Spring

BIOL 310 (4) Basics of Human Physiology
Principles of functions of human cells, organs, and systems with an emphasis on organ/system interactions. Designed for majors that do not require a strong medical and research emphasis. Includes an active learning laboratory to facilitate learning the complex lecture material. Prerequisite: BIOL 220, CHEM 104 or CHEM 106 or CHEM 111 or CHEM 201 Fall, Spring, Summer

BIOL 316 (3) Animal Diversity
A comprehensive phylogenetic survey of both invertebrate and vertebrate animals. Emphasis on evolutionary relationships among phyla, the evolution of organ systems, animal organization and function, animal adaptations, and zoogeographical considerations. Research and inquiry of animal unity and diversity will include using the Internet. Lab included. Prerequisite: BIOL 105 and BIOL 106 Fall

BIOL 320 (4) Cell Biology
An examination of eukaryotic cellular structure, organization and physiology. Lab included. Prerequisite: BIOL 105 and BIOL 106, BIOL 211 Fall and Spring, Summer (On Demand)

BIOL 324 (3) Neurobiology
Basic anatomy and physiology of the nervous system. The course is designed for students majoring in biology, psychology or health related programs. Prerequisite: BIOL 220 Fall

BIOL 330 (4) Principles of Human Physiology
Principles of functions of human cells, organs, and systems with an emphasis on organ/system interactions. This course is designed for students majoring in biology, chemistry, or related sciences, and medically-related areas. Includes a laboratory with a research and medical emphasis. Prerequisite: BIOL 220, CHEM 104 or CHEM 106 or CHEM 111 or CHEM 201 Fall, Spring, Summer

BIOL 380 (3) Blood Banking/Urinanalysis
Basic understanding of the principles of immunohematology applied to the area of blood banking including major blood group systems, principles for antigen/antibody detection and identification, donor blood collection, transfusion evaluation, theory of renal function in health and disease, specimen collection, handling, and processing, and components of routine urinalysis. Spring

BIOL 402 (4) Stream Ecology
The structure and function of stream ecosystems are presented with emphasis on adaptations of organisms to stream life and connections between stream organisms, the aquatic environment, and the surrounding watershed. Includes lab, field work, and team projects. Prerequisite: BIOL 105, BIOL 106, BIOL 215 or consent Summer

BIOL 403 (3) Conservation Biology
Applications of principles from ecology, genetics, behavior, demography, economics, philosophy, and other fields to the conservation and sustainable use of natural populations of plants and animals. Lectures and discussions address topics such as habitat fragmentation, parks and reserves, genetic diversity, population viability, and extinction. Prerequisite: BIOL 215 or consent Spring

BIOL 404 (4) Wetlands
To provide students the values and functions of wetlands and to use wetlands as an example of the relationship of ecology to management, and the impact that classification systems have politically. Lab (fieldwork) included. Prerequisite: BIOL 105, BIOL 106, BIOL 215, or consent Spring
Biology 405 (3) Fisheries Biology
An introduction to fish biology and fisheries management. Diversity, form and function in the aquatic environment, functional physiology, evolution and speciation, identification and use of keys, ecology, and management topics. Prerequisite: BIOL 105, BIOL 106, BIOL 215; or consent of instructor. Alt-Fall

Biology 408 (4) Vertebrate Ecology
A field course in the ecology of birds, mammals, amphibians, reptiles, and fishes. Students are trained in sampling techniques such as mark-and-recapture, population size estimation, and monitoring, and species identification of live and preserved specimens. Lectures encompass evolution and adaptation, origins, energetics, mating systems, morphology, geographical distributions, and population-level phenomena. Lecture and laboratory. Prerequisite: BIOL 105, BIOL 106, BIOL 215 or consent Fall

Biology 409 (4) Advanced Field Ecology
A field course focused on the function and dynamics of various North American ecosystems. Emphasis will be on natural history, critical thought, and experimental design. Students will be trained in a variety of soil, plant, and animal sampling techniques. Depending on enrollment, there may be additional costs (e.g., camping fees) for the course. Prerequisite: BIOL 105, BIOL 106, BIOL 215 or consent. Summer (On Demand)

Biology 410 (3) Global Change Biology
This class examines the effects of natural and human-induced changes in climate on terrestrial and marine ecosystems. The course focuses on the science behind global change issues that have biological, social, and economic implications. Prerequisite: BIOL 105, BIOL 106, BIOL 215 or consent Fall

Biology 412 (4) Soil Ecology
Soil ecology will focus on the genesis and classification of soils, the physical properties of soil as they relate to habitat formation, niches, interactions that exist among soil organisms, human impact on soil systems relative to population pressures and management practices. Lab included. Prerequisite: BIOL 105, BIOL 106, BIOL 215 or consent Spring

