BIOLOGICAL SCIENCES

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Lecturers: Anna Ballew, Shyamala D. Malladi, Timothy J. Meier, David Muir, Katherine Preston, James Watanabe, Melanie Yelton

Courtesy Professors: Joseph Berry, Wolf Frommer, Arthur R. Grossman, Richard G. Klein, W. James Nelson, Terry Root, Shauna Somerville, Irving Weissman

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* Recalled to active duty.

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Courses given in Biological Sciences have the subject code BIOSCI. For a complete list of subject codes, see Appendix.

The facilities and personnel of the Department of Biological Sciences are housed in the Gilbert Building, Herrin Laboratories, Herrin Hall, the Jasper Ridge Biological Preserve, the Clark Center and the Lokey Chemistry/Biology Building on the main campus, and at the Hopkins Marine Station in Pacific Grove on Monterey Bay.

The department provides: (1) courses designed for the non-major; (2) a major program leading to the B.S. degree; (3) a minor program; (4) a coterminal program leading to the M.S. degree; (5) a terminal program leading to the M.S. degree; and (6) a program leading to the Ph.D. degree.

Course and laboratory instruction in the Department of Biological Sciences conforms to the "Policy on the Use of Vertebrate Animals in Teaching Activities," the text of which is available at http://www. stanford.edu/dept/DoR/rph/8-2.html.

The Jasper Ridge Biological Preserve is a 1,200 acre natural area containing an unusual diversity of plant communities. It is managed solely for teaching and research purposes and is available to investigators from various institutions. Stanford-based research at Jasper Ridge currently concentrates on physiological, ecological, and population studies. More information is available at http://jasper1.stanford.edu.

Special laboratory facilities for marine research are described in the pamphlet *Hopkins Marine Station*, available at the department's student services office (Gilbert 108) or on the Hopkins Marine Station web site at http://www-marine.stanford.edu. Courses taught at Hopkins Marine Station with the subject code BIOHOPK are listed directly after BIOSCI courses in this section.

The department's large collections of plants (Dudley Herbarium), fishes, reptiles, and amphibians, as well as smaller collections of birds, mammals, and invertebrates, are housed at the California Academy of Sciences in San Francisco, where they, and extensive collections of the academy, are available to those interested in the systematics of these groups. Entomological collections, restricted to those being used in particular research projects, are housed in the Herrin Laboratories. No general collections are maintained except for teaching purposes.

The Falconer Biology Library in Herrin Hall, http://library. stanford.edu/depts/falconer/, contains over 1,200 current subscriptions and an extensive collection of monographs and reference works. A specialized library is maintained at the Hopkins Marine Station.

UNDERGRADUATE PROGRAMS

BACHELOR OF SCIENCE

ADVISING

Most members of the Biological Sciences faculty are available for advising on such academic matters as choice of courses and career plans. The student services office maintains a current list of faculty advisers, advising schedules, and research interests.

The student services office is prepared to answer questions on administrative matters, such as requirements for the major, approved out-of-department electives, transfer course evaluations, and petition procedures. This office also distributes the department's *Bachelor of Science Handbook*, which delineates policies and requirements, as well as other department forms and information handouts.

Each undergraduate interested in the Biological Sciences major is required to select a department adviser as part of the major declaration process. Students who plan to attend medical or graduate school, enroll in the honors or coterminal programs, take courses at Hopkins Marine Station, or attend one of the overseas campuses will find their faculty adviser particularly helpful.

REQUIREMENTS

Candidates for the B.S. degree must complete:

Core Courses and Electives—

Courses	*Units*
BIOSCI 41*	5
BIOSCI 42*	5
BIOSCI or BIOHOPK 43*	5
BIOSCI 44X	4
BIOSCI or BIOHOPK 44Y (may be replaced by 4 units of 175H or 176H)	4
BIOSCI 54 (in combination with 55, substitutes for BIOSCI 44X,Y)	3
BIOSCI 55	6
Total	23-24
Electives	24

* Letter grade only.

Required Cognate Courses—Students may take up to two cognate courses credit/no credit (CR/NC).

1. Introductory, organic, and physical chemistry with lab: CHEM 31X (or 31A,B), 33, 35, 36, 130, 131, 135 (or 171). For those interested in ecology and evolutionary biology, an advanced Mathematics course of 100-level or above may be substituted for 130.
2. General Physics: PHYSICS 21, 22, 23, 24; or 41, 43, 45; or 28, 29.
3. Math through calculus: MATH 19, 20, 21; or 41, 42.
4. One additional cognate course in Mathematics, Statistics, or Computer Science: MATH 51 or beyond; BIOSCI 141*; BIOHOPK 174H*; PSYCH 10; STATS 60 or beyond; or CS 106A or X.

* If taken to fulfill the additional cognate requirement, these courses do not count toward the 24 elective unit requirement.

Electives—Electives must be 100-level or above and selected from the offerings in the Department of Biological Sciences or from the list of approved out-of-department electives. This list may be obtained from the student services office. Stanford Introductory Seminars may not be used to fulfill this requirement.

The program for the junior and senior year should include a total of 24 elective units beyond the core. The courses making up these units should include at least one course from at least three of the following four central menu areas. The rest of the 24 units can include more courses from this central menu, courses available in diverse areas directly after the core, or

advanced courses for which menu courses are prerequisites. A complete central menu course listing including inactive and alternate year courses is available in the student services office. Active central menu courses are:

1. *Molecular*
   BIOSCI 104. Advanced Molecular Biology
   BIOSCI 113. Fundamentals of Molecular Evolution**
   BIOSCI 118. Genetic Analysis of Biological Processes*
   BIOSCI 133. Genetics of Prokaryotes*
   BIOSCI 134. Replication of DNA*
   BIOSCI 162. Advanced Microbial Genetics and Genomics*
   BIOSCI 188. Biochemistry I
   BIOSCI 189. Biochemistry II
   BIOSCI 230. Molecular and Cellular Immunology*
   BIOSCI 274A. Environmental Microbiology I
   CBIO 101. Cancer Biology*
2. *Cell/Developmental*
   BIOSCI 118. Genetic Analysis of Biological Processes*
   BIOSCI 129A. Cellular Dynamics I: Cell Motility and Adhesion
   BIOSCI 129B. Cellular Dynamics II: Building a Cell
   BIOSCI 133. Genetics of Prokaryotes*
   BIOSCI 134. Replication of DNA*
   BIOSCI 154. Molecular and Cellular Neurobiology†
   BIOSCI 158. Developmental Neurobiology†
   BIOSCI 160. Developmental Biology
   BIOSCI 162. Advanced Microbial Genetics and Genomics*
   BIOHOPK 183H. Environmental Cell & Developmental Biology
   BIOSCI 230. Molecular and Cellular Immunology*
   BIOSCI 274A. Environmental Microbiology I
   CBIO 101. Cancer Biology*
3. *Organismal*
   BIOSCI 110. Vertebrate Biology
   BIOSCI 112. Human Physiology
   BIOSCI 120. General Botany
   BIOSCI 124. Plant Physiological Ecology††
   BIOSCI 138. Ecology and Evolution of Plants††
   BIOSCI 153/PSYCH 120. Cellular Neuroscience
   BIOSCI 154. Molecular and Cellular Neurobiology†
   BIOSCI 158. Developmental Neurobiology†
   BIOSCI 163. Neural Systems and Behavior
   BIOHOPK 161H. Invertebrate Zoology
   BIOHOPK 162H. Comparative Animal Physiology
   BIOHOPK 167H. Nerve, Muscle, and Synapse
   BIOHOPK 169H. Neurobiology and Behavior
   BIOHOPK 171H. Ecological and Evolutionary Physiology
   BIOSCI 213. Biology of Viruses
   MI 185. Topics in Microbiology
4. *Ecology and Evolution*
   BIOSCI 101. Ecology
   BIOSCI 113. Fundamentals of Molecular Evolution**
   BIOSCI 121. Biogeography
   BIOSCI 124. Plant Physiological Ecology††
   BIOSCI 127/220. Ecology of Microorganisms
   BIOSCI 136. Evolutionary Paleobiology
   BIOSCI 138. Ecology and Evolution of Plants††
   BIOSCI 142. Topics in Theoretical Ecology
   BIOSCI 143/243. Evolution
   BIOSCI 144. Conservation Biology
   BIOSCI 145. Behavioral Ecology
   BIOHOPK 163H. Oceanic Biology
   BIOHOPK 172H/272H. Marine Ecology
   BIOSCI 184. Principles and Practice of Biosystematics
   BIOSCI 274A. Environmental Microbiology I

* May be used to satisfy either area I or area II requirement.
† May be used to satisfy either area II or area III requirement.
** May be used to satisfy either area I or area IV requirement.
†† May be used to satisfy either area III or area IV requirement.

No more than 6 units from any combination of individual instruction courses (BIOHOPK 175H, 176H; BIOSCI 198, 198X, 199, 199X, 290, 291, 300, or 300X) may be applied toward the total number of elective units. No more than 6 units applied toward the elective unit requirement may be taken CR/NC; this policy does not apply to transfer credit.

Students intending to pursue research careers in biology, especially in ecology, population genetics, or theoretical biology, should be aware that MATH 19, 20, 21, or MATH 41, 42 are minimum mathematics requirements for the B.S. degree in Biological Sciences. Substantial additional training in mathematics, including differential equations, linear algebra, and probability theory, is often highly advisable. Students should consult the Biological Sciences faculty to discuss individual needs.

Additionally, even though only two or three quarters of physics are required, students should be aware that many graduate and professional schools (for example, Medicine and Education) require a year of general physics with a lab. Biological Sciences majors are therefore advised to take the year-long physics sequence PHYSICS 21, 22, 23, 24, 25, 26 if they plan to attend graduate or medical school.

For students considering residence at Hopkins Marine Station during the junior or senior year, or an overseas program, the department recommends fulfilling as many University General Education Requirements as possible in the first two years at Stanford.

TYPICAL SCHEDULE FOR A FOUR-YEAR MINIMUM PROGRAM

FIRST YEAR

Course No. and Subject	*Qtr. and Units*		
	A	*W*	*S*
CHEM 31X*, 33, 35, 36	4	4	7
MATH 19, 20, 21. Calculus and Analytic Geometry	3	3	4
Freshman requirements or electives	8	8	6
Totals	15	15	17

* This schedule varies slightly if student takes CHEM 31A,B.

