

Biology

College of Science and Mathematics

Chair: Dr. Randy W. Cohen

Chaparral Hall (CR) 5101

(818) 677-3356

www.csun.edu/biology

Faculty

Larry Allen, Lisa Banner, Larry Baresi, Maria Elena de Bellard, David Bermudes, Robert Carpenter, Randy Cohen, Steve Dudgeon, Peter Edmunds, Robert Espinoza, Michael Franklin, David Gray, Fritz Hertel, Ray Hong, Cheryl Hogue, Timothy Karels, Ernest Kwok, Cindy Malone, Jennifer Matos, Rheem Medh, Aida Metzenberg, Stan Metzenberg, Sean Murray, Daniel Odom, Steven Oppenheimer, Paula Schiffman, Mark Steele, Mary-Pat Stein, Michael Summers, Paul Tomasek, Virginia Vandergon, Paul Wilson, Maria Elena Zavala

Emeritus Faculty

Nancy Bishop, Jim Dole, Warren Furumoto, Kenneth Jones, John Kontogiannis, Daisy Kuhn, Joyce Maxwell, Edward Pollock

Adjunct Faculty

Jack Barrett, Maurie Beck, Christy Brigham, Kerry Clegg, Peter Eggena, Svetlana Eremenko, Norman Glover, Alan Holtzman, Rehwa Lee, Joyce Maxwell, Daniel Pondella, Raymond Sauvajot, Craig Rudolph, Ken Tachiki, Thomas Vandergon

Programs

Undergraduate:

B.A., Biology

B.S., Biology

Minor in Biology

Graduate:

M.S., Biology

Biology Subject Matter Program for the Single Subject Credential

Credential Information

The B.A. program plus a few additional courses (or the B.S. Option II with some modification) have been approved by the California Commission on Teacher Credentialing as an academic subject matter program for the Single Subject Credential in Science: Biology. For advisement students should contact the Biology Department Office. Subject matter program information is also found at www.csun.edu/biology/teacher. For details on the Single Subject Credential program, see the Credentials and Department of Secondary Education sections in this catalog.

Academic Advisement

Advisement is required of Biology B.S. undergraduate and graduate students during the fall semester before registering for the spring semester. Advisement can be obtained at the Biology Student Advisement Center or from any Biology faculty member in the student's option. The Biology Student Advisement Center is located in Chaparral Hall 5104 and can be reached at (818) 677-2675.

Contact Jim Dole or Daniel Odom for undergraduate advisement, and the Graduate Coordinator Tim Karels for questions about graduate study.

Contact the following option advisors: Stan Metzenberg (Biotechnology), Daisy Kuhn and Terri Richardson (Medical, Dental, Pharmacy, Optometry, Physician Assistant, Veterinary and Podiatry), Sean Murray (Medical Technology), and Jennifer Matos and Stan Metzenberg (Teacher Preparation).

Pre-Medical and Pre-professional Information

The B.A. degree is recommended for all pre-professional students; however, any of the B.S. options may be followed by students with special interests. Pre-medical, pre-dental and other students pursuing health associated professional careers should see Terri Richardson M.D. or Daisy Kuhn.

The Major

Biology is the study of life, its variety and processes. The discipline is dynamic and its intellectual framework is expanding rapidly. In one direction, the study of organisms is the basis for the understanding of how populations of organisms interact among themselves and with their environment. This includes a consideration of the distribution and abundance of organisms, change in organisms over time, energy flow among organisms and cycling of inorganic and organic resources. In another direction, the study of biological molecules is the basis for understanding cell structure and function, including metabolism, growth, development, reproduction in organisms. Additional information about the Biology program, faculty interests, and the like can be found at: www.csun.edu/biology.

Student Learning Outcomes

The Biology Department has identified four learning outcomes to be achieved by its students as a result of completing one of its baccalaureate degree programs.

1. Students should demonstrate knowledge of a) the structure and metabolism of cells; b) the transmission and expression of genetic information; and c) the immediate and long term (evolutionary) consequences of interactions between organisms and their environment.
2. Students should demonstrate specialized knowledge in one or more disciplines of biology.
3. Students should be aware of and/or capable of using new and existing methods and technologies in these disciplines.
4. Students must demonstrate facility in applying the methods of scientific inquiry, including observation, hypothesis testing, data collection and analysis.

Careers

Many career opportunities are available to the student majoring in biology. The undergraduate program provides an excellent background for further work in medicine, dentistry, pharmacy, optometry, veterinary medicine, biotechnology, clinical laboratory science and graduate programs. It also can serve for direct entry into teaching and a variety of positions in industrial, research and governmental organizations. Graduates of our program have been very successful in gaining admission and successfully completing advanced degrees at high quality universities.

Bachelor of Arts Program

The B.A. degree is designed for students seeking a broad foundation in biology as part of a liberal education in the arts and sciences. Provided that careful attention is paid to the requirements for advanced (post-baccalaureate) and professional programs, the B.A. degree is appropriate for those students (1) preparing for dentistry, medicine, optometry, pharmacy or veterinary medicine, (2) seeking a teaching credential (see above), or (3) intending to enter a graduate program. The B.A. degree is also suitable for careers in such areas as pharmaceutical sales and medical illustration (see Pre-medical and Pre-professional Information).

Bachelor of Science Program

The B.S. degree is appropriate for students seeking in-depth training in a particular biological field as preparation for a specific career. It

is designed to prepare students for (1) employment in commercial, industrial or governmental operations or labs, (2) traineeships required for certification or licensure in designated areas of applied biology and microbiology, or (3) academic graduate programs.

Cell and Molecular Biology (Option I) of the B.S. degree prepares students for work in private or government labs where modern cellular and molecular techniques are used. This option also prepares the student for advanced graduate study.

Environmental Biology (Option II) of the B.S. degree prepares graduates for employment in positions such as ecologist or wildlife preserve manager; for positions with the U.S. Department of Agriculture, Bureau of Land Management, National or State Parks and other government agencies and private organizations; or for consulting positions in formulating environmental impact reports. A modified version of this option is appropriate for students seeking a teaching credential. This option also prepares the student for advanced graduate study.

Microbiology (Option III) of the B.S. degree prepares students for employment in microbiology labs, both government and private, and meets the requirements of the California Department of Health Services. This option also prepares the student for advanced graduate study.

Biotechnology/Medical Technology (Option IV) of the B.S. degree is designed: (1) to meet the State academic requirements for Clinical Lab Science (Medical Technology) or Public Health Microbiology; or (2) to prepare a student for a career in biotechnology. Students who complete the course sequence for Medical Technology will be prepared to apply for the clinical year of training in Clinical Lab Science or to begin a career in industry or government. Students completing the Biotechnology course sequence will be well prepared for an entry-level biotechnology position in industry or government or for graduate programs in biotechnology. Students choosing either track of this option should consult an advisor as early as possible concerning the proper course sequence to be followed and other requirements in each field.

Marine Biology (Option V) of the B.S. degree prepares graduates for advanced graduate study and for employment in the marine sciences.

Requirements for the Bachelor of Arts Degree

Each student is required to complete the Core Program plus all of the requirements in the Selective Program.

A. Core Program

1. Lower Division Courses (26 Units)

BIOL	106/L	Biological Principles I and Lab (3/1)
BIOL	107/L	Biological Principles II and Lab (3/1)
CHEM	101/L	General Chemistry I and Lab (4/1)
CHEM	102/L	General Chemistry II and Lab (4/1)
PHYS	100A/L	General Physics I and Lab (3/1)
PHYS	100B/L	General Physics II and Lab (3/1)

2. Upper Division Courses (17 Units)

BIOL	322	Evolutionary Biology (3)
BIOL	360	Genetics (3)
BIOL	380	Cell Biology (3)
CHEM	333/L	Principles of Organic Chemistry I and Lab (3/1)
CHEM	334/L	Principles of Organic Chemistry II and Lab (3/1)

3. Mathematics Requirement

All biology B.A. students are required to demonstrate proficiency in mathematics equivalent to a passing grade in MATH 105 (or MATH 102 and 104). They may do this by receiving a passing score on the Math Placement Test sufficient for admission to MATH 255A.

B. Selective Program (20 Units)

Students must take a minimum of 20 units of specialized coursework in addition to the Core. With the approval of a faculty advisor and the concurrence of the Department Curriculum Committee, students may create their own program. Approval for such individualized programs must be obtained before enrollment in the last 12 units of Biology courses. By appropriate choice of courses, students may obtain the equivalent of a traditional degree in Botany or Zoology.

1. Molecular, Cellular, and Physiological Biology

Take at least 7 units from the following, including at least one course that has a bench lab designated by an "L" and at least one course that is at the 400-level or above:

BIOL	281/282	Human Physiology and Lab (3/1)
BIOL	315/L	Principles of Microbiology and Lab (2/2)
BIOL	316/L	Plant Biology and Lab (3/1)
BIOL	381	Cell Biology Lab (1) (not an "L" course)
BIOL	408/L	Applied Microbiology and Lab (2/2)
BIOL	411/L	Animal Histology and Lab (2/2)
BIOL	417/L	Microbial Physiology and Lab (2/2)
BIOL	441/L	Embryology and Lab (2/2)
BIOL	468	Human Genetics (3)
BIOL	470	Biotechnology (3)
BIOL	481/L	Plant Physiology and Lab (2/2)
BIOL	482/L	Animal Physiology and Lab (2/2)
BIOL	485/L	Immunology with Serology Lab (2/2)
BIOL	487/L	Hematology and Lab (2/2)
BIOL	536	Medical Mycology (3)
BIOL	542	Developmental Biology (3)
BIOL	544	Biology of Viruses (3)
BIOL	551/L	Computer Modeling in Biology and Lab (2/2)
BIOL	561	Molecular Genetics of Microorganisms (3)
BIOL	562	Molecular Genetics of Eukaryotic Organisms (3)
BIOL	563	Cytogenetics (3)
BIOL	564	Human Biochemical Genetics (3)
BIOL	566	Genetics of Bacteria and Their Viruses (3)
BIOL	567	Medical Genetics (3)
BIOL	568	Clinical Cytogenetics and Cancer Genetics (3)
BIOL	571	Molecular Diagnostics (3)
BIOL	572/L	Recombinant DNA Techniques and Lab (2/2)
BIOL	575/L	Biological Imaging and Lab (2/2)
BIOL	577/L	Cell and Tissue Culture and Lab (2/2)
BIOL	580/L	Cellular Physiology and Lab (2/2)
BIOL	581	Endocrinology (3)
BIOL	582/L	Principles of Neurophysiology and Lab (3/1)
BIOL	585	Mechanisms of Bacterial Pathogenesis (3)
BIOL	589	Cellular Immunology (3)

This requirement assures that the student will study 2 examples of the molecular and functional mechanisms that occur within individual organisms.

