Biochemistry

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Administration:
Interdepartmental Biochemistry Committee: Louise E. Anderson (Biological Sciences), Wonwha Cho (Chemistry), Constance Jeffery (Biological Sciences), Brian Nichols (Biological Sciences)

The Bachelor of Science in Biochemistry is awarded by the College of Liberal Arts and Sciences to students who successfully complete this curriculum. It is a joint program of the Department of Biological Sciences and the Department of Chemistry. It is intended for students planning advanced study in biochemistry or molecular biology, who wish to pursue a medical degree, or who will be seeking employment and careers in biochemistry, molecular biology, biotechnology, or related fields. Students may be advised through the LAS advisors in the Department of Chemistry.

Professional Approval
The BS in Biochemistry is certified by the American Chemical Society and endorsed by the American Society of Biochemistry and Molecular Biology.

Distinction

Distinction. Research is recognized as an important component of the honors candidate’s program. Favorable consideration will be given to those individuals who demonstrate superior performance in chemical or biological research. Distinction in biochemistry is awarded to students who qualify as described below:

a. A GPA of at least 3.50/4.00 in chemistry, biology, and mathematics courses, excluding independent study or independent research.

b. Evidence of biochemical research ability as demonstrated by research in chemistry CHEM 499 or BIOS 399. Students who qualify for program distinction may be conferred high or highest distinction on the basis of superior performance.

High Distinction. In addition to fulfilling criterion 2 above, a GPA of at least 3.70/4.00 in chemistry, biology, mathematics, and physics courses.

Highest Distinction. In addition to fulfilling criterion 2 above, a GPA of at least 3.80/4.00 in chemistry, biology, mathematics, and physics courses, and presentation of other evidence of truly exceptional performance. Such performance may be identified in one or more of the following ways: independent research at an advanced level, superior performance in class work beyond that reflected in the grade point average, rapid completion of course requirements, completion of honors activities in 300-level course work taken through the Honors College.

Degree Program
- BS in Biochemistry

Biological Sciences (p. 1)
Chemistry (p. 5)
Physics (p. 9)

Biological Sciences

BIOS 104. Biology for Non-majors. 4 hours.
Origin and diversity of life; genetics, evolution, ecology and ecosystems; energy flow; photosynthesis; human anatomy and physiology; development of biological ideas; and biology, biotechnology and human society. Course Information: Credit is not given for BIOS 104 if the student has credit in BIOS 100 or BIOS 101 or BIOS 110 or BIOS 120. Animals may be used in instruction. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture. Natural World - With Lab course.

BIOS 110. Biology of Cells and Organisms. 4 hours.
Introductory biology at the molecular, cellular, and organismal level. Topics include: Scientific skills, biological chemistry, cell structure and function, metabolism, cell division, molecular genetics, diversity, anatomy and physiology. Course Information: Previously listed as BIOS 100. Animals used in instruction. THIS COURSE IS INTENDED FOR SCIENCE MAJORS. BIOS 110 and BIOS 120 may be taken in any order. Credit is not given for BIOS 110 if the student has credit in BIOS 100. Credit is not given for BIOS 104 if the student has credit in BIOS 100, BIOS 101, BIOS 110 or BIOS 120. Class Schedule Information: To be properly registered, students must enroll in one Lecture and one Laboratory-Discussion. Natural World - With Lab course.

BIOS 112. Program Design I in the Context of Biological Problems. 3 hours.
Introduction to programming using Biology as the context for programming in a high-level language; control structures, variables, simple and aggregate data types; problem-solving techniques; biology topics include central dogma and genetics. Course Information: Same as CS 112. Credits is not given for CS 112, if student has credit in CS 111 or CS 113. Course Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

BIOS 120. Biology of Populations and Communities. 4 hours.
Introductory biology at the level of populations and communities. Topics include: Scientific skills, evolution, Mendelian and population genetics, biological diversity, and ecological systems including ecosystem processes and human impacts. Course Information: Previously listed as BIOS 101. Animals used in instruction. This course is intended for science majors. BIOS 110 and BIOS 120 may be taken in any order. Credit is not given for BIOS 120 if the student has credit in BIOS 101. Credit is not given for BIOS 104 if the student has credit in BIOS 100, BIOS 101, BIOS 110 or BIOS 120. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Laboratory-Discussion. Natural World - With Lab course.

BIOS 184. The Basics of Neuroscience. 1 hour.
Introduction to the scientific study of the brain and behavior. Overview of neuroscience as an integrative discipline. Course Information: Same as PHIL 184 and PSCH 184. Satisfactory/Unsatisfactory grading only.

BIOS 196. Biology Colloquium. 2 hours.
Combines in-class seminars with off-campus day and weekend field trips, with the goal of introducing students to different areas of the Biological Sciences, and alternate career options. Course Information: May be repeated up to 1 time(s). Field trips required at a nominal fee. Prerequisite(s): Major in biological sciences, biochemistry, or neuroscience.
BIOS 199. Introduction to Research. 1 hour.
An introduction to research for students interested in becoming biology majors. Credit is contingent on approval by the research supervisor of a written report that is also submitted to the Biology colloquium faculty adviser. Course Information: 1 hour. Satisfactory/Unsatisfactory grading only. May be repeated. Prerequisite(s): Approval of the department. Class Schedule Information: To be properly registered, students must enroll in one Conference and one Laboratory.

BIOS 220. Genetics. 3 hours.
Principles of genetics, gene and chromosome structure, gene expression, inheritance of complex traits, Mendelian and non-Mendelian inheritance, genomes, and genetic engineering. Course Information: Prerequisite(s): BIOS 196 or BIOS 110; and BIOS 101 or BIOS 120. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Lecture.

BIOS 222. Cell Biology. 3 hours.
The physiological processes that govern cell function. Topics include enzyme kinetics, metabolism, membranes, membrane transport, electrical and chemical signaling, intracellular motors, motility, and junctions. Prerequisite(s): BIOS 100 or BIOS 110.

BIOS 230. Evolution and Ecology. 3 hours.
Molecular and ecological basis of evolutionary change through adaptation or natural selection to explain diversity of species, behaviors, populations, communities and ecosystems and how these interactions are affected by the changing environment. Prerequisite(s): BIOS 101 or BIOS 120.

BIOS 236. Animal Behavior. 3 hours.
Examine the proximate and ultimate causes of animal behavior; neural and hormonal mechanisms; diversity of behavior and their relationship to an organism's ecology and evolution. Course Information: Prerequisite(s): BIOS 101 or BIOS 120.

BIOS 237. The Human Skeleton. 4 hours.
Examination of the human skeleton, emphasizing bone identification and functional anatomy. Course Information: Same as ANTH 237. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

BIOS 272. Comparative Vertebrate Anatomy. 4 hours.
Comparative vertebrate anatomy through the analysis of varying morphological features of hard and soft tissues. Course Information: Animals used in instruction. Prerequisite(s): BIOS 100 or BIOS 110; and BIOS 101 or BIOS 120. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

BIOS 286. The Biology of the Brain. 3 hours.
Survey of basic neurobiology. Brain structure, chemistry, development and control of behavior (sensation, movement, emotions, memory, cognition, sex). Course Information: Prerequisite(s): BIOS 100 or BIOS 110.

BIOS 294. Special Topics in Biological Sciences. 1-5 hours.
Selected topics in the Biological Sciences. Course Information: May be repeated. Students may register for more than one section per term.

BIOS 296. Directed Instruction. 2 hours.
Leadership opportunity for upper-division students who wish to assist with the biology colloquium. Course Information: May be repeated to a maximum of 4 hours. Field trips required at a nominal fee. Students will be required to submit a final report describing their leadership activities and experiences. Prerequisite(s): BIOS 196 and approval of the department. To be properly registered, students must enroll in one Lecture-Discussion and one Practice.

