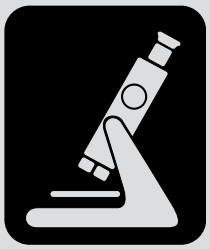

Biological Sciences

College of Natural Sciences and Mathematics

Bachelor of Arts • Bachelor of Science • Honors Program
Subject Matter Program (Pre-Credential Preparation)
Minor • Certificate • Master of Science

PROGRAM DESCRIPTION

The Department of Biological Sciences offers both undergraduate and graduate degree programs.

At the undergraduate level, students are able to earn a Bachelor of Arts degree, a Bachelor of Science degree, or a Minor in Biological Sciences. Within the Bachelor of Science degree program students may focus their work by selecting one or more of the following concentrations: Biological Conservation, Clinical Laboratory Science, Forensic Biology, Microbiology or Molecular Biology; or students may choose to obtain the Bachelor of Science with no concentration.

At the Graduate level, students may earn a Master of Science degree in Biological Sciences and may also focus their work by pursuing a concentration in Biological Conservation or in Molecular and Cellular Biology within the Master of Science in Biological Sciences.

Career Possibilities

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

Faculty

William Avery, Ruth Ballard, Juanita Barrena, James Baxter, Rosalee Carter, Ronald Coleman, Shannon Datwyler, Nicholas Ewing, Sarah Greenleaf, Laurel Heffernan, Brett Holland, Christine Kirvan, Jamie Kneitel, Winston Lancaster, Tom Landerholm, Susanne Lindgren, Melanie Loo, Jennifer Lundmark, Robert Metcalf, Hao Nguyen, Thomas Peavy, Adam Rechs, Mary Ann Reihman, Ben Sacks, Chris Sullivan, Nathan Trueblood, Rose Leigh Vines

Contact Information

Nicholas N. Ewing, Department Chair
Nancy Angell, Administrative Support Coordinator
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(916) 278-6535
www.csus.edu/bios

Special Features

- Opportunities for paid biology-related work experiences are available through participation in the Cooperative Education Program.
- The Biological Sciences Honors Program provides undergraduates with an in-depth research experience.
- An Academic Achievement Certificate in *Issues in Natural Resource Management* may be earned with course work beyond the B.S.
- There are 18 laboratories specially designed to serve the various courses.
- 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 1,900 mammal specimens and 2,500 bird specimens; a greenhouse containing a teaching collection of over 4,000 plants; an herbarium with an extensive collection of plants from western North America; and an arboretum.
- Students have the opportunity to engage in research in a wide range of projects with individual faculty and through two University-recognized centers, each of which is composed of a cross-disciplinary interdepartmental group of faculty: CREST (the Center for Regional Environmental Science and Technology) and CIMERA (the Center for Interdisciplinary Molecular Biology Education, Research and Advancement).
- The Sierra Nevada and the Pacific Coast are equally accessible from Sacramento, providing field biology students the opportunity to study an extraordinary number of varied habitats.
- Sacramento State is one of the seven participating CSU campuses at Moss Landing Marine Laboratories (MLML) near Monterey.
- Located in the State Capital, Sacramento State provides a unique opportunity for students to become involved with various State and Federal agencies through biological internships and part-time employment.
- Public agencies, hospitals, clinics, and private health practices in the Sacramento area provide 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.

UNDERGRADUATE PROGRAMS

Requirements • Bachelor of Arts Degree

Units required for Major: 64-65
Minimum total units required for the BA: 120

Courses in parentheses are prerequisites.

A. Required Lower Division Core Courses (37-38 units)

(5)	BIO 1	Biodiversity, Evolution and Ecology (Corequisite: CHEM 1A suggested)
(5)	BIO 2	Cells, Molecules and Genes (BIO 1, CHEM 1A)
(5)	CHEM 1A	General Chemistry I (High school algebra [two years] and high school chemistry; or equivalent)
(5)	CHEM 1B	General Chemistry II (CHEM 1A with a passing grade of "C" or better)
(3)	CHEM 20	Organic Chemistry Lecture – Brief Course (CHEM 1B)
(4)	PHYS 5A	General Physics: Mechanics, Heat, Sound (Recently completed three years of high school algebra and geometry; and a college course in algebra and trigonometry (MATH 9 recommended) for those having an inadequate mathematics background)
(4)	PHYS 5B	General Physics: Light, Electricity and Magnetism, Modern Physics (PHYS 5A or instructor permission)
(3)	STAT 1	Introduction to Statistics (MATH 9 or three years of high school mathematics which includes two years of algebra and one year of geometry; completion of ELM requirement and the Intermediate Algebra Diagnostic Test)

(3-4) Select one of the following:

	MATH 26A	Calculus I for the Social and Life Sciences (MATH 11 or three years of high school mathematics which includes two years of algebra and one year of geometry; completion of ELM requirement and the Intermediate Algebra Diagnostic Test)
	MATH 30	Calculus I (MATH 29 or four years of high school mathematics which includes two years of algebra, one year of geometry, and one year of mathematical analysis; completion of ELM requirement and Pre-Calculus Diagnostic Test)

Notes:

- Prehealth professional students should take the Chemistry and Math requirements as stated in the Prehealth Professional Program section of this catalog.
- CHEM 24 and CHEM 124 may be taken in lieu of CHEM 20. (CHEM 124 is not counted toward the 24 upper division unit requirement in the major.)

B. Required Upper Division Core Courses (16 units)

(3)	BIO 121	Cell Physiology (BIO 10, BIO 11, BIO 12, or both BIO 1 and BIO 2; CHEM 161)
(4)	BIO 139	General Microbiology (BIO 10 or BIO 20 or both BIO 1 and BIO 2; CHEM 6B, CHEM 20 or CHEM 24)
(3)	BIO 160	General Ecology (BIO 10, BIO 11 and BIO 12 or both BIO 1 and BIO 2; STAT 1)
(3)	BIO 184	General Genetics (BIO 10, BIO 11 and BIO 12 or both BIO 1 and BIO 2; BIO 139)
(3)	CHEM 161	General Biochemistry (CHEM 20 or CHEM 124; one year of biological science is recommended)

Notes:

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

Notes:

- No more than 2 units from BIO 195, BIO 197A, BIO 197B, BIO 197C, BIO 199A, and BIO 199B combined can be applied to the Biological Sciences upper division major requirement.
- BIO 106 is not acceptable toward a BA in Biological Sciences.
- With approval, up to six units of upper division course work from related fields may be applied as electives in the major.

Requirements • Bachelor of Science Degree

Units required for Major: 76-84, includes units of study in chosen concentration (see below).

Minimum total units required for the BS: 120-125

Courses in parentheses are prerequisites.

Note: Additional units may be required to meet the Sacramento State foreign language requirement.

