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## BIOLOGY

### BIOLOGY MS

#### BIOLOGY EDUCATION MS

(DISCIPLINE-BASED)

College of Science, Engineering, & Technology  
Department of Biological Sciences  
242 Trafton Science Center S • 507-389-2786

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The Biological Sciences graduate program is designed flexibly to allow students, with their advisors, to mold and focus their program of study on professional interests and specific needs. To do this, students can draw from a broad range of graduate courses and select from a diverse and well-trained faculty for direction in research.

The Department of Biological Sciences is located in Trafton Science Center one of the best science buildings in the state university system. Trafton Science Center presents an open, collaborative atmosphere for graduate study and research, and includes well-equipped research and classroom laboratories. Another attractive feature is Biology's proximity to other science departments, whose faculty members provide opportunities for multidisciplinary study in chemistry, mathematics, computer science, physics and electrical engineering.

The department's modern facilities provide opportunities for research and teaching, with 18 research laboratories, plus support areas. Among those are a media kitchen, environmental chambers, animal complex, greenhouse, dishwashing facility, herbarium, museum and a garage for field equipment. The department's equipment is suitable for biological investigations ranging from ecosystem analysis to subcellular physiology.

Instrumentation available includes transmission and scanning electron microscopes, ultracentrifuges, diode array spectrophotometers, graphite furnace AA, scintillation counter, gas chromatographs with FID, ECD and MSD, ultrafreezers, computer-controlled physiology data acquisition, Coulter counter, fermentation facility, freeze dryers, thermocyclers (PCR) and other equipment necessary for modern biological research opportunities.

All members of the department's graduate faculty hold doctorates and have extensive research experience. Areas of concentration in research and teaching are Biology Education, Microbiology, Human Biology/Physiology, Environmental Science, Ecology, and Plant Science. Sub areas of teaching specialization include cellular biology, developmental biology, plant and animal ecology, genetics, parasitology, immunology, entomology, and aquatic biology.

Approximately 25 graduate teaching assistantships (TA) are available each year to qualified applicants. A minimum 3.0 GPA in undergraduate courses in math, chemistry, biology and physics and a 600 paper-based TOEFL (250 on the computer based exam) are required for consideration of a TA. Research assistantships are also offered, depending on external funding. Applications should be submitted by February 3 to the Biological Sciences Department. Although the first selection of assistantships occurs in March for the following academic year, the department encourages applications year-round because periodic openings occur.

Admission. In addition to completing the minimum requirements for the College of Graduate Studies and Research, admission to the Biology program must be approved by the Biology Graduate Committee prior to completion of 16 credits of graduate coursework.

For admission to the Biology Program, applicants must provide a one-page statement of career interests and goals. In addition, the applicant must have an undergraduate degree in Biology from an accredited, four-year institution or in another field of science with evidence of having had the following equivalent undergraduate biology core: Biology I (BIO 105), Biology II (BIO 106), Genetics (BIO 211), and two of the following: General Ecology (BIO 215), Cell Biology (BIO 320) or physiology course including laboratory. Students lacking one or more of the above courses may be admitted to the program on the condition that the deficiencies will be rectified during their first year in the program.

In addition, a booklet, "Graduate Studies in Biology," is issued to help each student and advisor keep the graduate program on schedule.

Requirements. The Written Comprehensive Examination may be required at the discretion of the Examining Committee. The Oral Comprehensive Examination is

required for each degree candidate and includes an open seminar on the candidate's research. The candidate distributes seminar announcements to department faculty at least one week prior to the seminar.

