

# DIVISION OF NATURAL AND HEALTH SCIENCES

## BIOLOGY

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<b>Monika G. Baldrige</b>	Assistant Professor
<b>Cynthia J. Horst</b>	Associate Professor
<b>Susan E. Lewis</b>	Professor
<b>Julie A. Rapps-Hedgcock</b>	Assistant Professor
<b>Eric T. Thobaben</b>	Assistant Professor

The biology program is home to three distinct majors: Biology, Clinical Laboratory Sciences (in partnership with the University of Wisconsin, Milwaukee) and Marine Sciences (in partnership with Hawaii Pacific University). Each major provides students with an excellent foundation in the life sciences that can lead to professional careers, graduate study, or professional school (e.g., medical, dental, or veterinary school). The requirements for the Biology major are described below. The Clinical Laboratory Sciences and Marine Sciences programs are described in other parts of the catalog.

### Learning Outcomes for Biology

Students in the biology program will receive training in how to:

- Think critically about biology
- Understand basic biological principles
- Communicate biological information
- Consider ethical implications
- Develop career awareness
- Understand experimental design
- Execute empirical procedures
- Develop life skills

Students in the biology program may apply for graduation with program honors if they complete the following requirements:

GPA, Biology courses: 3.6 or higher

GPA, Overall: 3.4 or higher

Presentation of research project results at a regional or national meeting

(e.g., BBB or Wisconsin Academy of Sciences) or submission of a manuscript to a peer-reviewed journal

Demonstrated commitment to the biology profession, broadly defined, above and beyond that of the average student. Evidence of such commitment will come from one or more of the following:

- Active membership in Beta Beta Beta, the Biological Honor Society
- Active membership in a professional/scholarly organization related to biology (e.g., Ecological Society of America, American Society for Microbiology, etc.)
- Significant educational activity/outreach (e.g., tutoring, mentoring) at the university or other level.

- Consistent and sustained volunteer activity in an organization working on environmental, health, or other issues relevant to biology.
- Significant research activity separate from or above and beyond the capstone.
- Sustained activity in science-related policy/consulting in communication, journalism, government, public policy, business, industry or education.

Applications will be available in spring semester each year and will be reviewed by faculty.

### **Fees**

Specific courses that require use of transportation, equipment or disposable supplies are assigned a course fee.

## **Biology Major Bachelor of Science**

The biology major is designed to give students excellent preparation for graduate study or professional careers in the life sciences. Within the major, students select one of several emphases (e.g., pre-medicine, pre-physical therapy, secondary education, animal behavior) that best matches their particular interests and career goals. All students have opportunities to develop excellent research skills beginning in the core courses and culminating in the capstone research project.

### **Core Courses**

Biology 150, Organismal Biology I

Biology 160, Organismal Biology II

Biology 250, Introduction to Genetics

Biology 260, Introduction to Ecology and Evolution

Note: BIO 250 and 260 may be taken in either order

Biology 396, Capstone: Introduction to Biological Problem Solving

### **Required Support Courses (\*Required for primary majors only)**

Chemistry 109 and 110

Mathematics 112, or Mathematics 140 or higher\*

Computer Science 107 or higher\*

Plus completion of an emphasis, as listed below

### **General Biology Emphasis**

#### **Core courses, plus**

Five elective courses in Biology (minimum 18 credits above the 100-level; at least

2 electives must be 300 level or higher, excluding Biology 380 - Internship)

Biology 496, Biological Problem Solving I

Biology 497, Biological Problem Solving II

### **Pre-Medical, Pre-Dental, Pre-Veterinary, Healing**

#### **Core courses, plus**

Five elective courses in Biology (minimum 18 credits above the 100-level; at least

2 electives must be 300 level or higher, excluding Biology 380 - Internship)

Biology 496, Biological Problem Solving I

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Biology 497, Biological Problem Solving II

Chemistry 203, 204, Organic Chemistry (Pre-Med, Pre-Dent) or

Chemistry 203, Organic Chemistry and Chemistry 308, Biochemistry (Pre-Vet)

Physics 101, 102, Introductory Physics

Students may need additional courses as required by the specific professional school. Pre-professional students should consult with the appropriate pre-professional adviser regarding requirements.