A. Required Lower Division Core Courses (37-38 units)

(5)	BIO 1	Biodiversity, Evolution and Ecology (Corequisite: CHEM 1A suggested)
(5)	BIO 2	Cells, Molecules and Genes (BIO 1, CHEM 1A)
(5)	CHEM 1A	General Chemistry I (High school algebra [two years] and high school chemistry; or equivalent)
(5)	CHEM 1B	General Chemistry II (CHEM 1A with a passing grade of "C" or better)
(3)	CHEM 20	Organic Chemistry Lecture - Brief Course (CHEM 1B)
(4)	PHYS 5A	General Physics: Mechanics, Heat, Sound (Recently completed three years of high school algebra and geometry; and a college course in algebra and trigonometry (MATH 9 recommended) for those having an inadequate mathematics background)
(4)	PHYS 5B	General Physics: Light, Electricity and Magnetism, Modern Physics (PHYS 5A or instructor permission)
(3)	STAT 1	Introduction to Statistics (MATH 9 or three years of high school mathematics which includes two years of algebra and one year of geometry; completion of ELM requirement and the Intermediate Algebra Diagnostic Test)

(3-4) Select one of the following:

MATH 26A	Calculus I for the Social and Life Sciences (MATH 11 or three years of high school mathematics which includes two years of algebra and one year of geometry; completion of ELM requirement and the Intermediate Algebra Diagnostic Test)
MATH 30	Calculus I (MATH 29 or four years of high school mathematics which includes two years of algebra, one year of geometry, and one year of mathematical analysis; completion of ELM requirement and Pre-Calculus Diagnostic Test)

Notes:

- Prehealth professional students should take the Chemistry and Math requirements as stated in the Prehealth Professional Program section of this catalog.
- CHEM 24 and CHEM 124 may be taken in lieu of CHEM 20. (CHEM 124 is not counted toward the 36 upper division unit requirement in the major.)

B. Required Upper Division Core Courses (16 units)

(3)	BIO 121	Cell Physiology (BIO 10, BIO 11, BIO 12, or both BIO 1 and BIO 2; CHEM 161)
(4)	BIO 139	General Microbiology (BIO 10 or BIO 20 or both BIO 1 and BIO 2; CHEM 6B, CHEM 20 or CHEM 24)
(3)	BIO 160	General Ecology (BIO 10, BIO 11 and BIO 12 or both BIO 1 and BIO 2; STAT 1). Not required in the Clinical Laboratory Technology concentration.
(3)	BIO 184	General Genetics (BIO 10, BIO 11 and BIO 12 or both BIO 1 and BIO 2; BIO 139)
(3)	CHEM 161	General Biochemistry (CHEM 20 or CHEM 124; one year of biological science recommended)

Notes:

- CHEM 161 is not counted toward the 36 upper division unit requirement in the major.
- CHEM 160A and CHEM 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 and BIO 108 are not acceptable toward a BS in Biological Sciences.

Additional Requirements for Concentrations

Units required: 23-30

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 interests. 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, (with additional course work in Math and Chemistry), 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 "BA Major Requirements: C. Upper Division Electives."

Biological Conservation (23 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).

(4)	BIO 112	Plant Taxonomy (BIO 12 or both BIO 1 and BIO 2)
(3)	BIO 118	Natural Resource Conservation (BIO 11 and BIO 12 or both BIO 1 and BIO 2)
(3)	BIO 167	Quantitative Methods in Biology (BIO 11, BIO 12, STAT 1)
(3)	BIO 173	Principles of Fisheries Biology (STAT 1, BIO 160)
(3)	BIO 179	Principles of Wildlife Management (BIO 160, BIO 166, BIO 168, or instructor permission)
(7)	Select seven units from the following:	
	BIO 117	Field Botany and Vegetation Inventory (BIO 102, BIO 112 or instructor permission)
	BIO 157	General Entomology (BIO 11 or both BIO 1 and BIO 2) **OR**
	BIO 172	Aquatic Entomology (BIO 11 or both BIO 1 and BIO 2)
	BIO 162	Ichthyology: The Study of Fish (BIO 11 or both BIO 1 and BIO 2)
	BIO 164	Herpetology (BIO 11 or both BIO 1 and BIO 2; BIO 165)
	BIO 165	Vertebrate Natural History (BIO 11 or both BIO 1 and BIO 2)
	BIO 166	Ornithology (BIO 11 or both BIO 1 and BIO 2)
	BIO 168	Mammalogy (BIO 11 or both BIO 1 and BIO 2)
	BIO 169	Animal Behavior (BIO 11 or both BIO 1 and BIO 2)
	BIO 186B	Ecological and Environmental Issues Seminar (BIO 10, BIO 11 and BIO 12 or both BIO 1 and BIO 2. Cross-listed with ENVS 186B.)

Clinical Laboratory Science (30 units)

The curriculum in Clinical Laboratory Science meets the undergraduate course work requirements of the State of California for eligibility to take the Clinical Laboratory Scientist (CLS) Licensure Examination. Eligibility to take the licensure examination also requires a one year (CLS) internship training program at a state approved hospital laboratory. Completion of BS degree requirements in the Clinical Laboratory Science concentration does not guarantee admission to a CLS internship training program. Information on admission criteria and application procedures for the various CLS internship training programs throughout the state is available through the California Association for Medical

Laboratory Technology (CAMLT) at their website, *www.camlt.org/cls/*.

(3) BIO 124 Clinical Hematology (CHEM 161 and BIO 10 or BIO 20 or both BIO 1 and BIO 2)
(4) BIO 144 Pathogenic Bacteriology (BIO 139)
(3) BIO 149A Immunology Lecture (BIO 139, CHEM 161; Corequisite: BIO 121)
(1) BIO 149B Immunology and Serology Laboratory (BIO 139, BIO 149A)
(4) BIO 152 Human Parasitology (BIO 11 or both BIO 1 and BIO 2)
(4) CHEM 31 Quantitative Analysis (CHEM 1B)
(3) CHEM 162 General Biochemistry Laboratory (CHEM 31; CHEM 160A or CHEM 161 either may be taken concurrently; ENGL 20 or an equivalent second semester composition course)
(8) Eight additional upper division units selected in consultation with an advisor. Recommended electives are:
BIO 125 Body Fluid Analysis (CHEM 161 or instructor permission)
BIO 131 Systemic Physiology (BIO 1, BIO 2, BIO 10, BIO 20, or BIO 22 and one year of college chemistry)
BIO 131A Advanced Problems in Physiology (BIO 131 must be taken concurrently)
BIO 134 Medical Mycology (BIO 139)
BIO 143 General Virology (BIO 139, CHEM 161)

Notes:

- BIO 160 is not required in the Clinical Laboratory Science concentration.
- 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 CHEM 25 is taken.

