

# BIOLOGY (BIOL)

## Faculty

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Biology is the natural science that concerns itself with study of the living world. The faculty of the biology department approaches the principles of the science from the unifying perspective of the theory of evolution. Emphases include the theory and practice of how scientific investigations are conducted as well as the more practical applications of biology.

A major in biology may serve as a sound preparation for those interested in careers in the life sciences, including those who go on to graduate or medical school. Majoring in biology also adds to students' understanding of the issues concerned with health, the environment and agriculture. In addition, Bucknell's biology majors are given the opportunity to become broadly educated "whole" scientists. They are encouraged to explore their interests within the humanities and social sciences.

## Biology Majors

Two degree programs are offered through the biology program.

### Bachelor of Arts

The **Bachelor of Arts major** requires eight courses in biology.

#### Core Sequence

BIOL 201	Biological Inquiries and Observations <sup>1</sup>	1
BIOL 202	Course-based Undergraduate Research Experience <sup>1</sup>	1
BIOL 203	Integrated Concepts in Biology Fall <sup>1</sup>	1
BIOL 204	Integrated Concepts in Biology Spring <sup>1</sup>	1
Four 300-level biology electives <sup>2</sup>		4
CHEM 205 or CHEM 207	Principles of Chemistry <sup>3</sup> Explorations in Chemistry	1
CHEM 211	Organic Chemistry I <sup>3</sup>	1
MATH 201 or MATH 202	Calculus I Calculus II	1
MATH 216	Statistics I	1

<sup>1</sup> Must be completed by the end of the third year.

<sup>2</sup> One elective may be BIOL 399 Mentored Undergraduate Research, but additional 399 credit may be applied as electives beyond the courses offered for the major.

At least one elective must be in each of the three areas listed below. Two of these courses from different areas must be a laboratory or field course.

<sup>3</sup> Must be completed by the end of the sophomore year.

#### Area I - Cellular/Molecular

BIOL 302	Microbiology	1
BIOL 308	Microbial Genetics	1
BIOL 323	Mammalian Histology	1
BIOL 324	Neurophysiology	1
BIOL 326	Cytogenetics	1
BIOL 327	Molecular Biology	1

BIOL 331	Genomics	1
BIOL 332	Developmental Neurobiology	1
BIOL 340	Biochemical Methods	1
BIOL 347	Virology	1
BIOL 348	Immunology	1
BIOL 352	Cell Biology	1
BIOL 363	Receptors of Biological Membranes	1
BIOL 364	Advanced Data Analysis in Biology	1
BIOL 365	Introduction to Microscopy	1
BIOL 375	Cellular and Molecular Neurobiology	1

**Area II - Organismal**

BIOL 306	Biology of Host-Microbe Interactions	1
BIOL 309	Wildlife and Emerging Diseases	1
BIOL 312	Comparative Vertebrate Anatomy	1
BIOL 313	Mammalogy	1
BIOL 314	Amphibian Biology and Conservation	1
BIOL 316	Plant Growth and Development	1
BIOL 318	Principles of Physiology	1
BIOL 328	Endocrinology	1
BIOL 332	Developmental Neurobiology	1
BIOL 339	Developmental Biology	1
BIOL 342	Neuroethology	1
BIOL 357	Ornithology	1
BIOL 358	Invertebrate Zoology	1
BIOL 359	General Entomology	1
BIOL 373	Mycology	1

**Area III - Ecological/Evolutionary**

BIOL 307	Conservation Genetics	1
BIOL 321	Behavioral Ecology	1
BIOL 325	Evolutionary Genomics	1
BIOL 330	Plant Systematics	1
BIOL 334	Limnology	1
BIOL 341	Evolution	1
BIOL 351	Field Botany	1
BIOL 353	Ecosystem Ecology	1
BIOL 354	Tropical Ecology	1
BIOL 355	Social Insects	1
BIOL 370	Primate Behavior and Ecology	1
BIOL 371	Field Entomology	1
BIOL 378	Evolutionary Medicine	1
Seminars (topics and area designations vary)		
BIOL 319	Seminar	1
BIOL 320	Seminar	1

**Bachelor of Science**

The Bachelor of Science major requires nine courses in biology. The major provisions in biology are the same as those noted under the Bachelor of Arts major, but five rather than four 300-level electives are required, only one of which may be BIOL 399 Mentored Undergraduate Research.

