The Master of Science in Biology Program is a multi-disciplinary program that allows students advanced study in several traditional and non-traditional areas of biology. Students have the option of a general M.S. degree in biology (Build your own degree!) or may obtain an M.S. degree in biology with a formal concentration in aquatic science, cellular and molecular biology, clinical microbiology, microbiology, nurse anesthesia, or physiology.

Admission to the program is based, in part, on undergraduate grade point average (GPA), scores on the GRE general exam, letters of recommendation, and on individually prescribed undergraduate course work to meet prerequisite requirements for each concentration. Each student will choose a major advisor and an advisory committee during the first semester of residence. This committee will assist the student in drafting the student’s plan of study, which will dictate the student’s curriculum for the ensuing semesters.

All students complete a capstone experience. Students obtaining the M.S. in biology or M.S. in biology with a clinical microbiology concentration complete a thesis or seminar paper. Students obtaining the M.S. in biology with an aquatic science concentration, cellular and molecular biology concentration, microbiology concentration, or physiology concentration complete a thesis. Students obtaining the M.S. in biology with a nurse anesthesia concentration complete extensive clinical training.

2017-18 Faculty/Staff
The following is the graduate faculty as of the publication date of this catalog. This list will not be updated again until the next catalog is published in June.

Professor
Scott Cooper
Roger Haro
Margaret Maher
Jennifer Miskowskki
Mark Sandheinrich

Associate Professor
Michael Abler
Anita Baines
Anne Galbraith
Tisha King-Heiden
Sumei Liu
Anton Sanderfoot
Bradley Seebach

Assistant Professor
Sierra Colavita
Christine Schwartz

Graduate degrees
- Biology - MS (http://catalog.uwlax.edu/graduate/programrequirements/biology/biology-ms)
- Biology - MS: Aquatic science concentration (http://catalog.uwlax.edu/graduate/programrequirements/biology/biology-aquatic-science-concentration-ms)
- Biology - MS: Cellular and molecular biology concentration (http://catalog.uwlax.edu/graduate/programrequirements/biology/biology-cellular-molecular-biology-concentration-ms)
- Biology - MS: Nurse anesthesia concentration (http://catalog.uwlax.edu/graduate/programrequirements/biology/biology-nurse-anesthesia-concentration-ms)
- Biology - MS: Physiology concentration (http://catalog.uwlax.edu/graduate/programrequirements/biology/physiology-concentration-ms)

Courses
BIO 501 Cr.4
Comparative Vertebrate Anatomy
Comparative anatomy is fundamental to vertebrate function and evolutionary biology. The course will cover the chordate body system-by-system and across the group’s evolution, diversity, and ecological challenges, from flying and running vertebrates to sea squirts and lampreys. Labs will raise insight and skill through comprehensive, respectful dissection of cats, dogfish sharks, lampreys, and representative organ specimens. Lect. 3, Lab 2. Offered Spring.

BIO 404/504 Cr.3
Plant Taxonomy
Collection, identification, classification, and evolution of the vascular plants with emphasis on local flora. Lect. 1, Lab. 4. Prerequisite: BIO 203 or BIO 304. Offered Spring - Odd Numbered Years.
**AQUATIC AND WETLAND VASCULAR PLANTS**
Identification and collection of vascular plants of aquatic and marsh habitats with emphasis on adaptive morphology and ecology of local species. Field trips required. Lect. 1, Lab. 2. Prerequisite: BIO 203 or BIO 304. Offered Fall - Even Numbered Years.

**BIO 406/506 Cr.4**

**Parasitology**
A survey of the major groups of animal parasites with regard to their taxonomy, morphology, life histories, host-parasite relationships, and economic importance. Lect. 2, Lab 4. Prerequisite: BIO 203 or BIO 210 or BIO 303. Offered Fall.

**BIO 408/508 Cr.4**

**Developmental Biology**
An exploration of the cellular and molecular mechanisms that underlie embryonic development in several model organisms. Topics include fertilization, regulation of gene expression, cell fate determination, stem cells, early pattern formation, morphogenesis of tissues/organs, and limb formation. The course primarily focuses on animal models with an emphasis on evolutionarily conserved processes, structures, and molecular pathways. Technological advances and relevance to human development and disease are highlighted throughout. Lect. 2, Lab. 4. Prerequisite: BIO 203 or BIO 210 or BIO 303; BIO 306 or MIC 416; BIO 315. Offered Spring.