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(Thesis Plan - 30 credits)  
(Alternate Plan Paper - 34 credits)

##### Required Core (11 credits)

BIOL 601 Biometrics (2)  
BIOL 602 Research Methods/Proposal (2)  
BIOL 695 Graduate Seminar (1) (3 Seminar credits required)  
BIOL 619 Selected Topics (2-3) (4 Selected Topics credits required)  
ENVI 619 Selected Topics (3)  
(may be taken to satisfy 3 credits of the BIOL 619 requirement)

##### Required Electives (19-23 credits)

Choose any 500/600 level Biology courses in consultation with an advisor

##### Required Thesis or Alternate Plan Paper

BIOL 694 APP (1-2)  
BIOL 699 Thesis (3-6)

#### BIOLOGY EDUCATION MS

(Discipline-based)  
(Thesis Plan - 30 credits)  
(Alternate Plan Paper - 34 credits)

Teaching licensure is a prerequisite to pursuing this degree which is for teachers interested in enrichment in a teaching area. This degree does not lead to initial teaching licensure. Students who desire initial licensure should consult the Master of Arts in Teaching (MAT) program. Please see the section concerning the MAT program that is listed in this bulletin.

##### Required Core (11 credits)

BIOL 601 Biometrics (2)  
BIOL 602 Research Methods/Proposal (2)  
BIOL 695 Graduate Seminar (1) (3 Seminar credits required)  
BIOL 619 Selected Topics (2-3) (4 Selected Topics credits required)  
ENVI 619 Selected Topics (3)  
(may be taken to satisfy 3 credits of the BIOL 619 requirement)

##### Required Biology Electives (7-11 credits)

Choose any 500/600 level Biology courses in consultation with an advisor

##### Required Professional Education (6 credits)

Choose 6 credits of professional education courses in consultation with an advisor

##### Required Related Science Electives (6)

Choose 6 credits of related science courses in consultation with an advisor

##### Required Thesis or Alternate Plan Paper

BIOL 694 Alternate Plan Paper (1-2)  
BIOL 699 Thesis (3-6)

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## COURSE DESCRIPTIONS

#### BIOL 502 (4) Stream Ecology

Study of flowing water on environment. Lab (fieldwork) included.

Prerequisite: BIOL 105, 106, 215, or consent

#### BIOL 503 (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.

(S) Prerequisite: BIOL 215 or consent

#### BIOL 504 (4) Wetlands

To provide students the values and functions of wetlands and to use wetlands as an

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example of the relationship of ecology to management, and the impact that classification systems have politically. Lab (fieldwork) included.

(S) Prerequisite: BIOL 105, 106, 215, or consent

#### BIOL 505 (3) Fisheries Biology

An introduction to fish biology and fisheries management, diversity, form and function in the aquatic environment, functional physiology, evolution and speciation, identification and use of keys, ecology, and management topics.

(F) Prerequisite: BIOL 105, 106, 215, or consent

#### BIOL 508 (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

#### BIOL 509 (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

#### BIOL 510 (3) Global Change Biology

The natural or human-induced change in climate and the effect on terrestrial and marine ecosystems. The human species' place in the biological world, effects on various communities and potential methods of correcting detrimental effects with economic and social implications.

(S) Prerequisite: BIOL 105, 106, 215, or consent

#### BIOL 512 (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.

(S) Prerequisite: BIOL 105, 106, 215 or consent

#### BIOL 517 (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.

(S) Prerequisite: BIOL 100 or 105

#### BIOL 518 (4) Macro & 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).

(F) Prerequisite: one year of physics

#### BIOL 519 (2-3) Special Topics in Instrumentation

Instruction in specialized biological instrumentation.

(F) Prerequisite: BIOL 105 and 106

#### BIOL 520 (3) Diagnostic Parasitology

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

#### BIOL 521 (3) Entomology

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

(ALT-F) Prerequisite: BIOL 105 and 106 or consent

#### BIOL 530 (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.

(S) Prerequisite: BIOL 230

#### BIOL 531 (3) Comparative Animal Physiology

A comparison of adaptation mechanisms, from cell to organ-systems, used by animals in response to "changes in" environmental conditions such as oxygen, carbon dioxide, food availability, temperature, waste, solutes, pressure and buoyancy.