SECOND YEAR

BIOSCI 41. Principles of Biology*	5		
BIOSCI 42. Principles of Biology*		5	
BIOSCI or BIOHOPK 43. Principles of Biology*			5
BIOSCI 44X. Core Experimental Laboratory		4	
BIOSCI or BIOHOPK 44Y. Core Experimental Laboratory			4
CHEM 130, 131, 135 (or 171). Organic and Physical Chemistry	8	3	
General Education Requirements or electives	3	5	8
Totals	16	17	17

* Letter grade only.

THIRD YEAR

PHYSICS 21, 22, 23, 24. Introductory Physics	4	4	
General Education Requirements or electives	11	11	11
Totals	15	15	11

FOURTH YEAR

Electives	15	15	15

SPECIALIZATION TRACKS

In addition to the undergraduate major program described above, the Department of Biological Sciences offers these five specialized tracks for students wishing to concentrate their studies in particular areas of biology:

1. Biochemistry and Biophysics
2. Marine Biology
3. Molecular and Cellular Biology
4. Neurobiology
5. Ecology and Evolution

Candidates for the B.S. degree in Biological Sciences with an area of specialization are expected to complete:

1. A specific set of cognate courses.
2. A specific set of courses in the chosen area of specialization.
3. The equivalent of the requirements for graduation with honors in Biological Sciences.

For further information on the specialized track programs, including detailed descriptions of their requirements and deadlines, see http://www.stanford.edu/dept/biology/programs.html.

TRANSFER STUDENTS

Because of differences between Stanford undergraduate courses and prerequisites and those of many other institutions, transfer students may face problems not encountered by entering freshmen. Transfer students are strongly urged to visit the student services office in Gilbert 108 during transfer orientation to obtain information on course credit evaluations. Course catalogs, syllabi, and/or lecture notes from the former institution are necessary in the evaluation and accreditation process. Transfer students are encouraged to find a faculty adviser soon after arrival.

All transfer courses intended to fulfill department requirements must be evaluated on Evaluation of Course Content forms (available in the student services office), which are kept in the student's file. This department procedure is in addition to the process of having units earned at other institutions transferred for Stanford credit that appear on the Stanford transcript.

The department authorizes transfer credit only for courses whose content parallels the Stanford courses and that have comparable prerequisites (not merely a comparable course title). To substitute a course taken elsewhere for an upper-division Stanford course, course content must be approved by a department faculty member teaching in the area of the course. Submit as complete a course description as practical (including prerequisites and their descriptions) using the Evaluation of Course Content form available in the student services office before taking an off-campus course. Students must provide exams, reading lists, term papers, and other materials for the evaluation. Credit is not allowed for projects for which the student was paid, nor is credit allowed for work of a purely technical or clinical nature. Credit for natural history, culture biology, and similar courses is rarely appropriate and can be obtained only by meeting the same criteria outlined above. Academic performance is verified upon receipt of the official transcript. Please note that semester units are not converted to quarter units; units awarded for transfer credit are determined by faculty evaluation.

MINORS

Students interested in the minor in Biological Sciences must declare the minor and submit their course plan online via Axess no later than two quarters prior to the student's intended quarter of degree conferral. The Biological Sciences minor requires a minimum of six courses meeting the following criteria:

1. All courses must be taken for a letter grade.
2. All courses must be worth 3 or more units.
3. All courses, other than the Biological Sciences Core (41, 42, or 43), must be at or above the 100-level. Stanford Introductory Seminars may not be used to fulfill this requirement.
4. Courses used to fulfill the minor may not be used to fulfill any other department degree requirements (minor or major).
5. At least one course from the Biological Sciences Core must be taken.
6. The Biological Sciences Core Laboratory (44X and 44Y) does not count towards the minor degree.
7. All courses must be Department of Biological Sciences' elective courses or recognized out-of-department elective courses. See the out-of-department electives list available in the student services office.
8. Elective credit for research (BIOSCI 199/199X) is limited to a maximum of 3 units.

HONORS PROGRAM

To graduate with departmental honors, a student must:

1. Submit an honors petition proposal to the department's undergraduate research coordinator by the fifth Friday of the quarter, two quarters prior to graduation. For instance, students graduating Spring Quarter must submit petitions no later than mid-Autumn Quarter.
2. Complete at least 10 units of an approved (BIOSCI 199 or BIOSCI 199X) research project.
3. Obtain at least a 3.0 (B) grade point average (GPA) in all Biological Sciences major requirements taken at Stanford (cognate, core, and elective courses). Grades earned from teaching (290 and 291) and research (BIOHOPK 175H, 176H, and BIOSCI 199) are not computed into this GPA.
4. If graduating in June, participate in the Biological Sciences Honors Symposium by presenting a poster or giving an oral presentation. The symposium is at the end of May. If graduating Autumn, Winter, or Summer Quarter, produce a poster.
5. Complete and submit, by the end of the quarter of graduation, two signed and bound copies of an honors thesis approved by at least two readers (one of whom must be from the faculty of the Department of Biological Sciences and both must be Academic Council members). In addition, students must submit two copies of the honors thesis abstract (one paper copy and one electronic copy), which include student name, thesis title, research sponsor, and sponsor's department.

Further information on the honors program is available in the office of the Undergraduate Research Coordinator in Gilbert 118, as well as on the web at http://biohonors.stanford.edu. Questions should be directed to the Undergraduate Research Coordinator, Dr. Timothy Meier (gastrula@stanford.edu, 650-723-3767, Gilbert 118).

REQUIREMENTS FOR PREHEALTH PROFESSIONS

Students who are not biology majors should take at least the following courses in Biological Sciences: 44X, 44Y; or 41, 42, 43, and such upper-division electives as may be recommended by Stanford's Undergraduate Advising Program, Sweet Hall.

COTERMINAL B.S. AND M.S. DEGREES

The Department of Biological Sciences admits a limited number of undergraduates to the coterminal B.S. and M.S. degree program in Biological Sciences. Students may apply to the program after they have earned a minimum of 120 units toward graduation (UTG) and at least one quarter prior to conferring the undergraduate degree. The application includes a statement of purpose, a Stanford transcript, official GRE or MCAT scores, two letters of recommendation from faculty members in this department (if two such letters are not available, a letter from someone outside the department can be used in lieu of one of those, but that typically reduces the likelihood of admission), a list of courses in which they intend to enroll to fulfill degree requirements, and an application fee of $50. Students must meet all requirements for both the B.S. and M.S. degrees in Biological Sciences. Unit requirements for a coterminal program are 180 units for the bachelor's degree and 45 units for the master's degree.

Coterminal students are permitted to use course work taken up to two quarters immediately prior to their first graduate quarter toward their graduate degree. Students may defer admission to the coterminal program up to one quarter after admission, as long as they still meet all University and departmental requirements for coterminal admission.

For University coterminal degree program rules and University application forms, see http://registrar.stanford.edu/publications/#Coterm.

GRADUATE PROGRAMS

MASTER OF SCIENCE

For information on the University's basic requirements for the M.S. degree, see the "Graduate Degrees" section of this bulletin.

The M.S. degree program offers general or specialized study to individuals seeking biologically oriented course work, and to undergraduate science majors wishing to increase or update their science background or obtain advanced research experience. Students who have majored in related fields are eligible to apply, but must complete, or have completed by the time of graduation, the equivalent of a Stanford B.S. in Biological Sciences. The M.S. program does not have an M.S. with thesis option. Students are welcome to write a master's thesis, but it would not be formally recognized by the University.

The M.S. program consists of Department of Biological Sciences (or otherwise pre-approved) course work totaling at least 45 units at or above the 100-level, distributed as follows:

1. A minimum of 36 units must be Department of Biological Sciences courses or approved out-of-department electives; a list is available in the student services office and on the department's web site.
   a) at least 18 of these 36 units must be courses designated primarily

for graduate students at the 200-level or above, excluding research and teaching units.

b) a maximum of 18 of the 36 units may be a combination of Biological Sciences research and teaching (BIOSCI 175H, 176H, 198, 198X, 199, 199X, 290, 291, 300, or 300X).

2. The remaining 9 units may be advanced cognate courses in Chemistry, Computer Science, Mathematics, Physics, or Statistics beyond the level required for the undergraduate degree, or other Stanford course work at the 100-level or above that pertains to the student's program of study.

Each candidate designs a coherent program of study in consultation with her or his department adviser. Although there are no specific courses required, program proposals must adhere to department parameters.

A program proposal, signed by the student's adviser and approved by the chair of the M.S. committee, must be filed during the first month of the first quarter of enrollment. Students may take only 6 units CR/NC and must receive a grade of 'B-' or better in all courses taken for the degree.

To apply, students submit an application for admission to the M.S. program, two letters of recommendation, official transcripts, and official Graduate Record Examination (GRE) scores. The application is available online at http://gradadmissions.stanford.edu. Applicants should plan on taking the GRE at least six weeks prior to the application deadline to insure that the official scores are available when applications are evaluated. Applications are accepted for matriculation to Autumn Quarter only; the deadline is March 14. Financial support for students in this program is not available from either the department or the University.

TEACHING CREDENTIALS

For information concerning the requirements for teaching credentials, consult the "School of Education" section of this bulletin or address an inquiry to the Credential Administrator, School of Education.

DOCTOR OF PHILOSOPHY

For information on the University's basic requirements for the Ph.D. degree, see the "Graduate Degrees" section of this bulletin.

ADMISSIONS

Preparation for Graduate Study—Students seeking entrance to graduate study in Biological Sciences ordinarily should have the equivalent of an undergraduate major in Biological Sciences at Stanford. However, students from other disciplines, particularly the physical sciences, are also encouraged to apply. Such students are advised at the time of initial registration on how they should complete background training during the first year of graduate study. In addition to the usual basic undergraduate courses in biology, it is recommended that preparation for graduate work include courses in chemistry through organic chemistry, general physics, and mathematics through calculus.

Application, Admission, and Financial Aid—Prospective graduate students should apply online at http://gradadmissions.stanford.edu. The department's program is divided into three separate tracks: ecology/evolution; integrative/organismal; and molecular/cellular/developmental/genetic.

Applicants are required to take the Graduate Record Examination (GRE) general test as well as a subject test in biology, biochemistry, cellular and molecular biology, or chemistry. Applicants should plan on taking the GRE at least one month prior to the application deadline to insure that the official scores are available when applications are evaluated.