**BIO/PAS/PTS 509 Cr.3**

**Human Gross Anatomy**
A comprehensive consideration of human gross anatomy. Systems included are musculoskeletal, neurological, urogenital, gastrointestinal, and cardiopulmonary. Function, development, and topographic correlations are emphasized as a means toward evaluating clinical applications. Biomechanical function, topographic and clinical applications are emphasized. Prerequisite: admission to the Biology CRNA Program, PAS Program, or DPT Professional Program; concurrent enrollment in BIO/PAS/PTS 510 under same department. (Cross-listed with BIO/PAS/PTS; may only earn credit in one department.) Offered Summer.

**BIO/PAS/PTS 510 Cr.3**

**Applied Human Gross Anatomy**
A comprehensive consideration of human anatomy including both neuro-musculoskeletal components and internal organ systems. Systems included are musculoskeletal, neurological, urogenital, gastrointestinal, and cardiopulmonary. The course provides an in-depth understanding of the gross anatomy of the human body through regional dissection. This understanding will then be demonstrated through the application of anatomy within clinical presentations. Prerequisite: admission to the Biology CRNA Program, PAS Program, or DPT Professional Program; concurrent enrollment in BIO/PAS/PTS 509 under same department. (Cross-listed with BIO/PAS/PTS; may only earn credit in one department.) Offered Summer.

**BIO 412/512 Cr.4**

**Mycology**
A survey of all the major groups of fungi of the fungal kingdom (and relatives) in terms of systematics, anatomy, morphology, ecology, physiology, genetics, evolutionary relationships, and human and plant pathology. Laboratory includes microscopic and macroscopic study of the fungi, as well as making a collection of cultures and of fungal reproductive structures (including mushrooms) from selected groups. Lect. 2, Lab. 4. Prerequisite: BIO 203 or BIO 304 or MIC 230. Both the microbiology course and one of the biology courses are strongly recommended. Offered Fall.

**BIO 413/513 Cr.3**

**Medical Mycology**
A study of the increasing number of medically important fungi, including the yeasts, molds, other fungi, and actinomycetes that are pathogenic to humans and other animals. Emphasis is on laboratory techniques for isolation and identification of these pathogenic fungi. Lect. 2, Lab. 2. Prerequisite: BIO 412/512 or MIC 230. Offered Spring.

**BIO 414/514 Cr.3**

**Freshwater Invertebrate Zoology**
Introduces the ecology and taxonomy of the metazoan, non-parasitic freshwater invertebrates. An extensive course designed to provide a foundation for taxonomic knowledge, and basic understanding of the biology and ecology of freshwater invertebrates for advanced students in aquatic and environmental sciences. Lectures will focus on ecology; labs on taxonomy and quantitative skills. A student reference collection and weekend field trips will be required. Lect. 2, Lab. 2. Prerequisite: BIO 203 or BIO 210 or BIO 341. Offered Occasionally.

**BIO 419/519 Cr.3**

**Quantitative Methods in Ecology**
An introduction to field and laboratory procedures used by ecologists to describe and analyze the interactions between organisms and their environments. The course will emphasize quantitative techniques, including the use of computer technology, for collecting, recording, and interpreting ecological data. Lect. 2, Lab. 2. Prerequisite: BIO 307 or BIO 341. Offered Fall.

**BIO 421/521 Cr.3**

**Comparative Vertebrate Endocrinology**
A comprehensive study of the production, regulation, structure, molecular to whole-body actions, metabolism, and excretion of biochemical signaling molecules across vertebrates with a focus on amphibians, fish, birds, and mammals. Hormone and neurotransmitter pathways will be examined with relationship to evolutionary and environmental influences using lecture, review of primary literature, and case studies. Prerequisite: BIO 313 or BIO 458/558. Offered Spring.

**BIO 422/522 Cr.3**

**Ichthyology**
A study of the taxonomy, anatomy, physiology, and ecology of fish, with emphasis on the fresh water fishes. Lect. 2, Lab. 2. Prerequisite: BIO 203 or BIO 210 or BIO 303. Offered Fall - Odd Numbered Years.

