

CELL BIOLOGY/BIOCHEMISTRY (BICH)

Faculty

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Developed jointly by the biology and chemistry departments, the major in cell biology/biochemistry at Bucknell is interdisciplinary in nature. The bachelor of science major is designed for students who are interested in understanding living organisms at the cellular and molecular level. This course of study will provide strong foundations in both biology and chemistry and will offer the student both the intellectual and the laboratory skills to grapple with questions at the interface of these two disciplines. In addition to a rigorous scientific education, this program enables students to gain a strong background in the liberal arts and to think critically about the impact of biotechnology on social and ethical issues.

The major in cell biology/biochemistry will focus on subdisciplines within biology and chemistry such as immunology, genetic engineering, nucleic acids, biomembrane function, cell biology of cancer, and enzymology. This program strongly emphasizes independent student research, including both seminar programs and hands-on research. A major in cell biology/biochemistry offers students an excellent preparation for careers in biotechnology, biomedical technology, medicine, pharmacology and bioengineering. It also is an excellent foundation for students preparing for entrance into Ph.D. programs in cell and molecular biology or biochemistry, or Ph.D./M.D. programs in medically-related fields.

Cell Biology/Biochemistry Major

The **major** requires:

BIOL 201	Biological Inquiries and Observations ^{1,2}	1
BIOL 203	Integrated Concepts in Biology Fall ¹	1
BIOL 204	Integrated Concepts in Biology Spring ¹	1
BIOL 327	Molecular Biology	1
BIOL 340/CHEM 358	Biochemical Methods ¹	1
BIOL 352	Cell Biology	1
CHEM 205 or CHEM 207	Principles of Chemistry Explorations in Chemistry	1
CHEM 211	Organic Chemistry I	1
CHEM 212	Organic Chemistry II	1
CHEM 231	Analytical Chemistry	1
CHEM 340 or CHEM 341	Biological Physical Chemistry Physical Chemistry I	1
CHEM 351	Biochemistry I	1
PHYS 211	Classical and Modern Physics I	1
PHYS 212	Classical and Modern Physics II	1
MATH 201	Calculus I	1
MATH 202	Calculus II	1
Select three of the following: ³		3
BIOL 302	Microbiology	
BIOL 306	Biology of Host-Microbe Interactions	
BIOL 308	Microbial Genetics	
BIOL 316	Plant Growth and Development	
BIOL 318	Principles of Physiology	
BIOL 323	Mammalian Histology	
BIOL 324	Neurophysiology	
BIOL 325	Evolutionary Genomics	
BIOL 326	Cytogenetics	
BIOL 328	Endocrinology	
BIOL 331	Genomics	
BIOL 332	Developmental Neurobiology	

BIOL 339	Developmental Biology
BIOL 347	Virology
BIOL 348	Immunology
BIOL 362	Topics in Cell Biology
BIOL 363	Receptors of Biological Membranes
BIOL 364	Advanced Data Analysis in Biology
BIOL 365	Introduction to Microscopy
BIOL 375	Cellular and Molecular Neurobiology
BIOL 399	Mentored Undergraduate Research ⁴
CHEM 313	Synthetic Organic Chemistry
CHEM 314	Mechanistic Organic Chemistry
CHEM 317	Special Topics in Organic Chemistry
CHEM 321	Inorganic Chemistry I
CHEM 322	Inorganic Chemistry II
CHEM 327	Special Topics in Inorganic Chemistry
CHEM 332	Analytical Chemistry II
CHEM 337	Special Topics in Analytical Chemistry
CHEM 342	Physical Chemistry II
CHEM 347	Special Topics in Physical Chemistry
CHEM 352	Biochemistry II
CHEM 357	Special Topics In Biochemistry
CHEM 360	Advanced Environmental Chemistry
CHEM 375	Undergraduate Research ⁴
CHEM 376	Undergraduate Research ⁴

Total Credits**19**

¹ Contributes to satisfying the writing in the major and information literacy requirements.

² Satisfies the formal presentation requirement.

³ At least one of these biology or chemistry electives must be a laboratory course.

⁴ One full credit of a research course may be counted as an elective toward the major.

The Culminating Experience requirement will be fulfilled by cell biology/biochemistry students after completing one of the following:

- Enrolling in a 300-level laboratory course in biology during their last three semesters. These classes will utilize inquiry-based learning and require students to demonstrate writing, information literacy and speaking at a level that is appropriate for a graduating Cell Biology/Biochemistry major.
- Registering for independent research in either biology (BIOL 399 Mentored Undergraduate Research), or chemistry (CHEM 375 Undergraduate Research or CHEM 376 Undergraduate Research).
- Completing an honors thesis.

