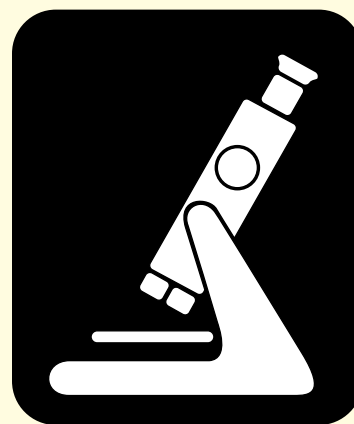


BIOLOGICAL SCIENCES

**BACHELOR OF ARTS
BACHELOR OF SCIENCE
SUBJECT MATTER PROGRAM
MINOR
CERTIFICATE
MASTER OF SCIENCE**



PROGRAM DESCRIPTION

Biological Sciences includes all aspects of the scientific study of life. The structure, function, and behavior of organisms are studied at the molecular, cellular, organismal, and environmental levels.

The Department of Biological Sciences offers the Bachelor of Arts (BA) in Biological Sciences and the Bachelor of Science (BS) in Biological Sciences. The BA program provides a broad background in Biological Sciences with coverage of the principal fundamental areas of biology. The BA program supplemented with three geoscience courses satisfies the minimum requirements for subject matter program competency leading to a teaching credential. With additional coursework in chemistry and mathematics and appropriate selection of courses in the General Education Program, the BA satisfies minimum requirements for admission to professional schools in dentistry, human medicine, veterinary medicine, and other allied health fields. The BS programs provide the necessary preparation for postbaccalaureate work and are the preferred degree programs for students pursuing careers in biology, teaching, or the health sciences.

The graduate program in Biological Sciences leads to a Master of Science (MS) degree. The graduate program provides an opportunity to receive advanced training in biological sciences and to pursue independent research investigations in the student's specialized area of interest. The MS degree program provides the option of a concentration in biological conservation.

FACULTY

Laurel Heffernan, *Department Chair*

Michael Baad; Juanita Barrera; Rosalee Carter; Elijah Christian; Nicholas Ewing; Linnea Hall; Dennis Huff; Yuh Lin Hwang; Tom Kantz; Jeri Langham; Gordon Leidahl; Melanie Loo; Gary Meeker; Robert Metcalf; Charles Moser; Ann Motekaitis; MaryAnne Reihman; William Shepard; Gene Trapp; David Vanicek; Rose Leigh Vines; Marda West

Janet Sonoda, *Department Secretary*

Department Office, Science 202, 278-6535

FEATURES

There are 18 laboratories designed to serve the various courses in Biological Sciences. Support facilities include: an entomology museum, containing over 30,000 specimens; a vertebrate ectotherm museum, containing several thousand specimens (fish, reptiles and amphibians); a vertebrate endotherm museum, containing over 1900 mammal specimens and 2500 bird specimens; a greenhouse, containing a teaching collection of over 4000 plants; and an arboretum.

The Sierra Nevada and the Pacific Coast are equally accessible from Sacramento, providing students interested in field biology the opportunity to study an extraordinary number of varied habitats. CSUS is one of the six participating CSU campuses at Moss Landing Marine Laboratories (MLML) near Monterey.

CSUS is located in the State Capitol and provides a unique opportunity for students to become involved with various State and Federal wildlife and conservation agencies through biological internships (BIO 195) and part-time employment. A number of public agencies, hospitals, clinics, and private health practices in the Sacramento area provide similar opportunities for students interested in the health care fields.

Opportunities for paid biology-related work experiences are available through participation in the Cooperative Education Program.

CAREER POSSIBILITIES

Clinical Lab Technologist • Bacteriologist • Molecular Biologist • Food/Drug Inspector • Public Health Microbiologist • Pathologist • Physiologist • Pharmaceutical Sales • Geneticist • Agricultural Biologist • Fishery Biologist • Wildlife Biologist • Marine Biologist • Naturalist • Zoologist • Botanist • Ecologist • Biologist • Medicine • Dentistry • Veterinary Medicine • Lab Tech in Research Lab • High School Teacher • Biotechnologist • Immunologist • Science Writer • Medical Illustrator • Lab Tech in Food Processing Facility/Drug Company

MAJOR REQUIREMENTS • BA

Total units required for BA: 124

Total units required for Major: 62-63

Courses in parentheses are prerequisites.

This degree program provides the minimum preparation for biology students interested in the biology subject matter competency for a teaching credential (three supplementary geoscience courses are required) and admission to health professional schools. It should be noted that the B.S. program in Biological Sciences is the preferred degree for graduate schools, most health professional schools, and most entry-level technical employment in industry and government agencies.

A. Required Lower Division Core Courses (35-36 units)

- (3) BIO 10 Basic Biological Concepts
- (4) BIO 11 Animal Biology (BIO 10)
- (4) BIO 12 Plant Biology (BIO 10)
- (5) CHEM 1A General Chemistry
- (5) CHEM 1B General Chemistry (CHEM 1A)
- (3) CHEM 20 Organic Chemistry Lecture (CHEM 1B)
- (4) PHYS 5A General Physics: Mechanics, Heat, Sound (MATH 9 or three years high school math or qualifying exam)
- (4) PHYS 5B General Physics: Light, Electricity & Magnetism, Modern Physics (PHYS 5A)
- (3-4) Select one of the following:
 - MATH 26A Calculus I for the Social & Life Sciences (MATH 11 or three years high school math)
 - MATH 29 Pre-Calculus Mathematics (MATH 11 or three years high school math)
 - MATH 30 Calculus I (MATH 29)

Note:

- Prehealth professional students should take the Chemistry and Math requirements as stated in the Premedical Program section of this catalog.
- CHEM 24 **and** 124 may be taken in lieu of CHEM 20.
- BIO 106, 107, and 108 are not acceptable toward a BA in Biological Sciences

B. Required Upper Division Core Courses (16 units)

- (3) BIO 121 Cellular Physiology (BIO 11, 12, CHEM 161)
- (4) BIO 139 General Microbiology (BIO 11, 12, **and** CHEM 20)
- (3) BIO 160 General Ecology (BIO 11 **and** 12)
- (3) BIO 184 General Genetics (BIO 11, 12 **and** 139)
- (3) CHEM 161 General Biochemistry (CHEM 20 **or** 124)

Notes:

- CHEM 161 is **not** counted toward the 24 upper division unit requirement in the major.
- CHEM 160A **and** 160B may be taken in lieu of CHEM 161. Three units may be counted toward the 24 upper division unit requirements for the major.