Forensic Biology (30 units)

The curriculum in Forensic Biology is designed to prepare students for careers as criminalists specializing in the analysis and interpretation of serological and DNA evidence. This curriculum meets the educational requirements for entry level career positions with city, county, and federal agencies. Students selecting this concentration are urged to pursue internship opportunities (BIO 195), such as those available through the Sacramento County Coroner's Office, and/or directed research (BIO 199A or BIO 199B) with a faculty member in Biological Sciences or Chemistry who utilizes molecular biology techniques and instrumentation.

(3) BIO 150 Forensic Biology (BIO 1, BIO 2, CHEM 20)
(2) BIO 180 Molecular Biology Lecture (BIO 184)
(2) BIO 181 Molecular Biology Laboratory (BIO 139, BIO 184; BIO 180 is recommended)
(4) CHEM 31 Quantitative Analysis (CHEM 1B)
(3) CHEM 162 General Biochemistry Laboratory (CHEM 31; CHEM 160A or CHEM 161 either may be taken concurrently; ENGL 20 or an equivalent second semester composition course)
(3) CRJ 4 General Investigative Techniques
(3) CRJ 146 Introduction to Physical Evidence (CRJ 4)
(3) CRJ 175 The Structure and Function of the American Courts (CRJ 1, CRJ 2; restricted to declared majors and minors or instructor permission)
(7) Upper division electives in Biological Sciences from approved list or with approval of advisor. Approved list: (BIO 122, BIO 124, BIO 125, BIO 130 (strongly recommended), BIO 131, BIO 149A, BIO 149B, BIO 186A, BIO 195, BIO 199A or BIO 199B.

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

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 course work 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.

(3) BIO 149A Immunology Lecture (BIO 139, CHEM 161; Corequisite: BIO 121)
(1) BIO 149B Immunology and Serology Laboratory (BIO 139, BIO 149A)
(1) CHEM 20L Introductory Organic Chemistry Laboratory (CHEM 20 may be taken concurrently)
(4) CHEM 31 Quantitative Analysis (CHEM 1B)
(3) CHEM 162 General Biochemistry Laboratory (CHEM 31; CHEM 160A or CHEM 161 either may be taken concurrently; ENGL 20 or an equivalent second semester composition course)

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

(16) 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.
BIO 134* Medical Mycology (BIO 139)
BIO 143 General Virology (BIO 139, CHEM 161)
BIO 144* Pathogenic Bacteriology (BIO 139)
BIO 145 The Diversity of Micro-organisms (BIO 139)
BIO 152* Human Parasitology (BIO 11 or both BIO 1 and BIO 2)
BIO 155 Immunobiology (BIO 149A)
BIO 156 Food Microbiology (BIO 139)
BIO 180 Molecular Biology Lecture (BIO 184)
BIO 181 Molecular Biology Laboratory (BIO 139, BIO 184; BIO 180 recommended)
BIO 185 Topics in Biology (BIO 10, BIO 11 and BIO 12 or both BIO 1 and BIO 2; CHEM 20)

	BIO 186A	Cell and Molecular Biology Seminar (BIO 10, BIO 11 and BIO 12 or both BIO 1 and BIO 2)
	BIO 195	Biological Internship (Department chair and instructor – representing the appropriate biological discipline – permission)
	BIO 199A	Undergraduate Laboratory Field Research (Department Chair and instructor permission)
	HLSC 148*	Epidemiology (BIO 10, CHEM 1A, STAT 1 or instructor permission)

* Required to qualify for Public Health Microbiology Traineeship.

Molecular Biology (27 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.

(3)	BIO 143	General Virology (BIO 139, CHEM 161)
(3)	BIO 149A	Immunology Lecture (BIO 139, CHEM 161; Corequisite: BIO 121)
(2)	BIO 180	Molecular Biology Lecture (BIO 184)
(2)	BIO 181	Molecular Biology Laboratory (BIO 139, BIO 184; BIO 180 recommended)
(4)	CHEM 31	Quantitative Analysis (CHEM 1B)
(3)	CHEM 162	General Biochemistry Laboratory (CHEM 31; CHEM 160A or CHEM 161 either may be taken concurrently; ENGL 20 or an equivalent second semester composition course)

(10) Upper division electives in Biological Sciences or Chemistry. Select electives in consultation with an advisor.

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

Cooperative Education Program (Work Experience)

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 Sacramento State 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.

Requirements • Honors Program

(with either BA or BS Degree Program)

Biological Sciences Honors Program provides 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 biology courses with at least 15 units of biology and have completed at least 6 units of upper division biology courses, excluding BIO 106, BIO 195, BIO 197A, BIO 197B, BIO 197C, BIO 199A, and BIO 199B.

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

(2)	BIO 198A	Honors Proseminar and Research (Open only to honors students in Biological Sciences as defined above)
(2)	BIO 198B	Honors Research and Seminar (BIO 198A)

Requirements • Minor

Units required for Minor: 20 units

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 course work in biological sciences, including Chemistry, Nursing, Environmental Studies, Health Science, Kinesiology, and Family and Consumer Sciences.

The minor requires 20 units. The 20 units must include a minimum of 10 upper division units at least one of the upper division courses must have a laboratory component. Three units of biochemistry may be counted toward the minor. Six upper division units must be earned in residence. No more than two units of BIO 186A, BIO 186B, BIO 194, BIO 195, BIO 197A, BIO 197B, BIO 197C, BIO 199A, and BIO 199B may be counted toward the minor.

Note: All prerequisites for all courses will be enforced.

Requirements • 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 College of Education. The Single Subject Credential in General Science/Biology allows graduates to teach all four of the sciences (Geoscience, Biology, Chemistry, and Physics) at the General Science level in 7-12 grades, and Biology 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 Biological Sciences have created significant demands for students with this credential. Biological Sciences majors who have an interest in teaching should contact one of the credential advisors in the Biological Sciences Department, Melanie Loo or Jennifer Lundmark.

Note: Due to policy changes from the California Commission on Teacher Credentialing and the federal No Child Left Behind mandate, the Science Subject Matter program was under review at the time of this catalog printing and is subject to revision. As a result, it is important to consult a credential advisor for current details.

Requirements • Certificate – Issues in Natural Resource Management

Units required for Certificate: 15, in addition to requirements for BS (see below)

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.

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 and Environmental Degradation
(3)	ECON 123	Resource Economics (ECON 1B)
(3)	ENVS 110	Contemporary Environmental Issues
(3)	ENVS 112	International Environmental Problems (Passing score on WPE)
(3)	ENVS 128/ GOVT 128	Environment and the Law (ENVS 110, ENVS 111 or instructor permission)
(3)	GEOG 161	California's Water Resources
(3)	GEOL 140	Geology and the Environment
(3)	GOVT 170	Public Policy Development (GOVT 1 or equivalent, passing score on WPE)

GRADUATE PROGRAM

The graduate program in Biological Sciences leads to a Master of Science (MS) 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 degree requires completion of a thesis and has concentrations in Biological Conservation and in Molecular and Cellular Biology to provide advanced training and research experience in these fields.

