Biochemistry and Molecular Biology

Biochemists and molecular biologists study the chemistry of life. This includes the study of protein structure and function, metabolism, and the mechanics of DNA, RNA and protein synthesis. The CLU program emphasizes genomics and bioinformatics as methods that teach students how to perform research. Like other CLU science majors, biochemistry and molecular biology students are encouraged to design and carry out their own experiments, and advanced students are encouraged to complete independent studies and internships. The University's state-of-the-art equipment and resources offer students access to the latest scientific information and techniques.

Preprofessional programs in medicine, dentistry, veterinary medicine, pharmacy and bioengineering can be pursued through the biochemistry program at CLU. The biochemistry curriculum prepares students for positions in industrial and governmental research laboratories.

Careers in biochemistry and molecular biology are available in government and private companies and include positions in a variety of research industries. The growing areas of genetics and biotechnology provide many career opportunities with companies such as Amgen and Baxter Biotech, both international biotechnology companies that are located near the University.

Likewise, many biochemistry majors from CLU are accepted into medical, dental, pharmaceutical and graduate schools throughout the United States.

Bachelor of Arts in Biochemistry and Molecular Biology

38 credits minimum, 24 credits upper division.

BIOL 121	Introduction to Cells and Organisms	3
or BIOL 122	Introduction to Metabolism, Genes and Development	
BIOL 124L	Introduction to Biological Experimentation II	2
BIOL 425/425L	Biochemistry and Biochemistry Lab	4
BIOL 426/426L	Molecular Biology and Molecular Biology Lab	4
BIOL 427	Genomics	2-4
or BIOL 422	Bioinformatics-Analytical	
CHEM 151	General Chemistry	4
CHEM 151L	General Chemistry Lab	1
CHEM 152	General Chemistry II	4
CHEM 152L	General Chemistry II Lab	1
CHEM 305/305L	Quantitative Analysis and Quantitative Analysis Lab	4
CHEM 331	Organic Chemistry	4
CHEM 332	Organic Chemistry II	4
CHEM 341	Organic Chemistry Lab	1
CHEM 342	Organic Chemistry II Lab	1
BIOL 399/498/499	Junior Honors and Senior Honors I - Capstone and Senior Honors II - Capstone	2-8
or CHEM 485	Capstone Seminar	
Total Hours		41-49

Required Supporting Courses

MATH 251	Calculus I	4
MATH 252	Calculus II	4
Select one of the following:		8-10
PHYS 201/201L/202/202L	Mechanics and Thermodynamics-Algebra and Mechanics and Thermodynamics-Algebra Lab and Electricity, Magnetism, and Optics - Algebra and Electricity, Magnetism, and Optics - Algebra Lab	

PHYS 211/211L/212/212L	Mechanics and Thermodynamics-Calculus and Mechanics and Thermodynamics-Calculus Lab and Electricity, Magnetism, and Optics - Calculus and Electricity, Magnetism, and Optics - Calculus Lab	
Total Hours		16-18

Recommended

BIOL 331/331L	Genetics and Genetics Lab	4
BIOL 332	Macromolecular Structure	2
BIOL 361/361L	Microbiology and Microbiology Lab	4
BIOL 375/375L	Cell Biology and Cell Biology Lab	4
BIOL 428/428L	Virology and Virology Lab	4
CHEM 405/405L	Physical Chemistry and Physical Chemistry Lab	4
CHEM 406/406L	Physical Chemistry and Physical Chemistry Lab	4
CSC 210	Introduction to Computer Programming	4
Total Hours		30

Bachelor of Science in Biochemistry and Molecular Biology

46 credits minimum, 30 credits upper division.

BIOL 121	Introduction to Cells and Organisms	3
BIOL 122	Introduction to Metabolism, Genes and Development	3
BIOL 124L	Introduction to Biological Experimentation II	2
BIOL 425/425L	Biochemistry and Biochemistry Lab	4
BIOL 426/426L	Molecular Biology and Molecular Biology Lab	4
BIOL 427	Genomics	2-4
or BIOL 422	Bioinformatics-Analytical	
CHEM 151	General Chemistry	4
CHEM 151L	General Chemistry Lab	1
CHEM 152	General Chemistry II	4
CHEM 152L	General Chemistry II Lab	1
CHEM 305/305L	Quantitative Analysis and Quantitative Analysis Lab	4
CHEM 331	Organic Chemistry	4
CHEM 332	Organic Chemistry II	4
CHEM 341	Organic Chemistry Lab	1
CHEM 342	Organic Chemistry II Lab	1
CHEM 405	Physical Chemistry	4
BIOL 399/498/499	Junior Honors and Senior Honors I - Capstone and Senior Honors II - Capstone	2-8
or CHEM 485	Capstone Seminar	
Total Hours		48-56