Admission to the Ph.D. program is competitive and in recent years it has been possible to offer admission to only 10 percent of the applicants.

Admitted students are normally offered financial support in the form of Stanford Graduate Fellowships, research assistantships, NIH traineeships, or Biological Sciences fellowships.

Qualified applicants should apply for nationally competitive predoctoral fellowships, especially those from the National Science Foundation.

GENERAL REQUIREMENTS

General Departmental Requirements—An admitted applicant is required to fulfill the requirements of the University as outlined in the "Graduate Degrees" section of this bulletin and the departmental requirements stated below.

Course work is planned in consultation with an advising committee assigned for a student's track. In addition, students must take a course on the ethical conduct of research: BIOSCI 312 for the ecology/evolution track; MED 255 for the integrative/organismal and molecular/cellular/developmental/genetic tracks).

1. Teaching experience and training are part of the graduate curriculum. Each student assists in teaching one course in the department's core lecture (41, 42, or 43) or lab (44X, 44Y) series, and a second course that can be either a core course or central menu course. Three quarters are required for ecology/evolution students.
2. Graduate seminars devoted to the discussion of current literature and research in particular fields of biology are an important means of attaining professional perspective and competence. Seminars are presented under individual course listings or are announced by the various research groups. A department seminar meets on most Mondays at 4 p.m. Topics of current biological interest are presented by speakers from Stanford and other institutions and are announced in the weekly *Stanford Report*. Graduate students are expected to attend.
3. Third Year and Beyond: each student must meet with the advising committee beginning the third year, and each year thereafter prior to the end of the Spring Quarter. The committee signs a form to ensure compliance. During Autumn Quarter of the fourth year, candidates must meet with their committee to evaluate the project and to discuss financial support, if required, beyond the fourth year. Advanced students are required to meet with their committee at least twice a year.

TRACK SPECIFIC REQUIREMENTS

Cell and Molecular Students—

1. *First Year:*
   a) *Advising Committee:* shortly after arrival, each entering student meets with the first-year advising committee. The committee reviews the student's previous academic work and current goals and advises the student on a program of Stanford courses, some of which may be required and others recommended. Satisfactory completion of the core curriculum (below) is required of all students.
   b) *Core Curriculum:** all students are required to take the following courses for a letter grade, unless previous course work has fulfilled these requirements:
      BIOSCI 203. Advanced Genetics
      BIOSCI 214. Cell Biology of Physiological Process
      BIOSCI 301. Frontiers in Biology: satisfies first-year talk requirement; must be taken Autumn and Winter quarters.
      MED 255. Responsible Conduct of Research
      One of the following:
      BIOC/SBIO 241. Biological Macromolecules
      MCP 256. Molecular Physiology of Cells
      MPHA 210. Signal Transduction
      Three additional courses in the student's area of interest, or as advised by committee.
   c) *Lab Rotations:** first-year students are required to complete rotations in three different laboratories.
   d) *Dissertation Lab:* by June 1, each first-year student is expected to have selected a lab in which to perform dissertation research and to have been accepted by the faculty member in charge. Students and faculty must wait until April 15 to discuss the choice of a dissertation lab. In consultation with that faculty member (who at this point becomes the student's adviser), the student chooses a projected field of expertise that is broader than the research of the adviser's lab, such as developmental biology or plant biology.
   e) *Seminar:* each student must present a public seminar in BIOSCI 301 that is evaluated by two faculty members. Evaluation consists of meeting with each faculty member within one week following

the seminar to obtain feedback and signatures. Faculty may require an additional seminar presentation.

* Written petitions for exemptions to core curriculum and lab rotation requirements are considered by the advising committee. Approval is contingent upon special circumstances and is not routinely granted.

2. *Second Year*: each student must pass a two-part qualifying exam.
   a) *Area Proposal:* the area proposal is a research proposal that lies within the student's field of expertise, but is in an area other than that of the proposed dissertation research. The written proposal should be prepared in the same detail as a grant application, including references, plans for specific experiments, and discussion of the interpretation of possible experimental results. The written proposal must be turned in to the student services office by the end of Autumn Quarter. Before the end of Winter Quarter, the student is examined orally on the contents of the written proposal and on general knowledge in the student's projected field of expertise, including important cognate areas. The oral examination is administered by the dissertation advising committee (consisting of the adviser and three other faculty members who have agreed to serve on the committee).
   b) *Dissertation Proposal:* before the end of Spring Quarter of the second year, the student must prepare a dissertation proposal that outlines the student's projected dissertation research. An expert assessment of the current literature is expected. After submission of the proposal to the dissertation advising committee, an oral examination is held. The student's adviser is not present at the examination, which is administered by the other members of the dissertation advising committee.

   Advancement to candidacy is contingent upon satisfactory completion of both proposals and oral exams. The deadline for completion is May 15, before the annual faculty meeting devoted to evaluation of student progress. Failure to complete these requirements on schedule results in the withholding of the graduate stipend.
3. *Third Year and Beyond—Dissertation and Dissertation Defense:* the finished dissertation must be turned in to the student's reading committee at least one month before the oral exam is planned. The reading committee is comprised of at least three faculty members, two of whom must be Stanford Academic Council members. At least three weeks before the oral exam, the student checks in with the committee and must incorporate any changes they require by the time of the exam. The exam cannot be formally scheduled or publicly announced until the student receives comments; however, the student should make informal arrangements with the committee earlier to ensure that everyone is available on the projected date.

Integrative/Organismal Students—

1. *First Year:* each entering student is assigned a first-year advising committee whose function is to develop a schedule of required and recommended courses and to meet once each quarter with the student during the first year.
   a) students are required to take: BIOSCI 306, Current Topics in Integrative and Organismal Biology; and BIOSCI 312, Ethical Issues in Ecology and Evolutionary Biology, or MED 255, Responsible Conduct of Research. Students specializing in integrative biology may also be asked to take appropriate graduate-level courses such as DBIO 210; MCP 215; NBIO 206, 216; or PSYCH 228.
   b) *First-Year Paper:* each student must prepare and submit a paper that is evaluated by the advising committee, before the end of Spring Quarter of their first year. This paper should be a step toward the development of a dissertation proposal and may consist of an analysis of new data or a literature review and synthesis. Evaluation is in written form by two faculty members.
   c) *Seminar:* each student must present a public seminar that is evaluated by two faculty members. Evaluation consists of meeting with each faculty member within one week following the seminar to obtain feedback and signatures. Faculty may require an additional seminar presentation.
2. *Second Year:* the student is expected to write a major dissertation proposal. The proposal is evaluated by a committee of three faculty (the dissertation advising committee) in an oral presentation. This is to be completed by the end of Spring Quarter of the second year. Advancement to candidacy depends on satisfactory completion of the dissertation proposal.
3. *Third Year and Beyond—Dissertation and Dissertation Defense:* at least one month before the oral exam takes place, the student must submit his or her dissertation to the dissertation advising committee. At least two weeks before the oral exam, the student must incorporate into the dissertation any changes required by the committee. The exam cannot be formally scheduled or publicly announced until that time.

Ecology, Evolution, and Population Biology Students—

1. *First Year:* each entering student is assigned a first-year advising committee whose function is to develop a schedule of required and recommended courses and to meet once each quarter with the student during the first year.
   a) students are required to take BIOSCI 302, 303, 304, Current Topics and Concepts in Population Biology, Ecology and Evolution, and BIOSCI 312, Ethical Issues in Ecology and Evolutionary Biology.
   b) *First-Year Paper:* each student must prepare and submit a paper that is evaluated by the advising committee before the end of Spring Quarter of their first year. This paper should be a step toward the development of a dissertation proposal and may consist of an analysis of new data or a literature review and synthesis. Evaluation is in written form by two faculty members.
   c) *Seminar:* each student must present a public seminar that is evaluated by two faculty members. Evaluation consists of meeting with each faculty member within one week following the seminar to obtain feedback and signatures. Faculty may require an additional seminar presentation.
2. *Second Year:* the student is expected to write a major dissertation proposal. The proposal is evaluated by a committee of three faculty (the dissertation advising committee) in an oral presentation. This is to be completed by the end of Spring Quarter of the second year. Advancement to candidacy depends on satisfactory completion of the dissertation proposal.
3. *Third Year and Beyond: Dissertation and Dissertation Defense:* at least one month before the oral exam takes place, the student must submit his or her dissertation to the dissertation advising committee. At least two weeks before the oral exam, the student must incorporate into the dissertation any changes required by the committee. The exam cannot be formally scheduled or publicly announced until that time.

Residency Requirement—A minimum of 135 units of graduate registration is required of each candidate. The department normally accepts only full-time students for study leading to the Ph.D. degree.

COURSES

WIM indicates that the course satisfies the Writing in the Major requirement.

Additional courses not listed here are frequently offered by postdoctoral or advanced Ph.D. personnel in the areas of their research competence. They are listed in the quarterly *Time Schedule*, with course descriptions available in the student services office.

INTRODUCTORY

BIOSCI 1. Human Evolution and Environment—Human genetic and cultural evolution and how people interact with their environments, from the ancestors of Australopithecus to current events. Issues include race, gender, and intelligence; pesticide and antibiotic resistance; abortion and contraception; ecosystem services; environmental economics and ethics; the evolution of religion; climate change; population growth and overconsumption; origins and spread of ideas and technologies; and the distribution of political and economic power.

3 units, Spr (Ehrlich)

BIOSCI 2. Current Research Topics in Biological Sciences—Primarily for sophomores interested in majoring in Biological Sciences. Weekly seminars by faculty: molecular biology and genetics; theory and mathematics in biology; ecology, physiology, and the environment; molecular and cellular aspects of neurobiology, immunology, and developmental biology; biological chemistry; behavioral biology; and evolution. May be repeated for credit.

1 unit, Aut, Win (Meier)

BIOSCI 3. Frontiers in Marine Biology—An introduction to contemporary research in marine biology, including ecology, conservation biology, environmental toxicology, behavior, biomechanics, evolution, neurobiology, and molecular biology. Emphasis is on new discoveries and the technologies used to make them. Weekly lectures by faculty from the Hopkins Marine Station.