2. Systematics and Comparative Biology

Choose one from the following list. Either the course chosen here in List 2 (Systematics and Comparative Biology) or the one chosen in List 3 (Ecology and Environmental Biology) must have a field studies component, as designated by an asterisk (*).

BIOL	311/L	Comparative Anatomy and Lab (2/2)
BIOL	312/L/392F	Vertebrate Biology (2/1/1)*
BIOL	313/L/392B	Invertebrate Zoology (2/1/1) *
BIOL	403/L	Plant Morphology and Lab (2/2)
BIOL	406/L/492K	Flowering Plant Systematics (2/1/1)*
BIOL	409/L/492J	Non-Flowering Plants (2/1/1)*
BIOL	410/L	Medical Microbiology (2/2)

BIOL	415/L/492M	Mammalogy (2/1/1)*
BIOL	418/L	Bacterial Diversity (2/2)
BIOL	435/L	Parasitology (2/2)
BIOL	504/L/592P	Phycology (2/1/1)*
BIOL	506/L/592R or 492R	Tropical Botany (2/1/2)*
BIOL	508/L/592T or 492T	Biology of Tropical Vertebrates (2/1/2)*
BIOL	509/592U	Tropical Biodiversity and Field Studies (2/1)*
BIOL	512/L/592E	Herpetology (2/1/1)*
BIOL	513/L/592F	Entomology (2/1/1)*
BIOL	530/L/592J	Ichthyology (2/1/1)*

This requirement assures that the student will have the opportunity to study biodiversity closely in one group of organisms from the points of view of adaptive diversification, phylogeny, biogeography, and classification.

3. Ecology and Environmental Biology

Choose one from the following list. Either the course chosen here in List 3 (Ecology and Environmental Biology) or the one chosen in List 2 (Systematics and Comparative Biology) must have a field studies component, as designated by an asterisk (*).

BIOL	407/L/492N	Plant Ecology* (2/1/1)
BIOL	419/L/492C	Microbial Ecology and Lab and Field Studies * (2/1/1)
BIOL	421/L/492B	Marine Biology* (2/1/1)
BIOL	422/L	Physiological Ecology (2/2)
BIOL	423/492F	Field Ecology* (2/2)
BIOL	424/L/492G	Ecological Modeling (2/1/1)
BIOL	426/L/492P	Biology of Deserts* (2/1/1)
BIOL	427/L/492H	Principles of Ecology* (2/1/1)
BIOL	428/L/492W	Wildlife Ecology and Management (2/1/1)
BIOL	507/L/592S	
	or 492S	Tropical Ecology and Conservation* (2/1/2)
BIOL	514/L/592A	Avian Ecology* (2/1/1)
BIOL	524/326	Tropical Biology/Regional Excursions* (3/1)
BIOL	525/592D	Animal Behavior with Field Studies* (3/1)
BIOL	527/L/592L	Biology of Pelagic Organisms* (2/1/1)
BIOL	528/L/592B	Behavioral Ecology* (2/1/1)
BIOL	529/L/592I	Marine Ecology* (2/1/1)
BIOL	531/L/592Q	Ecology of Marine Fishes* (2/1/1)
BIOL	533/592C	Conservation Biology* (3/1)

This requirement assures that the student will study some aspect of the interactions between organisms and their environment.

4. Elective Requirement

Electives should be taken to bring the total beyond the Core to 20 units including at least 17 upper division units. No more than 3 units of BIOL 490, 495, 499, and 526 combined may be used, and they may not be used to satisfy either lab or field requirements. Electives may include any upper division biology course (except those explicitly excluded in their description) or the following:

MATH	255A	Calculus for the Life Sciences I (3)
CHEM	461	Biochemistry I (4)
CHEM	464	Principles of Biochemistry (4)
GEOL	322/L	Introductory Oceanography and Lab (3/1)
GEOL	351/L	Fundamentals of Paleontology and Lab (3/1)
BIOL	310/L	Functional Human Anatomy and Lab (3/1)
BIOL	330/L	Design and Analysis of Experiments and Lab (2/1)
BIOL	431/L	Food Microbiology and Lab (2/2)
BIOL	447/L	F.I.R.E. and Lab (2/2)
BIOL	490, 495, 499, 526	(no more than 3 units combined)
BIOL	502/L	Biometry and Lab (3/1)
BIOL	503/L	Bioinformatics and Lab (3/1)
BIOL	510	Seminar in Tropical Biology

BIOL	560	Advanced Topics in Evolution (3)
------	-----	----------------------------------

This requirement gives additional opportunity for student choices in the program while guaranteeing that students are exposed to biological concepts and practices.

* Total Units in the Option:	63
* General Education Units:	39
* Additional Units:	18

* Total Units Required for a B.A. Degree:	120
---	-----

Biology Subject Matter Program for the Single Subject Credential

Note that the Science (Biological Sciences) Subject Matter Program at CSUN is a set of Commission on Teacher Credentialing-approved courses that provide a means for teacher candidates to demonstrate subject matter competency towards a single-subject credential. Teacher candidates not eligible for an exam waiver may demonstrate subject matter competency through passage of the CSET examinations, as administered by the State of California (<http://www.ctc.ca.gov/credentials/CAW-exams.html#CSET>).

Requirements for the Bachelor of Science Degree

Each student pursuing a Bachelor of Science degree must complete the designated Core program plus all required courses and the selective program of one of the options.

Core Program for All B.S. Options

1. Lower Division Courses (27 Units)

BIOL	106/L	Biological Principles I and Lab (3/1)
BIOL	107/L	Biological Principles II and Lab (3/1)
CHEM	101/L	General Chemistry I and Lab (4/1)
CHEM	102/L	General Chemistry II and Lab (4/1)
PHYS	100A	General Physics I (3)
PHYS	100B	General Physics II (3)
MATH	255A	Calculus for the Life Sciences I (3)

2. Upper Division Courses (9 Units)

BIOL	322	Evolutionary Biology (3)
BIOL	360	Genetics (3)
BIOL	380	Cell Biology (3)

A. Option I: Cell and Molecular Biology

The Cell and Molecular option prepares students for graduate programs or careers as research associates in a variety of fields (e.g. medical, pharmaceutical, agricultural, or biotechnology) in academic, governmental, or industrial labs or a variety of similar settings.

1. Required Courses (11 Units)

BIOL	381	Cell Biology Lab (1)
PHYS	100AL	General Physics I Lab (1)
PHYS	100BL	General Physics II Lab (1)
CHEM	333/L	Principles of Organic Chemistry I and Lab (3/1)
CHEM	334/L	Principles of Organic Chemistry II and Lab (3/1)

(MATH 255B is highly recommended)

2. Selective Program

Select courses from the Biochemistry, Cells and Tissue, Molecular Genetics, and Elective sections below for a total of at least 30 units. You must take at least 7 units of lab courses (designated with an "L") within the Selective Program.

Biochemistry (3-8 units) Choose from the following:

CHEM	464	Principles of Biochemistry (lab may be taken for credit in Elective section) (3)
	or CHEM 461 and 462	Biochemistry I and II (includes 2 lab units) (8)

Cells and Tissues (6-8 units) Choose TWO courses

from the following:

BIOL 410/L	Medical Microbiology and Lab (2/2)
BIOL 411/L	Animal Histology and Lab (2/2)
BIOL 417/L	Microbial Physiology and Lab (2/2)
BIOL 441/L	Embryology and Lab (2/2)
BIOL 481/L	Plant Physiology and Lab (2/2)
BIOL 482/L	Animal Physiology and Lab (2/2)
BIOL 485/L	Immunology with Serology Lab (2/2)
BIOL 487/L	Hematology and Lab (2/2)
BIOL 536	Medical Mycology (3)
BIOL 575/L	Biological Imaging and Lab (2/2)
BIOL 577/L	Cell and Tissue Culture and Lab (2/2)
BIOL 580/L	Cellular Physiology and Lab (2/2)
BIOL 581	Endocrinology (3)
BIOL 582/L	Principles of Neurophysiology and Lab (3/1)
BIOL 585	Mechanisms of Bacterial Pathogenesis (3)
BIOL 589	Cellular Immunology (3)

Molecular Genetics (6-7 units) Choose TWO courses from the following:

BIOL 468	Human Genetics (3)
BIOL 470	Biotechnology (3)
BIOL 542	Developmental Biology (3)
BIOL 544	Biology of Viruses (3)
BIOL 561	Molecular Genetics of Microorganisms (3)
BIOL 562	Molecular Genetics of Eukaryotic Organisms (3)
BIOL 563	Cytogenetics (3)
BIOL 564	Human Biochemical Genetics (3)
BIOL 566	Genetics of Bacteria and their Virus (3)
BIOL 567	Medical Genetics (3)
BIOL 568	Clinical Cytogenetics and Cancer Genetics (3)
BIOL 571	Molecular Diagnostics (3)
BIOL 572/L	Recombinant DNA Techniques and Lab (2/2)

Electives. Select additional courses from the Biochemistry, Cells and Tissue and Molecular Genetics sections above, or from the courses listed below, for a total of at least 30 units:

BIOL 310/L	Functional Human Anatomy and Lab (3/1)
BIOL 315/L	Principles of Microbiology and Lab (2/2)
BIOL 330/L	Design and Analysis of Experiments and Lab (2/1)
BIOL 435/L	Parasitology and Lab (2/2)
BIOL 447/L	F.I.R.E. and Lab (2/2)
BIOL 490, 495, 499, 526	(no more than 3 units combined)
BIOL 502/L	Biometry and Lab (3/1)
BIOL 503/L	Bioinformatics and Lab (3/1)
BIOL 551/L	Computer Modeling in Biology (2/2)
CHEM 464L	Biochemistry lab (1)
MATH 255B	Calculus II (3)

General Education (36 Units) The entire section of Natural Sciences is fulfilled by required courses in the Biology major. Basic Skills, Mathematics is satisfied by MATH 255A.

Total Units in Option I	77
General Education Units	36
Additional Units	7
Total Units Required for a B.S. Degree	120

B. Option II: Environmental Biology

The Environmental Option prepares graduates for positions such as ecologist or wildlife manager with government agencies and private organizations. In modified form this option also meets the requirements for a teaching credential. (See Credential Programs section of this catalog).

Areas of interest: Before electing upper division courses in the

Selective Program, each student should consult an advisor in his/her area of interest to select a program of courses appropriate to the student's goals.