C. Upper Division Electives (11 units)

Select eleven (11) upper division biology units in consultation with an advisor. Upper division electives in biological sciences must include one course in plant biology and one course in animal biology.

Note: No more than 2 units from BIO 195, 197, 198, and 199 combined can be applied to the Biological Sciences upper division major requirement.

Honors Program

Biological Sciences Honors Program is designed to provide undergraduate students with an in-depth research experience. An undergraduate research experience is highly recommended for entry into many graduate and professional programs. Culmination of the Honors Program will consist of an undergraduate thesis and an undergraduate seminar. To enter this program, students must have an overall GPA of 3.25 and a minimum of 3.0 GPA in BIO 10, 11, and 12 and in at least 6 units of upper division biology courses.

The curriculum of the Honors Program is designed to be coupled with the BA degree or the BS degree programs. The Honors Program requires the following courses, completed with a grade of "B" or better, for the BA or the BS degree:

- (1) BIO 198A Honors Proseminar (BIO 10, 11, 12, and at least 6 units of upper division biology)
- (2) BIO 198B Honors Research & Seminar (BIO 198A)

MAJOR REQUIREMENTS • BS

Total units required for BS: 132

Total units required for Major: 74-82

Courses in parentheses are prerequisites.

A. Required Lower Division Core Courses (35-36 units)

- (3) BIO 10 Basic Biological Concepts
- (4) BIO 11 Animal Biology (BIO 10)
- (4) BIO 12 Plant Biology (BIO 10)
- (5) CHEM 1A General Chemistry
- (5) CHEM 1B General Chemistry (CHEM 1A)
- (3) CHEM 20 Organic Chemistry Lecture (CHEM 1B)
- (4) PHYS 5A General Physics: Mechanics, Heat, Sound (MATH 9 or three years high school math or qualifying exam)
- (4) PHYS 5B General Physics: Light, Electricity & Magnetism, Modern Physics (PHYS 5A)
- (3-4) Select one of the following:
 - MATH 26A Calculus I for the Social & Life Sciences (MATH 11 or three years high school math)
 - MATH 29 Pre-Calculus Mathematics (MATH 11 or three years high school math)
 - MATH 30 Calculus I (MATH 29)

Notes:

- CHEM 24 **and** 124 may be taken in lieu of CHEM 20.
- Prehealth professional students should take the Chemistry and Math requirements as stated in the Premedical Program section of this catalog.
- PHYS 5B is required for all biology majors; however, with advisor permission, students concentrating in Biological Conservation may substitute certain courses in mathematics and physical sciences for PHYS 5B.

B. Required Upper Division Core Courses (16 units)

- (3) BIO 121 Cellular Physiology (BIO 11, 12, **and** CHEM 161)
- (4) BIO 139 General Microbiology (BIO 11, 12, **and** CHEM 20)
- (3) BIO 160 General Ecology (BIO 11 **and** 12). Not required in the Clinical Laboratory Technology concentration.

- (3) BIO 184 General Genetics (BIO 11, 12, **and** 139)
 (3) CHEM 161 General Biochemistry (CHEM 20 **or** 124)

Notes:

- CHEM 161 is not counted toward the 36 upper division unit requirement in the major.
- CHEM 160A and 160B may be taken in lieu of CHEM 161. Three units may be counted toward the 36 upper division unit requirement for the major.
- BIO 106, 107, and 108 are not acceptable toward a BS in Biological Sciences.

C. Concentration Requirements (23-30 units)

1. No Concentration (23 units)

This degree program provides a broad background in biological sciences and the opportunity to select electives that meet individual needs and interest. The BS in Biological Sciences (with three supplemental geoscience courses) meets requirements leading to the Biology Subject Matter Competency Teaching Credential, satisfies requirements for admission to health professional schools, and provides necessary preparation for most graduate programs and selected entry level technical positions in industry and government. Requirements are one upper division course in plant biology and one upper division course in animal biology and enough additional upper division elective units to total 23. See Major Requirements

- BA, C. Upper Division Electives.

2. Biological Conservation (26 units)

The curriculum in Biological Conservation is designed to prepare students for careers in the fields of fisheries and wildlife biology/management, conservation biology, natural resource conservation, environmental impact assessment and related areas. This curriculum meets the educational requirements for various entry level career positions with state and federal agencies. Students majoring in this concentration are urged to obtain on-the-job training with conservation agencies (such as California Department of Fish and Game) through summer or part-time employment, or through internships BIO 195.

- (3) STAT 1 Introduction to Statistics
 (4) BIO 112 Plant Taxonomy (BIO 12)
 (3) BIO 118 Natural Resource Conservation (BIO 11, 12)
 (3) BIO 167 Biometrics (BIO 11, 12)
 (3) BIO 173 Principles of Fishery Biology (BIO 160)
 (3) BIO 179 Principles of Wildlife Management (BIO 160, 166, **and** 168, **or** permission of instructor)
 (7) Select two of the following:
 BIO 117 Field Botany & Vegetation Inventory
 BIO 157 General Entomology **OR**
 BIO 172 Aquatic Entomology
 BIO 162 Ichthyology: The Study of Fishes
 BIO 165 Vertebrate Natural History
 BIO 166 Ornithology
 BIO 168 Mammalogy

3. Clinical Laboratory Technology (30 units)

The curriculum in Clinical Laboratory Technology meets the coursework requirements of the State for eligibility to take the California Laboratory Technologist licensure examination. Eligibility to take the examination also requires a one year traineeship at a state approved hospital laboratory. Completion of B.S. degree requirements in the Clinical Laboratory Technology concentration does not guarantee admission to a trainee program. Information on admission criteria and application

procedures for the various medical technology trainee programs throughout the state is available through the Student Record Center, P.O. Box 1320, West Covina, CA 91793-1320.