Biology 417 (3) Biology of Aging and Chronic Diseases
Emphasis is placed on the biomedical aspects of aging and chronic disease. The course is designed for students majoring in biology, gerontology programs, or other health related programs. Prerequisite: BIOL 100 or BIOL 105 Fall, Spring

Biology 420 (3) Diagnostic Parasitology
Clinically important parasites. Protozoans, Flukes, Tapeworms, Roundworms, Ticks, Mites and Insects. Designed for Medical Technology, Vet-Med, VetMed and Biology majors. Identification, clinical disease, epidemiology and ecology are covered. Lab included. Prerequisite: BIOL 100 or BIOL 105, BIOL 106 recommended Spring

Biology 421 (3) Entomology
Morphological, physiological, medical, and economic significance of insects. Prerequisite: BIOL 105 and BIOL 106 or consent Alt-Fall

Biology 424 (3) Developmental Biology
Understanding the process of cell differentiation and development. These principles are then applied to the descriptive study of human embryology including the basis of congenital malformations. Prerequisite: BIOL 100 or BIOL 105 Fall

Biology 425 (1) Development Biology Lab
Biology 425 is an optional 1-credit laboratory in addition to Developmental Biology, Biology 424. In the laboratory component, students will be exposed to modern techniques used to examine developmental processes in several key model systems. Laboratory exercises consist of experiments designed to demonstrate fundamental concepts in development and to familiarize students with experimental approaches utilized in studying developmental biology and embryology. Fall

Prerequisite: BIOL 211; Corequisite: BIOL 424

Biology 430 (4) Hematology/Introduction to Immunology
Collection, examination, evaluation, morphology, function and diseases of blood cells. Hemostasis/coagulation of blood. Immunology theory is presented. Lab included. Spring

Biology 431 (3) Comparative Animal Physiology
A comparison of adaptation mechanisms, from cell to organ-system, used by animals in response to “changes in” environmental conditions such as oxygen, carbon dioxide, food availability, temperature, water, solutes, pressure and buoyancy. Prerequisite: BIOL 105, BIOL 106 or consent Spring

Biology 432 (4) Lake Ecology
This course is an introduction to the physical, chemical, and biological characteristics and interactions of inland freshwater lakes. Labs will emphasize field work, including data collection from five local lakes, analysis, and discussion. Alt-Fall

Biology 433 (3) Cardiovascular Physiology
This course is a functional study of the heart and circulatory system. Fall

Biology 435 (4) Histology
Study of types, arrangements and special adaptations of human tissues. Lab included. Prerequisite: BIOL 220 Spring

Biology 436 (4) Animal Behavior
An exploration of behavioral strategy, communication, learning, and social systems of animals, with emphasis placed on the causes, evolution, ecological implications, and function of behavior at the individual and population level. Lab included. Prerequisite: BIOL 105, BIOL 106, BIOL 215 Spring

Biology 438 (3) General Endocrinology
This course provides the basis for understanding hormones and the mechanisms of their actions in both the normal and pathological states. Sample topics to be included are diabetes, osteoporosis, hormones of reproduction and current social and medical issues related to the course. Prerequisite: BIOL 100 or BIOL 105 Spring

Biology 441 (4) Plant Physiology
Plant functions such as water relations, mineral nutrition, translocation, metabolism, photosynthesis, photospiration, fat and protein metabolisms, respiration, growth and development, phytohormones, reproduction and environmental physiology. Lab included. Prerequisite: BIOL 105, BIOL 106, BIOL 217, one semester organic chemistry recommended. Spring

Biology 442 (4) Flora of Minnesota
Field identification of plants with emphasis on local flora. History systematic, technical, planting biology, methods of plant collection, preservation, preparation of herbarium specimens are covered. Lab and field trips included. Spring

Biology 443 (4) Plant Ecology
Expands upon general principles of ecology to focus on the factors that regulate the distribution and abundance of plants, analysis of plant populations, and dynamics of plant communities. Lecture and lab (fieldwork) included. Prerequisite: BIOL 105, BIOL 106, BIOL 215 or consent BIOL 217 strongly recommended. Fall

Biology 451 (4) Plant Biotechnology
Lecture/laboratory course that presents an integrated view of plant biology, crop science, and current issues in biotechnology. Course focuses on issues of global concern such as sustainable food production, biofuels, genetically modified crops, molecular pharming, and tissue culture. Prerequisite: BIOL 105, BIOL 106 Fall

Biology 452 (3) Biological Instrumentation
The principle and operation of instruments and their application to biological research. Types of instrumentation examined include spectroscopic, chromatographic, electroanalytic, radiographic, and imaging. Laboratory Information Management systems (LIMS) will also be examined. Emphasis is placed on GMP, GLP, and ISO 9000 practices. Prerequisite: BIOL 105, BIOL 106, or consent Spring
BIOLOGY CONTINUED