Required Supporting Courses

MATH 251	Calculus I	4
MATH 252	Calculus II	4

Select one of the following:		8-10
PHYS 201/201L/202/202L	Mechanics and Thermodynamics-Algebra and Mechanics and Thermodynamics-Algebra Lab and Electricity, Magnetism, and Optics - Algebra and Electricity, Magnetism, and Optics - Algebra Lab	
PHYS 211/211L/212/212L	Mechanics and Thermodynamics-Calculus and Mechanics and Thermodynamics-Calculus Lab and Electricity, Magnetism, and Optics - Calculus and Electricity, Magnetism, and Optics - Calculus Lab	
Total Hours		16-18

Recommended

Recommended Courses:		
BIOL 331/331L	Genetics and Genetics Lab	4
BIOL 332	Macromolecular Structure	2
BIOL 361/361L	Microbiology and Microbiology Lab	4
BIOL 375/375L	Cell Biology and Cell Biology Lab	4
BIOL 428/428L	Virology and Virology Lab	4
CHEM 406/406L	Physical Chemistry and Physical Chemistry Lab	4
CSC 210	Introduction to Computer Programming	4
Total Hours		26

Biology Courses

Lower Division

BIOL 111. Principles of Biology. (4).
For non-majors or students not pursuing a preprofessional program related to biology. Includes general biological principles and a survey of the plant and animal organisms. Lecture, 3 hours/week; Laboratory, 2 1/2 hours/week.

BIOL 111L. Principles of Biology Lab. (0).

BIOL 113. Biology and Society. (4).
The course will provide a broad overview of biological topics in a style appropriate for students will little to no background in science. We will discuss relevant scientific research to enable students to make informed discussions about science related social and personal issues. We will explore topics ranging from the basic chemistry of life to the vast diversity of life on the planet to the processes through which life has evolved and how organisms have adapted to live in different environments. It is my hope and goal that by the end of this course students will leave with an increase appreciation and interest in our natural works and scientific fields of study. Lecture, 3 hours/week; Lab, 2.5 hours/week.

BIOL 115. Current Issues in Marine Biology. (3).
This course is designed for non-science majors and is an introduction to marine biology via current issues and problems facing our world’s ocean environment. Topics include coastal population growth and associated pollution, fisheries, and fisheries management, plastics in the ocean, climate chance and ocean acidification, mercury in seafood, beach erosion, alien species, marine biodiversity and coral reel ecology/decline. The course includes both lecture and laboratory experiences.

BIOL 118. The Oceans. (4).
For non-majors or students pursuing a minor in environmental studies. This general survey of geological and biological processes in the ocean has a strong environmental emphasis. Laboratory exercises and field trips illustrate and complement lecture material. Lecture, 3 hours/week; Laboratory, 2 1/2 hours/week. (cross-listed with GEOL 118).

BIOL 118L. The Oceans Lab. (0).

BIOL 120. Introduction to Ecology and Populations. (3).
This course is an introduction to the history of evolutionary thought and the mechanisms of evolution, including species formation and the use of phylogenetic information. Diversity of living organisms, from prokaryotes to advanced multicellular organisms, will be discussed with an emphasis on evolutionary relationships. The principles of population and community ecology will be treated. Ecosystems and the environmental impacts of human activities will also be discussed. No prerequisites.

BIOL 121. Introduction to Cells and Organisms. (3).
This course introduces important areas of cell biology such as cell organization of both prokaryotic and eukaryotic cells, cellular membranes, and signaling mechanisms. Included will be discussions of bacteria, Archaea, virus, fungi, and protists. Further studies will involve a broad, comparative survey of animal physiology, including animal motility, respiratory and circulatory physiology, principles of immunology, nutrition, neurobiology, endocrinology, reproduction and development. No prerequisites. Recommended: BIOL 120.