The Bachelor of Science major also requires:

CHEM 205 or CHEM 207	Principles of Chemistry <sup>4</sup> Explorations in Chemistry	1
CHEM 211	Organic Chemistry I <sup>4</sup>	1
MATH 201 or MATH 202	Calculus I Calculus II	1
MATH 216	Statistics I	1
PHYS 211 & PHYS 212	Classical and Modern Physics I and Classical and Modern Physics II	2
Select two of the following: <sup>5</sup>		
BMEG 431	Biomimetic Materials	
CHEG 494	Pharmaceuticals Vaccines Food and Drink in London	
CHEM 212	Organic Chemistry II (highly recommended)	
CHEM 230	Principles of Chemistry 2	
CHEM 231	Quantitative Analysis	
CHEM 313	Synthetic Organic Chemistry	
CHEM 314	Mechanistic Organic Chemistry	
CHEM 317	Special Topics in Organic Chemistry	
CHEM 321	Inorganic Chemistry I	
CHEM 351	Biochemistry I	
CHEM 352	Biochemistry II	
CSCI 203	Introduction to Computer Science	
CSCI 204	Data Structures & Algorithms	
ENST 211	Environmental Pollution and Control	
ENST 215	Environmental Planning	
ENST 230	Introduction to Sustainable Design	
ENST 240	Sustaining Nature	
GEOG 204	Applied G.I.S.	
GEOG 345	Food and the Environment	
GEOL 107	Global Change - Past and Present	
GEOL 203	Physical/Environmental Geology	
GEOL 204	Evolution of the Earth	
GEOL 230	Environmental GIS	
GEOL 305	Introduction to Geochemistry	
GEOL 316	Geomorphology	
GEOL 317	Paleontology	
LING 230	Psycholinguistics	
LING 325	Language and the Brain	
MATH 202	Calculus II	
MATH 211	Calculus III	
MATH 217	Statistics II	
PHIL 103	Logic	
PHIL 201	Symbolic Logic	
PHIL 220	Philosophy of Science	
PHIL 272	Philosophy of Biology	
PSYC 203	Learning	
PSYC 204	Human Cognition	
PSYC 250	Biopsychology	
PSYC 252	Sensation and Perception	
PSYC 317	Comparative Animal Cognition	
PSYC 324	Advanced Psychological Statistics	

<sup>4</sup> Typically completed during the first year.

<sup>5</sup> Other courses may be substituted with department approval.

Students interested in behavioral aspects of biology may wish to consider the animal behavior major; those interested in biochemistry, the cell biology/biochemistry major; those interested in environmental issues, the environmental science bachelor of arts within the Environmental Studies program; and those interested in neurobiology, the neuroscience program. Students planning to continue with graduate training in biology are encouraged to elect MATH 217 Statistics II and/or MATH 202 Calculus II, and to consult their academic adviser or pre-health professions adviser.

One possible sequence for the bachelor of science major is as follows, but the biology department typically advises incoming first-year students to consider choosing between CHEM 205/CHEM 207 and MATH 201 during the first semester rather than taking them both in combination with BIOL 201 or BIOL 202.

#### First Year

First Semester	Credits	Second Semester	Credits
BIOL 201 or 202		1 BIOL 201 or 202	1
CHEM 205 or 207		1 CHEM 211	1
MATH 201 <sup>6</sup>		1 MATH 216	1
Foundation Seminar		1 Elective	1
		<b>4</b>	<b>4</b>

#### Sophomore

First Semester	Credits	Second Semester	Credits
BIOL 203		1 BIOL 204	1
Related area course <sup>7</sup>		1 Related area course	1
Elective		1 Elective	1
Elective		1 Elective	1
		<b>4</b>	<b>4</b>

#### Junior

First Semester	Credits	Second Semester	Credits
Elective in biology		1 Elective in biology	1
PHYS 211		1 PHYS 212	1
Elective		1 Elective	1
Elective		1 Elective	1
		<b>4</b>	<b>4</b>

#### Senior

First Semester	Credits	Second Semester	Credits
Two electives in biology		2 Elective in biology	1
Elective		1 Elective	1
Elective		1 Elective	1
		Elective	1
		<b>4</b>	<b>4</b>

**Total Credits: 32**

<sup>6</sup> If a student has placed out of MATH 201 but not received credit, MATH 202 should be taken.

<sup>7</sup> CHEM 212 is highly recommended.

## Biology Minor

A minor in Biology consists of five courses.

BIOL 203	Integrated Concepts in Biology Fall	1
BIOL 204	Integrated Concepts in Biology Spring	1
At least two 300-level courses <sup>1</sup>		2
One additional biology course (100-, 200- or 300-level)		1
<b>Total Credits</b>		<b>5</b>

<sup>1</sup> Cannot be BIOL 399 Mentored Undergraduate Research.

## College of Arts & Sciences Core Curriculum – Disciplinary Exploration Requirements

Students in the biology major will satisfy the writing requirement by taking BIOL 201 Biological Inquiries and Observations, BIOL 203 Integrated Concepts in Biology Fall, and BIOL 204 Integrated Concepts in Biology Spring. Students in the biology major will satisfy the information literacy requirement by completing BIOL 201 Biological Inquiries and Observations and BIOL 202 Course-based Undergraduate Research Experience and at least two 300-level biology laboratory/field courses. They will satisfy the formal presentation requirement by completing BIOL 201 Biological Inquiries and Observations and BIOL 202 Course-based Undergraduate Research Experience as well as at least two 300-level courses in biology, which will include a required oral presentation. The Culminating Experience in Biology requirement will be fulfilled by taking one 300-level laboratory or field course from a list provided by the department in one of a student's last three semesters.