All students are required to complete a thesis involving field and/or laboratory research. The thesis research may be conducted on campus with a biology faculty member or at an off-campus location. In either case, the student's research must make a new contribution to the field of biology. If the research is conducted off campus, a biology faculty member must be identified as the student's thesis advisor. Following admission to the program, students are advised by a temporary faculty advisor or by the faculty member who has agreed to supervise the student in their thesis research. Students should plan their academic 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.

For additional information regarding the Biological Sciences Graduate Program, students may contact the Biological Sciences Department Office or consult the Biological Sciences Graduate Program Handbook, available online at the department's website.

Graduate Admission Requirements

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

- a baccalaureate degree;
- completion of a major in biological sciences or closely related field; or completion of 24 units of upper division biological sciences courses or courses in closely related fields, each of which must be passed with a "C-" or better;
- GRE General Test scores;
- GRE Subject Test scores (either Biology or Biochemistry, Cell and Molecular Biology scores are acceptable);
- a faculty member who has agreed to serve as their thesis advisor;
- two letters of recommendation from persons qualified to judge the applicant's potential for successful graduate study; and
- a statement of purpose.

It is important to note that meeting all admission requirements does not guarantee acceptance into the graduate program. Students who have deficiencies in admission requirements that can be removed by specified additional preparation, or who have not been accepted by a major professor, may be admitted with conditionally classified graduate status. Admission as a conditionally classified graduate student does not guarantee fully classified status. Fully classified graduate status is conferred when all deficiencies identified at the time of admission are removed and a biology faculty member has agreed to serve as their thesis advisor. Any deficiencies in admissions requirements will be noted on a written response to the admission application.

Graduate Admission Procedures

All prospective classified graduate students, including Sacramento State graduates, must file the following application materials with the Office of Graduate Studies, River Front Center 206, (916) 278-6470:

- an online application for admission; and
- two sets of official transcripts from all colleges and universities attended, other than Sacramento State.

In addition, all prospective graduate students must submit the following application materials directly to the Department of Biological Sciences:

- an online departmental application for admission;
- one set of unofficial transcripts from all colleges and universities attended, *other than Sacramento State*;
- GRE General Test scores;
- GRE Subject Test scores (either Biology or Biochemistry, Cell and Molecular Biology scores are acceptable);
- two letters of recommendation;
- a statement of purpose.

Deadlines for receipt of all application materials are March 15 for admittance in the fall semester and October 1 for admittance in the spring semester. Approximately eight 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;
- completed at least 12 units in the graduate program with a minimum 3.0 GPA, including at least one course at the 200-level;
- begun a preliminary study for the thesis; and
- passed the Writing Proficiency Examination (WPE) or secured approval for a WPE waiver.

Advancement to Candidacy forms are available in the Office of Graduate Studies. 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 Office of Graduate Studies for approval.

Requirements • Master of Science Degree

Units required for MS: 30 includes units required in areas of concentration.

Minimum GPA: 3.0

The MS degree requires completion of 30 units of course work with a minimum 3.0 GPA. The 30 units must include a minimum of 18 units of 200-level courses. No units from BIO 106, BIO 194, BIO 195, BIO 197A, BIO 197B, BIO 197C, BIO 198A, BIO 198B, BIO 199A or BIO 199B are acceptable toward the master's degree. No more than 6 units of BIO 299 and BIO 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.

All requirements for the Master's degree must be completed within seven years immediately prior to graduation.

A. Required Core Courses (4 units)

(2) BIO 220 Introduction to Scientific Inquiry
(1) BIO 294 Seminar
series course

B. Culminating Requirement (2 units)

(2) BIO 500 Master's Thesis (Advancement to candidacy)

Additional Requirements for Concentrations

Units required: 24

No Concentration (24 units)

(3) BIO 282 Evolution
(3) BIO 292 Biological Concepts
(18) Approved electives in Biological Sciences or supporting fields (see below)

Biological Conservation (24 unit minimum)

(3) BIO 282 Evolution
(3) BIO 292 Biological Concepts
(3) Select one of the following:
BIO 214 Advanced Plant Ecology (BIO 160)
BIO 260 Population and Community Ecology (BIO 160)
BIO 269 Behavioral Ecology (BIO 160 or instructor permission)
(5-6) Select two of the following:
BIO 270 Conservation Policy and Administration (BIO 118, BIO 173, or BIO 179)
BIO 273 Advanced Fishery Biology and Management (BIO 173 or instructor permission)
BIO 279 Conservation Biology and Wildlife Management (BIO 160, BIO 179; or instructor permission)
(9-10) Approved electives in Biological Sciences or supporting fields (see below)

Molecular and Cellular Biology (24 unit minimum)

(3) BIO 222 Molecular Biology (BIO 184, CHEM 161)
(3) BIO 224 Genomics, Proteomics and Bioinformatics (BIO 184, BIO 222 and graduate status or instructor permission)
(5-6) Select at least two of the following:
BIO 223 Human Molecular Genetics (BIO 139, BIO 184, CHEM 161)
BIO 245 Host Pathogen Interactions (BIO 121, BIO 139, BIO 184)
BIO 247 Contemporary Topics in Immunology (BIO 149A or instructor permission)
(12-13) Approved electives from the following list or as approved by advisor
BIO 104 Physiology of Human Reproduction (BIO 1, BIO 2, BIO 10, BIO 20)
BIO 127 Vertebrate Embryology (BIO 11, or both BIO 1 and BIO 2)
BIO 132 Neurophysiology (BIO 131, or both BIO 25 and BIO 26)
BIO 143 General Virology (BIO 139, CHEM 161)
BIO 144 Pathogenic Bacteriology (BIO 139)
BIO 149A Immunology Lecture (BIO 139, CHEM 161. Corequisite: BIO 121)
BIO 155 Immunobiology (BIO 149A)
BIO 181 Molecular Biology Laboratory (BIO 139, BIO 184; BIO 180 recommended)
BIO 185 Topics in Biology (BIO 10, BIO 11 and BIO 12 or both BIO 1 and BIO 2; CHEM 20)

BIO 186A	Cell and Molecular Biology Seminar (BIO 10, BIO 11 and BIO 12 or both BIO 1 and BIO 2)
BIO 282	Evolution
BIO 292	Biological Concepts
BIO 293	Research Conference (Graduate status and instructor permission)
BIO 297A/B	Teaching Biology Seminar/Laboratory Teaching (Acceptance in the GTA program or instructor permission)
BIO 299	Problems in Biological Sciences
CHEM 162	General Biochemistry Laboratory (CHEM 31; CHEM 160A or CHEM 161 either may be taken concurrently; ENGL 20 or an equivalent second semester composition course)
CHEM 164	Advanced Biochemistry Laboratory (CHEM 162 or equivalent; ENGL 20 or an equivalent second semester composition course)
CHEM 245	Computational Chemistry (CHEM 140A and CHEM 140B or CHEM 142 or instructor permission)
CHEM 260	Protein Biochemistry (One semester of biochemistry)

Note: 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).