BIOL 122. Introduction to Metabolism, Genes and Development. (3).
This course introduces the structure and function of biomolecules, energy flow in a cellular context, mechanisms of heredity, the expression of genetic information and the means by which genes encode developmental programs. It will be seen that genetics and development are part of a continuous process and that the genetic mechanisms and developmentalpatterns of living organisms reveal a fundamental kinship of life on earth. Genetics as a tool for the study of biological problems will be introduced, as will some current topics in genomic research and biotechnology. Students willing to explore these topics in greater detail are referred to upper division courses in Genetics, Macromolecular Structure, Developmental Biology, Cell Biology and Molecular Biology. No prerequisites. Recommended: BIOL 120, BIOL 121.

BIOL 123L. Introduction to Biological Experimentation I. (2).
This course introduces students to the processes of investigative biology and communication. It is not designed to accompany any particular core lecture course. The course is designed to develop the skills students need to progress as young scientists: forming and testing hypotheses, scientific observation, interpreting results, experimentation, analysis and communication of scientific discovery (both oral and written). Laboratories cover some topics presented in some of the core lecture courses (BIOL 120, BIOL 121 and BIOL 122) and introduce a variety of techniques including field sampling, statistical analysis, classification of organisms and physiological measurement. The course emphasizes experimental design, data collection, statistical analysis,integration of results with information reported in the scientific literature and the effective communication of conclusions. Evaluation is based on short lab assignments and scientific papers. A laboratory manual must be purchased. There are no prerequisites. (Offered Fall semester).

BIOL 124L. Introduction to Biological Experimentation II. (2).
This course exposes students to the processes of investigative biology and communication. This laboratory course is not designed to accompany any particular core lecture course, and will introduce a variety of subjects including including virology, gene expression, gene sequence analysis, gene manipulation and bioinformatics. The course may emphasize experimental design, data collection, statistical analysis, the integration of results with information reported in the literature and the effective communication of conclusions. In line with the philosophy of our inquiry-based curriculum, Biology 124 culminates in an independent project module, where students design and conduct their own experiments, analyze data (statistically, where appropriate) and present their results in both written and oral communications. Evaluation is based on short lab assignments and scientific papers; students will plan an oral presentation of their independent project. There are no prerequisites.(Offered Spring semester).

BIOL 211. Genes and Genesis. (4).
This course introduces the mechanisms of heredity, the expression of genetic information, and the genetic control of development, emphasizing human biology. A central theme of the course is that we owe our genesis, both as species and as individuals, to the remarkable, and fascinating, properties of genes. Lectures will emphasize the experimental basis for our knowledge of human genetics. Special attention will be focused on issues at the interface of genetics and society (e.g., human reprogenetics: stem cell research, cloning, gene therapy). Students will explore methods of modern genetics, including DNA analysis and bioinformatics, in laboratory exercises that are conducted in lecture class periods.

BIOL 212. Resource Management. (2).
In this course we will explore Earth's aquatic and terrestrial natural resource. We will examine the role of conservation biology in the 21st century as it relates to the biodiversity of our planet. Together we will discuss the importance of forests, lakes, rivers, and the oceans. The challenges of maintaining biological diversity in the face of global change and a population as it charges to 8 billion people will also be discussed. Concepts of biomimicry and how best to conserve all natural resources will also be addressed. Lecture, 2 hours/week.

BIOL 213. Climate Change. (2).
In this class we examine the implications of climate disruption on the world and its inhabitants. We will closely examine the effects of climate change on the oceans and forests and all life within. The role of polar, sea and land ice and its diminishing consequences and its effect on climate disruption will also be explored. A case study of insatiable bark beetles and their population explosion throughout western North American will be highlighted and ensuing discussion on loss of ecosystems services will be facilitated. Lecture, 2 hours/week.

BIOL 223. Human Anatomy. (4).
Human Anatomy is the study of the structure of the human body, from the cellular level to the organismal level with an emphasis on organ systems. While the focus of the course is structure, function will be covered in order to reinforce the interrelationship of structure and function. Microscopic and gross anatomy will be studied in the laboratory. Specimens studied in lab include microscopic slides, human bones, plastic models, clay models, and anatomical images (e.g., micrographs, radiographic images, photos, medical illustrations). Mammalian specimens and isolated mammalian organs will be used for dissection. Lecture, 3 hrs/week; Lab, 2.5 hours/week. Prerequisites: none. Co-requisite: BIOL 223L.

BIOL 223L. Human Anatomy Lab. (0).