- (4) CHEM 31 Inorganic Qualitative Analysis (CHEM 1B)
 (3) CHEM 162 General Biochemistry Laboratory (CHEM 31, 160A or 161)
 (3) BIO 124 Clinical Hematology (CHEM 162)
 (4) BIO 144 Pathogenic Bacteriology (BIO 139, CHEM 20)
 (2) BIO 149A Immunology & Serology Lecture (BIO 139)
 (1) BIO 149B Immunology & Serology Lab (BIO 139)
 (4) BIO 152 Human Parasitology (BIO 11)
 (9) Nine additional upper division units selected in consultation with an advisor. Recommended electives are:
 BIO 125 Body Fluid Analysis
 BIO 131 Systemic Physiology
 BIO 134 Medical Mycology
 BIO 143 General Virology

Notes:

- CHEM 162 can be included in the 36 upper division unit requirement for this concentration.
- A minor in Chemistry may be attained if either CHEM 20L or 25 is taken.

4. Microbiology (28 units)

The concentration in Microbiology is designed to prepare students for entry level technical positions in industry and graduate programs in Microbiology leading to careers in research and teaching. By taking specified elective courses, the concentration will satisfy the coursework requirements of the State for eligibility to take the California Public Health Microbiologist Certificate Examination. Eligibility to take the examination also requires six months as a trainee at an approved Public Health Laboratory. Completion of BS degree requirements does not guarantee admission to a trainee program. Possession of a Public Health Microbiologist Certificate is a requirement for employment in both California State and County Public Health Laboratories. Concentration includes a minor in Chemistry.

- (1) CHEM 20L Organic Chemistry Lab (CHEM 20 **or** 24)
 (4) CHEM 31 Inorganic Quantitative Analysis (CHEM 1B)
 (3) CHEM 162 Biochemistry Laboratory (CHEM 31 **and** CHEM 160A **or** 161)
 (2) BIO 149A Immunology & Serology Lecture (BIO 139)
 (1) BIO 149B Immunology & Serology Lab (BIO 139)

Note: CHEM 162 can be included in the 36 upper division unit requirement for this concentration.

- (17) Elective courses selected from the following list: A total of 36 upper division units is required for the concentration, CHEM 161 is required but is not counted in the 36 upper division unit requirement. Electives should be selected in consultation with an advisor.
 HS 148* Epidemiology (BIO 10, CHEM 1A, STAT 1 or permission of instructor)
 BIO 134* Medical Mycology (BIO 139)
 BIO 144* Pathogenic Bacteriology (BIO 139)
 BIO 152* Human Parasitology (BIO 11)

BIO 143	General Virology (BIO 139, CHEM 161)
BIO 145	Diversity of Microorganisms (BIO 139)
BIO 155	Immunobiology (BIO 149A)
BIO 156	Food Microbiology (BIO 139)
BIO 180	Molecular Biology Lecture (BIO 184)
BIO 181	Molecular Biology Lab (BIO 139, 184)
BIO 185	Topics in Cellular & Molecular Biology
BIO 195	Biological Internship
BIO 199A	Special Problems

* Required to qualify for Public Health Microbiology Traineeship.

5. Molecular Biology (30 units)

The concentration in Molecular Biology provides a foundation for research and teaching activity in recombinant DNA technology, cell biology, developmental biology, genetics, and immunology. There are no current professional certifications for most research technologists in molecular biology, so requirements for employment vary. In most cases, further laboratory and academic preparation is desirable for challenging employment opportunities in hospitals, universities and private industry.

- (4) CHEM 31 Inorganic Quantitative Analysis (CHEM 1A, 1B)
- (3) CHEM 162 Biochemistry Lab (CHEM 31)
- (3) BIO 143 General Virology (BIO 139)
- (2) BIO 149A Immunology & Serology Lecture (BIO 139)
- (2) BIO 180 Molecular Biology Lecture (BIO 134, 184)
- (2) BIO 181 Molecular Biology Lab (BIO 134, 184)
- (14) Upper division electives in Biological Sciences or Chemistry. Select electives in consultation with an advisor.

Honors Program

An Honors Program is available with both the BA and BS degrees in Biological Sciences. For additional information see "Honors Program" in the preceding section.

SUBJECT MATTER PROGRAM (Pre-Credential Preparation)

Biological Sciences majors who intend to pursue a teaching credential must complete the science subject matter program which is described in this catalog. Successful completion of this program fulfills the subject matter competence program in the School of Education. The Science Teaching Credential allows graduates to teach all four of the sciences (Geoscience, Biology, Chemistry, and Physics) at the General Science level in 7-12 grades, and Geoscience at an advanced level in high school.

Currently there is a great need for K-12 teachers educated in science. Changes in State Board of Education Standards and increasing interest in earth and space sciences have created significant demands for students with this credential. Biological Sciences majors who have an interest in teaching should contact credential advisors in the Biological Sciences Department (Tom Kantz or Gary Meeker).

MINOR REQUIREMENTS

The minor in Biological Sciences is designed to provide students in other majors with the opportunity to broaden their exposure to and understanding of the biological sciences. The minor complements several majors that require coursework in biological sciences, including Nursing, Environmental Studies, Physical Education, and Family and Consumer Sciences (Nutrition and Food).

The minor requires 20 units, all of which must be taken in Biological Sciences. A minimum of 9 upper division units is required. **Six** of these units must be earned in residence. BIO 106, 107 and 108 cannot be counted toward the minor. Specific course requirements are:

- (3) BIO 160 General Ecology (BIO 11, 12) **OR**
- (3) BIO 184 General Genetics (BIO 11, 12 and 139)
- One upper division course in plant biology
- One upper division course in animal biology

The requirement for an upper division plant course may be waived for those students currently in the Nursing major.

CERTIFICATE

The Academic Achievement Certificate in *Issues in Natural Resource Management* is designed to provide an interdisciplinary perspective on the conflicts, controversies and biopolitical issues that natural resource biologists must deal with in their careers, and to introduce students to the non-biological considerations that influence decision making processes in natural resource utilization and management.

Certificate Requirements:

A minimum of 15 units selected from the following list in addition to requirements for the BS in Biological Sciences with a concentration in Biological Conservation. The certificate may also be awarded to students completing the BS in General Biology with the approval of the Biological Conservation advisors.