### **Pre-Physical Therapy Emphasis**

#### **Core courses, plus**

Biology 322, Comparative Anatomy and five elective courses in Biology (minimum 16 credits above the 100-level; at least 8 credits must be 300 level or higher, excluding Biology 380 - Internship)

Physics 101, 102, Introductory Physics

Note: For students who do not enter Carroll's DPT program, Biology 496, Biological Problem Solving I and Biology 497, Biological Problem Solving II are also required. Pre-PT students may need to take additional courses as required by the specific professional school.

### **Secondary Education Emphasis**

#### **Core courses, plus**

Biology 212, Microbiology

Biology 322, Comparative Anatomy

Biology 301, Animal Physiology

Biology 360, Aquatic Ecology or

Biology 370, Terrestrial Ecology

One elective course in Biology (2-4 credits; 300 level or higher, excluding Biology 380 - Internship)

Biology 496, Biological Problem Solving I

Biology 497, Biological Problem Solving II

Students should be prepared to demonstrate mastery of biological concepts on the ETS Praxis II exam, required for licensure.

### **Animal Behavior Emphasis**

#### **Core courses, plus**

Psychology 240, Biopsychology

Biology 360, Aquatic Ecology or

Biology 370, Terrestrial Ecology

Biology 380, Internship in Biology

Biology 417, Behavioral Ecology

Biology 496, Biological Problem Solving I

Biology 497, Biological Problem Solving II

One elective course in Biology (2-4 credits; 300 level or higher, excluding Biology 380 - Internship)

Plus Psychology Minor (20 credits):

Psychology 101, Introductory Psychology plus a minimum of four additional courses, including Psychology 205, Statistics and Experimental Design and Psychology 314, Learning and Animal Behavior

### **Human Biology Emphasis**

**Core courses, plus**

Biology 301, Animal Physiology or  
Biology 403, Human Physiology  
Biology 496, Biological Problem Solving I  
Biology 497, Biological Problem Solving II

Four elective courses (minimum 14 credits), with at least one course 300-level or higher, from the following:

Biology 212, Microbiology  
Biology 224, Bioethics  
Biology 314, Histology  
Biology 321, Developmental Biology  
Biology 402, Human Anatomy  
Biology 412, Advanced Microbiology  
Biology 432, Gene Manipulation and Genomics Biology  
Biology 452, Cell Biology  
Biology 471, Immunology

### **Biology Minor**

Biology 150, Organismal Biology I  
Biology 160, Organismal Biology II  
Biology 250, Introduction to Genetics or  
Biology 260, Introduction to Ecology and Evolution  
Two Elective Courses in Biology (2-4 credits 200-level or higher; 4 credits 300 level or higher)

### **Human Biology Minor**

Biology 130, Introduction to Human Anatomy and Physiology I and Biology 140, Introduction to Human Anatomy and Physiology II or  
Biology 150, Organismal Biology I and Biology 160, Organismal Biology II  
Biology 212, Microbiology or  
Biology 224, Bioethics  
Biology 402, Human Anatomy,  
Biology 403, Human Physiology

#### **100. Introductory Human Biology**

**L2**

**4 credits**

The basic principles and concepts of biology are presented in this course with an emphasis on human biology. Cellular function, genetic and developmental concerns, and physiological regulation are studied throughout the semester. Four hours of lecture/discussion and one three-hour laboratory. (Required course fee) (*Fa, Su*)

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### 130. Introduction to Human Anatomy and Physiology I 4 credits

This is the first of two courses which present the unifying concepts of anatomy and physiology required for understanding the human body as a structural and functional unit. This course emphasizes the mechanisms that underlie the normal functions of cells, tissues, organs, and organ systems. This course includes the study of basic biochemistry and inheritance and the structure and function of the integumentary, skeletal, muscular, nervous and endocrine systems. Four hours lecture and three hours laboratory. (Required course fee) (*Fa, Su*)

