Biology

College of Science, Engineering & Technology
Department of Biological Sciences
242 Trafton Science Center • 507-389-2786
Web site: www.mnsu.edu/dept/biology
Chair: Gregg Marg, Ph.D.
Daryl Adams, Ph.D.; Michael Bentley, Ph.D.; Bill Bessler, Ed.D.; Christopher Conlin, Ph.D.; Bradley Cook, Ph.D.; Marilyn Hart, Ph.D.; Penny Knoblich, DVM; Ph.D.; John D. Krenz, Ph.D.; Bethann Lavoie, Ph.D.; Mark Lyte, Ph.D.; Alison Mahoney, Ph.D.; Brock R. McMillan, Ph.D.; Steven Mercurio, Ph.D.; Donovan Nielsen, Ph.D.; Beth Proctor, Ph.D.; Christopher Ruhland, Ph.D.; Timothy Secott, Ph.D.; Robert Sorensen, Ph.D.; Edward Williams, Ph.D.; Dorothy Wrigley, Ph.D.

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 and 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.

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

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

One physiology course (BIOL 230, 431, 441, or 476)

Required Electives (5-8 credits):
Choose two courses from the following:
BIOL 301 BIOL 316 BIOL 403 BIOL 408 BIOL 418
BIOL 330 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.

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):
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)

Recommended Support Courses (0 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.

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, 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).

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):

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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:
a) BIOL 320 Cell Biology (4)
b) BIOL 431 Comparative Animal Physiology (3)
c) BIOL 217 Plant Science (3) and
   BIOL 441 Plant Physiology (4)
d) 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#
   #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 to 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) (include Math requirements)
CHEM 201 General Chemistry I (5)
MATH 121 Calculus I (4)

Electives Courses (0 credits required)
HLTH 475 Biostatistics (3)
CHEM 360 Principles of Biochemistry (4)
MATH 122 Calculus (4)

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 I (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 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#
   #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. 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

Electives 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)
Since toxins can be antibiotics, antiviral, or other chemotherapeutic medications, undergraduate level in a field where there are few programs in the United States. and hands-on research techniques of an interdisciplinary biological science at the medical analyses. The purpose of this option is to train students in the theory result. Then students can do elementary risk assessment and environmental or etc. to understand all aspects of how an exposure may or may not yield a toxic students to connect their background on chemistry, biology, physics, mathematics, Toxicology is the study of the harmful effects of chemicals, radiation, and other TOXICOLOGY OPTION your advisor.

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

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<tr>
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<th>Course Title</th>
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<tbody>
<tr>
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<td>General Biology I</td>
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<tr>
<td>BIOL 106</td>
<td>General Biology II</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 211</td>
<td>Genetics</td>
<td>3</td>
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Required General Education (13 credits) (including Math requirements):

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<tr>
<th>Course Code</th>
<th>Course Title</th>
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<tbody>
<tr>
<td>STAT 154</td>
<td>Elementary Statistics</td>
<td>3</td>
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<tr>
<td>HLTH 475</td>
<td>Biostatistics</td>
<td>3</td>
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Core Courses (16 credits):

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<td>BIOL 215</td>
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<tr>
<td>BIOL 217</td>
<td>Plant Science</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 441</td>
<td>Plant Physiology</td>
<td>4</td>
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<tr>
<td>BIOL 442</td>
<td>Plant Taxonomy</td>
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Recommended Support Courses (12 credits)

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<tbody>
<tr>
<td>ENG 271</td>
<td>Technical Communication</td>
<td>4</td>
</tr>
<tr>
<td>COMS 100</td>
<td>Introduction to Computer Science</td>
<td>4</td>
</tr>
<tr>
<td>MATH 121</td>
<td>Calculus I</td>
<td>4</td>
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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

<table>
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<th>Course Title</th>
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<tbody>
<tr>
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<td>General Biology I</td>
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<tr>
<td>BIOL 320</td>
<td>General Biology II</td>
<td>4</td>
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<tr>
<td>BIOL 430</td>
<td>Environmental Toxicology</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 401</td>
<td>Plant Science</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 412</td>
<td>Plant Physiology</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 432</td>
<td>Plant Taxonomy</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 440</td>
<td>Plant Taxonomy</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 443</td>
<td>Plant Taxonomy</td>
<td>4</td>
</tr>
</tbody>
</table>

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 on 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):

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BIOL 105</td>
<td>General Biology I</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 106</td>
<td>General Biology II</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 211</td>
<td>Genetics</td>
<td>3</td>
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</table>

Required General Education (14 credits):

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CHEM 201</td>
<td>General Chemistry I</td>
<td>5</td>
</tr>
<tr>
<td>PHYS 211</td>
<td>Principles of Physics I</td>
<td>4</td>
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Math 121 Calculus I (4)

