# Biological Sciences, Division of

STUDENT AFFAIRS OFFICE
1128 Pacific Hall
(858) 534-0557
For undergraduate questions, email:
question@biology.ucsd.edu

FINANCIAL AND ADMINISTRATIVE OFFICES
1610 Urey Hall, Revelle College

http://www-biology.ucsd.edu/

**Professors**

Tim Baker, Ph.D.
Darwin K. Berg, Ph.D.
Ethan Bier, Ph.D.
Jack W. Bradbury, Ph.D., *Emeritus*
Steve Briggs, Ph.D.
Stuart Brody, Ph.D.
Ted J. Case, Ph.D., *Emeritus*
Gert Cauwenberghs, Ph.D.
Lin Chao, Ph.D., *Chair, Ecology, Behavior, and Evolution Section*
Maarten J. Chrispeels, Ph.D.
Nigel M. Crawford, Ph.D.
Russell F. Doolittle, Ph.D., *Research Professor*
Richard W. Dutton, Ph.D., *Emeritus*
Richard A. Firtel, Ph.D., *Chair, Cell and Developmental Biology Section*
Douglass J. Forbes, Ph.D.
E. Peter Geiduschek, Ph.D., *Research Professor*
Anirvan Ghosh, Ph.D.
Michael E. Gilpin, Ph.D., *Emeritus*
Melvin H. Green, Ph.D., *Emeritus*
Randolph Y. Hampton, Ph.D., *Academic Senate Distinguished Teaching Award, Chancellor's Associates Award for Excellence in Teaching*
Stephen M. Hedrick, Ph.D.
Donald R. Helinski, Ph.D., *Research Professor*
John J. Holland, Ph.D., *Emeritus*
John Huelsenbeck, Ph.D.
Randall S. Johnson, Ph.D.
James T. Kadonaga, Ph.D., *Chair, Molecular Biology Section*
William B. Kristan, Jr., Ph.D., *Chair, Neurobiology Section*
Russell S. Lande, Ph.D.
Dan L. Lindsley, Ph.D., *Research Professor*
William F. Loomis, Jr., Ph.D.
Eduardo R. Macagno, Ph.D., *Dean, Richard C. Atkinson Endowed Chair*
Vivek Malhotra, Ph.D.
William J. McGinnis, Ph.D.
Stanley E. Mills, Ph.D., *Emeritus*
S. Mauricio Montal, M.D., Ph.D.
Cornelis Murre, Ph.D.
Xuong Nguyen-Huu, Ph.D., *Emeritus*
Lorraine Pillus, Ph.D.
James W. Posakony, Ph.D.
Paul A. Price, Ph.D., *Academic Senate Distinguished Teaching Award*
Milton H. Saier, Ph.D.
Immo E. Scheffler, Ph.D., *Academic Senate Distinguished Teaching Award, Chancellor's Associates Award for Excellence in Teaching, Paul D. Saltman Professor of Science Endowed Chair*
Robert J. Schmidt, Ph.D.
Julian I. Schroeder, Ph.D., *Novartis Endowed Chair in Plant Sciences*
Terrence J. Sejnowski, Ph.D.
Allen I. Selverston, Ph.D., *Emeritus*
S. Jonathan Singer, Ph.D., *Research Professor/ University Professor Emeritus*
Douglas W. Smith, Ph.D., *Emeritus*
Nicholas C. Spitzer, Ph.D.
Suresh Subramani, Ph.D.
Kiyoteru Tokuyasu, Ph.D., *Emeritus*
Silvio S. Varon, M.D., *Research Professor*
Sandra L. Vehrencamp, Ph.D., *Emeritus*
Steven A. Wasserman, Ph.D.
Christopher J. Wills, Ph.D.
Flossie Wong-Staal, Ph.D., *Emeritus*
David S. Woodruff, Ph.D.
Michael P. Yaffe, Ph.D.
Martin F. Yanofsky, Ph.D.
Charles S. Zuker, Ph.D.

**Associate Professors**

Raffi V. Aroian, Ph.D.
Willie C. Brown, Ph.D., *Emeritus, Academic Senate Career Distinguished Teaching Award*
Michael David, Ph.D.
Marla B. Feller, Ph.D.
P.A.G. Fortes, M.D., Ph.D.
Partho Ghosh, Ph.D.
Joshua R. Kohn, Ph.D.
Ramón Piñón, Ph.D., *Emeritus*
Kit J. Pogliano, Ph.D.
Kaustuv Roy, Ph.D.
Percy J. Russell, Ph.D., *Emeritus*
Massimo Scanziani, Ph.D.
William R. Schafer, Ph.D.
Laurie G. Smith, Ph.D.
Yang Xu, Ph.D.

**Assistant Professors**

Peter Andolfatto, Ph.D.
Doris Bachtrog, Ph.D.
Lisa Boulanger, Ph.D.
Daniel E. Feldman, Ph.D., *Walter Heiligenberg Endowed Chair*
Ananda Goldrath, Ph.D.
Hopi Hoekstra, Ph.D.
David Holway, Ph.D.
Colin Jamora, Ph.D.
Walter Jetz, Ph.D.
Tracy Johnson, Ph.D.
Amy Kiger, Ph.D.
Karen E. Marchetti, Ph.D.
James C. Nieh, Ph.D.
Maho Niwa, Ph.D.
Amy Pasquinelli, Ph.D.
Gentry Patrick, Ph.D.
Joseph A. Pogliano, Ph.D.
Pamela Reinagel, Ph.D.
David Traver, Ph.D.
Jing Wang, Ph.D.
Yunde Zhao, Ph.D.

**Senior Lecturer with Security of Employment**

Gabriele K. Wienhausen, Ph.D., *Provost, Sixth College; Academic Senate Distinguished Teaching Award; Chancellor's Associates Faculty Award for Excellence in Teaching*

**Lecturers with Security of Employment**

Meredith Gould, Ph.D.
Muriel Nesbitt, Ph.D.
Stephanie Mel, Ph.D.

**Lecturers with Potential for Security of Employment**

Jon Christopher Armour, M.D., Ph.D.
Madeline Butler, Ph.D.
Stephanie Mel, Ph.D.

**Adjunct Faculty**

Seunghyon Choe, Ph.D.
Joanne Chory, Ph.D.
Joseph Ecker, Ph.D.
Scott Emr, Ph.D.
Ronald M. Evans, Ph.D.
Fred Gage, Ph.D.
Martyn D. Goulding, Ph.D.
Douglas R. Green, Ph.D.
Martin Haas, Ph.D.
Anthony R. Hunter, Ph.D.
Christopher Kintner, Ph.D.
Mitchell Kronenberg, Ph.D.
Nathaniel Landau, Ph.D.

Kuo-Fen Lee, Ph.D.
Marc R. Montminy, Ph.D.
Joseph Noel, Ph.D.
Dennis D.M. O'Leary, Ph.D.
Samuel Pfaff, Ph.D.
Michael Geoffrey Rosenfeld, M.D.
Oliver A. Ryder, Ph.D.
Moselio Schaechter, Ph.D.
Bartholomew M. Sefton, Ph.D.
John B. Thomas, Ph.D.
James Umen, Ph.D.
Wylie W. Vale, Ph.D.
Inder Verma, Ph.D.
Geoffrey M. Wahl, Ph.D.
Carl Ware, Ph.D.
Matthew Weitzman, Ph.D.
David J. Western, Ph.D.
John Young, Ph.D.

## *Division of Biological Sciences Required Review of Student Progress*

**Freshmen**

Entering students who have indicated the desire to major in biology (with the exception of bioinformatics) will be admitted directly to the biology major of their choice. To remain in good standing the student must complete a minimum of eight of the following courses (or equivalent) during their first five quarters at UCSD:

BILD 1, BILD 2, BILD 3

Chemistry 6A-B-C

Math 10A-20A, 10B-20B, 10C-11-20C

Physics 1A-2A, 1B-2B, 1C-2C

Chemistry 140A-141A, 140B-141B

BICD 100

BIBC 103

A student's best six grades from the eight courses listed will be used to calculate a GPA which must be at least a 2.5. If a student fails to complete the required courses, or to obtain the required minimum GPA, they will be dismissed from the biology major.

(**Note:** These are the minimal requirements to remain in the major, and do not satisfy all of the lower-division requirements of any biology major. Please consult the section regarding your particular major to ensure that you satisfy all lower-division and upper-division requirements.)

**Continuing Students**

Continuing UCSD students who wish to transfer into the major will be evaluated under the rules that were in effect the year in which they entered the university.

**Transfer Students**

Entering students who have indicated the desire to major in biology (with the exception of bioinformatics) will be admitted directly to the biology major of their choice. To remain in good standing the student must have completed eight of the following courses, or course equivalency, prior to transfer to UCSD:

BILD 1, BILD 2, BILD 3

Chemistry 6A-B-C

Math 10A-20A, 10B-20B, 10C-11-20C

Physics 1A-2A, 1B-2B, 1C-2C

Chemistry 140A-141A, 140B-141B

BICD 100

BIBC 103

A student's best six grades from the eight courses listed will be used to calculate a GPA which must be at least a 2.5. If a student fails to complete the required courses, or to obtain the required minimum GPA, they will be dismissed from the biology major. Transfer students who do not meet these requirements will be allowed a maximum of three quarters to satisfy any unmet requirements. Transfer students are therefore strongly encouraged to complete these requirements at their community college. (**Note:** These are the minimal requirements to remain in the major, and do not satisfy all of the lower-division requirements of any biology major. Please consult the section regarding your particular major to ensure that you satisfy all lower-division and upper-division requirements.)

**Exceptions**

The division will accept petitions from students to remain in the major with less than the required GPA or course work, and the success of such petitions will be evaluated based upon academic promise that is not reflected in the GPA. Exceptions might also be made to accommodate students who showed exceptional promise in laboratory experimentation, or students who had overcome extraordinary hardship while taking the required courses.

## *Division of Biological Sciences Laboratory Requirement*

**Freshmen**

The Division of Biological Sciences requires students in all biology majors, with the exception of bioinformatics, to take one biology lab before the end of the sophomore year.

**Continuing Students**

Continuing UCSD students who wish to transfer into the major will be evaluated under the rules that were in effect the year in which they entered the university.

**Transfer Students**

The Division of Biological Sciences requires students in all biology majors, with the exception of bioinformatics, to take one biology lab before the end of the sophomore year. Transfer students may petition to have community college course work cover the lab requirement. Transfer students whose community college laboratory course is determined to be equivalent in content to an existing biology lab will have completed the requirement upon transfer. Transfer students are therefore strongly encouraged to complete this requirement at their community college. Transfer students who do not meet this requirement at the time of transfer may petition the division for an extension.

## *Division of Biological Sciences Residency Requirement*

To receive a bachelor of science degree in biology from UCSD, all biology majors, including transfer students, must complete at least forty-eight or more units of upper-division course work.

To receive a bachelor of science degree in biology from UCSD, all students must complete at least nine upper-division biology courses (each course must be at least four units) in the Division of Biological Sciences while officially enrolled at UCSD. (Students participating in the Education Abroad Program (EAP), and courses at other UC campuses, may petition up to three of these courses to count toward their residency minima.) Biology courses completed through the UC Extension program (concurrent enrollment) will not be counted toward this residency requirement.