BIOL 224. Human Physiology. (4).
Human Physiology is the study of mechanisms that underlie the functioning of the human body, from the molecular level to the organismal level with an emphasis on organ systems. Physiology is a biological science that is inherently interdisciplinary since it utilizes mathematics, physics, chemistry and biology. While the focus of the course is physiology, anatomy will be covered in order to reinforce the interrelationship of structure and function. In the laboratory, students will conduct experiments related to the topics covered in the lecture. In the lab, students conduct hands-on investigational activities many of which involve recording and analyzing data from human subjects. Some laboratory exercises involves interactive computer situations. Lecture, 3hrs/week; Lab, 2.5 hours/week. Prerequisites: Human Anatomy BIOL 223 or BIOL 121. High school or college chemistry highly recommended. Co-requisite: BIOL 224L.

BIOL 224L. Human Physiology Lab. (0).

BIOL 282. Selected Topic. (1-4).

Upper Division

BIOL 304. Wildflowers of the Sierras. (3).
A study of the flora of the eastern Sierra Nevada, including the classification and ecological relationships of the various species. The major plant families are studied as an aid to identification, and collection techniques are discussed. A field trip to the Sierras is included. (summers only).

BIOL 305. Flora of Southern California. (3).
A study of native and introduced plants of Southern California, relating structure and form to environment. Plant families will be studied as a means of identification. Considerable class time will be spent in the field, observing plant characteristics and learning identification and collection techniques. (summers only).

BIOL 311. Evolution. (3).
Evolution is the central concept in all of biology and thus is the thread that ties together the multiple sub-disciplines of the biological sciences. This course examines evolution in historical and scientific contexts and aims to teach a deep understanding of the processes and mechanisms of evolutionary biology. Topics covered include population genetics, the theory of evolution by natural selection, concepts of fitness and adaptation, genetic and developmental bases of evolutionary change, modes of speciation, molecular evolution, principles of systematic biology, macroevolutionary trends in evolution, extinction and human evolution. Lecture, 3 hours/week. Prerequisite: BIOL 120, BIOL 121, BIOL 122.

BIOL 312. Darwin. (2).
"Darwin" is a 2-unit seminar course that explores the life and science of Charles Darwin. Students read two biographical books; (1) Charles Darwin: Voyaging and (2) Charles Darwin: the Power of Place. Each biographical sketch is a reflection of Darwin's personal life and how it influenced his scientific discoveries. In addition, the course not only focuses on Darwin but also places his works into a historical context. Students learn about the history of science and about the many scientists who were working at the same time as Charles Darwin. Students discuss matters of biological interest and are required to write summaries of their readings. Prerequisite: BIOL 120, BIOL 124L, BIOL 311.

BIOL 321. Field Studies: Marine Biology. (2).
Designed to give students experience in field techniques used in marine biological studies, the class has three components: a laboratory, field data collection and data analysis. This intensive two-week course is offered during the January holiday. The class spends at least one week in the field on a research vessel in one of the following locations: Catalina and Santa Barbara islands, Hawaii or Mexico.

BIOL 325. Environmental Ecology. (4).
A study of ecology with emphasis on humans and the environment. Problems such as overpopulation, food production, water and air pollution, the energy crisis and toxic waste disposal are discussed; their possible solutions are considered along with the social, political and economic ramifications. Lecture, 3 hours/week; Laboratory, 2 1/2 hours/week. Prerequisite: BIOL 122, BIOL 124L or equivalent.

BIOL 325L. Enviromental Ecology Lab. (0).

BIOL 331. Genetics. (4).
This course concerns the mechanisms by which genetic information is stored, decoded and transmitted. We will focus on the experimental basis upon which our understanding of the above mechanisms rests. Methods of genetic analysis that involve interpretation of abstract data will be emphasized, although molecular and bioinformatic approaches, including structural and functional genomics, will be treated. The use of genetic analysis as an incisive tool to dissect biological processes will be a central theme of the course. Lecture, 3 hours/week; Laboratory, 3 hours/week. Prerequisites: BIOL 122.

BIOL 331L. Genetics Lab. (0).

BIOL 332. Macromolecular Structure. (2).
The elaborate interplay of a variety of macromolecules underlies the mechanisms that govern cell function. This advanced course deals with the structure-function relationships of these macromolecular machines. It is intended that students emerge from this course with a deep understanding of the principles that govern macromolecular structure and the functional consequences of these principles. This is a seminar class in which students must assume responsibility for their own learning. Students will come to class prepared to discuss the reading assignment for the week. Lectures will focus on teaching the methods that students will employ to construct a Web-based tutorial on a macromolecule, chosen with input from the professor. Prerequisites: BIOL 122.

