

## Biology

College of Science, Engineering & Technology  
Department of Biological Sciences

242 Trafton Science Center S • 507-389-2786

Web site: [www.mnsu.edu/dept/biology](http://www.mnsu.edu/dept/biology)

Chair: Gregg Marg, Ph.D.

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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, clinical laboratory sciences, cytotechnology, food science technology and pre-professional programs including pre-agriculture, pre-forestry, pre-medicine, 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, bio-business, cytotechnology, ecology, human biology, microbiology, physiology, plant science, toxicology, or zoology. Programs in biotechnology, environmental sciences, food science technology and science teaching are also offered.

Admission to Major is granted by the department. Admission requirements are 32 earned semester credit hours including BIOL 105 and 106, with a grade of a "C" or better in both BIOL 105 and 106; and a minimum cumulative GPA of 2.00.

### BIOLOGY BA (40 credits)

Required for Major (Core, 21-25 credits):

BIOL 105 General Biology I (4)  
BIOL 106 General Biology II (4)  
BIOL 211 Genetics (3)

Choose two courses from the following:

BIOL 215 General Ecology (4)  
BIOL 270 Microbiology (4)

one physiology course [Biol 230 (4), Biol 431 (3), Biol 441 (4), or Biol 476 (5)]

Choose one course from the following:

BIOL 230 Human Physiology (4)  
BIOL 320 Cell Biology (4)  
BIOL 431 Comparative Animal Physiology (3)  
BIOL 441 Plant Physiology (4)  
BIOL 476 Microbial Physiology and Genetics (5)

Required Electives for Major (Biology, 19-22 credits):

Choose 19-22 credits of electives in consultation with an advisor.

Required for Bachelor of Arts (BA) degree ONLY:

Language (8)

Required Minor: Yes. Chemistry

### BIOLOGY BS

Students may elect to complete the general non-specialized biology major or select one of the alternative specialized options or emphases.

#### GENERAL, NON-SPECIALIZED OPTION (40 credits)

Required for Option (Core, 20-21 credits):

BIOL 105 General Biology I (4)  
BIOL 106 General Biology II (4)  
BIOL 211 Genetics (3)

Choose two courses from the following:

BIOL 215 General Ecology (4)  
BIOL 320 Cell Biology (4)

One physiology course [Biol 230 (4), Biol 431 (4), Biol 441 (4), or Biol 476 (5)]

Required Electives (5-8 credits):

Choose two courses from the following:

BIOL 301 BIOL 316 BIOL 403 BIOL 408 BIOL 418  
BIOL 430 BIOL 435 BIOL 436 BIOL 442 BIOL 443  
BIOL 451 BIOL 452

Additional upper division electives:

Choose additional Biology 300-400 level courses to total 40 credits in this option.

Required Minor: Yes. Chemistry.

#### BIOBUSINESS OPTION (40 credits)

Required for Option (credits vary):

A student may choose the Biology BA or any BS option or program to satisfy the BioBusiness option.

Required (Chemistry, 10 credits):

A minimum of one year of chemistry is required.

Required Minor: Yes. Any Business Minor.

#### CYTOTECHNOLOGY OPTIONS

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 at Mayo School of health-Related Sciences in Rochester, MN or Mercy Medical Center in Des Moines, IA. The BS degree is awarded by the university after successful completion of the internship year. Graduates are then eligible to take the certifying examination. Cytotechnologists are employed in hospital laboratories, universities, and private laboratories in the areas of research, education, and administration.

Required for Option (11 credits):

BIOL 105 General Biology I (4)  
BIOL 106 General Biology II (4)  
BIOL 211 Genetics (3)

Required General Education (4 credits):

(includes Math requirement)

Replace with one class from MATH 112, 113, 115, or 121.