## *Satisfactory Progress*

All students admitted into a biology major must maintain satisfactory progress in order to remain in a biology program. If the GPA in biology courses for such a student falls below 2.0, he or she will be placed on probation during the quarter after the average fell below the line. If the GPA is not brought above the 2.0 level during the quarter on probation, the student will be dropped from the major.

## *Prerequisites*

All students are expected to have completed all prerequisites prior to enrolling in any biology course. Please visit the student affairs office or consult our Web page for the most current information. Prerequisites are enforced in all courses and must be taken for a letter grade. Students who have satisfied the prerequisites of a class at another college may need to be pre-authorized to enroll. Please come to the biology student affairs office (1128 Pacific Hall) BEFORE your priority enrollment to be pre-authorized.

## *Enrollment in Biology Classes by Non-Biology Students*

Because biology is a popular major, enrollment in some lower-division and upper-division biology courses is limited to biology majors, and those majors for which biology courses are required for graduation. Every effort will be made, on a space available basis, to enroll students from other majors in those biology lecture and laboratory courses which may be required for post-graduate study.

## *Concurrent Enrollment in Biology Courses*

For more information on concurrent enrollment, please call (858) 534-3400 or email concurrent@ucsd.edu.

Enrollment process for biology courses:

- Select the biology course(s) you wish to enroll in. Be sure that you've completed the prerequisites.
- Attend class starting the first day of the quarter and continue attending. During the beginning of the third week, obtain the instructor's signature on the concurrent enrollment add card (available at the UCSD Extension Student Services office). Please note that instructors are not required to admit you to the course, and that enrollment is on a space-available basis.
- If you have a signed add card, take it to Biology Student Affairs for a department stamp. Space in the course will be verified at this time. Please note that even if the instructor has signed the add card, if space is not available, the card will not be stamped.
- Return your completed UCSD concurrent enrollment card to the Extension Student Services office with your enrollment fee. Submit one card per class. Concurrent enrollment is closed after the third week of the quarter.

Note: Students enrolling in a biology course will not incur a $50 late fee if enrolling during the third week.

## *Readmission to a Biology Major*

Students who were absent for six quarters or more, and who have been readmitted to UCSD, must adhere to the major requirements in effect at the time of readmission or those subsequently established.

Readmitted students may petition to follow the major requirements in effect at the time they left UCSD. These petitions will be reviewed on a case-by-case basis.

## *Grade Requirements for the Majors*

The minimum GPA requirement (for both the major and overall UC) for graduation is 2.0. D grades in courses required for the major are acceptable, providing that the student's major GPA and overall UC GPA is at least 2.0. Students who received D and/or F grades should contact one of the Division of Biological Sciences undergraduate advisers to determine the effect of such grades on their GPAs. The biology major GPA calculation is based on upper-division courses required for the major. (Upper-division courses from other UCs, other UCSD departments, and EAP which have been approved via petition to count toward the major are counted into the major GPA. Other transfer courses do not count toward the UC or major GPA.) All courses, required for any of the eight majors, must be taken for a letter grade with the exception of BISP 195, 196, 197, or 199.

## *Students with Transfer Credit*

All courses (including prerequisites) taken at other institutions must be reviewed by the Division of Biological Sciences before they can be applied toward any major requirement. Students must obtain approval from the Biology Student Affairs office prior to taking courses outside of UCSD (for example, students wishing to take a Chem. 6BL equivalent at another institution must consult with Biology Student Affairs *before enrolling in the substitute course*). In addition, any student wishing to satisfy a major requirement with upper-division transfer work (with the exception of organic chemistry) must first submit an Undergraduate Petition. Contact Biology Student Affairs (1128 Pacific Hall) for specific information regarding transfer documentation and petition procedures.

The Division of Biological Sciences requires that students take the full content equivalencies to UCSD series in math, chemistry, and physics. The Division of Biological Sciences will follow the respective department's recommendations for equivalency. In some cases, attaining full content equivalency will require a student to complete more than two semesters in a subject. If the courses a student took do not provide full content equivalency, s/he will be required to complete the lacking material at UCSD or at a community college where the material is equivalent.

## *Programs Abroad*

The Division of Biological Sciences strongly encourages students to participate in the Education Abroad Program (EAP) or the UCSD Opportunities Abroad Program (OAP). It is very important that students who plan to participate in the UC Education Abroad Program (including the Costa Rica Tropical Ecology program) or the UCSD Opportunities Abroad Program obtain the name of a faculty adviser from the Biology Student Affairs Office in order to discuss the proposed program of study. For most EAP programs, it is strongly recommended that biology majors complete biochemistry (BIBC 100 or 102) and genetics (BICD 100) and their prerequisites before going abroad. For more information, please visit http://programsabroad.ucsd.edu.

## *Special Studies Courses*

For information on requirements and application procedures for special studies courses, students should go to the Biology Student Affairs Office (1128 Pacific Hall) or visit the Web site at http://biology.ucsd.edu/undergrad/BISP_info.html

How to apply special studies courses toward your biology major:

- Two quarters of BISP 194 (topics must vary) may count as one upper-division elective for any biology major.
- One quarter of BISP 195 may count as an upper-division elective for any biology major.
- One quarter of BISP 196, 197, or 199 may count as an upper division elective for any biology major.
- [a] *Biochemistry/Cell Biology, General Biology, Human Biology, and Physiology/Neuroscience*
  The second consecutive quarter of BISP 196 or 199, taken in the same research laboratory, may be petitioned to substitute for one of the upper-division elective lab requirements. The second quarter of BISP 196 or 199 must be complete prior to petitioning. Students are required to submit an undergraduate petition and summary of research to Biology Student Affairs.
- *Microbiology, Molecular Biology, Ecology/ Behavior, and Evolution*
  The second consecutive quarter of BISP 196 or 199, taken in the same research laboratory, may be petitioned to substitute for one of the upper-division required laboratory courses. The content of the BISP 196 or 199 must be equivalent to the content covered in the required lab in order to be approved. The second quarter of BISP 196 or 199 must be complete prior to petitioning. Students are required to submit an undergraduate petition and summary of research to Biology Student Affairs
- Subsequent quarters of BISP 195, 196, 197, or 199 may be applied toward college and university requirements.

Note: Students who are approved to use a BISP 196 or 199 to satisfy a lab requirement cannot also use BISP 196, 197, or 199 to satisfy an upper-division elective requirement.

### BISP 194—Advanced Topics in Modern Biology

Advanced Topics in Modern Biology is a two-unit topics course taught at a high level and open to upper-division students only. The course content will vary. Students should consult the quarterly *Schedule of Classes* for topics and descriptions.

### BISP 195—Introduction to Teaching in Biology

Being a teaching assistant is an important task and can provide students with experience and faculty contact which can be valuable when applying for graduate school. Students who are interested in being an undergraduate tutor should have received a strong grade in the course which they want to teach, have an overall GPA of at least 3.0, and have taken at least ninety total units. Students should apply very early in the quarter prior to the quarter they wish to teach. Applications will be accepted beginning the second week of the quarter prior to the quarter in which the student wishes to teach. All undergraduate tutor applications are online and may be accessed through the biology Web site, http://www.biology.ucsd.edu/undergrad/index.html.

### BISP 196—Honors Thesis in Biological Sciences

Students in any one of the eight biology major programs who have a 3.7 grade-point average or above in upper-division science courses, the biology major, and overall UC at the end of their junior year are eligible to undertake the honors thesis. This program covers the senior year of undergraduate study and involves a maximum of twelve units of senior thesis research (BISP 196) taken in addition to the major requirements for graduation. (Four units of senior thesis research BISP 196 are to be taken during three consecutive quarters.) Research is conducted under the supervision of a faculty member of the Division of Biological Sciences only and cannot be performed in the research labs of other departments such as the School of Medicine, SIO, etc. If there are any questions as to which faculty members are eligible, students should consult with Biology Student Affairs. The research will culminate in a senior thesis and an oral report (see below). Students who complete the program satisfactorily will have "Distinction in Biology" recorded on their transcript. Students who fail to make satisfactory progress will be advised to withdraw from the program. Students may also withdraw voluntarily from the program. Grades for BISP 196 are P, NP, or I only.

#### APPLICATION TO THE HONORS THESIS PROGRAM

1. Students interested in the program who are eligible as of the end of the spring quarter of their junior year (the fourth quarter prior to graduation) need to find a Division of Biological Sciences faculty member willing to act in the capacity of thesis adviser and inform the Biology Student Affairs Office of their intent.
2. After an adviser is selected, the student and the adviser should complete the Special Studies application form and research plan (available on the biology Web site).
3. The application form and research plan should then be submitted to the Biology Student Affairs Office. The deadline for submitting this form is the end of the eighth week of the quarter prior to the quarter the research will begin.
4. The application will be submitted to the honors thesis coordinator after eligibility has been determined.
5. If the student is approved for admission to the program, he or she will then be authorized to register for BISP 196.

Entry into the second and third quarter of the program will require submission to the honors thesis adviser of a written report in which the student summarizes the data obtained in the previous quarters. A brief oral interview with the student on this report can also be expected. If the progress made appears reasonable for an honors student, then the 196 petition will be signed. If not, the student may be dropped from the program. Completion of the program will require a final written report by the student at the end of the third quarter in addition to an oral presentation in the middle of the quarter to a suitable group of faculty and students, including the honors thesis adviser.

### BISP 197—Biology Internship Program

The Division of Biological Sciences, in collaboration with local biotech industries, created Biotechnology Internship Opportunities (BIO). The mission of BIO is to provide biology majors with an opportunity to participate in research in an industrial setting. We believe that working as

an intern in the private sector will enrich a student's educational experience. Students will gain valuable insight into the relationship between theory and practice, and hence, a better understanding of the relevance of course work in their major. Most importantly, students will learn the importance of outstanding oral and written communication skills. This course may be counted as one of the upper-division electives for a biology major, providing that no other special studies courses have already been counted toward the major. Information on BIO may be accessed through the undergraduate biology Web site, http://biointern.ucsd.edu.

To enroll in BISP 197, students must have accrued at least ninety-quarter units with an overall UC GPA of at least 3.0.

There will be one weekly scheduled meeting lasting up to 1.5 hours. Attendance and participation at these meetings are mandatory and will affect the grade a student receives. There will be three formal oral and three written presentations, interspersed with informal discussions of progress achieved. All written reports must be done with the input of the industry and must have that mentor's signature. Grading will be based on the formal and informal written and oral presentations, as well as input from the industry mentor.

**BISP 199—Individual Research for Undergraduates**

Individual Research BISP 199 is intended to provide interested and qualified biology students with an opportunity to work closely with faculty and professionals in their chosen field and can be a valuable contribution to the student's preparation for graduate school or career goals. To enroll in BISP 199, students must have accrued at least ninety quarter-units with an overall UC GPA of at least 3.0. Students may select for their instructor any professor at UCSD, but the BISP 199 application must be submitted for approval to the Division of Biological Sciences. The deadline to apply for BISP 199 is the eighth week of the quarter prior to the quarter in which the research will begin.

**AIP 197—Academic Internship Program**

Because the undergraduate research conducted through the Academic Internship Program is generally done at a site not affiliated with the UCSD Division of Biological Sciences, students who wish to request that an AIP 197 course be counted toward their major must submit an Undergraduate Petition for their request. Biology faculty will review the student's research and ascertain the project's compatibility with the student's academic goals and major requirements. Please be advised that an AIP 197 may not be approved toward major requirements. If an AIP 197 course is approved for the student's major, no other special studies course (BISP 196, 197, or 199) can be used toward the major. For further information, please see http://aip.ucsd.edu.