The recommended sequence for the bachelor of science major is as follows:

First Year

First Semester	Credits	Second Semester	Credits
BIOL 201		1 BIOL 204	1
CHEM 205 or 207		1 CHEM 211	1
MATH 201		1 MATH 202	1
	3		3

Sophomore

First Semester	Credits	Second Semester	Credits
BIOL 203		1 BIOL 327	1
CHEM 212		1 CHEM 231	1
	2		2

Junior

First Semester	Credits	Second Semester	Credits
BIOL 352		1 BIOL 340 or CHEM 358	1

CHEM 351	1	PHYS 212	1
PHYS 211	1	Elective in biology or chemistry	1
	3		3
Senior			
First Semester	Credits	Second Semester	Credits
Elective in biology or chemistry		1 CHEM 340 or 341	1
		Elective in biology or chemistry	1
		1	2

Total Credits: 19

Learning Goals (mapped to University Learning Goals)

Majors in Cell Biology/Biochemistry will be able to:

1. Demonstrate a working conceptual knowledge of relevant sub-disciplines of biology and chemistry, including molecular and cell biology, genetics, organismal biology, organic, inorganic, analytical and physical chemistry and biochemistry (1, 4).
2. Demonstrate laboratory skills in both chemistry and biology (1, 6).
3. Write a well-organized, logical and scientifically sound research report (1, 6, 7).
4. Communicate scientific information through a well-organized, logical and scientifically sound oral presentation (1, 6, 7).
5. Formulate and test hypotheses, critically analyze evidence and draw logical conclusions (1, 4, 6).
6. Skillfully utilize the scientific literature and databases in biochemistry, molecular and cell biology (1, 8, 9).
7. Be aware of current research opportunities and career paths at the interface of chemistry and biology (1, 9).

Numbers in parentheses reflect related Educational Goals of Bucknell University.

Biology 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 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:6**

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

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 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 BIOL 609.

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 BIOL 612.

BIOL 313. Mammalogy. 1 Credit.**Offered Alternating Fall Semester; 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 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,Lab: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 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 Spring Semester Only; 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 BIOL 628.

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 BIOL 653 and 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) and 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 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 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 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 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.

Chemistry Courses**CHEM 105. Introduction to Chemistry. 1 Credit.****Offered Fall Semester Only; Lecture hours:3,Lab:3**

A terminal elementary course covering in-depth selected topics, which may vary from year to year. Satisfies science requirement for Bachelor of Arts students not majoring in science or engineering. Not open to students who have taken CHEM 160 or any 200-level CHEM course. Prerequisite: seniors by permission only.

CHEM 160. Introduction to Environmental Chemistry. 1 Credit.**Offered Spring Semester Only; Lecture hours:3,Lab:3**

One semester terminal course in chemistry. Introduction to the basic chemistry principles that govern natural processes and anthropogenic effects on the environment. Satisfies laboratory science requirement for Bachelor of Arts students not majoring in science or engineering. Not open to students who have taken CHEM 105 or any 200-level CHEM. Crosslisted as ENST 160.

CHEM 203. General Chemistry for Engineers. 1 Credit.**Offered Fall Semester Only; Lecture hours:3,Other:4**

Fundamental principles in inorganic chemistry including aqueous reactions, atomic and molecular structure, coordination compounds, solids, liquids, and gases, and basic equilibrium. Laboratory experiments are both qualitative and quantitative.

CHEM 205. Principles of Chemistry. 1 Credit.**Offered Both Fall and Spring; Lecture hours:3,Other:4**

First college chemistry course for most students. Introduction to chemical principles. Prerequisite: high school chemistry or equivalent. Credit not given for both CHEM 205 and CHEM 207.

CHEM 207. Explorations in Chemistry. 1 Credit.**Offered Fall Semester Only; Lecture hours:3,Lab:5**

Advanced introductory chemistry course for students with a strong chemistry background. Inquiry based projects and lab experiences. Students seeking permission to take CHEM 207 (instead of CHEM 205) must take the online placement test. Credit not given for both CHEM 207 and CHEM 205.

CHEM 211. Organic Chemistry I. 1 Credit.**Offered Spring Semester Only; Lecture hours:3,Other:4**

First-year, second-semester course for students majoring in chemistry, biochemistry, and biology. Bonding and structure in organic compounds, resonance, organic acid/base reactions, basic nomenclature, conformational analysis, stereochemistry, properties and reactions of functional groups. Prerequisite: CHEM 205, CHEM 207 or permission of instructor.