### 131. Human Genetics L1, L2 4 credits

This course will introduce non-science majors to human genetics and the scientific way of knowing. Students will learn how DNA determines traits and how traits are inherited. Students will also learn how modern genetic technologies influence the products we buy, our health and, potentially, our genetic futures. The relationship between the scientific method and our understanding of human genetics will be stressed and students will have the opportunity to propose and perform an experiment of their own design. Four hours of lecture/discussion and one three-hour laboratory. (Required course fee) (*Sp*)

### 140. Introduction to Human Anatomy and Physiology II 4 credits

This is the second of two courses which present the unifying concepts of anatomy and physiology required for understanding the human body as a structural and functional unit. This course includes the study of the structure and function of the cardiovascular, lymphatic, immune, respiratory, digestive, urinary and reproductive systems. A body systems approach is used to emphasize the interrelationships between structure and function of the gross and microscopic levels of organization of the human body. Four hours lecture and three hours laboratory. (Required course fee) (*Sp, Su*)  
Prerequisite: BIO 130 or equivalent is strongly recommended.

### 150. Organismal Biology I L1, L2 4 credits

This course is designed to introduce the student to the structure and function of the biomes within which organisms live, and the living organisms themselves: their needs and the means of meeting these needs, their basic classification, and an evolutionary survey of plants and fungi. Four hours of lecture/discussion and one three-hour laboratory. (Required course fee) (*Fa*)

### 160. Organismal Biology II L1, L2 4 credits

This course is designed to introduce the student to the structure and function of cells, basic genetic mechanisms, the structure and function of animals and plants: their needs and the means of meeting these needs, and an evolutionary survey of animals. Four hours of lecture/discussion and one three-hour laboratory. (Required course fee) (*Sp*) Prerequisite: BIO 150.

### 200H. Human Biology: Health and Disease L2 4 credits

This honors course is intended to generate understanding of basic biochemistry, cell biology, select human anatomy and physiology, and genetics and then to allow students to use this understanding to delve deeper into biomedical topics. Students build their literacy in the field of biomedical science and then use this literacy to independently

investigate, learn about, and then share practical information about current topics related to cancer, cardiovascular disease, and the role of genetics in medicine. A primary objective of this course is to improve students' ability to access scientific information and use this information to make informed decisions regarding personal and social health issues. BIO 200H can not be counted as an elective course for a biology or human biology major. Four hours of lecture/discussion and one three-hour laboratory. (Required course fee) (*Fa, odd years*)

**212. Microbiology****4 credits**

This course examines the fundamentals of microbiology (structure, metabolism, genetics, and growth) and surveys the microbial world. The interaction between microbe and host, and the diseases caused by microbes is examined. Four hours of lecture/discussion and two two-hour laboratory periods. (Required course fee) (*Fa, Sp, Su*) Prerequisites: BIO 130 or 150; CHE 102 or 110 or concurrent registration; or consent of the instructor.

**219. Field Botany****4 credits**

This course emphasizes field identification of local plant species. Students will become proficient in the use of taxonomic keys, plant preservation, and the classification and ecology of plants. Daily field trips will be combined with lectures and laboratory activities. Because this is a field course, students should be prepared for moderately strenuous exercise in a variety of weather conditions. (*Su, even years*)

**224. Bioethics****L7****4 credits**

An interdisciplinary course dealing with the problems and conflicts created by the impact of biological research and other technological advances on human values. Encounter with these conflicts in an attempt to approach some resolution is the goal of this course. (*Fa, Su*)

**250. Introduction to Genetics****4 credits**

This course will introduce students to the fields of cell biology and genetics. Students will gain an understanding of the synthesis and function of cellular components, the organization and function of genetic material, and Mendelian genetics. Students will have the opportunity to propose and perform an experiment of their own design. Four hours of lecture/discussion and one three-hour lab. (Required course fee) (*Fa, Sp*) Prerequisites: BIO 160 and CHE 109, or consent of instructor. Note: BIO 250 and BIO 260 may be taken in either order.