- (3) ECON 120 Economics & Environmental Degradation
- (3) ECON 123 Resource Economics (ECON 1B)
- (3) ECON 125 Land Economics (ECON 1B)
- (3) ENVS 110 Contemporary Environmental Issues
- (3) ENVS 112 International Environmental Problems (Passing score on WPE)
- (3) ENVS 118 Environment & the Law (ECON 111)
- (3) GEOL 140 Geology & the Environment
- (3) GOVT 160 Public Policy Development (GOVT 1 or equivalent)
- (3) GOVT 169 Environmental Politics & Policy (GOVT major or approval of instructor)

COOPERATIVE EDUCATION

Biology majors can participate in the University's Cooperative Education Program. This program provides biology-related, paid, off-campus work experience in government agencies or private industry. The experience can enhance the student's employment prospects upon graduation. Participants in this program will complete at least one six-month period. During the work period, the participant generally will not attend classes on the CSUS campus but will enroll in BIO 194, Biology-related Work Experience. (BIO 194 units do not replace the curricular requirements of the Biological Sciences degree programs.) Students interested in this program should contact the Biological Sciences Department or the campus Cooperative Education Program office for further information.

GRADUATE PROGRAM

The graduate program in Biological Sciences leads to a Master of Science degree, and provides an opportunity for students to receive advanced training and to pursue independent investigations in particular fields of biology. It allows students to upgrade their qualifications for educational advancement to doctoral programs or for professional advancement in teaching, laboratory work, or fieldwork. The MS concentration in Biological Conservation provides advanced training and research experience in fields associated with biological conservation.

Students should plan their programs in consultation with a faculty advisor as early as possible, preferably in the semester prior to the one in which graduate study will begin. Students may contact the Biological Sciences Department office for information on advising.

Admission Requirements

Admission as a classified graduate student to the MS program in Biological Sciences requires:

- a baccalaureate degree **and**
- beginning courses in botany and zoology, or a year-long introductory sequence of courses in biology which includes the organismal biology of plants and animals **and**
- 24 units of upper division biological sciences courses, including each of the following courses, which must have been passed with a "C-" or better: Microbiology, Genetics, Ecology, and Physiology **and**
- one year course in general chemistry (inorganic), a course in organic chemistry, and a course in biochemistry **and**
- two semesters of Physics with a lab, **and**
- a minimum 2.75 grade point average in all biology courses and a minimum 3.0 grade point average in upper division biology courses (CSUS BIO 106, 107, 108, 195, 197, 199—or their equivalents from other institutions—cannot be included in the grade point calculations)

Students who have deficiencies in Admission Requirements that can be removed by specified additional preparation may be admitted with conditionally classified graduate status. Any such deficiencies will be noted on a written response to the admission application.

Admission Procedures

All prospective classified graduate students, including CSUS graduates, must file the following with the Graduate Center:

- an application for graduate admission, a supplemental application for admission to the Biological Sciences program (Parts A and B in the CSU Graduate Post Baccalaureate Admission booklet)
- two sets of official transcripts from all colleges and universities attended, **other** than CSUS

Approximately six weeks after receipt of all items listed above, a decision regarding admission will be mailed to the applicant.

Advancement to Candidacy

Each student must file an application for Advancement to Candidacy, indicating a proposed program of graduate study. This procedure should begin as soon as the classified graduate student has:

- removed any deficiencies in Admission Requirements **and**
- completed at least 12 units in the graduate program with a minimum 3.0 grade point average, including at least one course at the 200 level **and**
- begun a preliminary study for the thesis

Advancement to Candidacy forms are available in the Graduate Center. The student fills out the form after planning a degree program in consultation with his/her Biological Sciences advisor. After approval by the Biological Sciences Graduate Committee and the student's thesis committee, the completed form is returned to the Graduate Center for approval.

Degree Requirements

The MS degree requires completion of 30 units of coursework with a minimum 3.0 grade point average. The 30 units must include a minimum of 15 units of 200-level courses. No units from BIO 106, 107, 108, 195, 197, 198A, 198B, or 199 are acceptable toward the master's degree. No more than 6 units of BIO 299 and 500 may be applied toward the 30 unit requirement.

Each student who receives a Master's degree from the Department of Biological Sciences must submit a thesis based on original research in biology. A thesis can be based on either of the following sources of data:

- data generated by the student's original research in which the student performs the fieldwork or laboratory experiments **or**
- data obtained from sources other than the student's own fieldwork or laboratory experiments, provided the data are analyzed in a manner in which they were not previously analyzed.

The use of data must result in an original contribution to the problem being investigated.

Degree requirements must be completed within seven years after the beginning of the first course that is used to meet degree requirements. No extensions of the seven-year deadline will be granted; students who fail to

complete all degree requirements within a seven-year period will have their graduate programs automatically terminated. Students who have had their graduate programs terminated because they have reached the seven-year limit will not be readmitted to the graduate program.

A. Required Core Courses (10 units)

- (3) BIO 220 Research Methods in Biology
- (3) BIO 282 Evolution
- (3) BIO 292 Biological Concepts
- (1) BIO 294 Seminar

B. Concentration Requirements

1. No Concentration (18 units)

Approved electives in Biological Sciences or supporting fields (see below)

2. Biological Conservation (18 unit minimum)

- (3) Select one of the following:
 - BIO 214 Advanced Plant Ecology
 - BIO 260 Population & Community Ecology
 - BIO 269 Behavioral Ecology
- (5-6) Select two of the following:
 - BIO 270 Conservation Policy & Administration
 - BIO 273 Advanced Fishery Biology & Management
 - BIO 279 Conservation Biology
- (9-10) Approved electives in Biological Sciences or supporting fields (see below)

C. Culminating Requirement (2 units)

- (2) BIO 500 Master's Thesis

Supporting Fields

A maximum of 10 units from an approved supporting field (e.g., chemistry, physics, environmental studies) may be counted toward the degree, with advisor and graduate committee approval obtained before taking the course(s).

Foreign Language

A foreign language is not required for the degree. However, students who plan further graduate study are encouraged to take courses in French, German, or Russian since proficiency in two of these languages may be required in doctoral programs.

LOWER DIVISION COURSES

5. General Biology. An introduction to basic principles of biology, with emphasis at the organismal level. Survey of plant and animal kingdom, structure and function of organ systems of major groups, adaptations to environment, and evolutionary relationships. Lecture three hours, laboratory three hours. **Note:** not open to biology majors or students who have received credit for BIO 11 or 12. Fee course. 4 units.