BIOL 333. Ecology. (4).
This course teaches the foundational principles of the science of ecology. Fundamental concepts of the course include the physical and biotic environment, responses of organisms to the environment, distribution or organisms, behavioral and community ecology, natural ecosystems, and human interaction with ecosystems. Lecture, 3 hours/week; Lab, 3 hours/week. Prerequisites: BIOL 120, MATH 110; Recommended: MATH 231.

BIOL 333L. Ecology Lab. (0).

BIOL 334. Contemporary Issues in Biology. (4).
The course will cover current issues relating to the biological sciences from the cell and including, our ecosystem and biosphere. We will discuss current issues and debates through print and emedia and compare and contrast these secondary, tertiary and quaternary sources of information to primary research sources. Our interest lies not only in gathering information and learning basic biological principles, but how these issues impact human health, politics, business, ecosystems and our daily life. Lecture, 4 hours/week. Perquisites: at least 5 units of lower division Biology Courses.

BIOL 341. Comparative Anatomy. (4).
The comparative study of vertebrate anatomy within an evolutionary perspective; includes the evolution, development, structure and function of vertebrate systems. Lecture, 3 hours/week; Laboratory, 3 hours/week. Prerequisites: BIOL 120, BIOL 121, BIOL 122, BIOL 123L, BIOL 124L.

BIOL 341L. Comparative Anatomy Lab. (0).

BIOL 342. Developmental Biology. (4).
This course concerns the mechanisms by which multicellular organisms are constructed. We will focus on the experimental evidence that supports our understanding of these mechanisms. After an introduction to the history of developmental biology, the processes of gametogenesis, fertilization, cleavage, gastrulation and organogenesis will be covered. The course will progress to a treatment of some of the mechanisms by which genes are differentially expressed during the embryogenesis of model organisms, including Drosophilia, Xenopus and mouse. We will finish up with considerations of developmental mechanisms of evolutionary change. Lecture, 3 hours/week; Laboratory, 3 hours/week. Prerequisites: BIOL 121, BIOL 122, Recommended: BIOL 120, BIOL 123L, BIOL 124L, BIOL 331.

BIOL 342L. Developmental Biology Lab. (0).

BIOL 343. Invertebrate Zoology. (4).
Studies the morphology, physiology, taxonomy and ecology of most invertebrate phyla. Field trips and laboratory observation of living animals are emphasized. Lecture, 3 hours/week; Laboratory, 3 hours/week. Prerequisites: BIOL 120, BIOL 123L.

BIOL 343L. Invertebrate Zoology Lab. (0).

BIOL 345. Marine Biology. (4).
The study of marine life of the world, with special emphasis on tidepool and shallow water life of the West Coast. Includes identification, distribution, adaptations of marine forms and their interrelationship to each other. Lecture, 3 hours/week; Laboratory, 3 hours/week. Prerequisite: BIOL 120, BIOL 123L.

BIOL 345L. Marine Biology Lab. (0).

BIOL 350. Introduction to Neuroscience. (4).
Neuroscience is an interdisciplinary science that examines the fundamental principles that govern the action of neurons and nervous systems. The course covers the structure and function of the nervous system with an emphasis on the mammalian nervous system. There are four main topic areas: the cellular organization of the nervous system; neuronal signaling (the ionic mechanisms underlying electrical activity in the nerve cells and the physiology and biochemistry of synaptic transmission); transduction and coding of sensory information; the generation and coordination of motor output and behavior. Higher order functions such as memory, language, and behavior will be covered. Prerequsites: BIOL 121, BIOL 122, and MATH 151.

BIOL 350L. Neuroscience Lab. (0).

BIOL 352. Oceanography. (4).
An introduction to the multidisciplinary nature of oceanography, including the origin and geography of the ocean basins, physical and chemical properties of sea water, the shaping of coastlines, oceanic and atmospheric circulation patterns and ecological relationships of marine organisms and the ocean environment. Lecture, 3 hours/week; Laboratory, 2 1/2 hours/week. Prerequisite: BIOL 120, BIOL 123L.

BIOL 352L. Oceanography Lab. (0).

BIOL 361. Microbiology. (4).
Studies the morphology, physiology, taxonomy and ecology of micro-organisms and their role in infection and disease. Lecture,3 hours/week; Laboratory, 3 hours/week. Prerequisite: BIOL 121, BIOL 122, BIOL 124L or equivalent.

BIOL 361L. Microbiology Lab. (0).