1 unit, Aut (Somero)

BIOSCI 4. Introduction to Biotechnology—The scientific basis for key biotechnologies (cell transformation, DNA cloning, organismal cloning) and societal reactions to them. Focus is on defining current issues with specific technologies (use of DNA screening in forensics, animal cloning, genetically modified foods). GER:DB-EngrAppSci

4 units (Walbot) not given 2005-06

BIOSCI 8. Frontiers in Organismal Biology—Preference to freshmen and sophomores. How animals work. Research frontiers in organismal biology including integrative physiology, biomechanics, neurobiology, and environmental physiology and ecology.

1 unit, Aut (B. Block, Staff)

BIOSCI 20. Introduction to Brain and Behavior—(Same as HUMBIO 21.) Evolutionary principles to understand how the brain regulates behavior, described in physiological terms, and is influenced by behavioral interactions. Topics include neuron structure and function, transmission of neural information, anatomy and physiology of sensory and motor systems, regulation of body states, the biological basis of learning and memory, and behavioral abnormalities. GER:DB-NatSci

3 units (Fernald) alternate years, given 2006-07

STANFORD INTRODUCTORY SEMINARS

BIOSCI 6N. Climate Change: Drivers, Impacts, and Solutions—Stanford Introductory Seminar. The scientific understanding of climate change, and the evidence, driving forces, and options for managing its impacts. GER:DB-NatSci

3 units, Win (Field)

BIOSCI 10N. Light and Life—Stanford Introductory Seminar. Preference to freshmen. The importance of light for life. Focus is on active areas of research including pigments and coloration, bioluminescence (life creating light), phototaxis (light-directed movement), circadian rhythms, and vision.

3 units, Aut (Elrad)

BIOSCI 13N. Environmental Problems and Solutions—Stanford Introductory Seminar. Preference to freshmen. Students do independent investigations of current environmental problems, analyzing differing views of them and discussing possible solutions. Each student gives two seminar presentations and leads two seminar discussions. Short, documented position papers are written for policy makers. GER:DB-NatSci

3 units, Spr (Ehrlich)

BIOSCI 16N. Island Ecology—Stanford Introductory Seminar. Preference to freshmen. How ecologists think about the world. Focus is on the Hawaiian Islands: origin, geology, climate, evolution and ecology of flora and fauna, and ecosystems. The reasons for the concentration of threatened and endangered species in Hawaii, the scientific basis for their protection and recovery. How knowledge of island ecosystems can contribute to ecology and conservation biology on continents. GER:DB-NatSci

3 units, Spr (Vitousek)

BIOSCI 17N. Light, Pigments, and Organisms—(Same as CHEM 17N.) Stanford Introductory Seminar. Preference to freshmen. Multidisciplinary lab course. The molecular basis of pigments, light absorption, color, and fluorescence using chemical techniques and biological materials. Topics include: the diversity of photosynthetic pigments, how cyanobacteria modify their pigment composition in diverse light environments, and the importance of photoreceptors in assessing an organism's light environment. GER:DB-NatSci

3 units, Win (Elrad, Zare)

BIOSCI 19N. Diversity, Gender, and Sexuality—Stanford Introductory Seminar. Preference to freshmen. The diversity of gender expression and sexuality among vertebrates and human cultures, and the developmental biology of sexual differentiation in humans. How science studies contribute to the understanding of gender, a topic primarily treated in the humanities and social sciences. Focus is on Roughgarden, *Evolution's Rainbow: Diversity, Gender, and Sexuality in Nature and People*. GER:DB-NatSci

3 units, Win (Roughgarden)

BIOSCI 22N. Infection, Immunity, and Global Health—Stanford Introductory Seminar. Preference to sophomores. The causes and prevention of infectious diseases, focusing on the interplay between pathogens and the immune system that determines the outcome of the disease. The basic principles of microbiology, immunology, and epidemiology. Diseases of the past and present including SARS, AIDS, TB, and malaria. The roles of biological, environmental, and societal factors in disease emergence, spread, and prevention. Primary scientific literature, student-led discussions, and research projects. Prerequisite: biology background, preferably introductory college biology at the level of 41 or 42, or HUMBIO 2A, 3A. GER:DB-NatSci

3 units, Spr (Jones)

BIOSCI 26N. Maintenance of the Genome—Stanford Introductory Seminar. Preference to freshmen. Focus is on DNA repair systems which scan the genome to ensure genomic stability in the face of natural endogenous threats to DNA and those due to radiation and chemicals in the external environment. Redundancy of the genetic message ensured by complementary DNA strands facilitates recovery of information when one of the strands is altered. Predisposition to cancer often implicates a defective DNA repair gene. Relevance for oncology, aging, developmental biology, environmental health, and neurobiology. GER:DB-NatSci

3 units, Spr (Hanawalt)

BIOSCI 28N. Molecular Basis of Cancer—Stanford Introductory Seminar. Preference to freshmen. Current knowledge on the molecular basis of cancer. Topics: cell cycle regulation, oncogenes, tumor suppressor genes, telomere biology, angiogenesis, and apoptosis. Current cancer biology literature.

3 units, Win (Fang)

BIOSCI 31Q. Ants: Behavior, Ecology, and Evolution—Stanford Introductory Seminar. Preference to sophomores. Behavior: the organization of colonies, how they operate without central control, how they resemble other complex systems like brains. Ecology: how populations of colonies change, comparing the ecology of a species in SW American desert and invasive Argentine ants. Evolution: why are there so many species of ants; how are they alike, how do they differ, and why? Ants as the theme for exploring how to do research in animal behavior, ecology, and evolution. Research project will be on the invasive Argentine ant: its distribution on campus, foraging trails, and nest structure.

3 units, Spr (Gordon)

BIOSCI 35N. Nobel Prize Winning Research in Biology and Medicine—Stanford Introductory Seminar. Preference to freshmen. Nobel prize winning scientific research in biomedicine that has had the most profound impact on understanding of the biological world. Students present original papers.

3 units, Spr (Shen)

BIOSCI 106Q. The Heart of the Matter—Stanford Introductory Seminar. Preference to sophomores. The molecular and biochemical basis of life. Emphasis is on the methods and scientific logic that lead to advances in knowledge. The human heart and circulatory system is the unifying theme for topics such as the constituents and activities of cells, tissues, and organs; the chemicals and proteins that carry on life processes; the biotechnology revolution; the role of genes in human disease and normal functions; and the Human Genome Project. How scientific knowledge is built up through research; how biology initiates advances in medicine; and how science, engineering, and economics interact in biotechnology. Student presentations, demonstrations, and field trips. GER:DB-NatSci

3 units, Win (Myers, Simoni)

CORE

BIOSCI 41, 42, 43. Principles of Biology—Comprehensive study of the principles of modern biological sciences, taken in sequence, preferably in the sophomore year. Biological Sciences majors must take for a letter grade. Prerequisites: CHEM 31X (or 31A and B), 33, 35; MATH 19, 20, 21, or 41, 42.

BIOSCI 41. Genetics, Biochemistry, and Molecular Biology—Emphasis is on macromolecules (proteins, lipids, carbohydrates, and nucleic acids) and how their structure relates to function and higher order assembly; molecular biology, genome structure and dynamics, gene expression from transcription to translation. GER:DB-NatSci

5 units, Aut (Simon, Simoni)

BIOSCI 42. Cell Biology and Animal Physiology—Cell structure and function; principles of animal physiology (immunology, renal, cardiovascular, sensory, motor physiology, and endocrinology); neurobiology from cellular and developmental to neural regulation of physiology. GER:DB-NatSci

5 units, Win (Cyert, Jones, C. Heller, Sapolsky)

BIOSCI 43. Plant Biology, Evolution, and Ecology—Principles of evolution: macro- and microevolution and population genetics. Ecology: the principles underlying the exchanges of mass and energy between organisms and their environments; population, community, and ecosystem ecology; populations, evolution, and global change. Equivalent to BIOHOPK 43. GER:DB-NatSci

5 units, Spr (Mudgett, Petrov, Gordon)

BIOSCI 44X,Y. Core Experimental Laboratory—Two quarters of lab projects provide a working familiarity with the concepts, organisms, and techniques of modern biological research. Emphasis is on experimental design, analysis of data, and written and oral presentation of the experiments. Lab fee. Prerequisites: CHEM 31X, or 31A,B, and 33. Recommended: Biological Sciences or Human Biology core, and statistics; 44X,Y should be taken sequentially in same year. 44Y equivalent to BIOHOPK 44Y. WIM

4 units, **44X:** *Win,* **44Y:** *Spr (Malladi, Yelton)*

BIOSCI 54. Genes, Genomes, and Proteins: Introduction to Advanced Independent Research Laboratory—Preference to sophomores. First of two-part sequence. For students interested in pursuing research-oriented careers in biological sciences. The impact of genomic information on experimental biology. Recently developed techniques at a conceptual level and examples of their application to biology. Emphasis is on primary scientific literature and hands-on analyses of genome information using online databases and computational tools. Topics include microarray analysis, the use of comprehensive genome-wide mutant collections, and investigation of the proteome. Limited enrollment. Prerequisite: consent of instructors. 54,55 substitutes for 44X,Y to fulfill Biological Sciences major lab requirement. GER:DB-NatSci, WIM

3 units, Win (Cyert, Stearns, Ballew)

BIOSCI 55. Advanced Independent Research Laboratory—Preference to sophomores. Second of two-part sequence. For students interested in pursuing research-oriented careers in biological sciences. Project lab course using a modern research laboratory with cutting-edge technologies introduced in 54 to investigate gene and protein function on a genomic level to understand how cells work. Students design and execute original research projects using the yeast Saccharomyces cerevisiae to explore fundamental questions in eukaryotic cell biology. Limited enrollment. Prerequisite: 54, consent of instructors. 54, 55 substitutes for 44X, Y to fulfill Biological Sciences major lab requirement. GER: DB-NatSci, WIM

6 units, Spr (Cyert, Stearns, Ballew)

BIOSCI 96A,B. Jasper Ridge Docent Training—Two quarter preparation for Stanford and community students to join the Jasper Ridge education program. Multidisciplinary environmental education; hands-on field research. Field ecology and the natural history of plants and animals, archaeology, geology, hydrology, land management, and research projects of the preserve presented by faculty, local experts, and staff. Participants lead research-focused educational tours as docents, assist with classes, and participate in continuing education classes available to members of the JRBP community after the course.

2 units, **A***: Win (Vitousek),* **B***: Spr (Staff)*

HOPKINS MARINE STATION

For courses offered at the Hopkins Marine Station, see the "Hopkins Marine Station" section of this bulletin which follows immediately after this section. Several of the Hopkins Marine Station courses may be used to fulfill department major requirements.