1. Required Courses (7-12 Units)

BIOL 330/L	Design and Analysis of Experiments and Lab (2/1)
or BIOL 502/L	Biometry and Lab (3/1)
CHEM 235/L	Introductory Organic Chemistry and Lab (3/1)
or CHEM 333/L/334/L	Principles of Organic Chemistry I and II and Labs (3/1) and (3/1)

2. Selective Program (32 Units) Select 32 additional upper division units from the following lists.**Ecology (11-13 Units) Choose three from the following:**

BIOL 407/L/492N	Plant Ecology† (2/1/1)
BIOL 422/L	Physiological Ecology and Lab (2/2)
BIOL 423/492F	Field Ecology (2/2)
BIOL 424/L/492G	Ecological Modeling (2/1/1)
BIOL 426/L/492P	Biology of Deserts (2/1/1)
BIOL 427/L/492H	Principles of Ecology and Lab (2/1/1)
BIOL 428/L/492W	Wildlife Ecology and Management 2/1/1)
BIOL 507/L/592S or 492S	Tropical Ecology and Conservation (2/1/2)
BIOL 509/592U	Tropical Biodiversity (2/1)
BIOL 514/L/592A	Avian Ecology† (2/1/1)
BIOL 528/L/592B	Behavioral Ecology (2/1/1)
BIOL 529/L/592I	Marine Ecology (2/1/1)
BIOL 533/592C	Conservation Biology (3/1)

Botany (4-5 Units) Choose one from the following:

BIOL 316/L	Plant Biology and Lab (3/1)
BIOL 403/L	Plant Morphology and Lab (2/2)
BIOL 406/L/492K	Flowering Plant Systematics (2/1/1)*
BIOL 409/L/492J	Non-Flowering Plants (2/1/1)*
BIOL 407/L/492N	Plant Ecology (2/1/1) †
BIOL 481/L	Plant Physiology and Lab (2/2)
BIOL 504/L/592P	Phycology (2/1/1)
BIOL 506/L/592R or 492R	Tropical Botany (2/1/2)

Zoology (3-5 Units) Choose one from the following:

BIOL 312/L/392F	Vertebrate Biology (2/1/1)
BIOL 313/L/392B	Invertebrate Zoology (2/1/1)
BIOL 415/L/492M	Mammalogy (2/1/1)
BIOL 508/L/592T or 492T	Biology of Tropical Vertebrates (2/1/2)
BIOL 512/L/592E	Herpetology (2/1/1)
BIOL 513/L/592F	Entomology (2/1/1)
BIOL 514/L/592A	Avian Ecology† (2/1/1)
BIOL 525	Animal Behavior (3)

(Note: An optional field course in animal behavior, BIOL 592D, is listed under Electives.)

BIOL 530/L/592J	Ichthyology (2/1/1)
-----------------	---------------------

† Note that Plant Ecology (BIOL 407/L/492N) may be used to fulfill the Botany requirement or the Ecology requirement, but not both. Avian Ecology (BIOL 514/L/592A) may be used to fulfill the Zoology requirement or the Ecology requirement, but not both.

3. Electives (9-14 Units)

- Select 1 additional course from the Botany or Zoology sections above.
- Select additional courses from the Ecology, Botany, or Zoology sections above, or from the courses listed below, for a total of 32 upper division units in the Selective Program. Other courses may be substituted with the approval of an Environmental Biology advisor.

BIOL 315/L	Principles of Microbiology and Lab (2/2)
BIOL 419/L/492C	Microbial Ecology (2/1/1)
BIOL 421/L/492B	Marine Biology (2/1/1)

BIOL 435/L	Parasitology and Lab (2/2)
BIOL 490, 495, 499, 526	(no more than 3 units combined)
BIOL 510	Seminars in Tropical Biology (3)
BIOL 527/L/592L	Biology of Pelagic Organisms (2/1/1)
BIOL 560	Advanced Topics in Evolution (3)
BIOL 592D	Animal Behavior Field Studies (1)*
GEOL 508/L	Invertebrate Paleontology and Lab (3/1)
or GEOL513/L	Micropaleontology and Lab (2/2)

*Note that BIOL 592D requires concurrent enrollment in BIOL 525; see listing under Zoology.

General Education (36 Units): Basic Skills Mathematics and the entire Natural Sciences section are fulfilled by required courses in the major.

Total Units in Option II	75-79
General Education Units	36
Additional Units	5-9
Total Units Required for a B.S. Degree	120

C. Option III: Microbiology

The Microbiology option prepares students for graduate programs or careers as research associates in a variety of fields (e.g. medical, pharmaceutical, agricultural, or environmental biotechnology; medical device, cosmetic, food, and water quality assurance) in academic, governmental, or industrial labs or a variety of similar settings.

1. Required Courses (26 Units)

BIOL 315/L	Principles of Microbiology and Lab (2/2)
BIOL 410/L	Medical Microbiology and Lab (2/2)
BIOL 417/L	Microbial Physiology and Lab (2/2)
BIOL 418/L	Bacterial Diversity and Lab (2/2)
or BIOL 419/L/492C	Microbial Ecology (2/1/1)
CHEM 333/L	Principles of Organic Chemistry I and Lab (3/1)
CHEM 334/L	Principles of Organic Chemistry II and Lab (3/1)
PHYS 100AL	General Physics I Lab (1)
PHYS 100BL	General Physics II Lab (1)

(MATH 140 and 255B are highly recommended.)

2. Selective Program (16 Units)

Choose any courses from the following list or other courses with advisor approval.

BIOL 381	Cell Biology Lab (1)
BIOL 408/L	Applied Microbiology and Lab (2/2)
BIOL 418/L	Bacterial Diversity and Lab (if not used to meet required course units) (2/2)
BIOL 419/L/492C	Microbial Ecology and Lab and Field Studies (if not used to meet required course units) (2/1/1)
BIOL 431/L	Food Microbiology and Lab (2/2)
BIOL 435/L	Parasitology and Lab (2/2)
BIOL 470	Biotechnology (3)
BIOL 485/L	Immunology with Serology Lab (2/2)
BIOL 487/L	Hematology and Lab (2/2)
BIOL 490, 495, 499, 526	(no more than 3 units combined)
BIOL 536	Medical Mycology (3)
BIOL 544	Biology of Viruses (3)
BIOL 551/L	Computer Modeling in Biology (2/2)
BIOL 561	The Molecular Genetics of Microorganisms (3)
BIOL 566	Genetics of Bacteria and Their Viruses (3)
BIOL 572/L	Recombinant DNA Techniques and Lab (2/2)
BIOL 575/L	Biological Imaging and Lab (2/2)
BIOL 577/L	Cell and Tissue Culture and Lab (2/2)
BIOL 585	Mechanisms of Bacterial Pathogenesis (3)

BIOL 589	Cellular Immunology (3)
CHEM 321/L	Chemical Analysis I and Lab (2/2)
CHEM 464	Principles of Biochemistry and Lab (3/1)

Note that completion of CHEM 101/L, 102/L, 321/L, 333, 334, and 464 satisfies the course requirements for a minor in Chemistry; see Chemistry Department for evaluation.

General Education (36 Units): Basic Skills Mathematics and the entire Natural Sciences section are fulfilled by required courses in the major.

Total Units in the Option III	78
General Education Units	36
Additional Units	6
Total Units Required for a B.S. Degree	120

D. Option IV: Biotechnology/Medical Technology

This option has two tracks. The Biotechnology track prepares students for graduate programs or careers in biotechnology or cellular and molecular biology in medical, industrial, agricultural, or other applications. The Medical Technology track prepares students for the clinical year of training and the California License exam in Clinical Laboratory Science or for training and Certification in Public Health Microbiology. Students in either track should consult the appropriate faculty advisor.

1. Required Courses For Both Biotechnology and Medical Technology (19 Units)

PHYS 100AL	General Physics I Lab (1)
PHYS 100BL	General Physics II Lab (1)
BIOL 315/L	Principles of Microbiology and Lab (2/2)
BIOL 381	Cell Biology Lab (1)
CHEM 333	Principles of Organic Chemistry I and Lab (3/1)
CHEM 334	Principles of Organic Chemistry II and Lab (3/1)
CHEM 365	Introduction to Biochemistry and Lab (3/1)
or CHEM 464/L	Principles of Biochemistry and Lab (3/1)

2. Biotechnology Additional Required Courses (11 Units)

BIOL 470	Biotechnology (3)
BIOL 572/L	Recombinant DNA Techniques and Lab (2/2)
BIOL 577/L	Cell and Tissue Culture and Lab (2/2)

3. Biotechnology Selective Program (6-8 Units)

Choose two from the following list:

BIOL 330/L	Design and Analysis of Experiments and Lab (2/1)
BIOL 408/L	Applied Microbiology and Lab (2/2)
BIOL 417/L	Microbial Physiology and Lab (2/2)
BIOL 418/L	Bacterial Diversity and Lab (2/2)
BIOL 419/L/492C	Microbial Ecology and Lab and Field Studies (2/1/1)
BIOL 431/L	Food Microbiology and Lab (2/2)
BIOL 468	Human Genetics (3)
BIOL 481/L	Plant Physiology and Lab (2/2)
BIOL 482/L	Animal Physiology and Lab (2/2)
BIOL 485/L	Immunology with Serology Lab (2/2)
BIOL 503/L	Bioinformatics and Lab (3/1)
BIOL 542	Developmental Biology (3)
BIOL 544	Biology of Viruses (3)
BIOL 551/L	Computer Modeling in Biology (2/2)
BIOL 561	Molecular Genetics of Microorganisms (3)
BIOL 562	Molecular Genetics of Eukaryotic Organisms (3)
BIOL 564	Human Biochemical Genetics (3)
BIOL 566	Genetics of Bacteria and Their Viruses (3)
BIOL 568	Clinical Cytogenetics and Cancer Genetics (3)
BIOL 571	Molecular Diagnostics (3)
BIOL 575/L	Biological Imaging and Lab (2/2)

BIOL 580/L	Cellular Physiology and Lab (2/2)
BIOL 581	Endocrinology (3)
BIOL 582/L	Principles of Neurophysiology and Lab 3/1
BIOL 589	Cellular Immunology (3)
CHEM 321/L	Chemical Analysis I and Lab (2/2)

Note that completion of CHEM 101/L, 102/L, 321/L, 333, 334, plus CHEM 365 or 464 satisfies the course requirements for a minor in Chemistry; see Chemistry Department for evaluation.

4. Medical Technology Additional Required Courses (20 Units)

BIOL 410/L	Medical Microbiology and Lab (2/2)
BIOL 435/L	Parasitology and Lab (2/2)
BIOL 485/L	Immunology with Serology Lab (2/2)
BIOL 487/L	Hematology and Lab (2/2)
CHEM 321/L	Chemical Analysis I and Lab (2/2)

Note that completion of CHEM 101/L, 102/L, 321/L, 333, 334, plus CHEM 365 or 464 satisfies the course requirements for a minor in Chemistry; see Chemistry Department for evaluation.