BIOS 299. Honors Biology. 1 hour.
An additional hour of related work for students registered in another course in Biological Sciences. Course Information: May be repeated. Prerequisite(s): Membership in Honors College, or, for superior students, approval of the department; and registration in a Biological Sciences course (except BIOS 391 or BIOS 399) and consent of the instructor. Open only to freshmen, sophomores, and juniors. Honors course.

BIOS 305. Plant Evolutionary Ecology. 3 hours.
Fundamental aspects of plant structure and function, plant-environment interactions, and how they shape biodiversity, with an emphasis on their evolutionary context. Prerequisite(s): BIOS 230.

BIOS 310. Genetics Laboratory. 3 hours.
Advanced laboratory techniques in gene inheritance, expression and regulation using genetic engineering, molecular biology and bioinformatic and statistical analysis to study Mendelian, microbial, molecular, human and population genetics. Course Information: Previously listed as BIOS 221. Animals used in instruction. Credit is not given for BIOS 310 if student has credit in BIOS 221. Prerequisite(s): Credit or concurrent registration in BIOS 220.

BIOS 312. Cell Biology Laboratory. 2 hours.
Laboratory training in advanced cell biology methods used in research and clinical settings. Microscopy, protein extraction and quantification, immunoassays, cell culture, experimental design, data analysis and scientific writing are emphasized. Course Information: Previously listed as BIOS 223. Credit is not given for BIOS 312 if the student has credit in BIOS 223. Prerequisite(s): Credit or concurrent credit in BIOS 222.

BIOS 320. Developmental Biology. 3 hours.
Principles governing growth and differentiation from the molecular to the organismic level. Course Information: Prerequisite(s): BIOS 220.

BIOS 321. Developmental Biology Laboratory. 3 hours.
Laboratory problems in developmental biology. Course Information: Animals used in instruction. Prerequisite(s): Credit or concurrent registration in BIOS 320.

BIOS 323. Molecular Biology Laboratory. 3 hours.
Modern molecular biology techniques used in the isolation and functional analysis of genes. Bioinformatics, gene cloning, gene fusions and expression assays will be used in the analysis of the gene isolation and analysis. Course Information: Prerequisite(s): BIOS 220.

BIOS 325. Human Embryology. 3 hours.
Major events in human development between fertilization and birth. The developmental origins of adult body structure and function, normal anatomical variations, and congenital malformations. Course Information: Prerequisite(s): BIOS 100 or BIOS 110.

BIOS 326. Embryology Laboratory. 1 hour.
Examination of histological sections of mammalian embryos. Identification of cells and tissues from their microscopic appearance, reading serial sections. Prerequisite(s): Credit or concurrent registration in BIOS 325.

BIOS 331. General Ecology Laboratory. 3 hours.
Field and laboratory data collection for hypothesis testing; required field trips to representative plant communities. Course Information: Animals used in instruction. Required field trips on Saturdays. Prerequisite(s): BIOS 101 or BIOS 120. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Practice.

BIOS 336. Animal Behavior Laboratory. 3 hours.
Field and laboratory data collection for hypothesis testing in animal behavior. Course Information: Animals used in instruction. Field trip required at a nominal fee. Field work required. Prerequisite(s): Credit or concurrent registration in BIOS 236.
BIOS 340. Environmental Physiology. 3 hours.
The performance of an organism or group of organisms in the context of their natural environment and their evolutionary background. The organism as an integrated system rather than a collection of cellular or organ processes. Course Information: Prerequisite(s): BIOS 100 or BIOS 110; and BIOS 101 or BIOS 120.

BIOS 343. Animal Physiological Systems. 3 hours.
How the human body works including digestive, neuromuscular, sensory, respiratory, excretory, endocrine and cardiovascular systems using examples across animal species and human case studies. Course Information: Previously listed as BIOS 240. Credit is not given for BIOS 343 if student has credit in BIOS 240. Prerequisite(s): BIOS 100 or BIOS 110; and BIOS 101 or BIOS 120. Recommended background: BIOS 222.

BIOS 350. General Microbiology. 3 hours.
An introduction to the morphology, staining, genetics, physiology and biochemistry of microbial life. Medical significance of bacteria, archaea, fungi, protozoa, algae and helminthes. The significance of viruses, prions, and viroids. Prerequisite(s): BIOS 100 or BIOS 110; and Credit or concurrent registration in CHEM 130 or CHEM 230 or CHEM 232. Recommended background: BIOS 101 or BIOS 120.

BIOS 351. Microbiology Laboratory. 2 hours.
Laboratory experience with aseptic and pure culture techniques; staining and microscopy of microorganisms; identification of unknown bacteria; control of microbial growth; antibiotics; medical microbiology. Prerequisite(s): Credit or concurrent registration in BIOS 350.

BIOS 352. Introductory Biochemistry. 3 hours.
Structure and function of cellular constituents; enzyme kinetics; metabolism of carbohydrates, lipids, amino acids, nucleotides; molecular biology of biosynthesis of proteins and nucleic acids. Course Information: Same as CHEM 352. No credit given for BIOS 352 if student has credit in BIOS 452 or BIOS 454 or CHEM 452 or CHEM 454. No credit toward the degree in biochemistry. Prerequisite(s): BIOS 100 or BIOS 110; and BIOS 101 or BIOS 120; and CHEM 230 or CHEM 232.

BIOS 360. Introduction to Paleontology. 4 hours.
The morphology, ecology, and relationships of fossil organisms. Basic principles of paleontology, including evolution, paleoecology and functional morphology. Course Information: Same as EAES 360. Field trip required at a nominal fee. One day field trip to collect fossils. Prerequisite(s): EAES 101 or EAES 111; or BIOS 100 or BIOS 110; and BIOS 101 or BIOS 120. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

BIOS 365. Human Ecological Systems. 3 hours.
Human-environmental interactions and feedbacks (positive and negative) and the ecological basis for health and sustainability of human-dominated landscapes. Case studies of real-world environmental issues. Course Information: Prerequisite(s): BIOS 101 or BIOS 120 or EAES 101 or PSCH 100 or SOC 100; or consent of the instructor.

BIOS 386. Seminar on Neurobiology. 2 hours.
Reading and discussion of both classic and recent research papers that are important in neurobiology. Course Information: Prerequisite(s): BIOS 286 or PSCH 262.

BIOS 391. Independent Study. 1 hour.
Individual study not covered in standard courses under close supervision of a faculty member. Credit is contingent on approval by research supervisor of a written report that is submitted to the department. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Students may register in more than one section per term. A maximum of 5 hours of BIOS 391 and/or BIOS 399 may be credited toward the department undergraduate major requirements. Prerequisite(s): Minimum of 2.00 grade point average in biological sciences courses and consent of the instructor. Class Schedule Information: This course counts toward the limited number of independent study hours accepted toward the degree and the major.

BIOS 399. Independent Research. 2 hours.
Individual research. Credit is contingent on approval by the research supervisor of a written report that is submitted to the department. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Students may register in more than one section per term. A maximum of 5 hours of BIOS 391 and/or BIOS 399 may be credited toward the department undergraduate major requirements. Prerequisite(s): Minimum of 2.00 grade point average in biological sciences courses, approval of the department, and consent of the instructor. Recommended background: Junior standing. Class Schedule Information: This course counts toward the limited number of independent study hours accepted toward the degree and the major.

BIOS 416. Natural Products. 3 or 4 hours.
Biogenetic approach to secondary metabolites. General principles and selected studies of phenolic compounds, terpenes, alkaloids, and other interesting natural products. Course Information: Same as CHEM 456. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): One year of organic chemistry.