INTERMEDIATE UNDERGRADUATE AND GRADUATE

BIOSCI 101. Ecology—Introduction to the principles of ecology. Topics: interactions of organisms with their environment, dynamics of populations, species interactions, structure and dynamics of ecological communities, biodiversity. Prerequisites: 43, or consent of instructor. Recommended: statistics. GER:DB-NatSci

3 units, Aut (Bohannan, Vitousek)

BIOSCI 102. Demography: Health, Development, Environment—(Same as HUMBIO 137.) Demographic methods and their application to understanding and projecting changes in human infant, child, and adult mortality and health, fertility, population, sex ratios, and demographic transitions. Progress in human development, capabilities, and freedoms. Relationships between population and environment. Prerequisites: numeracy and basic statistics. GER:DB-SocSci

3 units, Spr (Tuljapurkar)

BIOSCI 103. Seminar in Biological Sciences—Primarily for undergraduates interested in careers in research. Held in conjunction with the Biological Sciences seminar series in which visiting scientists present their work. Students meet prior to the seminar to discuss the upcoming speaker's work. GER:DB-NatSci

3 units, Aut (Stearns, Ballew)

BIOSCI 104/200. Advanced Molecular Biology—(Graduate students register for 200.) Molecular mechanisms that govern the replication, recombination, and expression of eukaryotic genomes. Topics: DNA replication, DNA recombination, gene transcription, RNA splicing, regulation of gene expression, protein synthesis, and protein folding. Prerequisite: Biological Sciences core. GER:DB-NatSci

5 units, Win (Fang, Frydman)

BIOSCI 109/209. The Human Genome and Disease—(Graduate students register for 209; same as HUMBIO 114.) The variability of the human genome and the role of genomic information in research, drug discovery, and human health. Concepts and interpretations of genomic markers in medical research and real life applications. Human genomes in diverse populations. Original contributions from thought leaders in academia and industry and interaction between students and guest lecturers. GER:DB-NatSci

3 units, Spr (R. Heller, Kumm)

BIOSCI 110. Vertebrate Biology—(Enroll in HUMBIO 110.)

3-4 units (Porzig) not given 2005-06

BIOSCI 112/212. Human Physiology—(Graduate students register for 212.) The functioning of organ systems emphasizing mechanisms of control and regulation. Topics: structure and function of endocrine and central nervous systems, cardiovascular physiology, respiration, salt and water balance, exercise, and gastrointestinal physiology. Prerequisite: Biological Sciences or Human Biology core. GER:DB-NatSci

4 units, Win (Garza)

BIOSCI 113/244. Fundamentals of Molecular Evolution—(Graduate students register for 244.) The inference of key molecular evolutionary processes from DNA and protein sequences. Topics include random genetic drift, coalescent models, effects and tests of natural selection, combined effects of linkage and natural selection, codon bias and genome evolution. Prerequisites: Biological Sciences core or graduate standing in any department, and consent of instructor. GER:DB-NatSci

4 units, Win (Petrov)

BIOSCI 117. Biology and Global Change—(Same as EARTHSYS 111.) The biological causes and consequences of anthropogenic and natural changes in the atmosphere, oceans, and terrestrial and freshwater ecosystems. Topics: glacial cycles and marine circulation, greenhouse gases and climate change, tropical deforestation and species extinctions, and human population growth and resource use. Prerequisite: Biological Sciences or Human Biology core or graduate standing. GER:DB-NatSci

3 units, Win (Vitousek)

BIOSCI 118/218. Genetic Analysis of Biological Processes—(Graduate students register for 218.) Genetic principles and their experimental applications. Emphasis is on the identification and use of mutations to study cellular function. Prerequisite: Biological Sciences core. GER:DB-NatSci

5 units, Win (Hatzidakis)

BIOSCI 120. General Botany—Introduction to plant development, structure, and function in an ecological and evolutionary context. Themes include comparative morphology, systematics and diversity, and broad-scale evolutionary trends. Prerequisites: Biological Sciences or Human Biology core, or consent of instructor. GER:DB-NatSci

3-5 units, Aut (Preston)

BIOSCI 121. Biogeography—Global distributions of organisms through the Phanerozoic, with emphasis on historical causes. Topics: plate tectonics, island biogeography, climatic change, dispersal, vicariance, ecology of invasions, extinction, gradients, diversity. GER:DB-NatSci

3 units, Spr (Hadly) alternate years, not given 2006-07

BIOSCI 124/224. Plant Physiological Ecology: From Leaf to Globe—(Graduate students register for 224.) A functional approach to understanding terrestrial vegetation. Prerequisites: 42 and 43, or consent of instructor. GER:DB-NatSci

4 units (Berry, Field, Mooney) not given 2005-06

BIOSCI 125. Ecosystems of California—Distribution, functioning, human utilization, and management through time. Prerequisite: 43, HUMBIO 2A, or EARTHSYS 10. GER:DB-NatSci

3 units (Mooney) not given 2005-06

BIOSCI 127/220. Ecology of Microorganisms—(Graduate students register for 220.) Interactions between microorganisms and their environments from an ecological and evolutionary perspective. Topics: nutrient acquisition and environmental sensing, behavioral ecology, growth of cells and populations, population interactions, communities, and microbial biodiversity. Prerequisite: Biological Sciences core or equivalent, or consent of instructor. Recommended: 133, 142. GER:DB-NatSci

3 units (Bohannan) not given 2005-06

BIOSCI 128/228. The Economic Individual in the Behavioral Sciences—(Graduate students register for 228; same as HUMBIO 113.) Empirical evidence for the idea of the economic individual and its associated models in economics. How the economic individual maximizes utility and cooperates with others only when it is rational to do so. Applications of this idea to animal behavior. Readings include political philosophy, psychology, and evolutionary biology; recent research articles on empirical work in animal behavior. Student presentations.

3 units, Aut (Gordon, Satz)

BIOSCI 129A. Cellular Dynamics I: Cell Motility and Adhesion—Cell motility emphasizing role of actin assembly and dynamics coupling actin organization to cell movement. Interaction of cells with extracellular matrix, and remodelling of extracellular matrix in development and disease. Directed cell migration by chemotaxis (neuronal path-finding, immune cells). Cell-cell adhesion, formation of intercellular junctions and mechanisms regulating cell-cell interactions in development and diseases. Emphasis is on experimental logic, methods, problem solving, and interpretation of results. Students present research papers. Prerequisite: Biological Sciences core. GER:DB-NatSci

4 units, Win (Nelson)

BIOSCI 129B. Cellular Dynamics II: Building a Cell—Principles of cell organization; how common biochemical pathways are modified to generate diversity in cell structure and function. Roles of actin and microtubule cytoskeletons in cellular architecture. Mechanisms of protein sorting and trafficking, and protein modules and switches in regulating cell polarity. Yeast to polarized epithelial cells and neurons. Emphasis is on experimental logic, methods, problem solving, and interpretation of results. Students present research papers. Prerequisite: Biological Sciences core. Recommended: 129A. GER:DB-NatSci

4 units, Spr (Nelson)

BIOSCI 132/232. Advanced Imaging Lab in Biophysics—(Graduate students register for 232; same as BIOPHYS 232, MCP 232.) Laboratory and lectures. Microscopy, emphasizing hands-on experience with a range of apparatus and techniques. Topics include microscope optics, Koehler illumination, contrast-generating mechanisms (bright/dark field, fluorescence, phase contrast, differential interference contrast), and resolution limits. Advanced topics vary by year, but include single-molecule fluorescence, fluorescence resonance energy transfer, confocal microscopy, two-photon microscopy, optical trapping, and fiberoptic methods. Limited enrollment. Recommended: basic physics, Biological Sciences core or equivalent, and consent of instructor. GER:DB-NatSci

4 units, Spr (S. Block, Schnitzer, S. Smith, Stearns)

BIOSCI 133. Genetics of Prokaryotes—Genetic approaches for understanding cellular processes in bacteria, including metabolism, adaptive and stress responses, signal transduction, gene expression, genetic exchange and recombination, chromosome dynamics and evolution, cell division, motility, surface attachment, and developmental responses. Emphasis is on the power of effectively combining genetics with biochemistry, microscopy, and genomics. Prerequisite: Biological Sciences core GER:DB-NatSci

4 units, Aut (Burkholder, Campbell)

BIOSCI 134. Replication of DNA—Seminar. Modes of DNA replication and their control in prokaryotes and eukaryotes. Structures, properties, and functions of DNA polymerases and associated factors. Emphasis on experimental approaches and their limitations. Current research literatures. Students prepare journal club style report and lead class discussions. Enrollment limited to 20 advanced undergraduates. Prerequisite: Biological Sciences core. Recommended: 118. GER:DB-NatSci

3 units, Win (Burkholder, Hanawalt)

BIOSCI 135. Biological Clocks—(Same as HUMBIO 182.) The biological basis for endogenous timekeeping in organisms from flies to human beings. How biological clocks are constructed at the molecular, tissue, and behavioral levels; how these clocks interact with other physiological systems and allow animals to anticipate changes in their environment. Applications of circadian rhythm principles to treating human disorders and diseases such as cancer. Prerequisite: Biological Sciences or Human Biology core, or consent of instructor. GER:DB-NatSci

3 units, Spr (C. Heller, Ruby)

BIOSCI 136. Evolutionary Paleobiology—A paleontological approach to evolutionary theory. Topics: history of life, speciation, heterochrony, evolutionary constraint, coevolution, macroevolution, the Cambrian Explosion, mass extinctions, taphonomy, life on land, life in the sea, life in the air. GER:DB-NatSci

4 units, Win (Hadly) alternate years, not given 2006-07

BIOSCI 137/237. Plant Genetics—(Graduate students register for 237.) Gene analysis, mutagenesis, and transposable elements; developmental genetics of flowering and embryo development; biochemical genetics of plant metabolism; scientific and societal lessons from transgenic plants. Prerequisite: Biological Sciences core or consent of instructor. GER:DB-NatSci

3 units, Spr (Walbot, Barton) alternate years, not given 2006-07

BIOSCI 138/238. Ecology and Evolution of Plants—(Graduate students register for 238.) Topics: plants in the environment, natural selection in plant populations, population dynamics, evolution of life history, and physiological ecology. Prerequisite: 43 or consent of instructor. Recommended: statistics. GER:DB-NatSci

3 units, Spr (Preston)

BIOSCI 138A/238A. Plant Ecology Lab—(Graduate students register for 238A.) Weekly lab sessions to design and conduct field research projects and read primary literature. Corequisite: 138.