Required Support Courses (18 credits):

Choose from the following to total at least 18 credits in Chemistry:

CHEM 201 General Chemistry I (5)  
CHEM 202 General Chemistry II (5)  
CHEM 305 Analytical Chemistry (4)  
CHEM 320 Organic Chemistry (5)  
CHEM 360 Principles of Biochemistry (4)

Core Courses (16 credits):

BIOL 220 Human Anatomy (4)  
BIOL 230 Human Physiology (4)  
BIOL 270 General Microbiology (4)  
BIOL 320 Cell Biology (4)

Recommended Support Courses (0 credits)

Required Courses (3-4 credits)

BIOL 420 Diagnostic Parasitology (3)  
BIOL 434 Development and Human Embryology (3)  
BIOL 435 Histology (4)

Required Minor: None

## Professional Education (32 credits)

Clinical internship at Mayo School of Health-Related Sciences in Rochester, MN or Mercy Medical Center in Des Moines, IA.

BIOL	422	General Principles of Cytology (2)
BIOL	423	Gynecologic Cytology (4)
BIOL	425	Advanced Gynecologic Cytology (3)
BIOL	427	Urinary Cytology (3)
BIOL	428	Gastrointestinal Cytology (3)
BIOL	429	Body Cavity and Miscellaneous Secretion Cytology (3)
BIOL	444	Fine Needle Aspiration Cytology (3)
BIOL	447	Cytology Preparation Techniques (2)
BIOL	448	Independent Projects (3)
BIOL	450	Clinical Cytology (5)

## ECOLOGY OPTION

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, first biologist, marine biologist, conservation training or graduate school. For more information about the option and the ecology faculty, select "ecology" at the department page (see [www.mnsu.edu](http://www.mnsu.edu)).

## Required for Option (11 credits):

BIOL	105	General Biology I (4)
BIOL	106	General Biology II (4)
BIOL	211	Genetics (3)

## Required General Education (9 credits):

CHEM	201	General Chemistry I (5)
PHYS	211	Principles of Physics I (4)

## Required Support Courses (8 credits):

Choose one:

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

Choose one:

STAT	154	Elementary Statistics (3)
HLTH	475	Biostatistics (3)

## Core Courses (21-27 credits required):

BIOL	215	General Ecology (4)
BIOL	301	Evolution (2)
BIOL	408	Vertebrate Ecology (4)
BIOL	412	Soil Ecology (4)
BIOL	443	Plant Ecology (4)

Choose one letter:

- BIOL 320 Cell Biology (4)
- BIOL 431 Comparative Animal Physiology (3)
- BIOL 217 Plant Science (3) and  
BIOL 441 Plant Physiology (4)
- BIOL 270 Microbiology (4) and  
BIOL 476 Microbial Physiology and Genetics (5)

## Recommended Support Courses (12 credits)

COMS	100	Introduction to Computer Science (4)
MATH	121	Calculus I (4)
ENG	271	Technical Communication (4)

## Elective Courses (20-28 credits)

I. Choose 2-8 credits from the following Biology courses for a total of 40 credits of Biology:

BIOL	316	BIOL	403	BIOL	404	BIOL	409	BIOL	410
BIOL	431	BIOL	432	BIOL	436	BIOL	441	BIOL	442
BIOL	460	BIOL	472	BIOL	479	BIOL	492#	BIOL	497#
BIOL	499#	and others by consent of advisor.							

#Limit of 4 credits total from these courses.

II. Choose at least 18 credits from non-Biology courses in consultation with your advisor.

## HUMAN BIOLOGY OPTIONS

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 of a specific medical school, please contact that school for their specific requirements.

## Required for Option (11 credits):

BIOL	105	General Biology I (4)
BIOL	106	General Biology II (4)
BIOL	211	Genetics (3)

## Required General Education (9-10 credits):

CHEM	201	General Chemistry I (5)
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Choose one:

PHYS	211	Principles of Physics I (4)
PHYS	221	General Physics I (5)

## Required Support Courses (25-27 credits):

CHEM	202	General Chemistry II (5)
CHEM	305	Analytical Chemistry (4)
CHEM	320	Organic Chemistry I (5)
CHEM	360	Principles of Biochemistry (4)

Choose one:

