

# BIOLOGY

## Departmental Guidelines

The Department of Biology endeavors to provide a comprehensive foundation in concepts and skills across the breadth of biology. This is achieved in part through an introductory core of three courses that prepare students for a deep exploration of sub-disciplines and research methods through subsequent advanced courses. The core covers the major concepts of biology, encompassing an exploration of the natural history of life on Earth, coupled with the basic skills of acquiring and processing information, solving problems, and analyzing data. Our program then allows students the flexibility to explore specific areas of biology in depth through a suite of advanced courses in which they can expand and apply their knowledge and skills.

The major prepares students for careers in science and related fields, as well as graduate and professional schools (including pre-medical, pre-dental and pre-veterinary studies), while allowing students the flexibility to design the program that best suits their specific interests and career goals. In addition, biology majors are offered the opportunity to collaborate with faculty in research and laboratory instruction, to present exceptional work at professional meetings, and to assist in the maintenance of the 350-acre Biological Reserve and other departmental facilities. Information on studies in Pre-Health is provided in the "Special Programs and Opportunities" section of the catalog.

Writing is an integral component of science, and as such, the Biology Department understands that the development of writing skills is essential for all students who pursue the study of biology. The goal for our students is that they emerge as strong writers, able to construct cohesive bodies of written work in which they express clear, concise and logical arguments, supported by empirical evidence and/or information from appropriate sources. A developmental model of writing skills is tightly woven into the biology curriculum to achieve this goal. Our major core curriculum establishes the foundation of good writing practices. Basic grammatical expression is addressed in BIOL 210 - Molecular Biology and Unicellular Life, while BIOL 220 - Multicellular Life focuses on understanding the format of biological literature, culminating in BIOL 230 - Ecology and Evolution, where students write multiple full-length papers. Taken sequentially, BIOL 220 - Multicellular Life and BIOL 230 - Ecology and Evolution serve as one of the W requirements for general education. In our advanced curriculum, students continue to explore more sophisticated levels of writing, including employing distinct disciplinary conventions and engaging with different genres applicable to biological writing. Students who undertake a senior research project write a comprehensive thesis of their work (counting as an additional W requirement), putting into practice the many writing skills that they have developed throughout the curriculum.

## Mission Statement

The Department of Biology seeks to provide a supportive and rigorous intellectual environment in which students actively engage the breadth and depth of biology and participate in the scientific process, with the goal of empowering students to be independent and critical thinkers who are prepared to address broader societal issues related to the natural world.

## Faculty

Associate Professor Lina I. Yoo, Chair

Professors Rebecca Homan, Jessica E. Rettig, Heather J. Rhodes, Geoffrey R. Smith, Jeffrey S. Thompson; Associate Professors Cristina Caldari, Warren D. Hauk, Ayana Hinton, Clare C. Jen, Andrew C. McCall, Laura A. Romano, Christine L. Weingart; Assistant Professors Tessa Carrel, Solomon Chak, Susan Villarreal; Visiting Assistant Professor Joy Dorsten

### Academic Administrative Assistant

Jenny Etz

### Academic Lab Safety and Facilities Manager

John Grossenbacher

### Laboratory Manager

Kim Pinkerton

### Bioreserve Manager

Josh Cherubini

View faculty profiles and contact information (<https://denison.edu/academics/biology/contacts/>)

## Biology Major

### Requirements for Biology Majors

Students can pursue either a B.A. or B.S. degree in Biology (distinctions between the two degrees are outlined below). For either degree, students should aim to complete the three Biology core courses by the end of their second year: BIOL 210 - Molecular Biology and Unicellular Life, BIOL 220 - Multicellular Life, and BIOL 230 - Ecology and Evolution. Students who have completed comparable course work at other accredited institutions may petition to have such courses transferred to Denison and credited toward the major, at the discretion of the department. In contrast, students with credit-earning scores on Advanced Placement (4 or 5) or International Baccalaureate (6 or 7) tests in Biology will be granted academic credit for BIOL 100 - Modern Topics in Biology, but typically will be required to complete all three major core courses.

Majors must achieve a grade point average of 2.0 or higher across the three core courses (BIOL 210 - Molecular Biology and Unicellular Life, BIOL 220 - Multicellular Life, BIOL 230 - Ecology and Evolution) upon completion of the core sequence before proceeding to 300-level elective courses. Students who do not meet the GPA requirement must repeat one or more core courses to achieve the standard; the highest grade awarded for any repeated core course will be exclusively used in calculating the "biology core GPA", but all biology grades will be used to calculate the overall major GPA for graduation, as per university policy. This policy applies only to students pursuing a biology major; it does not apply to students pursuing the biology minor or other non-biology degrees.

The major additionally requires two semesters of introductory level chemistry (CHEM 131 - Atoms and Molecules: Structure and Dynamics and CHEM 132 - Organic Structure and Reactivity; grades of C or better are strongly recommended). CHEM 131 - Atoms and Molecules: Structure and Dynamics must be completed before undertaking 300-level electives, but CHEM 132 - Organic Structure and Reactivity can be taken concurrently.