2 units, Spr (Preston)

BIOSCI 139. Biology of Birds—The ways birds interact with their environments and each other, emphasizing studies that had impact in the fields of population biology, community ecology, and evolution. Students become familiar with local bird communities; emphasis is on field research. Enrollment limited to 20. Prerequisites: 43 or equivalent, and consent of instructor. Recommended: birding experience. GER:DB-NatSci

3 units (Root) not given 2005-06

BIOSCI 140. Population Biology of Butterflies—Field work on Euphydryas populations under study on campus and elsewhere in California. Course offered as participation in research when conditions permit; decisions not made until Winter Quarter. Prerequisites: 43 and consent of instructor.

2-5 units, Spr (Ehrlich)

BIOSCI 141. Biostatistics—(Same as STATS 141.) Statistical analysis of biological data. Topics: discrete and continuous distributions, testing hypotheses and confidence procedures, fixed and random effects analysis of variance, regression, and correlation. Wilcoxon and other nonparametric procedures, inference on contingency tables and other data arising from counts. Tests of goodness of fit. Emphasis is on finding numerical solutions to biostatistical problems, and practical interpretations and their implications. GER:DB-Math

4-5 units, Aut (Rogosa)

BIOSCI 142. Topics in Theoretical Ecology—Introductory. Issues include foraging theory, demography and life history theory, population dynamics and species interactions including ecosystem stability, ecological economics and marine reserve design, evolutionary theory, evolutionary ecology, and evolution of gender sexuality and family structure. Prerequisites: 43 or 101, calculus, and computer programming. Recommended: linear algebra and differential equations. GER:DB-NatSci

3 units (Roughgarden) not given 2005-06

BIOSCI 143/243. Evolution—(Graduate students register for 243.) The basic facts and principles of the evolution of all life. The logic of and evidence for the correctness of Darwin's argument for evolution by natural selection. How Mendelian genetics was integrated into evolutionary thinking. The integration of physiological and ecological perspectives into the study of evolutionary adaptation within species. Species formation and evolutionary divergence among species. Patterns of evolution over long time scales. GER:DB-NatSci

3 units, Win (Watt)

BIOSCI 144. Conservation Biology—(Same as HUMBIO 119.) Principles and application of the science of preserving biological diversity. Topics: sources of endangerment of diversity; the Endangered Species Act; conservation concepts and techniques at the population, community, and landscape levels; reserve design and management; conflict mediation. Case studies and local field trips. 3 units if taken without field trips. Prerequisites: BIOSCI 101, or HUMBIO 2A with consent of instructor. GER:DB-NatSci

3-4 units, Win (Boggs, Launer)

BIOSCI 145/245. Behavioral Ecology—(Graduate students register for 245.) Animal behavior from an evolutionary and ecological perspective. Topics: foraging, territoriality, reproductive behavior, social groups. Lecture/seminar format; seminars include discussion of journal articles. Independent research projects. Prerequisites: Biological Sciences or Human Biology core, or consent of instructor. Recommended: statistics. GER:DB-NatSci, WIM

4 units, Spr (Gordon)

BIOSCI 146. Population Studies—Series of talks by distinguished speakers introducing approaches to population and resource studies.

1 unit, Win (Feldman)

BIOSCI 147/247. Controlling Climate Change in the 21st Century—(Graduate students register for 247; same as EARTHSYS 147/247.) The science, economics, and environmental diplomacy of global climate change. Topics: the science of climate change, climate change and global environmental law; global economic approaches to carbon abatement, taxes, and tradable permits; joint implementation, consensus, and division in the EU; gaining the support of China, other developing countries, and U.S. corporations; alternative energy and energy efficiencies for less carbon-intensive electric power and transport. GER:DB-NatSci

3 units (Schneider, Rosencranz) alternate years, given 2006-07

BIOSCI 148/248. Biosystematics and Evolution—(Graduate students register for 248.) Panel discussion and outside speakers. Topics of current interest in the systematics and evolution of living diversity. Sponsored jointly with the California Academy of Sciences.

1 unit, Spr (Watt)

BIOSCI 149/249. Principles of Sleep Research—(Graduate students register for 249.) Preference to seniors and graduate students. The neurochemistry and neurophysiology of changes in brain activity and conscious awareness associated with changes in the sleep/wake state. Behavioral and neurobiological phenomena including sleep regulation, sleep homeostasis, circadian rhythms, sleep disorders, sleep function, and the molecular biology of sleep. Enrollment limited to 16. GER:DB-NatSci

4 units (Franken, C. Heller) not given 2005-06

BIOSCI 150/250. Human Behavioral Biology—(Graduate students register for 250.) Multidisciplinary. How to approach complex normal and abnormal behaviors through biology. How to integrate disciplines including sociobiology, ethology, neuroscience, and endocrinology to examine behaviors such as aggression, sexual behavior, language use, and mental illness. GER:DB-NatSci

3-6 units, Spr (Sapolsky) alternate years, not given 2006-07

BIOSCI 151. Mechanisms of Neuron Death—For Biology majors with background in neuroscience. Cell and molecular biology of neuron death during neurological disease. Topics: the amyloid diseases (Alzheimer's), prion diseases (kuru and Creutzfeldt-Jakob), oxygen radical diseases (Parkinson's and ALS), triplet repeat diseases (Huntington's), and AIDS-related dementia. Student presentations. Enrollment limited to 15; application required.

3 units, Aut (Sapolsky)

BIOSCI 152. Imaging: Biological Light Microscopy—(Same as MCP 222.) Survey of instruments which use light and other radiation for analysis of cells in biological and medical research. Topics: basic light microscopy through confocal fluorescence and video/digital image

processing. Lectures on physical principles; involves partial assembly and extensive use of lab instruments. Lab. Prerequisites: some college physics, Biological Sciences core. GER:DB-NatSci

3 units, Spr (S. Smith)

BIOSCI 153. Cellular Neuroscience: Cell Signaling and Behavior—(Enroll in PSYCH 120.)

4 units, Aut (Wine)

BIOSCI 154/254. Molecular and Cellular Neurobiology—(Graduate students register for 254; same as NBIO 254.) For advanced undergraduates and graduate students. Cellular and molecular mechanisms in the organization and functions of the nervous system. Topics: wiring of the neuronal network, synapse structure and synaptic transmission, signal transduction in the nervous system, sensory systems, molecular basis of behavior including learning and memory, molecular pathogenesis of neurological diseases. Prerequisite for undergraduates: Biological Sciences core or equivalent, or consent of instructors. GER:DB-NatSci

4 units (Luo, Shen, Clandinin) alternate years, given 2006-07

BIOSCI 158. Developmental Neurobiology—For advanced undergraduates and coterminal students. The principles of nervous system development from the molecular control of patterning, cell-cell interactions, and trophic factors to the level of neural systems and the role of experience in influencing brain structure and function. Topics: neural induction and patterning cell lineage, neurogenesis, neuronal migration, axonal pathfinding, synapse elimination, the role of activity, critical periods, and the development of behavior. Prerequisite: 42 or equivalent. GER:DB-NatSci

4 units (McConnell) alternate years, given 2006-07

BIOSCI 160. Developmental Biology—The principles of developmental biology. Focus is on the molecular mechanisms underlying the generation of diverse cell types and tissues during embryonic and post-embryonic development in animals. Prerequisite: Biological Sciences core.

4 units (Simon, McConnell) alternate years, given 2006-07

BIOSCI 162/262. Advanced Microbial Genetics and Genomics—(Graduate students register for 262; same as GENE 262.) Genetic tools for studying the cell biology and behavior of bacteria. Case studies on genetic approaches in combination with biochemistry, microscopy, and genomics to study mechanisms of gene expression, signal transduction, cell cycle regulation, development, and pathogenesis. GER:DB-NatSci

4 units, Spr (Tan, Burkholder)

BIOSCI 163/263. Neural Systems and Behavior—(Graduate students register for 263.) The field of neuroethology and its vertebrate and invertebrate model systems. Research-oriented. Readings include reviews and original papers. How animal brains compare; how neural circuits are adapted to species-typical behavior; and how the sensory worlds of different species represent the world. Prerequisites: 42, HUMBIO 4A or equivalent. GER:DB-NatSci

4 units, Aut (Fernald)

BIOSCI 175. Tropical Ecology and Conservation—Field trip to a field station at Los Tuxtlas, Mexico; lectures at Stanford. How to address scientific questions concerning ecology and conservation. Field trip includes natural history observations and group research projects. Symposium based on project results. Recommended: 43, 101, and 141 or STATS 60.

5 units, Spr (Dirzo)

BIOSCI 180/280. Fundamentals of Sustainable Agriculture—(Graduate students register for 280; same as EARTHSYS 180/280.) Ecological, economic, and social dimensions of sustainable agriculture in the context of a growing world population. Focus is on management and technological approaches, and historical content of agricultural growth and change, organic agriculture, soil and water resource management, nutrient and pest management, biotechnology, ecosystem services, and climate change. GER:DB-NatSci

3 units (Naylor, Daily) alternate years, given 2006-07

BIOSCI 183A/283A. Population Genetic Theory and Evolution I—(Graduate students register for 283A.) Relationship between the theory of evolution and genetic variation. Selection in large populations, interaction between genes, quantitative inheritance, and gene-culture coevolution.

4 units, Win (Feldman)

BIOSCI 183B/283B. Population Genetic Theory and Evolution II—(Graduate students register for 283B.) Role of population size and random effects in evolution. Genomic data and how they are used to infer the processes of evolution. Introduction to population structure and expansion. Prerequisite: 183A/283A.

