

CELL BIOLOGY/BIOCHEMISTRY

Faculty

Director: Marie C. Pizzorno

Coordinating Committee: Moria Cairns Chambers, Kenneth A. Field, Matthew B. Heintzelman, Marie C. Pizzorno, David Rovnyak, Sarah Smith, Timothy G. Strein, Rebecca L. Switzer

Other Participating Faculty: Matthew Q. Clark, Julie A. Gates, Mark F. Haussmann, Michael R. Krout, Leocadia V. Paliulis, Emily Stowe

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 provides strong foundations in biology and chemistry and will offer the student 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 focuses 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 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	Principles of Chemistry	1
or CHEM 207	Explorations in Chemistry	
CHEM 211	Organic Chemistry I	1
CHEM 212	Organic Chemistry II	1
CHEM 231	Quantitative Analysis	1
CHEM 340	Biological Physical Chemistry	1
or CHEM 341	Physical Chemistry I	
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 318	Principles of Physiology	
BIOL 324	Neurophysiology	
BIOL 325	Evolutionary Genomics	
BIOL 328	Endocrinology	
BIOL 329	Foundations of Genetics	
BIOL 331	Genomics	
BIOL 332	Developmental Neurobiology	
BIOL 339	Developmental Biology	
BIOL 347	Virology	

BIOL 348	Immunology	
BIOL 362	Topics in Cell Biology	
BIOL 364	Advanced Data Analysis in Biology	
BIOL 365	Introduction to Microscopy	
BIOL 368	Microbiota-Gut-Brain Axis	
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	Instrumental Analysis	
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
Elective in biology or chemistry		1 CHEM 340 or 341
		Elective in biology or chemistry
	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 103. DNA & Decision Making. 1 Credit.

Offered Fall Semester Only; Lecture hours:3

This is an "Inside-Out" course, taught in a local prison with both Bucknell and incarcerated students. Topics include the basic biology of DNA and the uses and misuses of technology related to DNA and genetics (e.g. genetically modified foods, genetic testing, genetic manipulations, DNA and the legal system). Preference for majors that are not biology-related. Prerequisite: Permission of the Instructor.

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 121. Biology for Non-majors. 1 Credit.

Offered Either Fall or Spring, TLC Tutoring Course; 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, TLC Tutoring Course; 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 132. Science of Sex. 1 Credit.

Offered Summer Session Only; Lecture hours:3

Sex, Gender, Reproduction and Sexuality are powerful and interlinked parts of the human experience. This course serves as an introduction to the science underlying reproductive biology and sexology.

BIOL 136. Introduction to Infectious Diseases. 1 Credit.**Offered Summer Session Only; Lecture hours:6**

Infectious diseases affect our health and well-being. This non-majors course explores the biology of three main types of microorganisms that cause diseases in humans – bacteria, viruses and parasites. Course will integrate popular and scientific sources and include a variety of student activities including case studies and short hands-on lab activities. Open to BCCSP only. Prerequisite: permission of the instructor.

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**

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:2,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,TLC Tutoring Course; 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.**TLC Tutoring Course,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 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.

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 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,Lab: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 and permission of the instructor. Crosslisted as BIOL 602.

BIOL 303. Vertebrate Ecology. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Vertebrate ecology explores how vertebrates interact with their physical environment from individual to global scales. We will overview the major clades of vertebrates, including a discussion about how environments in which they live shapes their anatomy, physiology and behavior. We will also cover population dynamics and community structures. Prerequisites: (BIOL 203 and BIOL 204) or (ANBE/BIOL/PSYC 266) and instructor permission. Crosslisted as ANBE 303, ANBE 603 and BIOL 603.

BIOL 305. Vertebrate Ecology- with Lab. 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. Prerequisites: BIOL 203 and BIOL 204 and permission of 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**

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. Prerequisites: (BIOL 203 and BIOL 204) or (BIOL 207 and BIOL 208). 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 and permission of the instructor. 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 and permission of the instructor. Crosslisted as ANBE 309, ANBE 609 and 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) 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 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 and permission of the instructor. Crosslisted as ANBE 314 and BIOL 614 and ANBE 614.

BIOL 315. Social Behavior and Sociality. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

As humans, being social is an integrated aspect of our lives that we often take for granted. However, from an evolutionary perspective there are a lot of reasons animals should live alone. In this course we will focus on studying the animals that live in social groups or interact socially.

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 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 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.**Offered Either Fall or Spring; 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 and permission of the instructor.

Crosslisted as ANBE 325, ANBE 625 and BIOL 625.

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 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 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 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 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. Prerequisites: BIOL 203 and BIOL 204 and permission of the instructor. 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 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 and permission of the instructor. 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 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 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. Prerequisites: BIOL 203 and BIOL 204 and permission of the instructor. 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 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 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 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 bio-membranes, cell growth patterns, cell signaling, the cytoskeleton, cell organelles, and microscopic techniques. Laboratory includes experience with cell culture. Prerequisites: BIOL 203 and BIOL 204 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 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 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 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 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 and permission of the instructor. Crosslisted as ANBE 358, ANBE 658 and BIOL 658.

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 364. Advanced Data Analysis in Biology. 1 Credit.**Offered Spring Semester Only; Lecture hours:3,Lab:3**

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. Prerequisites: BIOL 203 and BIOL 204 and MATH 216 and permission of the instructor. Crosslisted as ANBE 364, ANBE 664 and 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. Crosslisted as BIOL 667.