Note that the following courses are recommended but not required in the Medical Technology track: BIOL 536 Medical Mycology; BIOL 544 Biology of Viruses; BIOL 571 Molecular Diagnostics; BIOL 577 Cell and Tissue Culture; and BIOL 589 Cellular Immunology.

General Education (36 Units): Basic Skills Mathematics and the entire Natural Sciences section are fulfilled by required courses in the major.

Total Units in the Medical Technology Track	75
General Education Units	36
Additional Units	9
Total Units Required for a B.S. Degree	120

E. Option V: Marine Biology

The Marine Biology Option prepares graduates for employment in the marine sciences and for advanced graduate study. Advisement is mandatory and a course program must be approved by an advisor by the beginning of the student's junior year.

1. Required Courses (13-18 Units)

BIOL 330/L	Design and Analysis of Experiments and Lab (2/1)
or BIOL 502/L	Biometry and Lab (3/1)
BIOL 421/L/492B	Marine Biology (2/1/1)
PHYS 100AL	General Physics I Lab (1)
PHYS 100BL	General Physics II Lab (1)
CHEM 235/L	Introductory Organic Chemistry and Lab (3/1)
or CHEM 333/L/334/L	Principles of Organic Chemistry I and II and Labs (3/1) and (3/1)

2. Selective Program (27 Units)

Select three additional courses from Section 1 (Marine Biology) below and 15 units from Section 2 (Electives), for a total of 27 units.

Marine Biology (12 Units)

BIOL 313/L/392B	Invertebrate Zoology (2/1/1)
BIOL 504/L/592P	Phycology (2/1/1)
BIOL 527/L/592L	Biology of Pelagic Organisms (2/1/1)
BIOL 529/L/592I	Marine Ecology (2/1/1)
BIOL 530/L/592J	Ichthyology (2/1/1)
BIOL 531/L/592Q	Ecology of Marine Fishes (2/1/1)

Electives (15 Units)

BIOL 312/L/392F	Vertebrate Biology (2/1/1)
BIOL 316/L	Plant Biology and Lab (3/1)
BIOL 403/L	Plant Morphology and Lab (2/2)
BIOL 406/L/492K	Flowering Plant Systematics and Lab (2/1/1)
BIOL 409/L/492J	Non-Flowering Plants and Lab (2/1/1)
BIOL 407/L/492N	Plant Ecology (2/1/1)

BIOL 415/L/492M	Mammalogy (2/1/1)
BIOL 422/L	Physiological Ecology and Lab (2/2)
BIOL 423/492F	Field Ecology (2/2)
BIOL 424/L/492G	Ecological Modeling (2/1/1)
BIOL 427/L/492H	Principles of Ecology and Lab (2/1/1)
BIOL 428/L/492W	Wildlife Ecology and Management (2/1/1)
BIOL 481/L	Plant Physiology and Lab (2/2)
BIOL 490, 495, 499, 526	(no more than 3 units combined)
BIOL 502/L	Biometry (3/1) (if not used to meet required courses)
BIOL 514/L/592A	Avian Ecology (2/1/1)
BIOL 525	Animal Behavior (3)
BIOL 592D	Animal Behavior Field Studies (1)
BIOL 528/L/592B	Behavioral Ecology (2/1/1)
BIOL 532/L	Advanced Ichthyology (2/2)
BIOL 533/592C	Conservation Biology (3/1)
BIOL 560	Advanced Topics in Evolution (3)
GEOL 322/L	Introductory Oceanography and Lab (3/1)

General Education (36 Units): Basic Skills Mathematics and the entire Natural Sciences section are fulfilled by required courses in the major.

Total Units in Option V	76-80
General Education Units	36
Additional Units	4-8
Total Units Required for a B.S. Degree	120

Minor in Biology

Take one course or sequence of courses from each category.

1. (8 or 10 units)

CHEM 101/L, 102/L	General Chemistry I and II with Labs (4/1, 4/1)
CHEM 103, 104	Introductory Chemistry I and II (4, 4)

2. (4 or 8 units)

BIOL 101/L	General Biology with Lab (3/1)
BIOL 106/L, 107/L	Biological Principles I and II with Labs (3/1, 3/1)

3. BIOL 322

Evolutionary Biology (3)

4. BIOL 360

Genetics (3)

5. (4 units)

BIOL 215/L	Introductory Microbiology and Lab (2/2)
BIOL 312/L/392F	Vertebrate Biology (2/1/1)
BIOL 313/L/392B	Invertebrate Zoology (2/1/1)
BIOL 315/L	Principles of Microbiology and Lab (2/2)
BIOL 316/L	Plant Biology and Lab (3/1)
BIOL 513/L/592F	Entomology (2/1/1)

6. (3 units)

BIOL 241	Human Pregnancy and Embryology (3)
BIOL 281	Human Physiology (3)
BIOL 380	Cell Biology (3)

7. One or more upper division Biology courses, if needed, for a minimum total of 26 units, including at least 8 upper division units in Biology.

Total Units Required for the Minor	26-31
------------------------------------	-------

Honors Program

This program provides an opportunity for outstanding Biology majors to gain research experience with individual faculty guidance and may be of value for research-minded premedical students. The designation "Honors" will be added to the academic record of any student who completes the program.

Admission to the program is granted by approval of the Department Honors Committee. Students in the B.A. degree program or in any of the B.S. options are eligible provided they have: 1) completed 90 units of college work; 2) maintained a 3.50 grade point average overall and

in the biology major; and 3) obtained the approval of a faculty sponsor who will supervise their research. Interested students should contact the Biology Department office.

Graduation with Honors requires:

1. Completion of the following courses.

BIOL	330/L	Design and Analysis of Experiments and Lab (2/1)
BIOL	498	Senior Thesis (2)
BIOL	495	Directed Research (3)

All 8 units must be in addition to those completed for the major.

2. Maintenance of a GPA of 3.50 overall and in all courses in the Biology major completed at CSUN.
3. Approval of a senior thesis by the Honors Committee, including a presentation of the research.

Graduate Program

The purpose of the Graduate Program is to provide students an opportunity for advanced study in specialized areas of Biology and to develop the skills required to do independent research.

Requirements for the Master of Science Degree

A. For Admission to the Department

Students may be admitted as either Classified or Conditionally Classified Graduate students. In addition to University requirements, the Biology Department requires:

1. Submission of a Biology Department Graduate Program Application. This is a separate application in addition to the University Application, and is available at www.csun.edu/biology

Departmental Application Deadlines:

Fall Semester: March 15 preceding entry into program.

Spring Semester: October 15 preceding entry into program.

2. Consent of a faculty member to serve as research advisor.
3. Demonstrated proficiency in basic biology.*
4. General Graduate Record Examination, scoring at or above the 50th percentile on at least 1 section of the general test.
5. TOEFL and TWE (foreign students only): minimum score acceptable by the University.

* Requirement 3 can be met in the following ways:

For students whose undergraduate degree is in Biology, either:

- a. an undergraduate Biology GPA at or above 3.0, or,
- b. subject GRE scores at or above the 50th percentile.

For students whose undergraduate degree is not in Biology:

- c. subject GRE scores are required at or above the 50th percentile.

In unusual circumstances, a student who does not meet the biology proficiency requirements may be admitted to the Department with the strong written support of a faculty sponsor.

B. For Classified Status

The requirements for admission to Classified Status in Biology are the following:

1. General University requirements for Classified Status, which include passing the University Upper Division Writing Proficiency Exam.
2. Completion of any prerequisite coursework specified by Biology Graduate Committee upon admission (often the equivalent of BIOL 322, 360, 380, CHEM 235, etc.)

C. Conditionally Classified Status:

If a student meets the Department admission requirements but does not meet the requirements for classified status, conditional classification is given. Students accepted to the program with deficiencies in Biology core courses are expected to complete the core before proceeding with 600-level courses. It is important to achieve fully classified status prior to completing more than 12 units of graduate work, as

no more than 12 units of work prior to attaining fully classified status will be applied to a master's program.

D. For the Degree:

First semester graduate students in Biology must meet with the graduate coordinator during their first semester in the program. In addition, every graduate student must meet once a year during the fall semester with a member of the Department Graduate Committee.

1. Completion of a minimum of 30 units of grade A, A-, B+, or B work in all approved courses applied towards the Master's degree:
 - a. Seminars (12 units):
 - BIOL 691 Graduate Proseminar (3 units) and 600-level seminar or lecture courses (9 Units).
 - b. BIOL 502 Biometry or BIOL 503 Bioinformatics (an equivalent 3-unit upper division course may be substituted) (3 units).
 - c. Additional Courses: Any 400, 500, or 600-level biology courses except BIOL 490, 495, 497EE, 499, 692, 696, 698, and 699. A maximum of 9 units of 400-level courses may be applied toward the degree. No more than 6 units from other disciplines such as Chemistry, Psychology, etc., may be counted.
 - d. Thesis courses:
 - BIOL 696, 699 (up to 6 units combined)
 - BIOL 698 Thesis (3-6 units)
2. Enrollment and attendance in at least 1 semester of Biology Colloquium, BIOL 692 (1 unit credit/no credit).
3. Completion and successful oral defense of a thesis.
4. Formal approval by the Biology faculty.

Total Units Required for the M.S. Degree

31

Course List

BIOL 100. Introductory Biology (3)

Not for credit in Biology major. May not be taken for credit by students who have completed BIOL 101, 102, 106 or 107. Analysis of selected topics illustrating major biological concepts, including ecology, evolution, heredity and organismal and cellular structure and physiology. Primarily designed for non-science majors. Lecture three hours. (Students using this course to satisfy the Natural Sciences requirement in General Education may satisfy the corresponding lab requirement by completing BIOL 100L.)

BIOL 100L. Introductory Biology Lab (1)

Recommended Corequisite: BIOL 100. Not for credit in Biology major. Observations, experiments, demonstrations, and required field trips to augment Introductory Biology. Emphasis on the methods of science, basic biological principles, the natural environment, and the effects of human activity on the environment. Lab three hours. (May be used to satisfy the Natural Sciences lab requirement in General Education provided BIOL 100 is also completed.)

BIOL 101/L. General Biology and Lab (3/1)

Corequisite: BIOL 101L. Not for credit in Biology major and may not be taken for credit by students who have completed BIOL 106 or 107. Analysis of selected topics illustrating major concepts in biology, including evolution, environmental relationships, heredity, the cell, energetics and functions of living systems, and development. Available for General Education, Natural Sciences, if required in the major. Lecture three hours, lab three hours. (Available for General Education, Natural Sciences if required by student's major.)