BIOS 420. Genomics. 3 hours.
Theoretical background in genomics with practical experience in obtaining and analyzing large scale Next Generation Sequencing (NGS) datasets using high capacity computational resources. Course Information: Extensive computer use required. Prerequisite(s): BIOS 220 or BIOS 230; or consent of the instructor. Recommended background: STAT 101 or STAT 130 or BIOS 112.

BIOS 427. Ecosystem Ecology. 3 or 4 hours.
Flow of energy and matter between the environment and biological organisms including biological interactions that govern the cycling of water, carbon and nutrients at various spatial and temporal scales. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): BIOS 230.

BIOS 430. Evolution. 4 hours.
Focuses on empirical evolutionary data and theory, with an intro to data science, modeling, simulations in R programming language; it covers the history of evolution, population genetics, the species problem, biodiversity, macroevolution. Course Information: Extensive computer use required. Prerequisite(s): BIOS 120 AND either BIOS 220 or consent of the instructor. Recommended background: BIOS 230. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Laboratory.

BIOS 431. Plant and Animal Interactions. 3 hours.
Ecology of plant and animal interactions. In-depth reading and discussion of primary literature on herbivory and plant defense and pollination, seed dispersal and protection mutualisms. Course Information: Prerequisite(s): BIOS 230.
BIOS 435. Plant Evolution. 3 hours.
Examines the history of plant life in a rigorous survey of plant genetics, factors that influence diversity of form and function, the astonishing diversity of plant sexual systems, and conservation. Course Information: Prerequisite(s): BIOS 230.

BIOS 437. Topics in Tropical Ecology. 3 hours.
Introduction to the character of tropical ecosystems. In-depth reading and discussion of one or more current topics. Course Information: Prerequisite(s): BIOS 230.

BIOS 443. Animal Physiological Systems Laboratory. 3 hours.
Discussion and laboratory exploration of mammalian physiological systems, including immune, endocrine, cardiac, vascular, nervous, pulmonary, renal, and digestive systems. Course Information: Animals used in instruction. Prerequisite(s): Credit or concurrent registration in BIOS 343; or Credit or concurrent registration in BIOS 340; or consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Lecture, one Laboratory, and one Lecture-Discussion.

BIOS 446. Evolution and Human Disease. 3 hours.
Pathogen evolution, transmission of infectious disease, host response to pathogens, drug resistance in pathogens, and cancer progression/treatment are examined in light of natural selection, phylogenetics, coevolution, and population genetics. Course Information: Prerequisite(s): BIOS 230. Recommended background: BIOS 220.

BIOS 450. Advanced Microbiology. 3 hours.
Comprehensive analysis of metabolic, ecological, genomic, and functional diversity among the major groups of microorganisms. Relationship between microbial diversity and biogeochemistry in the environment, human/animal hosts, and engineered systems. Course Information: Prerequisite(s): BIOS 350.

BIOS 452. Biochemistry I. 4 hours.
Chemistry of proteins, nucleic acids, carbohydrates and lipids. Course Information: Same as CHEM 452. Prerequisite(s): Credit or concurrent registration in CHEM 234. Class Schedule Information: To be properly registered, students must enroll in one Discussion/Recitation and one Lecture.

BIOS 454. Biochemistry II. 4 hours.
Continues Biological Sciences 452. Carbohydrate and lipid metabolism, electron transport. Metabolism of amino acids, nucleic acids, proteins. Biosynthesis of macromolecules and regulation of macromolecular synthesis. Course Information: Same as CHEM 454. Prerequisite(s): BIOS 452 or CHEM 452. Class Schedule Information: To be properly registered, students must enroll in one Discussion/Recitation and one Lecture.

BIOS 455. Introduction to Landscape Ecology. 3 hours.
Uses a combination of lectures, discussions, and hands-on activities to introduce the concepts and methods of landscape ecology. We will discuss how landscape ecology can be applied to solving current environmental problems. Course Information: Extensive computer use required. Prerequisite(s): BIOS 230; or BIOS 331.

BIOS 458. Biotechnology and Drug Discovery. 3 or 4 hours.
Molecular and gene therapy, using small molecules including antisense, aptamers, and proteins. Structure-based drug design. Structural bioinformatics and drug discovery program. High-throughput screening. Combinatorial chemistry technology. Course Information: Same as CHEM 458. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): BIOS 352 or CHEM 352; or Credit or concurrent registration in BIOS 452 or Credit or concurrent registration in CHEM 452; or consent of the instructor.

BIOS 466. Principles of Paleontology. 3 hours.
Theory and methods of evolutionary paleobiology; includes paleoecology, functional morphology, and major features of organic evolution. Course Information: Same as EAES 466. Prerequisite(s): EAES 360 or consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture.

BIOS 473. Soils and the Environment. 4 hours.
Soil science, emphasizing local soils and parent materials, soil classification and mapping, soil physics, soil gases and greenhouse gas emissions, soil chemistry and biogeochemistry, soil-plant interactions, and soil invertebrates. Course Information: Same as EAES 473. Field work required. Recommended background: Introductory courses in Chemistry and Biology are recommended. Coursework in EAES (such as EAES 101 and/or 111) is preferred.

BIOS 475. Neural Engineering I: Introduction to Hybrid Neural Systems. 3 or 4 hours.
Modeling and design of functional neural interfaces for in vivo and in vitro applications, electrodes and molecular coatings, neural prostheses and biopotential control of robotics. Course Information: Same as BME 475. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): BIOE 472 or BME 472.

BIOS 480. Introduction to Modern Biostatistics with R. 3 hours.
An in-depth intro to research design, data visualization, and modern univariate statistics, from basic linear model to generalized linear models and linear mixed-effects models. Course Information: Extensive computer use required. All work done in the open-source R statistical computing language. Prerequisite(s): MATH 170 or MATH 180 or STAT 130. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Laboratory.

BIOS 482. Molecular and Developmental Neurobiology Laboratory. 3 hours.
A hands-on laboratory course designed to explore the most recent neurotechniques and how they are being used to advance knowledge of the brain. Model organism use will be restricted to small invertebrates (C. elegans). Course Information: Prerequisite(s): BIOS 286; or PSCH 262.

BIOS 483. Neuroanatomy. 4 hours.
Organization of the nervous system, with an emphasis on mammals. Course Information: Same as PSCH 483 and NEUS 483. Animals used in instruction. Prerequisite(s): BIOS 272 or BIOS 286 or BIOS 325 or PSCH 262; or consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

BIOS 484. Neuroscience I. 3 hours.
Neuroscience as an integrative discipline. Neuroanatomy of vertebrates, neural development, cellular neurobiology, action potential mechanisms, synaptic transmission and neuropharmacology. Course Information: Same as PHIL 484 and PSCH 484. Prerequisite(s): BIOS 286 or PSCH 262.

BIOS 485. Neuroscience II. 3 hours.
Integrative neuroscience, including sensory and motor systems; learning, memory, and language; pathology of nervous systems; philosophical perspectives, and modeling. Course Information: Same as PHIL 485 and PSCH 485. Prerequisite(s): BIOS 286 or PSCH 262.
BIOS 486. Animal Behavior and Neuroethology. 4 hours.
Neural and behavioral mechanisms of environmental information processing and interaction throughout the animal kingdom. Laboratory emphasizing a research project with journal style lab report, essay on assigned topic, occasional field trips required. Course Information: Animals used in instruction. Prerequisite(s): One course in neuroscience, animal physiology, or animal behavior. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

BIOS 489. Cellular Neurobiology Laboratory. 3 hours.
Recording from and analyzing the activity of nerve cells, neuronal networks, and other electrically excitable tissues. Course Information: Prerequisite(s): BIOS 286 or the equivalent.

BIOS 490. Topics Biological Sciences. 3 or 4 hours.
In-depth analysis of advanced topics in molecular, cellular, biomedical, ecology and evolution and neuroscience involving reading primary literature, term paper, student presentations and critical discussion. Course Information: 3 undergraduate hours. 4 graduate hours. May be repeated. Students may register in more than one section per term. Prerequisite(s): BIOS 230; or BIOS 220; or BIOS 222; or Graduate standing; or consent of the instructor.