BIOL 453 (4) Biological Engineering Analysis I
The application of engineering principles and skills as applied to fermentation and to biological product recovery.
Prerequisite: BIOL 270 and one semester each of calculus, physics, and organic chemistry, taken concurrently with BIOL 456.
Fall

BIOL 454 (4) Biological Engineering Analysis II
Continuation of Biological Engineering Analysis I. The application of engineering principles and skills as applied to fermentation and to biological product recovery.
Prerequisite: BIOL 453, taken concurrently with BIOL 457
Spring

BIOL 456 (3) Biotechnology Project/Laboratory I
Practical laboratory experience in biotechnology through the selection and development of a research project. Students are expected to spend an average of 12 hours per week on the project.
Prerequisite: Concurrent enrollment in BIOL 453
Fall

BIOL 457 (3) Biotechnology Project/Laboratory II
Continuation of Biotechnology Project/Laboratory I. Practical laboratory experience in biotechnology through the selection and development of a research project. Students are expected to spend an average of 12 hours per week on the project.
Prerequisite: BIOL 456, taken concurrently with BIOL 454
Spring

BIOL 460 (3) Introduction to Toxicology
A lecture course covering basic principles of toxicity evaluation in living organisms, mechanisms of responses to chemicals or physical agents within an overview of practical medical, environmental, and science policy implications. Presentation of comparisons of specific organ and tissue reactions to toxins in a variety of species follow these introductory concepts.
Prerequisite: BIOL 105, BIOL 106, and 1 year of General Chemistry
Alt-Fall

BIOL 461 (4) Environmental Toxicology
A lecture/laboratory course that focuses on anthropogenic and natural toxicants, mathematical modeling of the dispersion of chemical and physical agents in the environment, effects on species and ecosystems with a special section on aquatic risk assessment. The laboratory includes techniques in environmental toxicity and a genuine research project.
Prerequisite: BIOL 460
Alt-Spring

BIOL 462 (1) Toxicology Seminar
A seminar course that involves critical evaluation of published studies in toxicology, student presentations of a selected published manuscript and requires students to write a paper on one aspect of the course's topic area that semester. Topic areas vary each time the course is offered.
Prerequisite: BIOL 105, BIOL 106, and General Chemistry
Alt-Fall

BIOL 464 (3) Methods of Applied Toxicology
A lecture/laboratory course focusing on the steps necessary to start a research project from project definition through methods testing and evaluation, and a final report that includes a project flow chart. Third year students will have senior and/or graduate mentors.
Prerequisite: BIOL 105, BIOL 106, and General Chemistry
Alt-Fall

BIOL 465 (3) Applied Toxicology Project
A lecture/laboratory course where students perform all aspects of their own designed research topic in toxicology while critically evaluating the progress of other projects as well. Students will be expected to keep timelines or develop modified timelines as necessary. The inverted triangle approach of project design will be examined and then included in all designs.
Prerequisite: BIOL 464
Alt-S

BIOL 466 (3) Principles of Pharmacology
A lecture course that examines mechanisms of drug action, physiological responses and adverse reactions from sensitivities or allergies through overdose.
Prerequisite: BIOL 105, BIOL 106, and 1 year of General Chemistry
Alt-Spring

BIOL 467 (3) Industrial Hygiene
A lecture course that examines Minnesota State Mankato, as your own workplace to develop reports on a selected group of chemical and physical hazards of the workplace. Evaluation methods and solutions to existing problems are developed with concise reporting skills.
Prerequisite: BIOL 105, BIOL 106, and 1 year of General Chemistry
Alt-Fall

BIOL 472 (4) Microbial Ecology and Bioremediation
Role of microorganisms in soil, air, water, sewage processes as well as methods of measurement and detection. Special emphasis on the role of microorganisms in bioremediation. Lab included.
Prerequisite: BIOL 105, BIOL 106, and BIOL 270
Fall

BIOL 473 (3) Virology
Viruses infect all living things, such as bacteria, fungi, plants, and animals (including humans). There are many viruses that cause significant human mortality and morbidity, such as influenza and smallpox viruses. However, the vast majority of viruses that infect humans have little or no negative impact on our health and well-being. This course will teach Virology by stressing the rules of replication that every virus must follow. The use of viruses as molecular tools, virus-host interactions, and current viral outbreaks will also be discussed.
Prerequisite: BIOL 105, BIOL 106, and BIOL 270
Spring

BIOL 474 (4) Immunology
Fundamental principles of humoral and cell mediated immunity and the application of these principles. Current experimental work in the different areas of immunology will be discussed. Lab included.
Prerequisite: BIOL 105, BIOL 106, and BIOL 270
Fall

BIOL 475 (4) Medical Microbiology
This course will cover bacterial, fungal, and viral human pathogens: what diseases they cause, how they cause disease, and how humans defend against and prevent those diseases. In the laboratory the student will isolate and identify pathogenic microorganisms using microbiological, biochemical, and immunological techniques.
Prerequisite: BIOL 270
Fall