**260. Introduction to Ecology and Evolution****4 credits**

This course investigates the mechanisms of biological evolution and how these mechanisms shape and are shaped by the ecology of organisms, populations, and communities. Students will learn the theoretical foundations of ecology and evolution, as well as practical applications such as what factors influence human population growth, why small population size threatens many species, or how agriculture and forestry impact terrestrial and aquatic ecosystems. The course will involve lecture, discussion of case studies, and laboratory and field investigations. (Required course fee) (*Fa, Sp*)

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Prerequisites: BIO 150 and BIO 160; or consent of instructor. Note: BIO 250 and BIO 260 may be taken in either order.

### 273. Hematology and Phlebotomy

4 credits

An introduction to the science of hematology and phlebotomy. Topics include origin and development of blood cells and their biochemistry, physiology and pathology. Laboratory includes microscopic examination of normal and abnormal erythrocytes and leukocytes morphology, as well as manual assays pertinent to clinical hematology. Four hours lecture/discussion and three hours of laboratory. Note: This course can not be used to satisfy requirements for the Biology major. (Required course fee) (*Sp, odd yrs*) Prerequisite: BIO 130 and BIO 140.

### 301. Animal Physiology

4 credits

A comprehensive study of animal function. Organ and system physiological activity is related to basic cellular phenomena: surface membrane activity, energy requirements, intermediary metabolism, nutritional requirements, etc. Current research methods are emphasized. Four hours of lecture/discussion, one three-hour laboratory period. (Required course fee) (*Sp*) Prerequisites: BIO 250 or BIO 260; CHE 110 or consent of instructor. Students cannot count both BIO 301 and BIO 403 towards the biology major.

### 314. Histology

4 credits

Microanatomy of tissues. Four hours of lecture/discussion and one three-hour laboratory period. (Required course fee) (*Fa, odd yrs*) Prerequisite: BIO 212 or BIO 250 or BIO 260.

### 321. Developmental Biology

4 credits

Study of morphogenesis of selected animal and plant species at the molecular, cellular, tissue, organ, and organ system levels, with emphasis on vertebrate systems. Four hours of lecture/discussion and one three-hour laboratory. (Required course fee) (*Fa, even yrs*) Prerequisite: BIO 250.

### 322. Comparative Anatomy

4 credits

This course examines the anatomical similarities and differences among seven vertebrate classes. Ontogeny and phylogeny of the vertebrates are related to structure and function. Adaptive changes vertebrates have undergone during evolution will be emphasized. Four hours of lecture/discussion and two 2-hour laboratory periods. (Required course fee) (*Sp, even years*) Prerequisite: BIO 260 or consent of instructor.

### 332. Gene Manipulation and Genomics

4 credits

Introduces students to the fields of gene manipulation and genomics through an integrated laboratory/lecture/discussion approach. Students will gain hands-on experience with the basic methods, the biological basis for those methods, and a practical understanding of how they are applied in the fields of medicine, basic science research, environmental science, ethics, and law. (Required course fee) (*Fa, even yrs*) Prerequisite: BIO 250.

**350. Endocrinology****4 credits**

The structural and functional classification of hormones, principles of hormone action, and the regulation of body functions by the endocrine system are presented. Special emphasis is placed on species differences and evolutionary changes in some selected hormone systems as they relate to homeostasis. Small group discussions, clinical cases, and research article presentations are included. (*Sp, odd years*) Prerequisites: BIO 250 and CHE 110; junior or senior standing or instructor consent.

**360. Aquatic Ecology****4 credits**

An advanced ecology course that builds upon the prerequisite BIO260 – Ecology and Evolution. This course explores the basic ecology of wetlands, lakes, and streams and is a companion course to BIO370 – Terrestrial Ecology. Students will examine physical and chemical processes that are largely responsible for the biological responses evident in these different habitat types. The lecture component draws about half of its material from the textbook with the other half relying heavily upon peer reviewed scientific literature. Laboratory activities (a three-hour laboratory is part of the course) further examine and reinforce ecological concepts derived from lecture and readings. (Required course fee) (*Sp, odd yrs*) Prerequisite: BIO 260.