Chemistry

CHEM 100. Chemistry and Life. 5 hours.
Principles of structural and environmental chemistry underlying the phenomenon of life on Earth, discussed in a historical, cultural and philosophical framework. Includes weekly two-hour laboratory. Course Information: Credit is not given for CHEM 100 if the student has credit in CHEM 112 or CHEM 116 or CHEM 122. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture. Natural World - With Lab course.

CHEM 101. Preparatory Chemistry. 4 hours.
Emphasis on problem solving. Metric units, dimensional analysis, chemical nomenclature, the mole concept, chemical stoichiometry. Course Information: For students without entrance credit in high school chemistry or inadequately prepared. Credit is not given for CHEM 101 if the student has credit in CHEM 116 or CHEM 122. Prerequisite(s): Adequate performance on the UIC chemistry placement examination. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion, one Lecture and one Quiz.

CHEM 105. Chemistry and the Molecular Human: An Inquiry Perspective. 4 hours.
A general education chemistry course that uses the empirical inquiry methods of science applied to the interaction of molecules—in foods, in the environment, and in medicines—with humans. Course Information: 4 hours. Credit is not given for CHEM 105 if the student has credit in CHEM 112 or CHEM 114 or CHEM 122 or CHEM 123 or CHEM 124 or CHEM 125. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion, one Discussion and one Laboratory. Natural World - With Lab course.

CHEM 110. Chemistry Problem Solving Workshop. 1 hour.
Problem solving and study strategies in study of general chemistry courses. Techniques for learning technical terms in textbooks will be covered. Methods of analyzing complex problems conceptually and solving them appropriately. Course Information: Satisfactory/ Unsatisfactory grading only. May be repeated for credit. Credit is not given for CHEM 110 if the student has credit in CHEM 124 or CHEM 116. Corequisites: Students will be enrolled in a UIC course in chemistry or a related area.

CHEM 115. Comprehensive General Chemistry. 5 hours.
One-semester introduction to general chemistry, including stoichiometry, periodicity, reaction types, gaseous state, solution stoichiometry, chemical equilibria, acid-base equilibria, dissolution-precipitation equilibria. Includes a weekly 3-hour lab. Course Information: Credit is not given for CHEM 115 if the student has credit in CHEM 112 or CHEM 116 or CHEM 122 or CHEM 123. This course is intended for pre-nursing students and should not be taken by those who need CHEM 122/123 or CHEM 116. Prerequisite(s): Grade of C or better in CHEM 101; or appropriate score on the department placement test. Class Schedule Information: To be properly registered, students must enroll in one Lecture, one Laboratory, and one Quiz. Natural World - With Lab course.

CHEM 116. Honors and Majors General and Analytical Chemistry I. 5 hours.
General and analytical chemistry with laboratory. Coverage of the fundamentals of chemistry including stoichiometry and equilibrium. Coverage of the principles of analytical chemistry, including the use of instrumentation. Course Information: Credit is not given for CHEM 116 if the student has credit in CHEM 112 or CHEM 122 and CHEM 123. Prerequisite(s): Superior performance on the UIC chemistry placement examination. Class Schedule Information: To be properly registered, students must enroll in one Laboratory, one Lecture and one Quiz. Natural World - With Lab course.

CHEM 118. Honors and Majors General and Analytical Chemistry II. 5 hours.
General and analytical chemistry with laboratory. Coverage of the fundamentals of chemistry including atomic and molecular structure, thermodynamics, and kinetics. Coverage of principles of analytical chemistry, including the use of instrumentation. Course Information: Credit is not given for CHEM 118 if the student has credit in CHEM 114 or CHEM 124 and CHEM 125. Prerequisite(s): Grade of C or better in CHEM 116. Class Schedule Information: To be properly registered, students must enroll in one Laboratory, one Lecture and one Quiz. Natural World - With Lab course.

CHEM 122. Matter and Energy. 3 hours.
An introductory one-semester course in chemical principles, including the quantum model of the atom, periodicity, bonding, reaction types, solutions, stoichiometry, thermochemistry, intermolecular forces, chemical equilibrium, acid-base equilibria. Course Information: Credit is not given for CHEM 122 if the student has a C or better in CHEM 112 or a C or better in CHEM 116. Students should complete CHEM 123 within a semester of completing CHEM 122. Prerequisite(s): Grade of C or better in CHEM 101 or appropriate score on the department placement test. Class Schedule Information: To be properly registered, students must enroll in one Discussion and one Lecture. Natural World - No Lab course.

CHEM 123. Foundations of Chemical Inquiry I. 2 hours.
Laboratory in general chemistry, including the quantum model of the atom, stoichiometry, periodicity, reaction types, intermolecular forces, and pH. Course Information: Credit is not given for CHEM 123 if the student has a C or better in CHEM 112 or C or better in CHEM 116. Students should complete CHEM 123 within one semester of completing CHEM 122. Prerequisite(s): Grade of C or better in CHEM 101; and concurrent registration or Grade of C or better in CHEM 122. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Discussion. Natural World - With Lab course.
CHEM 124. Chemical Dynamics. 3 hours.
A second semester course in chemical principles including chemical thermodynamics, phase transitions, spontaneity/equlibrium, electrochemistry, kinetics, bonding, molecular spectroscopy, coordination compounds, and buffer solutions. Course Information: Credit is not given for CHEM 124 if the student has a grade of C or better in CHEM 114 or CHEM 118. Students should complete CHEM 125 within a semester of completing CHEM 124. Prerequisite(s): Grade of C or better in CHEM 116; or Grade of C or better in CHEM 122 and Grade of C or better or concurrent registration in CHEM 123; or Grade of B or better in CHEM 115 and department consent. Class Schedule Information: To be properly registered, students must enroll in one Discussion and one Lecture. Natural World - No Lab course.

CHEM 125. Foundations of Chemical Inquiry II. 2 hours.
Laboratory in general chemistry including chemical thermodynamics, spontaneity, chemical equilibrium, acid-base equilibrium, electrochemistry, kinetics, bonding, order/symmetry in condensed phases, coordination compounds, and spectroscopy. Course Information: Credit is not given for CHEM 125 if the student has a grade of C or better in CHEM 114 or CHEM 118. Students should complete CHEM 125 within one semester of completing CHEM 124. Prerequisite(s): Grade of C or better in CHEM 116; or Grade of C or better in CHEM 122 and Grade of C or better in CHEM 123; or Grade of B or better in CHEM 115 and department consent; and Grade of C or better or concurrent registration in CHEM 124. Natural World - With Lab course.

CHEM 130. Survey of Organic and Biochemistry. 5 hours.
Chemistry of classes of carbon compounds relevant to life sciences, and an introduction to the structure and metabolism of proteins, nucleic acids, lipids, and carbohydrates. Course Information: Credit Restrictions: Credit is not to be given for CHEM 130 if the student has credit in CHEM 114 or CHEM 118 or CHEM 124 or CHEM 125. Prerequisite(s): Grade of C or better in CHEM 115; or Grade of C or better in CHEM 116; or Grade of C or better in CHEM 122 and Grade of C or better in CHEM 123. This course is intended for pre-nursing students and should not be taken by those who need CHEM 124/CHEM 125 or CHEM 118. Class Schedule Information: To be properly registered, students must enroll in one Laboratory, one Lecture and one Quiz. Natural World - With Lab course.

CHEM 201. Elements of Glass Blowing. 1 hour.
Demonstrations and practice in glass blowing and the construction of simple laboratory equipment. Course Information: Prerequisite(s): Senior standing in chemistry and consent of the instructor.