10. Basic Biological Concepts. An introduction to the biological sciences with emphasis at the molecular and cellular levels. Concepts and principles common to all living systems will be stressed. Intended for both majors and non-majors. Lecture two hours, laboratory three hours. Fee course. 3 units. (CAN BIOL 2)

11. Animal Biology. Survey of the animal kingdom, with emphasis on structure, function, adaptations, and phylogenetic relationships of major animal groups. Lecture three hours, laboratory three hours. Fee course. **Prerequisite:** BIO 10. 4 units. (CAN BIOL 4)

12. Plant Biology. Survey of the plant kingdom with emphasis on structure, function, adaptations, and phylogenetic relationships of major plant groups. Lecture three hours, laboratory three hours. Field trips may be required. Fee course. **Prerequisite:** BIO 10. 4 units. (CAN BIOL 6)

20. Biology: A Human Perspective. An introduction to the major concepts of biology and their application to humans. Major topics include reproduction and heredity, energy, and metabolism, ecology, evolution, and the levels of biological organization using the human as an example. Lecture three hours. **Note:** not open to majors in biological sciences and students who have received credit for BIO 10. 3 units.

22. Introductory Human Anatomy. An introduction to the study of the gross and microscopic structure of the human body using a systemic approach. Lecture three hours, laboratory three hours. Fee course. **Prerequisite:** BIO 10, 20, or permission of instructor. 4 units. (CAN BIOL 10)

31. Introductory Human Physiology. A comprehensive survey of normal human physiology, emphasizing the function and integration of organ systems. Lecture three hours, laboratory three hours. Does not fulfill the requirements for admission to Athletic Training, Biodynamics, Pre-Nursing, and Pre-Physical Therapy majors at CSUS. **Note:** not open to students who have taken BIO 131. Fee course. **Prerequisites:** BIO 10 or 20, and CHEM 6A or 1A. 4 units.

96. Experimental Offerings in Biological Sciences. Special topics and new courses in Biological Sciences. Not offered each semester. 1-3 units.

UPPER DIVISION COURSES

102. The Natural History of Plants. The major plant communities of California provide a framework for understanding the interrelationships of natural environments and the dominant trees and shrubs of these areas. Identification of these species and the wildflowers of the communities is emphasized in the lab and field trips. Course designed for minors in biology or for those with an interest in their natural surroundings, but is acceptable for majors who have not completed BIO 112. Lecture one hour, laboratory six hours. Fee course. **Prerequisite:** a college course in biology or permission of instructor. Spring only. 3 units.

103. Plants and Civilization. A study of the significance of plants in the development of human civilization. Emphasis will be placed on the botanical, sociological and economic aspects of plants useful to humans. Lecture three hours. **Prerequisite:** BIO 10 or equivalent. 3 units.

104. Physiology of Human Reproduction. A study of the physiology of human reproduction. Topics to be covered include: gametogenesis, the basis of fertility, conception, prenatal development, parturition, lactation and the physiology of contraception. Lecture three hours. **Prerequisite:** BIO 10, 20, or permission of instructor. Not offered every semester. 3 units.

106. Genetics: from Mendel to Molecules. An introductory genetics course dealing with the principles of genetics and scientific approaches used to define those principles. The physical basis of heredity, the impact of selective breeding and genetic engineering will be discussed. Lecture two hours, discussion one hour. **Note:** BIO 10 recommended. Not offered every semester. 3 units.

107. Investigations in Basic Biology. An activity course utilizing inquiry techniques in demonstrating some basic biological principles. Satisfies the upper division biological science requirement for multiple-subject teaching credential for students with catalog rights previous to 1991-1994. Lecture one hour, laboratory three hours. Fee course. **Prerequisite:** one semester of general biological science with laboratory. 2 units.

108. Laboratory Investigations in Biology. Investigational laboratories demonstrating the use of the scientific method to explore topics in genetics, ecology, and evolution. Satisfies the upper division biological sciences requirement for multiple-subject teaching credential for students with 1992-1994 catalog rights. Laboratory three hours. Fee course. **Prerequisites:** BIO 5, PHYS 7, CHEM 106; CHEM 106 may be taken concurrently. 1 unit.

112. Plant Taxonomy. Spring flora of central California is used as the focus of study in the classification and identification of native vascular plants. Lecture two hours, laboratory six hours. Field trips may be required. Fee course. **Prerequisite:** BIO 12. Spring only. 4 units.

113. Nonvascular Plants. Studies of the structure, development and interrelationships of non-vascular plants (fungi and algae). Lecture two hours, laboratory three hours. Fee course. **Prerequisite:** BIO 12. Not offered every semester. 3 units.

115. Introduction to Neuroscience. An investigation of the structure and function of the central nervous system including neuroanatomy and neurophysiology, sensorimotor integration. The lectures and readings emphasize the empirical questions, techniques and methods used in neuroscience research. Laboratory exercises focus on gross- and micro- neuroanatomy, models of membrane electrophysiology and motor system function. Lecture/discussion three hours, laboratory three hours. This course is also cross-listed as PSYC 115; and may be counted only once for credit. **Prerequisites:** PSYC 1, 101; physiology and chemistry background strongly recommended. 4 units.

117. Field Botany and Vegetation Inventory. Survey of the terrestrial and aquatic vascular plant communities of central California. Emphasis will be on the development of an ability to sight identify the major components of regional spring flora. Lecture one hour, laboratory six hours. Fee course. **Prerequisites:** BIO 102, 112 or permission of instructor. Not offered every semester. 3 units.

118. Natural Resource Conservation. An introduction to the principles and practices of biological conservation. Historical development of conservation philosophy; current issues in conservation of renewable natural resources; conservation administration. Lecture three hours. **Prerequisites:** BIO 11, 12. Not offered every semester. 3 units.

120. Biology of Aging. The theories of aging, cellular aging and aging effects on the various human body systems. Lecture three hours. **Prerequisite:** BIO 10 or 20; BIO 20 preferred. Not offered every semester. 3 units.

121. Cell Physiology. A current description of eukaryotic cell function. Emphasis will be placed on the cytoskeleton (including muscle), membrane systems, membrane receptors, and transport phenomena. Laboratories will include group projects. Lecture two hours, laboratory three hours. Fee course. **Prerequisites:** BIO 11, 12, CHEM 161; CHEM 161 may be taken concurrently. 3 units.

122. Advanced Human Anatomy. The gross structure of the human body using a regional approach. Lecture three hours; laboratory three hours. Fee course. **Prerequisites:** BIO 22 or equivalent. 4 units.