BIOL 102/L. Biological Concepts and Lab (3/1)

Prerequisite: For Liberal Studies majors only or instructor consent.
Corequisite: BIOL 102L. Not open for credit in the Biology major or for students who have already completed BIOL 100, 101, 106 or 107. Analysis of selected topics illustrating major biological concepts, including ecology, evolution, heredity, organismal and cellular structure, presented in the context of the Science Content Standards for California Public Schools. Some sections of this course may offer a community service opportunity with activities relating to concepts and theories presented. Check the schedule of classes for the CS designation. Lecture three hours, lab three hours.

BIOL 106/L. Biological Principles I and Lab (3/1)

Corequisite: BIOL 106L. Primarily for Biology majors. Half of a two-semester sequence that includes BIOL 107/L. Selected topics illustrating major concepts in biology, including the scientific process, heredity, evolution, taxonomy and systematics, ecology, and animal behavior. Observations, experiments and demonstrations. Emphasis on unifying biological concepts and methods in science. (Available for General Education, Natural Sciences, if required in a student's major.) Lecture three hours, lab three hours.

BIOL 107/L. Biological Principles II and Lab (3/1)

Corequisite: BIOL 107L. *Recommended Corequisite or Preparatory:* CHEM 102/L. Half of a two-semester sequence that includes BIOL 106/L. Selected topics illustrating major concepts in biology, including biological chemistry, cells, molecular genetics, animal development, and plant and animal physiology. Observations, experiments and demonstrations. Emphasis on unifying biological concepts and methods in science. (Available for General Education, Natural Sciences, if required in a student's major.) Lecture three hours, lab three hours.

BIOL 211. Human Anatomy (2)

Prerequisites: BIOL 101/L or 106/L and 107/L. *Corequisite:* BIOL 212. Not for credit in Biology major. Survey of the gross anatomy and histology of the major human organ systems including the muscle and skeletal systems, the digestive, circulatory, respiratory, excretory, endocrine and reproductive systems. Lecture two hours.

BIOL 212. Laboratory Studies in Human Anatomy (1)

Prerequisites: BIOL 101/L or 106/L and 107/L. *Corequisite:* BIOL 211. Not for credit in Biology major. Examination of the anatomy and histology of the major organ systems by dissection and microscopic study. Lab three hours.

BIOL 215/L. Introductory Microbiology and Lab (2/2)

Prerequisites: BIOL 101/L or 106/L and 107/L; CHEM 102/L or 104. *Corequisite:* BIOL 215L. *Preparatory:* BIOL 281 or CHEM 235. Introduction to the biology of major groups of microorganisms including their role in infectious diseases, their role in nature and their relationship to humankind. Lecture two hours, lab six hours.

BIOL 241. Human Pregnancy and Embryology (3)

Prerequisites: BIOL 100 or 101/L or 102/L or 106/L or 107/L. Available for Biology minor credit but not for Biology major. Description of biological events leading up to ovulation, emission, conception, implantation and pregnancy, and the resulting stages of human development including placenta development and birth, with a discussion of biological aspects of genetic counseling, birth defects, miscarriage, and abortion. Lecture three hours. (Students using this course to satisfy the Natural Sciences requirement in General Education may satisfy the corresponding lab requirement by completing BIOL 241L.)

BIOL 241L. Human Pregnancy and Embryology Lab (1)

Prerequisites: BIOL 100/L or 101/L or 102/L or 106/L or 107/L. *Recommended Corequisite:* BIOL 241. Not for credit in Biology ma-

ior. Observation of slides, preserved specimens, and plastic models, demonstrating male and female gamete production; changes of uterus and ovary during menstrual cycle and pregnancy; normal and abnormal human chromosomes; human blood groups leading to problem pregnancies; pregnancy tests; human development with emphasis on nervous system, eye, heart, skeleton, external genitalia and internal sex organs. Lab three hours. (May be used to satisfy the lab requirement in Natural Sciences of General Education provided BIOL 241 is also completed.)

BIOL 281. Human Physiology (3)

Prerequisites: BIOL 101/L or 106 and 107/L. Survey of the physiology of nerve and muscle, the digestive, circulatory, respiratory, excretory, endocrine and reproductive systems. Lecture three hours.

BIOL 282. Lab Experiments in Human Physiology (1)

Prerequisites: BIOL 101/L or 106/L and 107/L. *Recommended Corequisite:* BIOL 281. Selected lab experiments in human physiology. Lab three hours.

BIOL 285. Biology of Cancer (2)

Not for credit in Biology major. Study of the disease of cancer from a biological viewpoint, emphasizing the cellular, biochemical and environmental aspects of the disease with discussion on the types of cancer, their diagnosis and treatment. Lecture two hours. (Available for General Education, Lifelong Learning)

BIOL 299A-C. Introduction to Biological Research (1-3)

Prerequisite: Instructor Consent. *Not for credit in Biology major.* Introduction to original biological literature and the use of the scientific method in investigating biological problems. Under the guidance of a faculty mentor, students take part in individual lab or field studies, including the reading and discussion of the literature pertinent to the study. May be repeated, but no more than 3 units may be counted towards degree requirements. Credit/No Credit Only.

Upper Division**BIOL 310/L. Functional Human Anatomy and Lab (3/1)**

Prerequisites: BIOL 101/L or 106/L and 107/L. *Recommended Corequisite:* BIOL 310L. Designed for students who desire a more complete study of the gross and microscopic anatomy of the organ systems of the human body than is presented in BIOL 211. Functional relationships between the organ systems are stressed. Cadaver dissection is included in lab. (Students taking this course will not receive credit for BIOL 211) Lecture three hours, optional lab three hours.

BIOL 311/L. Comparative Anatomy and Lab (2/2)

Prerequisites: BIOL 106/L, 107/L. *Corequisite:* BIOL 311L. Evolution of vertebrate structure. Comparative morphology of vertebrate types. Lecture two hours, lab six hours.

BIOL 312/L. Vertebrate Biology and Lab (2/1)

Prerequisites: BIOL 101/L or 106/L and 107/L. *Corequisites:* BIOL 312L; 392F. Introduction to the Biology of Vertebrates including aspects of their evolution, ecology, life history, and behavior. Lecture two hours, lab three hours.

BIOL 313/L. Invertebrate Zoology and Lab (2/1)

Prerequisites: BIOL 101/L or 106/L and 107/L. *Corequisites:* BIOL 313L, 392B. Biology and classification of the invertebrate animals, with emphasis on marine forms. Evolutionary and adaptive implications of form and function will be considered. Lecture two hours, lab three hours.

BIOL 315/L. Principles of Microbiology and Lab (2/2)

Prerequisites: BIOL 106/L, 107/L, CHEM 102/L. *Corequisite:* BIOL 315L. *Preparatory:* CHEM 333. Credit will not be allowed for both

BIOL 215 and 315. Introduction to the biology of microorganisms with emphasis on the bacteria. General course designed for Biology majors and students who wish to pursue further study in microbiology or bacteriology. Lecture two hours, lab six hours.

BIOL 316/L. Plant Biology and Lab (3/1)

Prerequisite: BIOL 101/L or 106/L and 107/L. *Corequisite:* BIOL 316L. Survey course covering those aspects of cytology, physiology, systematics, anatomy, morphology, and ecology unique to plants. Lecture three hours, lab three hours.

BIOL 317/L. Microbes and Society, and Lab (3/1)

Prerequisites: BIOL 100/L or 101/L or 102/L or 106/L or 107/L and completion of lower division writing requirement. *Corequisite:* BIOL 317L. Introduces microorganisms and how they influence all life on earth. Students will explore the workings of microbes and their influence on history, medicine, economics, the environment, and human lives through lectures, assigned readings, videos, writing assignments, internet activities, discussions, and lab activities. This course cannot be substituted for credit for either BIOL 215/L or BIOL 315/L. Three hours lecture, three hours lab. (Available for General Education, Natural Sciences) (IC)

BIOL 322. Evolutionary Biology (3)

Prerequisites: BIOL 101/L or 106/L and 107/L. Introduction to the mechanisms of evolution, drawing heavily on relevant principles in ecology, population genetics, and systematics. Lecture three hours.

BIOL 323. Plants and Animals of Southern California (3)

Prerequisites: Completion of lower division writing requirement. *Corequisite:* BIOL 392E. For non-science majors to acquaint them with the classification, behavior, ecology and distribution of the more important plants and animals of Southern California. Lecture three hours. (Students using this course to satisfy a General Education requirement in Natural Sciences will satisfy the corresponding lab requirement by completing BIOL 392E.)

BIOL 325/L. Life in the Sea and Lab (3/1)

Prerequisite: Completion of lower division writing requirement. Not for credit in Biology major. From the shore to the depths, analysis of the diversity of life in the world's oceans with emphasis on the Southern California biota. (Lecture and Lab available for General Education, Natural Sciences) (IC)

BIOL 326A-Z. Regional Excursions (1-4)

Prerequisite: Upper Division standing. Extended field excursions during vacation periods to selected regions of the world, emphasizing the United States and Mexico, for the study of the natural history of these regions.

BIOL 327. Ecology and People (3)

Prerequisite: Completion of the lower division writing requirement. Our influence on the environment, the influence of the environment on us. Lecture three hours. (Available for General Education, Lifelong Learning) (IC)

BIOL 330/L. Design and Analysis of Experiments and Lab (2/1)

Prerequisites: BIOL 106/L, 107/L; one of the following: MATH 105, 140, or 255A. *Corequisite:* BIOL 330L. Structuring biological experiments to maximize useful results, and presenting the results graphically and quantitatively. Although emphasis is placed on data collected during ecological field trips, other kinds of biological experiments are also analyzed. Lecture two hours, lab three hours.

BIOL 360. Genetics (3)

Prerequisites: BIOL 101/L or BIOL 106/L and 107/L; MATH 105 or (MATH 102+104) or MPT2A; CHEM 102/L or CHEM 104; completion of the lower division writing requirement. Role of genes in heredity,

development, cellular metabolism and function of organisms; introduction of cytogenetics, genomics and molecular genetics; genetic basis of human disease, including cancer. Lecture three hours.

BIOL 362/L. Genetics and Society Lab (3/1)

Prerequisites: BIOL 100/L or 101/L or 102/L or 106/L or 107/L and completion of the lower division writing requirement. *Corequisite:* BIOL 362L. Introduction to current topics in genetics and their impact on society and life, in language that is non-technical. Learn about the application of genetics to agriculture, environment, human health and medicine. Understand issues pertaining to genetic engineering, cloning, gene therapy, stem cells etc. Not for credit in Biology Major. Three hours lecture, three hours lab. (Lecture and Lab available for General Education, Natural Sciences) (IC)

BIOL 380. Cell Biology (3)

Prerequisites: CHEM 102/L or 104, and either BIOL 101/L or BIOL 106/L and 107/L. *Preparatory:* CHEM 235 or 333. Study of the organization of cells with emphasis on structure, chemical composition, bioenergetics, metabolism, regulation of the metabolism, cell differentiation and special cell functions. (BIOL 381 is required of Biology majors in B.S. Options I and IV.) Lecture three hours.

