Please Note:
Highlighting indicates substantive updates for the 2009/2010 academic year.

Updates are effective July 1, 2009.

Faculty

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Degrees and Programs

Biologists seek to understand the complexity of the living world through observation and experiment. By offering course work and laboratory experience concerning microorganisms, plants, animals (including humans), and the interrelationships among these living things, the Biology Department encourages the student to consider the study of life an exciting and continuing challenge, whether at the level of molecules, cells, organisms, populations, or ecosystems.

The biology major prepares students for careers in the practice or teaching of the life sciences, for graduate study, or for entering professional schools in dentistry, medicine, and veterinary medicine.

The biology curriculum may be enriched by research (BIOL 412) either on or off campus, and by the marine courses offered during the summer session at the Rosario Beach Marine Station in Washington.

Major in Biology, B.S.

A minimum of 99 hours (51 upper-division hours)

➤ ***Required Core Courses (39 hours):***

BIOL 111-112-113	Biological Foundations	5-5-5
BIOL 222	Introduction to Research Methods	2
BIOL 233	Principles of Ecology	4
BIOL 320	Cellular and Molecular Biology	4
BIOL 348	Systems Physiology	5
BIOL 354	Genetics	4
BIOL 396	Seminar (4 quarters)	.5-.5-.5-.5
BIOL 450	Philosophy of Origins	3

➤ ***Required Core Electives (21 hours):***

At least 21 hours from the following:		21
BIOL 323	Vertebrate Biology (4)	
BIOL 325	Flowering Plants (3)	
BIOL 328	Animal Behavior (4)	
BIOL 331	Marine Science (4)	
BIOL 366	Medical Microbiology (5)	
BIOL 400*	Topics in Biology (5)	
BIOL 403*	Ornithology (5)	
BIOL 412	Research in Biology (1-3)	
BIOL 417*	Behavior of Marine Organisms (5)	
BIOL 419	Developmental Biology (3)	
BIOL 422	Advanced Human Anatomy (4)	
BIOL 426	Histology (5)	
BIOL 430	Neurobiology (4)	
BIOL 445	Biotechnology (3)	
BIOL 458*	Marine Biology (5)	
BIOL 460*	Marine Ecology (5)	
BIOL 463*	Marine Phycology (5)	
BIOL 469	Immunology (4)	
BIOL 475*	Marine Invertebrates (5)	
ENVR 360/L	Conservation Biology & Lab (4)	

**Only offered during the summer at the Rosario Beach Marine Station.*

➤ *Required Cognate Courses (39 hours):*

CHEM 111-112-113	General Chemistry	5-5-5
CHEM 371-372-373	Organic Chemistry	4-4-4
PHYS 111-112-113	General Physics	4-4-4

Recommended Cognate Courses:

CHEM 381	Biochemistry I (4)
MATH 131	Calculus I (4)

Pre-medical and pre-dental students:

The B.S. degree curriculum, including recommended cognates, exceeds all undergraduate science requirements for pre-medical and pre-dental students applying to Loma Linda University and many other schools.

Major in Biology, B.A.

A minimum of 87 hours (24 upper-division hours)

Required core courses and cognate courses are the same as those for the B.S. degree. Core electives: Select 9 hours in biology from the core electives listed above for the B.S. degree. BIOL 412 is not applicable toward the B.A. degree.

Major in Environmental Studies, B.S.

A minimum of 90 hours (30 upper-division hours)

➤ *Required Core Courses (60 hours):*

BIOL 111-112-113	Biological Foundations	5-5-5
BIOL 222	Introduction to Research Methods	2
BIOL 233	Principles of Ecology	4
BIOL 450	Philosophy of Origins	3
CHEM 111-112-113	General Chemistry	5-5-5
ENVR 360	Conservation Biology	3
ENVR 360L	Conservation Biology Laboratory	1
ENVR 361	Energy and Climate Change	3
ENVR 361L	Energy and Climate Change Laboratory	1
ENVR 362	Pollution and Environmental Quality	3
ENVR 362L	Pollution and Environmental Quality Laboratory	1
ENVR 396	Seminar (4 quarters)	.5-.5-.5-.5
ENVR 450	Internship	4
RELT 240	Eco-theology	3