123. Neuroanatomy. The gross and microscopic structures of the central, peripheral and autonomic nervous systems. The lectures are correlated with laboratory exercises and demonstrations using human prosected cadaver specimens, audio-visual slide projected materials, charts and models. Lecture two hours, laboratory three hours. Fee course. **Prerequisite:** BIO 22. Spring only. 3 units.

124. Clinical Hematology. Basic principles and current clinical laboratory procedures used in the study of blood; emphasis on morphological and chemical changes in the disease processes. Lecture two hours, laboratory three hours. Fee course. **Prerequisite:** CHEM 162 or equivalent; CHEM 162 may be taken concurrently. Not offered every semester. 3 units.

125. Body Fluid Analysis. The production of body fluids (e.g., urine, cerebrospinal, pleural, peritoneal, pericardial, and synovial fluids); their normal characteristics and pathological changes will be discussed. A description of the laboratory tests used in the clinical evaluation of body fluids will also be presented. **Prerequisite:** CHEM 161 or permission of instructor. Not offered every semester. 1 unit.

127. Vertebrate Embryology. Descriptive embryology of vertebrates. Developmental processes, organogenesis and introduction to experimental interpretation. Lecture two hours, laboratory six hours. Fee course. **Prerequisite:** BIO 11 or equivalent. Fall only. 4 units.

131. Systemic Physiology. Physiology of organ systems with emphasis on control and integration of system function. Experiments using selected vertebrate animal models are performed in the laboratory to illustrate functional characteristics of organ systems discussed in lecture and to provide direct experience with techniques, recording systems, and methods of data analysis commonly used in physiology and related fields. Lecture three hours, laboratory three hours. Fee course. **Prerequisites:** BIO 10, 20, or 22, and one year of college chemistry. 4 units.

133. Gross Anatomy. The course covers the gross anatomy of the human body using a regional approach. Special emphasis will be placed on musculoskeletal, nervous, and cardiopulmonary anatomy. Lectures are correlated with laboratory exercises and demonstrations using human cadaver specimens, skeletal material, x-rays, computers and audio-visual material. Clinically relevant case studies will also be presented. Lecture two hours, laboratory six hours. Open to Physical Therapy majors and others on a space available basis with permission of instructor. Fee course. Prerequisite: BIO 22 or equivalent. 4 units.

134. Medical Mycology. Study of the morphology, cultural characteristics and classification of fungi which are pathogenic for humans, as well as fungi which appear as common contaminants. Lecture two hours, laboratory three hours. Fee course. Prerequisite: BIO 139 or equivalent. Not offered every semester. 3 units.

135. Neuroanatomy and Neurophysiology. An integrated course which covers gross and microscopic anatomy and the fundamental principles of the physiology of the central and peripheral nervous systems. Lectures are correlated with laboratory exercises and demonstrations using human cadaver specimens, skeletal material, X-rays, MRI's, CAT scans, computer simulations, and audio-visual material. Clinically relevant case studies will also be presented. Open to Physical Therapy majors and others on a space available basis with permission of instructor. Lecture three hours, laboratory three hours. Fee course. Prerequisites: BIO 131 and 133 or 122, or the equivalent. Not offered every semester. 3 units.

139. General Microbiology. An introduction to microorganisms, particularly bacteria and viruses, their physiology and metabolism. Laboratory work includes aseptic techniques, methods of cultivating and identifying bacteria, and demonstration of microbial properties. Lecture three hours, laboratory three hours. Fee course. Prerequisites: BIO 10, 11, 12, and CHEM 20 or 6B. 4 units.

143. General Virology. Lectures and demonstrations on the fundamental characteristics and properties of plant, animal and bacterial viruses. Lecture three hours. Prerequisites: BIO 139, CHEM 161. Spring only. 3 units.

144. Pathogenic Bacteriology. The morphological, physiological and immunological characteristics of pathogenic bacteria. In the laboratory, pure culture studies are emphasized. Lecture two hours, laboratory six hours. Fee course. Prerequisites: BIO 139 or equivalent. 4 units.

145. The Diversity of Microorganisms. The isolation, cultivation and characterization of a wide variety of soil and water microbes from natural habitats using the elective enrichment technique; natural habitats also will be examined directly for the numbers and varieties of microbes which are present. Lecture two hours, laboratory three hours. Fee course. Prerequisite: BIO 139. Not offered every semester. 3 units.

149A. Immunology and Serology Lecture. The nature of antigens, antibodies and their reactions. The development of the immune response and its role in immunity and pathology. Lecture two hours. Prerequisite: BIO 139 or equivalent. 2 units.

149B. Immunology and Serology Laboratory. Laboratory exercises designed to provide familiarity with common clinical laboratory procedures in serology. Laboratory three hours. Fee course. Prerequisites: BIO 139 or equivalent; BIO 149A is not a prerequisite. Not offered every semester. 1 unit.

152. Human Parasitology. Examines in detail the most important species of protozoans, flukes, tapeworms and roundworms that infect humans. Life cycles, pathology and prophylaxis constitute the principal topics in lecture. Morphology, physiology, taxonomy and diagnosis constitute the principal topics in the laboratory. Lecture two hours, laboratory six hours. Fee course. Prerequisite: BIO 11 or permission of the instructor. Not offered every semester. 4 units.

155. Immunobiology. Lectures, discussions, and readings involving the biology of the immune response and its relation to other areas of biology. Lecture two hours. Prerequisite: BIO 149A or equivalent. Not offered every semester. 2 units.

156. Food Microbiology. The microbiology of food fermentations, food preservation and spoilage. Lecture two hours, laboratory three hours. Fee course. Prerequisite: BIO 139. Not offered every semester. 3 units.

157. General Entomology. The biology of insects and a brief consideration of other terrestrial arthropods. The course includes structure, physiology, ecology, classification, economic importance, collection and preservation of insects. Lecture three hours, laboratory three hours. Fee course. Prerequisite: BIO 11. Not offered every semester. 4 units.

160. General Ecology. A survey of the interrelationships between organisms and their environments designed for the major in Biological Sciences or related fields. Topics include the composition and function of terrestrial and aquatic ecosystems, population dynamics and human effects on ecosystems. Field trips required. Lecture two hours, laboratory three hours. Fee course. Prerequisites: BIO 11, 12. 3 units.