BIOL 381. Cell Biology Lab (1)

Prerequisites: CHEM 102/L or 104, and either BIOL 101/L or 106/L and 107/L. *Preparatory:* CHEM 235 or 333. *Recommended Corequisite:* BIOL 380. Basic lab techniques in cell biology, including calorimetry and spectrophotometry, centrifugation, enzymological assays, respirometry, cell counting and molecular methods. Lab three hours. (Required of Biology majors in B.S. Options I and IV.)

BIOL 392B-F. Field Studies in Biology (1)

Three hours per week or equivalent. Course Fee. **(B)** Invertebrate Zoology *Corequisite:* BIOL 313/L, **(E)** Plants and Animals of Southern California *Corequisite:* BIOL 323, and **(F)** 392F. Vertebrate Zoology *Corequisite:* BIOL 312/L

Courses Acceptable for the M.S. Degree

Note that 300-level courses and BIOL 490, 495, 497EE, and 499 do not carry graduate credit for a Master's degree in Biology. A maximum of nine units of 400-level courses may be applied toward the Master's degree.

BIOL 403/L. Plant Morphology and Lab (2/2)

Prerequisite: BIOL 106/L, 107/L. *Corequisite:* BIOL 403L. Structure and evolution of plants; comparative lifecycles and reproductive mechanisms in the major phyla. Lecture two hours, lab six hours.

BIOL 406/L. Flowering Plant Systematics and Lab (2/1)

Prerequisites: BIOL 106/L, 107/L. *Corequisites:* BIOL 406L, 492K. Classification, identification and evolutionary relationships of flowering plants. Lecture two hours, lab three hours.

BIOL 407/L. Plant Ecology and Lab (2/1)

Prerequisite: BIOL 106/L; 107/L; 322. *Corequisites:* BIOL 407L; 492N. Examination of plants and their habitats from an ecological and evolutionary perspective. Concepts of adaptation, species diversity, and biological change over time are stressed. Lecture two hours, lab three hours.

BIOL 408/L. Applied Microbiology and Lab (2/2)

Prerequisites: BIOL 101/L or 106/L and 107/L, 215/L or 315/L. *Corequisite:* BIOL 408L. Examination of the role of microbes and their control in the production and deterioration of foods, in industry, in agriculture, in waste disposal and in the production of energy. Lecture two hours, lab six hours.

BIOL 409/L. Non-Flowering Plants and Lab (2/1)

Prerequisites: BIOL 106/L. *Corequisites:* 409L, 492J. The diversity of land plants other than angiosperms (mosses, ferns, conifers, etc.) - their phylogeny, life cycles, ecological niches, biogeography, identification, and comparative biology. Lecture two hours, lab three hours.

BIOL 410/L. Medical Microbiology and Lab (2/2)

Prerequisite: BIOL 315/L, 380; CHEM 333. *Corequisite:* BIOL 410L. Study of bacterial pathogens with emphasis on mechanisms of pathogenicity, diagnosis, chemotherapy, and host interaction. Lecture two hours, lab six hours.

BIOL 411/L. Animal Histology and Lab (2/2)

Prerequisites: BIOL 106/L, 107/L. *Corequisite:* BIOL 411L. *Preparatory:* CHEM 334. Microscopical and histochemical analysis of mammalian cells as organized into tissue and organ systems. Lecture two hours, lab six hours.

BIOL 415/L. Mammalogy and Lab (2/1)

Prerequisites: BIOL 106/L, 107/L, 322. *Corequisite:* BIOL 415L, 492M. Classification, ethology and ecology of mammals. Adaptive and evolutionary significance of form and function are considered. Lecture two hours, lab six hours.

BIOL 417/L. Microbial Physiology and Lab (2/2)

Prerequisite: BIOL 215/L or 315/L. *Corequisite:* BIOL 417L. *Preparatory:* CHEM 333; BIOL 380. Metabolism and special physiology of microbial forms of life, with special emphasis on the bacteria. Lecture two hours, lab six hours.

BIOL 418/L. Bacterial Diversity and Lab (2/2)

Prerequisite: BIOL 315/L. *Corequisite:* BIOL 418L. Analysis of evolution, diversity and relationships among the bacteria, as illustrated by a detailed study of the more specialized groups of bacteria with regard to cell form, habitat, and developmental abilities. Lecture two hours, lab six hours.

BIOL 419/L. Microbial Ecology and Lab (2/1)

Prerequisites: BIOL 315/L. *Corequisites:* BIOL 419L; 492C. Examination of the natural distribution of bacteria, fungi, algae and protozoa in the biosphere, and a study of the physical, chemical and biological factors that govern their distribution. Inquiry into the role of microbes as they interact directly and indirectly with higher organisms in the ecosystem. Lecture two hours, lab three hours.

BIOL 421/L. Marine Biology and Lab (2/1)

Prerequisites: BIOL 106/L; 107/L. *Corequisites:* BIOL 421L; 492B. *Preparatory:* BIOL 322. Marine life of the world with special emphasis on the shore and shallow sea. Identification, distribution, physiological and morphological adaptation of marine forms. Lecture two hours, lab three hours.

BIOL 422/L. Physiological Ecology and Lab (2/2)

Prerequisite: BIOL 106/L; 107/L. *Corequisite:* BIOL 422L. *Preparatory:* BIOL 322. Study of physiological, morphological and behavioral responses of organisms to physical environmental factors such as temperature, light, water salinity. Lecture two hours, lab six hours.

BIOL 423. Field Ecology (2)

Prerequisites: BIOL 106/L; 107/L. *Corequisite:* BIOL 492F. Techniques used in studying population dynamics, the development and functioning of biological communities and the interaction among organisms in the natural environment. Lecture two hours.

BIOL 426/L. Biology of Deserts and Lab (2/1)

Prerequisite: BIOL 106/L; 107/L; 322. *Corequisites:* BIOL 426L; 492P. Study of life in deserts with emphasis on the organisms of the deserts of southwestern U.S.; structural, physiological, and behavioral adapta-

tions for survival; identification and ecology of desert organisms; techniques for studying desert ecology. Lecture two hours, lab three hours.

BIOL 427/L. Principles of Ecology and Lab (2/1)

Prerequisite: BIOL 106/L; 107/L; 322. *Corequisites:* BIOL 427L; 492H. Lectures summarize the major concepts and controversies of ecology. Discussions and activities focus on case studies from the classic and recent original literature. Lecture two hours, lab three hours.

BIOL 428/L. Wildlife Ecology and Management and Lab (2/1)

Prerequisite: BIOL 106/L; 107/L; 322. *Corequisite:* BIOL 428L, 492W. *Recommended Preparatory:* BIOL 330/L. Study and application of ecological principles used in the management of wildlife. Practical examination of management techniques and tools used in monitoring and managing wildlife populations, include censusing techniques, measurement and analysis of vital rates, and population modeling techniques. Course is computationally and writing intensive. Lecture two hours, lab three hours.

BIOL 431/L. Food Microbiology and Lab (2/2)

Prerequisite: BIOL 215/L, BIOL 315/L or equivalent. *Corequisite:* BIOL 431L. The biology, ecology and physiology of microorganisms associated with food and beverage production, preservation, spoilage, food borne illness and contamination control. Procedures and techniques for isolation, detection, identification and enumeration of food microorganisms. Methods and principles for controlling microbial contamination and preventing growth of undesirable microorganisms in raw and processed food. Lecture 2 hours, laboratory 6 hours. Available for graduate credit.

BIOL 435/L. Parasitology and Lab (2/2)

Prerequisites: BIOL 106/L; 107/L. *Corequisite:* BIOL 435L. Study of the biology of parasites and other symbionts. Lecture two hours, lab six hours.

BIOL 441/L. Embryology and Lab (2/2)

Prerequisites: BIOL 360 or 380. *Corequisite:* BIOL 441L. Cellular, physiological, and anatomical aspects of embryonic development with emphasis on vertebrates. Mechanisms of morphogenesis and differentiation. Lecture two hours, lab six hours.

BIOL 447/L. Full Immersion Research Experience (FIRE) and Lab (2/2)

Prerequisites: BIOL 380; CHEM 333; 334; PHYS 100A; 100B. *Corequisite:* BIOL 447L. Innovative undergraduate experience in creativity that invites participants to engage scientific research in its fullness as co-learners. Student-initiated ideas ascend through a system of collaborative and independent strategies involving peer review, recitation, tutorials, experimental work, and oral and written communication. Lecture two hours, lab six hours.

BIOL 468. Human Genetics (3)

Prerequisites: BIOL 360; MATH 105 or 140 or score on Math Placement Test (MPT) sufficient for admission to MATH 255A. Study of variation and heredity in humans. Includes immunogenetics, polygenic inheritance and population genetics as well as abnormalities of chromosomes and metabolism and their consequences. Lecture three hours.

BIOL 470. Biotechnology (3)

Prerequisite: BIOL 360. *Recommended Corequisite or Preparatory:* BIOL 380. Application of organisms, biological systems, and processes to manufacturing and service industries. Role of microorganisms in industrial, agricultural, and pharmaceutical processes, biologically produced sources of energy, single cell protein, waste management, mining, and other areas. Impact of genetic engineering; enzyme biotechnology; recent advances in the genetics and physiology of industrial microorganisms for strain improvement. Lecture three hours.

BIOL 481/L. Plant Physiology and Lab (2/2)

Prerequisites: BIOL 380; CHEM 334. *Corequisite:* BIOL 481L. Plant functions: photosynthesis, respiration, cell mechanics, growth and water relationships. Lecture two hours, lab six hours.

BIOL 482/L. Animal Physiology and Lab (2/2)

Prerequisites: BIOL 380. *Corequisite:* BIOL 482L. *Preparatory:* PHYS 100A/L; 100B/L; CHEM 334. Examination of the processes and mechanisms by which organisms maintain themselves and interact with their environment. Adaptive significance of physiologic mechanisms is treated under certain topics. Lecture two hours, lab six hours.

BIOL 485/L. Immunology with Serology Lab (2/2)

Prerequisite: BIOL 380. *Corequisite:* BIOL 485L. *Preparatory:* BIOL 381. Study of the immune response examining humoral and cellular immunity, the nature, structure and reactions of antigens and antibodies, mediators of immunity, hypersensitivity and immuno-hematology. The Lab: emphasizes the principles and uses of serological methods for evaluation of the immune response. Lecture two hours, lab six hours.