Lower Division Courses

BIO 1. Biodiversity, Evolution and Ecology. Introduction to properties of life and cells leading to genetic and biological diversity. Survey of biological diversity emphasizing variation leading to natural selection; introduction to ecological concepts within an evolutionary framework; a survey of ecosystems and global climate change; Development of scientific skills will be emphasized. Designed for science majors; Lecture three hours; laboratory three hours; activity two hours. **Note:** Field trips may be required. **Corequisite:** CHEM 1A suggested. **Units:** 5.0.

BIO 2. Cells, Molecules and Genes. Introduction to molecular and cellular biology and genetics. Topics include biomolecules, cell structure and function, cellular energetics, molecular flow of information, cell division, and genetic inheritance. Development of scientific skills and a scientific mindset will be emphasized throughout the course, particularly in lab exercises and activities. Designed for science majors. Lecture three hours; laboratory three hours; activity two hours. **Prerequisite:** BIO 1, CHEM 1A. **Units:** 5.0.

BIO 5. General Biology. Introduction to basic principles of biology, with emphasis at the organismal level. Survey of plant and animal kingdoms, 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 BIO 12. Fee course. **Units:** 4.0.

BIO 7. Introduction to the Science of Biology. Introduction to major concepts of biology, including properties of living things, cells and their molecular constituents, the unity and diversity of organisms, genetics, ecology, evolution, and the scientific methods of investigation employed by biologists. Satisfies requirements in biology for students planning to obtain the Multiple Subject Teaching Credential. Lecture three hours; laboratory three hours. Fee course. **Units:** 4.0.

BIO 10. Basic Biological Concepts. 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. **Units:** 3.0.

BIO 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. **Units:** 4.0.

BIO 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. **Units:** 4.0.

BIO 20. Biology: A Human Perspective. 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. **Units:** 3.0.

BIO 22. Introductory Human Anatomy. 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 1, BIO 2, BIO 10, or BIO 20. **Units:** 4.0.

BIO 25. Human Anatomy and Physiology I. BIO 25/26 series provides an introduction to the structure and function of the major organ systems of the human body. BIO 25 offers basic terminology and concepts pertaining to the disciplines of anatomy and physiology, including structure/function relationships, homeostasis, and organizational levels; and provides an introduction to the structure and function of the muscular and nervous systems. **Note:** Not open to students who have successfully completed BIO 22 and BIO 131, or an equivalent combination of separate anatomy and physiology courses. Lecture three hours; laboratory three hours. Fee course. **Units:** 4.0.

BIO 26. Human Anatomy and Physiology II. BIO 25/26 series provides an introduction to the structure and function of the major organ systems of the human body. BIO 26 provides an introduction to the structure and function of the cardiovascular, respiratory, renal and digestive systems, and emphasizes homeostatic control mechanisms. **Note:** Not open to students who have successfully completed BIO 22 and BIO 131, or an equivalent combination of separate anatomy and physiology courses. Lecture three hours; laboratory three hours. Fee course. **Prerequisite:** BIO 25 or instructor permission. **Units:** 4.0.

BIO 96. Experimental Offerings in Biological Sciences. Special topics and new courses in Biological Sciences. Not offered every semester. **Units:** 1.0-3.0.

Upper Division Courses

BIO 102. The Natural History of Plants. 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. 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 instructor permission. **Units:** 3.0.

BIO 103. Plants and Civilization. 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. **Units:** 3.0.

BIO 104. Physiology of Human Reproduction. 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 1, BIO 2, BIO 10, or BIO 20. **Units:** 3.0.

BIO 106. Genetics: From Mendel to Molecules. Introduction to 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. **Units:** 3.0.

BIO 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. Laboratory three hours. Fee course. **Prerequisite:** BIO 5, PHYS 7, CHEM 106; CHEM 106 may be taken concurrently. **Units:** 1.0.

BIO 111. Land Plants: Evolution, Life and Times. A study of the evolution of land plants including transition to the land environment and the first land plants. Emphasis will be placed on three stages of plant diversification: initial, gymnosperm, and angiosperm. Lecture three hours. **Prerequisite:** BIO 12 or both BIO 1 and BIO 2. **Units:** 3.0.

BIO 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 or both BIO 1 and BIO 2. **Units:** 4.0.

BIO 113. Evolution and Speciation in Flowering Plants. A survey of the important tools and mechanisms used to study speciation in plants. Topics include the molecular basis of evolutionary change, intraspecific genetic variation at both the local and landscape levels, theory regarding mechanisms of speciation, and the importance of polyploidy. Readings will be from both a text and from the primary literature, and will include in-depth discussions of historical and modern studies in plant evolution. Lecture three hours. **Prerequisite:** BIO 1 and BIO 2 or equivalent and instructor permission. **Units:** 3.0.

BIO 115. Introduction to Neuroscience. 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. **Prerequisite:** PSYC 1, PSYC 101; physiology and chemistry background strongly recommended. **Cross-listed:** PSYC 115; only one may be counted for credit. **Units:** 4.0.

BIO 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. **Prerequisite:** BIO 102, or BIO 112, or instructor permission. **Units:** 3.0.

BIO 118. Natural Resource Conservation. 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. **Prerequisite:** BIO 11 and BIO 12 or both BIO 1 and BIO 2. **Units:** 3.0.

BIO 120. Biology of Aging. Theories of aging, cellular aging and aging effects on the various human body systems. Lecture three hours. **Note:** Not open for credit to students who have previously taken BIO 131. **Prerequisite:** BIO 1, BIO 2, BIO 10 or BIO 20. **Units:** 3.0.

BIO 121. Cell Physiology. 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. **Prerequisite:** BIO 10, BIO 11, and BIO 12, or both BIO 1 and BIO 2; CHEM 161. **Units:** 3.0.

BIO 122. Advanced Human Anatomy. Gross structure of the human body using a regional approach. Lecture three hours; laboratory three hours. Fee course. **Prerequisite:** BIO 22. **Units:** 4.0.

BIO 123. Neuroanatomy. 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. **Units:** 3.0.

BIO 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 161 and BIO 10 or BIO 20, or both BIO 1 and BIO 2. **Units:** 3.0.

BIO 125. Body Fluid Analysis. 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 instructor permission. **Units:** 1.0.

BIO 126. Comparative Vertebrate Morphology. Study of the anatomical systems of vertebrates in an evolutionary and functional context. Covers vertebrate form, function, development and phylogeny, overviews of organ systems, and how their modification founded the major events of vertebrate evolution including metamorphosis, water-to-land transition, tetrapodal locomotion, feeding and reproduction. Labs complement lectures with dissections of three representative species (shark, salamander, cat), and surveys of specializations in other forms. Lecture two hours; laboratory three hours. Fee course. **Prerequisite:** BIO 11 or both BIO 1 and BIO 2. **Units:** 3.0.