4 units, Spr (Feldman)

BIOSCI 184/284. Principles and Practice of Biosystematics—(Graduate students register for 284.) The principles and major operating procedures of systematic biology; the classification of organisms and of the relationships among them. Concepts and issues common to the study of all organisms; examples from particular groups of creatures. GER:DB-NatSci

4 units (Watt, Gosliner, Jablonski) not given 2005-06

BIOSCI 188/288. Biochemistry I—(Graduate students register for 288; same as CHEMENG 188/288, CHEM 188.) Chemistry of major families of biomolecules including proteins, nucleic acids, carbohydrates, lipids, and cofactors. Structural and mechanistic analysis of properties of proteins including molecular recognition, catalysis, signal transduction, membrane transport, and harvesting of energy from light. Molecular evolution. Pre- or corequisites: 41, CHEM 131, and CHEM 135 or 171. GER:DB-NatSci

3 units, Aut (Kohler)

BIOSCI 189/289. Biochemistry II—(Graduate students register for 289; same as CHEM 189, CHEMENG 189/289.) Metabolism. Glycolysis, gluconeogenesis, citric acid cycle, oxidative phosphorylation, pentose phosphate pathway, glycogen metabolism, fatty acid metabolism, protein degradation and amino acid catabolism, protein translation and amino acid biosynthesis, nucleotide biosynthesis, DNA replication, recombination and repair, lipid and steroid biosythesis. Medical consequences of impaired metabolism. Therapeutic intervention of metabolism. Prerequisite: 188/288. GER:DB-NatSci

3 units, Win (Khosla)

UNDERGRADUATE, INVOLVING INDIVIDUAL WORK

Students majoring in Biological Sciences are encouraged to pursue directed reading and research opportunities. An introduction to research is provided by BIOSCI 2.

BIOSCI 191. Research in Bird Biology—Semi-independent field research in ornithology emphasizing ecological relationships. Projects involve research, planned and carried out by the student in consultation with the instructor. Results are written in publication format. Enrollment limited. Prerequisites: 43, concurrent or subsequent enrollment in 139, and consent of instructor. GER:DB-NatSci

3 units, Win, Spr (Ehrlich)

BIOSCI 193. Undergraduate Journal Club—Weekly discussion, led by students and facilitated by faculty, for reading scientific literature and presenting papers. Contact Tim Meier (gastrula@stanford.edu) by the fifth week of the previous quarter if requesting a particular research topic. Minimum enrollment required. Prerequisites: Biological Sciences core and consent of instructor. Recommended: 199 or 199X.

1 unit, Aut, Win, Spr (Meier)

BIOSCI 198. Directed Reading in Biological Sciences—Individually arranged under the supervision of members of the faculty.

1-15 units, Aut, Win, Spr, Sum (Staff)

BIOSCI 198X. Out-of-Department Directed Reading—Individually arranged under the supervision of members of the faculty. Credit for work arranged with out-of-department faculty is restricted to Biological

Sciences majors and requires department approval. See http://biohonors.stanford.edu for information and petitions, or email gastrula@stanford.edu for more information.

1-15 units, Aut, Win, Spr, Sum (Staff)

BIOSCI 199. Advanced Research Laboratory in Experimental Biology—Individual research taken by arrangement with in-department instructors. See http://biohonors.stanford.edu for information on research sponsors, units, and credit for summer research, or email gastrula@stanford.edu.

1-15 units, Aut, Win, Spr, Sum (Staff)

BIOSCI 199X. Out-of-Department Advanced Research Laboratory in Experimental Biology—Individual research by arrangement with out-of-department instructors. Credit for 199X is restricted to declared Biological Sciences majors and requires department approval. See http://biohonors.stanford.edu for information on research sponsors, units, petitions, deadlines, credit for summer research, and out-of-Stanford research, or email gastrula@stanford.edu.

1-15 units, Aut, Win, Spr, Sum (Staff)

ADVANCED UNDERGRADUATE AND GRADUATE

BIOSCI 203. Advanced Genetics—(Same as GENE 203, DBIO 203.) For graduate students in Bioscience programs; may be appropriate for graduate students in other programs. The genetic toolbox. Examples of analytic methods, genetic manipulation, genome analysis, and human genetics. Emphasis is on use of genetic tools in dissecting complex biological pathways, developmental processes, and regulatory systems. Faculty-led discussions sections with evaluation of papers. Students with minimal experience in genetics should prepare by working out problems in college level textbooks.

4 units, Aut (Barsh, Kim, Sidow, Stearns)

BIOSCI 205. DNA Repair and Genomic Stability—Interactions of endogenous and environmental mutagens with cellular DNA. Cellular responses to damaged DNA including molecular mechanisms for DNA repair, translesion DNA synthesis, and genetic recombination. Inducible repair responses and error-prone mechanisms. Human hereditary diseases that predispose to cancer. Relationships of DNA repair to mutagenesis, carcinogenesis, aging, and human genetic disease. Current research literature. Prerequisites: 41 and 118, or consent of instructor.

3 units, Spr (Hanawalt, Ford)

BIOSCI 206. Field Studies in Earth Systems—(Same as EARTHSYS 189.) Field-based, focusing on the components and processes by which terrestrial ecosystems function. Topics from biology, chemistry, ecology, geology, and soil science. Lecture, field, and lab studies emphasize standard field techniques, experimental design, analysis of data, and written and oral presentation. Small team projects test the original questions in the functioning of natural ecosystems. Admission by application; see *Time Schedule*. Prerequisites: BIOSCI 141 or GES 160, or equivalent. GER:DB-NatSci

5 units (Chiariello, Fendorf, Matson, Miller) alternate years, given 2006-07

BIOSCI 207. Life and Death of Proteins—How proteins are made and degraded in the cell. Discussion of primary literature. Case studies follow the evolution of scientific ideas, and evaluate how different experimental approaches contribute to our understanding of a biological problem. Topics: protein folding and assembly, mechanisms of chaperone action, sorting into organelles and the ubiquitin-proteasome pathway. Enrollment limited to 20.

3 units (Frydman) not given 2005-06

BIOSCI 208. Developmental Biology—(Enroll in DBIO 210.)

5 units, Spr (Talbot, Nusse, Crabtree, Fuller, Kim, Kingsley, Scott)

BIOSCI 211. Biophysics of Sensory Transduction—Neural and aneural mechanisms that organisms have evolved to detect physical cues from the environment. Sensory topics: vision, hearing, taste, olfaction, chemoreception, mechanoreception, electromagnetic sensing, and other modalities. Emphasis is on common and/or emergent biophysical themes, such as sensitivity, amplification, encoding, adaptation, and the molecular basis of cellular signaling. Interdisciplinary aspects of biology and physics. Student presentations. Prerequisites: undergraduate physics, calculus, and basic biology. GER:DB-NatSci

4 units (S. Block) not given 2005-06

BIOSCI 213. Biology of Viruses—Principles of virus growth, genetics, architecture, and assembly. The relation of temperate viruses and other episomes to the host cell. Prerequisite: Biological Sciences core. Recommended: 118.

3 units, Win (Campbell)

BIOSCI 214. Cell Biology of Physiological Processes—(Same as MCP 221.) The basic mechanisms of membrane and cellular biogenesis in relation to physiological processes. Emphasis is on regulatory and signaling mechanisms involved in coordinating complex cellular phenomena such as cellular organization, function, and differentiation. Topics: cellular compartmentalization, transport and trafficking of macromolecules, organelle biogenesis, cell division, motility and adhesion, and multicellularity. Prerequisites: Biological Sciences core, BIOSCI 187/287.

2-5 units, Win (Kopito, Frydman, Nelson)

BIOSCI 215. Biochemical Evolution—Biochemical viewpoints on the evolutionary process. Topics: prebiotic biochemistry and the origins of life; adaptive organization of metabolism; enzyme polymorphisms and other biochemical aspects of population genetics; macromolecular phylogeny and protein clocks. Prerequisites: Biological Sciences core or substantial equivalent.

3 units, Aut (Watt)

BIOSCI 216. Terrestrial Biogeochemistry—Nutrient cycling and the regulation of primary and secondary production in terrestrial, freshwater, and marine ecosystems; land-water and biosphere-atmosphere interactions; global element cycles and their regulation; human effects on biogeochemical cycles. Prerequisite: graduate standing in science or engineering; consent of instructor for undergraduates or coterminal students.

3 units (Vitousek) alternate years, given 2006-07

BIOSCI 217. Neuronal Biophysics—Biophysical descriptions and mechanisms of passive and excitable membranes, ion channels and pumps, action potential propagation, and synaptic transmission. Introduction to dynamics of single neurons and neuronal networks. Emphasis is on the experimental basis for modern research applications. Interdisciplinary aspects of biology and physics. Literature, problem sets, and student presentations. Prerequisites: undergraduate physics, calculus, and biology. GER:DB-NatSci

4 units, Aut (Schnitzer)

BIOSCI 219. Ubiquitin and the Biology of the Cell—For graduate students and advanced undergraduates. The biochemistry, genetics, and molecular biology of the ubiquitin system and its central role in the biology of the eukaryotic cell. Topics: biochemistry and enzymology of the ubiquitin-dependent proteolysis, function of proteolysis in cell cycle control, transcriptional regulation, cellular signaling, vesicular trafficking, and quality control of misfolded proteins. The role of the ubiquitin system in the pathogenesis of neurodegenerative diseases and cancer. Student presentations. Prerequisites: 41, 42, 118 or equivalent.

5 units, Win (Fang, Kopito) alternate years, not given 2006-07

BIOSCI 220. Ecology of Microorganisms—(Same as BIOSCI 127.) Interactions between microorganisms and their environments from an ecological and evolutionary perspective. Topics: nutrient acquisition and environmental sensing, behavioral ecology, growth of cells and populations, population interactions, communities, and microbial biodiversity. Prerequisite: Biological Sciences core or equivalent, or consent of instructor. Recommended: 133, 142. GER:DB-NatSci

3 units (Bohannan) not given 2005-06

BIOSCI 221. Methods of Theoretical Population Biology—Formulation and analysis of problems in population biology using theoretical and computational numerical methods. Topics include deterministic and stochastic models, structured populations, stability and bifurcations, and data-driven models with applications in ecology and genetics. No auditors. Prerequisites: recent courses in advanced calculus and linear algebra.

4 units, Spr (Tuljapurkar)

BIOSCI 222. Exploring Neural Circuits—Seminar. The logic of how neural circuits control behavior; how neural circuits are assembled during development and modified by experience. Emphasis is on primary literature. Topics include: neurons as information processing units; simple and complex circuits underlying sensory information processing and motor control; and development and plasticity of neural circuits. Advanced undergraduates with background in physical science, engineering, and biological science may apply to enroll. Recommended: background in neuroscience.