**BIO 424/524 Cr.3**

**Human Endocrinology**
A comprehensive study of the production, regulation, structure, molecular to whole body actions, metabolism, and excretion of biochemical signaling molecules in humans. The classical and more recently recognized neurotransmitter and hormone pathways and clinical and pharmacology considerations of each will be explored with lectures, primary literature and case studies. Prerequisite: BIO 313 or BIO 458/558. Offered Fall.

**BIO 428/528 Cr.3**

**Advanced Nutrition for the Health Professions**
A comprehensive study of nutrition-related diseases and nutrition assessment, evaluation, and management in clinical settings that people working in healthcare may encounter. Prerequisite: BIO 313 or NUT 200. Offered Fall, Spring.

**BIO 429/529 Cr.3**

**Evolution**
Consideration of the principles and the record of organic evolution of plants and animals. Lect. 3. Prerequisite: BIO 306. Offered Spring.
BIO 432/532 Cr.2
Biology of Cancer
A survey of the current knowledge of cancer biology. The course will include lectures, readings and discussions on a wide range of cancer topics, including: characteristics of cancer cells, carcinogenesis, cancer genes, tumor classification, invasion, metastasis, impact of cancer on body functions, epidemiology, inheritance, immunology, diagnosis, treatment, and prevention. Prerequisite: BIO 303 or BIO 313; BIO 306 or MIC 416. Offered Fall.

BIO 435/535 Cr.3
Molecular Biology
A study of molecular biology with an emphasis on eukaryotic systems. The course will focus on the molecular aspects controlling biological processes. The impact of recombinant DNA technology on biotechnology and medicine will also be examined. Lect. 3. Prerequisite: BIO 306 and BIO 315, or MIC 416/516; three semesters of college chemistry including organic chemistry. Biochemistry strongly recommended. BIO 436/536 is an optional laboratory which can be taken concurrently. Offered Fall.

BIO 436/536 Cr.1
Molecular Biology Laboratory
A study of molecular biology with an emphasis on eukaryotic systems. Laboratory emphasis is on recombinant DNA technology, current techniques used to express recombinant proteins in eukaryotic cells, computer based DNA analysis, macromolecular modeling using computers, and quantitative assay techniques. Lab. 3. Prerequisite: taken concurrently with BIO 435/535. This lab is optional for those enrolled in BIO 435/535. Offered Fall.

BIO 437/537 Cr.3
Plant Growth and Development
Discussion of experiments and analysis of research data obtained from the living plant. Prerequisite: BIO 203 or BIO 304 or equivalent. Offered Occasionally.

BIO 439/539 Cr.3
Plant Anatomy
A detailed examination of plant structure and development as revealed with the light and electron microscopes. Primarily seed plants will be examined. Structure and development will be studied as a means by which plants cope with their ecology, evolution and function. Lect. 2, Lab. 2. Prerequisite: BIO 203 or BIO 304 or an equivalent general botany course. Offered Occasionally.

BIO/MIC 440/540 Cr.2
Bioinformatics
In this course, students will use computers to study and compare the sequence of nucleotides in DNA or RNA, or the amino acids in a protein. Computers also are used to examine the three dimensional structure of protein. Being able to manipulate and study this information is the basis for the current revolution in biotechnology. Topics include evolution, taxonomy, genomics and understanding disease. This course provides students an opportunity to explore the relationships between biology, microbiology, chemistry, and computer science. Lect. 1, Lab 2. Prerequisite: BIO 306 or MIC 416/516. (Cross-listed with BIO/MIC; may only earn credit in one department.) Offered Spring, Winter.

BIO 441/541 Cr.3
Environmental Toxicology
The study of the lethal and sublethal effects of chemical contaminants on ecosystems and humans. Topics covered include environmental legislation, chemical distribution and fate in the environment, methods of toxicity testing, assessment of exposure and risk, effects of chemical contaminants on humans, and fish and wildlife populations, communities and ecosystems, and toxicity of specific chemical groups. Prerequisite: BIO 307 or BIO 341; CHM 104. Offered Spring - Odd Numbered Years.