BIOL 487/L. Hematology and Lab (2/2)

Prerequisites: BIOL 380; CHEM 334. *Corequisite:* BIOL 487L. Histological, biochemical, and clinical diagnostic study of blood, blood cell formation, iron metabolism, blood pathology, and practical lab technology. Lecture two hours, lab six hours.

BIOL 490. Tutorial Studies (1)

Prerequisite: With consent of instructor, open to senior Biology majors. Supervised individual projects involving reading and discussion, lab research, or field studies in specific areas of biology. May be repeated for a maximum of three units. Does not carry graduate credit toward the M.S. degree in Biology.

BIOL 492A-Z. Field Studies in Biology (1-2)

Course Fee. The 400-level courses are available for graduate credit.

One unit each, 3 hours per week or equivalent:

- 492B. Marine Biology (Corequisite: BIOL 421/L)
- 492C. Microbial Ecology (Corequisite: BIOL 419/L)
- 492G. Ecological Modeling (Corequisite: BIOL 424/L)
- 492H. Principles of Ecology (Corequisite: BIOL 427/L)
- 492J. Non-flowering Plants (Corequisite: BIOL 409/L)
- 492K. Flowering Plant Systematics (Corequisite: BIOL 406/L)
- 492M. Mammalogy (Corequisite: BIOL 415/L)
- 492N. Plant Ecology (Corequisite: BIOL 407/L)
- 492P. Deserts (Corequisite: BIOL 426/L)

Two units each, 6 hours per week or equivalent:

- 492F. Field Ecology (Corequisite: BIOL 423)
- 492R. Tropical Botany (Corequisite: BIOL 506/L)
- 492S. Tropical Ecology and Conservation (Coreq: BIOL 507/L)
- 492T. Tropical Vertebrates (Corequisite: BIOL 508/L)

BIOL 495A-Z. Directed Undergraduate Research (3)

Designed for students of advanced rank and proven competence in Biology. Program of original, independent research, culminating in a written report, to be carried out under the direction of one of the Biology faculty. Upon prior approval by the Biology department of a detailed research proposal the research may be performed in off-campus facilities. In such a case the report must be submitted to and evaluated by a designated member of the Biology faculty. May be repeated for credit but no more than 3 units may be applied to the elective section of any option.

BIOL 496A-Z. Experimental Topics in Biology (2-4)

Special studies in biology with topics to be determined.

BIOL 497EE. Supervised Off-Campus Experiential Education (1-6)

Not for graduate credit toward M.S. in Biology. Student work experiences that are planned, organized and evaluated by faculty in cooperation with organizations other than the University's academic departments. No remuneration for this work may be received in addition to academic credit. Academic Internship course. Credit/No Credit only.

BIOL 498. Senior Thesis (2)

Prerequisites: Senior standing in biology and consent of instructor. *Recommended Corequisite or Preparatory:* BIOL 330; 499. Student selects and does original research on a topic of current biological interest in consultation with a sponsoring faculty member. Results of this research are presented both orally and in a written report in scientific format.

BIOL 499. Independent Study (1-3)

Not for graduate credit toward M.S. in Biology. Maximum of 3 units of Independent Study may be applied to satisfy unit requirements of Elective Areas for the baccalaureate degree in Biology.

Graduate

Both graduate and advanced undergraduate students may take 500-level courses. Only graduate students are permitted to enroll in 600-level courses.

BIOL 502. Biometry (3)

Application of quantitative methods to variation patterns in biological systems, their analysis and interpretation. Lecture three hours.

BIOL 502L. Biometry Lab (1)

Corequisite: BIOL 502. Students have supervised time to work problem sets. Lab three hours.

BIOL 503/L. Bioinformatics and Lab (3/1)

Prerequisites: BIOL 360; 322. *Corequisite:* BIOL 503L. Bioinformatics tools (statistics and computer analysis) and their application to molecular data analysis. Lecture three hours, computer lab three hours.

BIOL 504/L. Phycology and Lab (2/1)

Prerequisites: BIOL 106/L; 107/L. *Corequisites:* BIOL 504L; 592P. *Preparatory:* BIOL 322. Study of the algae with emphasis on their systematics, morphology, physiology and ecology. Lecture two hours, lab three hours.

BIOL 506/L. Tropical Botany and Lab (2/1)

Prerequisites: BIOL 106/L; 107/L; 322. *Corequisites:* Students taking this course must also be enrolled in other linked courses that are part of the Tropical Biology semester. *Preparatory:* BIOL 312; 316; 330; 427. Intensive, hands-on immersion into the biology of tropical plants including tropical plant anatomy, architecture, morphology, biochemistry, reproduction, systematics, and evolution. Lecture two hours, lab three hours.

BIOL 507/L. Tropical Ecology and Conservation and Lab (2/1)

Prerequisites: BIOL 106/L; 107/L; 322. *Corequisites:* Students taking this course must also be enrolled in other linked courses that are part of the Tropical Biology semester. *Preparatory:* BIOL 312; 316; 330; 427. Intensive, hands-on immersion in the ecology and conservation of tropical organisms and ecosystems. Lecture two hours, lab three hours.

BIOL 508/L. Biology of Tropical Vertebrates and Lab (2/1)

Prerequisites: BIOL 106/L; 107/L; 322. *Corequisites:* Students taking this course must also be enrolled in other linked courses that are part of the Tropical Biology semester. *Preparatory:* BIOL 312; 316; 330; 427. Intensive, hands-on immersion into the biology of tropical vertebrates, including morphology, behavior, ecology, systematics, and evolution. Lecture two hours, lab three hours.

BIOL 509/592U. Tropical Biodiversity and Field Study (2/1)

Prerequisites: BIOL 106/L; 107/L; 322. *Corequisites:* Students taking this course must also be enrolled in other linked courses that are part of the Tropical Biology Semester. Examination of the generation and maintenance of biodiversity, with particular reference to tropical groups of organisms. Lectures, discussions and intensive hands on field experience. Recommended preparatory courses: BIOL 312; 316; 330; 427.

BIOL 510. Seminar On Topics in Tropical Biology (3)

Prerequisites: BIOL 106/L; 107/L; 322. *Corequisites:* Students taking this course must also be enrolled in other linked courses that are part of the Tropical Biology semester. *Preparatory:* BIOL 312; 316; 330; 427. Seminar addressing topics in tropical biology in the context of physical science, culture and politics.

BIOL 512/L. Herpetology and Lab (2/1)

Prerequisites: BIOL 106/L; 107/L. *Corequisites:* BIOL 512L; 592E. Biology, ecology and evolution of amphibians and reptiles. Adaptive significance of form and function is stressed. Lecture two hours, lab three hours.

BIOL 513/L. Entomology and Lab (2/1)

Prerequisites: BIOL 106/L; 107/L. *Corequisites:* BIOL 513L; 592F. Biology and classification of insects with emphasis on phylogeny and on adaptive implications of morphology. Lecture two hours, lab three hours.

BIOL 514/L. Avian Ecology and Lab (2/1)

Prerequisites: BIOL 106/L; 107/L, 322. *Corequisites:* BIOL 514L, 592A. Consideration of the interactions between birds and their environment, including such topics as habitat requirements, resource utilization, species interactions, territoriality and reproduction. Lecture two hours, lab three hours.

BIOL 524. Tropical Biology (3)

Prerequisites: Biology Major, BIOL 322 or equivalent. *Preparatory:* At least 1 course which deals with the evolution and ecology of a major group of organisms. Examination of life functions and biotic interactions under conditions occurring in low latitude environments. Emphasis on characteristics and evolution of tropical biotas and their significance in relation to the total biosphere.

BIOL 525. Animal Behavior (3)

Prerequisites: BIOL 106/L; 107/L, 322. *Recommended Corequisite:* BIOL 592D. Ecology, genetics and evolution of behavior in vertebrates and invertebrates with emphasis on organisms in their natural environment. Lecture three hours.

BIOL 526. Extended Field Study (3)

Prerequisite: consent of instructor, typically following prior coursework on the topic; *Preparatory:* BIOL 322. First-hand field work on a selected group of organisms at selected locations, to be complemented by readings on the evolution and ecology of the organisms and locations. Projects typically involve species identification, the application of censusing designs, data collection, statistical analysis, oral and graphic presentations, written reports, and often a collection to be deposited in a museum. A- Botany; B-Wildlife; C-Fish Biology; D-Entomology; E-Zoology

BIOL 527/L. Biology of Pelagic Organisms and Lab (2/1)

Prerequisites: BIOL 106/L; 107/L; 322. *Corequisites:* BIOL 527L; 592L. Survey of organisms occupying the open ocean environment; ecological, morphological, and physiological adaptations of selected groups; population dynamics, community structure, and fisheries biology. Lecture two hours, lab three hours.

BIOL 528/L. Behavioral Ecology and Lab (2/1)

Prerequisite: BIOL 106/L; 107/L; 322. *Corequisites:* 528L; 592B. Study of the interactions between individuals and the environment.

Emphasis placed on the behavioral adaptations of animals. Lecture two hours, lab three hours.

BIOL 529/L. Marine Ecology and Lab (2/1)

Prerequisites: BIOL 106/L; 107/L; 322. *Corequisites:* BIOL 529L; 592I. Marine community structure and dynamics. Study of the open seas, rocky and sandy shores and bays are used to illustrate the basic features of marine communities. Lecture two hours, lab three hours.

BIOL 530/L. Ichthyology and Lab (2/1)

Prerequisites: BIOL 106/L; 107/L; 322. *Corequisites:* 530L; 592J. Biology, ecology, and evolution of fish. Emphasis placed on adaptive significance of form and function. Lecture two hours, lab three hours.

BIOL 531/L. Ecology of Marine Fishes and Lab (2/1)

Prerequisites: BIOL 530/L; 592J. *Corequisites:* BIOL 531L; 592Q. Species assemblages, general ecology, adaptations and behavioral ecology of near shore marine fishes. Lecture two hours, lab three hours.

BIOL 532/L. Advanced Ichthyology and Lab (3/1)

Prerequisites: BIOL 530/L; 592J; *Graduate standing.* *Corequisite:* BIOL 532L. Advanced topics in ichthyology and fisheries biology. Advanced biosystematics of fishes; reproduction; age and growth; ecology, including feeding and community structure. Lecture three hours, lab three hours.

BIOL 533. Conservation Biology (3)

Prerequisites: BIOL 106/L, 107/L, 322. *Corequisite:* BIOL 592C. Application of ecological and evolutionary principles to problems in environmental biology. Factors affecting biodiversity and causes of species extinction receive particular attention. Lecture three hours.