BIOL 375. Cell Biology. (4).
The cellular nature of life is explored by studying prokaryotic and eukaryotic cells and their component parts at the structural and functional levels. Lecture, 3 hours/week; Laboratory, 3 hours/week. Prerequisites: BIOL 121, BIOL 122, BIOL 124L; CHEM 151, CHEM 152. Recommended: BIOL 331; CHEM 201 or CHEM 331.

BIOL 375L. Cell Biology Lab. (0).

BIOL 399. Junior Honors. (2).
This class consists of mentored literature research, in which students work closely with a faculty member to develop an approach to address a particular question in biology. Each student will produce several drafts of a literature review/research proposal, which frames the questions being addressed by the proposed research and provides a strategy for an experimental approach(es) to address these questions. The research proposal will serve as the basis for subsequent Senior Honors courses (BIOL 498 and BIOL 499). A student's grade will be determined by quality of the final draft as determined by two faculty readers (the research mentor and one other). Prerequisites: Permission of instructor.

BIOL 422. Bioinformatics-Analytical. (4).
Various approaches are addressed for solving typical bioinformatics problems, including genomics, gene expression, phylogenetics, and structure prediction. Key bioinformatics databases are introduced. This class emphasizes the algorithms used for the analyses. Prerequisites: BIOL 122.

BIOL 425. Biochemistry. (4).
The structure and function of proteins is covered, along with the structure, function, and metabolism of carbohydrates, lipids, and amino acids. Regulation of proteins and metabolism is emphasized. Lecture, 3 hours; Laboratory, 3 hours/week. Prerequisites: CHEM 331 and CHEM 332. Recommended: BIOL 122 and BIOL 124L. (cross-listed with CHEM 425).

BIOL 425L. Biochemistry Lab. (0).
Prerequisite: concurrent enrollment in BIOL 425 / CHEM 425. (cross-listed with CHEM 425L).

BIOL 426. Molecular Biology. (4).
The biosynthesis of DNA, RNA, and protein is studied, with emphasis on the structure and regulation of genes. Chromatin structure, recombination, mutagenesis, and genomics is also covered. Lecture, 3 hours/week; Laboratory, 3 hours/week. Prerequisite: BIOL 122 and BIOL 124L or BIOL 425 / CHEM 425.

BIOL 426L. Molecular Biology Lab. (0).

BIOL 427. Genomics. (2).
This course introduces students to genomics through participation in research projects, including sequence improvement of a genome and the annotation of genes in a genome. Various computer analyses will be used for these projects. Lab, 4 hours/week. Prerequisites: BIOL 122 and BIOL 124L or equivalent.

BIOL 428. Virology. (4).
The study of prokaryotic and eukaryotic viruses. The structure and function of viruses, including their genomes, replication, and assembly are explored. Also covered are transmission of viruses, virus-host interactions, vaccines and antiviral drugs. Lecture, 3 hours/week; Laboratory, 3 hours/week. Prerequisite: BIOL 122 and BIOL 124L.

BIOL 428L. Virology Lab. (0).

BIOL 434. Medical Microbiology. (2).
The host-parasite relationship with emphasis on bacteria and viruses, including mechanisms involved in disease production as well as host defenses. Prerequisites: BIOL 121, BIOL 122, BIOL 124L.

BIOL 437. Herpetology. (4).
The lecture will emphasize the evolution, systematics, distribution, natural history, ecology, and behavior of amphibians and reptiles. In laboratory, identification, adaptations, morphology, behavior, natural history, and life history will be emphasized. The first half of the laboratory portion of the course will be spent exclusively on taxon and species identification with an emphasis on the herpetofauna of southern California. The second half of laboratory will be used to review identification and also to dicuss current research in herpetology. This course is predominantly a whole-organism zoology course. Lecture, 3 hours/week; Lab, 3 hours/week. Prerequisite: BIOL 120, BIOL 311. Recommended: BIOL 333.

BIOL 437L. Herpetology Lab. (0).

BIOL 438. Immunology. (4).
This course will cover the basic concepts of immunology on a cellular and molecular level. Concepts such as innate and acquired immune responses, humoral and cell-mediated responses will be integrated throughout the course. Advances in modern molecular immunology are consistently shaping our understanding of the immune system and, as such, students will be required to read and analyze recent publications in the field. We will also be studying principles of immunology in the laboratory. Students will discover how blood typing, white blood cell counts, pregnancy tests, allergy tests and immunity tests are all performed using concepts of immunology. It is expected that this is the first course in immunology that students will have taken, however, a good understanding of cellular and molecular biology is a prerequisite. Lecture, 3 hours/week; Lab, 3 hours/week. Prerequisites: BIOL 121, BIOL 124L and at least one course of the Cellular and Molecular Biology category.