(ALT-F) Prerequisite: BIOL 105, 106 or consent

#### BIOL 532 (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, analysis and discussion from five local lakes.

Prerequisite: BIOL 105, 106, 215, or consent

#### BIOL 533 (3) Cardiovascular Physiology

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

(S) Prerequisite: BIOL 230

#### BIOL 534 (3) Development & 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.

(F) Prerequisite: BIOL 100 or 105

#### BIOL 535 (4) Histology

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

(S) Prerequisite: BIOL 220

#### BIOL 536 (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. (S)

Prerequisite: BIOL 105, 106, 215 or consent

#### BIOL 538 (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.

(S) Prerequisite: BIOL 100 or 105

#### BIOL 541 (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.

(S) Prerequisite: BIOL 105, 106, 217, and one semester organic chemistry

#### BIOL 542 (4) Flora of Minnesota

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

(S) Prerequisite: BIOL 105, 106, or consent. BIOL 217 recommended.

#### BIOL 543 (4) Plant Ecology

Expands upon general principles of ecology and focuses on the factors that affects the distribution and abundance of plants, analysis of plant populations, and dynamics of plant communities. Lecture and lab (field work) included.

(F) Rerequisite: BIOL 105, 106, 215, or consent. BIOL 217 strongly recommended.

#### BIOL 545 (4) Economic Botany

We interact with plants every day and they've had a profound effect 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.

(F) Prerequisite: BIOL 100 or 105 or consent

#### BIOL 549 (2) Computers, Networks, & Science

This course provides students with the necessary skills to explore and utilize computer resources for scientific purposes. Students learn techniques for communicating with the world scientific community electronically, accessing internal computer networks, and locating computer-based scientific resources through a hands-on, problem solving approach.

#### BIOL 552 (3) Biological Instrumentation

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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.

(S) Prerequisite: BIOL 105, 106, or consent

### BIOL 553 (4) Biological Engineering Analysis I

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

(F) Prerequisite: BIOL 270 and one semester each of calculus, physics, and organic chemistry

### BIOL 554 (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.

(S) Prerequisite: BIOL 553

### BIOL 556 (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.

(S) Prerequisite: concurrent enrollment in BIOL 553

### BIOL 557 (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.

(S) Prerequisite: BIOL 556, concurrent enrollment in BIOL 554

### BIOL 560 (3) Introduction to Toxicology

A lecture course covering basic principles of toxicity evaluation in living organisms, mechanisms of responses to chemicals or physical agents within an overview of practical medical, environmental and science policy implications. Presentation of comparisons of specific organ and tissue reactions to toxins in a variety of species follow these introductory concepts.

Prerequisite: BIOL 105, 106, and one year of general chemistry

### BIOL 561 (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, and effects on species and ecosystems with a special section on aquatic risk assessment. The laboratory includes techniques in environmental toxicity and a genuine research project.

Prerequisite: BIOL 460/560

### BIOL 562 (1) Toxicology Seminar

A seminar course that involves critical evaluation of published studies in toxicology, student presentations of a selected published manuscript, and requires students to write a paper on one aspect of the course's topic area that semester. Topic areas vary each time the course is offered.

Prerequisite: BIOL 105, 106, and general chemistry

### BIOL 564 (3) Methods of Applied Toxicology

A lecture/laboratory course focusing on the steps necessary to start a research project from project definition through method testing and evaluation, and a final report that includes a project flow chart. Third year students will have senior and/or graduate mentors.

Prerequisite: BIOL 105, 106, and general chemistry

### BIOL 565 (3) Applied Toxicology Project

A lecture/laboratory course where students perform all aspects of their own designed research topic in toxicology while critically evaluating the progress of other projects as well. Students will be expected to keep timelines or develop modified timelines as necessary. The inverted triangle approach of project design will be examined and then included in all designs.

Prerequisite: BIOL 464/564

### BIOL 566 (3) Principles of Pharmacology

A lecture course that examines mechanisms of drug action, physiological responses and adverse reactions from sensitivities or allergies through overdose.

Prerequisite: BIOL 105, 106, 230, and one year of general chemistry

### BIOL 567 (3) Industrial Hygiene

A lecture course that examines Minnesota State University 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.