MATH	121	Calculus I (4)
MATH	354	Concepts of Probability and Statistics (3)
HLTH	475	Biostatistics (3)

Choose one to complete one year of a Physics sequence:

PHYS	212	Principles of Physics II (4)
PHYS	222	General Physics II (5)

## Core Courses (15-16 credits):

BIOL	220	Human Anatomy (4)
BIOL	230	Human Physiology (4)
BIOL	320	Cell Biology (4)

Choose one:

BIOL	270	Microbiology (4)
BIOL	217	Plant Science (3)

## Recommended Support Courses (3 credits)

CHEM	321	Organic Chemistry II (2)
CHEM	331	Organic Chemistry II lab (1)

## Electives Courses (13-14 credits):

Choose electives from the following to total 40 credits in Biology:

Choose at least one:

BIOL	316	BIOL	420	BIOL	430	BIOL	433	BIOL	435
BIOL	452	BIOL	474	BIOL	475	BIOL	479	BIOL	497#
BIOL	499#								

# Choose a maximum of 4 credits from these courses

Choose additional credits from:

BIOL	324	BIOL	410	BIOL	417	BIOL	418	BIOL	434
BIOL	438	BIOL	474	BIOL	460	BIOL	466		

Required Minor: Yes. Chemistry.

## MICROBIOLOGY OPTIONS

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 (ex. quality assurance, vaccine production) and government (ex. 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.

## 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.

Required for Option (11 credits):

BIOL 105 General Biology I (4)  
BIOL 106 General Biology II (4)  
BIOL 211 Genetics (3)

Required General Education (8-9 credits) (include Math requirements)

CHEM 201 General Chemistry I (5)  
MATH 112 or any higher numbered math course listed in General Education Category 4

Required Support Courses (14 credits):

CHEM 202 General Chemistry II (5)  
CHEM 305 Analytical Chemistry (4)  
CHEM 320 Organic Chemistry I (5)

Core Courses (8 credits):

BIOL 270 General Microbiology (4)  
Choose one from the following:  
BIOL 215 General Ecology (4)  
BIOL 217 Plant Science (4)  
BIOL 230 Human Physiology (4)  
BIOL 320 Cell Biology (4)

Recommended Support Courses (0 credits required)

HLTH 475 Biostatistics (3)  
CHEM 360 Principles of Biochemistry (4)  
CHEM 460 Biochemistry I (3)  
CHEM 465 Biochemical Techniques I (1)  
MATH 122 Calculus (4)  
STAT 154 Elementary Statistics (3)

Electives Courses (21 credits):

Choose electives from the following to total 40 credits in Biology:  
BIOL 420 BIOL 452 BIOL 472 BIOL 474 BIOL 475  
BIOL 476 BIOL 478 BIOL 479 BIOL 499

PHYSIOLOGY OPTION (48-50 credits)

Physiology is the study of cell, tissue, organ, and system function. The study of physiology seeks to understand whole organism function, plant or animal, by investigations at the organ/system, cellular, or molecular level. These studies may involve adaptations to external or internal environmental changes, or the effect of disease on biological processes. Research in physiology may involve plants or animals. Current plant physiology research at Minnesota State University, Mankato investigates metabolism, photosynthesis, respiration, growth, and ecology of vascular plants. Current animal physiology research at Minnesota State University, Mankato uses animal models to investigate high blood pressure, kidney disease, or bladder functions.

Post undergraduate careers in human physiologic include research in industry or university. Plant physiology option is an excellent preparation for other professional careers such as medicine.