Transfer students must complete at least four courses in biology in residence at Bucknell, only one of which may be BIOL 399 Mentored Undergraduate Research.

For Bucknell students who elect to study abroad, at least three upper division courses toward the major and at least one toward the minor must be taught by Bucknell faculty.

Students who pass the BIOL 121 Biology for Non-majors, BIOL 122 Biology for Non-majors sequence with a grade of B or better in both courses may receive one core credit toward the biology major pending consultation with the department chair.

Biology Department Learning Goals

### I. Knowledge

Students completing the BA or BS major in Biology will:

1. Demonstrate a proficiency with the concepts and methodologies of the traditional core of biology. (1, 4, 6, 8, 9)
2. Demonstrate the ability to use the scientific method. (1, 8)
3. Demonstrate the ability to apply concepts from diverse sub-disciplines of biology. (1, 6, 8)
4. Develop critical thinking skills to formulate and test biological questions. (1, 4, 6)

In addition students completing a BS in biology will:

1. Apply and integrate other related disciplines with their knowledge of Biology. (1, 2, 6)

### II. Communication

Students completing the BA or BS major in Biology will:

1. Be able to write a well organized, logical and scientifically sound research paper or report. (1, 7, 8)
2. Be able to present a well organized, logical and scientifically sound oral presentation on a topic in Biology. (1, 7, 8)

### III. Career

Students completing the BA or BS major in Biology will:

1. Be encouraged to pursue research experiences both on and off campus. (1, 9)
2. Be educated about the wide variety of career paths in Biology via seminars and invited speakers.

Faculty in the department will provide strong personalized advising allowing students to make informed post-graduation decisions.

Non-STEM students fulfilling their natural sciences requirements will:

1. Demonstrate a familiarity with biological principles and practices. (4, 6, 8, 9)
2. Appreciate the impact of biology on society and gain confidence in their ability to understand biologically related issues. (4, 6, 8, 9)

Numbers in parentheses reflect related Educational Goals of Bucknell University.

## Courses

**BIOL 112. Animals and Pandemics. 1 Credit.**

**Offered Occasionally; Lecture hours:6**

A non-majors introduction to the biology of zoonoses (pathogens that spillover from animals to people - including the COVID-19 virus, Ebola, and HIV). Course will integrate popular and scientific sources and will include a variety of student activities, including case studies and student-produced multimedia educational products.

**BIOL 113. The Hidden Secrets of Genomes. 1 Credit.****Offered Occasionally; Lecture hours:2,Other:6**

Learn the secrets of life by studying viral genomes (with an emphasis on the coronavirus causing COVID-19), bacterial genomes, and eukaryotic genomes; and special features that make life possible. This is an introductory-level laboratory course with no prerequisites. Students need access to a kitchen and a computer with internet connection.

**BIOL 115. Freshwater Biology. 1 Credit.****Offered Summer Session Only; Lecture hours:4,Other:4**

Freshwater ecosystems hold an amazing diversity of life, which provides humans with clean water, food resources, recreational opportunities and other benefits. However, human development impacts water quality, degrades aquatic habitats, blocks river systems and introduces non-native species. In this course, students will learn about organisms living in freshwater ecosystems, changes.

**BIOL 120. Fight or Flight: The Biology of Stress. 1 Credit.****Offered Summer Session Only; Lecture hours:6**

An exploration of biology through the lens of stress, this course will cover topics such as how stress relates to heart attacks, dwarfism, sex drive, memory loss, appetite, and aging. The course concludes with a biological-based discussion on how to effectively manage stress. Open to BCCSP.

**BIOL 121. Biology for Non-majors. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Lab:3; May require dissection or live animal experimentation**

Introductory course primarily for the non-science major. Focuses on life at the cellular and biochemical levels, genetics, and biotechnology. This course is not appropriate preparation for the majority of pre-health graduate programs. Please consult with the Pre-health Adviser for more information.

**BIOL 122. Biology for Non-majors. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Lab:3; May require dissection or live animal experimentation**

Introductory course primarily for the non-science major. Topics covered include principles of ecology, evolution, animal diversity, behavior, and structure, and function. This course is not appropriate preparation for the majority of pre-health graduate programs. Please consult with the Pre-health Adviser for more information.

**BIOL 130. Health and Disease. 1 Credit.****Offered Occasionally; Lecture hours:3**

A biology course, for non-science majors, that explores the basic biological principles underlying normal health and the most common diseases of humans. Students who have taken any 200-level Biology courses are not eligible for enrollment.

**BIOL 131. Biology of Food. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Other:3**

A course for non-majors that investigates fundamental concepts in biology through a focus on food and agriculture. We will debate current issues, such as genetic engineering, fad diets and our national farm policy. Lab involves hands on learning including growing and preparing food.