CHEM 212. Organic Chemistry II. 1 Credit.**Offered Fall Semester Only; Lecture hours:3,Other:4**

A continuation of CHEM 211 with focus on properties and reactions of functional groups, synthesis, and spectroscopic analysis. Prerequisite: CHEM 211.

CHEM 230. Principles of Chemistry 2. 1 Credit.**Offered Spring Semester Only; Lecture hours:3,Other:4**

Quantitative topics in equilibrium, including acid-base chemistry, solubility, and electrochemistry. Solid state crystal structures, coordination complexes, and nuclear chemistry are also introduced. Especially appropriate for life-science students. Prerequisite: CHEM 203, or CHEM 205, or CHEM 207.

CHEM 231. Analytical Chemistry. 1 Credit.**Offered Spring Semester Only; Lecture hours:3,Other:5**

Chemical equilibrium and modern analysis with an emphasis on acid-base systems, solubility, metal ion determinations, electroanalytical chemistry, spectrophotometry, and separation methods. Prerequisite: CHEM 203, or CHEM 205, or CHEM 207.

CHEM 233. Analytical Chemistry for Engineers. 1 Credit.**Offered Fall Semester Only; Lecture hours:3,Other:4**

Chemical equilibrium and modern analysis with an emphasis on acid-base systems, solubility, metal ion determinations, electroanalytical chemistry, and spectrophotometry. College of Engineering students only. Prerequisite: CHEM 205 or CHEM 207, or by instructor permission. Students may take only one of these for credit: CHEM 230, CHEM 231, or CHEM 233.

CHEM 2NT. Chemistry Non-traditional Study. 1-2 Credits.**Offered Fall, Spring, Summer; Lecture hours:Varies,Other:Varies**

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

CHEM 313. Synthetic Organic Chemistry. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3,Recitation:1**

Modern synthetic organic chemistry, with examples involving complex natural products. Application of organic mechanism, synthetic strategy, and advanced transformations to total synthesis. Prerequisite: CHEM 212. Crosslisted as CHEM 613.

CHEM 314. Mechanistic Organic Chemistry. 1 Credit.**Offered Either Fall or Spring; Lecture hours:4,Recitation:2**

Thermal and kinetic aspects of organic reactions are discussed along with the effect of substituents, solvents, and stereochemistry on reaction pathways. Qualitative molecular orbital theory of organic compounds is covered in depth. Weekly problem sessions are held. Prerequisite: CHEM 212. Crosslisted as CHEM 614.

CHEM 317. Special Topics in Organic Chemistry. 1 Credit.**Offered Either Fall or Spring; Lecture hours:4; Repeatable**

Available by independent study. Prerequisites: CHEM 212 and permission of the instructor.

CHEM 321. Inorganic Chemistry I. 1 Credit.**Offered Fall Semester Only; Lecture hours:3,Lab:4**

Structures and reactivity of inorganic systems. Emphasizes hands-on, experiential learning in workshops and laboratory. Prerequisites: CHEM 211 and CHEM 231 or permission of the instructor.

CHEM 322. Inorganic Chemistry II. 1 Credit.**Offered Spring Semester Only; Lecture hours:3,Other:5**

Survey course in modern inorganic chemistry covering transition metal, coordination, organometallic, and bioinorganic chemistry. Laboratory will consist of synthetic and physical measurements as well as the manipulation of air sensitive materials. Prerequisite: CHEM 321 or permission of the instructor. Crosslisted as CHEM 622.

CHEM 327. Special Topics in Inorganic Chemistry. 1 Credit.**Offered Either Fall or Spring; Lecture hours:4; Repeatable**

Topics vary. Available by independent study. Prerequisite: CHEM 221. Crosslisted as CHEM 627.

CHEM 332. Analytical Chemistry II. 1 Credit.**Offered Fall Semester Only; Lecture hours:3,Lab:4**

Theory and practice of techniques of instrumental analysis including spectrophotometry, fluorescence, mass spectrometry, atomic absorption, chromatography, capillary electrophoresis, and dynamic electrochemistry. Prerequisite: CHEM 231. Crosslisted as CHEM 632.

CHEM 337. Special Topics in Analytical Chemistry. 1 Credit.**Offered Either Fall or Spring; Lecture hours:4**

Available by independent study. Prerequisite: CHEM 231 and permission of the instructor. Crosslisted as CHEM 637.

CHEM 340. Biological Physical Chemistry. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3,Other:6**

Introduction to physical chemistry for life science students, with emphasis on thermodynamics, hydrodynamics and spectroscopy. Not open to B.S. chemistry majors. Prerequisites: CHEM 231, MATH 201, and PHYS 211. MATH 202 and PHYS 212 are recommended. Crosslisted as CHEM 640.