Required for Option (11 credits):

BIOL 105 General Biology I (4)  
BIOL 106 General Biology II (4)  
BIOL 211 Genetics (3)

Required General Education (7-9 credits):

Choose one:  
PHYS 211 Principles of Physics I (4)  
PHYS 221 General Physics I (5)

Choose one:

MATH 121 Calculus I (4)  
STAT 154 Elementary Statistics (3)

Required Support Courses (21 credits):

CHEM 201 General Chemistry I (5)  
CHEM 202 General Chemistry II (5)  
CHEM 305 Analytical Chemistry (4)  
CHEM 320 Organic Chemistry (5)  
CHEM 460 Biochemistry I (3)

Core Courses (18 credits):

BIOL 230 Human Physiology (4)  
BIOL 320 Cell Biology (4)  
BIOL 431 Comparative Animal Physiology (3)  
BIOL 441 Plant Physiology (4)  
BIOL 460 Introduction to Toxicology (3)

Recommended Support Courses (0 credits)

Elective Courses (9 credits):

Choose from:

BIOL 324 BIOL 433 BIOL 438 BIOL 466 BIOL 479  
BIOL 499

PLANT SCIENCE OPTION

The Plant Biology option includes the study of cells, genetics, anatomy, physiology, taxonomy, and ecology of terrestrial and aquatic vascular plants, mosses, algae and fungi. The option emphasizes plant structure and function, diversity, evolutionary and anatomical adaptations and interactions between plants and their environment. An option in plant sciences prepares undergraduate students for careers in education, biotechnology, field biology, pharmaceutical companies and government agencies. In addition, the option prepares students for Master's and Doctoral degrees in Plant Science.

Required for Option (11 credits):

BIOL 105 General Biology I (4)  
BIOL 106 General Biology II (4)  
BIOL 211 Genetics (3)

Required General Education (13 credits) (including Math requirements):

MATH 111 College Algebra (4)  
PHYS 211 Principles of Physics I (4)  
CHEM 201 General Chemistry I (5)

Required Support Courses (8 credits):

Choose one:

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

Choose one:

STAT 154 Elementary Statistics (3)  
HLTH 475 Biostatistics (3)

Core Courses (16 credits):

BIOL 215 General Ecology (4)  
BIOL 217 Plant Science (3)  
BIOL 441 Plant Physiology (4)  
BIOL 442 Plant Taxonomy (4)

Recommended Support Courses (12 credits)

ENG 271 Technical Communication (4)  
COMS 100 Introduction to Computer Science (4)  
MATH 121 Calculus I (4)

Electives (13 credits required)\*:

I. Choose at least 13 credits from the following list of Biology courses. The electives must include a minimum of two courses with a laboratory component

BIOL 301 BIOL 320 BIOL 430 BIOL 404 BIOL 409  
BIOL 410 BIOL 412 BIOL 432 BIOL 440 BIOL 443  
BIOL 445 BIOL 451 BIOL 460 BIOL 479 BIOL 492†  
BIOL 497† BIOL 499†

† Limit of 4 credits total from these courses

II. Choose at least 18 credits from non-Biology courses in consultation with your advisor.

TOXICOLOGY OPTION

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. 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 an testing of pharmaceuticals, pesticides, and environmental toxicology in industry, government, or 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.

#### Required for Option (11 credits):

BIOL 105 General Biology I (4)  
 BIOL 106 General Biology II (4)  
 BIOL 211 Genetics (3)

#### Required General Education (14 credits):

CHEM 201 General Chemistry I (5)  
 PHYS 211 Principles of Physics I (4)  
 MATH 121 Calculus I (4)

#### Required for Support Courses (28 credits):

CHEM 202 General Chemistry II (5)  
 CHEM 305 Analytical Chemistry (4)  
 CHEM 320 Organic Chemistry (5)  
 CHEM 321 Organic Chemistry (2)  
 CHEM 460 Biochemistry I (3)  
 CHEM 461 Biochemistry II (3)  
 CHEM 465 Biochemical Techniques I (1)  
 CHEM 466 Biochemical Techniques II (2)  
 HLTH 475 Biostatistics (3)

#### Core Courses (32 credits):

BIOL 215 General Ecology (4)  
 BIOL 230 Human Physiology (4)  
 BIOL 270 Microbiology (4)  
 BIOL 460 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)

#### Recommended Support Courses (0 credits)

Elective Courses (0 credits)

#### ZOOLOGY OPTION

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 the functions, genetics, development, evolution, behavior, and ecological interactions. Occupations that may be available to graduate 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 the ability to collect and analyze data, and an interest in problem solving and decision making.