➤ *Required Core Electives (30 hours):*

At least 30 hours from the following:		30
AGRI 212	Home Greenhouse Gardening (2)	
AGRI 213	Home Vegetable Gardening (2)	
BIOL 227	Natural History of California (4)	
BIOL 323	Vertebrate Biology (4)	
BIOL 325	Flowering Plants (3)	
BIOL 328	Animal Behavior (4)	
BIOL 331	Marine Science (4)	
BIOL 366	Medical Microbiology (5)	
BIOL 400*	Topics in Biology (5)	
BIOL 403*	Ornithology (5)	
BIOL 417*	Behavior of Marine Organisms (5)	
BIOL 458*	Marine Biology (5)	
BIOL 460*	Marine Ecology (5)	
BIOL 463*	Marine Phycology (5)	
BIOL 475*	Marine Invertebrates (5)	
CHEM 324-325	Analytical Chemistry I-II (3-3)	
CHEM 324L-325L	Analytical Chemistry I-II Laboratory (2-2)	
CHEM 371-372-373	Organic Chemistry (4-4-4)	
CHEM 451-452	Physical Chemistry (3-3)	
CHEM 450L	Physical Chemistry Laboratory (1)	
ENVR 412	Research in Environmental Studies (1-3)	
GEOL 233	Geology (4)	
MATH 131-132	Calculus (4-4)	
PHYS 111-112-113	General Physics (4-4-4)	

Recommended courses for students interested in specific areas:

The following courses are recommended to help students become better prepared for a job or for graduate school in more specialized areas of environmental studies. These courses are not intended to provide students with the specific skills required for a job.

Air Quality:
CHEM 324, 324L, 325, 325L, 371-372-373, 450L, 451-452, MATH 131-132, PHYS 111-112-113

Conservation Biology:
BIOL 227, 323, 325, 328

Energy:
CHEM 324, 324L, 325, 325L, 371-372-373, 450L, 451-452, GEOL 233, MATH 131-132, PHYS 111-112-113

Environmental Economics:
ACCT 121-122-123, ECON 261, 265, MATH 131-132

Environmental Policy:
PLSC 124, 274, SOWK 232

Marine Resources:
BIOL 331 or 458, 417, 460, 463, 475

Solid Waste Management:
CHEM 324, 324L, 325, 325L, 371-372-373, 450L, 451-452, PHYS 111-112-113

**Only offered during the summer at the Rosario Beach Marine Station.*

Water Management:
BIOL 366, CHEM 324, 324L, 325, 325L, 371-372-373, 450L, 451-452-453, MATH 131-132, MICR 134, PHYS 111-112-113

Wildlife Management:
BIOL 227, 323, 328, 403

Major in Natural Science, B.S. Biology Emphasis

A minimum of 100 hours (26 upper-division hours)

This major provides appropriate preparation for teaching science at the secondary level. The core requirement of 65 quarter hours of course work corresponds to science subjects commonly taught in California public schools, and the emphasis treats the subject matter at a depth more than adequate for teaching the higher secondary science courses in biology. Emphases may also be obtained in chemistry or physics. For further information, see the sections entitled "Chemistry" and "Physics" in this catalog.

➤ ***Required Core Courses (65 hours):***

ASTR 115	Astronomy	5
ASTR 173	Meteorology	1
BIOL 111-112-113	Biological Foundations	5-5-5
BIOL 331	Marine Science	4
BIOL 450	Philosophy of Origins	3
CHEM 111-112-113	General Chemistry	5-5-5
GEOL 233	Geology	4
PHYS 390	History and Philosophy of Science	3
At least one of the following courses:		3
ENVR 360	Conservation Biology (3)	
ENVR 361	Energy and Climate Change (3)	
ENVR 362	Pollution and Environmental Quality (3)	
One of the following sequences:		4-4-4
PHYS 111-112-113	General Physics (4-4-4)	
PHYS 211-212-213	Physics with Calculus (4-4-4)	

Biology Emphasis (35-36 hours)