162. Ichthyology: The Study of Fishes. The biology of fishes: structure, physiology, ecology, economic importance, propagation and classification. Methods of identification, life history study, propagation, collection and preservation. Lecture two hours, laboratory three hours. Field trips may be required. Fee course. Prerequisite: BIO 11. Not offered every semester. 3 units.

164. Herpetology. Taxonomy, natural history, ecology and distribution of amphibians and reptiles with emphasis on local forms. Lecture two hours, laboratory three hours. Field trips may be required. Fee course. Prerequisites: BIO 11 and 165, or consent of instructor. Not offered every semester. 3 units.

165. Vertebrate Natural History. Introduction to the phylogeny, classification, reproductive and life history strategies, and adaptation of fishes, amphibians, reptiles, birds, and mammals. Laboratory emphasizes identification and distribution of California's vertebrate fauna. Lecture two hours, laboratory six hours. Field trips. Fee course. Prerequisite: BIO 11. Fall only. 4 units.

166. Ornithology. The biology of birds: structure, physiology, ecology, behavior, and classification. Methods of life history study, laboratory and field identification, collection and preservation. Lecture one hour, laboratory six hours. Field trips required. Fee course. Prerequisite: BIO 11. Spring only. 3 units.

167. Biometrics. Biometrics is designed to familiarize the student in biology with a representative sampling of statistical procedures that have general application throughout the life sciences. Statistics will be stressed as a means to an end, a way of obtaining insight into biological problems. An effort will be made to obtain data from a wide range of biological disciplines to be analyzed during the course. Lecture two hours, laboratory three hours. Fee course. Prerequisites: BIO 11, 12, STAT 1. Fall only. 3 units.

168. Mammalogy. Biology of mammals: structure, physiology, ecology, behavior, classification. Methods of life history, laboratory and field identification, collection and preservation. Lecture one hour, laboratory six hours. Field trips required. Fee course. **Prerequisite:** BIO 11 or instructor permission. Fall only. 3 units.

169. Ethology: the Behavior of Animals. An introduction to the biological basis and the functional mechanisms of animal behavior and to the functions of behavior in relation to the environment and social partners of the animal. Lecture two hours, laboratory three hours. Fee course. **Prerequisite:** BIO 11 or permission of instructor. Spring only. 3 units.

170. Advanced Nutrition and Metabolism. Study of the metabolic roles of macro- and micronutrients. Discussion of integrated metabolism with regard to organ system and nutrient interactions. Biochemical discussion of inborn errors of metabolism and effects upon nutrient metabolism and dietary requirements. Analysis of experimental designs and methods employed in nutritional science research. Cross-listed as HUES 170, only one of these courses may be counted for credit. Lecture, discussion. **Prerequisites:** CHEM 161, HUES 113; or permission of instructor. 3 units.

172. Aquatic Entomology. The study of those species of insects which at some stage of their life history live in or on water. The course includes identification to the generic level, when possible, the adaptations, and the role of the various species in a variety of aquatic habitats. Lecture two hours, laboratory three hours. Field trips. Fee course. **Prerequisite:** BIO 11 or equivalent. Not offered every semester. 3 units.

173. Principles of Fishery Biology. An introduction to the biological principles basic to fishery resource management, with reference to recruitment, growth, abundance, and mortality. Fundamental methods of assessing fish populations and their habitats are reviewed. Lecture two hours, laboratory three hours. Fee course. **Prerequisite:** BIO 160. Fall only. 3 units.

179. Principles of Wildlife Management. The principles for analyzing, controlling and manipulating wildlife populations and/or the ecological factors of their habitat. Lecture two hours, laboratory and fieldwork three hours. Fee course. **Prerequisites:** BIO 160, 166, 168, or permission of instructor. Spring only. 3 units.

180. Molecular Biology Lecture. The mechanisms and control of DNA replication, transcription, and translation. The initiation, elongation, termination, and processing of macromolecules. Lecture two hours. **Prerequisite:** BIO 184. Fall only. 2 units.

181. Molecular Biology Laboratory. An introduction to methods of isolating and characterizing DNA, RNA, and protein from biological systems. Laboratory six hours. Fee course. **Prerequisites:** BIO 139, 184; BIO 180 is recommended. Spring only. 2 units.

184. General Genetics. Principles of inheritance as they relate to microorganisms, plants, animals and humans. Genetic mechanisms are analyzed according to evidence derived from both classical and current research. The nature, structure and function of the genome are considered at the molecular level. Lecture two hours, laboratory three hours. Fee course. **Prerequisites:** BIO 11, 12, 139. 3 units.

185. Topics in Biology. Current topics in cellular, developmental and/or molecular biology. Topics will vary. Course may be taken more than once provided that topics are different. Lecture three hours. **Prerequisites:** BIO 10, 11, 12, CHEM 20; see instructor for other course prerequisites. Not offered every semester. 3 units.

193A-193F. Mini Courses in Biology. A series of courses in biology utilizing directed reading, self-study, audio-tutorial, and group conferences or other methods to study selected subjects in specialized areas in greater depth than normally available in traditional course offerings in biology. **Prerequisite:** an introductory course in the discipline or its equivalent. 1 unit.

193A. Circulation Special Organs.

193B. Physiology Acid-Base Balance.

193C. Kidney Function.

193D. Cardio-Respiratory Regulation.

193E. Body Temperature Regulation.

193F. Physiological Rhythms.

194. Biology-Related Work Experience. Supervised employment in a biology or biology-related company or agency arranged through the Department of Biological Sciences and the Cooperative Education Program office. Requires preparation of application packet, completion of a three to six month, full-time or part-time work assignment, and a written report. **Note:** open only to upper division or graduate students with appropriate course preparation. Consent of Department Cooperative Education Committee required, and Committee will determine the number of units to be granted. Students may enroll for no more than 12 total units, and units may not be used to meet biology major or graduate coursework requirements. Graded Credit/No Credit. 6-12 units.

195. Biological Internship. A supervised work-learn experience in biology with a public or private organization. Approval of Department Chair and a sponsoring professor representing the appropriate biological discipline is required. Up to 4 units may be taken. No more than 2 units from BIO 195, 197 and 199 combined can be applied to the biological sciences upper division major requirement. Graded Credit/No Credit. 1-2 units.

196. Experimental Offerings in Biological Sciences. Special topics and new courses in Biological Sciences. Not offered every semester. 1-3 units.