**BIOL 150. Plants, People, and the Environment. 1 Credit.****Offered Fall Semester Only; Lecture hours:3**

The diversity and evolution of plants, fungi, and related organisms with special emphasis on flowering plants; their importance for food, fiber, medicine, and psychoactive compounds; origins of agriculture; domestication of plants; and the role of plants in the environment.

**BIOL 1NT. Biology Non-traditional Study. .5-2 Credits.****Offered Fall, Spring, Summer; Lecture hours:Varies**

Non-traditional study in Biology. Prerequisite: permission of the instructor.

**BIOL 201. Biological Inquiries and Observations. 1 Credit.****Offered Both Fall and Spring; Lecture hours:3,Other:1**

A seminar-style course focused around a major theme in biology to teach advanced reasoning skills and key topics in evolution, biodiversity, central dogma of molecular biology, scientific study design, and science communication. First or second core course for Biology majors. First-year students only.

**BIOL 202. Course-based Undergraduate Research Experience. 1 Credit.****Offered Either Fall or Spring; Lecture hours:1,Other:3**

Course-based Undergraduate Research Experience. An authentic research experience using student-designed experiments to test hypotheses. First or second core course for Biology majors. First-year students only.

**BIOL 203. Integrated Concepts in Biology Fall. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Other:5; May require dissection or live animal experimentation**

An overview of the core concepts in biology using an interdisciplinary approach that highlights connections across the diverse fields of molecular, physiological, ecological, and evolutionary biology. Complements BIOL 204. Typically third core course for Biology majors. Not open to first-year students.

**BIOL 204. Integrated Concepts in Biology Spring. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Lab:3; May require dissection or live animal experimentation**

An overview of the core concepts in biology using an interdisciplinary approach that highlights connections across the diverse fields of molecular, physiological, ecological, and evolutionary biology. Complements BIOL 203. Typically fourth core course for Biology majors.

**BIOL 205. Introduction to Molecules and Cells. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Other:4**

An introductory course which focuses on the molecular biology of cells. Basic biochemical processes, cellular and subcellular structure and function are emphasized.

**BIOL 206. Organismal Biology. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Other:4; May require dissection or live animal experimentation**

An introductory course for biology majors emphasizing organisms as dynamic systems by integrating structure with function. Laboratories introduce scientific method and collaborative learning.

**BIOL 207. Genetics. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Other:1**

A comprehensive survey of genetic mechanisms and methodologies, including classical genetics, recombinational analysis in bacteria, fungi, and higher eukaryotes, molecular genetics and populational and quantitative genetics. Prerequisite: BIOL 205.

**BIOL 208. Principles of Ecology and Evolution. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Lab:3**

Introduction to systematic biology, evolutionary theory, physiological ecology, behavioral ecology, population and community ecology, and ecosystem structure and function. BIOL 206 and BIOL 207 strongly recommended as prerequisites.

**BIOL 220. Human Anatomy & Physiology I. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Lab:2; May require dissection or live animal experimentation**

Introduction to human anatomy and physiology. Emphasis on the relationship between structure/function of the integumentary, musculoskeletal, nervous, and endocrine systems. Overview of anatomical terminology, cellular and tissue structures, and chemistry will be discussed. Does not count toward the biology major. Lab involves cat dissection. Prerequisite: permission of the instructor.

**BIOL 221. Human Physiology. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Lab:2**

A course that focuses on the functions of and interactions between human organ systems. Does not count toward the biology major. Prerequisite: permission of the instructor.

**BIOL 222. Human Anatomy & Physiology II. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Lab:2; May require dissection or live animal experimentation**

Introduction to human anatomy and physiology. Emphasis on the relationship between structure/function of the blood, cardiovascular, lymphatic, immune, respiratory, digestive, urinary, and reproductive systems. May require dissection or live animal experimentation. Does not count toward the biology major. Lab involves cat dissection. Prerequisite: permission of the instructor.

**BIOL 235. Microbiology for Health Professions. 1 Credit.****Offered Fall, Spring or Summer; Lecture hours:3,Other:3**

This course will introduce students to the diversity of microorganisms by covering properties of eukaryotic and prokaryotic organisms, microbial genetics and biochemistry, and roles of microbes in disease. Labs will provide experience with common microbiology lab techniques: microscopy, identification, sterile technique, cell culture and plating, and staining methods.

**BIOL 254. Introduction to Ecology in West Africa. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Other:3**

Introductory-level course in tropical ecology in West Africa, focusing on ecological phenomena and animal behavior with practical implications in Ghana. The course will examine basic ecological principles (biodiversity patterns explanations, biological productivity, plant-animal interactions, habitat structures) and tropical habitats (rain forest, savannah, coastal lagoon, agricultural systems). Designed for non-science majors. Crosslisted as ANBE 254.