BIO/MIC 442/542 Cr.3
Plant Microbe Interactions
This course will explore in-depth various ways that plants interact with microbes in the environment, at the macroscopic, cellular, and molecular levels. Case studies will include both parasitic and mutualistic (symbiotic) interactions. Microbes include fungi, bacteria, nematodes, and viruses. Includes plant pathology and studies of the beneficial relationships between plants and microbes. Inquiry-based labs are integrated into the lecture and discussion sessions. Lect. 2, Lab 2. Prerequisite: BIO 203 or BIO 304; MIC 230; BIO 306 or MIC 416. (Cross-listed with BIO/MIC; may only earn credit in one department.) Offered Spring - Even Numbered Years.

BIO 443/543 Cr.3
Molecular Mechanism of Disease and Drug Action
A survey of the leading non-infectious and non-cancerous diseases in the industrialized world. This course will explore the molecular mechanisms of disease, clinical symptomology, and pharmacological treatment. Students will be expected to conduct thorough research on a given disease and present their results in a poster session. Prerequisite: BIO 306, BIO 313; CHM 300 or CHM 304. Offered Spring.

BIO 444/544 Cr.4
Entomology
Insects and their close relatives are ubiquitous, affecting humans' lives in profound ways. We will investigate the anatomy, behavior, evolution, and ecology of insects, as well as how insects impact human culture. Discussions, presentations, illustrations, field research, curation of specimens, and other activities offer opportunities for students to apply insect research knowledge and skills. This course is taught largely at an undergraduate level. Graduate students will have additional course requirements/expectations. Lect. 3, Lab 2. Prerequisite: BIO 203. Offered Fall - Even Numbered Years.

BIO 546 Cr.3
Animal Behavior
We will explore factors that help to explain how and why animals behave as they do. Example topics include social behavior, learning, symbiotic relationships, sensory systems, communication, mating systems, defense, and parental care. Emphasis will be placed on non-human animals. Discussions, presentations, illustrations, and other activities offer opportunities for students to apply behavioral research knowledge and skills. Offered Annually.

BIO 447/547 Cr.3
Biostatistics
This course will instruct students on the use of standard methods for analyses of selected biological, chemical, and physical constituents commonly included in water quality analyses. Quality assurance procedures, including Good Laboratory Practice Standards (GLPS) will be integrated into all activities. Materials covered include: principles of methods used; evaluation of precision, bias, and contamination; proper reporting and interpretation of results; and environmental sources and significance of constituents analyzed. Lect. 1, Lab 4. Prerequisite: BIO 203 or BIO 210 or BIO 303 or BIO 304, and three semesters of college chemistry. BIO 341 recommended. Offered Spring.
BIO 548 Cr.4

Aquatic Toxicology
A study of the lethal and sub lethal effects of chemical contaminants in aquatic systems, specific chemical effects, chemical distribution and fate, and environmental legislation. Procedures for toxicity evaluation, experimental design and statistical analysis will be emphasized in the laboratory. Lect. 3, Lab. 2. Prerequisite: four semesters of college biology; three semesters of college chemistry. BIO 341 recommended. Offered Occasionally.

BIO 449/549 Cr.3

Advanced Microscopy and Biological Imaging
Principles and techniques used in modern microscopy and biological image analysis. Emphasis will be on student projects to become proficient at confocal, fluorescence, and scanning electron microscopy. Students will also learn specimen preparation, digital imaging, and image processing and analysis for biological applications. Lect. 2, Lab. 2. Prerequisite: BIO 315 or MIC 230. Offered Fall - Even Numbered Years.

BIO 456/556 Cr.4

Plant Ecology
Conservation biology, ecological restoration, and predicting the effects of climate change all require an understanding of plant ecology. This course is focused on the interactions among plants, other organisms, and the environment. We will work across the individual, population, and community levels, and emphasize an exploratory approach to plant ecology. Class activities will include lectures, the discussion of ecological journal articles, and carrying out student-designed experiments. Offered Fall - Even Numbered Years.

BIO 458/558 Cr.4

Comparative Animal Physiology
This course has both a lecture and a laboratory component. It aims to provide a thorough understanding of animal physiology from a comparative perspective. Emphasis will be placed on the basic physiological principles by which animals perform their life sustaining functions. Lectures will focus on vertebrate animals, but will span both invertebrate and vertebrate models to illustrate how largely divergent groups have evolved different (or similar) mechanisms to cope with environmental challenges. The laboratory component will provide an active learning environment and hands-on experience in physiological experimentation. Lect. 3, Lab 2. Offered Fall.