#### Required for Option (11 credits):

BIOL 105 General Biology I (4)  
 BIOL 106 General Biology II (4)  
 BIOL 211 Genetics (3)

#### Required General Education (13 credits):

CHEM 201 General Chemistry (5)  
 MATH 112 College Algebra I (4)  
 PHYS 211 Principles of Physics I (4)

#### Recommended Support Courses (8 credits):

Choose one:

MATH 121 Calculus I (4)

#### Required Support Courses (8 credits):

Choose one:

CHEM 111 Chemistry of Life Processes (5)

CHEM 202 General Chemistry II (5)

Choose one:

STAT 154 Elementary Statistics (3)

HLTH 475 Biostatistics (3)

#### Core Courses (22-23 credits):

BIOL 215 General Ecology (4)  
 BIOL 301 Evolution (2)  
 BIOL 316 Animal Diversity (3)  
 BIOL 408 Vertebrate Ecology (4)  
 BIOL 431 Comparative Animal Physiology (3)

Choose two from the following:

BIOL 420 Diagnostic Parasitology (3)

BIOL 421 Entomology (3)

BIOL 436 Animal Behavior (4)

BIOL 438 General Endocrinology (3)

#### Recommended Support Courses (0 credits required):

COMS 100 Introduction to Computer Science (4)

ENGL 271 Technical Communication (4)

MATH 121 Calculus I (4)

#### Electives Courses (24 credits):

I. Choose at least six credits from the following Biology courses

BIOL 320 BIOL 324 BIOL 403 BIOL 408 BIOL 409  
 BIOL 410 BIOL 412 BIOL 420 BIOL 434 BIOL 435  
 BIOL 438 BIOL 460 BIOL 472 BIOL 479 BIOL 492#  
 BIOL 497# BIOL 499#

Other electives may apply with advisor's consent.

II. Choose at least 18 credits from non-Biology courses in consultation with your advisor.

#### LIFE SCIENCE TEACHING BS

See the SCIENCE TEACHING section of this bulletin.

#### BIOLOGY MINOR

#### Required for Minor (Core, 17 credits):

BIOL 105 General Biology I (4)

BIOL 106 General Biology II (4)

BIOL 211 Genetics (3)

Choose one course from the following:

BIOL 215 BIOL 217 BIOL 220 BIOL 270

Additional Elective :

Any 200 level or above course to total 17 credits in the minor.

#### POLICIES/INFORMATION

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 2.6 in the sciences must be maintained to meet student teaching requirements.

Several biology scholarships are available for entering freshmen and currently enrolled MSU students who meet the requirements. Application deadline is March 31 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 bulletin.

## COURSE DESCRIPTIONS

### BIOL 100 (4) Our Natural World

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, pre-natal development, and heredity. Lecture, laboratory, and small group discussions.

F, S  
GE-3

### BIOL 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 sub-titles.

F, S

### BIOL 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.

F, S  
GE-3 CD-Core

### BIOL 103 (3) Introduction to Biotechnology

An introductory course designed for students not majoring in science. Focuses on basic biological principles as applied to biotechnology. Includes basic natural science principles, scientific problem solving, and human and social aspects of biotechnology. Lecture, laboratory, and small group discussions.

F  
GE-1C, 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.

F, S  
GE-1C, 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.

Pre: BIOL 105 F, S

### 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, field observations.

S

### BIOL 199 (3) CLEP Biology

F, S

### BIOL 201 (3) Ecology and Human Society

Ecological principles as related to current environmental problems. Topics of current interest include energy, human demography, food productions, pollution, and social, political, and economic change. Primarily for general education and non-science majors.

GE-8, 10 CD-Related

### BIOL 203 (3) Taxidermy Techniques

### BIOL 211 (3) Genetics

Introduction to genetic analysis. Topics covered include: crosses, linkage and mapping, Mendelian and Non-Mendelian inheritance, molecular genetics, genetic manipulation of organisms, population genetics and evolution.