## Major Programs in Biological Sciences

For more information, please see biology's Web page, http://www-biology.ucsd.edu/.

The UCSD Division of Biological Sciences is structured around the different levels of biological organization—biochemical, cellular, physiological, and ecological. The research and teaching of the division emphasize the fundamentally important processes that occur at each of these levels. With a solid foundation in these processes future training and study in any area of biology is possible, from plant breeding to genetic counseling, from medical microbiology to ecological epidemiology, from veterinary science to cancer research. The UCSD campus is situated among some of the finest research institutions in the world. The Division of Biological Sciences is fortunate in having close ties with the Scripps Institution of Oceanography, the Salk Institute of Biological Studies, and the Scripps Clinic and Research Foundation, all of which open interesting avenues for motivated students.

The division offers eight different major programs, each of which provides an excellent background for future graduate or professional study. They are (1) biochemistry and cell biology, (2) biology with a specialization in bioinformatics, (3) ecology, behavior, and evolution, (4) general biology, (5) human biology, (6) microbiology, (7) molecular biology, and (8) physiology and neuroscience. The requirements of each of the majors are designed to meet the needs of a different group of students. These requirements are quite concordant, reflecting the division's philosophy that familiarity with certain basic aspects of the subject is fundamental to all specialized understanding. Bachelor of science degrees granted in each of these majors will be so designated.

The Student Affairs Office (1128 Pacific Hall) administers the undergraduate biology program for all six colleges. For complete details regarding policies and procedures pertaining to the biology programs, please contact Biology Student Affairs.

## Biochemistry and Cell Biology Major

**Please refer to the "Division of Biological Sciences Required Review of Student Progress" notice detailed earlier in the Division of Biological Sciences section of this catalog.**

This major is designed to provide students with the fundamental courses required for entry into a school of medicine or into postgraduate training in a wide variety of areas of biological and biomedical sciences: biochemistry, biophysics, genetics, molecular biology, cell biology, developmental biology, microbiology, virology, human biology (physiology, metabolism, genetic disorders), cancer biology, pharmacology, and others. The emphasis is on basic principles which help us understand those processes unique to living organisms at the molecular level.

The program includes two required upper-division biology laboratory courses to provide practical experience with modern techniques and useful technology for those seeking positions as lab technicians in clinical and basic research laboratories. The opportunity to select four elective courses allows students either to seek a still broader background in a variety of biology courses or to begin specialization in a chosen field of study.

### *Lower-Division Requirements*

BILD 1 and 3 (Note: BILD 2 is not required, but is a prerequisite for many upper-division courses.)

Chemistry 6A-B-C and 6BL

Mathematics 10A-B, and 11 or 10C or 20A-B-C

Physics 1A/1AL, 1B/1BL, 1C/1CL or 2A-B-C, and one lab

### *Upper-Division Requirements*

1. Organic Chemistry (Chemistry 140A and 140B or 141A and 141B)

2. Organic Chemistry (Chemistry 143A) or Physical Chemistry (Chemistry 105A)
3. Structural Biochemistry (BIBC 100) or Physical Biochemistry (BIBC 110) or Physical Chemistry (Chemistry 126)
4. Metabolic Biochemistry (BIBC 102)
5. Biochemical Techniques (BIBC 103)
6. Genetics (BICD 100)
7. Cell Biology (BICD 110)
8. Molecular Biology (BIMM 100)
9. One of the following seven courses: BIBC 104 (Biochemistry and Biotechnology of Plants), BIBC 110 (Physical Biochemistry), BIBC 120 (Nutrition), BIBC 130 (Marine Biochemistry, BICD 118 (Pathways of Intracellular Protein Trafficking and Compartmentation), BIMM 118 (Pharmacology), BIMM 130 (Microbial Biochemistry)
10. One upper-division biology lab to be chosen from the following: BIBC 105, BICD 101, 111, 123, 131, 133, 145, BIMM 101, 103, 121, 127, 141, BIPN 105, 145, or Chemistry 143C.
11. Four additional upper-division biology courses (each course must be at least four units) taken through the UCSD Division of Biological Sciences are required.

    **Note:** For more information on how the BISP 194, 195, 196, 197, or 199 can count toward major requirements, please see the previous section "Special Studies Courses."

The following courses offered by the Department of Chemistry and Biochemistry are recommended as electives for the biochemistry and cell biology major: Chemistry 115, 116, 122, 124, 126, 127. Please note that these courses will not count towards the Division of Biological Sciences residency requirement and must be petitioned.

## Bioinformatics Specialization in the Division of Biological Sciences

This major offers a rigorous, interdisciplinary training in the new and rapidly-evolving field of bioinformatics within the Division of Biological Sciences. Bioinformatics refers to advanced computational and experimental methods that model the flow of information (genetic, metabolic, and regulatory) in living systems to provide an integrated understanding of the systems properties of model organisms. For a detailed understanding of the large amount of qualitative and quantitative data that is currently accruing, the bioinformatician of the future must have a substantial mastery in biology, chemistry, mathematics, physics, and computer sciences. This interdisciplinary specialization will be offered by three other departments (computer science and engineering, chemistry, and bioengineering), each with their own set of requirements and electives. The program offered by the Division of Biological Sciences is aimed at a student interested in applying, and to some extent developing, tools of bioinformatics for the study of biological systems. Students will receive a B.S. degree in Biology with a Specialization in Bioinformatics. This degree will prepare students for graduate studies in biological and biomedical sciences, or provide excellent opportunities in the biomedical, pharmaceutical, biotechnology, and bioinformatics industries.

### Admission

Because the number of pre-majors and majors will be limited as described in the section on bioinformatics, student demand may exceed capacity. Therefore, admission to the specialization is not guaranteed and will be based on academic excellence, as described below. Since bioinformatics is an interdisciplinary major, a steering committee involving faculty from the participating departments will select among the best candidates applying and recommended through each department, while insuring active participation of the departments and divisions offering the major.

### Freshmen

Entering freshmen will go through a two-stage process to be admitted to a bioinformatics program. Students should enter the division as a declared major in some subdiscipline offered by the division (e.g., molecular biology, general biology, etc.) Freshmen can choose to apply for a bioinformatics pre-major after completing the following courses by the end of their first year. Admission will be based primarily on the GPA in the following courses, but also on a written statement, completion of the other listed requirements and overall academic excellence:

BILD 1

Chemistry 6A

Math 20B

Math 20C

Pre-bioinformatics majors can then choose to apply for admission to the bioinformatics major after competing CSE 11 and CSE 12 by the end of their sophomore year. Admission to the bioinformatics major within each department or division will be based on the GPA in all six screening courses. The final decision on admission to the pre-major and major will be made by the bioinformatics Steering Committee, in consultation with the departments.

If a student applies for admission to the bioinformatics specialization but is not selected after completion of the screening courses, that student will be eligible to remain in the specialization or major to which they were admitted initially. Students with undeclared majors may also apply to the bioinformatics specialization, but in the event they are not selected for this competitive major, they may choose any other major in biology as long as they satisfy the requirements of that major.

### Continuing Students

Students who have not declared the bioinformatics pre-major, but who have completed the screening courses, may apply for entry to a bioinformatics program after six quarters (the end of the sophomore year). They will be admitted on a space-available basis, after pre-majors have been screened for admission to the major.

### Transfer Students

Applicants seeking admission to a bioinformatics major must have completed the following courses with a strong GPA that is competitive with that of UCSD students applying for entry into this specialization:

a year of calculus (equivalent to Math 20A-B-C)

a year of general chemistry, with lab (equivalent to Chem 6A-B-C and 6BL)

the highest level programming course offered at the community college (equivalent to CSE 11 and 12)

at least one semester of biology (equivalent to BILD 1 and BILD 2)

Those who have not completed the equivalent courses may be admitted as pre-majors, using the same criteria that apply for UCSD students, and will be allowed a maximum of three quarters to complete pre-major requirements. Transfer stu-

dents are therefore encouraged to complete these requirements at the community college.

If a student applies for admission to a bioinformatics specialization but is not selected after completion of the screening courses, that student will remain eligible for specialization or major to which they were originally admitted.

**Lower-Division Requirements**

Mathematics 20A-B-C, 20F and Mathematics 15B or CSE 21

Chemistry 6A-B-C and lab

Physics 2A-B-C

BILD 1 and 2

BILD 94

CSE 11, CSE 12 (Students may take the slower paced version, CSE 8A + CSE 8B, instead of CSE 11.)

**Upper-Division Requirements**

1. Organic Chemistry (Chemistry 140A-B)
2. Advanced Data Structure (CSE 100 or Mathematics 176)
3. Design and Analysis of Algorithms (CSE 101 or Mathematics 188)
4. Metabolic Biochemistry (BIBC 102) or Biochemical Energetics and Metabolism (Chemistry 114B)
5. Biochemical Techniques (BIBC 103)
6. Physical Biochemistry (BIBC 110) or Physical Chemistry (Chemistry 127)
7. Genetics (BICD 100)
8. Cell Biology (BICD 110)
9. Molecular Biology (BIMM 100) or Molecular and Cellular Biochemistry (Chem 114D)
10. Recombinant DNA Lab (BIMM 101)
11. Molecular Sequence Analysis (BIMM 181)
12. Biological Databases (BIMM 182)
13. Applied Genomic Technologies (BENG 183)
14. Computational Molecular Biology (BIMM 184)
15. Bioinformatics Lab (BIMM 185)
16. Probability and Statistics (Math 186)
17. Three additional upper-division biology courses (each course must be at least four units) taken through the UCSD Division of Biological Sciences are required.

## Ecology, Behavior and Evolution Major

**Please refer to the "Division of Biological Sciences Required Review of Student Progress" notice detailed earlier in the Division of Biological Sciences section of this catalog.**

This major includes the fields of population biology, ecology, conservation biology, animal behavior, population genetics, biogeography, and evolution. These fields have in common a focus on evolutionary processes and whole organisms in relation to each other and to their environments. Research careers in ecology, behavior, and evolution can be found in universities, government agencies, and the biotechnology industry. More applied careers for ecologists are equally varied: recent graduates now work in forestry and wildlife management, as ecological consultants for U.S. and foreign governments and private industry, as teachers, or in new fields such as ecological medicine and epidemiology, environmental design and planning, and conservation biology. Because organismal biology spans such a wide variety of topics, this major has been designed to provide the basic fundamentals while allowing maximum flexibility within the general topic areas.

### *Lower-Division Requirements*

BILD 1, 2, and 3

Chemistry 6A-B-C. Laboratories in chemistry are not required.