➤ ***Required Core Courses: (27-28 hours):***

BIOL 233	Principles of Ecology	4
BIOL 320	Cellular and Molecular Biology	4
BIOL 354	Genetics	4
BIOL 396	Seminar (4 quarters)	.5-.5-.5-.5
MICR 134	General Microbiology	5
At least one of the following courses:		5
BIOL 102	Human Physiology (5)	
BIOL 348	Systems Physiology (5)	
At least one of the following courses:		3-4
BIOL 323	Vertebrate Biology (4)	
BIOL 325	Flowering Plants (3)	

➤ ***Required Cognate Courses (8 hours):***

CHEM 102	Survey of Organic Chemistry	4
CHEM 103	Survey of Biochemistry	4

Teaching Credential

Students desiring to enter a program of studies leading to a California teaching credential in science with a concentration in biology should take the B.S. degree in Natural Science, Biology Emphasis. Students will need to pass the science (biology concentration) portion of the CSET exam one quarter prior to doing full-time student teaching. Students are invited to discuss the program with their major advisor in the Biology Department.

Those who plan to teach on the secondary level should consult with the credential analyst in the Education Department and should become acquainted with the specific requirements for admission to and successful completion of the Teacher Education Program as outlined in the section entitled "Education" in this catalog.

Minor in Biology

A minimum of 30 hours (12 upper-division hours)

➤ ***Required Courses (18 hours):***

BIOL 111-112-113	Biological Foundations	5-5-5
BIOL 450	Philosophy of Origins	3

➤ ***Required Electives (12 hours):***

At least 12 hours from the following (9 upper-division): 12
Additional non-service BIOL courses

Minor in Environmental Studies

A minimum of 31 hours (12 upper-division hours)

➤ ***Required Courses (31 hours):***

BIOL 233	Principles of Ecology	4
ENVR 360	Conservation Biology	3
ENVR 360L	Conservation Biology Laboratory	1
ENVR 361	Energy and Climate Change	3
ENVR 361L	Energy and Climate Change Laboratory	1
ENVR 362	Pollution and Environmental Quality	3
ENVR 362L	Pollution and Environmental Quality Laboratory	1
At least one of the following sequences:		15
BIOL 111-112-113	Biological Foundations (5-5-5)	
CHEM 111-112-113	General Chemistry (5-5-5)	

Agriculture

Lower-Division Courses:

AGRI 212 **2 W**
Home Greenhouse Gardening
The greenhouse as a solar energy source for the home. Growth and multiplication of plants for food and home beautification. One lecture and one laboratory per week.

AGRI 213 **2 S**
Organic Vegetable Gardening
Developing a home vegetable garden using all-natural methods for preparing, growing, maintaining, protecting, and harvesting garden crops. One lecture and one laboratory per week.

Biology

Service Courses:
*(Not applicable to a major or minor in this department)**

BIOL 101 **5 F, W**
Human Anatomy
Human structure as the expression of basic principles of morphology. Each functional system considered in terms of its cell, tissue, and organ types. Four lectures and one laboratory per week.

BIOL 102 **5 W, S**
Human Physiology
The function of human body systems, emphasizing the relationships among these systems; the role of each system in normal body function and health. Four lectures and one laboratory per week. Prerequisite: BIOL 101.

BIOL 105 **5 W**
Introduction to Biology
The organization and complexity of living organisms. The central questions of biology: the relationship between form and function, acquisition and use of energy, continuity between generations, and biodiversity. Enrollment limited to non-science majors; not available to students who have had a college biology course. Four lectures and one laboratory per week.

BIOL 223 **2 S**
Medical Terminology
The terminology of science and medicine.

BIOL 227 **4 S**
Natural History of California
Plants and animals of California as they relate to its diverse topography and geography. Three lectures and one laboratory per week.

BIOL 355 **3 F**
Philosophy of Biology
Scientific and Biblical models regarding the origin and history of life. Special reference to the impact of origins philosophy on the interpretation of biological, geological, and paleontological evidence. Enrollment limited to non-biology majors. Intended for the general student.