BIO 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 both BIO 1 and BIO 2. **Units:** 4.0.

BIO 130. Histology. Study of the morphology and physiology of cells in primary normal human tissues and the arrangement and adaptations of tissues in organs and organ systems. The characteristics and properties of abnormalities in human tissues will be covered if time permits. Lecture two hours; laboratory three hours. **Prerequisite:** BIO 10 and BIO 11 or both BIO 1 and BIO 2. **Units:** 3.0.

BIO 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. **Prerequisite:** One year of College Chemistry and BIO 1, BIO 2, BIO 10, BIO 20 or BIO 22. **Units:** 4.0.

BIO 131A. Advanced Problems in Physiology. Advanced problem-solving in physiology designed for students concurrently enrolled in BIO 131. Students explore solutions to challenging problem sets under the direct supervision of an experienced section leader. Discussion: two hours. **Corequisite:** BIO 131 **Graded:** Credit / No Credit. **Units:** 1.0.

BIO 132. Neurophysiology. Organization and function of the nervous system will be explored. Topics include mechanisms of communication between neurons, integration of sensory and motor systems, and functional brain systems. Diseased states will be introduced, as appropriate. Lecture 3 hours. **Prerequisite:** BIO 131 or both BIO 25 and BIO 26. **Units:** 3.0.

BIO 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. **Units:** 3.0.

BIO 139. General Microbiology. 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. **Prerequisite:** BIO 10 or BIO 20 or both BIO 1 and BIO 2; CHEM 6B, CHEM 20 or CHEM 24. **Units:** 4.0.

BIO 143. General Virology. Lectures and demonstrations on the fundamental characteristics and properties of plant, animal and bacterial viruses. Lecture three hours. **Prerequisite:** BIO 139, CHEM 161. **Units:** 3.0.

BIO 144. Pathogenic Bacteriology. Morphological, physiological and immunological characteristics of pathogenic bacteria. In the laboratory, pure culture studies are emphasized. Lecture two hours; laboratory six hours. Fee course. **Prerequisite:** BIO 139. **Units:** 4.0.

BIO 145. The Diversity of Micro-organisms. 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. **Units:** 3.0.

BIO 149A. Immunology Lecture. 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, CHEM 161. **Corequisite:** BIO 121. **Units:** 3.0.

BIO 149B. Immunology and Serology Laboratory. Laboratory exercises designed to provide familiarity with common clinical laboratory procedures in serology. Laboratory three hours. Fee course. **Prerequisite:** BIO 139, BIO 149A. **Units:** 1.0.

BIO 150. Forensic Biology. Principles governing the application of biology and biological statistics to solve crimes. Topics include evidence examination and preservation, presumptive and confirmatory serological tests, hair comparison, generation and statistical analysis of mitochondrial and nuclear DNA profiles, structure and administration of the modern crime laboratory, and the role of the criminalist in the U.S. court system. Lecture two hours; laboratory three hours. **Prerequisite:** BIO 1, BIO 2, CHEM 20. Not offered every semester. **Units:** 3.0.

BIO 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 both BIO 1 and BIO 2. **Units:** 4.0.

BIO 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. **Units:** 2.0.

BIO 156. Food Microbiology. Microbiology of food fermentations, food preservation and spoilage. Lecture two hours; laboratory three hours. Fee course. **Prerequisite:** BIO 139. **Units:** 3.0.

BIO 157. General Entomology. Biology of insects and a brief consideration of other terrestrial arthropods. Includes structure, physiology, ecology, classification, economic importance, collection and preservation of insects. Lecture three hours; laboratory three hours. Fee course. **Prerequisite:** BIO 11 or both BIO 1 and BIO 2. **Units:** 4.0.

BIO 160. General Ecology. Examination of the interrelationships among organisms and their environments. Designed for the major in Biological Sciences or related fields. Topics include the structure and function of terrestrial and aquatic ecosystems, population and community dynamics and human effects on ecosystems. Projects and field trips required. Lecture two hours; laboratory three hours. Fee course. **Prerequisite:** BIO 10, BIO 11, and BIO 12 or both BIO 1 and BIO 2; STAT 1. **Units:** 3.0.

BIO 162. Ichthyology: The Study of Fish. 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 or both BIO 1 and BIO 2. **Units:** 3.0.

BIO 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. **Prerequisite:** BIO 11 or both BIO 1 and BIO 2; BIO 165. **Units:** 3.0.

BIO 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 or both BIO 1 and BIO 2. **Units:** 4.0.

BIO 166. Ornithology. 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 or both BIO 1 and BIO 2. **Units:** 3.0.

BIO 167. Quantitative Methods in Biology. Focuses on statistical hypothesis testing and experimental design in the biological sciences. Topics include the development of a hypothesis, study design and implementation, management and presentation of data, identification of data types, and appropriate use of statistical procedures. General application to a wide range of biological disciplines and will emphasize the scientific process, critical thinking skills, and the interpretation of statistical results, which will include a project culminating a scientific paper and presentation. Lecture two hours; laboratory three hours. **Prerequisite:** BIO 11, BIO 12, STAT 1. **Units:** 3.0.

BIO 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 both BIO 1 and BIO 2. **Units:** 3.0.

BIO 169. Animal Behavior. Introduction to the fascinating world of why animals do the things that they do. Focus is on the evolution and function of animal behavior through understanding the costs and benefits of different behavior including foraging, fighting and reproduction. Lecture two hours; laboratory three hours. Fee course. **Prerequisite:** BIO 11 or both BIO 1 and BIO 2. **Units:** 3.0.

BIO 170. Advanced Nutrition and Metabolism. Study of the physiologic function of carbohydrates, lipids, protein and micronutrients including integrated metabolism, transport, regulation and relation to inborn errors/chronic disease. Introduction to gene-nutrient interaction. **Prerequisite:** CHEM 161, FACS 113; or instructor permission. **Cross-listed:** FACS 170; only one may be counted for credit. **Units:** 3.0.

BIO 172. Aquatic Entomology. Study of those species of insects which at some stage of their life history live in or on water including 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 both BIO 1 and BIO 2. **Units:** 3.0.

BIO 173. Principles of Fisheries Biology. Introduction to the biological principles basic to fisheries science, including enumeration, recruitment, growth, abundance and mortality. Mathematics, computer modeling, and field methods will be used to understand natural populations and the impact of fishing on those populations in keeping with modern approaches to fisheries science which are grounded in population ecology and conservation biology. Lecture two hours; laboratory three hours. Fee course. **Prerequisite:** STAT 1, BIO 160. **Units:** 3.0.