Pre: BIOL 105, 106, and MATH 112 F, S

### 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.

Pre: BIOL 105 and 106 or consent F

### BIOL 217 (4) Plant Science

Biology of plants including unique features of plant cells, life histories, metabolism, anatomy, physiology, and ecology. The course empathizes 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.

Pre: BIOL 105 and 106 or consent S

### 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.

F, S

### BIOL 230 (4) Human Physiology

Function of living systems with emphasis on human species. Lab included.

Pre: BIOL 220 and 1 semester of chemistry F, S

### BIOL 270 (4) Microbiology

An introduction to the general principles and methods used in the study of microorganisms. Lab included.

Pre: 1 BIOL course and 1 CHEM course F, S

GE-3

### 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.

Pre: BIOL 105, 106 S

### 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.

Pre: BIOL 105 and 106 F

### BIOL 320 (4) Cell Biology

An examination of eukaryotic cellular structure, organization and physiology for students preparing careers in biology, medicine, and related fields. Topics include cell surface, intracellular compartments, cell junctions, cytoskeleton, cell motility, signal transduction mechanisms, energy flow and metabolism, information flow, protein sorting and transport, and common research techniques. Students will research on the Internet. Lab included.

Pre: BIOL 105 and 106 F

**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.

Pre: BIOL 220 and 230 F

**BIOL 380 (3) Blood Banking/Urinalysis**

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.

Pre: BIOL 230 S

**BIOL 402 (4) Stream Limnology****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.

Pre: BIOL 215 or consent S

**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.

Pre: BIOL 105, 106, 215, or consent S

**BIOL 405 (3) Fisheries Biology****BIOL 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.

Pre: BIOL 105, 106, 215 or consent F

**BIOL 409 (4) Advanced Field Ecology**

A field course focused on the function and dynamics of various North American ecosystems. Emphases 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.

Pre: BIOL 105, 106, 215 or consent S

**BIOL 410 (3) Human Ecology**

The human species' place in the biological world, effects on various communities and potential methods of correcting the detrimental effects with economic and social implications.

Pre: BIOL 105, 106, 215, or consent S

**BIOL 411 (2) Evolution for Teachers****BIOL 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.

Pre: BIOL 105, 106, 215, or consent S

**BIOL 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.

Pre: BIOL 100 or 105 F, S

**BIOL 418 (4) Macro and Microscopic Imaging**

Properties and physical principles underlying biological images. The course provides a survey of macro-imaging techniques (such as x-ray tomography, magnetic resonance imaging, positron emission tomography, and ultrasound) and micro-imaging techniques (such as light microscopy, transmission and scanning electron microscopy, fluorescence microscopy, laser scanning confocal microscopy and atomic force microscopy).

Pre: One Year of Physics F

**BIOL 419 (2-3) Special Topics in Instrumentation**

Instruction in specialized biological instrumentation.

Pre: BIOL 105 and 106 F

**BIOL 420 (3) Diagnostic Parasitology**

Clinically important parasites. Protozoans, Flukes, Tapeworms, Roundworms, Ticks, Mites and Insects. Designed for Medical Technology, Pre-Med, Pre-Vet and Biology majors. Identification, clinical disease, epidemiology and ecology are covered. Lab included.

Pre: BIOL 100 or 105, BIOL 106 recommended S

**BIOL 421 (3) Entomology**

Morphological, physiological, medical, and economic significance of insects.

Pre: BIOL 105 and 106 or consent ALT-F

**BIOL 422 (2) General Principles of Cytology**

This course consists of a series of lectures, demonstrations, and laboratory sessions designed to teach the principles of cytology. This includes basic (ultra and light microscope) cell structures, cellular biology, including cell division and growth and general mechanisms of pathologic changes. Cytotechnology emphasis only. Permission required.

F, S

**BIOL 423 (4) Gynecologic Cytology**

This course involves a study of the normal and abnormal anatomy, physiology, histology, and cytology of the female genital tract. Lectures, demonstrations, and laboratory sessions are given. Normal and abnormal cytology are emphasized. Non-neoplastic changes, such as hormonal abnormalities and inflammatory conditions are discussed. Cytotechnology emphasis only. Permission required.