**BIOL 266. Animal Behavior. 1 Credit.****Offered Both Fall and Spring; Lecture hours:3**

A survey of important theories, issues, and empirical techniques in the interdisciplinary field of animal behavior emphasizing both proximate and ultimate mechanisms and explanations for behavior. Crosslisted as ANBE 266 and PSYC 266.

**BIOL 2NT. Biology Non-traditional Study. 1-2 Credits.****Lecture hours:Varies,Other:Varies**

Nontraditional study in biology.

**BIOL 302. Microbiology. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Other:4**

Ultra-structure, behavior, metabolism, molecular biology, and development of micro-organisms. Roles in disease and food production. Laboratory will emphasize cultivation and identification. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 205 and BIOL 207) and permission of the instructor. Crosslisted as BIOL 602.

**BIOL 305. Vertebrate Ecology. 1 Credit.****Offered Occasionally; Lecture hours:3,Other:3**

An upper-level laboratory course covering topics in Vertebrate Animal Ecology. Subfields of ecology to be determined by the instructor. Crosslisted as ANBE 305, ANBE 605 and BIOL 605.

**BIOL 306. Biology of Host-Microbe Interactions. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other:2**

Through study of the primary literature, this course will investigate the relationship between animals and their microbes, including evolution of host-microbe relationships, the impact of microbes on human health, the techniques used to study the microbiota, the biology of the microbiome, and other recent advances in the field. Crosslisted as BIOL 606.

**BIOL 307. Conservation Genetics. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other:3**

As biodiversity has quickly eroded for the past few centuries, some scientists argue that humans are causing the 6th mass extinction event. This course emphasizes the application of population genetics, molecular phylogenetics, and reproductive genetics to answering biological questions in wildlife conservation. Crosslisted as ANBE 307 and ANBE 607 and BIOL 607.

**BIOL 308. Microbial Genetics. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3**

Course focuses on molecular genetics of bacteria and archaea and the use of genetic tools to answer questions in microbiology. Primary literature will be used extensively. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 205 and BIOL 207); BIOL 208 or BIOL 327 strongly recommended. Crosslisted as BIOL 608.

**BIOL 309. Wildlife and Emerging Diseases. 1 Credit.****Offered Alternating Fall Semester; Lecture hours:3**

Biology of wildlife diseases, especially zoonoses (infections that jump to humans). Course will integrate popular and scientific sources. Prerequisites: (BIOL 203 and BIOL 204) or BIOL 206 and permission of the instructor. Crosslisted as ANBE 309, ANBE 609 and BIOL 609.

**BIOL 311. Climate Change Ecology. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other:3**

Climate change is one of the most important and complex challenges that we are facing in the 21st century. To overcome we must find solutions that stop destructive practices, mitigate harm, and use adaptive approaches. Topics included: causes and consequences; resilience; biodiversity; conservation; social and economic issues; amplifying diverse voices. Crosslisted as ANBE 311, ANBE 611 and BIOL 611.

**BIOL 312. Comparative Vertebrate Anatomy. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Other:3; May require dissection or live animal experimentation**

Gross morphology with emphasis on functional and evolutionary modifications of animal structure. Gross dissection and techniques used in morphology. Prerequisites: BIOL 122 or (BIOL 203 and BIOL 204) or BIOL 206 and permission of the instructor. Crosslisted as ANBE 312, ANBE 612 and BIOL 612.

**BIOL 313. Mammalogy. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other:3; May require dissection or live animal experimentation**

Biology of mammals, including evolution, classification, biodiversity, behavior, anatomy, physiology, ecology and conservation. Lab will include specimen identification, preparation and field studies. Prerequisites: (BIOL 203 and BIOL 204) or BIOL 206 and permission of the instructor. Crosslisted as ANBE 313, ANBE 613 and BIOL 613.

**BIOL 314. Amphibian Biology and Conservation. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Other:3**

The biology of amphibians, including classification, physiology, reproduction, ecology, evolution, and conservation. Laboratory section will include identification of amphibians and field work to identify conservation issues surrounding local amphibian populations. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 206 and BIOL 208) and permission of the instructor. Crosslisted as ANBE 314 and BIOL 614 and ANBE 614.

**BIOL 316. Plant Growth and Development. 1 Credit.****Offered Alternating Fall Semester; Lecture hours:3,Other:3**

The physiological and molecular bases of growth and development at the organ, tissue, and cellular levels. Effects of environmental stimuli and hormones on gene expression and the resultant changes at higher levels of organization. Crosslisted as BIOL 616.

**BIOL 318. Principles of Physiology. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other:3**

Emphasizes the breadth of physiology and explores physiological principles of animals from a cellular, organismal, medical and ecological framework. Laboratory focuses on experimental design and independent research. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 205 and BIOL 206) and permission of the instructor. Crosslisted as ANBE 318, ANBE 618 and BIOL 618.

**BIOL 319. Seminar. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3; Repeatable**

Topics vary. Crosslisted as BIOL 619.