Lower-Division Courses:

BIOL 111-112-113 **5-5-5 F-W-S**
Biological Foundations
An integrated foundation in life science principles for biology majors and preprofessional students in the biomedical sciences. Prerequisite to most biology courses with higher numbers. Should be taken in sequence. Four lectures and one laboratory per week.
BIOL 111: The cell as the structural and functional unit of life; organelles and their functions; structure and function of essential biomolecules; and an introduction to molecular genetics. Prerequisite: CHEM 101 or CHEM 111
BIOL 112: Mendelian genetics, biodiversity, ecology, and evolution.
BIOL 113: The form and function of plants and animals.

BIOL 222 **2 W**
Introduction to Research Methods
The tools of biological research, including the choice of a model system, statistical tests, data recording and analysis, interpretation and presentation of experimental results, and the writing of research proposals. One lecture and one laboratory per week. Prerequisites: BIOL 111-112-113 and STAT 222.

BIOL 233 **4 F**
Ecology
The interaction of physical and biological factors in maintaining balance within the ecosystem. Survey of world biomes and aquatic ecosystems. Laboratories examine and compare biotic communities and their structure on Howell Mountain. Three lectures and one laboratory per week. Prerequisite: BIOL 111-112-113.

* *Exceptions: BIOL 102 is applicable to the B.S. in Natural Science, emphasis in Biology, and BIOL 227 is applicable to the B.S. in Environmental Studies.*

Upper-Division Courses:

BIOL 320 4 W
Cellular and Molecular Biology
Composition, structure, and function of the cell and its organelles; emphasis on intracellular and intercellular communication and control principles. Prerequisites: BIOL 111-112-113; CHEM 371.

BIOL 323 4 W
Vertebrate Biology
Biology of the vertebrates, including their relationship to the physical environment and to other species and their social and reproductive patterns. The laboratory emphasizes the vertebrates in northern California. Three lectures and one laboratory per week. Prerequisite: BIOL 111-112-113.

BIOL 325 3 S
Flowering Plants
Structure of typical flowers; methods of analyzing, collecting, identifying, and preserving representative specimens. Two lectures and one laboratory per week. Prerequisite: BIOL 113 or BIOL 227.

BIOL 328 4 S
Animal Behavior
Diversity of animal behavior including instinct, learning, communication, sociobiology, and the genetic, physiological, and ecological aspects of behavior. Three lectures and one laboratory per week. Prerequisite: BIOL 111-112-113 or consent of the instructor.

BIOL 331 4 F
Marine Science
Introduction to oceanography, marine life, and humanity's impact on the marine environment. Three lectures and one laboratory per week. Prerequisites: BIOL 111-112-113 or consent of the instructor.

BIOL 348 5 F
Systems Physiology
Functions of the nervous, muscular, endocrine, cardiovascular, respiratory, renal, and reproductive systems with emphasis on regulatory mechanisms and integration. Examines processes used by animals in adjusting to their external environment and controlling their internal environment. Laboratories involve firsthand analysis of selected aspects of the major functional systems. Four lectures and one laboratory per week. Prerequisites: BIOL 111-112-113 or BIOL 101-102.

BIOL 354 4 S
Genetics
Genetics of bacteria, plants, and animals. Chromosome mapping, population and evolutionary genetics, prokaryotic and eukaryotic genetic control, and molecular genetics. Emphasis on the study of modern molecular genetic techniques and concepts. Three lectures and one laboratory per week. Prerequisites: BIOL 111-112-113, 320.

BIOL 366 5 W
Medical Microbiology
Major groups of bacteria, viruses, and fungi that are pathogens or normal flora of humans. Laboratory work emphasizes the culture, characterization, and identification of unknown bacteria of medical importance. Four lectures and one laboratory per week. Prerequisite: BIOL 111-112-113 or MICR 134.

BIOL 395 1-3 F, W, S, Su
Special Topics in Biology
Additional laboratory or library studies correlated with biology courses.

BIOL 396 .5 F, W, S
Seminar
(See also CHEM 396, CPTR 396, ENVR 396, PHYS 396)
Single topics of current interest in the natural sciences are presented by guest lecturers. To pass, a student must be on time and attend five course appointments. Biology majors are required to enroll in the course two out of three quarters in each of their junior and senior years. Credit earned only during the junior and senior years counts toward the Seminar requirement for a degree in biology. Repeatable to a maximum of 2 credits. Graded S/F.