BIOL 476 (5) Microbial Physiology and Genetics
This course presents the physiology and genetics of microorganisms emphasizing those aspects unique to bacteria and archaea. Topics include: energy production; biosynthesis of small molecules and DNA, RNA, and proteins; the formation of cell walls and membranes; microbial differentiation and behavior; and the genetic and biochemical regulation of these processes. Lab included.
Prerequisite: BIOL 105, BIOL 106, BIOL 270
Spring

BIOL 478 (4) Food Microbiology and Sanitation
The role microbes play in production and spoilage of food products, as prepared for mass market. Topics include foodborne pathogens, epidemiology and control, essential principles in sanitation including Hazard Analysis/Critical Control Point and ISO 9000 requirements. Lab included.
Prerequisite: BIOL 105, BIOL 106 and BIOL 270
Spring

BIOL 479 (4) Molecular Biology
This course will cover both eukaryotic and prokaryotic molecular biology including: DNA and RNA structure, transcription, regulation of gene expression, RNA processing, protein synthesis, DNA replication, mutagenesis and repair, recombination, and insertion elements. A number of important techniques used in recombinant DNA technology will be discussed and practiced.
Prerequisite: BIOL 105, BIOL 106, BIOL 211
Spring

BIOL 480 (3) Biological Laboratory Experiences for Elementary Teachers
Provides experience with a wide variety of biological laboratory exercises to prepare prospective elementary teachers. Emphasis is on building knowledge, skills, and confidence. The course will cover major biological concepts and environmental education through classroom-ready examples selected to illustrate each concept.
Fall, Spring
BIOL 481 (1) Lab Supervision and Maintenance
Experience in maintaining and supervising laboratories. For individuals desiring additional experience with students in laboratory situations.
Fall, Spring

BIOL 483 (1) MAX Scholar Seminar
This class provides MAX scholars with an opportunity to explore a set of topics related to achieving success in academic, professional and personal realms. Speakers will include faculty, graduate students, visiting researchers and industry members as well as student participants. Students will be required to participate in mentoring of lower division MAX scholarship recipients and provide written and oral presentations of various topics during the semester. Prerequisite: Recipient of a MAX scholarship or instructor consent.
Fall, Spring

BIOL 485 (4) Biology Teaching Methods and Materials
A basic science methods course designed to prepare prospective junior and senior high life science teachers. Course will cover science teaching methods and support materials as they apply to life science teaching situations. Prerequisite: 16 credits BIOL
Fall

BIOL 486 (3) Field-Based Teaching Methods and Materials
A lecture/laboratory course that provides opportunity for prospective junior and senior high life science teachers to observe, practice, and refine their teaching skills. Students will work in a school setting and experience actual classroom. Prerequisite: BIOL 485
Fall

BIOL 490 (1-4) Workshop
A variable topic course designed for a selected topic in Biology. Workshops provide an intensive learning experience on a new topic in the Biological Sciences and/or hands-on experiences in a current area not covered by other course offerings. The course involves background reading, demonstrations, and laboratory or field experiences. Prerequisite: Consent
Fall, Spring

BIOL 492 (1-3) Honors Research
Fall, Spring

BIOL 493 (1-12) Cytotechnology Clinical Internship I
The clinical internship and training includes lectures, demonstrations, laboratory sessions, and clinical practicum in the area of cytotechnology. Instructor permission required.
Fall, Spring

BIOL 494 (1-12) Cytotechnology Clinical Internship II
Continuation of Cytotechnology Clinical Internship I. The clinical internship and training includes lectures, demonstrations, laboratory sessions, and clinical practicum in the area of cytotechnology. Instructor Permission required.
Fall, Spring

BIOL 495 (1-12) Cytotechnology Clinical Internship III
Continuation of Cytotechnology Clinical Internship II. The clinical internship and training includes lectures, demonstrations, laboratory sessions, and clinical practicum in the area of cytotechnology. Instructor Permission required.
Fall, Spring

BIOL 496 (1-12) Cytotechnology Clinical Internship IV
Continuation of Cytotechnology Clinical Internship III. The clinical internship and training includes lectures, demonstrations, laboratory sessions, and clinical practicum in the area of cytotechnology. Instructor Permission required.
Fall, Spring

BIOL 497 (1-12) Internship I
Experience in applied biology according to a prearranged training program for a minimum of five 40-hour weeks. Prerequisite: Consent
Fall, Spring

BIOL 498 (1-12) Internship II
Experience in applied biology according to a prearranged training program for a minimum of five 40 hour weeks. Only four credits can be applied to the major. Prerequisite: Consent
Fall, Spring

BIOL 499 (1-4) Individual Study