CHEM 222. Analytical Chemistry. 4 hours.
Theory and application of chemical equilibria and instrumentation in quantitative analysis. Includes two weekly three-hour laboratories. Course Information: Prerequisite(s): Grade of C or better in CHEM 114; or Grade of C or better in CHEM 124 and Grade of C or better in CHEM 125; or Grade of C or better in CHEM 118 or the equivalent. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

CHEM 230. Organic Chemistry of Biological Systems. 4 hours.
One-semester introduction to organic chemistry as it pertains to biological systems, biomedical sciences and chemical biology. Course Information: Credit is not given for CHEM 230 if student has credit in CHEM 232 or CHEM 234. Prerequisite(s): Grade of C or better in CHEM 124 and Grade of C or better in CHEM 125; or Grade of C or better in CHEM 118; or Grade of C or better in CHEM 130; or consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Lecture and one Quiz.

CHEM 232. Structure and Function. 3 hours.
First semester of a one-year sequence. Structure, reactivity, and synthesis of organic molecules. Course Information: Prerequisite(s): Grade of C or better in CHEM 122 and Grade of C or better in CHEM 123; or Grade of C or better in CHEM 116 and Grade of C or better in CHEM 118. Recommended background: Concurrent registration in CHEM 233. Class Schedule Information: To be properly registered, students must enroll in one Lecture and one Quiz.

CHEM 233. Synthesis Techniques Laboratory. 2 hours.
Introductory organic chemistry laboratory. Basic techniques (distillation, crystallization, chromatography, MP and BP), reactions (substitution, elimination, Diels-alder, oxidation-reduction), instrumentation (gas and liquid chromatography, IR). Course Information: Prerequisite(s): Grade of C or better in CHEM 230 or Grade of C or better or concurrent registration in CHEM 232; and Grade of C or better in CHEM 122 and Grade of C or better in CHEM 123; or Grade of C or better in CHEM 116 and Grade of C or better in CHEM 118; or consent of the instructor.

CHEM 234. Chemical Synthesis. 3 hours.
Continuation of CHEM 232. Course Information: Prerequisite(s): Grade of C or better in CHEM 232; and Grade of C or better in CHEM 124 and Grade of C or better in CHEM 125; or Grade of C or better in CHEM 118. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Discussion.

CHEM 240. Mathematical Methods in Physical Chemistry. 2 hours.
Chemistry workshop to support the development of students' math skills applied to physical chemistry courses at UIC. Course Information: Co-requisite(s): Students must be enrolled concurrently in CHEM 340 or CHEM 342.

CHEM 305. Environmental Chemistry. 3 hours.
The chemistry of the environment and the consequences of pollution brought about by natural and synthetic materials and modern energy usage. Course Information: Prerequisite(s): CHEM 230 or CHEM 232.

CHEM 314. Inorganic Chemistry. 4 hours.
Chemistry of the main-group elements, coordination chemistry and the transition elements, bioinorganic chemistry. Includes a weekly laboratory. Course Information: Prerequisite(s): Grade of C or better in CHEM 232 and grade of C or better in CHEM 233. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

CHEM 333. Interdisciplinary Approach to Chemical Synthesis. 3 hours.
Advanced organic/inorganic chemistry laboratory. Multi-step synthesis of small molecule sensing and molecular recognition, nucleic acid chemistry, bio-inspired catalysis, structure-function studies of therapeutics. Course Information: Prerequisite(s): Grade of C or better in CHEM 235 and Grade of C or better in CHEM 314. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.
CHEM 340. Physical Chemistry for Biochemists I. 3 hours.
Thermodynamics of gases, solutions, reaction equilibria, and phase transitions. Course Information: Credit is not given for CHEM 340 if the student has credit for CHEM 342. Prerequisite(s): Grade of C or better in MATH 181; and Grade of C or better in CHEM 118 or Grade of C or better in both CHEM 124 and CHEM 125; and Grade of C or better in PHYS 132 or Grade of C or better in PHYS 142.

CHEM 342. Physical Chemistry I. 3 hours.
Thermodynamics of gases, solutions, reaction equilibria, and phase transitions. Course Information: Credit is not given for CHEM 342 if the student has credit for CHEM 340. Prerequisite(s): Grade of C or better in MATH 181; and Grade of C or better in CHEM 118 or CHEM 124 and CHEM 125; and Grade of C or better in PHYS 142; and grade of C or better or concurrent registration in MATH 210. Class Schedule Information: To be properly registered, students must enroll in one Discussion/Recitation and one Lecture.

CHEM 343. Physical Chemistry Laboratory. 3 hours.
Experiments demonstrating principles of thermodynamics, reaction kinetics, spectroscopy and quantum mechanics in chemical systems using modern instrumentation and methods of data analysis. Course Information: Prerequisite(s): Grade of C or better in CHEM 340 or Grade of C or better in CHEM 342. Class Schedule Information: To be properly registered, students must enroll in one Discussion/Recitation and one Laboratory.

CHEM 344. Physical Chemistry for Biochemists II. 3 hours.
Introduction to molecular kinetics, quantum mechanics, and spectroscopy with applications of principles of physical chemistry to biochemical systems. Course Information: Credit is not given for CHEM 344 if the student has credit for CHEM 346. Prerequisite(s): Grade of C or better in CHEM 340 or Grade of C or better in CHEM 342; and Grade of C or better in PHYS 132 or Grade of C or better in PHYS 142; and Grade of C or better in MATH 181. Class Schedule Information: To be properly registered, students must enroll in one Lecture and one Discussion.

CHEM 346. Physical Chemistry II. 3 hours.
Kinetic and molecular theory of gases; introduction to the principles of quantum mechanics with application to model systems, multi-electron atoms, diatomic molecules, and bonding. Course Information: Credit is not given for CHEM 346 if the student has credit for CHEM 344. Prerequisite(s): Grade of C or better in CHEM 342 and Grade of C or better in MATH 210. Class Schedule Information: To be properly registered, students must enroll in one Discussion/Recitation and one Lecture.

CHEM 352. Introductory Biochemistry. 3 hours.
Structure and function of cellular constituents; enzymology; metabolism of carbohydrates, lipids, amino acids, nucleotides; molecular biology of biosynthesis of proteins and nucleic acids. Course Information: Same as BIOS 352. No credit given for BIOS 352 if student has credit in BIOS 452 or BIOS 454 or CHEM 452 or CHEM 454. No credit toward the degree in biochemistry. Prerequisite(s): BIOS 100 or BIOS 110; and BIOS 101 or BIOS 120; and CHEM 230 or CHEM 232.

CHEM 402. Chemical Information Systems. 2 hours.
Introduction to chemical information, including the use of databases for searching chemical information and the use of molecular modeling and related computational systems to determine calculated properties of chemical substances. Course Information: Previously listed as CHEM 302. Prerequisite(s): Grade of C or better in CHEM 234, or consent of instructor. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Discussion.

CHEM 414. Advanced Inorganic Chemistry. 2 or 3 hours.
Introduction to the principles of inorganic chemistry. Structural and descriptive chemistry of the main-group elements. Course Information: 2 undergraduate hours. 3 graduate hours. Prerequisite(s): Grade of C or better in CHEM 314; and Grade of C or better in CHEM 340 or Grade of C or better in CHEM 342; or consent of the instructor.

CHEM 415. Inorganic Chemistry Laboratory. 0-4 hours.
Advanced inorganic chemistry laboratory. Preparative methods, Schlenk techniques, dry box, Fourier-transform infra-red and UV-visible spectroscopy, crystal growth. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade of C or better in CHEM 314. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

CHEM 416. Inorganic Chemistry II. 3 or 4 hours.
Structural and descriptive chemistry of the transition elements. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CHEM 414.