Mathematics 10A-B, and 11 or 10C or 20A-B-C

Physics 1A/1AL, 1B/1BL, 1C/1CL or 2A-B-C

### *Upper-Division Requirements*

1. Genetics (BICD 100)
2. Biometry (BIEB 100)
   This course is a prerequisite for several core courses and should be taken in the first or second year.
3. Introductory Ecology (BIEB 102)
4. Evolution (BIEB 150)
5. Seven core courses to be chosen from BIEB 121-180 are required. At least two of these courses must be laboratory or field courses (BIEB 121, 131, 165, 167, and/or 179). Laboratory courses may be taken concurrently with the prerequisite lecture course *if Biometry (BIEB 100) has been taken*. Note that some of the courses may not be offered every year. For that reason, it is recommended that students take as many required courses as possible when the courses are offered. Students who take the intensive EAP field courses in tropical biology offered in Costa Rica or marine biology in Australia will receive credit toward their degree. All EAP courses must be petitioned upon return. Consult the Education Abroad Program Office at the UCSD International Center for details.
6. Three additional upper-division courses (each course must be at least four units) in biology or other departments are required. EBE-related courses are offered in mathematics, chemistry, environmental systems, earth sciences, economics, biological anthropology, urban studies (GIS), some other social science departments, and in the graduate programs at SIO (marine biology and oceanography) and IR/PS. *Students are required to meet the Division of Biological Sciences residency requirement.* Courses to be completed outside of the Division of Biological Sciences **must be petitioned** (prior to enrollment) to satisfy this requirement. EBE students whose graduate education or careers require biochemistry should take Organic Chemistry 140A, 140B, and Metabolic Biochemistry (BIBC 102) to satisfy this three-course requirement.

   **Note:** For more information on how the BISP 194, 195, 196, 197, or 199 can count toward major requirements, please see the previous section "Special Studies Courses."

## General Biology Major

**Please refer to the "Division of Biological Sciences Required Review of Student Progress" notice detailed earlier in the Division of Biological Sciences section of this catalog.**

This program allows the most diversified exposure to biology of any of the majors offered by the Division of Biological Sciences. It is designed for students with broad interests who do not wish to be constrained by the specialized requirements of the other majors and who desire maximum freedom to pursue their particular educational goals.

### *Lower-Division Requirements*

BILD 1, 2, and 3
Chemistry 6A-B-C and BL
Mathematics 10A-B, and 11 or 10C or 20A-B-C
Physics 1A/1AL, 1B/1BL, 1C/1CL or 2A-B-C and one lab

### *Upper-Division Requirements*

1. Organic Chemistry (Chemistry 140A and 140B or 141A and 141B)
2. Metabolic Biochemistry (BIBC 102)
3. Genetics (BICD 100)
4. Two upper-division biology labs to be chosen from the following: BIBC 103, 105, BICD 101, 111, 123, 131, 133, 145, BIEB 121, 165, 167, 179, BIMM 101, 103, 121, 127, BIPN 105, or 145.
5. Seven additional upper-division biology courses (each course must be at least four units) taken through the UCSD Division of Biological Sciences are required.

   **Note:** For more information on how the BISP 194, 195, 196, 197, or 199 can count toward major requirements, please see the previous section "Special Studies Courses."

Although students are free to design upper-division curricula which meet their individual educational goals, Molecular Biology (BIMM 100) and Cell Biology (BICD 110) are strongly recommended for those contemplating applying to graduate or professional schools.

## Human Biology Major

This major is designed to provide students with the fundamental courses required for entry into: schools of medicine, veterinary medicine, dentistry, and pharmacy; Ph.D. programs in the biomedical sciences; and biotech research, teaching, medical technology, patent law, physical therapy, nutrition, and nursing. The core classes required of all human biology majors provide the student with the basic principles that help us understand normal human physiology and the molecular basis of human disease. The course options in Human Physiology, Human Disease, and Biomedical-related laboratories provide the students with educational breadth while still allowing them considerable flexibility in tailoring their course of study to suit their educational goals.

### *Lower-Division Requirements*

BILD 1 and 3 (Note: BILD 2 is not required, but is a prerequisite for many upper-division courses.)

Chemistry 6A-B-C and 6BL

Physics 1A/1AL, 1B/1BL, 1C/1CL or Physics 2A-B-C and one lab

Mathematics 10A-B, and 11 or 10C or 20A-B-C

### *Upper-Division Requirements*

1. Organic Chemistry (Chemistry 140A and 140B or 141A and 141B)
2. Organic Chemistry Lab (Chemistry 143A)
3. Metabolic Biochemistry (BIBC 102)
4. Genetics (BICD 100)
5. Molecular Biology (BIMM 100)
6. Molecular Basis of Human Disease (BIMM 110)
7. Mammalian Physiology I (BIPN 100)
8. Three courses from the following two groups, Human Physiology and Human Disease. At least one course must be taken from each group.

   **Human Physiology**
   Nutrition (BIBC 120)
   Embryos, Genes, and Development (BICD 130)
   Human Reproduction and Development (BICD 134)
   Immunology (BICD 140)
   Endocrinology (BICD 150)
   Mammalian Physiology II (BIPN 102)
   Biology of Exercise (BIPN 108)
   Cellular Basis of Learning and Memory (BIPN 148)

   **Human Disease**
   AIDS Science and Society (BICD 136)
   Topics in Human Genetics (BICD 170)
   Virology (BIMM 114)
   Pharmacology (BIMM 118)
   Bacteriology (BIMM 120)
   Medical Microbiology (BIMM 124)
   Biology of Cancer (BIMM 134)
9. Two of the following lab courses:
   Biochemical Techniques (BIBC 103)
   Signal Transduction Lab (BIBC 105)
   Cell Biology Lab (BICD 111)
   Embryology Lab (BICD 131)
   Developmental Biology Lab (BICD 133)
   Laboratory in Molecular Medicine (BICD 145)
   Recombinant DNA Techniques (BIMM 101)
   Microbiology Lab (BIMM 121)
   Animal Physiology Lab (BIPN 105)
10. At least two other upper-division courses (each course must be at least four units) offered by the UCSD Division of Biological Sciences. Recommended courses include additional courses from the Human Physiology and Human Disease lists in section 8 above and BICD 110 (Cell Biology), BIEB 154 (Molecular Evolution), and BICD 118 (Pathways of Intracellular Protein Trafficking and Compartmentation).

    **Note:** For more information on how the BISP 194, 195, 196, 197, or 199 can count toward major requirements, please see the previous section "Special Studies Courses."

## Microbiology Major

**Please refer to the "Division of Biological Sciences Required Review of Student Progress" notice detailed earlier in the Division of Biological Sciences section of this catalog.**

The microbiology major is designed to prepare students for graduate studies and for professional careers in a variety of health-related programs. The specialization in microbiology can provide the basic background for work in medical technology, or for further training in public health or other health-related specialties. The program is also designed to provide a foundation for graduate studies in microbiology, virology, and a variety of allied fields as well as for medical and dental school.

### *Lower-Division Requirements*

BILD 1 and 3 (Note: BILD 2 is not required, but is a prerequisite for many upper-division courses.)

Chemistry 6A-B-C and BL

Mathematics 10A-B, and 11 or 10C or 20A-B-C

Physics 1A/1AL, 1B/1BL, 1C/1CL or 2A-B-C and one lab

### *Upper-Division Requirements*

1. Organic Chemistry (Chemistry 140A-B or 141A-B)
2. Organic Chemistry Laboratory (Chemistry 143A)
3. Metabolic Biochemistry (BIBC 102)
4. Biochemical Techniques (BIBC 103)
5. Genetics (BICD 100)

6. Immunology (BICD 140)
7. Molecular Biology (BIMM 100)
8. Virology (BIMM 114)
9. Bacteriology (BIMM 120)
10. Laboratory in Microbiology (BIMM 121)
11. Medical Microbiology (BIMM 124)
12. Three additional upper-division biology courses (each course must be at least four units) taken through the UCSD Division of Biological Sciences are required. Other courses of special interest to microbiology majors are listed below:

    Cell Biology (BICD 110)

    Regulation of Gene Activity in Eucaryotic Cells (BIMM 112)

    Microbial Genetics (BIMM 122)

    Recombinant DNA Techniques (BIMM 101)

    **Note:** For more information on how the BISP 194, 195, 196, 197, or 199 can count toward major requirements, please see the previous section "Special Studies Courses."

## Molecular Biology Major

**Please refer to the "Division of Biological Sciences Required Review of Student Progress" notice detailed earlier in the Division of Biological Sciences section of this catalog.**

The program for molecular biology is designed to provide an intensive exposure to the theoretical concepts and experimental techniques of molecular biology. The concepts and techniques of molecular biology are the foundation for the studies of all aspects of biology in modern time. A focus on molecular biology, therefore, provides an excellent preparation for a wide range of advanced studies including basic research, medicine, bioengineering, and biotechnology. Considerable emphasis is placed on chemistry, biochemistry, and genetics for students enrolled in the program. As such, it is recommended for those students who have a particularly strong interest in this field of study.

### *Lower-Division Requirements*

BILD 1 and 3 (Note: BILD 2 is not required, but is a prerequisite for many upper-division courses.)

Chemistry 6A-B-C and BL

Mathematics 20A-B-C

Physics 1A/1AL, 1B/1BL, 1C/1CL or 2A-B-C, and one lab

### *Upper-Division Requirements*

1. Organic Chemistry (Chemistry 140A-B or 141A-B)
2. Organic Chemistry Laboratory (Chemistry 143A) or Physical Chemistry Laboratory (Chemistry 105A)
3. Structural Biochemistry (BIBC 100)
4. Metabolic Biochemistry (BIBC 102)
5. Biochemical Techniques (BIBC 103)
6. Genetics (BICD 100)
7. Cell Biology (BICD 110)
8. Molecular Biology (BIMM 100)
9. Recombinant DNA Techniques (BIMM 101)
10. Regulation of Gene Activity in Eukaryotic Cells (BIMM 112)
11. Microbial Genetics (BIMM 122)
12. Four additional upper-division biology courses (each course must be at least four units) taken through the UCSD Division of Biological Sciences are required. Attention is drawn to BICD 120, BICD 122, BICD 140, BIMM 110, and BIMM 114.

    **Note:** For more information on how the BISP 194, 195, 196, 197, or 199 can count toward major requirements, please see the previous section "Special Studies Courses."

## Physiology and Neuroscience Major

**Please refer to the "Division of Biological Sciences Required Review of Student Progress" notice detailed earlier in the Division of Biological Sciences section of this catalog.**

This major provides a program for studying the bodily and neural functions of complex organisms. A student may concentrate upon a more specialized area of study, such as neurobiology, animal physiology, or endocrinology.

This major is designed to provide students with the fundamental courses required for entry into medical school, graduate school in biological or neural sciences, or entry into other health-related professions such as nursing, dentistry, veterinary medicine, pharmacy, physical therapy, physical education, agriculture, and wildlife management.

### *Lower-Division Requirements*

BILD 1 and 3 (Note: BILD 2 is not required, but is a prerequisite for many upper-division courses.)

Chemistry 6A-B-C and BL

Mathematics 10A-B, and 11 or 10C or 20A-B-C

Physics 1A/1AL, 1B/1BL, 1C/1CL or 2A-B-C, and one lab

### *Upper-Division Requirements*

1. Organic Chemistry (Chemistry 140A, 140B, or 141A, 141B)
2. Organic Chemistry Laboratory (Chemistry 143A)
3. Metabolic Biochemistry (BIBC 102)
4. Genetics (BICD 100)
5. Molecular Biology (BIMM 100)
6. Four from the following eight courses:
   Mammalian Physiology I (BIPN 100)
   Mammalian Physiology II (BIPN 102)
   Comparative Physiology (BIPN 106)
   Cellular Neurobiology (BIPN 140)
   Systems Neurobiology (BIPN 142)
   Developmental Neurobiology (BIPN 144)
   Computational Neurobiology (BIPN 146)
   Cellular Basis of Learning and Memory (BIPN 148)
7. One of four laboratories (BICD 131, BICD 133, BIPN 105, BIPN 145)
8. One upper-division biology lab to be chosen from the following: BIBC 103, 105, BICD 101, 111, 123, 131, 133, 145, BIEB 121, 131, 165, 167, 179, BIMM 101, 103, 121, 127, BIPN 105, 145. This requirement may include a lab from number 7 that has not already been taken by the student.
9. Three additional upper-division biology courses (each course must be at least four units) taken through the UCSD Division of Biological Sciences are required and may include the above (numbers 6–8) if not already taken.