**370. Terrestrial Ecology****4 credits**

An advanced ecology course that builds upon the prerequisite BIO260 – Ecology and Evolution. This course explores the basic ecology of forests, deserts, tundra, and savannas and is a companion course to BIO360 – Aquatic Ecology. Students will examine physical and chemical processes that are largely responsible for the biological responses evident in these different habitat types. The lecture component draws about half of its material from the textbook with the other half relying heavily upon peer reviewed scientific literature. Laboratory activities (a three-hour laboratory is part of the course) will further examine and reinforce ecological concepts derived from lecture and readings. (Required course fee) (*Fa, odd years*) Prerequisite: BIO 260.

**371. Winter Ecology of Wolf and Lynx****3 credits**

This course is taught at the Audubon Center of the North Woods (ACNW) in Sandstone, MN. The focus will be the gray wolf, lynx and the white-tailed deer, but all animals directly or indirectly associated with or affected by these predators or prey may be included. The course is field-oriented and includes opportunities for backcountry travel, wildlife observation and tracking, as well as an introduction to habitats, how wildlife respond to natural and artificial disturbance, and human factors. Additional topics include wildlife research techniques, data acquisition and analysis, as well as management practices. (*Wn*) (Tuition is paid directly to ACNW; an additional fee for Carroll credit will apply. See Dr. Susan Lewis for more details.)

**380. Internship in Biology****1-4 credits**

A program of placement in industry, hospital, field, health agency, laboratory, school, etc., for on-the-job experience and observation. Program approval required prior to registration. Four credits maximum will apply toward the major. (*Fa, Sp, Su*)

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### **BIO 385/NCEP 305. Reefs, Rainforests and Ruins of Belize L1,L2 4 credits**

This course focuses on tropical reef biology and rainforest ecology. While in Belize, students explore the world's second largest barrier reef and trek through a tropical rainforest to observe bullet trees, howler monkeys and exotic birds. While at these sites, students design and perform investigative experiments to gain an understanding of the scientific method. In addition, students experience the ancient Mayan civilization visiting the ruins at Lamanai, and Tikal. Students are introduced to these topics in Fall semester followed by a three-week experience in Belize in Winter term. (*Fa, even yrs; Wn, odd yrs*)

### **396. Capstone: Introduction to Biological Problem Solving 2 credits**

A team-taught course on principles and practices of biological investigation. Students are taught the basic skills needed to plan and initiate a biological investigation including problem identification, information science, and considerations of instrumentation, experimental design and analysis. Working in close cooperation with a faculty mentor, students will familiarize themselves with a specific biological problem and prepare a formal research proposal in preparation for BIO 496 and 497. In addition to regular class meetings, students are required to attend seminars and laboratory meetings. (*Sp*) Prerequisite: Junior standing plus BIO 250 and BIO 260 (or BIO 212 for Human Biology majors) or consent of instructor.

### **402. Human Anatomy 4 credits**

The microanatomy and gross anatomy of muscle, bone and cartilage and the integumentary, nervous, cardiovascular, lymphatic, respiratory, renal, digestive, endocrine, and reproductive systems are studied. Using multi-media software, male and female bodies are dissected from anterior, posterior, medial, lateral, and medial/lateral views and histologies, radiologies, cross-sections, and MRIs are linked to the anatomy. Models are also employed to study the structure of the human body. In addition, palpation laboratories are integrated into the course. (Required course fee) (*Fa, Su*) Prerequisites: BIO 130 and 140 or BIO 150 and 160, plus junior standing. BIO 322 is strongly recommended.

### **403. Human Physiology 4 credits**

Fundamental concepts related to the normal function of the human body are presented. The normal functioning of the human body is discussed across gender, race, and life span. Basic pathophysiological concepts are introduced. Resources used include physiology laboratories, computer simulations, and videos. (Required course fee) (*Sp, Su*) Prerequisites: Junior standing, plus BIO 130 and 140 or BIO 150 and 160; CHE 110 or a C or better in CHE 101 and CHE 102. Note: Students cannot count both BIO 301 and BIO 403 toward the Biology major.

### **412. Advanced Microbiology 4 credits**

This course will present a study of biological entities collectively known as "Microbes" and include bacteria, viruses, protozoans, fungi and certain invertebrates. These organisms may be food sources at the bottom of the food chain, may be actually edible for humans or be involved in decomposition and recycling of nutrients for various food chains. A large number of these organisms, although a minority, are capable of causing

disease in other organisms including humans. We will investigate the properties of the biological entities including the structure, biochemistry, physiology, molecular biology and pathogenicity of various microbes. (*Sp, odd yrs*) Prerequisite: BIO 212 or BIO 250.