BIO 175. Aquatic Pollution Assessment. Examines both the negative and positive impacts that anthropogenic activities have on groundwater, streams and lakes. Introduces the interrelationships among plants, animals, and environmental factors with in polluted aquatic ecosystems. Emphasizes laboratory and field procedures used in strategies take to assess and manage these impacts. Concentrates on the application of field sampling techniques and laboratory analysis currently used to assess the pollution impacts on biotic and abiotic components of groundwater, streams and lakes. **Prerequisite:** BIO 160, CHEM 1A or concurrent enrollment, or instructor permission. **Cross-listed:** ENVS 175; only one may be counted for credit. **Units:** 3.0.

BIO 179. Principles of Wildlife Management. 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. **Prerequisite:** BIO 160, BIO 166, BIO 168, or instructor permission. **Units:** 3.0.

BIO 180. Molecular Biology Lecture. Mechanisms and control of DNA replication, transcription, and translation. The initiation, elongation, termination, and processing of macromolecules. Lecture two hours. **Prerequisite:** BIO 184. **Units:** 2.0.

BIO 181. Molecular Biology Laboratory. Introduction to methods of isolating and characterizing DNA, RNA, and protein from biological systems. Laboratory six hours. Fee course. **Prerequisite:** BIO 139, BIO 184; BIO 180 is recommended. **Units:** 2.0.

BIO 183. Cancer Biology. Study of cancer from the molecular level to the effect on whole tissues and organs. Topics to be covered include the classification and nomenclature of cancers, the process leading up to the formation of a cancer, the possible causes of cancer, and possible treatment. Lecture two hours. **Prerequisite:** BIO 10, BIO 11, BIO 12, and CHEM 6B or CHEM 20. **Units:** 2.0.

BIO 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. **Prerequisite:** BIO 10, BIO 11 and BIO 12 or both BIO 1 and BIO 2; BIO 139. **Units:** 3.0.

BIO 185. Topics in Biology. Current topics in cellular, developmental and/or molecular biology. Topics will vary. May be taken more than once provided that topics are different. Lecture three hours. **Prerequisite:** BIO 10, BIO 11 and BIO 12 or both BIO 1 and BIO 2; CHEM 20. **Units:** 3.0.

BIO 186A. Cell and Molecular Biology Seminar. Series of at least 10 seminars in cell and molecular biology. Topics within each seminar will vary each semester. **Note:** May be repeated for credit. No more than one unit of BIO 186 may be counted toward the upper division major requirement. **Prerequisite:** BIO 10, BIO 11 and BIO 12 or both BIO 1 and BIO 2. **Graded:** Credit / No Credit. **Units:** 1.0.

BIO 186B. Ecological and Environmental Issues Seminar. Series of at least 10 seminars in ecological and environmental issues. Topics within each seminar will vary each semester. **Note:** May be repeated for credit. No more than one unit of BIO 186 may be counted toward the upper division major requirement. **Prerequisite:** BIO 10, BIO 11, and BIO 12 or both BIO 1 and BIO 2. **Cross-listed:** ENVS 186B; only one may be counted for credit. **Graded:** Credit / No Credit. **Units:** 1.0.

BIO 188. Evolution. General survey of evolutionary processes: mechanisms of evolutionary change, adaptation and history of life. Designed for biological sciences majors. Lecture two hours; discussion one hour. **Prerequisite:** BIO 184 or instructor permission. **Units:** 3.0.

BIO 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 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 course work requirements. **Graded:** Credit / No Credit. **Units:** 6.0-12.0.

BIO 195. Biological Internship. Supervised work-learn experience in biology with a public or private organization. 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. **Prerequisite:** Department chair and instructor (representing the appropriate biological discipline) permission. **Graded:** Credit / No Credit. **Units:** 1.0-2.0.

BIO 196. Experimental Offerings in Biological Sciences. Special topics and new courses in Biological Sciences. Not offered every semester. **Units:** 1.0-3.0.

BIO 197A. Laboratory Teaching Assistant. Supervised experiences will include aspects of laboratory preparation and aspects of teaching biology laboratory courses. Conferences and laboratory experiences four to eight hours weekly. Admission requires approval of professor and Department Chair. **Note:** May be taken more than once, but no more than 2 units from BIO 195, BIO 197 and BIO 199 combined can be applied to the Biological Sciences upper division major requirement. **Prerequisite:** Department Chair and instructor permission. **Units:** 1.0-2.0.

BIO 197B. Laboratory Techniques. Supervised laboratory experiences for advanced students in the organization and techniques for operation of a basic sciences laboratory. Conferences and laboratory experiences four to eight hours weekly. Admission requires approval of professor and Department Chair. **Note:** May be taken more than once, but no more than 2 units from BIO 195, BIO 197 and BIO 199 combined can be applied to the Biological Sciences upper division major requirement. **Prerequisite:** Department Chair and instructor permission. **Graded:** Credit / No Credit. **Units:** 1.0-2.0.

BIO 197C. Co-curricular Activities in Biology. Students may earn BIO 197C credit by participating as tutors and/or section or discussion leaders for Sacramento State Biological Sciences classes or teaching as voluntary instructors or tutors in K-12 courses or programs offered by other community organizations. Participation requires four to eight hours weekly. Admission requires approval of professor and Department Chair. **Note:** May be taken more than once, but no more than 2 units from BIO 195, BIO 197 and BIO 199 combined can be applied to the Biological Sciences upper division major requirement. **Graded:** Credit / No Credit. **Units:** 1.0-2.0.

BIO 198A. Honors Proseminar and Research. 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. Each student develops a refined research proposal and prepares a seminar summarizing the proposal and the current state of knowledge in the topic area. Students will develop and refine their methodology under the direction of a faculty sponsor. **Prerequisite:** Open only to honors students in Biological Sciences who have an overall GPA of 3.25 and a minimum of 3.0 GPA in biology courses (at least six units of upper division biology excluding BIO 106, 108, 194, 195, 197 and 199). **Units:** 2.0.

BIO 198B. Honors Research and Seminar. Directed research involving completion of an independently conducted research project for which a proposal and methodology was developed in BIO 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, poster and presentation of a seminar summarizing results and conclusions. **Note:** Open only to honors students in Biological Sciences. Fee course. **Prerequisite:** BIO 198A. **Units:** 2.0.

BIO 199A. Undergraduate Laboratory /Field Research. Student will conduct independent laboratory or field research on an original research question in biology. The research must culminate in a formal report. Weekly meetings may be required. Admission requires submission of a prospectus approved by the faculty member under whom the work is to be conducted and the Department Chair. **Note:** May be taken more than once, but no more than 2 units from BIO 195, BIO 197 and BIO 199 combined can be applied to the Biological Sciences upper division major requirement. **Prerequisite:** Department Chair and instructor permission. **Graded:** Graded (CR/NC Available). **Units:** 1.0-2.0.

BIO 199B. Directed Readings. Directed Readings on a topic in Biology culminating in a research paper. Admission requires submission of a prospectus approved by the faculty member under whom the work is to be conducted and the Department Chair. **Note:** May be taken more than once, but no more than 2 units from BIO 195, BIO 197 and BIO 199 combined can be applied to the Biological Sciences upper division major requirement. **Prerequisite:** Department Chair and instructor permission. **Units:** 1.0-2.0.