CHEM 421. Instrumental Analysis. 0-4 hours.
A survey of contemporary instrumentation for chemical analysis. Emphasis on fundamentals of instrumental methods with actual experience on typical equipment. Includes a weekly three-hour laboratory. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade of C or better in CHEM 222; or Grade of C or better in CHEM 118. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

CHEM 432. Advanced Organic Chemistry. 3 or 4 hours.
Rigorous treatment of the physical principles upon which modern organic chemistry is developed to understand the interplay between chemical structure and reactivity. Course Information: 3 undergraduate hours. 4 graduate hours. Extensive computer use required. Prerequisite(s): Grade of C or better in CHEM 235.

CHEM 444. Spectroscopy in Chemistry and Biochemistry. 3 or 4 hours.
Applications of theory and experiment to the spectroscopy of molecules and biological macromolecules. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Grade of C or better in CHEM 346 or Grade of C or better in CHEM 344.

CHEM 448. Statistical Thermodynamics. 3 or 4 hours.
Introduction to statistical mechanics, partition functions, chemical equilibrium, ensembles, fluctuations, real gases, Einstein and Debye models of solids, magnetic materials, electrolytes, introduction to liquids. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CHEM 346.

CHEM 452. Biochemistry I. 4 hours.
Chemistry of proteins, nucleic acids, carbohydrates and lipids. Course Information: Same as BIOS 452. Prerequisite(s): Credit or concurrent registration in CHEM 234. Class Schedule Information: To be properly registered, students must enroll in one Discussion/Recitation and one Lecture.

CHEM 454. Biochemistry II. 4 hours.
Continues Chemistry 452. Carbohydrate and lipid metabolism, electron transport. Metabolism of amino acids, nucleic acids, proteins. Biosynthesis of macromolecules and regulation of macromolecular synthesis. Course Information: Same as BIOS 454. Prerequisite(s): BIOS 452 or CHEM 452. Class Schedule Information: To be properly registered, students must enroll in one Discussion/Recitation and one Lecture.
CHEM 455. Biochemistry Laboratory. 3 hours.
Introduction to modern biochemistry and molecular biology research. Includes recombinant DNA techniques, protein purification, site-directed mutagenesis, polymerase chain reaction, enzyme kinetics, protein structure data analysis and molecular graphics. Course Information: Prerequisite(s): CHEM 222 or CHEM 118; and CHEM 452 or BIOS 452. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Laboratory-Discussion.

CHEM 456. Natural Products. 3 or 4 hours.
Biogenetic approach to secondary metabolites. General principles and selected studies of phenolic compounds, terpenes, alkaloids, and other interesting natural products. Course Information: Same as BIOS 416. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): One year of organic chemistry.

CHEM 458. Biotechnology and Drug Discovery. 3 or 4 hours.
Molecular and gene therapy, using small molecules including antisense, aptamers, and proteins. Structure-based drug design. Structural bioinformatics and drug discovery program. High-throughput screening. Combinatorial chemistry technology. Course Information: Same as BIOS 458. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): BIOS 352 or CHEM 352; or Credit or concurrent registration in BIOS 452 or Credit or concurrent registration in CHEM 452; or consent of the instructor.

CHEM 470. Educational Practice with Seminar I. 6 hours.
The first half of a two-segment sequence of practice teaching, including seminar, to meet certification requirements for teaching in grades six through twelve. Course Information: Graduate credit only with approval of the department. Prerequisite(s): Good academic standing in a teacher education program, completion of 100 clock hours of pre-student-teaching field experiences, and approval of the department. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Practice.

CHEM 471. Educational Practice with Seminar II. 6 hours.
The second half of a two-segment sequence of practice teaching, including seminar, to meet certification requirements for teaching in grades six through twelve. Course Information: Graduate credit only with approval of the department. Prerequisite(s): Good academic standing in a teacher education program, completion of 100 clock hours of pre-student-teaching field experiences, credit or concurrent registration in CHEM 470, and approval of the department. Class Schedule Information: To be properly registered, students must enroll in one Conference and one Practice.

CHEM 472. Teaching Methods in Chemistry. 2 or 3 hours.
A course in the methods of teaching high school chemistry, including the integration of technology. Course Information: 2 undergraduate hours. 3 graduate hours. Extensive computer use required. Prerequisite(s): 24 semester hours of undergraduate chemistry, including two semesters of laboratory chemistry. Recommended background: ED 210.

CHEM 474. Teaching Chemistry in High Schools. 1 hour.
Modern ways to help beginning learners construct in their own minds an understanding of scientific concepts and scientific method. Emphasis on the concepts of chemistry. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. Prerequisite(s): Approval of the department.

CHEM 475. Learning and Teaching of Physical Sciences. 3 hours.
Provides teacher candidates with the foundation and experience necessary to teach physical sciences in secondary schools. Course Information: Same as PHYS 475. Prerequisite(s): Senior standing or above; or approval of the department. Recommended background: Knowledge of first-year college physics and chemistry. Class Schedule: To be properly registered; Students must enroll in one Lecture-Discussion and one Laboratory.

CHEM 480. Elements of Machining Scientific Equipment. 1 hour.
Elements of machining scientific equipment, including the use of machine shop tools and technical drawing of scientific apparatus. Course Information: Same as EAES 478 and PHYS 480. Satisfactory/Unsatisfactory grading only. May be repeated. A maximum of 6 hours of CHEM 480, CHEM 492 and CHEM 499 combined may be credited toward departmental undergraduate degree course requirements. Prerequisite(s): Concurrent registration in LAS 289 or consent of the instructor.

CHEM 482. Independent Study. 1-2 hours.
Individual study under supervision of a faculty member in areas not covered in standard courses. Credit is contingent on the submission of a final report. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. A maximum of 6 hours of CHEM 482, CHEM 492 and CHEM 499 combined may be credited toward departmental undergraduate degree course requirements. Prerequisite(s): 2.50 grade point average in science courses and consent of the instructor. Class Schedule Information: This course counts toward the limited number of independent study hours accepted toward the undergraduate degree and the major.

CHEM 492. Independent Study. 1-2 hours.
Individual study under supervision of a faculty member in areas not covered in standard courses. Credit is contingent on the submission of a final report. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. A maximum of 6 hours of CHEM 482, CHEM 492 and CHEM 499 combined may be credited toward departmental undergraduate degree course requirements. Prerequisite(s): 2.50 grade point average in science courses and consent of the instructor. Class Schedule Information: This course counts toward the limited number of independent study hours accepted toward the undergraduate degree and the major.

CHEM 494. Special Topics in Chemistry. 1-4 hours.
Course content is announced prior to each term in which the course is given. Course Information: May be repeated. Students may register in more than one section per term. Prerequisite(s): Approval of the department.

CHEM 499. Supervised Research. 3 hours.
Individual research performed under supervision of a faculty member. Credit is contingent on the submission of a final report. Research experience is strongly encouraged for career students. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated to a maximum of 6 hours. A maximum of 6 hours of CHEM 482, CHEM 492 and CHEM 499 combined may be credited toward departmental undergraduate degree course requirements. Prerequisite(s): Junior standing or above, approval of the department, consent of the instructor and a grade point average of 2.50 in science courses; or graduate standing. Recommended background: Credit in CHEM 333 or CHEM 314. Class Schedule Information: This course counts toward the limited number of independent study hours accepted toward the undergraduate degree and the major.
Physics

PHYS 100. Preparatory Physics. 3 hours.
Introduction to basic physics concepts, problem-solving skills, and quantitative reasoning. Course Information: No credit toward the Major in Physics, BS in Physics, or Minor in Physics. Prerequisite(s): Grade of C or better or concurrent registration in MATH 121; or appropriate score on the department placement test.