**417. Behavioral Ecology****4 credits**

Investigates the biological bases of animal behavior, focusing particularly on the evolution of social behavior in non-human animals. Theoretical foundations of the field as well as their practical applications are studied through lecture/discussion. Experience in experimental design and observation techniques are developed through studies of animal behavior. These experiences culminate in a final research project of the student's own design. Four hours lecture/discussion plus a three-hour laboratory. (Required course fee) (*Sp, odd yrs*) Prerequisite: BIO 260 or PSY 314; or consent of instructor.

**452. Cell Biology****4 credits**

Basic principles of cell physiology, molecular biology, biochemistry, and biophysics are studied in relation to the structure and function of cells and their organelles through an integrated laboratory/lecture/discussion approach. Four hours of lecture/discussion. (Required course fee) (*Sp, even yrs*) Prerequisite: BIO 250.

**460. Restoration Ecology****4 credits**

An interdisciplinary course that introduces students to the philosophy, theory, and practice of restoration ecology. Students will develop skills in all aspects of restoration ecology, including goal identification, site assessment, grant writing, and the planning, execution, monitoring, and evaluation of restoration projects. Laboratory activities center on visiting, evaluating, and participating in local restoration projects. Because the laboratory portion of the course is field-based, students should be prepared for moderately strenuous exercise in a variety of weather conditions. Four hours of lecture/discussion and one three-hour laboratory. (Required course fee) (*Sp, even yrs*) Prerequisite: BIO 260 or consent of the instructor.

**471. Immunology****4 credits**

Fundamentals of the immune system in the human body, including development, events of the immune response, immunological deficiencies, cancer immunology, autoimmune disease, and transplant biology. Modern techniques of immunoassay and clinical immunodiagnosis are covered. Four hours of lecture and one three-hour laboratory. (Required course fee) (*Fa, odd yrs*) Prerequisites: BIO 212, CHE 110.

**491. (or 291) Special Topics in Biology****1-4 credits**

Study of a selected topic not covered in regular course offerings. Lecture and discussion. The topic will be announced prior to registration. Four credits maximum will apply toward the major.

**496. Biological Problem Solving I****2 credits**

The first of two semesters of problem solving experiences with a faculty member selected by the student. During this semester students will initiate the investigation designed in BIO 396. Working in close cooperation with a faculty mentor, students will develop sufficient mastery of their system of interest to allow them to acquire data appropriate

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for the resolution of their specific problem. Students are required to spend a minimum of six hours per week in this experience under the direction of their faculty mentor. In addition, students are required to attend seminars and laboratory meetings. (Required course fee) (*Fa*) Prerequisite: BIO 396.

### 497. Biological Problem Solving II

2 credits

The second of two semesters of problem solving experiences with a faculty member. During this semester students will complete the investigation designed in BIO 396. Working in close cooperation with a faculty mentor, the student will complete data collection and analysis, and develop a final written report and poster presentation summarizing the investigation. Students are required to spend a minimum of six hours per week in this experience under the direction of their faculty mentor. In addition, students are required to attend seminars and laboratory meetings. (*Sp*) Prerequisite: BIO 496.

### 498. (or 398) Independent Study

1-4 credits

Independent study of selected areas in biology under supervision of a faculty member. Usually does not involve laboratory work. Four credits maximum will apply toward the major. Prerequisite: Approval of the divisional dean and consent of the instructor.

### 499H. Honors Biological Problem Solving

2 credits

The second of two semesters of problem solving experiences with a faculty member. During this semester students will complete the investigation designed in BIO 396. Working in close cooperation with a faculty mentor, the student will complete data collection and analysis, and develop a final written report summarizing the investigation. Students are strongly encouraged to present their results at a regional or national scientific meeting. Students are required to spend a minimum of six hours per week in this experience under the direction of their faculty mentor. In addition, students are required to attend seminars and laboratory meetings. (*Sp*) Prerequisite: BIO 496.