   **Note:** For more information on how the BISP 194, 195, 196, 197, or 199 can count toward major requirements, please see the previous section "Special Studies Courses."

## Minor in Biological Sciences

To receive a minor from the Division of Biological Sciences, a student must complete at least seven four-unit biology courses (for a total of at least twenty-eight units of course work).

### *Lower-Division Requirements*

BILD 1 and 3
*or*
BILD 10 and 3

### *Upper-Division Requirements*

- Any five upper-division biology courses offered by the Division of Biological Sciences at UCSD
- Students may apply transferable biology courses from another institution toward the lower-division requirements, after obtaining approval from the UCSD Division of Biological Sciences.
- No courses taken outside of the Division of Biological Sciences may be applied toward the biology minor.
- All courses must be taken for a letter grade.
- The minimum GPA requirement for the biology minor is 2.0 in the upper-division courses.
- Advanced placement (AP) biology scores may be applied toward the minor.
- BISP 195 may not be used toward the biology minor. One quarter of BISP 196, 197, or 199 may be counted toward the minor.
- Students may not minor and major in the Division of Biological Sciences.

## Secondary School Biology Teaching

UCSD's biological sciences division is committed to the education of future biology teachers and offers an excellent preparation for teaching biology in secondary schools. If you are interested in earning a California teaching credential from UCSD, contact the Teacher Education Program for information about the prerequisite and professional preparation requirements. It is recommended that you contact TEP and the Biology Student Affairs Office early in your academic career to help you plan a suitable biology curriculum. If you plan to get your credential at another institution, keep in mind that a broad education in biology is the best preparation to become a teacher.

We suggest that students take courses in plant and animal biology, microbiology, ecology, population biology, evolution, marine biology, genetics, and biochemistry. Courses in cellular and molecular biology are also advisable. After completion of BILD 1, 2, and 3, a suggested program of upper-division courses would be: BIBC 100 or 102, BICD 100, 120, 130, BIEB 102, 150, BIPN 106, SIO 275B. This would give you as a prospective teacher the required breadth of education.

## Integrated Bachelor's/ Master's Degree Program

An integrated program leading to a bachelor of science degree and a master of science degree in biology is offered to those undergraduate students who are enrolled in any of the major programs offered by the Division of Biological Sciences at UCSD. Qualified students are able to obtain the M.S. degree within one year following receipt of the B.S. degree. Students interested in applying to this program should meet with the BS/MS adviser in the Biology Student Affairs Office BEFORE the end of their junior year.

The program is open only to UCSD undergraduates. The Division of Biological Sciences does not have financial aid available for students enrolled in this program.

### *Eligibility and Enrollment*

To be eligible, students must have completed the first two quarters of their junior year in residence at UCSD and must have an overall UC GPA of at least 3.0. Students' major GPA should be at least 3.3. Students must demonstrate excellent performance in upper-division biology core courses during their undergraduate program to be eligible to enroll in biology graduate core courses.

It is the responsibility of the prospective B.S./M.S. student to select a faculty member (from the Division of Biological Sciences) who would be willing to serve as the student's adviser and in whose laboratory the student would complete at least twenty-four units of research over a two-year period. The units of research which must be completed during the student's senior undergraduate year, must be taken IN ADDITION to the requirements for the bachelor's degree. These units will count toward the requirements for the master's degree only. Students must complete six consecutive quarters of research to fulfill the research component of the program. Any deviation from this plan, such as a break in enrollment for one or more quarters, will be cause for the student to be dropped from the program.

Students who have been approved (by both the Division of Biological Sciences and the UCSD Office of Graduate Admissions) for the program must enroll in a Special Studies Course, BISP 199 (senior year) or BGGN 271 (graduate year), for each, and every, quarter of participation in the B.S./M.S. program. Students can obtain the appropriate course code and division stamp at the Biology Student Affairs Office.

Research work (BGGN 271) will be credited toward the B.S./M.S. program requirements only if it is completed during the time a student is officially enrolled at UCSD and has paid tuition for that quarter.

### *Requirements for the Master of Science Degree*

1. Completion of six consecutive quarters of research during the senior undergraduate year and the graduate year.
2. Completion of at least thirty-six units of graduate course work (BGGN 200-level or higher, or approved [via petition] graduate courses offered by related departments at a similar level) during the graduate year. The course of study must be approved by the faculty adviser.
3. Twelve of the thirty-six units must be in courses other than BGGN 271 (BGGN 297 and BGGN 299 may not be used to satisfy this requirement).
4. Serve as a graduate teaching assistant.
5. Maintenance of a grade-point average (both overall and in the major) of at least 3.0 for all course work, both cumulatively and for each quarter of enrollment in the B.S./M.S. program. If the student's GPA falls below 3.0 (for either overall or in the major), he or she will be automatically dropped from the program.
6. Completion of a thesis, with an oral presentation to, and approval of, a three-member Thesis Committee. A student may have any regular faculty at UCSD or any adjunct faculty as their adviser and chair of their Thesis Committee. The Thesis Committee must contain at least two regular faculty from the Division of

Biological Sciences and no more than one adjunct faculty can serve on the committee. If an adjunct faculty serves as chair of the Thesis Committee, one of the biology members must serve as co-chair.

7. At least three complete, separate, and consecutive quarters of residency as a graduate student which will commence the quarter immediately following the quarter in which the B.S. degree is awarded. (Note: The summer session is not considered an official quarter during the graduate year.)
8. Students who have been approved for the B.S./M.S. program must provide the Office of Graduate Admissions with a copy of their official UCSD transcripts with the B.S. degree posted, PRIOR TO THE COMMENCEMENT OF THE GRADUATE YEAR IN THE PROGRAM.

## Non-Degree Program

The Division of Biological Sciences will accept applicants into the non-degree program for a maximum of one year only. Qualified applicants must have at least a 3.0 GPA in their upper-division work to be accepted. Justification will not be made for those who fall below the GPA minimum.

Students who wish to apply to the UCSD biological sciences Ph.D. program at a later date should not apply for this program. However, students who have applied to graduate or medical schools elsewhere, but have not yet been accepted, are welcome to apply.

Once accepted into this program, the student has graduate status for the academic year. Courses may be taken on the undergraduate or graduate level with consent of the instructor. Students will not be assigned faculty advisers and must make their own academic plans.

## The Doctoral Program

Graduate studies for a Ph.D. degree in the Division of Biological Sciences in affiliation with the Salk Institute are oriented mainly toward the development of the capacity for independent research and for teaching in the biological sciences.

The requirements for entrance to graduate study in the Division of Biological Sciences are flexible, but a strong background in mathematics, chemistry, and physics is recommended.

Formal course work and opportunities for dissertation research include most basic areas of experimental biology, with emphasis in the general areas of biochemistry, biophysics, cell biology, developmental biology, genetics, immunology, molecular biology, neurobiology, plant molecular biology, ecology, behavior and evolution, virology, and cancer biology.

During the first year of graduate study, each student undertakes a research project in the laboratory of each of four to six different faculty members, and is expected to spend a major portion of his or her academic time on this project. The laboratories are selected by the student in consultation with the first year adviser to provide a broad view of the research interests of the division. The student is also expected to enroll in the first-year graduate biology sequence which includes advanced material in genetics, developmental biology, plant biology, neurobiology, molecular biology, cell biology, virology, and immunology. Students are also required to complete a minimum of twelve units of BGGN 500 (Apprentice Teaching in Biology.) A program of further study, including seminars and courses appropriate to a student's background and interests, is arranged through consultation between the student and the faculty. Much reliance is placed on informal instruction through early and close association of the student with the faculty and research staff, and through regular seminars. After becoming familiar with the research activities of the faculty through the laboratory rotation program, the student begins work on a thesis research problem of his or her choice no later than the end of the first year. The student is free to choose for the thesis adviser a regular member of the UCSD faculty or an adjunct member of the Division of Biological Sciences faculty. The student is required to have completed a two-part examination in order to be admitted to candidacy for the Ph.D. degree. The purpose of the examinations is for the student to demonstrate competence in the field of major interest and in related fields of biology. The major remaining requirement for the Ph.D. degree is the satisfactory completion of a dissertation consisting of original research carried out under the guidance of a faculty member.

Close collaboration with members of the Department of Chemistry and Biochemistry is a vital and stimulating aspect of the biology program. Additional strength and breadth in biology are gained by collaborating with the Department of Marine Biology of the Scripps Institution of Oceanography, with The Scripps Research Institute, and with the Salk Institute for Biological Studies.

### *Divisional Ph.D. Time Limit Policies*

Students must be advanced to candidacy by the end of four years. Total university support cannot exceed seven years. Total registered time at UCSD cannot exceed seven years.

### *Specialization in Computational Neurobiology*

Students interested in computational neurobiology may apply to the Division of Biological Sciences. These young scientists are trained in the broad range of scientific and technical skills essential to understand the computational resources of neural systems. Students in this program have the opportunity to join labs of faculty from several participating departments, including the Departments of Neurosciences, Cognitive Science, and ECE.

### *Joint Doctoral Program with San Diego State University*

The Division of Biological Sciences at UCSD participates in a joint graduate program with the Department of Biology at SDSU, primarily in the areas of cell and molecular biology, and leading to the Ph.D. degree in biology. Graduate student participants in the joint doctoral program are required to spend one year enrolled at UCSD; thesis research is carried out under the supervision of the SDSU faculty.

Information regarding admission is found in the current edition of the San Diego State University Graduate Bulletin.