PHYS 101. Active Learning of the Physical World. 4 hours.
A continuation of the first 7 weeks of PHYS 141, focusing on the exploration of the physical world through active learning. Student-centered learning through team activities in small group settings, working on problem-solving activities. Course Information: Credit is not given for PHYS 101 if student has credit in PHYS 141. Enrollment available only after week 7 and only to students currently enrolled in PHYS 141. Prerequisite(s): Physics 141; and registration and approval of the department. Restricted to students currently enrolled in PHYS 141.

PHYS 112. Astronomy and the Universe. 4 hours.
Astronomy in the context of the scientific process, history and current events. Covers the Solar System, stars and galaxies and the origin and fate of the universe. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture. Natural World - With Lab course.

PHYS 116. Energy for Future Decision-Makers. 3 hours.
Survey of energy sustainability and environmental issues. All energy forms of production, sources, storage, and uses; their environmental implications on a global scale within the scientific, technological, political, economic, and social context. Course Information: Same as EAES 116. Recommended background: High school algebra. Natural World - No Lab course.

PHYS 118. Physics in Modern Medicine. 3 hours.
Survey course of physical technologies used in modern medicine and the underlying physics, including applications of optics, imaging, and nuclear medicine to diagnosis, surgery, therapy and treatment. Course Information: Prerequisite(s): High school algebra, trigonometry, and biology. Natural World - No Lab course.

PHYS 131. Introductory Physics for Life Sciences I. 4 hours.
Algebra-based physics and its relationship to the life sciences, including mechanics, waves, diffusion and fluids with applications to molecular, cell and human biology. Course Information: Prerequisite(s): High school algebra and trigonometry. Credit for PHYS 131 is not given if the student has credit for PHYS 105 or PHYS 141. To be properly registered, students must enroll in one Laboratory, one Lecture and one Discussion/Recitation. Natural World - With Lab course.

PHYS 132. Introductory Physics for Life Sciences II. 4 hours.
Algebra-based physics and its relationship to the life sciences, including electromagnetism, optical, quantum, and thermal physics, with applications to molecular, cell and human biology. Course Information: Prerequisite(s): Grade of C or better in PHYS 105 and Grade of C or better in PHYS 106; or Grade of C or better in PHYS 131. Credit for PHYS 132 is not given if the student has credit for PHYS 107 or PHYS 142. To be properly registered, student must enroll in one Laboratory, one Discussion/Recitation and one Lecture. Natural World - With Lab course.

PHYS 141. General Physics I (Mechanics). 4 hours.
Kinematics, vectors, Newton's laws of motion; linear momentum, collisions; work and kinetic energy; potential energy, conservation of energy; rotational kinematics and energy; rotational dynamics, static equilibrium; simple harmonic motion. Course Information: Credit is not given if the student has credit in PHYS 105 or PHYS 106 or PHYS 131. Students may obtain one additional hour of credit by concurrently registering in PHYS 144. Prerequisite(s): Grade of C or better or concurrent registration in MATH 180; or approval of the department; and Grade of C or better in PHYS 100 or adequate performance on the departmental placement test. Class Schedule Information: During the fall and spring terms, combined-section final exam will be held on Wednesday of finals week from 6 to 8 p.m. To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

PHYS 142. General Physics II (Electricity and Magnetism). 4 hours.
Electrostatics; electric currents; d-c circuits; magnetic fields; magnetic media; electromagnetic induction; a-c circuits; Maxwell's equations; electromagnetic waves; reflection and refraction; interference; geometrical optics. Course Information: Credit is not given for PHYS 142 if the student has credit in PHYS 107 or PHYS 132. Prerequisite(s): Grade of C or better in PHYS 141; and Grade of C or better or concurrent registration in MATH 181. Natural World - With Lab course.

PHYS 144. Problem-Solving Workshop for General Physics I (Mechanics). 1 hour.
A workshop where smaller groups of students work together with the instructor to enhance their problem solving skills by solving additional problems both similar to, as well as more challenging than, the ones given in Physics 141. Course Information: Satisfactory/Unsatisfactory grading only. Must enroll concurrently in PHYS 141.

PHYS 145. Problem-Solving Workshop for General Physics II (Electricity and Magnetism). 1 hour.
A workshop where smaller groups of students work together with the instructor to enhance their problem-solving skills by solving additional problems both similar to, as well as more challenging than, problems given in Physics 142. Course Information: Satisfactory/Unsatisfactory grading only. Requires concurrent registration in PHYS 142.

PHYS 215. Computational and Mathematical Methods for the Physical Sciences. 4 hours.
Computation and mathematical methods applied to basic problems in physics. Course Information: Extensive computer use required. Prerequisite(s): Grade of C or better in PHYS 142; or Grade of B or better in PHYS 107 or Grade of B or better in PHYS 132; and Grade of C or better in MATH 181 and Grade of C or better or concurrent registration in MATH 210. Class Schedule Information: To be properly registered, students must enroll in one Lecture and one Laboratory.

PHYS 230. Fundamentals of Relativity. 3 hours.
Introduction to the theory of relativity, including special relativity (Lorentz contraction, time dilation, energy-mass equivalence, kinematics and electrodynamics) and general relativity (gravity, black holes). Course Information: Prerequisite(s): Grade of C or better in MATH 181; and Grade of C or better in PHYS 142; or Grade of B or better in PHYS 107 or Grade of B or better in PHYS 132.
PHYS 240. Fundamentals of Modern Quantum Theory. 3 hours.
Modern introduction to the quantum theory including discrete systems (qubits, etc.), quantum measurement theory, entanglement, Bell's Theorem, the Uncertainty Principle, one-dimensional potential models, and the Schrödinger-von Neumann equation. Course Information: Prerequisite(s): Grade of C or better in MATH 181; and Grade of C or better in PHYS 142; or Grade of B or better in PHYS 107 or Grade of B or better in PHYS 132. Physics majors (BA and BS) are required to register concurrently for PHYS 241.

PHYS 241. Experiments in Modern Physics. 1 hour.
Companion course to PHYS 240 that includes laboratory experiments on introductory quantum theory and modern physics. Course Information: Prerequisite(s): Grade of C or better in MATH 181; and Grade of C or better in PHYS 142; or Grade of B or better in PHYS 107 or Grade of B or better in PHYS 132. Requires concurrent registration in PHYS 240 or approval of the department.

PHYS 245. Introduction to Vibrations, Waves, and Thermal Physics. 4 hours.
Free, forced, damped, and coupled oscillations; normal modes; Fourier analysis; resonance; waves; interference; diffraction; heat energy; entropy; introduction to thermodynamics, kinetic theory of gases, and basic statistical physics. Course Information: Prerequisite(s): Grade of C or better in MATH 181; and Grade of C or better in PHYS 142; or Grade of B or better in PHYS 107 or Grade of B or better in PHYS 132. Recommended background: Credit or concurrent registration in MATH 220. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

PHYS 260. Introduction to Thermal Physics. 2 hours.
Calculus-based introduction to thermal physics. The first and second laws of thermodynamics, entropy, free energy, statistical physics, and their applications. Course Information: Extensive computer use required. Computer and internet access are required. This course does not satisfy the requirements for BA and BS degrees in physics. Prerequisite(s): Grade of C or better in MATH 181 and Grade of C or better in PHYS 142 or Grade of B or better in PHYS 107 or Grade of B or better in PHYS 132. Recommended background: Credit or concurrent registration in MATH 220. Class Schedule Information: To be properly registered, students must enroll in one Lecture and one Discussion.

PHYS 391. Physics Seminar. 1 hour.
Preparation and presentation by students of talks on topics of current interest in physics. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated to a maximum of 4 hours. Prerequisite(s): Senior standing.

PHYS 392. Physics Research. 2-4 hours.
Research under the close supervision of a faculty member. Course Information: Prerequisite(s): Approval of the department. Class Schedule Information: This course counts toward the limited number of independent study hours accepted toward the degree and the major.