Biology majors subsequently complete five 300-level advanced courses. Any combination of advanced courses may be taken, but one of these electives must be designated a "biological diversity" course (see description below). BIOL 452 - Advanced Senior Research is credited as a 300-level course, but BIOL 361 - Directed Study, BIOL 362 - Directed Study, BIOL 363 - Independent Study, BIOL 364 - Independent Study,

and BIOL 451 - Senior Research are not counted as 300-level advanced courses toward the requirements for the major. Students are encouraged to consult with an advisor in the Biology Department in order to select the most appropriate suite of advanced courses.

Biology majors preparing for medical school or most graduate programs are additionally advised to take CHEM 251 - Intermediate Organic Chemistry, and CHEM 258 - Intermediate Biochemistry, PHYS 121 - General Physics I and PHYS 122 - General Physics II), and two semesters of college-level math (e.g., MATH 130 - Essentials of Calculus, MATH 135 - Single Variable Calculus, or MATH 145 - Multi-variable Calculus) or MATH 120 - Elements of Statistics). These courses can count toward the "science cognate" requirement that is part of the B.S. degree (see requirements below).

Lastly, students majoring in Biology must satisfactorily complete BIOL 300 - Biology Assessment I (core curriculum assessment exam taken during the term immediately following completion of the biology core) and BIOL 301 - Biology Assessment II (senior writing assessment and survey; administered during the final semester prior to graduating) in order to fulfill the requirements for the degree.

## Bachelor of Arts in Biology

The requirements for the Bachelor of Arts degree in Biology include a total of ten courses:

- three biology core courses (BIOL 210 - Molecular Biology and Unicellular Life, BIOL 220 - Multicellular Life, BIOL 230 - Ecology and Evolution),
- five 300-level biology courses (one of which must be a designated as a "biological diversity" course),
- and one year of introductory level chemistry (CHEM 131 - Atoms and Molecules: Structure and Dynamics and CHEM 132 - Organic Structure and Reactivity).

## Bachelor of Science in Biology

The requirements for the Bachelor of Science degree in Biology include a total of fourteen courses:

- three biology core courses (BIOL 210 - Molecular Biology and Unicellular Life, BIOL 220 - Multicellular Life, BIOL 230 - Ecology and Evolution),
- five 300-level biology courses (one of which must be designated a "biological diversity" course),
- one year of introductory level chemistry (CHEM 131 - Atoms and Molecules: Structure and Dynamics and CHEM 132 - Organic Structure and Reactivity),
- and four "science cognate" courses. The science cognate requirement is the lone distinction between the B.A. and B.S. degrees, serving as a means for B.S. majors to become more broadly trained in the sciences. Any non-biology course within the science division will count toward this requirement, as will any environmental studies (ENVS) science course, or Applied Anatomy HESS 202 - Applied Anatomy. Students are encouraged to select courses that "do" science, such as classes that include laboratory sections. No more than two courses within a single department or program can be used to fulfill this requirement (note that CHEM 131 - Atoms and Molecules: Structure and Dynamics and CHEM 132 - Organic Structure and Reactivity do not count toward the cognate requirement, nor do they count toward the "two courses per department" stipulation).

## Biology Minor

The requirements for the Biology Minor include a total of seven courses:

- three biology core courses
  - (BIOL 210 - Molecular Biology and Unicellular Life, BIOL 220 - Multicellular Life, BIOL 230 - Ecology and Evolution),
- three 300-level biology courses (one of which is a "biological diversity" course),
- and one semester of chemistry (CHEM 131 - Atoms and Molecules: Structure and Dynamics). CHEM 131 - Atoms and Molecules: Structure and Dynamics must be completed prior to undertaking 300-level electives. BIOL 452 - Advanced Senior Research is credited as a 300-level course, but BIOL 361 - Directed Study, BIOL 362 - Directed Study, BIOL 363 - Independent Study, BIOL 364 - Independent Study, and BIOL 451 - Senior Research are not counted as 300-level advanced courses toward the requirements for the minor.

## Additional Points of Interest

### Biological Diversity Courses

Courses that fulfill the biological diversity requirement emphasize the importance of scientific studies at the level of the whole organism. In these courses students gain a holistic perspective on the study of organisms, explore a variety of living forms through a broad survey of taxa, and evaluate the role of phylogenetic history in taxonomy. Students also use careful observation to learn morphology and diagnostic traits, identify organisms into meaningful taxonomic units, and learn the principles of scientific nomenclature. The biological diversity courses that are regularly offered include:

Code	Title
BIOL 308	Biodiversity Through Time
BIOL 312	Herpetology
BIOL 313	Vertebrate Zoology
BIOL 317	Diversity of Microorganisms
BIOL 320	Plant Systematics
BIOL 326	Plant Evolution and Reproduction
BIOL 327	Biology of Insects
BIOL 336	Invertebrate Zoology

### Off-Campus Study

Students may complement their major in biology through off-campus study. Denison University is a member of several consortia that offer course credit through off-campus programs. Those with course offerings relevant to Biology students include:

- the School for Field Studies,
- the Organization of Tropical Studies,
- the Duke University Marine Laboratory,
- the Semester in Environmental Science,
- the Oak Ridge National Laboratory,
- the Institute for Study Abroad,
- Denmark's International Study Program, and
- the Associated Colleges of the Midwest Wilderness Field Station.