## COURSES

***For course descriptions not found in the 2006–2007* General Catalog, *please contact the department for more information.***

**NOTE: The division will endeavor to offer the courses as outlined below; however, unforeseen circumstances sometimes mandate a change of scheduled offerings, especially the quarter offered (F,W,S). The following schedule is tentative for the academic**

**year 2006–2007 only. It should not be assumed that the same schedule will continue after this academic year.Students are strongly advised to check the Schedule of Classes or with the division's Student Affairs Office (1128 Pacific Hall) before relying on the following schedule. Courses required for the major may be scheduled on the same day and/or same time. This is of particular importance in planning schedules for graduation requirements.**

**Students who have satisfied the prerequisites for courses at another college or by AP credit may need to be pre-authorized to register for the course. Please come to the Biology Student Affairs Office before your registration time to be authorized. If the class is full please place your name on the waitlist and attend the first class meeting.**

**Students who do not attend the first thirty minutes of the first scheduled meeting (be it lab or lecture) will be considered not enrolled in the course and may be administratively dropped. Prior written notification to the instructor regarding an anticipated absence will ensure a space. However, responsibility for officially dropping the lab from the registrar's records belongs to the student.**

**IF A STUDENT DROPS A LAB COURSE AFTER THE END OF THE SECOND SESSION, THE DIVISION WILL REPORT A "W" FOR THE COURSE.**

## LOWER-DIVISION

**BILD 1. The Cell (4)**
An introduction to cellular structure and function, to biological molecules, bioenergetics, to the genetics of both procaryotic and eucaryotic organisms, and to the elements of molecular biology. Three hours of lecture and one hour of recitation. *Prerequisite: BILD 1 (F,W,S)*

**BILD 2. Multicellular Life (4)**
An introduction to the development and the physiological processes of plants and animals. Included are treatments of reproduction, nutrition, respiration, transport systems, regulation of the internal environment, the nervous system, and behavior. Three hours of lecture and one hour of recitation. *Prerequisite: BILD 1*. (F,W,S)

**BILD 3. Organismic and Evolutionary Biology (4)**
The first principles of evolutionary theory, classification, ecology, and behavior; a phylogenetic synopsis of the major groups of organisms from viruses to primates. Three hours of lecture and one hour of lab. *Prerequisite: none.* Note: E.B.E. majors should complete this course during their first year at UCSD. (F,W,S)

**BILD 7. The Beginning of Life (4)**
An introduction to the basic principles of plant and animal development, emphasizing the similar strategies by which diverse organisms develop. Practical applications of developmental principles as well as ethical considerations arising from these technologies will be discussed. *Prerequisite: none.* (S)

**BILD 10. Fundamental Concepts of Modern Biology (4)**
An introduction to the biochemistry and genetics of cells and organisms; illustrations are drawn from microbiology and human biology. Three hours of lecture and one hour of discussion. This course is designed for non-biology students and does not satisfy a lower-division requirement for any biology major. Note: Students may not receive credit for BILD 10 after receiving credit for BILD 1. (F,W,S)

**BILD 12. Neurobiology and Behavior (4)**
An introduction to the organization and functions of the nervous system; topics include molecular, cellular, developmental, systems, and behavioral neurobiology. Three hours of lecture and one hour of discussion. This course is designed for non-biology students and does not satisfy a lower-division requirement for any biology major.

**BILD 16. History of Life (4)**
Life has a very long history on earth and this course will chronicle patterns of biological diversity from its origin over 3 billion years ago to the present day. Topics covered will include methods for reconstructing the history of life on this planet, the origin and evolution of major groups of plants and animals, dinosaur paleobiology, past environmental changes and their effects on species and communities, and extinctions. We will also explore how insights from the past can be used to understand how present and future environmental changes will impact biological diversity. This course is designed for non-biology majors.

**BILD 18. Human Impact on the Environment (4)**
Course will focus on issues such as global warming, species extinction, and human impact on the oceans and forests. History and scientific projections will be examined in relation to these events. Possible solutions to these worldwide processes and a critical assessment of their causes and consequences will be covered. *Prerequisite: none.* (S)

**BILD 20. Human Genetics in Modern Society (4)**
Fundamentals of human genetics and introduction to modern genetic technology such as gene cloning and DNA finger printing. Applications of these techniques, such as forensic genetics, genetic screening, and genetic engineering. Social impacts and ethical implications of these applications. This course is designed for non-biology students and does not satisfy a lower-division requirement for any biology major. Note: Students may not receive credit for BILD 20 after receiving credit for BICD 100. (F)

**BILD 22. Human Nutrition (4)**
A survey of our understanding of the basic chemistry and biology of human nutrition; discussions of all aspects of food: nutritional value, diet, nutritional diseases, public health, and public policy. Three hours of lecture and one hour of discussion. This course is designed for non-biology students and does not satisfy a lower-division requirement for any biology major. Note: Students may not receive credit for BILD 22 after receiving credit for BIBC 120. (S)

**BILD 24. Biology of Human Reproduction (4)**
The topics covered are: sexual development in embryo and fetus, the nature and regulation of changes at puberty, the functioning of the mature sexual system. Three hours of lecture. This course is designed for non-biology students and does not satisfy a lower-division requirement for any biology major. Note: Students may not receive credit for BILD 24 after receiving credit for BICD 134. (W)

**BILD 26. Human Physiology (4)**
Introduction to the elements of human physiology and the functioning of the various organ systems. The course presents a broad, yet detailed, analysis of human physiology, with particular emphasis towards understanding disease processes. Three hours of lecture and one hour of discussion. This course is designed for non-biology students and does not satisfy a lower-division requirement for any biology major. (F)

**BILD 30. The Biology of Plagues: Past and Present (4)**
An introduction to diseases caused by viruses, bacteria, and parasites, and the impact of these diseases on human society. Topics include the biology of infectious disease, epidemiology, and promising new methods to fight disease. Three hours of lecture and one hour discussion. This course is designed for non-biology majors and does not satisfy a lower-division requirement for any biology major. (**Note:** Students may not receive credit for BILD 30 after receiving credit for BIMM 120.) (S)

**BILD 32. Biomedicine/Cancer (4)**
An introduction to molecular, cellular, and immunological aspects of cancer and a consideration of the sociological and psychological impact of cancer on the individual and general society. Three hours of lecture. This course is designed for non-biology students and does not satisfy a lower-division requirement for any biology major. Note: Students may not receive credit for BILD 32 after receiving credit for BIMM 134.

**BILD 36. AIDS Science and Society (4)**
An introduction to all aspects of the AIDS epidemic. Topics include the epidemiology, biology, and clinical aspects of HIV infection; HIV testing; education and approaches to therapy; and the social, political, and legal impacts of AIDS on the individual and society. In order to count for their major, biology majors must take the upper-division course, BICD 136.

**BILD 87. Freshman Seminar (1)**
The freshman seminar program is designed to provide new students with the opportunity to explore an intellectual topic with a faculty member in a small seminar setting. Freshmen seminars are offered in all campus departments and undergraduate colleges, and topics vary from quarter to quarter. Enrollment is limited to fifteen to twenty students, with preference given to entering freshmen. (F,W,S)

**BILD 90. Undergraduate Seminar (1)**
This seminar is restricted to lower-division undergraduate students (freshmen and sophomores). The course introduces current biological topics. The topics vary with instructors and for each quarter. Examples of topics which may be discussed are: wildlife conservation, signalling within and between cells, mapping the human genome, etc. This course does not satisfy any requirement for the biology major, biology minor, or college general/education.

**BILD 92. Professional Topics (1)**
This seminar will introduce students to the various subdisciplines and their research methodology in the biological sciences. Emphasis will be on bioinformatics, neurophysiology, and biotechnology. Current research topics in the specialized areas in academe

and industry will be discussed. The role and professional identity of biologists in research, consulting, government, management, and teaching will be reviewed. In addition, issues surrounding professional ethics will be discussed.

**BILD 94. Professional Issues in Bioinformatics (1)**
This seminar will introduce undergraduate students, especially freshmen and sophomores, to a variety of issues and topics in the field of bioinformatics. (S)

**BILD 95. Undergraduate Workshops (1)**
The workshops will be restricted to lower-division undergraduates. The course will introduce students to the methods of scientific research and to a variety of research topics in the biological/biomedical sciences. Examples of topics are: Introduction to Scientific Research, AIDS, Medical and Social Aspects, Is the Mind the Same as the Brain, Wildlife Conservation.

**BILD 99. Independent Research (2 or 4)**
Independent research by special arrangement with a faculty member. (P/NP grades only.) Students must have an overall UCSD GPA of at least 3.0 and a minimum of thirty units complete. Students must complete a "Special Studies" form and a Division of Biological Sciences "Research Plan." Credit may not be received for a course numbered 99 subsequent to receiving credit for a course numbered 199.

## UPPER-DIVISION

### Biochemistry

**BIBC 100. Structural Biochemistry (4)**
The structure and function of biomolecules. Includes protein conformation, dynamics, and function; enzymatic catalysis, enzyme kinetics, and allosteric regulation; lipids and membranes; sugars and polysaccarides; and nucleic acids. Three hours of lecture and one hour of recitation. *Prerequisites: two quarters of organic chemistry (second quarter may be taken concurrently).* (Note: Students may not receive credit for both BIBC 100 and Chem. 114A.) (F,W,S)

**BIBC 102. Metabolic Biochemistry (4)**
Energy-producing pathways–glycolysis, the TCA cycle, oxidative phosphorylation, photosynthesis, and fatty acid oxidation; and biosynthetic pathways–gluconeogenesis, glycogen synthesis, and fatty acid biosynthesis. Nitrogen metabolism, urea cycle, amino acid metabolism, neucleotide metabolism, and metabolism of macromolecules. Three hours lecture and one hour recitation. *Prerequisites: two quarters of organic chemistry (second quarter may be taken concurrently).* Note: Students may not receive credit for both BIBC 102 and Chem. 114B.) (F,W,S)

**BIBC 103. Biochemical Techniques (4)**
Introductory laboratory course in current principles and techniques applicable to research problems in biochemistry and molecular biology. Techniques include protein and nucleic acid purification; identification methods such as centrifugation, chromatography, and electrophoresis; immunological, spectrophotometric, and enzymatic methods. *Prerequisite: BILD 1.* Students may not receive credit for BIBC 103 after taking Chem. 112A. (F, W, S)

**BIBC 104. Biochemistry and Biotechnology of Plants (4)**
The biochemical and molecular basis of plant genetic engineering to understand modern approaches to crop improvement. *Prerequisite: BILD 1; Chem 140A. BIBC 102 and Chem 140B may be taken concurrently.* (S)

**BIBC 105. Signal Transduction Laboratory (6)**
A laboratory course involving the application of molecular, cellular, and biochemical techniques to explore signal transduction mechanisms in mammalian cells. The events between ligand-biding to a cell surface receptor and activation of gene transcription in the nucleus will be studied. *Prerequisites: BIBC 100, BIBC 103 and BIMM 100.*

**BIBC 110. Physical Biochemistry (4)**
The theory and applications of physical chemistry to biological molecules, process and systems and techniques used in biochemistry and physiology. Topics include reversible and irreversible thermodynamics, bioenergetics, energy coupling and transduction, solutions of macromolecules, sedimention, chromatography, electrophoresis, passive and active membrane transport, spectroscopy, and chemical kinetics. Three hours of lecture and one hour of recitation. *Prerequisites: calculus and organic chemistry.* (W)

**BIBC 115. Computer Programming in Biology (4)**
Use of computer programming in the analysis and presentation of biological data (computation of best value and standard deviation, histogram, least squares fitting procedure, simulation of genetic experiments, etc.) Students learn the C++ computer language and run their programs at the Computer Center. There are some visits to laboratories and hospitals to see applications of computers in biology and medicine. Three hours of lecture and about ten hours of homework per week; limited enrollment. *Prerequisite: upper-division standing or consent of instructor.* (**Note**: Students may not receive credit for both BIBC 115 and Chem. 134.)