BIOL 536. Medical Mycology (3)

Prerequisites: BIOL 315/L; 380. Study of mycotic pathogens; their morphology and pathogenicity, including diagnosis and treatment of fungal diseases. Lecture three hours.

BIOL 542. Developmental Biology (3)

Prerequisites: BIOL 360; 380. *Preparatory:* CHEM 334. Discussion of the general mechanisms of cell differentiation in the plant and animal kingdoms. Lecture three hours.

BIOL 544. Biology of Viruses (3)

Prerequisites: BIOL 360; 380. Comparative survey of the structure, gene expression and replication of viruses. Lecture three hours.

BIOL 551/L. Computer Modeling in Biology and Lab (2/2)

Prerequisites: BIOL 322, BIOL 360. *Corequisites:* BIOL 551L. Selected topics illustrating methods of computer modeling of biological systems. Students will be introduced in lecture and in computer laboratories to programming skills related to biological sciences and statistical analysis, including population genetics, cellular and molecular biology, physiological biology, or ecology. Emphasis on understanding the role that computer modeling and analysis can play in research questions. Lecture 2 hours, laboratory 6 hours.

BIOL 560. Advanced Topics in Evolution (3)

Prerequisites: BIOL 106/L; 107/L; 322; 360. Critical discussion of selected topics in evolutionary biology such as adaptation, speciation, molecular evolution, key innovations, social evolution, and coevolution. Lecture three hours.

BIOL 561. The Molecular Genetics of Microorganisms (3)

Prerequisites: BIOL 360; 380; CHEM 333. Discussion of the molecular structure of the gene, the chemistry of gene action, mutagenic agents, and genetic control mechanisms in microorganisms. Emphasis placed on experimental basis for current concepts in molecular genetics. Lecture three hours.

BIOL 562. Molecular Genetics of Eukaryotic Organisms (3)

Prerequisites: BIOL 360; 380; CHEM 333; 334. Examination of the

structure and function of chromatin, the structure of DNA and its associated proteins in chromosomes, replication of DNA and chromatin, transcription, RNA processing, recombination, and the regulation of gene expression in eukaryotes. Lecture three hours.

BIOL 563. Cytogenetics (3)

Prerequisite: BIOL 360. Correlated study of genetics and cytology in which the genetic results of chromosomal changes are investigated. Lecture three hours.

BIOL 564. Human Biochemical Genetics (3)

Prerequisites: BIOL 360; CHEM 461 and 462, or 464 or 365. Focus on different sources of human biochemical defects, the detection of such disorders, and their treatment. Lecture three hours.

BIOL 566. Genetics of Bacteria and Their Viruses (3)

Prerequisites: BIOL 315/L; 360. Study of the genetic systems found in bacteria, including transformation, conjugation and transduction. Viral replication, recombination and interaction with their bacterial hosts are investigated from a genetic perspective. Transposable elements, plasmids and other selected topics of current interest in this field are explored. Lecture three hours.

BIOL 567. Medical Genetics (3)

Prerequisites: BIOL 360; MATH 105 or 140 or a score on the Mathematics Placement Test (MPT) sufficient for admission to MATH 255A. Lecture and case presentations of the clinical, cytogenetic, biochemical, molecular and developmental aspects of human diseases and characters, knowledge that is necessary for the practice of medical genetics. Lecture three hours.

BIOL 568. Clinical Cytogenetics and Cancer Genetics (3)

Prerequisite: BIOL 468. Examination of the cytogenetics of human cancers and of hereditary predisposition to cancer, including rare and common familial cancer syndromes, risk assessment and surveillance, epidemiology and current research, ethics and genetic counseling in genetic risk assessment for cancer. Lecture three hours.

BIOL 571. Molecular Diagnostics (3)

Prerequisites: BIOL 360, MATH 105 or 140 or score on the Math Placement Test (MPT) sufficient for admission to MATH 225A. Survey of current techniques, applications and goals of molecular genetics research, including cloning strategies and techniques, genetic engineering techniques, progress in the Human Genome Project and related work, gene therapy, and ethical ramifications. Lecture three hours.

BIOL 572/L. Recombinant DNA Techniques and Lab (2/2)

Prerequisites: BIOL 360; CHEM 102/L. *Corequisite:* BIOL 572L. *Preparatory:* BIOL 380. Handling and processing of recombinant DNA, including DNA isolation, use of restriction enzymes, gel electrophoresis, ligation, cloning, blots, hybridization and associated microbiological techniques. Lecture two hours, lab six hours.

BIOL 575/L. Biological Imaging and Lab (2/2)

Prerequisites: BIOL 380. *Corequisite:* BIOL 575L. Theoretical and practical aspects of imaging as applied to cellular and molecular biology, biotechnology, and histology. Covers transmission and scanning electron microscopy, and light microscopy including confocal microscopy as well as MRI, PET and CAT scanning. Computer image processing and analysis, and the use of ultramicrotomy, fluorescent labels and immunochemistry to study macromolecules, cells, and tissues will also be studied. Lecture 2 hours, lab 6 hours.

BIOL 577/L. Cell and Tissue Culture and Lab (2/2)

Prerequisite: BIOL 380. *Corequisite:* BIOL 577L. *Preparatory:* BIOL 315/L. Theoretical and practical studies of animal and plant cell cultures. Techniques for primary and continuous cultures and the production of hybridomas and monoclonal antibodies are covered. Other

topics include cell culture storage, karyotyping, somatic embryogenesis, cytodifferentiation, and application of cell cultures in solving biological problems. Lectures and labs are highly integrated. Lecture two hours, lab six hours.

BIOL 580/L. Cellular Physiology and LAB (2/2)

Prerequisites: BIOL 380; CHEM 334. *Corequisite:* BIOL 580L. In-depth consideration of cellular physicochemistry, including organelle structure, composition and function, macromolecular biosynthesis, metabolism, membrane transport and bioelectric phenomena. 8 class hours of integrated lecture and lab.

BIOL 581. Endocrinology (3)

Prerequisite: BIOL 380. *Preparatory:* BIOL 281 or BIOL 482. A comprehensive study of the organization and function of the major endocrine organs. Lectures will focus on the hormonal control mechanisms that regulate metabolism, reproduction, development, and growth. Lecture three hours.

BIOL 582/L. Principles of Neurophysiology and Lab (3/1)

Prerequisite: BIOL 380. *Preparatory:* BIOL 482 or 580, CHEM 334, PHYS 100A, 100B. *Recommended Corequisite:* BIOL 582L. Examination of the structure, function and physiological principles of the nervous system. Surveys neuroanatomy, molecular neurobiology, sensory reception and relevant human neurological disorders. Lecture three hours; lab three hours.

BIOL 585. Mechanisms of Bacterial Pathogenesis (3)

Prerequisite: BIOL 315/L, 380. *Preparatory:* BIOL 410/L. Intensive study of the cellular and molecular mechanisms of bacterial pathogenesis, including the contribution of the host response, with emphasis on recent developments and comparative principles. Lecture three hours.

BIOL 589. Cellular Immunology (3)

Prerequisite: BIOL 485. Advanced studies on the cellular interactions and mechanisms of the immune response, including clinical aspects of cell-mediated reactions and immunologic disorders. Lecture three hours.

BIOL 592A-T. Field Studies in Biology (1-2)

One unit each, 3 hours per week or equivalent:

592A Avian Ecology	(Corequisite: BIOL 514/L)
592B Behavioral Ecology	(Corequisite: BIOL 528/L)
592C Conservation Biology	(Corequisite: BIOL 533)
592D. Animal Behavior	(Corequisite: BIOL 525)
592E. Herpetology	(Corequisite: BIOL 512/L)
592F. Entomology	(Corequisite: BIOL 513/L)
592I. Marine Ecology	(Corequisite: BIOL 529/L)
592J Ichthyology	(Corequisite: BIOL 530/L)
592L Pelagic Organisms	(Corequisite: BIOL 527/L)
592P Phycology	(Corequisite: BIOL 504/L)
592Q Ecology of Marine Fishes	(Corequisite: BIOL 531/L)

Two units each, 6 hours per week or equivalent

592R. Tropical Botany	(Corequisite: BIOL 506/L)
592S. Tropical Ecology/Conservation	(Corequisite: BIOL 507/L)
592T. Tropical Vertebrates	(Corequisite: BIOL 508/L)

BIOL 595A-Z. Experimental Topics (1-3)

BIOL 615A-G. Seminar in Organismal and Population Biology (3)

Prerequisites: BIOL 691; one or more 400-level courses in the area of specialization; graduate status. Advanced study, including student preparation and presentation of reports, in one of the following areas of biology: (A) Systematics and Phylogeny, (B) Morphology, (C) Ecology, (D) Ethology, (E) Biogeography, (F) Evolution, and (G) Tropical Biology.

BIOL 641. Biochemistry of Animal Development (3)

Prerequisites: BIOL 441 or 542. Advanced study in the mechanistic

approach to the study of development of animals. Topics include biochemical control mechanisms of metabolism, gene activity, cell motility and adhesion, pattern formation. Lecture three hours.

BIOL 655A-J. Seminar in Cellular and Molecular Biology (3)

Prerequisites: BIOL 691, one or more 400-level courses in the area of specialization; graduate status. Advanced study, including student preparation and presentation of reports, in one of the following areas of biology: (A) Microbiology, (B) Cellular Biology, (C) Development, (D) Genetics, (E) Physiology, (F) Immunology, (G) Molecular Biology, (H) Biotechnology, (I) Molecular Evolution, and (J) Medical Genetics.

BIOL 665. Colloquium in Human Genetics (2)

Prerequisite: Acceptance into the Genetic Counseling program. Attendance at a series of lectures given by specialists in medical genetics and genetic counseling. Each presentation followed by a discussion involving student participation. (Credit/No Credit Only)

BIOL 690. Graduate Tutorial (1)

Supervised individual projects involving reading and discussion, lab research or field studies in specific areas of biology. No more than two units may be credited toward the Master's degree, and they may not be taken concurrently. (Under special circumstances, unclassified graduate students may be permitted to take the course)

BIOL 691. Graduate Proseminar (3)

Recommended to be taken early in the graduate program in preparation for further graduate course work and the presentation of papers at professional meetings. Preparation and presentation of seminars based on current literature in Biology.

BIOL 692. Biology Colloquium (1)

Guest lecturers (contemporary researchers) presenting talks on a variety of topics in biological research. Each presentation will be followed by discussion involving student participation. (Credit/No Credit only)

BIOL 695A-Z. Experimental Topics (1-3)

BIOL 696A-Z. Directed Graduate Research (3)

BIOL 698. Thesis (1-6)

Prerequisites: Classified status in biology and consent of instructor. Preparing and writing the Master's thesis. May be repeated for a maximum of six units.

BIOL 699. Independent Study (1-6)