The Department of Biology is committed to awarding credit for courses offered through these programs that provide a sufficient focus on biological concepts and methods (lecture and laboratory). With prior

approval from the department, a maximum of two off-campus courses may be counted toward the requirements of the major. The Richard C. and Linda G. Seale Scholarship provides support to qualified Denison students for participation in summer courses at the Duke University Marine Laboratory. Financial aid may be available for other off-campus programs.

## General Education Credit in Biology

Students receive a lab science general education requirement by completing nearly any course offered by the Biology Department. While the 200-level courses are generally recommended for Biology and related majors, non-majors are welcome to take the initial biology major core course (BIOL 210 - Molecular Biology and Unicellular Life), and they can also consider taking one of our non-majors courses. The various versions of Modern Topics in Biology (BIOL 100 - Modern Topics in Biology: lab science GE; BIOL 103 - Modern Topics in Biology: lab science and quantitative reasoning GEs), and BIOL 110 - Biology and Politics of Women's Health (lab science and oral communication GEs) are designed for students to explore scientific inquiry and biological concepts through specific topics in the instructor's area of expertise. In addition, students who have had extensive biology training in secondary school may petition the Biology department for BIOL 100 - Modern Topics in Biology credit without General Education credit. However, such petitions must be made before the completion of the student's third year at Denison.

## Advanced Placement

Students with credit-earning scores on Advanced Placement (4 or 5) or International Baccalaureate (6 or 7) tests in Biology will be granted academic credit for BIOL 103 - Modern Topics in Biology. However, as noted above, students granted such AP/IB credit typically will be required to complete all three major core courses for the major.

## Biology and Computational Science

Students with an interest in both Biology and Computational Science may pursue a major in Biology with a concentration in Computational Science. Students interested in this option should refer to the description of the Computational Science concentration in the Computer Science section of the catalog, and should consult with a faculty member early in planning their Denison curriculum.

## Biology and Environmental Studies

Students with an interest in both Biology and Environmental Studies may pursue a major in Biology with a minor in Environmental Studies, or a major in Environmental Studies with a concentration in biology. Students are advised to choose the program path that best suits their post-graduate goals, and to seek early consultation with faculty in Biology and/or Environmental Studies. Specifics regarding these options can be found in the Environmental Studies section of the catalog.

## Biology and Neuroscience

Students with an interest in both Biology and Neuroscience may pursue a major in Biology with a concentration in Neuroscience. Students interested in this option should consult with a Neuroscience faculty member early in their career. Specifics regarding this concentration can be found in the Neuroscience section of the catalog.

## Courses

### BIOL 100 - Modern Topics in Biology (4 Credit Hours)

This course for non-majors only is intended to promote scientific literacy. Topics will vary with the instructor, but each edition of the course will focus on a specific topic as a vehicle for exploring the essentials of biology and the scientific method. This course satisfies the G.E. lab science requirement. Biology 100 may not be counted toward the major or minor in biology. Three class periods and one laboratory weekly.

### BIOL 103 - Modern Topics in Biology (4 Credit Hours)

This course for non-majors is intended to promote scientific literacy and quantitative reasoning. Topics vary with the instructor, but each edition of the course will focus on a specific topic as a vehicle for exploring the essentials of biology and the scientific method. This course satisfies the G.E. lab science requirement as well as the quantitative reasoning requirement. Biology 103 may not be counted toward the major in biology. Three class periods and one laboratory weekly.

### BIOL 105 - Special Topics in Biology for Non-Majors (4 Credit Hours)

This course for non-majors only is intended to promote scientific literacy. Topics will vary with the instructor, but each edition of the course will focus on a specific topic as a vehicle for exploring the essentials of biology and the scientific method. This course satisfies the G.E. non-lab science requirement (Y). This course does not have an associated laboratory. Biology 105 may not be counted toward the major or minor in biology.

### BIOL 110 - Biology and Politics of Women's Health (4 Credit Hours)

This course examines critical conversations in the biology, politics, culture, and history of women's health. The nation's greatest health issues include, but are not limited to, unmanaged chronic conditions (including cardiovascular health), environmental health risks and cancer, racial and ethnic health disparities, women's reproductive and sexual health, and the epidemic of obesity. Barriers in healthcare delivery, at healthcare system and provider levels, exist for women, trans people, and non-binary people. Evaluating the complexities of these gendered health issues involves both scientific literacy and socio-cultural literacy. This course provides a fundamental understanding of how biological system structures and functions are related, specific to the female human body. The laboratory component of this course familiarizes students with the scientific method, feminist theory in science, and methods in women's health research. This course promotes proficiency in oral communication through practice in a variety of formats that typically occur in biology and women's and gender studies.

**Crosslisting:** WGST 110.

### BIOL 199 - Introductory Topics in Biology (1-4 Credit Hours)

A general category used only in the evaluation of transfer credit.