**BIBC 116 Evolution of Genes and Proteins (4)**
The history of an organism can be found in its genome. analysis of the primary sequences will be used to recognize families of genes that arose by duplication and divergence. Topics include comparisons of amino acid sequences and three dimensional structures and range from the oldest and most widely distributed proteins to modem mosaics. Where possible, specific motifs and folds will be traced to their ancestral beginnings. *Prerequisites: BIBC 100, BIMM 100.* (W)

**BIBC 120. Nutrition (4)**
Emphasis is on the biochemical aspects of nutrition. The known functions of vitamins, minerals, fats, carbohydrates, and protein are discussed in terms of experiments in nutrition and an evaluation of the relation of the knowledge to nutrition in man. Three hours of lecture. *Prerequisite: BIBC 102 (may be taken concurrently).* (W)

**BIBC 130. Marine Biochemistry (4)**
Biochemical mechanisms of adaptation in organisms to the marine environment. Special emphasis will be on the effects of pressure, temperature, salinity, oxygen, and light on the physiology and biochemistry. *Prerequisites: BIBC 102 or consent of instructor.* (F)

### Genetics, Cellular and Developmental Biology of Plants and Animals

**BICD 100. Genetics (4)**
An introduction to the principles of heredity in diploid organisms, fungi, bacteria, and viruses. Mendelian inheritance; population genetics; quantitative genetics; linkage; sex determination; meiotic behavior of chromosome aberrations, gene structure, regulation, and replication; genetic code. Three hours of lecture and one hour of recitation. *Prerequisite: BILD 1 or the equivalent.* (F,W,S)

**BICD 101. Eucaryotic Genetics Laboratory (4)**
This course emphasizes the principles of Mendelian inheritance and requires the student to apply both cytological and genetic analysis to the solution of problems in transmission genetics. One hour of lecture and seven hours of laboratory. *Prerequisite: BICD 100.* Attendance at the first lecture/lab is required. Non-attendance will result in the student's being dropped from the course roster. It is the student's responsibility to officially drop the course. (S)

**BICD 110. Cell Biology (4)**
The structure and function of cells and cell organelles, cell growth and division, motility, cell differentiation and specialization. Three hours of lecture and one hour of recitation. *Prerequisites: BIBC 100 or BIBC 102, and BICD 100.* (F,W,S)

**BICD 111. Cell Biology Laboratory (6)**
A laboratory course in the application of cellular techniques to biological problems. The establishment, growth, transformation, immortalization, and senescence of mammalian cells will be studied at the molecular and the cellular level. Ten hours of laboratory. In addition to the formal lab hours listed above, there will be an average of two hours in which students will be required to work in the class laboratory to complete experiments and prepare for presentations. *Prerequisite: BICD 110 (may be taken concurrently); BIBC 103 is strongly recommended.* Attendance at the first lecture/lab is required. Non-attendance will result in the student's being dropped from the course roster. It is the student's responsibility to officially drop the course. (F)

**BICD 118. Pathways of Intracellular Protein Trafficking and Compartmentation (4)**
This course will focus on various subcellular organelles, their function, protein traffic, disulfide bond formation, protein folding, assembly of macromolecular complexes, protein quality control, and cellular responses to misfolded proteins. The emphasis will be on experimental approaches and model systems for the analysis of these problems, and on the connection of these topics to human disease. Three hours of lecture and one hour of mandatory discussion of primary publications per week. Open to upper-division students only. *Prerequisites: BICD 110 and BIMM 100.* (W)

**BICD 120. Fundamentals of Plant Biology (4)**
An introduction to the biology of plants. Basic principles of plant anatomy, physiology, development, and diversity are covered as well as specialized topics, including plant genetic engineering, plant disease and stress, medicinal plants, plants and the environment, and sustainable agriculture. *Prerequisites: BILD 1 and 2.* (F)

**BICD 122. Plant Cellular and Molecular Biology (4)**
The cellular and molecular basis of plant development, including plant hormones, signal transduction mechanisms, light and plant growth, plant microorganism interaction, plant transformation, genetic engineering of plants. *Prerequisite: BIBC 102 required.* (W)

**BICD 123. Plant Molecular Genetics and Biotechnology Laboratory (6)**
Techniques in plant cell and tissue culture, plant transformation, genetic selection and screening of mutants, host pathogen interactions, gene regulation, organelle isolation, membrane transport. Two hours of lecture and eight hours of laboratory each week. In

addition to the formal lab hours, there will be at least eight hours in which students will be required to work in the class laboratory to complete experiments and prepare for presentations. *Prerequisites: upper-division standing; BICD 120 strongly recommended.* Attendance at the first lecture/lab is required. Non-attendance will result in the student's being dropped from the course roster. It is the student's responsibility to officially drop the course. (S)

**BICD 130. Embryos, Genes, and Development (4)**
Developmental biology of animals at the tissue, cellular, and molecular levels. Basic processes of embryogenesis in a variety of invertebrate and vertebrate organisms. Cellular and molecular mechanisms that underlie cell fate determination and cell differentiation. More advanced topics such as pattern formation and sex determination are discussed. Open to upper-division students only. Three hours of lecture and one hour of recitation. *Prerequisites: BICD 100, upper-division standing, BIBC 100 or BIBC 102; BICD 110 strongly recommended, BIMM 100 strongly recommended.* (W)

**BICD 131. Embryology Laboratory (6)**
Descriptive and experimental embryology of marine invertebrates and of vertebrates. One and one-half hours of lecture and ten hours of laboratory each week. In addition to the formal lab hours, there will be at least six and a half hours in which students will be required to work in the class laboratory to complete experiments and prepare for presentations. *Prerequisites: BILD 1; BILD 2 or BIPN 100.* Attendance at the first lecture/lab is required. Nonattendance will result in the student's being dropped from the course roster. It is the student's responsibility to officially drop the course. (F)

**BICD 133. Developmental Biology Lab (6)**
Explore fundamentals of embryonic development using advanced techniques in light and fluorescent microscopy and by analyzing developmental mutants. Course includes selecting and knocking out genes of interest followed by phenotypic analysis. Invertebrate and vertebrate organisms covered. *Prerequisites: BILD 1; BILD 2 or BIPN 100; BIMM 100 and BIMM 110 are recommended.* Attendance at the first lecture/lab is required. Nonattendance will result in the student's being dropped from the course roster. It is the student's responsibility to officially drop the course.

**BICD 134. Human Reproduction and Development (4)**
This course is addressed to the development of the human sexual system, including gametogenesis, fertilization, and embryo implantation. Emphasis is placed on the physiology of reproductive functions. Three hours of lecture and one hour of discussion. *Prerequisites: BIBC 102 and BICD 100.* (F)

**BICD 136. AIDS Science and Society (4)**
An introduction to all aspects of the AIDS epidemic. Topics will include the epidemiology, biology, and clinical aspects of HIV infection, HIV testing, education and approaches to therapy, and the social, political, and legal impacts of AIDS on the individual and society. In order to count for their major, biology majors must take the upper-division course, BICD 136. *Prerequisites: BILD 1, BILD 2 recommended.* (S)

**BICD 140. Immunology (4)**
Formation and function of the mammalian immune system, molecular and cellular basis of the immune response, infectious diseases and autoimmunity. *Prerequisites: BICD 100, BIMM 100. BIBC 100 recommended.* (W,S)

**BICD 142. Topics in Immunology (4)**
This course covers selected topics in molecular and cellular immunology at a more advanced level, and is a sequel to Immunology (BICD 140). *Prerequisites: BICD 140 and upper-division standing.* (S)

**BICD 145 Laboratory in Molecular Medicine (4)**
This course focuses upon a molecular and immunological approach to study problems in modern medical research. The emphasis will be on novel approaches in medicine, including lymphocyte biology, cancer biology, and gene transfer. *Prerequisites: BIBC 103, BIMM 100.* Attendance at the first lecture/lab is required. Nonattendance will result in the student's being dropped from the course roster. It is the student's responsibility to officially drop the course. (W)

**BICD 150. Endocrinology (4)**
Normal function and diseases of the major hormone systems of the body including the hypothalamus/pituitary axis, the thyroid gland, reproduction and sexual development, metabolism and the pancreas, bone and calcium metabolism, and the adrenal glands. *Prerequisite: BIPN 100 (may be taken concurrently).* (W)

**BICD 162. Critical Reading and Writing in the Biological Sciences (4)**
Primary literature readings in the field of cell transport on how to approach a scientific paper, how to interpret results, and how to write a paper that summarizes scientific research. *Prerequisites: Chem. 140A, 140B; either BIBC 100 or BIBC 102; BIMM 100; BICD 110 is recommended; one laboratory course (BIBC 103 or BIMM 101 or BIMM 121 or BIPN 105) or other example of research experience (BISP 199 or research experience in industry).*

**BICD 170. Topics in Human Genetics (4)**
An advanced course covering aspects of human genetics in detail and using papers from the scientific literature as the major source of information. A review of basic genetics as applied to the human species is followed by the consideration of recent genetic insights into a number of human conditions which illustrate the principles covered in the first part of the course. *Prerequisites: BICD 100 (may not be taken concurrently), BIMM 100 is strongly recommended.*

**BICD 180. Genetics of Model Organisms (4)**
Survey of various organisms used in current biological/biomedical research. Biology faculty experts discuss organisms used in their research, outline history as genetic models, tools used for laboratory study, and contributions to the wider understanding of biological systems. *Prerequisite: BICD 100.*

## Ecology, Behavior, and Evolution

**BIEB 100. Biometry (4)**
Application of statistics in biological problems. Topics: parametric statistics, (t-test, correlation, regression, ANOVA), non-parametric statistics resampling methods, experimental design. Mandatory homework to apply theory using statistical Macintosh-based programs. Instructor conducts mandatory two-hour discussion session in computer lab. Three hours of lecture and two hours of laboratory section. *Prerequisite: BILD 3 recommended.* (S)

**BIEB 102. Introductory Ecology-Organisms and Habitat (4)**
This course emphasizes principles shaping organisms, habitats, and ecosystems. Topics covered include population regulation, physiological ecology, competition, predation, and human exploitation. This will be an empirical look at general principles in ecology and conservation with emphasis on the unique organisms and habitats of California. *Prerequisite: BILD 3 or equivalent.* (F)

**BIEB 110. Vertebrate Biology (4)**
Course will introduce students to the natural history of turtles, lizards, snakes, birds, and terrestrial and marine mammals from both an ecological and evolutionary perspective. Students will conduct an independent field project. One field trip required. *Prerequisite: BILD 3. BILD 1 or 2 recommended.*

**BIEB 121. Ecology Laboratory (6)**
A laboratory course to familiarize students with ecological problem solving and methods. Sections will use the Macintosh computer and also perform outdoor field work. Two hours of lecture and eight hours of laboratory each week. In addition to the formal lab hours, there will be at least nine hours in which students will be required to work in the class laboratory to complete experiments and prepare for presentations. *Prerequisites: BIEB 100.*

**BIEB 123. Molecular Methods in Ecology and Evolution Lab (4)**
Theory and practice of molecular biology techniques used in ecological and evolutionary research. Includes isolation of DNA and RNA, PCR and its applications, DNA sequencing, gene expression analysis, bioinformatics, and ecological and evolutionary analysis of molecular data. Students may not enroll in or receive credit for both BIMM 101 and BIEB 123. *Prerequisite: BILD 3.*

**BIEB 126. Plant Ecology (4)**
This course begins with an introduction to plant population biology including whole-plant growth and physiology. We then focus on three classes of ecological interactions: plant-plant competition, plant-herbivore coevolution, and plant reproductive ecology including animal pollination and seed dispersal. *Prerequisite: BILD 3.*