Required for Support Courses (28 credits):

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BIOL 215</td>
<td>General Ecology</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 230</td>
<td>Human Physiology</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 270</td>
<td>Microbiology</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 460</td>
<td>Introduction to Toxicology</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 461</td>
<td>Environmental Toxicology</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 462</td>
<td>Toxicology Seminar</td>
<td>1</td>
</tr>
<tr>
<td>BIOL 464</td>
<td>Methods of Applied Toxicology</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 465</td>
<td>Applied Toxicology Project</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 466</td>
<td>Principles of Pharmacology</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 467</td>
<td>Industrial Hygiene</td>
<td>3</td>
</tr>
</tbody>
</table>

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, Physicist, Veterinarian, Wildlife Rehabilitation, 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):

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<tbody>
<tr>
<td>BIOL 105</td>
<td>General Biology I</td>
<td>4</td>
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<tr>
<td>BIOL 106</td>
<td>General Biology II</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 211</td>
<td>Genetics</td>
<td>3</td>
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</table>

Required General Education (13 credits):

<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>CHEM 201</td>
<td>General Chemistry I</td>
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</tr>
<tr>
<td>MATH 121</td>
<td>Calculus I</td>
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Recommended Support Courses (8 credits):

<table>
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<tr>
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<th>Course Title</th>
<th>Credits</th>
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<tr>
<td>BIOL 215</td>
<td>General Ecology</td>
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<td>Human Physiology</td>
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<td>4</td>
</tr>
<tr>
<td>BIOL 462</td>
<td>Toxicology Seminar</td>
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<tr>
<td>BIOL 464</td>
<td>Methods of Applied Toxicology</td>
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</tr>
<tr>
<td>BIOL 465</td>
<td>Applied Toxicology Project</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 466</td>
<td>Principles of Pharmacology</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 467</td>
<td>Industrial Hygiene</td>
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### Biology Minor

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

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BIOL 215</td>
<td>General Ecology</td>
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<tr>
<td>BIOL 301</td>
<td>Evolution</td>
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<tr>
<td>BIOL 316</td>
<td>Animal Diversity</td>
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<tr>
<td>BIOL 408</td>
<td>Vertebrate Ecology</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 431</td>
<td>Comparative Animal Physiology</td>
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Choose two from the following:

<table>
<thead>
<tr>
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<th>Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>BIOL 420</td>
<td>Diagnostic Parasitology</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 421</td>
<td>Entomology</td>
<td>3</td>
</tr>
<tr>
<td>BIOL 436</td>
<td>Animal Behavior</td>
<td>4</td>
</tr>
<tr>
<td>BIOL 438</td>
<td>General Endocrinology</td>
<td>3</td>
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</table>

**Electives Courses (24 credits):**

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

<table>
<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
<td>BIOL 320</td>
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<tr>
<td>BIOL 324</td>
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<td>BIOL 403</td>
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<td>BIOL 408</td>
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<tr>
<td>BIOL 409</td>
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<td>BIOL 410</td>
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<td>BIOL 412</td>
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<td>BIOL 420</td>
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<td>BIOL 434</td>
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<td>BIOL 435</td>
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<td>BIOL 479</td>
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<td>BIOL 492#/</td>
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</tr>
<tr>
<td>BIOL 497#/</td>
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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):**

<table>
<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
<td>BIOL 105</td>
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<td>BIOL 106</td>
<td>General Biology II</td>
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</tr>
<tr>
<td>BIOL 211</td>
<td>Genetics</td>
<td>3</td>
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Choose one course from the following:

<table>
<thead>
<tr>
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<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BIOL 215</td>
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<tr>
<td>BIOL 217</td>
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<td>4</td>
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<tr>
<td>BIOL 220</td>
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<td>4</td>
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<tr>
<td>BIOL 270</td>
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**Additional Elective:**

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

### 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

**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

**BIOL 103W (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, S

**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. F, S

**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 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

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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 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.
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.
Pre: BIOL 105 and 106 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

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 blanking 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 adoption, 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) 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.
Pre: BIOL 105, 106, 215 or consent F

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 413 (3) Evolution for Teachers

BIOL 414 (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 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) 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.

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

Pre: 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, photosynthesis, carbon dioxide and protein metabolisms, respiration, growth and development, phytotropisms, 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.
BIOL 444 (4) Fine Needle Aspiration Cytology
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 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 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 105, 106, and General Chemistry 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 463 (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 464 (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 465 (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 466 (3) Industrial Hygiene
A lecture course that examines Minnesota State University, 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. Pre: BIOL 105, 106, and 1 year of General Chemistry ALT-S

BIOL 467 (3) 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 468 (3) 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 archea. 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 foodborn 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 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