

Biology

Biologists study many aspects of how **life** operates – from the molecular details of how cells work to how entire ecosystems function. The course offerings in the Cal Lutheran Biology Department reflect this diversity, with courses ranging from molecular to marine biology.

The Biology Department emphasizes “doing” science rather than listening to it or reading about it. Small classes and the availability of a faculty with diverse research interests allow students to get involved in ongoing scholarship. Students are encouraged to join faculty mentors as collaborators, either in formal laboratory or field classes, or in mentored research outside of the classroom. Undergraduate research projects help make Cal Lutheran graduates more competitive in their chosen career paths.

At Cal Lutheran, biology majors typically focus on one of three general career paths: health careers, which include physician, dentist, veterinarian or physical therapist; research in biological fields such as botany, physiology, marine biology, ecology, genetics or molecular biology; or teaching.

Careers in biology are available in both government and private companies and include positions in research, teaching, administration and sales of pharmaceuticals or medical equipment. In addition, the growing areas of genetics and biotechnology provide many career opportunities. The global biotechnology company Amgen is located near the University and hires Cal Lutheran graduates each year.

Likewise, many biology majors from Cal Lutheran are accepted into medical, dental and graduate schools throughout the United States.

Students interested in careers in teaching may obtain teaching credentials through the School of Education.

Bachelor of Arts in Biology

32 credits minimum, 20 credits upper division. At least 16 biology units must be taken at CLU.

BIOL 120	Introduction to Ecology and Populations	3
BIOL 121	Introduction to Cells and Organisms	3
BIOL 122	Introduction to Metabolism, Genes and Development	3
BIOL 123L	Introduction to Biological Experimentation I	2
BIOL 124L	Introduction to Biological Experimentation II	2
BIOL 311	Evolution	3
Select one of the following: (Biol 399, 498, 499 - Dept Honors Option)		8-3
BIOL 399/498/499 or BIOL 463	Junior Honors and Senior Honors I - Capstone and Senior Honors II - Capstone Scientific Literature	
Select three courses from the following with at least one from each category:		12
Molecular and Cellular Biology		
BIOL 331/331L	Genetics and Genetics Lab	
BIOL 375/375L	Cell Biology and Cell Biology Lab	
BIOL 425/425L	Biochemistry and Biochemistry Lab	
BIOL 426/426L	Molecular Biology and Molecular Biology Lab	
BIOL 428/428L	Virology and Virology Lab	
BIOL 438/438L	Immunology and Immunology Lab	
Organismal Biology and Ecology		
BIOL 325/325L	Environmental Ecology and Environmental Ecology Lab	
BIOL 333/333L	Ecology and Ecology Lab	
BIOL 345/345L	Marine Biology and Marine Biology Lab	
BIOL 352/352L	Oceanography and Oceanography Lab	
BIOL 361/361L	Microbiology and Microbiology Lab	
BIOL 437/437L	Herpetology and Herpetology Lab	
BIOL 452/452L	California Plant Communities and California Plant Communities Lab	
Functional Biology		
BIOL 341/341L	Comparative Anatomy and Comparative Anatomy Lab	
BIOL 342/342L	Developmental Biology and	
BIOL 343/343L	Invertebrate Zoology and Invertebrate Zoology Lab	
BIOL 350/350L	Introduction to Neuroscience and Neuroscience Lab	
BIOL 461/461L	Vertebrate Physiology and Vertebrate Physiology Lab	

Upper Division Biology Elective Credits (if needed)

0-2

Total Hours

36-33

Required Supporting Courses

MATH 231	Biostatistics (or a statistics course taught in a math department)	4
or MATH 251	Calculus I	
CHEM 151	General Chemistry	4
CHEM 151L	General Chemistry Lab	1
CHEM 152	General Chemistry II	4
CHEM 152L	General Chemistry II Lab	1
Select one of the following:		4
CHEM 331/341	Organic Chemistry and Organic Chemistry Lab	
CHEM 201/201L	Elementary Organic Chemistry and Elementary Organic Chemistry Lab	
Total Hours		18

Bachelor of Science in Biology

40 credits minimum, 28 credits upper division. At Least 16 biology units must be taken at CLU.

BIOL 120	Introduction to Ecology and Populations	3
BIOL 121	Introduction to Cells and Organisms	3
BIOL 122	Introduction to Metabolism, Genes and Development	3
BIOL 123L	Introduction to Biological Experimentation I	2
BIOL 124L	Introduction to Biological Experimentation II	2
BIOL 311	Evolution	3
Select one of the following: (Biol 399, 498, 499 - Dept Honors Option)		8-3
BIOL 399/498/499	Junior Honors and Senior Honors I - Capstone and Senior Honors II - Capstone	
or BIOL 463	Scientific Literature	
Select four courses from the following with at least one from each category: ¹		16
Molecular and Cellular Biology		
BIOL 331/331L	Genetics and Genetics Lab	
BIOL 375/375L	Cell Biology and Cell Biology Lab	
BIOL 425/425L	Biochemistry and Biochemistry Lab	
BIOL 426/426L	Molecular Biology and Molecular Biology Lab	
BIOL 428/428L	Virology and Virology Lab	
BIOL 438/438L	Immunology and Immunology Lab	
Organismal Biology and Ecology		
BIOL 325/325L	Environmental Ecology and Environmental Ecology Lab	
BIOL 333/333L	Ecology and Ecology Lab	
BIOL 345/345L	Marine Biology and Marine Biology Lab	
BIOL 352/352L	Oceanography and Oceanography Lab	
BIOL 361/361L	Microbiology and Microbiology Lab	
BIOL 437/437L	Herpetology and Herpetology Lab	
BIOL 452/452L	California Plant Communities and California Plant Communities Lab	
Functional Biology		
BIOL 341/341L	Comparative Anatomy and Comparative Anatomy Lab	
BIOL 342/342L	Developmental Biology and	
BIOL 343/343L	Invertebrate Zoology and Invertebrate Zoology Lab	
BIOL 350/350L	Introduction to Neuroscience and Neuroscience Lab	
BIOL 461/461L	Vertebrate Physiology and Vertebrate Physiology Lab	