BIOL 438L. Immunology Lab. (0).

BIOL 452. California Plant Communities. (4).
Students learn to recognize the characteristic plants of the various plant communities of Southern California. Problems resulting from habitat destruction, urbanization and loss of species are discussed. Laboratory includes collection and identification techniques and habitat comparisons. Lecture, 3 hours/week; Laboratory and fieldwork, 3 hours/week. Prerequisites: BIOL 120, BIOL 121, BIOL 123L.

BIOL 452L. California Plant Communities Lab. (0).

BIOL 461. Vertebrate Physiology. (4).
A study of fundamental physiological processes of vertebrate tissues organs and systems. Lecture, 3 hours/week; Laboratory, 3 hours/week. Prerequisites: BIOL 121, BIOL 122, BIOL 123L; CHEM 151, CHEM 152. Recommended: CHEM 201 or CHEM 331.

BIOL 461L. Vertebrate Physiology Lab. (0).

BIOL 463. Scientific Literature. (3).
An introduction to scientific literature. In this two-unit seminar course, students read scientific papers and analyze the works of other scientists. Prerequisites: BIOL 120, BIOL 121, BIOL 122, BIOL 123L, BIOL 124L, senior standing.

BIOL 482. Selected Topics. (2-4).

BIOL 482L. Selected Topics Lab. (0).

BIOL 490. Independent Study. (1-4).

BIOL 492. Internship. (1-4).

BIOL 498. Senior Honors I - Capstone. (3).
The class will consist of continuing faculty-mentored research through experimental or observational studies. Students are required to keep an accurate account of their experiments/studies and to meet with their research mentors on a regular basis. A grade will be determined by the student's research mentor, based on effort and quality of research. Prerequisite: BIOL 399.

BIOL 499. Senior Honors II - Capstone. (3).
This class consists of continuing faculty-mentored research through experimental or observational studies. Students are required to keep an accurate account of their experimentals/studies and to meet with their research mentors on a regular basis. A thesis, written in proper scientific format, is required. The thesis and a public presentation of the Honors research will be graded by the research mentor and one additional faculty member. Prerequisite: BIOL 399, BIOL 498.

Chemistry Courses

Lower Division

CHEM 111. Chemistry and the Environment. (4).
Explores the interface between chemistry and the world we live in, with particular emphasis on environmental issues such as pollution, energy depletion and global warming. The chemical principles required to understand these topics are introduced on an as-needed basis. This course is primarily intended for non-science majors and cannot be used for credit toward a chemistry degree. Lecture, 3 hours/week; Laboratory, 3 hours/week.

CHEM 111L. Chemistry and the Environment Lab. (0).

CHEM 151. General Chemistry. (4).
Covers the fundamental theories, principles and laws of chemistry, plus the properties of elements and compounds. Prerequisites: MATH 151: high school chemistry; Math Placement Exam section I score of 14 or better or completion of MATH 110; Corequisite: CHEM 151L.

CHEM 151L. General Chemistry Lab. (1).
Covers the laboratory techniques and apparatus of chemistry, plus the illustrations of quantitative relationships in chemistry. Includes a systematic course in theory and techniques of inorganic qualitative analysis. Corequisite: CHEM 151L: CHEM 151.

CHEM 152. General Chemistry II. (4).
Covers the fundamental theories, principles and laws of chemistry, plus the properties of elements and compounds. Prerequisites: CHEM 151: high school chemistry; Math Placement Exam section I score of 14 or better or completion of MATH 110; Corequisite: CHEM 152L.

CHEM 152L. General Chemistry II Lab. (1).
Covers the laboratory techniques and apparatus of chemistry, plus the illustrations of quantitative relationships in chemistry. Includes a systematic course in theory and techniques of inorganic qualitative analysis. Corequisite: CHEM 152.

CHEM 201. Elementary Organic Chemistry. (4).
An introduction to the study of the aliphatic and aromatic compounds of biochemical interest. Includes fundamentals of organic chemistry for students of biology, nursing, physical education and elementary education. Lecture, 3 hours/week; Laboratory, 3 hours/week. Prerequisite: CHEM 111 or CHEM 152.

CHEM 201L. Elementary Organic Chemistry Lab. (0).