BIO 460/560 Cr.1-4

Symposium in Biology
Studies in biology of interest to specific groups. Varying topics will be offered at intervals with a specific title assigned to each. May be staffed by resident faculty or visiting lecturers. Other departments may be invited to participate. Repeatable for credit - maximum 16. Variable offerings - check registration schedules. Prerequisite: four semesters of biology. Offered Occasionally.

BIO 563 Cr.3

Aqueous Animal Health
The study of pathogens of aquatic animals, including fish, shellfish, crustaceans, amphibians, waterfowl and mammals. Sections on nutrition and toxicology are included. Emphasis is on laboratory techniques for isolation and identification of pathogenic bacteria, viruses and parasites. Field trips required. Lect. 2, Lab. 3. Prerequisite: BIO 105; BIO 203 or BIO 210 or BIO 303; and CHM 103. MIC 230 strongly recommended. Offered Occasionally.

BIO 464/564 Cr.3

Stream and Watershed Ecology
Introduces key concepts and theory pertinent to understanding and managing fluvial ecosystems (rivers and streams) and their watersheds. The course will emphasize rivers as large-scale physical and biological systems. Course work includes a comparative case study of distinctive types of temperate, tropical, and polar rivers. Prerequisite: BIO 341 or BIO 307. Offered Spring.

BIO 465/565 Cr.3

Neurophysiology
An examination of the nervous system beginning at the cellular level and working up to neuronal systems. Topics covered include the ionic basis of membrane potentials, synaptic communication, organization of functional circuits of neurons, and systems within the brain and/or spinal cord which control learning and memory, and vision and motor function. Exploration of these fundamental neurophysiology topics form the basis for understanding a variety of student-selected topics which will be covered later in the semester. Late-semester topics often include higher-order aspects of brain function or challenges to the nervous system - such as the repair of brain or spinal cord injury, degenerative disease states, dyslexia, or gender differences. BIO 467/567 is an optional laboratory course which can be taken concurrently. Prerequisite: BIO 312. Offered Spring.

BIO 466/566 Cr.3

Human Molecular Genetics
A study of the basic principles of heredity in humans. Focus will be on modern molecular techniques used in isolating human disease genes and modes of inheritance of human traits and disorders. Ethical issues in human genetics will also be discussed. BIO 468/568 is an optional laboratory course which can be taken concurrently. Prerequisite: BIO 306. Offered Fall.

BIO 467/567 Cr.2

Neurobiology Laboratory Techniques
An introduction to common laboratory techniques in neurobiology, including electrophysiology with invertebrate preparations, mammalian neuronal cell culture, and computational modeling. Students will receive training in techniques while performing classical experiments, then design their own novel experiments and carry them out. Lab. 4. Prerequisite: BIO 312; BIO 465/565 or concurrent enrollment. Offered Spring - Odd Numbered Years.

BIO 468/568 Cr.1

Human Molecular Genetics Lab
A study of the techniques used in doing research in human molecular genetics with a focus on commonly used model organisms in the study of human genetic disorders. Laboratory emphasis is on phenotype analysis, library screening, DNA microarray analysis, gene mapping, and bioinformatics. This lab is optional for those enrolled in BIO 466/566. Lab. 3. Prerequisite: BIO 306. BIO 466/566 must be taken concurrently. Offered Fall.

BIO 473/573 Cr.3

Marine Biology
Marine biology is an interdisciplinary field that includes elements of geology, physics, chemistry and biology. Students will gain an introduction to how biological organisms deal with varying physical, geological and chemical conditions found in marine ecosystems. Emphasis will be placed on current conservation concerns and marine invertebrate diversity. Prerequisite: BIO 203 and CHM 103. Offered Spring - Odd Numbered Years.
Ecosystem Ecology
Ecosystems include the living and non-living components of an environmental system and have emergent properties that can only be understood by examining the system as a whole. This course will examine advanced ecological topics centered around the structure and function of aquatic and terrestrial ecosystems. Topics covered will include the development of the ecosystem concept, ecosystem succession, production/decomposition, energy transfer in food webs, and nutrient cycling. The course will consist of classroom lectures, problem sets, and reading/discussion of relevant literature. Prerequisite: BIO 307 and one semester of chemistry. Offered Spring - Even Numbered Years.