Upper Division Biology Elective Credits (if needed)

0-6

Total Hours

40-41

¹ Students that successfully complete the Biology Department Honors Program are exempted from one of these four course requirements.

Required Supporting Courses

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	
Select one of the following:		4
MATH 231	Biostatistics (or Statistics course taught in a Math Department)	
or MATH 251	Calculus I	
CHEM 151	General Chemistry	4
CHEM 151L	General Chemistry Lab	1
CHEM 152	General Chemistry II	4
CHEM 152L	General Chemistry II Lab	1
Select one of the following:		
CHEM 331/341	Organic Chemistry and Organic Chemistry Lab	
CHEM 201/201L	Elementary Organic Chemistry and Elementary Organic Chemistry Lab	
Total Hours		22-24

Minor in Biology

22 Credits minimum, 12 credits upper division.

Two Courses From:		6
BIOL 120	Introduction to Ecology and Populations	
BIOL 121	Introduction to Cells and Organisms	
BIOL 122	Introduction to Metabolism, Genes and Development	
BIOL 123L	Introduction to Biological Experimentation I	2
BIOL 124L	Introduction to Biological Experimentation II	2
Upper Division Biology Electives		12
Total Hours		22

The Biology Departmental Honors Program

Students with excellent academic credentials will be nominated by the Biology Department Faculty for Departmental Honors (Biol DH) in the Fall of their junior year. Students will be nominated based on Science GPA, Overall GPA, and demonstrated interest and aptitude for undergraduate research. Students who are not nominated may petition for admission to the Biol DH program by meeting with the Biology faculty in the Fall of their junior year.

Nominated/petitioned students who choose to participate in the Biol DH will enroll in a 2-unit Biology class, BIOL 399 Junior Honors , in the spring semester of their junior year. Students will then normally participate in the summer research on the proposed project between their junior and senior years. During the senior year, Biol DH students will enroll in BIOL 498 Senior Honors I - Capstone , during the Fall, and BIOL 499 Senior Honors II - Capstone in the Spring semester. Students who successfully complete these 8 units of coursework and present their work in a public setting will be awarded Departmental Honors in 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 with 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 increased appreciation and interest in our natural world 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 change and ocean acidification, mercury in seafood, beach erosion, alien species, marine biodiversity and coral reef 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 developmental patterns 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 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 reproductive: 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).****BIOL 282C. ST: (CORE). (1-4).**

Select Topic approved to satisfy core requirement.

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. Environmental 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 of 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 media 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. Prerequisites: 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 advanced course affords students the opportunity to study the experimental basis underlying current understanding of animal development. Students read and present their analyses of seminal research papers in Developmental Biology, including classic examples as well as recent breakthrough publications. The key tools used to study a treatment the mechanisms by which genes construct multicellular organisms from fertilized eggs are a major focus of the course. This team-taught course is not a comprehensive survey of animal development. Rather, the focus is on the empirical approaches used to generate developmental concepts. Background lectures by your professors will be followed by student presentations and discussions. Extensive class participation by all students in the class is expected. NOTE: This class does not have a lab component, however, it still fulfills the requirement of a Functional Biology category class. Prerequisites: BIOL 121, BIOL 122. Recommended: BIOL 120, BIOL 123L, BIOL 124L, BIOL 331.

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. Prerequisites: BIOL 121.

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 to address these questions. The research proposal will serve as the basis for subsequent Senior Honors courses (BIOL 498 and BIOL 499). Prerequisites: Permission of instructor.

BIOL 400. Cancer Biology. (4).

This course will cover basic concepts of Cancer Biology on a cellular and molecular level. Topics such as mutation, transformation, and the two-hit hypothesis will be integrated throughout the course, as well as the 10 hallmarks of cancer. Advances in modern molecular biology are consistently shaping our understanding of cancer cells and, as such, students will be required to read and analyze recent publications in the field. We will also be studying principles of cancer biology in the laboratory. Students will learn how to culture normal and transformed cell lines and recognize the differences between them. We will also be utilizing techniques in molecular biology to sequence putative cancer genes from cancer cells and identify mutations. It is expected that this is the first course in cancer or cell biology that students will have taken, however, a good understanding of cellular and molecular biology is a prerequisite.

BIOL 400L. Cancer Biology Lab. (0).**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 discuss 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 123L or BIOL-124L, and CHEM 151.

BIOL 461L. Vertebrate Physiology Lab. (0).**BIOL 463. Scientific Literature. (3).**

An introduction to scientific literature. In this three-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 482C. ST: Select Topic (core). (1-4).**

Select Topic approved to satisfy core.

BIOL 482L. Selected Topics Lab. (0).**BIOL 490. Independent Study. (1-4).****BIOL 492. Internship. (1-4).****BIOL 496. Directed Research. (1-3).****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.