CHEM 341. Physical Chemistry I. 1 Credit.**Offered Fall Semester Only; Lecture hours:3,Other:5**

Introductory physical chemistry with emphasis on thermodynamics, kinetics and electrochemistry. Prerequisites: CHEM 231, MATH 211, and PHYS 212. Not open to engineering majors. Crosslisted as CHEM 641.

CHEM 342. Physical Chemistry II. 1 Credit.**Offered Spring Semester Only; Lecture hours:3,Other:5**

Introductory physical chemistry with emphasis on quantum mechanics, structure and bonding, molecular spectroscopy and statistical mechanics. The customized laboratory experience will emphasize applications of spectroscopy and computational methods. Prerequisite: CHEM 341. Crosslisted as CHEM 642.

CHEM 343. Physical Chemistry for Engineers. 1 Credit.**Offered Fall Semester Only; Lecture hours:3,Recitation:1**

Introductory physical chemistry for engineers, with emphasis on thermodynamics, chemical kinetics and electrochemistry. Prerequisites: CHEM 231 or CHEM 233, MATH 211, PHYS 211. Only open to engineering majors.

CHEM 347. Special Topics in Physical Chemistry. 1 Credit.**Offered Either Fall or Spring; Lecture hours:4**

Topics vary. Prerequisite: CHEM 230 or CHEM 231. All others by permission of the instructor. Crosslisted as CHEM 647.

CHEM 351. Biochemistry I. 1 Credit.**Offered Fall Semester Only; Lecture hours:3,Recitation:1**

Introduction to biological chemistry with emphasis on the structure and function of proteins, lipids, carbohydrates and nucleic acids, kinetics and mechanisms of enzymes, bioenergetics, and metabolism. Prerequisites: CHEM 212 and either CHEM 230 or CHEM 231. Crosslisted as CHEM 651.

CHEM 352. Biochemistry II. 1 Credit.**Offered Spring Semester Only; Lecture hours:3,Recitation:1**

Advanced topics in protein structure and function, protein folding, enzyme mechanisms, electron transport and free-energy coupling mechanisms, biosynthesis, metabolic regulation, and supramolecular assemblies. Prerequisite: CHEM 351 or permission of the instructor. Crosslisted as CHEM 652.

CHEM 357. Special Topics In Biochemistry. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3,Other:1**

Structure/function relationships and dynamics of biomolecules. Prerequisite: permission of the instructor.

CHEM 358. Biochemical Methods. 1 Credit.**Offered Spring Semester Only; Lecture hours:2,Other:6**

A course in laboratory techniques including cell fractionation, protein, and nucleic acid analysis. Spectrophotometry, chromatography, centrifugation, electrophoresis, and mass spectrometry are emphasized. Crosslisted as BIOL 340.

CHEM 360. Advanced Environmental Chemistry. 1 Credit.**Offered Fall Semester Only; Lecture hours:4**

Chemistry of the atmosphere, hydrosphere, and lithosphere. Natural processes and anthropogenic effects will be discussed. Prerequisite: CHEM 230 or CHEM 231 or permission of the instructor. Crosslisted as CHEM 660.

CHEM 365. Atmospheric Chemistry and Physics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:4**

Addresses the relationships of chemistry, physics, and engineering principles in understanding processes in the Earth's atmosphere. Topics include overview of the Earth's atmospheric history and problems of current environmental concerns including urban ozone, acid rain, particulate pollution, and global change. Crosslisted as CHEG 455.

CHEM 371. Chemistry Lecture Series. .25 Credits.**Offered Both Fall and Spring; Lecture hours:1; Repeatable**

Formal oral presentations on current research will be given by students, faculty and visiting scientists. Prerequisites: participation in an approved research project or independent study for seniors or second term juniors only.

CHEM 375. Undergraduate Research. .5-2 Credits.**Offered Both Fall and Spring; Lecture hours:Varies,Other:Varies; Repeatable**

Original investigations in analytical, biological, organic, physical, environmental or inorganic chemistry.

CHEM 376. Undergraduate Research. .5-2 Credits.**Offered Both Fall and Spring; Lecture hours:Varies,Other:Varies; Repeatable**

Original investigations in analytical, biological, organic, physical, environmental or inorganic chemistry.

CHEM 385. Seminar. .5 Credits.**Offered Both Fall and Spring; Lecture hours:2; Repeatable**

Topics vary. Crosslisted as CHEM 685.

CHEM 386. Seminar. .5 Credits.**Offered Both Fall and Spring; Lecture hours:2; Repeatable**

Topics vary. Crosslisted as CHEM 686.