Graduate Courses

BIO 214. Advanced Plant Ecology. Fundamental properties of plant populations; population regulation; community productivity and structure; a study of ecotypic and ecoclinal variation in plant populations. Lecture one hour; laboratory and field six hours. **Prerequisite:** BIO 160. **Units:** 3.0.

BIO 220. Introduction to Scientific Inquiry. Introduction to scientific inquiry in the biological sciences. Students learn to apply the scientific method, critically evaluate the scientific literature, initiate their graduate project, and develop written and oral scientific presentation skills. Lecture two hours. **Units:** 2.0.

BIO 221A. Cell and Molecular Methods and Techniques. Introduction to research methods in molecular and cellular biology. Students learn both cell and molecular techniques in the context of hypothesis-driven research to answer questions relating to a specific gene and cellular system. Experimental design and commonly used laboratory techniques will be explored. Laboratory three hours. Fee course. **Prerequisite:** BIO 220 (may be taken concurrently). **Units:** 2.0.

BIO 221B. Methods in Ecology, Evolution and Conservation. Introduction to research methods in ecology, evolution and conservation biology. Students learn field and laboratory techniques with a variety to tax in a range of local ecosystems. Students will work with several faculty conducting research projects. Topics will include developing hypotheses, experimental design, study implementation, and statistical analyses. Students will be expected to present findings in oral and written form. Laboratory three hours. Fee course. **Prerequisite:** BIO 167, BIO 220 (may be taken concurrently). **Units:** 2.0.

BIO 222. Molecular Biology. Processes and control of DNA replication, transcription, and translation developed from a consideration of the current literature. Lecture three hours. **Prerequisite:** BIO 184, CHEM 161. **Units:** 3.0.

BIO 223. Human Molecular Genetics. In-depth study of the molecular basis of human disease, emphasizing current experimental approaches and technologies. Topics include the isolation and analysis of disease genes, the influence of teratogans and random environmental events on human embryonic development, the molecular and biochemical consequences of mutagenesis, and ethical issues that currently surround the field. Lecture 3 hours. **Prerequisite:** BIO 139, BIO 184, CHEM 161. **Units:** 3.0.

BIO 224. Genomics, Proteomics, and Bioinformatics. Examination of current approaches in structural genomics, functional genomics and proteomics, and the bioinformatics tools utilized to understand genome organization, the regulation of gene expression, gene function and the evolutionary relationships within and between genomes. Lecture two hours; laboratory 3 hours. **Prerequisite:** BIO 184, BIO 222 and graduate status or instructor permission. **Units:** 3.0.

BIO 233. Review of Human Gross Anatomy. Review of the gross anatomy of selected regions of the human body. Emphasis will be placed on musculoskeletal, neurovascular and joint anatomy of the back, thoracic wall, thoracic cavity, abdominal wall, upper limb and lower limb. Lecture one hour; laboratory three hours. **Note:** Course designed for students who are enrolled in the MS in Physical Therapy program. **Prerequisite:** BIO 22 and BIO 122 or a course in gross anatomy using a regional approach. **Units:** 2.0.

BIO 245. Host/Pathogen Interactions. Critical reading and discussion of current literature on host/pathogen interactions. Topics to be covered include: alteration of host intracellular trafficking, subversion of cell cytoskeleton for invasion, intracellular survival mechanisms, pathogen-induced cell killing, and evasion and subversion of the host immune system. **Prerequisite:** BIO 121, BIO 139, BIO 184. Courses recommended but not required: BIO 144, BIO 149, BIO 180. **Units:** 3.0.

BIO 247. Contemporary Topics in Immunology. Readings and discussions of current literature emphasizing new field developments and controversies. Lecture two hours. **Prerequisite:** BIO 149A or instructor permission. **Units:** 2.0.

BIO 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. **Units:** 3.0.

BIO 269. Behavioral Ecology. Advanced study of animal behavior focusing on the life history consequences of social organization, spacing systems, sexual behavior, reproductive ecology, feeding ecology, competitive interactions and predator-prey interactions. **Prerequisite:** BIO 160 or instructor permission. **Units:** 3.0.

BIO 270. Conservation Policy and Administration. 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, BIO 173, or BIO 179. **Units:** 2.0.

BIO 273. Advanced Fishery Biology and Management. 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 instructor permission. **Units:** 3.0.

BIO 279. Conservation Biology and Wildlife Management. Critical review of applications of ecological and wildlife-orientated theory in conservation biology research. Exploration of key topics and issues in conservation of organisms, with emphasis on vertebrate animals and plants. Lecture/discussion three hours. **Prerequisite:** BIO 160, BIO 179; or instructor permission. **Units:** 3.0.

BIO 282. Evolution. 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. **Units:** 3.0.

BIO 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. **Units:** 3.0.

BIO 292. Biological Concepts. 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. **Units:** 3.0.

BIO 293. Research Conference. Presentation and discussion of graduate student and faculty research and current literature with emphasis on critical evaluation of research design, data analysis and presentation techniques. **Note:** Discussion two hours. May be taken twice for credit. Only two units may be applied to the University's requirement for 200-level courses. **Prerequisite:** Graduate status and instructor permission. **Units:** 2.0.

BIO 294. Seminar. Specific topics under each heading will vary. **Units:** 1.0.

BIO 294A. Seminar in Botany.

BIO 294F. Seminar in Zoology.

BIO 294G. Seminar in Cell Biology.

BIO 296. Experimental Offerings in Biological Sciences. Special topics and new courses in Biological Sciences. Not offered every semester. **Units:** 1.0-3.0.

BIO 297A. Teaching Biology Seminar. Training for graduate students who wish to participate in the Department's Graduate Teaching Associate (GTA) Program and others interested in teaching biology. Weekly seminar session covering aspects of teaching biology laboratories. Lecture/discussion. Not applicable toward 18 unit 200-level course work requirement. **Prerequisite:** Acceptance in the GTA Program or instructor permission. **Graded:** Credit / No Credit. **Units:** 1.0.

BIO 297B. Laboratory Teaching. Training for graduate students admitted to the Graduate Teaching Associate (GTA) Program. Students assist in teaching three hours of biology laboratory weekly under the supervision of a laboratory instructor. Laboratory three hours. Not applicable toward 18 unit 200-level course work requirement. **Prerequisite:** Acceptance in the GTA Program or instructor permission. **Graded:** Credit / No Credit. **Units:** 1.0.

BIO 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. **Units:** 1.0-4.0.

BIO 500. Master's Thesis. Completion of a thesis approved for the Master's degree. Should be taken in final semester prior to the completion of all requirements for the degree. **Prerequisite:** Advanced to candidacy and chair permission of his/her thesis committee. **Graded:** Thesis in Progress. **Units:** 2.0.