197A. Laboratory Techniques. Supervised laboratory experiences for advanced students in the organization and techniques in the operation of a basic science laboratory. Conferences and laboratory experiences four to eight hours weekly. Admission to this course requires approval of professor and Department Chair. Up to 4 units may be taken. No more than 2 units from BIO 195, 197 and 199 combined can be applied to the biological sciences upper division major requirement. 1-2 units.

197B. Laboratory Techniques. Supervised laboratory experiences for advanced students in the organization and techniques for operation of a basic science laboratory. Conferences and laboratory experiences four to eight hours weekly. Admission to course requires approval of professor and Department Chair. Up to 4 units allowed. No more than 2 units of BIO 195, 197 and 199 combined can be applied to the biological science upper division major requirement. Graded Credit/No Credit. 1-2 units.

198A. Honors Proseminar. Contemporary topics in biology selected by students in the course will form the basis for an introduction to scientific journals, the scientific method, and research as a professional pursuit. Culmination will consist of a refined research proposal and preparation of a seminar summarizing the proposal and the current state of knowledge in the topic area. **Prerequisite:** open only to honors students in Biological Sciences who have completed BIO 10, 11, and 12, with a grade of "B" or better, and six units of upper division biology. 1 unit.

198B. Honors Research and Seminar. Directed research involving completion of an independently conducted research project for which a proposal was developed in 198A. Data collection, summary and analysis, and formulation of conclusions based on the data will be discussed periodically with a faculty sponsor. Culmination will consist of preparation of an undergraduate thesis and presentation of a seminar summarizing results and conclusions. **Note:** open only to Honors students in Biological Sciences. Fee course. **Prerequisite:** BIO 198A. 3 units.

199A. Special Problems. Individual projects or directed reading for students competent to assume individual work. Admission to this course requires approval of professor and Department Chair. Up to 4 units may be taken. No more than 2 units from BIO 195, 197 and 199A combined can be applied to the biological sciences upper division major requirement. 1-2 units.

GRADUATE COURSES

The following graduate courses are open only to classified graduate students in the Department of Biological Sciences.

214. Advanced Plant Ecology. Fundamental properties of plant populations; population regulation; community productivity and structure; a study of ecotypic and ecocline variation in plant populations. Lecture one hour, laboratory and field six hours. **Prerequisite:** BIO 160. Not offered every semester. 3 units.

220. Research Methods in Biological Sciences. An introduction to a variety of investigative methods applicable to the full spectrum of biological systems—from molecules to populations. General models for the design, execution, interpretation, and presentation of experiments will be explored using local populations of animals or plants. Lecture two hours, laboratory three hours. Spring only. 3 units.

222. Molecular Biology. The processes and control of DNA replication, transcription, and translation developed from a consideration of the current literature. Lecture three hours. **Prerequisites:** BIO 184, CHEM 161. Fall only. 3 units.

247. Contemporary Topics in Immunology. Readings and discussions of current literature emphasizing new field developments and controversies. Lecture two hours. **Prerequisite:** BIO 149A or permission of instructor. Not offered every semester. 2 units.

260. Population and Community Ecology. Principles and applications of theoretical ecology as they apply to both single species populations and the community. Examples will be drawn from the literature of both plant and animal ecology. Lecture two hours, laboratory three hours. Field trips may be required. **Prerequisite:** BIO 160. Not offered every semester. 3 units.

269. Behavioral Ecology. Advanced study of ethological adaptations to natural environments from the point of view of function and evolution. Inquiry is made into strategies of social organization, spacing systems, sexual behavior, reproductive ecology, feeding ecology, competitive interactions, and predator-prey interactions that result in optimizing efficiency of resource utilization. Lecture three hours. **Prerequisite:** BIO 160 or permission of instructor. Spring only, even years. 3 units.

270. Conservation Policy and Administration. A study of local, state, national and international policies and regulations affecting methods used and factors involved in the administration of conservation agencies. Lecture and/or discussion two hours. **Prerequisite:** BIO 118, 173, or 179, or equivalent. Fall only, even years; 2 units.

273. Advanced Fishery Biology and Management. A critical review and evaluation of current techniques and concepts relating to the management, protection, and improvement of fishery resources. Lecture three hours. **Prerequisite:** BIO 173 or permission of instructor. Spring only, odd years; 3 units.

279. Conservation Biology. Critical review of applications of ecological theory in conservation biology research. Exploration and development of innovative strategies for anticipation, prevention, minimization, and repair of ecological damage and biodiversity diminishment. Lecture/discussion three hours. **Prerequisites:** BIO 160 or equivalent, and at least one upper division course in plant or animal biology. Fall only. 3 units.

282. Evolution. The process of evolution throughout the taxonomic hierarchy and factors responsible for the generation of variability of the gene, cell, organism and population levels are explored through lectures, text readings and a survey of current periodical literature. Lecture 3 hours. Fall only. 3 units.

283. Biogeography. Study of the past and present plant and animal distributions, and the geologic, climatic and ecologic factors involved in their migration, establishment and extinction. Lecture/discussions three hours. Not offered every semester. 3 units.

292. Biological Concepts. A historical approach to the development of major concepts of the biological sciences. Examples of concepts may include molecular evolution, cell concept, gene concept, species concept, and ecosystem concept. Literature, seminars, and term paper will be used to develop concepts from ancient times to the present. Fall only. 3 units.

294. Seminar. Specific topics under each heading will vary. 1 unit per seminar.

294A. Seminar in Botany.

294F. Seminar in Zoology.

294G. Seminar in Cell Biology.

296. Experimental Offerings in Biological Sciences. Special topics and new courses in Biological Sciences. Not offered each semester. 1-3 units.

299. Problems in Biological Sciences. Library research, short-term original research, technique development, or thesis research site selection and preliminary field observations. Culminating experience will be in the format of a scientific paper, annotated bibliography, demonstration of technique mastery, or oral presentation. Enrollment requires classified graduate status and approval of the project by a faculty supervisor and the department chair. Graded Credit/No Credit. 1-4 units.

500. Master's Thesis. Credit given upon successful completion of a thesis approved for the master's degree. Only open to the graduate student who has been advanced to candidacy for the master's degree and who secures the permission of the chair of the supervisory committee. Should be taken in final semester prior to the completion of all requirements for the degree. Graded Credit/No Credit. 2 units.