The Biology Program will transform students into biologists with enhanced skills in critical thinking and scientific reasoning. Students will learn in an environment that fosters creativity, independent thinking, and the application of knowledge in the biological sciences. When biology students graduate from Carroll University, they will have the confidence and skills necessary to be successful professionals in a dynamic work force.

The biology major is designed to give students excellent preparation for graduate study or professional careers in the life sciences, including molecular biology, physiology, field biology, research, teaching, dentistry, medicine, physical therapy, physician assistant, or veterinary medicine. All students have opportunities to develop excellent research skills throughout the core courses and upper-level biology electives, and many students collaborate with biology faculty on their current scholarly research.

**Learning Outcomes for Biology**

As students progress through the biology major, they will strengthen their abilities to:

1. Learn how to learn.
2. Read scientific literature.
3. Understand basic biological principles.
4. Apply knowledge to new situations.
5. Analyze complex issues.
6. Synthesize their understanding of diverse concepts.
7. Effectively conduct research.
8. Effectively communicate scientific information.
9. Understand and apply ethical principles.
10. Focus their career options.

Students in the Biology program may be considered 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 a disciplinary society) 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.

The Biology faculty will review these requirements for all graduating seniors in the spring semester of each year.

**Fees**

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

**Biology Major**

**Bachelor of Science**

**Core Courses**
- Biology 120, General Biology I
- Biology 125, General Biology II
- Biology 220, Genetics
- Biology 225, Organismal Physiology
- Biology 399, Capstone in Biological Science

**Four Elective Courses**

Including at least one course from each area listed below: Ecological, Organismal, and Cellular/Molecular. Biology 324, Bioethics, may be counted as a fourth elective course.

**Ecological**
- Biology 319, Field Botany
- Biology 333, Experimental Methods in Field Biology
- Biology 360, Aquatic Ecology
- Biology 417, Behavioral Ecology
- Biology 460, Restoration Ecology

**Organismal**
- Biology 322, Comparative Vertebrate Zoology
- Biology 350, Endocrinology
Biology 402, Human Anatomy
Biology 403, Human Physiology

**Cellular/Molecular**
Biology 312, Microbiology
Biology 332, Gene Manipulation and Genomics
Biology 452, Advanced Cell Biology

**Required Support Courses (*Required for primary majors only)**
Chemistry 109, 110, and 203
Computer Science 107 or higher*
Mathematics 112, or Mathematics 140 or higher*
One of the following: Chemistry 204, Chemistry 308, or Physics 101

**Pre-Dental, Pre-Medical, Pre-Physician Assistant, Pre-Physical Therapy, and Pre-Veterinary**
Students preparing for pre-professional programs must complete the requirements in the Biology major as well as some of the following courses as appropriate for the specific professional program:

Chemistry 204, Organic Chemistry II
Chemistry 308, Biochemistry
Mathematics 112, Introduction to Statistics
Mathematics 160, Calculus I
Physics 101, 102, Introductory Physics
Psychology 101, Introductory Psychology
One English writing course beyond English 170, Writing Seminar

It is the responsibility of each pre-professional student to compile a list of schools and their admittance requirements related to the courses listed above. Pre-professional students should then consult with the appropriate pre-professional advisor to ensure that the requirements will be met prior to graduation.

**Secondary Education**
To meet DPI requirements, Biology majors with a secondary education minor must complete the following courses:

**Core Courses, plus**
Biology 312, Microbiology
Biology 322, Comparative Vertebrate Zoology
Biology 333, Experimental Methods in Field Biology
One elective course in Biology (see Electives under Biology Major)

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

Biology Minor

Biology 120, General Biology I
Biology 125, General Biology II
Biology 220, Genetics
Biology 225, Organismal Physiology
Two elective courses in Biology (see Electives under Biology Major above)

BIO 100. Introductory Human Biology 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 three hours laboratory. (Required course fee) (Sp, Su)

BIO 120. General Biology I N1 4 credits
This course investigates the origins and diversity of life and how organisms interact with each other and their environment. Students will learn how evolutionary principles provide the foundation for understanding life throughout Earth’s history. Case studies and student research during laboratory will develop the ability of students to apply their knowledge of how organisms interact at different biological scales. This is the first course in the Biology major and is traditionally challenging for non-science majors. Four hours lecture/discussion and three hours laboratory. (Required course fee) (Fa)

BIO 125. General Biology II 4 credits
This course investigates the structure, function, and biochemistry of cells. Students will learn how evolutionary principles provide the foundation for understanding the cellular processes that support life. Case studies and student research during laboratory will develop the ability of students to apply their knowledge of how underlying cellular processes explain complex organismal functions. Four hours lecture/discussion and three hours laboratory. (Required course fee) (Sp) Prerequisite: BIO 120.

BIO 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)

BIO 131. Human Genetics N1 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 lecture/discussion and three hours laboratory. (Required course fee) (Fa)

BIO 140. Introduction to Human Anatomy and Physiology II 4 credits
This is the second of two courses that 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.

BIO 212. Introduction to 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 laboratories. (Required course fee) (Fa, Sp, Su) Prerequisites: BIO 130; CHE 102 or concurrent registration; or instructor consent.