### BIOL 210 - Molecular Biology and Unicellular Life (4 Credit Hours)

This course, the first of the three-course biology majors core sequence, is designed to introduce students to principles of molecular and cellular biology, with an examination of both prokaryotic and eukaryotic unicellular species. Major themes that will be covered include molecular origins of life, bioenergetics, the molecular basis of genetic expression, and cellular reproduction. Coursework will be designed to train students in the scientific method; finding, reading, and understanding scientific literature; analyzing data; and communicating scientific research in written and oral formats. A weekly laboratory period will allow students to learn cellular and molecular biology techniques and carry out independent group research projects. Three class periods and one lab session per week. Offered Fall and Spring semesters. This course satisfies the Quantitative Reasoning GE requirement.

**Corequisite(s):** CHEM 131 is recommended (but is not required).

**BIOL 220 - Multicellular Life (4 Credit Hours)**

Multicellular Life is the second of a three course sequence for biology majors, minors, and some affiliated majors. It is an exploration of how multicellular organisms have evolved and adapted to the challenges of life including acquiring energy, responding to stimuli, regulating the internal conditions for physiological process, and reproduction. Representative examples will be taken from the Kingdoms of plants, animals, and fungi. Imbedded throughout the course are many of the skills expected of practicing biologists including the ability to develop hypotheses and analyze and interpret data, the ability to present scientific data, scientific writing, and a familiarity with the scientific literature. This course also is a writing intensive class within Denison's Writing Program. As such, students will receive instruction on writing within the context of the biological sciences and have multiple opportunities to develop and improve their writing skills. In conjunction with the subsequent completion of BIOL 230, students will fulfill one of the W overlay GE requirements. Can be taken concurrently with W101, but BIOL 230 must be completed in the sophomore year or later to fulfill a W GE requirement. Three class periods and one laboratory weekly.

**Prerequisite(s):** BIOL 210 or consent of the instructor.

**BIOL 230 - Ecology and Evolution (4 Credit Hours)**

Ecology and Evolution, the third and final course in the biology major core sequence, covers the fundamentals of both ecology and evolution. Emphasis is placed on understanding how organisms function and interact at the population, community, and ecosystem levels, and on understanding the mechanisms of micro- and macroevolution. Labs are designed to give experience in scientific reasoning and critical thinking, as well as designing, conducting, analyzing, and presenting scientific research. This course also is a writing intensive class within Denison's Writing Program. As such, students will receive instruction on writing within the context of the biological sciences and have multiple opportunities to develop and improve their writing skills. In conjunction with the prior completion of BIOL 220 and W 101, students completing this course in the sophomore year or later will fulfill one of the W overlay GE requirements. Three class periods and one laboratory weekly.

**Prerequisite(s):** BIOL 210 and BIOL 220, or consent of the instructor.

**BIOL 250 - Minor Problems (1,2 Credit Hours)**

A research problem (library or laboratory) of limited scope which provides the opportunity for the qualified student to extend his or her interest beyond the limits of particular course offerings. Does not count toward minimal department requirements.

**BIOL 299 - Intermediate Topics in Biology (1-4 Credit Hours)**

A general category used only in the evaluation of transfer credit.

**BIOL 300 - Biology Assessment I (0 Credit Hours)**

A pass/fail course used to track all biology majors' completion of the required assessment exam covering the Biology core. Earning the required S (pass) in this course entails attending an information session explaining the exam and taking the assessment exam in good faith.

**BIOL 301 - Biology Assessment II (0 Credit Hours)**

A pass/fail course used to track all biology major's completion of the required senior interview. Earning the required S (pass) in this course entails completing the senior interview in good faith. Seniors enroll in BIOL 301 in their last semester at Denison.

**BIOL 308 - Biodiversity Through Time (4 Credit Hours)**

An introduction to the study of fossil invertebrates with emphasis on preservation, taphonomy, diversity trajectories through geologic time, evolutionary mechanisms, extinction, paleobiology and paleoecology. Special emphasis will be placed on using fossils to interpret ancient depositional environments. Labs will introduce the student to the major invertebrate phyla commonly preserved in the geologic rock record. Normally offered Fall Semester in alternate years. Biodiversity Through Time qualifies as a "biological diversity" course for the major.

**Prerequisite(s):** EESC / GEOS 210 or BIOL core, and CHEM 131, or consent of instructor.

**BIOL 310 - Wetland Ecology (4 Credit Hours)**

This course is a comprehensive study of wetland ecology, management, and policy. The main emphasis is on biological, chemical, and physical aspects of major wetland ecosystems found in North America. The course also deals with valuation, classification, and delineation of wetlands. A significant portion of the course focuses on local and regional wetland ecosystems: their history, ecology, and current status. Labs will be field-based explorations of the biology, chemistry, and ecology of these regional wetlands.