Mammalogy
A study of the diversity and biology of mammals. The origins and evolutionary history of mammals grounds a survey of modern mammalian groups, including their phylogenetic relationships, ecology, adaptations, and complex behaviors. Wisconsin species will be highlighted. Graduate students will assist with instruction on the mammal groups of their choice. Prerequisite: graduate standing in biology. Offered Fall.

Current Topics in Biology Education
Biological researchers produce new discoveries almost daily. The purpose of this course is to train K-12 pre-service and in-service teachers in the current technologies and theories used in biology and to demonstrate the current approaches to teaching these materials. Repeatable for credit under different topics. Departmental option for pass/fail grading. Pass/Fail grading. Offered Occasionally.

Communication in the Biological Sciences
This course covers in detail the preparation and submission of scientific manuscripts for publication and the presentation of papers at scientific conferences. Topics covered include preparation of manuscript sections, figures, and tables; writing with clarity, precision, and word economy; dealing with journal editors and reviewers; reviewing and editing of manuscripts; preparation of proposals for funding; presentation of oral (platform) and poster papers at scientific conferences; preparation of visual aids; serving on expert panels; serving as an expert witness; and communicating with the public, the press, lawyers, and politicians. Offered Spring - Even Numbered Years.

Physiology of Drug Action
A study of the general principles of pharmacodynamics and pharmacokinetics of drugs in human systems with emphasis on the physiological responses at the cellular and organ levels. Prerequisite: BIO 718 or concurrent enrollment. Offered Occasionally.

Advanced Genetics
The application of molecular-genetic analysis to problems in modern biology. The course will cover the fundamentals of genetic analysis in both procaryotic and eucaryotic systems. Assigned readings from current literature will be discussed and evaluated. A variety of topic areas will be considered including ecology, biotechnology, bioremediation, food science, medicine and basic research. Prerequisite: a previous course in genetics, microbial genetics, or molecular biology. (Cross-listed with BIO/MIC; may only earn credit in one department.) Offered Spring - Odd Numbered Years.
BIO 725 Cr.1-3

**Forum in Biology**
An in-depth examination of selected topics in biology through critical analysis of the primary literature. Participants will be required to read and discuss the experimental design, methods, results and major conclusions of scientific research. Repeatable for credit - maximum six. Variable offerings - check registration schedules. Offered Occasionally.

BIO 726 Cr.1-3

**Advanced Laboratory Techniques in Biology**
Development of accessory research skills in specialized areas of biology. Repeatable for credit - maximum six. Variable offerings - check registration schedules. Offered Occasionally.

BIO 732 Cr.2

**Effective Teaching Strategies for Grad Teaching Assts in the Science Lab**
This course aims to improve proficiency of graduate teaching assistants in the science laboratory. Topics covered may include, but are not limited to, students learning styles, lecture and question techniques, design of assessment tools, portfolio development, and grading techniques. Offered Fall.

BIO/MIC 751 Cr.1

**Graduate Seminar**
Reading, oral reports, and discussion on selected topics in biology and microbiology. Repeatable for credit - maximum two. (Cross-listed with BIO/MIC.) Offered Fall, Spring.

BIO 761 Cr.2

**Research and Seminar in Biology**
Principles of research in biology. As part of the requirements for this course and for the degree, each student must complete an acceptable scientific communication (such as a seminar paper, manuscript, or poster) unless pursuing Plan A and writing a master's thesis. Offered Fall, Spring, Summer.

BIO 779 Cr.1-2

**Biology Laboratory Assistant**
Allows graduate students to gain experience in assisting with preparation and teaching 300 and 400 level laboratory-based courses in conjunction with the regular instructor. Students will be expected to assist in preparation of course materials, demonstrate proper techniques, and evaluate students' performance. Repeatable for credit - maximum three. Lab. 2-6. Prerequisite: graduate standing. Not applicable to students assisting in 100 or 200 level courses. Consent of instructor. Offered Fall, Spring.

BIO 799 Cr.1-9

**Research: Master's Thesis**
Independent research on a problem selected for a thesis under the direction of an assigned staff member. For students following Plan A. Repeatable for credit - maximum 15. Maximum of six credits applicable to the M.S. in biology degree. Offered Fall, Spring, Summer.