PHYS 393. Special Problems. 2-4 hours.
Special problems or reading in modern physics under individual arrangement with a faculty member. Course Information: Prerequisite(s): Approval of the department. Class Schedule Information: This course counts toward the limited number of independent study hours accepted toward the degree and the major.

PHYS 401. Electromagnetism I. 4 hours.
Vector calculus; electrostatic and magnetostatic fields in vacuum; electrostatic boundary-value problems; electrodynamics; Maxwell's equations; electromagnetic waves in vacuum; reflection and transmission phenomena in linear media. Prerequisite(s): PHYS 215 and MATH 220; or approval of the department.

PHYS 402. Electromagnetism II. 4 hours.
Electrostatics, magnetostatics, and electromagnetic waves in matter; radiation; relativistic electrodynamics; special topics chosen by the instructor. Course Information: Prerequisite(s): PHYS 230 and PHYS 401; or approval of the department.

PHYS 411. Quantum Mechanics I. 4 hours.
Wave particle duality; wave functions; matrix representation; operators and observables; 1-D potentials; harmonic oscillator; eigenvalues and eigenfunctions; time-independent perturbation theory; approximation methods; 3-D Schroedinger's equation. Course Information: Prerequisite(s): PHYS 215 and PHYS 240 and PHYS 245; or approval of the department. Recommended background: MATH 220.

PHYS 412. Quantum Mechanics II. 4 hours.
This is the second semester of a two-semester undergraduate level sequence on the concepts and methods of Quantum Mechanics and their applications. Course Information: Prerequisite(s): PHYS 411; or approval of the department.

PHYS 421. Modern Physics: Atoms and Molecules. 4 hours.
Hydrogenic atoms, electron spin, external fields, multi-electron atoms, diatomic molecules, wave functions, energy, electron theory of metals; electronic band theory; semiconductors and insulators; other electromagnetic processes, positrons, positronium, elastic electron scattering. Course Information: Prerequisite(s): Credit or concurrent registration in PHYS 245; or approval of the department.

PHYS 425. Modern Optics. 4 hours.
Review of electromagnetic wave theory and introductory optics; advanced geometrical optics; Fourier transforms and optics; interference and diffraction; solar cells and LEDs; laser cavities and gain media; introduction to nonlinear and fiber optics. Course Information: Prerequisite(s): PHYS 240; or approval of the department. Class Schedule Information: To be properly registered, students must enroll in one Discussion, one Laboratory and one Lecture.

PHYS 431. Modern Physics: Condensed Matter. 4 hours.
Crystal structures; interatomic binding; lattice vibrations; thermal and magnetic properties; quantum statistical mechanics; free electron theory of metals; electronic band theory; semiconductors and insulators; superconductivity. Course Information: Prerequisite(s): PHYS 411 and PHYS 461; or consent of the instructor.

PHYS 441. Theoretical Mechanics. 4 hours.
Review of Newtonian mechanics, variational calculus, Lagrangian mechanics, central force problems, non-inertial frames, rigid body motion, coupled oscillators, non-linear mechanics, Hamiltonian mechanics, and numerical examples. Course Information: Prerequisite(s): PHYS 215 and Credit or concurrent registration in PHYS 245; or approval of the department.

PHYS 450. Molecular Biophysics of the Cell. 4 hours.
Introduction to force, time energies at nanometer scales; Boltzmann distribution; hydrodynamic drag; Brownian motions; DNA, RNA protein structure and function; sedimentation; chemical kinetics; general aspects of flexible polymers. Course Information: Same as BME 450. Prerequisite(s): PHYS 245 or the equivalent; or approval of the department.

PHYS 451. Modern Physics: Nuclei and Elementary Particles. 4 hours.
Accelerators, detectors, symmetries, conservation laws, leptons, weak interactions, electroweak theory, strong interactions, hadrons, nuclear forces, systematics and reactions, nuclear models, nuclear astrophysics, quarks, quantum chromodynamics. Course Information: Prerequisite(s): PHYS 411.
PHYS 461. Thermal and Statistical Physics. 4 hours.
Thermal equilibrium (Zeroth Law); thermodynamic states (First Law); irreversibility; entropy (Second Law); thermodynamic potentials and properties; phase transitions; kinetic theory of gases; classical statistical mechanics. Course Information: Prerequisite(s): PHYS 245; or approval of the department.

PHYS 469. The Learning and Teaching of Physics. 4 hours.
Provides teacher candidates with the foundations and experiences necessary for teaching physics in secondary schools. For those currently teaching, it will also provide tools and background to improve their physics instruction. Course Information: 4 hours. Extensive computer use required. Prerequisite(s): PHYS 142; or PHYS 107 and PHYS 108; or approval of the department. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Laboratory.

PHYS 470. Educational Practice with Seminar I. 6 hours.
The first half of a two-segment sequence of practice teaching, including seminar, to meet certification requirements for teaching in grades six through twelve. Course Information: Graduate credit only with approval of the department. Prerequisite(s): Good academic standing in a teacher education program, completion of 100 clock hours of pre-student-teaching field experiences, and approval of the department. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion and one Practice.

PHYS 471. Educational Practice with Seminar II. 6 hours.
The second half of a two-segment sequence of practice teaching, including seminar, to meet certification requirements for teaching in grades six through twelve. Course Information: Graduate credit only with approval of the department. Prerequisite(s): Good academic standing in a teacher education program, completion of 100 clock hours of pre-student-teaching field experiences, credit or concurrent registration in PHYS 470, and approval of the department. Class Schedule Information: To be properly registered, students must enroll in one Conference and one Practice.

PHYS 475. Learning and Teaching of Physical Sciences. 3 hours.
Provides teacher candidates with the foundation and experience necessary to teach physical sciences in secondary schools. Course Information: Same as CHEM 475. Prerequisite(s): Senior standing or above; or approval of the department. Recommended background: Knowledge of first-year college physics and chemistry. Class Schedule: To be properly registered students must enroll in one Lecture-Discussion and one Laboratory.

PHYS 480. Elements of Machining Scientific Equipment. 1 hour.
Elements of machining scientific equipment, including the use of machine shop tools and technical drawing of scientific apparatus. Course Information: Same as CHEM 480 and EAES 478. Satisfactory/Unsatisfactory grading only. Prerequisite(s): Graduate standing; and approval of the department.

PHYS 481. Modern Experimental Physics I. 4 hours.
Theory and experimental use of linear circuits, semiconductor devices, amplifiers, oscillators. Techniques and experiments in atomic, molecular and solid-state physics. Course Information: Prerequisite(s): PHYS 240; or approval of the department. Requires concurrent registration in PHYS 499 for students enrolled in the BA or BS in Physics programs. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

PHYS 482. Modern Experimental Physics II. 4 hours.
Techniques and experiments in nuclear and particle physics. Gamma-gamma correlations, muon lifetime, Compton scattering, alpha particle scattering. Computer-based experimentation. Course Information: Prerequisite(s): PHYS 481; or approval of the department. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

PHYS 491. Special Topics in Physics. 1-4 hours.
Selected topics of current interest in Physics. Course Information: May be repeated. Prerequisite(s): PHYS 215 and sophomore standing or above; or approval of the department.

PHYS 494. Special Topics in Physics Teaching. 2-4 hours.
Seminar on various topics related to the teaching of physics. Subjects are announced. Course Information: May be repeated. Students may register in more than one section per term. Supervised teaching practice included. Prerequisite(s): Graduate standing or approval of the department.

PHYS 499. Survey of Physics Problems. 1 hour.
Problem-solving techniques applied to the variety of undergraduate physics topics. Course Information: No graduation credit for graduate students. Grade of C or better required to graduate with an undergraduate degree in physics. Co-requisite(s): Concurrent registration in PHYS 481.