**BIOL 320. Seminar. 1 Credit.****Offered Either Fall or Spring; Lecture hours:Varies,Other:3; Repeatable**

Topics vary. Crosslisted as BIOL 620.



**BIOL 321. Behavioral Ecology. 1 Credit.****Offered Spring Semester Only; Lecture hours:3**

How have ecological selection pressures (generated by animals' biotic and abiotic environments) shaped the fascinating diversity of animal behaviors? Topics include habitat choice, foraging behavior, defenses against predation, cooperation and competition, sexual selection, and parental care. Heavy emphasis on primary literature and experimental design. Crosslisted as ANBE 321, ANBE 621 and BIOL 621.

**BIOL 323. Mammalian Histology. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other:3**

A detailed study of the microscopic architecture and associated physiology of mammalian cells, tissues and organ systems. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 205 and (BIOL 206) and permission of the instructor. Crosslisted as BIOL 623.

**BIOL 324. Neurophysiology. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3; May require dissection or live animal experimentation**

A course that will explore the different circuits and systems of the brain and the corresponding brain structures. The laboratory portion of the course will include dissection of brain specimens to better visualize the content presented in class. Crosslisted as BIOL 624.

**BIOL 325. Evolutionary Genomics. 1 Credit.****Lecture hours:3,Other:3**

An exploration of evolutionary questions using large sequencing databases, with an emphasis on developing strategies for computational sequence analysis. Includes review of the primary literature. No coding experience. Prerequisites: (BIOL 203 and BIOL 204) or BIOL 207 and permission of the instructor. BIOL 208 recommended but not required.

**BIOL 326. Cytogenetics. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Other:3**

Study of chromosome structure, organization, aberrations, and behavior. Multiple eukaryotic systems will be considered with links to human disease. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 205 and BIOL 207) and permission of the instructor. Crosslisted as BIOL 626.

**BIOL 327. Molecular Biology. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Lab:3**

Synthesis of DNA, RNA, and protein, and the regulation of these processes in both prokaryotic and eukaryotic cells; laboratory experience in the manipulation and analysis of genes. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 205 and BIOL 207) and permission of the instructor. Crosslisted as BIOL 627.

**BIOL 328. Endocrinology. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Problem Session:2**

Regulation and function of hormones and their receptors from molecular to organismal levels. Role of hormones in development, physiology and behavior; endocrine disease. Prerequisites: (BIOL 203 and BIOL 204) or BIOL 205 and permission of the instructor. Crosslisted as ANBE 328, ANBE 628 and BIOL 628.

**BIOL 329. Foundations of Genetics. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3**

This course will discuss the mechanisms of heredity from a classical and modern perspective. Topics include the structure, function and molecular nature of the genome, biological variation from mutation and selection, the genetics of populations and the use of genetics as tool in modern Biology in relation to understanding evolution. Crosslisted as BIOL 629.

**BIOL 330. Plant Systematics. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Other:4**

Exploration of the diversity of plant life on Earth through lectures, labs, and field trips; includes biogeography, natural history, evolutionary relationships, ethnobotanical uses, and identification. Prerequisites: (BIOL 203 and BIOL 204) or BIOL 206 and permission of the instructor. Crosslisted as BIOL 630.

**BIOL 331. Genomics. 1 Credit.****Offered Occasionally; Lecture hours:3,Other:2**

A computer research-based course in which students study the structure, content, expression and evolution of genomes. Prerequisites: (BIOL 203 and BIOL 204) or BIOL 207 and permission of the instructor. Crosslisted as BIOL 631.

**BIOL 332. Developmental Neurobiology. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other:3**

Developmental neurobiology with a laboratory section. Topics include: neural cell identity determination and differentiation; axon growth and target selection; formation and plasticity of neural connections; behavioral development. Crosslisted as BIOL 632 and NEUR 332.

**BIOL 334. Limnology. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Other:3**

The physical, chemical, and biological characteristics of fresh-water communities are studied. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 208 or ENST 208) and permission of the instructor. Crosslisted as BIOL 634.

**BIOL 339. Developmental Biology. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other:3; May require dissection or live animal experimentation**

This course provides an introduction to early animal development with emphasis on the molecular, cellular and genetic mechanisms that drive the formation of the embryo. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 205 and BIOL 206). Crosslisted as BIOL 639.

**BIOL 340. Biochemical Methods. 1 Credit.****Offered Spring Semester Only; Lecture hours:2,Other:6**

A course in laboratory techniques including cell fractionation and analysis of proteins and nucleic acids. Spectrophotometry, chromatography, centrifugation, electrophoresis, and methods of molecular cloning are emphasized. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 205) and CHEM 351 and permission of the instructor. Crosslisted as CHEM 358.

**BIOL 341. Evolution. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3**

Survey of evolutionary processes, phenomena, and mechanisms. Topics covered may include natural selection, sexual selection, adaptation, evolutionary constraints, speciation, evolution and development, coevolution, behavioral evolution, and macroevolution. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 208) and permission of the instructor. Crosslisted as ANBE 341 and ANBE 641 and BIOL 641.