Upper Division

CHEM 301. Environmental Chemistry. (4).
In this course, principles of chemistry will be applied to environmental problems including water, air and soil chemistry and toxicology. Lecture, 3 hours/week; Lab, 3 hours/week. Prerequisite: CHEM 201.

CHEM 301L. Environmental Chemistry Lab. (0).

CHEM 305. Quantitative Analysis. (4).
Covers the principles and techniques of gravimetric and volumetric analysis. Lecture, 3 hours/week; Laboratory, 3 hours/week.

CHEM 305L. Quantitative Analysis Lab. (0).

CHEM 306. Chemical Instrumentation. (4).
Covers the theories and application of instrumentation in chemistry. Lecture, 2 hours/week; Laboratory, 6 hours/week. Prerequisite: CHEM 305.

CHEM 306L. Chemical Instrumentation Lab. (0).

CHEM 331. Organic Chemistry. (4).
Covers the structure, nomenclature, reactions and synthesis of organic compounds, plus the theory and mechanism of organic reactions. Lecture, 4 hours/week.

CHEM 332. Organic Chemistry II. (4).
Covers the structure, nomenclature, reactions and synthesis of organic compounds, plus the theory and mechanism of organic reactions. Lecture, 4 hours/week. Prerequisite CHEM 331.

CHEM 341. Organic Chemistry Lab. (1).
Laboratory work in isolation, characterization and synthesis of organic compounds. Laboratory, 3 hours/week. Corequisite: CHEM 331.

CHEM 342. Organic Chemistry II Lab. (1).
Laboratory work in isolation, characterization and synthesis of organic compounds. Laboratory, 3 hours/week. Corequisite: CHEM 332.

CHEM 405. Physical Chemistry. (4).
The study of kinetic theory, structure of condensed phases, thermodynamics, equilibria, electrochemistry, quantum chemistry and chemical kinetics. Lecture, 3 hours/week; Laboratory, 3 hours/week. Prerequisites: one year each of calculus and physics or consent of instructor.

CHEM 405L. Physical Chemistry Lab. (0).

CHEM 406. Physical Chemistry. (4).
The study of kinetic theory, structure of condensed phases, thermodynamics, equilibria, electrochemistry, quantum chemistry and chemical kinetics. Lecture, 3 hours/week; Laboratory, 3 hours/week. Prerequisites: one year each of calculus and physics or consent of instructor.

CHEM 406L. Physical Chemistry Lab. (0).

CHEM 411. Advanced Inorganic Chemistry. (3).
The advanced treatment of special topics in inorganic chemistry, including atomic structure, classification of elements and inorganic reactions in aqueous and non-aqueous solutions. Lecture, 3 hours/week. Prerequisite: consent of instructor. (on demand).

CHEM 412. Advanced Organic Chemistry. (3).
Further study in organic chemistry, emphasizing synthesis, reaction mechanisms and stereoisomerism. Lecture, 3 hours/week. Prerequisite: CHEM 332 or consent of instructor. (on demand).

CHEM 421. Qualitative Organic Analysis. (3).
The classification, reactions, derivatives and identification of organic compounds. Lecture, 1 hour/week; Laboratory, 6 hours/week. Prerequisite: CHEM 332 and CHEM 342 or consent of instructor. (on demand).

CHEM 421L. Qualitative Organic Analysis Lab. (0).

CHEM 425. Biochemistry. (4).
The structure and function of proteins is covered, along with the structure, function, and metabolism of carbohydrates, lipids, and amino acids. Regulation of proteins and metabolism is emphasized. Lecture, 3 hours; Laboratory, 3 hours/week. Prerequisites: CHEM 331 and CHEM 332. Recommended: BIOL 122 and BIOL 124L. (cross-listed with BIOL 425).

CHEM 425L. Biochemistry Lab. (0).
Prerequisite: Concurrent enrollment in BIOL 425 / CHEM 425. (cross-listed with BIOL 425L).

CHEM 461. Chemical Preparations. (2).
The preparation and purification of selected inorganic or organic compounds; introduces the student to chemical literature and laboratory research methods. Prerequisite: consent of instructor.

CHEM 482. Selected Topics. (1-4).

CHEM 482L. Selected Topics Lab. (1-4).

CHEM 485. Capstone Seminar. (2).
Introduces students to the skills and practices required of professional scientists. Students will gain experience with conducting literature searches, conducting and presenting scientific work, reviewing the work of others and writing research proposals. Prerequisite: senior standing.

CHEM 490. Independent Study. (1-4).

CHEM 492. Internship. (1-4).