Prerequisite: BIOL 105, 106, and one year of general chemistry

### BIOL 572 (4) Microbial Ecology & Bioremediation

Role of microorganisms in soil, air, water, and sewage processes as well as methods of measurement and detection. Special emphasis on the role of microorganisms in bioremediation. Lab included.

Prerequisite: BIOL 105, 106, and 270 or 320

### BIOL 574 (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.

(F) Prerequisite: BIOL 105, 106, and 270

### BIOL 575 (4) Medical Microbiology

This course will cover bacterial, fungal, and viral human pathogens: what diseases they cause, how they caused 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.

(F) Prerequisite: BIOL 105, 106, 270, or consent

### BIOL 576 (5) Microbial Physiology & 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.

(S) Prerequisite: BIOL 105, 106, 270

### BIOL 578 (4) Food Microbiology & Sanitation

The role microbes play in production and spoilage of food products, as prepared for mass market. Topics include food-borne pathogens, epidemiology and control, and essential principles in sanitation including Hazard Analysis/Critical Control Point and ISO 9000 requirements. Lab included.

(S) Prerequisite: BIOL 105, 106 and 270

### BIOL 579 (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.

(S) Prerequisite: BIOL 105, 106, or consent

### BIOL 580 (2) Biological Laboratory Experiences for Elementary

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) Prerequisite: BIOL 100 and C&I 322

### BIOL 585 (4) Biology Teaching Methods & 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.

(F) Prerequisite: 16 credits BIOL and EDFN 345

### BIOL 586 (3) Field-Based Teaching Methods & Materials

A lecture/laboratory course that provides opportunity for prospective junior and senior high life science teachers to observe, practice, and refine their teaching skills. Students will work in a school setting and experience actual classroom.

Prerequisite: BIOL 485/585

### BIOL 590 (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 591 (1-4) In-Service  
(F, S)

BIOL 601 (2) Biometrics  
This course will focus on the application of biometric principles to the planning and analysis of biological research similar to the student's thesis research. Completion of this course will aid the student in planning and completing her/his thesis.  
(F)

BIOL 602 (2) Research Methods  
The design, planning, and writing of a biological research proposal will be discussed in terms of scientific method application, problem selection, methods, and assessments. The students will apply information from the class to prepare their research/thesis proposals and other professional communications.  
(S)

BIOL 603 (2) Research in the Biological Sciences I

BIOL 604 (2) Research in the Biological Sciences II

BIOL 605 (2) Ethical Issues in Biological Research  
What does it mean to do biological research ethically? This course will discuss scientific integrity and misconduct, human and animal research, conflicts of interest and the ethical dimension of other topics in modern biological and biomedical research.

BIOL 612 (3) Practicum in Electron Microscopy  
A laboratory course of basic training in the instrumentation and methodology use in scanning and transmission electron microscopy. With a hands-on approach, students will learn instrument operation and techniques necessary to process and examine a variety of samples, and whenever possible, to examine specimens related to their own research interests.  
(S) Prerequisite: BIOL 418/518

BIOL 618 (2) Biological Monitoring

BIOL 619 (2-3) Selected Topics in Biology  
Selected study of graduate level topics. May be repeated for different titled topic.  
(F,S)

BIOL 677 (1-5) Individual Study  
Prerequisite: consent

BIOL 681 (1-2) Laboratory Supervision  
Practical experience in preparing and teaching laboratory courses.  
(F,S) Prerequisite: consent

BIOL 685 (2) Teaching Assistant Methods  
This course is design to provide teaching assistants (TA) with the knowledge and skills needed to prepare and teach college-level science courses. Special emphasis will be placed on the attainment of skills that maximize the effectiveness of material that will be presented to students.  
(F)

BIOL 691 (1-5) In-Service  
(F,S)

BIOL 694 (1-2) Alternate Plan Paper  
(F,S)

BIOL 695 (1) Seminar  
Students will attend and critique seminars presented by other students, faculty, and by people from external agencies and institutions.  
Prerequisite: none (F,S)

BIOL 697 (1-12) Internship  
(F, S)

BIOL 699 (1-6) Thesis  
(F,S)