**BIOL 342. Neuroethology. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3**

A course that integrates neurobiology and behavior in natural contexts. Emphasis on signal detection, recognition, discrimination, localization, orientation, and the control of complex acts. Neuronal and hormonal mechanisms, ontogeny and evolution of behavior will be considered. Crosslisted as ANBE 342 and ANBE 642 and BIOL 642.

**BIOL 347. Virology. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Other:2**

The study of virus structure, genome organization, replication and host-interactions. Emphasis will be on animal and bacterial viruses. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 205 and BIOL 207) and permission of the instructor. Crosslisted as BIOL 647.

**BIOL 348. Immunology. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Other:3; May require dissection or live animal experimentation**

Development and function of the immune system in animals. The immune response in health and disease. Techniques in immunology. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 205 and BIOL 206) and permission of the instructor. Crosslisted as BIOL 648.

**BIOL 350. Independent Study. 1 Credit.****Lecture hours:Varies,Other:3; Repeatable**

Selected topics.

**BIOL 351. Field Botany. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Other:1**

Outdoor field experience in plant diversity and ecology. Excursions to natural areas focused on identification, community dynamics, and ecological interactions/adaptations. Prerequisites: (BIOL 203 and BIOL 204) or BIOL 208 and permission of the instructor. Crosslisted as BIOL 651.

**BIOL 352. Cell Biology. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Lab:3**

Covers biomembranes, cell growth patterns, cell signaling, the cytoskeleton, cell organelles, and microscopic techniques. Laboratory includes experience with cell culture. Prerequisites: (BIOL 203 and BIOL 204) or BIOL 205 and permission of the instructor. Crosslisted as BIOL 652.

**BIOL 353. Ecosystem Ecology. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Recitation:1**

Interactions between organisms and the physical and chemical environment including nutrient cycling and energy flow, biogeochemistry, and temporal and spatial dynamics of ecosystems. Prerequisites: (BIOL 203 and BIOL 204) or BIOL 208 or ENST 208, junior or senior status, and permission of the instructor. Crosslisted as ANBE 353, ANBE 653, BIOL 653, ENST 353.

**BIOL 354. Tropical Ecology. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3**

Introduction to tropical ecology including life history strategies of vertebrates and invertebrates, biodiversity management and conservation. Emphasis on class and individual projects, data collection and journal keeping. Prerequisites: (BIOL 203 and BIOL 204) or BIOL 208 or permission of the instructor. Crosslisted as ANBE 354 and ANBE 654 and BIOL 654.

**BIOL 355. Social Insects. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Other:3**

Evolution and genetics of social behavior, caste, communication in foraging and colony defense, queen and worker control over reproduction, social homeostasis and population dynamics. Occasionally may be taught as a laboratory science. Prerequisites: (BIOL 203 and BIOL 204) or BIOL 208 and permission of the instructor. Crosslisted as ANBE 355.

**BIOL 357. Ornithology. 1 Credit.****Offered Occasionally; Lecture hours:3,Other:3**

The biology of birds, including evolution, behavior, anatomy, physiology, ecology, and conservation; lab trips focus on identification of birds in the field. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 206 and BIOL 208) and permission of the instructor. Crosslisted as ANBE 357 and ANBE 657 and BIOL 657.

**BIOL 358. Invertebrate Zoology. 1 Credit.****Offered Alternating Fall Semester; Lecture hours:3,Other:3**

A survey of the animal phyla covering phylogenetic relationships, functional morphology, ecology, life histories, symbiosis, ontogeny and behavior. Includes hands-on study of organisms in lab and field. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 206 and BIOL 208) and permission of the instructor. Crosslisted as ANBE 358, ANBE 658 and BIOL 658.

**BIOL 359. General Entomology. 1 Credit.****Offered Alternating Fall Semester; Lecture hours:3,Other:3**

The biology of insects and their kin: anatomy, physiology, ecology, behavior, development, evolution, systematics and diversity. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 206 and BIOL 208) and permission of the instructor. Crosslisted as ANBE 359, ANBE 659 and BIOL 659.

**BIOL 362. Topics in Cell Biology. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Other:1.5**

Selected topics in cell biology will be covered in a format (lecture, discussion, demonstration, seminar) that may vary from year to year. Topics may include membrane structure and dynamics, cell signaling, the cytoskeleton, protein synthesis and targeting, the cell cycle, mitosis, cell-cell interactions and cell-substrate interactions, among others.

**BIOL 363. Receptors of Biological Membranes. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3**

A course focused on the receptors and channels that function in biological membranes. The primary research literature will be used to explore the molecular bases of cellular communication, neuronal connectivity, and sensory transduction. Crosslisted as BIOL 663 and NEUR 363.