**Prerequisite(s):** BIOL core or consent, and CHEM 131.

**Crosslisting:** SES 310.

**BIOL 312 - Herpetology (4 Credit Hours)**

Herpetology is the study of amphibians and reptiles, two diverse taxonomic groups that share the characteristic of being ectothermic vertebrates. This course will examine three main areas of herpetology: 1) the evolutionary relationships and biogeographical histories of these taxonomic groups, 2) comparative physiology, and adaptations of amphibians and reptiles to their natural environments, and 3) the ecology of the herpetofauna, as well as conservation issues, with a focus on amphibians. Emphasis will be placed on the critical reading of primary literature on both historical and current issues in herpetology, as well as on gaining hands-on experiences with amphibians and reptiles. Laboratories will include comparative studies of physiology and field studies of native Ohio amphibians and reptiles, making extensive use of the Denison University Biological Reserve. Herpetology qualifies as a "biological diversity" course for the major.

**Prerequisite(s):** Biology core or consent, and CHEM 131.

**BIOL 313 - Vertebrate Zoology (4 Credit Hours)**

In this course we investigate the biology of vertebrates. In particular, we will be considering the many ways in which vertebrates interact with and respond to their environment, and thus this course will emphasize the evolution, ecology, and physiology of vertebrates. Laboratories will focus on the biology of local vertebrates, and will consist of field and laboratory exercises, as well as field research projects. Vertebrate Zoology qualifies as a "biological diversity" course for the major and satisfies the Oral Communication requirement.

**Prerequisite(s):** Biology core or consent, and CHEM 131.

**BIOL 315 - General Microbiology (4 Credit Hours)**

This is an introductory course in microbiology emphasizing the general structure, occurrence, habitats, and types of bacteria, viruses, and eukaryotic microbes. Mechanisms of pathogenicity and host defense strategies also are discussed. The course structure includes small group activities, student presentations, traditional lectures, and discussions of scientific literature. Laboratory emphasis is placed on the fundamental techniques of microbiology (i.e., staining, microscopy, and streak plating) and self-designed investigative labs. Students may either take General Microbiology (BIOL 315) or Diversity of Microorganisms (BIOL 317) during their academic career, but not both courses.

**Prerequisite(s):** Biology core or consent, and CHEM 131, or CHEM majors - BIOL 210 and BIOL 220 and CHEM 300 (or concurrently).

**BIOL 316 - Virology (4 Credit Hours)**

This course will examine plant, animal, and bacterial viruses with an emphasis on molecular interactions between the host and virus, the genetics and chemical nature of viruses, and the replication strategies of viruses. This course also will examine how viruses impact our society through investigations of pathogenesis and epidemiology, and how they are used to help treat animal diseases. The structure of the course will provide peer learning activities, class discussions of primary literature, and traditional lectures. The structure of the laboratory will allow students to develop and test their own hypotheses while learning bacteriophage and tissue culture techniques.

**Prerequisite(s):** Biology core or consent, and CHEM 131, or CHEM majors - BIOL 210, and BIOL 220, and CHEM 300 (or concurrently).

**BIOL 317 - Diversity of Microorganisms (4 Credit Hours)**

This course examines the remarkable cellular, environmental, physiological, and metabolic diversity of prokaryotic and eukaryotic microorganisms. More specifically, diversity will be studied in terms of taxonomy and phylogeny, the ability of species to live in various environments, and the application of genomics. Emphasis will be placed on reading primary literature and using that information to make connections with course material. The structure of the course includes traditional lectures, in-class activities and a lab with self-designed experiments. Diversity of Microorganisms qualifies as a "biological diversity" course for the major and minor. Students may either take General Microbiology (BIOL 315) or Diversity of Microorganisms (BIOL 317) during their academic career, but not both courses.

**Prerequisite(s):** Biology core or consent, and CHEM 131 or CHEM majors - BIOL 210, and BIOL 220, and CHEM 300 (or concurrently).

**BIOL 320 - Plant Systematics (4 Credit Hours)**

In Plant Systematics students learn about evolutionary relationships of the major groups of vascular plants, with emphasis on the flowering plants. Using living plant material whenever possible, students examine both vegetative and reproductive morphology of plants, and develop and practice skills of organization, observation, decision-making, and memorization. Students engage with primary literature and writing through examining the history of classification of modern plant families. Field-based activities engage students in collecting, pressing, mounting, and keying local species. Understanding evolutionary relationships among modern plant families is a central theme. This course provides important background for students planning to do fieldwork in ecology, conservation, plant-animal interactions, environmental education, and related subjects. Plant Systematics fulfills the biological diversity requirement for the biology major and minor.

**Prerequisite(s):** Biology core or consent, and CHEM 131 or CHEM majors - BIOL 220, and BIOL 230 and CHEM 300 (or concurrently).

**BIOL 321 - Plant Ecology (4 Credit Hours)**

In this course we will explore how plants interact with their environments and with other organisms, including man. We will begin at the individual level, learning how plants obtain resources from abiotic sources and through mutualistic interactions with bacteria and fungi. We will also consider how the theories of plant community ecology developed in the early 20th century and why they are pertinent today. Students will also have the opportunity to read and critique primary literature from leading journals in the field. Finally, we will develop several projects to be completed at the Denison Biological Reserve during the term for lab projects. These projects will be student-inspired and driven, with the hopes that they will contribute to our understanding of our immediate surroundings at Denison.