3 units, Win (Luo)

BIOSCI 230. Molecular and Cellular Immunology—For graduate students and advanced undergraduates. Components of the immune system: structure and functions of antibody molecules; cellular basis of immunity and its regulation; molecular biology and biochemistry of antigen receptors and signaling pathways; genetic control of immunity and disease susceptibility. Emphasis is on key experimental approaches. Extra unit for discussion section on immunology literature. Prerequisite for undergraduates: Biological Sciences or Human Biology core, or consent of instructor.

4-5 units, Aut (Jones)

BIOSCI 241. Biological Macromolecules—(Enroll in SBIO 241.)

3-5 units, Aut (Puglisi, Weis, Block, Herschlag, Ferrell, McKay, Pande, Garcia)

BIOSCI 257. Plant Biochemistry—The biochemistry of plants relevant to their physiology and cell biology. Topics include: the biosynthesis, assembly, function, and regulation of cell walls; lipids; pigments; photoreceptors; transporters; and the response of plants to pathogens and stresses. Prerequisite: Biological Sciences core or equivalent, or consent of instructors. GER:DB-NatSci

3 units, Spr (Mudgett, Briggs, Frommer, Grossman, C. Somerville, S. Somerville)

BIOSCI 258. Neural Development—For Ph.D. students. Seminar; students also attend BIOSCI 158 lectures. Topics: neural induction and patterning, cell lineage, neurogenesis, neuronal migration, axonal pathfinding, synapse elimination, the role of activity, critical periods, and the development of behavior.

4 units (McConnell) alternate years, given 2006-07

BIOSCI 261A,B. Advanced Topics in Behavioral Biology—Seminar. The biological roots of aggression, competition, cooperation, and altruism. May be repeated for credit. Prerequisite: 150/250, and consent of instructor.

3 units, **261A:** *Aut,* **261B:** *Win (Sapolsky)*

BIOSCI 267. Molecular Mechanisms of Neurodegenerative Disease—(Same as NENS 267.) The epidemic of neurodegenerative disorders such as Alzheimer and Parkinson disease spawned by an aging human population. Genetic, molecular, and cellular mechanisms. Clinical aspects through case presentations.

3 units, Win (Kopito, Reimer, Wyss-Coray, So, Bronte-Stewart, Greicius) alternate years, not given 2006-07

BIOSCI 274A,B,C. Environmental Microbiology I, II, III—(Enroll in CEE 274A,B,C)

3 units, **A:** *Aut, Sum (Staff),* **B:** *Spr (Spormann),* **C:** *not given 2005-06*

BIOSCI 290. Teaching of Biological Sciences—Open to upper-division undergraduates and graduate students. Practical experience in teaching lab biology or serving as an assistant in a lecture course. May be repeated for credit. Prerequisite: consent of instructor.

1-5 units, Aut, Win, Spr (Staff)

BIOSCI 290X. Out-of-Department Teaching of Biological Science—May be repeated for credit. Prerequisite: consent of instructor.

1-5 units, Aut, Win, Spr (Staff)

BIOSCI 291. Development and Teaching of Core Experimental Laboratories—Preparation for teaching the core experimental courses (44X and Y). Emphasis is on lab, speaking, and writing skills. Focus is on updating the lab to meet the changing technical needs of the students. Must be taken prior to teaching either of the above courses. May be repeated for credit. Prerequisite: selection by instructor.

1-2 units, Aut, Win (Malladi, Yelton)

PRIMARILY FOR GRADUATE STUDENTS

BIOSCI 300. Graduate Research—For graduate students only. Individual research by arrangement with in-department instructors.

1-15 units, Aut, Win, Spr, Sum (Staff)

BIOSCI 300X. Out-of-Department Graduate Research—Individual research by arrangement with out-of-department instructors. Master's students: credit for work arranged with out-of-department instructors is restricted to Biological Sciences students and requires approved department petition. See http://biohonors.stanford.edu for information on research sponsors, units, petitions, deadlines, credit for summer research, and out-of-Stanford research, or email gastrula@stanford.edu. May be repeated for credit.

1-15 units, Aut, Win, Spr, Sum (Staff)

BIOSCI 301. Frontiers in Biology—Limited to and required for all first-year Ph.D. students interested in molecular, cellular, and developmental biology in the Department of Biological Sciences. Current research in molecular, cellular, and developmental biology emphasizing primary research literature. Held in conjunction with the department's Monday seminar series. Students and faculty meet weekly before the seminar for a student presentation and discussion of papers related to the upcoming seminar.

1-3 units, Aut, Win (Gozani, Bergmann)

BIOSCI 302,303,304. Current Topics and Concepts in Population Biology, Ecology, and Evolution—Required of first-year graduate students in population biology, and ecology and evolution; open to all graduate students. Major conceptual issues and developing topics.

302: *1-3 units, Aut,* **303:** *1-3 units, Win,* **304:** *1 unit, Spr (Staff)*

BIOSCI 305. DNA Repair and Genetic Toxicology—Seminar. Literature review and discussion of current research, emphasizing experimental approaches for studying DNA damage processing in bacteria, yeast, and mammalian cells. Enrollment limited to graduate students and advanced undergraduate students doing research in this field. Prerequisite: consent of instructor.

1-3 units, Win, Spr (Hanawalt)

BIOSCI 306. Current Topics in Integrative Organismal Biology—Limited to and required of graduate students doing research in this field. At Hopkins Marine Station.

1 unit, Aut (Epel)

BIOSCI 307. Seminar in Microbial Ecology and Evolution—Recent and classical research papers in microbial ecology and evolution. Presentation of research in progress by participants. May be repeated for credit. Prerequisite: consent of instructor.

1 unit, Aut, Win, Spr (Bohannan)

BIOSCI 312. Ethical Issues in Ecology and Evolutionary Biology—Focus is on ethical issues addressed in the *Academic Duty* and others of importance to academics and scientists in the fields of ecology, behavior, and evolutionary biology. Discussions led by faculty and outside guests. Satisfies ethics course requirement for ecology and evolutionary biology. Prerequisite: graduate standing in the ecology and evolutionary biology or marine program, or consent of instructor.

1 unit, Aut (Ehrlich)

BIOSCI 315. Seminar in Biochemical Evolution—Literature review and discussion of current topics in biochemical evolution and molecular evolutionary genetics. Prerequisite: consent of instructor.

1-3 units, Spr (Watt)

BIOSCI 342. Plant Biology Seminar—Topics announced at the beginning of each quarter. Current literature. May be repeated for credit.

1-15 units, Aut, Win, Spr (Walbot, Long, Mudgett, C. Somerville, S. Somerville, Barton, Berry, Frommer, Grossman, Wang)

BIOSCI 344. Advanced Seminar in Cellular Biology—Enrollment limited to graduate students directly associated with departmental research groups working in cell biology.

1-3 units, Aut, Win, Spr (Burkholder, Cyert, Fang, Frydman, Kopito, Rexach, Stearns)

BIOSCI 346. Advanced Seminar on Prokaryotic Molecular Biology—Enrollment limited to graduate students associated with departmental research groups in genetics or molecular biology.

1 unit, Aut, Win, Spr (Long, Campbell, Spormann, Grossman, Burkholder, Yanofsky)

BIOSCI 358. Advanced Topics in Biological Sciences—May be repeated for credit.

1-3 units, Aut, Win, Spr (B. Baker, Fernald, Luo, McConnell, Shen)

BIOSCI 383. Seminar in Population Genetics—Literature review, research, and current problems in the theory and practice of population genetics and molecular evolution. Prerequisite: consent of instructor.

1-3 units, Aut, Win, Spr (M. Feldman)

BIOSCI 384. Theoretical Ecology—(Same as GEOPHYS 185Y/385Y.) Recent and classical research papers in ecology, and presentation of work in progress by participants. Prerequisite: consent of instructor.

1-2 units, Aut, Win, Spr (Roughgarden)

BIOSCI 385. Speaking About Science—Communication about science occurs in settings such as presenting scientific work to an audience of peers, communicating difficult concepts in a classroom, or describing a new finding to a reporter. Focus is on practice in speaking about science, emphasizing strategies for making difficult ideas easy to understand and integrating visual aids into oral presentations. Limited to Ph.D. students.

2 units, Spr (McConnell) alternate years, not given 2006-07

BIOSCI 388. Communication and Leadership Skills—(Same as IPER 210.) Focus is on delivering information to policy makers and the lay public. How to speak to the media, congress, and the general public; how to write op-eds and articles; how to package ideas including titles, abstracts, and CVs; how to survive peer review, the promotion process, and give a job talk; and how to be a responsible science advocate.

2 units (Root) not given 2005-06

BIOSCI 450. Introduction to Biotechnology—(Enroll in CHEMENG 450.)

3 units, Spr (Khosla)

BIOSCI 459. Frontiers in Interdisciplinary Biosciences—(Same as CHEMENG 459, CHEM 459, PSYCH 459, BIOC 459, BIOE 459.) For specialists and non-specialists. Sponsored by the Stanford BioX Program. Three seminars per quarter address scientific and technical themes related to interdisciplinary approaches in bioengineering, medicine, and the chemical, physical, and biological sciences. Leading investigators from Stanford and the world present breakthroughs and endeavors that cut across core disciplines. Pre-seminars introduce basic concepts and background for non-experts. Registered students attend all pre-seminars; others welcome. See http://www.stanford.edu/group/biox/courses/459.html. Recommended: basic mathematics, biology, chemistry, and physics.

1 unit, Aut, Win, Spr (Robertson)

OVERSEAS STUDIES

These courses are approved for the Biological Sciences major and taught overseas at the campus indicated. Students should discuss with their major advisers which courses would best meet individual needs. Descriptions are in the "Overseas Studies" section of this bulletin, or at the Overseas Studies Office, 126 Sweet Hall.

AUSTRALIA

BIOSCI 109Z. Coral Reef Ecosystems—(Same as EARTHSYS 120X, HUMBIO 61X.) Two units only counted for Biological Sciences major.

3 units, Win (Arrigo, Dove, Hoegh-Guldberg)

BIOSCI 110Z. Coastal Resource Management—(Same as EARTHSYS 121X, HUMBIO 62X.) Two units only counted for Biological Sciences major.

3 units, Win (Johnstone)

BIOSCI 111Z. Coastal Forest Ecosystems—(Same as EARTHSYS 122X, HUMBIO 63X.) Two units only counted for Biological Sciences major.

3 units, Win (Duke, Pole)