BIO 220. Genetics 4 credits
This course investigates molecular, classical and population genetics. Students will learn how evolutionary principles are based on genetic processes. Case studies and student research during laboratory will develop the ability of students to apply their understanding of genetic mechanisms at different biological scales. Four hours lecture and three hours laboratory. (Required course fee) (Fa) Prerequisite: BIO 125.

BIO 225. Organismal Physiology 4 credits
This course investigates the diverse form and function of plants and animals. Students will learn how evolutionary principles provide the foundation for understanding how organisms meet specific physiologic challenges. Case studies and student research during laboratory will develop the ability of students to apply their understanding of physiologic mechanisms in diverse organisms. Four hours lecture and three hours laboratory. (Required course fee) (Sp) Prerequisite: BIO 220.

BIO 271. Clinical Immunology 4 credits
This course covers the theory and application of immunology. Students will learn about the development and function of the immune system including immune responses, antigen-antibody reactions, intercellular communication, and autoimmune and immunodeficiency disorders. The course will emphasize the principles and performance of protocols in cellular immunology, immunochemistry, and clinical serology. Four hours lecture and three hours laboratory. (Required course fee) (Fa, odd years) Prerequisites: BIO 140 and CHE 102.

BIO 312. 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 organ-
isms 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) Prerequisite: BIO 220 or instructor consent. Students cannot count both BIO 212 and BIO 312 towards the biology major.

BIO 319. 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 lecture/discussion 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) Prerequisite: BIO 225 or ENV 201, or instructor consent.

BIO 322. Comparative Vertebrate Zoology 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 lecture/discussion and three hours of laboratory. (Required course fee) (Fa) Prerequisite: BIO 225 or instructor consent.

BIO 324. Bioethics P1 4 credits
This course explores contemporary topics in biomedical ethics through an understanding of foundational biological principles and multiple ethical perspectives. Students critically read, analyze, and discuss essays that contrast viewpoints on bioethical topics. Improvement of student writing is emphasized (Fa, Sp, Su) Prerequisite: Sophomore standing.

BIO 332. Gene Manipulation and Genomics 4 credits
This course 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 years) Prerequisite: BIO 220 or instructor consent.

BIO 333. Experimental Methods in Field Biology 4 credits
This course will explore the diversity of methods used in field biology while further developing student understanding of ecological and evolutionary processes relevant to field biology. Course readings will draw heavily on primary literature. Four hours lecture/discussion and three hours laboratory. (Required course fee) (Fa) Prerequisite: BIO 225 or ENV 201, or instructor consent.
BIO 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, research article presentations, and grant writing are included. (Sp) Prerequisite: BIO 225 or instructor consent.

BIO 360. Aquatic Ecology  
4 credits
An advanced ecology course that builds upon the Biology core courses. This course explores the basic ecology of wetlands, lakes, and streams. 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) Prerequisite: BIO 225 or ENV 201, or instructor consent.

BIO 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.)

BIO 399. Capstone in Biological Science  
4 credits
This course allows students to synthesize their understanding of biology through exploration of contemporary issues in biology across multiple biological scales. Students will also explore case studies related to ethical practice in science and develop skills necessary to transition to future careers in biology. Four hours lecture/discussion, may be taught in a hybrid format. (Fa, Sp) Prerequisites: Junior standing; BIO 225.

BIO 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: Junior standing; BIO 225 or BIO 130 and 140; or instructor consent.
BIO 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; BIO 225 or BIO 130 and BIO 140; and CHE 110 or CHE 101 and CHE 102.

BIO 417. Behavioral Ecology 4 credits
This course investigates the biological bases of animal behavior, focusing particularly on the evolution of social behavior in nonhuman 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 and three hours laboratory. (Required course fee) (Fa) Prerequisite: BIO 225 or instructor consent.

BIO 452. Advanced Cell Biology 4 credits
In this course, 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 lecture/discussion and three hours laboratory. (Required course fee) (Fa) Prerequisite: BIO 220 or instructor consent.

BIO 460. Restoration Ecology 4 credits
This interdisciplinary course introduces students to the philosophy, theory, and practice of restoration ecology. Students will develop skills in all aspects of restoration ecology, including different views of nature, conflict resolution, goal identification, the planning and evaluation of restoration projects, and grant writing. Community assembly theory serves as an overarching model for understanding the process of restoration. Four hours of lecture/discussion. (Sp, even yrs) Prerequisite: BIO 225 or ENV 201, or instructor consent.

BIO 480. (or 380) Internship in Biology 1-4 credits
This internship places students in industry, hospital, field, health agency, laboratory, school, or other professional settings to obtain on-the-job experience and develop skills relevant to future career opportunities. The BIO 480 Internship differs from the BIO 380 Internship because it incorporates application of research-based skills to the internship experience. Prerequisites: BIO 225 and instructor consent.

BIO 485. Independent Research in Biology 1-4 credits
This experience involves independent laboratory or field-based research of selected areas in biology under supervision of a faculty member. Students will develop sufficient mastery of their system of interest to allow them to acquire data appropriate for resolution of their specific problem. Prerequisite: Instructor consent.
BIO 491. (or 291) Special Topics in Biology 1-4 credits
This course is a study of a selected topic not covered in regular course offerings. Lecture and discussion. The topic will be announced prior to registration.

BIO 498. (or 398) Independent Study 1-4 credits
This experience involves independent study of selected areas in biology under supervision of a faculty member that generally does not involve laboratory work. Prerequisite: Approval of the department chair and instructor consent.