F, S

**BIOL 424 (3) Advanced Gynecologic Cytology**

This course is a continuation of Gynecologic Cytology to include malignant conditions of the endocervix, endometrium, ovary and vagina. Lectures will also be given on special topics including cytology of pregnancy and therapeutic changes. Cytotechnology emphasis only. Permission required.

F, S

**BIOL 425 (3) Pulmonary Cytology**

This course consists of a series of lectures, demonstrations, and laboratory sessions of the gross and microscopic anatomy, physiology, pathology, and cytology of the respiratory tract. Particular areas covered include benign conditions, inflammatory disorders, malignancies, and therapeutic effects. Cytotechnology emphasis only. Permission required.

F, S

**BIOL 427 (3) Urinary Cytology**

This course consists of a series of lectures, demonstrations, and laboratory sessions of the gross and microscopic anatomy, physiology, pathology, and cytology of the urinary tract. Areas covered include benign conditions, inflammatory disorders, malignancies, and therapeutic effects. Cytotechnology emphasis only. Permission required.

F, S

**BIOL 428 (1) Gastrointestinal Cytology**

This course consists of a series of lectures, demonstrations, and laboratory sessions of the gross and microscopic anatomy, physiology, pathology, and cytology

ogy of the GI tract. Cytotechnology emphasis only. Permission required.  
F, S

## BIOL 429 (3) Body Cavity and Miscellaneous Secretion Cytology

This course consists of a series of lectures, demonstrations, and laboratory sessions of the gross and microscopic anatomy, physiology, pathology, and cytology of the body cavity fluids (pleural, peritoneal, and pericardial) and other sites including the cerebrospinal fluid and eye. Cytotechnology emphasis only. Permission required.

F, S

## BIOL 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.

Pre: BIOL 230 S

## BIOL 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.

Pre: BIOL 105, 106 or consent ALT-F

## BIOL 432 (4) Limnology

Biotic, physical and chemical characteristics of freshwater ecosystems. Lab (fieldwork) included.

Pre: BIOL 105, 106, 215, or consent F

## BIOL 433 (3) Cardiovascular Physiology

This course is a functional study of the heart and circulatory system.

S

## BIOL 434 (3) Development and Human Embryology

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.

Pre: BIOL 100 or 105 F

## BIOL 435 (4) Histology

Study of types, arrangements and special adaptations of human tissues. Lab included.

Pre: BIOL 220 S

## BIOL 436 (4) Animal Behavior

An exploration of behavioral strategy, communication, learning, and social systems of animals, with emphases placed on the causes, evolution, ecological implications, and function of behavior at the individual and population level. Lab included.

Pre: BIOL 105, 106, or consent S

## BIOL 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.

Pre: BIOL 100 or 105 S

## BIOL 440 (4) Horticulture

Fundamental principles of horticulture: classification, structure, growth and reproduction, technology including propagation, mineral nutrition, training and pruning, growth regulation and protection, horticultural crops and esthetic horticulture. Lab included.

Pre: BIOL 105 and 106 F

## BIOL 441 (4) Plant Physiology

Plant functions such as water relations, mineral nutrition, translocation, metabolisms, photosynthesis, photorespiration, fat and protein metabolisms,

respiration, growth and development, phytohormones, reproduction and environmental physiology. Lab included.

Pre: BIOL 105, 106, 217, one semester organic chemistry recommended. S

## BIOL 442 (4) Flora of Minnesota

Field identification of plants with emphasis on local flora. History, systematic techniques, plant biogeography, methods of plant collection, preservation, preparation of herbarium specimens are covered. Lab and field trips included.

Pre: BIOL 106; 217 recommended F

## BIOL 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.

Pre: BIOL 105, 106, 215 or consent. BIOL 217 strongly recommended. F

## BIOL 444 (3) Fine Needle Aspiration Cytology

This course consists of a series of lectures, demonstrations, and laboratory sessions of the gross and microscopic anatomy, pathology, and cytology of various areas sampled using fine needle aspiration. Cytotechnology emphasis only. Permission required.