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. Prerequisites: BIOL 203 and BIOL 204 and permission of the instructor. Crosslisted as BIOL 668.

BIOL 370. Primatology. 1 Credit.**Offered Either Fall or Spring; 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, cognitive abilities and management. Prerequisites: (ANBE 266 or BIOL 266 or PSYC 266) or (BIOL 203 and BIOL 204) and permission of the instructor. 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 and permission of the instructor. Crosslisted as BIOL 671.

BIOL 372. Microbial Ecology. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Students will explore the natural history and evolution of microbial communities across environments including soils, oceans and animal hosts. Key topics include community structure and function, biogeography, phylogenomics and community assembly. This course will cultivate a community of learners who apply reasoning and critical thinking skills to analyze impact. Prerequisites: BIOL 203 and BIOL 204 and permission of the instructor. Crosslisted as BIOL 672.

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 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 376. Animal Nutrition. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

This course explores the science of nutrition, emphasizing biochemical, physiological and metabolic processes. We'll examine physiological properties of macronutrients, assess health impacts of popular diets and discuss the physiological role of micronutrients. While touching on human health, the focus will be general principles of nutrition that apply to all animals. Prerequisites: BIOL 203 and BIOL 204 and permission of instructor. Crosslisted as ANBE 376, ANBE 676 and BIOL 676.

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 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 and permission of the instructor. Crosslisted as ANBE 382, ANBE 682 and BIOL 682.

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 Either Fall or Spring,TLC Tutoring Course; 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 107. Chemistry of Cooking. 1 Credit.**Offered Summer Session Only; Lecture hours:4,Other:3**

This course will introduce students to the fundamental principles of chemistry in the context of cooking and food preparation. Students will analyze and solve food-related questions using chemistry concepts, create their own recipes by understanding the scientific interactions between ingredients and cooking methods and gain appreciation for the science behind cooking.

CHEM 131. What's That Smell?. 1 Credit.**Offered Occasionally; Lecture hours:3,Lab:3**

Our sense of smell is an exquisite chemical detector that guides us to delicious foods, away from potential threats, and triggers memories of lived experiences. This course explores the many sources of smells in our environment, how we detect smelly chemicals, and how scents can be grouped using chemical thinking.

CHEM 203. General Chemistry for Engineers. 1 Credit.**Offered Fall Semester Only,TLC Tutoring Course; 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,TLC Tutoring Course; 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 Occasionally; 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 Both Fall and Spring,TLC Tutoring Course; 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 203 or CHEM 205 or CHEM 207 or permission of instructor.

CHEM 212. Organic Chemistry II. 1 Credit.**Offered Both Fall and Spring,TLC Tutoring Course; 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.**TLC Tutoring Course, Offered Spring Semester Only; Lecture hours:3, Other:4**

Quantitative topics in equilibrium, acid-base chemistry, solubility, and electrochemistry, solid state crystal structures, coordination complexes, and nuclear chemistry are introduced. Especially appropriate for life-science students. Prerequisite: CHEM 203, or CHEM 205, or CHEM 207. Students may take only one of these for credit: CHEM 230, CHEM 231, or CHEM 233.

CHEM 231. Quantitative Analysis. 1 Credit.**TLC Tutoring Course, 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. Students may take only one of the following courses for credit: CHEM 230, CHEM 231 or CHEM 233.

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 Occasionally; 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 Occasionally; Lecture hours:4**

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 Occasionally; Lecture hours:4; Repeatable**

Topics vary. Prerequisite: CHEM 212 or permission of the instructor. Crosslisted as CHEM 617.

CHEM 321. Inorganic Chemistry I. 1 Credit.**Offered Fall Semester Only; Lecture hours:3, Other:5**

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. Crosslisted as CHEM 621.

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 Occasionally; Lecture hours:4; Repeatable**

Topics vary. Prerequisite: CHEM 321 or permission of the instructor. Crosslisted as CHEM 627.

CHEM 332. Instrumental Analysis. 1 Credit.**Offered Fall Semester Only; Lecture hours:3, Other:5**

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 Occasionally; Lecture hours:4**

Topics vary. Prerequisite: CHEM 231 or permission of the instructor. Crosslisted as CHEM 637.

CHEM 340. Biological Physical Chemistry. 1 Credit.**Offered Spring Semester Only; 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 211P. 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**

Survey of physical chemistry including introductory thermodynamics, quantum mechanics, spectroscopy, kinetics, and statistical mechanics. Prerequisites: CHEM 231, MATH 211, and PHYS 212. 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 Occasionally; Lecture hours:4**

Topics vary. Prerequisite: CHEM 230 or CHEM 231 or 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 Occasionally; Lecture hours:3,Other:1**

Structure/function relationships and dynamics of biomolecules. Prerequisite: permission of the instructor. Crosslisted as CHEM 657.

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. Prerequisites: BIOL 203 and BIOL 204 and CHEM 351 and permission of the instructor. Crosslisted as BIOL 340.

CHEM 360. Advanced Environmental Chemistry. 1 Credit.**Offered Alternate Fall or Spring; 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 and CHEG 655.

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 Fall Semester Only; Lecture hours:2; Repeatable**

Topics vary. Crosslisted as CHEM 685.

CHEM 386. Seminar. .5 Credits.**Offered Spring Semester Only; Lecture hours:2; Repeatable**

Topics vary. Crosslisted as CHEM 686.