BIOL 412 1-3 F, W, S
Research in Biology
Original investigation in selected areas of biology. The research topic is selected and the work done under direction of a faculty advisor. Scholarly presentation of research results is encouraged. Prerequisites: BIOL 111-112-113, 222 and approval of the Biology faculty. Repeatable for up to 6 credits applied to the Biology major. Qualifies for IP grading.

BIOL 419 3 F
Developmental Biology
Principles of animal and plant development and its molecular basis in selected model organisms. Cell communication and differentiation, embryonic induction, pattern formation, morphogenesis, and the genetic control of development. Prerequisites: BIOL 111-112-113, 320, 354.

BIOL 422 4 S
Advanced Human Anatomy
Intensive study of the structure of the human body. The laboratory requires extensive cadaver dissection. Two lectures and two laboratories per week. Enrollment limited to eight students. Prerequisite: BIOL 101 with a grade of B or better.

BIOL 426 **5 W**
Histology
Microscopic structure of the fundamental tissues and organs of humans and other mammals with functional correlations. Three lectures and two laboratories per week. Prerequisite: BIOL 111, 112, 113. Recommended prerequisite: BIOL 320.

BIOL 430 **4 F**
Neurobiology
The neural basis of behavior with emphasis on the human nervous system. Includes cellular approaches to neural function, neuroanatomy, development of neurons and circuits, and neuroendocrine mechanisms. Three lectures and one laboratory per week. Prerequisite: BIOL 348.

BIOL 445 **3 F**
Biotechnology
Advanced molecular genetics techniques, including isolation of DNA, cloning, PC and DNA sequencing. Ethics and politics of genetic testing, cloning, gene therapy, stem cell research, and transgenic organisms. Two lectures and one laboratory per week. Prerequisite: BIOL 354.

BIOL 450 **3 W**
Philosophy of Origins
Historical and current issues relating to special creation and evolution models of origins. Biological, geological, and paleontological evidence and potential explanations along with the theological and scientific implications of a particular interpretation. Enrollment limited to upper-division students. Intended for science majors. Prerequisite: BIOL 111-112-113.

BIOL 469 **4 S**
Immunology
The lymphoid system and its response to foreign substances by humoral or cellular mechanisms that may protect or injure the host. Immunogens, immunoglobulins, complement, antigen-antibody reactions, phagocytosis, inflammation, immediate and delayed allergy, autoimmunity, and the immunology of transplantation, cancer and tolerance. Three lectures and one laboratory per week. Prerequisites: BIOL 111-112-113, 320

BIOL 495 **1-3 F, W, S, Su**
Independent Study
Properly qualified students in biology whose scholarship is of outstanding quality may undertake a limited amount of individual investigation. Repeatable to a maximum of 6 credits.

Courses offered at the Rosario Beach Marine Station

Lower-Division Courses:

BIOL 115-116-117 **4-4-4 Su**
General Biology
Study of the basic principles of biology including animals, plants, and microorganisms. Topics include the cell, physiology, genetics, development, taxonomy, and ecology. Must be taken in sequence. Includes laboratory. High school or college chemistry strongly recommended. Completion of BIOL 115-116-117 satisfies the requirement for BIOL 111-112-113.

Each summer, four upper-division courses are taught at the Rosario Beach Marine Station, chosen from courses such as the ones listed below. BIOL 111-112-113 or a full sequence General Biology equivalent is the prerequisite for all courses. Courses are 5 credits and include credit for a research problem.

Upper-Division Courses:

BIOL 400 **5 Su**
Topics in Biology
Investigation of various specialties in Biology. Repeatable for credit in different content areas. Examples of recent content areas include Phytoplankton, Plant Ecology and Entomology.

BIOL 403 **5 Su**
Ornithology
Study of native birds of North America, with emphasis on physiology, identification, migration, and life histories.

BIOL 417 **5 Su**
Behavior of Marine Organisms
Study of inter- and intraspecific behaviors of marine animals and their behavioral responses to the physical environment. Involves laboratory experiences, field observations, and a research project. Prerequisite: a course in animal behavior, organismal biology, deep-sea biology, and shallow-water marine communities.