**Prerequisite(s):** Biology core or consent, and CHEM 131 or CHEM majors - BIOL 220, and BIOL 230 and CHEM 300 (or concurrently).

**BIOL 324 - Developmental Biology (4 Credit Hours)**

Developmental biology is focused on understanding the process by which cells achieve their final fate and reach their final destination during embryogenesis to generate a species-specific morphology. The discipline also seeks to understand how reproduction is achieved so that the species persists from one generation to the next. Recently, the discipline has become more interdisciplinary with new areas of focus such as understanding how molecular pathways have evolved to produce morphological diversity among species, as well as how the environment can impact the outcome of embryonic development. This course provides an overview of the main stages of animal embryogenesis, while exploring a few specific topics in depth to gain appreciation for the complexity of the four-dimensional process that transforms a fertilized egg into an adult.

**Prerequisite(s):** Biology core or consent, and CHEM 131 or CHEM majors - BIOL 210, BIOL 220, and BIOL 230, and CHEM 300 (or concurrently).

**BIOL 325 - Genetics (4 Credit Hours)**

This course provides a detailed and up-to-date understanding of genetics, an appreciation of how genetics affects our lives every day from the supermarket to the doctor's office, and a realization of the applications of genetics to virtually every discipline of biology. We focus on three major areas of genetics: (1) Molecular genetics: Thinking about genetics on the DNA level - everything from DNA sequencing to mutagen testing. (2) Mendelian genetics: Thinking about genetics on the gene level-everything from inheritance to recombinational mapping. (3) The application of both molecular and Mendelian genetics to study biological processes. We start by seeing how genetic techniques can be used to dissect almost any biological process and end up answering questions such as: How does genetic disease screening work? How are genes cloned from complex organisms such as mice or even humans? How does gene therapy work? In the laboratory we carry out both molecular experiments and classical genetic experiments.

**Prerequisite(s):** Biology core or consent, and CHEM 131, or CHEM Majors - BIOL 210, BIOL 220, and CHEM 300 (or concurrently).

**BIOL 326 - Plant Evolution and Reproduction (4 Credit Hours)**

In this course we will explore the evolutionary relationships and histories among the major groups of plants, both terrestrial and aquatic. We will pay particular attention to their modes of reproduction and the structures that facilitate gamete production and dispersal. We will learn how plant physiology and developmental mechanisms have allowed taxa to persist or make major transitions among different environments over time. Class reading material will consist of the primary literature and will be presented by students every week. For the laboratory component we will have one overnight trip to Hocking Hills on a weekend in September to examine and identify plants in their natural habitat, as well as shorter trips to Blackhand Gorge and the Dawes Arboretum. We will also plan together and complete a semester-long project on the effects of environment on the development of reproductive structures in the model plant, *Arabidopsis thaliana*. Plant Evolution and Reproduction qualifies as a "biological diversity" course for the major.

**Prerequisite(s):** Biology core or consent, CHEM 131, or CHEM majors - BIOL 210, BIOL 220, and BIOL 230, and CHEM 300 (or concurrently).

**BIOL 327 - Biology of Insects (4 Credit Hours)**

In this course we will explore the world of insects and their interactions with other species. Our central focus will be to survey insect diversity and explore how various orders, families, and species are adapted through evolution to their specific environment. But we will also use that diversity as a lens through which we will examine major concepts in biology. Topics of discussion will include the following: plant-insect coevolution, mating systems, anti-predator defenses, eusocial behavior, parasitism, disease transmittance, insect conservation, and control of agricultural pests. Laboratory will involve collecting insects in the field (including at times outside of class hours), identification, and preparing a collection. Biology of Insects qualifies as a "biological diversity" course for the major.

**Prerequisite(s):** Biology core or consent, and CHEM 131, or CHEM majors - BIOL 210, BIOL 220, and BIOL 230, and CHEM 300 (or concurrently).

**BIOL 330 - Biostatistics (4 Credit Hours)**

This course provides an introduction to the principles and common methods of biostatistics, emphasizing applications in the health and biological sciences. Students will explore topics such as descriptive statistics, probability theory, hypothesis testing, confidence intervals, analysis of variance, and multiple regression. Students will learn the statistical programming language R and will use it to analyze datasets of their choosing in a final project. Students will also learn the historical development of the field and how biostatistics is used in several professions. No prior knowledge of statistics is required. Prerequisite: BIOL 210 and BIOL 220 and BIOL 230, or consent of the instructor.

**BIOL 334 - Comparative Physiology: Human and non-human animals (4 Credit Hours)**

This course is a comparative study of how humans and other animals perform their life-sustaining functions. We will explore the physiology of the cardiovascular, nervous, muscular, and endocrine systems, as well as examining key homeostatic functions such as thermoregulation, osmoregulation, and energy utilization. This course will examine the adaptive significance of physiological traits at the molecular, tissue, organ and whole organism level in humans and a variety of non-human animals. Students will participate in course labs and design their own physiology experiments.

**Prerequisite(s):** BIOL core, and CHEM 131 or consent of instructor, or CHEM majors - BIOL 210, BIOL 220, and CHEM 300 (or concurrently), or NEURO concentrators - BIOL 210, BIOL 220, and CHEM 131 and PSYC 200.