F, S

## BIOL 445 (4) Economic Botany

We interact with plants every day and they've had a profound affect on human history and society. This course surveys the roles of plants in foods, beverages, medicines, drugs, poisons, fibers, fuels, building materials, ceremony, landscape, and more. Lecture, discussion, lab, and field trip. Open to non-science majors.

Pre: BIOL 100 or 106, or consent S

## BIOL 447 (2) Cytopreparation Cytology

Lectures, demonstrations and laboratory sessions will be given in the various procedures carried out in the cytology laboratory. Collection and preparation techniques are described throughout the course series. Assignments in laboratory techniques continue through the year. Cytotechnology emphasis only. Permission required.

F, S

## BIOL 448 (3) Independent Projects

This course includes Check Sample and Journal Club presentations; projects involving literature research, cytopreparation, quality control/assurance, and cytology correlation. These projects will involve knowledge and use of: May search program, photography, computer skills (including Power Point for presentations) and educational methodology for presentation preparation. Cytotechnology emphasis only. Permission required.

F, S

## BIOL 449 (2) Computers, Networks, and Science

## BIOL 450 (5) Clinical Cytology

This portion of the program includes graded daily screening exercises. Students screen four hours a day at first, then move on to full day screening for approximately 30 days. A management series is presented during the clinical portion of the program, with two projects to be completed during the clinical segment. Cytotechnology emphasis only. Permission required.

F, S

## BIOL 451 (3) Plant Biotechnology

ALT-S

## BIOL 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 GLP, GMP, and ISO 9000 practices.

Pre: BIOL 105, 106, or consent

#### BIOL 453 (4) Biological Engineering Analysis I

The application of engineering principles and skills as applied to fermentation and to biological product recovery.

Pre: BIOL 270 and one semester each of calculus, physics, and organic chemistry F

#### 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.

Pre: BIOL 453 S

#### 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.

Pre: Concurrent enrollment in BIOL 453 F

#### 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.

Pre: BIOL 456, taken concurrently with BIOL 454 S

#### 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.

Pre: BIOL 105, 106, and 1 year of General Chemistry ALT-F

#### 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.

Pre: BIOL 460 ALT-S

#### 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.

Pre: BIOL 105, 106, and General Chemistry ALT-F

#### 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.

Pre: BIOL 105, 106, and General Chemistry ALT-F

#### 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.

Pre: 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.

Pre: BIOL 105, 106, 230, and 1 year of General Chemistry ALT-F

#### BIOL 467 (3) Industrial Hygiene

A lecture course that examines Minnesota State University, Mankato, as your own work place 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.

Pre: BIOL 105, 106, and 1 year of General Chemistry ALT-S

#### 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.

Pre: BIOL 105, 106, and 270 ALT-S

#### 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.

Pre: BIOL 105, 106, and 270 F

#### 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.

Pre: BIOL 270

#### 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.

Pre: BIOL 105, 106, 270 S

#### 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.

Pre: BIOL 105, 106 and 270 S

#### 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.

Pre: BIOL 105, 106, or consent S

#### BIOL 480 (2) 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.

F, S

#### BIOL 481 (1) Lab Supervision and Maintenance

Experience in maintaining and supervising laboratories. For individuals desiring additional experience with students in laboratory situations.

F, S

#### BIOL 485 (4) Biology Teaching Methods and Materials

A basic science methods course designed to prepare prospective junior and

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## Biology

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senior high life science teachers. Course will cover science teaching methods and support materials as they apply to life science teaching situations.  
Pre: 16 credits BIOL F

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.  
Pre: BIOL 485 ALT-S

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.  
F, S

BIOL 491 (1-4) In-Service  
F, S

BIOL 492 (1-3) Honors Research  
F, S

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

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.  
Pre: Consent F, S

BIOL 499 (1-4) Individual Study

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