BIOL 458 **5 Su**
Marine Biology
Understanding the marine environment primarily from an ecological perspective. Included are principles of basic oceanography, plankton biology, deep-sea biology, and shallow-water communities.

BIOL 460 **5 Su**
Marine Ecology
Interspecific, intraspecific, and community relationships demonstrated by marine organisms.

BIOL 463 **5 Su**
Marine Phycology
Marine algae, covering the principles of their classification, natural history, ecology, physiology, and practical use.

BIOL 475 **5 Su**
Marine Invertebrates
The biology of selected groups of marine invertebrates.

Environmental Studies

Upper-Division Courses:

ENVR 360 **3 F**
Conservation Biology
Conservation ethics, population biology, biodiversity, threats to biodiversity, conserving biodiversity, and the interplay of human populations, economics, and politics. Required corequisite for biology majors and for environmental studies majors and minors: ENVR 360L.

ENVR 360L **1 F**
Conservation Biology Laboratory
Laboratory activities coordinated with ENVR 360. Prerequisite: BIOL 111-112-113.

ENVR 361 **3 W**
Energy and Climate Change
Fossil fuels, alternative energy sources, energy conservation, energy politics, atmosphere and climate, natural climate changes, and global warming. Required corequisite for environmental studies majors and minors: ENVR 361L.

ENVR 361L **1 W**
Energy and Climate Change Laboratory
Laboratory activities coordinated with ENVR 361. Prerequisite: BIOL 111-112-113.

ENVR 362 **3 S**
Pollution and Environmental Quality
Air pollution, ozone depletion, acid rain, water quality, water pollution, wastewater treatment, solid waste management, food production, pest control, and various environmental hazards. Required corequisite for environmental studies majors and minors: ENVR 362L.

ENVR 362L **1 S**
Pollution and Environmental Quality Laboratory
Laboratory activities coordinated with ENVR 362. Prerequisite: BIOL 111-112-113.

ENVR 396 **.5 F, W, S**
Seminar
(See also BIOL 396, CHEM 396, CPTR 396, PHYS 396)
Single topics of current interest in the natural sciences are presented by guest lecturers. To pass, a student must be on time and attend five course appointments. Environmental studies majors are required to enroll in the course two out of three quarters in each of their junior and senior years. Credit earned only during the junior and senior years counts toward the Seminar requirement for a degree in environmental studies. Repeatable to a maximum of 2 credits. Graded S/F.

ENVR 412 **1-3 F, W, S**
Research in Environmental Studies
Original investigation in selected areas of environmental studies. The research topic is selected and the work done under direction of a faculty advisor. Scholarly presentation of research results is encouraged. Prerequisite: BIOL 222. Repeatable to a maximum of 6 credits.

ENVR 450 **1-4 F, W, S**
Internship
Volunteer service or employment with an environmental government agency or non-government organization. Intended to provide students with experience relevant to future employment or graduate studies. A report must be submitted summarizing duties performed and skills learned. Repeatable to a maximum of 4 credits.

Geology

Lower-Division Course:

GEOL 233 **4 F**
Geology
The materials, structure, and internal conditions of the earth; the physical and chemical processes at work upon it. Three lectures and one laboratory per week.

General Science

Service Course:
(Not applicable to a major or minor in this department)

GSCI 205 **3 F, W**
Scientific Discoveries

Major developments in biology, chemistry, and physics that have led to new ways of thinking in the sciences, with a synthesis of modern scientific thought and methods. Prerequisites: MATH 019 or equivalent; a full year of biology at the secondary level or BIOL 105; a full year of chemistry at the secondary level or CHEM 101; and a full year of physics at the secondary level or PHYS 105.

Microbiology

Service Course:
*(Not applicable to a major or minor in this department)**

MICR 134 **5 F, S**
General Microbiology

An introduction to microorganisms-the bacteria, viruses, and fungi; the usefulness of microorganisms in nature and manufacturing; pathogenesis and immunity. Consideration of each major infectious disease with respect to its causative agent, characteristics, diagnosis, transmission, and prevention. Four lectures and one laboratory per week.

* *Exception: MICR 134 is applicable to the B.S. in Natural Science, emphasis in Biology.*