**BIOL 335 - Pathophysiology (4 Credit Hours)**

This course will focus on the most prevalent diseases in the US and worldwide, including the causes of these diseases; lifestyle, microbial infections, genetic mutations, environmental factors, etc. Students will learn about the physiological and anatomical consequences of these diseases.

**Prerequisite(s):** BIOL core, CHEM 131 or consent of instructor, or CHEM majors – BIOL 210, BIOL 220 and CHEM 300 (or concurrently), or NEURO concentrators – BIOL 210, BIOL 220, CHEM 131 and PSYC 200.

**BIOL 336 - Invertebrate Zoology (4 Credit Hours)**

Invertebrates constitute more than 97% of all animal species on Earth. They are an incredibly diverse group of organisms that have been classified into more than 30 phyla, each with unique anatomical, physiological, and behavioral traits. In this course, we explore the evolutionary history of invertebrates, and how these traits evolved as adaptations for specific terrestrial, freshwater and/or marine environments. We examine certain taxa in greater detail to address major concepts in biology; this is done in conjunction with article discussions and laboratory exercises that involve a variety of approaches in both the lab and field. Students have the opportunity to complete at least one self-designed experiment by the end of the semester. Invertebrate Zoology qualifies as a "biological diversity" course for the major.

**Prerequisite(s):** Biology core or consent, and CHEM 131, or CHEM majors - BIOL 210, BIOL 220, and BIOL 230, and CHEM 300 (or concurrently).

**BIOL 340 - Animal Behavior (4 Credit Hours)**

In this course we study the proximate and ultimate causes of animal behavior from an evolutionary perspective. Topics include the genetic, developmental and neural bases of behavior as well as behavioral strategies of habitat choice, foraging, defense, courtship, parental care and sociality. The laboratory will include several multi-week experiments designed to test hypotheses concerning behaviors observed in the field and lab. There will be a strong emphasis on data analysis and interpretation, and use of the primary literature.

**Prerequisite(s):** Biology core or consent, and CHEM 131, or CHEM majors - BIOL 210, BIOL 220, and BIOL 230, and CHEM 300 (or concurrently).

**BIOL 341 - Immunology (4 Credit Hours)**

This course is a study of concepts in immunology, focusing on the cellular and molecular aspects of the immune system in humans and other animal models. We will delve into subjects allowing students to understand the fascinating and complex mechanisms with which our immune systems defend our bodies against a constant barrage of infectious microorganisms. Topics covered include immune cell development and function, specific and non-specific immune responses to infection, immunogenetics, vaccination, and clinical disorders of the immune system such as allergies, immunodeficiency diseases, and autoimmunity. Laboratory exercises will utilize immunological techniques to address questions pertaining to the molecular function and specificity of the immune system.

**Prerequisite(s):** Biology core or consent, and CHEM 131, or CHEM majors - BIOL 210, BIOL 220, and BIOL 230, and CHEM 300 (or concurrently).

**BIOL 345 - Eukaryotic Cell Biology (4 Credit Hours)**

This course will be an in-depth examination of fundamental cellular functions, with an emphasis on how disturbances in these functions lead to disease. Areas covered in the course include intracellular trafficking, cytoskeleton and cell motility, adhesion, signal transduction, cell cycle, and apoptosis. Laboratories will involve learning current methods to analyze biological processes in cells.

**Prerequisite(s):** Biology core or consent, and CHEM 131, or CHEM majors - BIOL 210, BIOL 220, and BIOL 230, and CHEM 300 (or concurrently).

**BIOL 349 - Neurophysiology (4 Credit Hours)**

We will use neurophysiology and neuroanatomy to understand the links between molecules, cells, systems, and ultimately behavior. The course will start with an exploration of neurons and signaling within and among cells. We will then examine some sensory and motor systems. The last portion of the course will examine the whole animal in a neurophysiological context. The classroom portion of the course consists of lectures, discussion of the text and of research articles, problem sets, analysis of case studies, and other activities. The laboratory component will involve a mixture of behavioral, anatomical, and physiological studies on vertebrate and invertebrate animals, electronic modeling of nerve circuits, and computer simulations of nerve activity. The labs are designed to introduce students to some fundamental neurophysiological techniques and to a variety of study organisms, and to strengthen experimental design and analysis skills.

**Prerequisite(s):** Biology Core, and CHEM 131 or consent, or CHEM majors - BIOL 210, BIOL 220, and CHEM 300 (or concurrently), or NEURO concentrators- BIOL 210, BIOL 220, and CHEM 131 and PSYC 200.

**BIOL 350 - Genomics (4 Credit Hours)**

This course will explore the interdisciplinary field of genome science. The genome is the entire collection of genetic information found in an organism. The human genome and the genomes of thousands of species have been determined, providing a wealth of information about the genomic architecture and evolutionary history between species. You will learn about how genomes are assembled and annotated, and how comparing genomes across species and individuals can give us insights into the organization, regulation, and evolution of genomes. Contemporary papers from the field of genomics will be discussed to complement the concepts addressed in class. The laboratory component of this course will be computer-based, utilizing online databases and "bioinformatic" programs to carry out a series of group and individual projects. This course satisfies the oral communication requirement.