**BIOL 364. Advanced Data Analysis in Biology. 1 Credit.****Offered Spring Semester Only; Lecture hours:2,Other:4**

Data exploration and visualization using state-of-the-art computational techniques. Using "big data" from their own research projects or public transcriptomic datasets, students will learn to analyze/visualize complex biological datasets. Lab includes hands-on work with R/virtual reality. No prior programming experience required. Crosslisted as BIOL 664.

**BIOL 365. Introduction to Microscopy. 1 Credit.****Offered Spring Semester Only; Lecture hours:3,Other:3**

This course is designed as an overview of light and electron microscopy, with emphasis placed on the use of instrumentation. Prerequisite: Permission of the instructor. Crosslisted as BIOL 665.

**BIOL 367. Plant Ecophysiology. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other:3**

For billions of years, plants and their ancestors have shaped the Earth's ecosystems, atmosphere and climate. We will study the physiological processes that allow plants to take sunlight, water, carbon dioxide and minerals to develop complex organisms from which all other life is possible. Includes a focus on ecological agriculture.

**BIOL 368. Microbiota-Gut-Brain Axis. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3**

Seminar on the microbiota-gut-brain axis. Topics include: microbiome; interaction between the gut, nervous system and animal behaviors; the role of the immune system in gut-brain communication, the microbiota-gut-brain axis and diseases. Crosslisted as BIOL 668.

**BIOL 370. Primate Behavior and Ecology. 1 Credit.****Offered Fall Semester Only; Lecture hours:3; May require dissection or live animal experimentation**

Introduction to research on prosimians, monkeys, and apes with emphasis on the evolutionary origin of diversity, habitat use, social structure, social behavior, and cognitive abilities. Crosslisted as ANBE 370 and ANBE 670 and BIOL 670 and PSYC 370 and PSYC 670.

**BIOL 371. Field Entomology. 1 Credit.****Offered Fall Semester Only; Lecture hours:2,Other:2**

Introduction to insects in their natural habitats, with emphasis on insect collecting, taxonomy, identification, ecology, and natural history. Students will make a professional-quality insect collection and acquire skills appropriate for biodiversity surveys. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 208) and permission of the instructor. Crosslisted as BIOL 671.

**BIOL 373. Mycology. 1 Credit.****Offered Either Fall or Spring; Lecture hours:3,Other:3**

Biology of fungi, including evolution, classification, biodiversity, ecology, and medical implications. Lab will involve identification, microscopy, culturing techniques, and field collection. Prerequisite: (BIOL 203 and BIOL 204) or (BIOL 206) and permission of the instructor. Crosslisted as BIOL 673.

**BIOL 375. Cellular and Molecular Neurobiology. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:3,Lab:3**

In this course, we will cover the molecular and cellular mechanisms that drive neuronal function, and include topics such as excitable membrane physiology, synaptic transmission, plasticity and learning. The laboratory provides an evaluation of laboratory techniques relevant to neuroscience and analysis of papers. Crosslisted as NEUR 253 and BIOL 675.

**BIOL 378. Evolutionary Medicine. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:3**

This seminar course will explore evolutionary approaches to medical theory and practice, including topics such as the fundamental nature of and relationship between patients and disease, evolution of human defenses to illness, pathogen evolution, cardiovascular disease, cancer, reproductive medicine, and mismatches between the modern environment and the human body. Crosslisted as BIOL 678.

**BIOL 379. Sensory Ecology. 1 Credit.**

**Offered Spring Semester Only; Lecture hours:3,Other:4**

Sensory Ecology will examine the evolutionary interplay of sensory systems, behavior, and the environment. Topics will include ultraviolet vision and foraging strategies, magnetic navigation, ultrasonic signaling, and electric communication. In lab, we will design and conduct field or lab-based experiments to test hypotheses of your choosing. Crosslisted as BIOL 679.

**BIOL 382. Mass Extinctions. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:3**

An upper-level course investigates the past five mass extinctions and the on-going sixth mass extinction of organisms from the perspective of ecology, evolution, and conservation biology. Prerequisites: (BIOL 203 and BIOL 204) or BIOL 208 and permission of the instructor. Crosslisted as ANBE 382, ANBE 682 and BIOL 682.

**BIOL 391. Foundations of Genetics. 1 Credit.**

**Offered Either Fall or Spring; Lecture hours:3**

This course will discuss the mechanisms of heredity from a classical and modern perspective. Topics include the structure, function molecular nature of the genome, biological variation from mutation and selection, the genetics of populations and the use of genetics as a tool in modern Biology. Crosslisted as BIOL 691.

**BIOL 399. Mentored Undergraduate Research. .5-2 Credits.**

**Offered Fall, Spring or Summer; Lecture hours:Varies,Other:Varies; Repeatable; May require dissection or live animal experimentation**

Undergraduate research mentored by a faculty member. Prerequisite: permission of the instructor.

**BIOL 3NT. Biology Nontraditional Study. .5-2 Credits.**

**Lecture hours:Varies,Other:Varies**

Nontraditional study in biology.