**Prerequisite(s):** Biology core or consent, and CHEM 131, or CHEM majors - BIOL 210, BIOL 220, and CHEM 300 (or concurrently).

**BIOL 351 - Restoration Ecology (4 Credit Hours)**

Many of Earth's ecosystems are degraded to the point where they no longer fully support the species and processes on which we depend. In response, western science has recently applied ecological theory to techniques of restoration. Some of these practices have long been used by cultures around the world, while others are experimental approaches to novel situations. In this course, students will learn foundational concepts and skills for the planning, design, actualization, and evaluation of restored ecosystems. Using literature review, discussion, projects, and labs, we will explore the following: landscapes in which ecological restoration may occur, including sociocultural landscapes; abiotic features of ecosystems and associated physiological limits of organisms; genetic aspects of restoration; population dynamics and community assembly; principles of succession and disturbance ecology; nonnative species and invasion ecology; and methods of evaluation. A primary focus of the course is exposure to real-world situations through fieldwork and consultation with professionals. This is a lab science course that fulfills the Y GE and adheres to Denison's Academic Credit policy.

**Prerequisite(s):** ENVS 274, BIOL 230, or consent.

**Crosslisting:** ENVS 351.

**BIOL 352 - Conservation Biology (4 Credit Hours)**

Conservation Biology requires the broad use of biological disciplines such as ecology, physiology, genetics, and animal behavior, as well as appreciation of policy issues, to understand and manage biodiversity. In this course, students will learn how to apply these biological tools for the purpose of defining and maintaining biodiversity at many scales. We will also cover human impacts on biodiversity, as well as the link between science and policy in protection efforts. This course will emphasize critical reading of primary literature as well as gaining hands-on experiences with population modeling, and measuring and monitoring local biodiversity.

**Prerequisite(s):** Biology core or consent, and CHEM 131.

**BIOL 353 - Population and Community Ecology (4 Credit Hours)**

In this course, we will examine 1) how populations and communities are structured, 2) how populations and communities change over time, and 3) how populations and communities are influenced by their environment or ecological context. An emphasis is placed on using primary literature, on doing ecology in the field and on writing in biology. This course satisfies the writing overlay of the General Education program.

**Prerequisite(s):** Biology majors/minors need the Biology core and CHEM 131; ENVS majors/minors need BIOL 220 and BIOL 230; or by consent.

**BIOL 354 - Evolutionary Biology (4 Credit Hours)**

This course builds on BIOL 202 and completes an in-depth survey of evolutionary theory with emphasis on processes that drive organismal change. We examine how molecular technology has impacted the study of evolutionary processes, and how new methods of analysis are changing the study of population genetics, phylogeny construction, adaptive radiation, etc. Experimental design and reading of primary and secondary scientific literature are stressed. Through the course, emphasis is placed on integration of all biological disciplines under the paradigm of evolution.

**Prerequisite(s):** Biology core or consent, and CHEM 131, or CHEM majors -BIOL 220, BIOL 230 and CHEM 300 (or concurrently).

**BIOL 356 - Special Topics (4 Credit Hours)**

Special topic courses with a focus on particular aspects of Biology.

**BIOL 361 - Directed Study (1-4 Credit Hours)**

A research problem (library, field, or laboratory) that provides the opportunity for the qualified student to extend his or her interest beyond the limits of particular course offerings. Does not count toward minimal departmental requirements.

**BIOL 362 - Directed Study (1-4 Credit Hours)**

A research problem (library, field, or laboratory) that provides the opportunity for the qualified student to extend his or her interest beyond the limits of particular course offerings. Does not count toward minimal departmental requirements.

**BIOL 363 - Independent Study (1-4 Credit Hours)****BIOL 364 - Independent Study (1-4 Credit Hours)****BIOL 399 - Advanced Topics in Biology (1-4 Credit Hours)**

A general category used only in the evaluation of transfer credit.

**BIOL 451 - Senior Research (4 Credit Hours)**

For seniors desiring to work on an advanced research problem. Biology 451 is to be taken if no previous work on the specific research project has been accomplished. Students with prior, substantial experience on their research project (such as a summer research experience with a Denison faculty member) may petition to move directly into BIOL 452. Prior consent of the advising faculty is required for registration. The grade is determined by the advisor. Completion of BIOL 451 does not fulfill an upper-level biology course requirement for the major.

**BIOL 452 - Advanced Senior Research (4 Credit Hours)**

For seniors working on an advanced research problem. Following the completion of a substantial research experience, such as BIOL 451 or a summer research experience with a Denison faculty member, students may take BIOL 452. Prior consent of the advising faculty is required for registration. The grade is determined by the advisor. Completion of BIOL 452 fulfills one upper-level biology course requirement for the major and also fulfills a writing overlay (W) requirement. Students enrolled in BIOL 452 have the option of pursuing senior research with Recognition. Interested students should speak with their research advisor or the Chair of Biology to learn more about the Recognition process and expectations.