**BIEB 128. Insect Ecology (4)**
This course begins with a survey of insect diversity and phylogenetic relationships. We then address ecological issues including thermal ecology, population dynamics (including outbreaks), movement and migration, competition, predation, herbivory, parasitism, insect defense, mimicry complexes, and sociality. *Prerequisite: BILD 3 or equivalent.*

**BIEB 130. Introductory Marine Ecology (4)**
An introduction to the marine environment–its physics and chemistry, the organisms which live there, and the ecological processes affecting the distributions and abundances of these organisms. *Prerequisites: BILD 3, high school physics, and chemistry.*

**BIEB 131. Marine Invertebrate Ecology Laboratory (6)**
A laboratory course introducing students to marine ecology. Students will participate in outdoor fieldwork and work in the laboratory gathering and analyzing ecological data. We will focus on ecological communities in estuary, sandy beach, and rocky intertidal habitats. Two hours of lecture and eight hours of laboratory each week. In addition to the formal lab hours, there will be at least nine hours in which students will be required to work in the class laboratory to complete experiments and prepare for presentations. *Prerequisite: BILD 3; BIEB 100.* (W)

**BIEB 132. Introduction to Marine Biology (4)**
Overview of marine organisms and their adaptations to sea life. Selected examples of physiological, behavioral, and evolutionary adaptations in response to the unique challenges of a maritime environment. *Prerequisite: BILD 3.* (F)

**BIEB 134. Introduction to Biological Oceanography (4)**
Basis for understanding the ecology of marine communities. The approach is process-oriented, focusing on major functional groups of organisms, their food-web interactions and community responses to environmental forcing, and contemporary issues in human and climate influences. *Prerequisite: upper-division standing; BILD 3 is recommended.* (W)

**BIEB 136. Ichthyology (4)**
Course will study aspects of the biology of fishes from all over the world, from the crushing pressure of the deep sea to the chilling temperatures of Antarctic waters. Students will learn about form/function that allow fishes to thrive in diverse marine environments. Students will conduct an independent field project. Field trips may be required. *Prerequisite: BILD 3 recommended.*

**BIEB 140. Biodiversity (4)**
An introduction to the patterns of geographic distribution and natural history of plants and animals living in terrestrial and marine ecosystems. We will explore: ecological and evolutionary processes responsible for generating and maintaining biological diversity; and the nature of extinction both in past and present ecosystem. *Prerequisite: BILD 3.* (S)

**BIEB 144. Quantitative Ecology and Conservation (4)**
Introduction to mathematical and statistical tools for prediction of deterministic and stochastic ecological systems, including age-structured population growth; population regulation; interspecific interaction; species diversity. Conservation biology topics include sustainable harvesting; metapopulation dynamics; extinction; case studies of endangered species. *Prerequisite: BILD 3; BIEB 100 and BIEB 102 recommended.* (F)

**BIEB 150. Evolution (4)**
Evolutionary processes are discussed in their genetic, historical, and ecological contexts. Microevolution, speciation, macroevolution, and the evolution of adaptations. Three hours of lecture and one hour of recitation. *Prerequisite: BILD 3; BIEB 100 and BIEB 102 recommended*. (S)

**BIEB 154. Molecular Evolution (4)**
This course deals with the evolution of genes and the molecules they encode. The role of mutation, selection, and drift at the molecular level are discussed. Molecular phylogenies, jumping genes, viral evolution, and searches for molecular homologies are a few of the topics covered. Three hours of lecture and one hour of discussion. *Prerequisites: BIBC 102, BICD 100, and BIMM 100 recommended.* (S)

**BIEB 156. Population Genetics (4)**
The first two-thirds of the course will cover the basic theory of population genetics, including selection, genetic drift, mutation, and migration. The last one-third of the course provides an introduction to quantitative genetics, including measurements of heritability and selection. The theory is illustrated throughout with biological examples. *Prerequisite: BICD 100. BIEB 100 is recommended.* (W)

**BIEB 164. Behavioral Ecology (4)**
A survey of the patterns of social behavior in animals and a discussion of the ecological principles underlying the evolution of animal societies. Three hours of lecture and one hour of discussion. *Prerequisite: BILD 3 recommended.* (W)

**BIEB 165. Behavioral Ecology Laboratory (6)**
This course will deal with quantitative methods for the study of animal social behaviors. Topics include spatial patterns, mating systems, and cooperation. The course includes both lab exercises and field trips. Two hours of lecture and eight hours of laboratory each week. In addition to the formal lab hours, there will be at least nine hours in which students will be required to work in the class laboratory to complete experiments and prepare for presentations. *Prerequisites: BIEB 100 and BIEB 164. (BIEB 164 may be taken concurrently.)* (S)

**BIEB 166. Animal Behavior and Communication (4)**
An integrated approach to animal behavior focusing on mechanisms of acoustic, visual, and olfactory communication. Course covers ethology and the genetics and neurobiology of behavior; orientation and navigation; and signal origins, properties, design, and evolution. *Prerequisite: BILD 3 recommended, but not required; Physics 1A or 2A, or equivalent recommended, but not required.* (S)

**BIEB 167. Animal Communication Laboratory (6)**
Laboratory exercises will introduce students to quantitative methods of visual, auditory, and olfactory signal analysis and to lab and field studies of animal signalling. Two hours of lecture and eight hours of laboratory each week. In addition to the formal lab hours, there will be at least nine hours in which students will be required to work in the class laboratory to complete experiments and prepare for presentations. *Prerequisites: BIEB 100 and BIEB 166. (BIEB 166 may be taken concurrently.)*

**BIEB 170. Applied Remote Sensing (4)**
Provides a working knowledge of remote sensing with emphasis on understanding the underlying concepts involved in the interaction of the electromagnetic spectrum and the natural world. May be taken only as part of the White Mountain Research "Integrated Methods in Ecology." *Prerequisites: consent of instructor; 3.0 GPA; departmental stamp.* For more information, consult http://www.wmrs.edu.

**BIEB 171. Landscape Analysis (4)**
Introduces perspectives on biological scales and levels of organization on how these concepts interrelate, and how they can be quantified and used for effective management. May be taken only as part of the White Mountain Research "Integrated Methods in Ecology." *Prerequisites: consent of instructor; 3.0 GPA; departmental stamp.* For more information, consult http://www.wmrs.edu.

**BIEB 172. Scientific Inquiry in Ecosystem Analysis (4)**
Designed to integrate remote sensing and landscape analysis with policy and management of natural resources in the western U.S. to foster student professional development. May be taken only as part of the White Mountain Research "Integrated Methods in Ecology." *Prerequisites: consent of instructor; 3.0 GPA; departmental stamp.* For more information, consult http://www.wmrs.edu.

**BIEB 176. Conservation and the Human Predicament (4)**
(Cross-listed with ANTH/BIO 132; however, biology majors must take the course as Biology 176.) An interdisciplinary discussion of the human predicament, the biodiversity crisis, and the importance of biological and environmental conservation in sustaining future societies. We explore the consequences of habitat destruction and species extinctions on the biosphere and human welfare. Three hours of lecture and one hour of discussion. *Prerequisite: upper-division standing and BILD 3 or consent of instructor.*

**BIEB 178. Principles of Conservation Ecology (4)**
Biodiversity will ultimately be preserved in "islands" of natural habitat. The principles of community ecology, island biogeography, and metropopulation dynamics will underlay the management decisions regarding the number, size, and locations of such reserves. Case studies are emphasized. *Prerequisite: BIEB 100.*

**BIEB 179. Conservation Biology Laboratory (6)**
Students will utilize, modify, and create computer software to solve conservation biology management problems. Topics included are pedigree analysis, stochastic population dynamics, community structure, and island biogeography. Two hours of lecture and eight hours of laboratory each week. In addition to the formal lab hours, there will be at least seven hours in which students will be required to work in the class laboratory to complete experiments and prepare for presentations. *Prerequisite: BIEB 178 or BIEB 180 (may be taken concurrently).*

## Molecular Biology, Microbiology

**BIMM 100. Molecular Biology (4)**
Molecular basis of biological processes, emphasizing gene action in context of entire genome. Chromosomes and DNA metabolism: chromatin, DNA replication, repair, mutation, recombination, transposition. Transcription, protein synthesis, regulation of gene activity. Procaryotes and eucaryotes *Prerequisites: BIBC 100 or BIBC 102, BICD 100.* (**Note**: Students may not receive credit for both BIMM 100 and Chem. 114C.) (F,W,S)

**BIMM 101. Recombinant DNA Techniques (4)**
Theory and practice of DNA cloning. This course aims at providing practical knowledge in the field of genetic engineering. Techniques covered include construction of plasmid and phage DNA libraries, screening libraries for desired DNA clones by hybridization methods, plasmid and phage DNA preparation, and DNA sequencing. Two hours of lecture, one hour of discussion, and eight hours of laboratory. *Prerequisite: BIMM 100.* Attendance at the first lecture/lab is required. Non-attendance will result in the student's being dropped from the course roster. It is the student's responsibility to officially drop the course. **Note**: Students may not receive credit for both BIMM 101 and Chem. 112B. (F,W,S)

**BIMM 103. Modern Techniques in Molecular Biology (4)**
This course focuses upon a combined biochemical and molecular genetic approach to study current biological problems. Techniques include amplification of rare nucleic acids with the polymerase chain reaction, purification and characterization of a eukaryotic protein expressed in bacteria, in vitro mutagenesis of DNA. One hour of lecture and eleven hours of laboratory. *Prerequisites: BIBC 103, BIMM 100.* Attendance at the first lecture/lab is required. Non-attendance will result in the student's being dropped from the course roster. It is the student's responsibility to officially drop the course.

**BIMM 108. Chromatin Structure and Dynamics (4)**
Chromatin is the natural state of DNA in the eukaryotic nucleus. Chromatin structure, nucleosome assembly, chromatin remodeling by ATP-dependent motor proteins, histone modifications and the histone code, heterochromatin, and the influence of chromatin upon DNA-directed processes in the nucleus will be discussed. *Prerequisite: BIMM 100.*

**BIMM 110. Molecular Basis of Human Disease (4)**
An examination of the molecular basis of human diseases. Course emphasizes inherited human disorders, and some important diseases caused by viruses. Focus on the application of genetic, biochemical, and molecular biological principles to an understanding of the diseases. Three hours of lecture. Course restricted to upper-division biology majors. *Prerequisites: BICD 100; BIBC 102; BIMM 100.* (F,S)

**BIMM 112. Regulation of Gene Activity in Eucaryotic Cells (4)**
This course explores problems in the regulation of gene activity in eucaryotic cells approached at the molecular level. The course includes the organization, structure, transcription, and regulation of eucaryotic genes; mechanism of hormonal regulation in controlling gene activity; induction of gene expression in eucaryotic cells; role of signal transduction in controlling gene expression; and regulation of gene activity during differentiation in developing systems. Examples are taken from eucaryotic microorganisms, invertebrates, as well as mammalian and other vertebrate systems. Three hours of lecture and one hour of discussion. *Prerequisite: BIMM 100.* (S)

**BIMM 114. Virology (4)**
An introduction to eucaryotic virology, with emphasis on animal virus systems. Topics discussed include the molecular structure of viruses; the multiplication strategies of the major virus families; and viral latency, persistence, and oncology. Three hours of lecture and one hour of discussion. *Prerequisite: BIMM 100.* (S)

**BIMM 116. Circadian Rhythms—Biological Clocks (4)**
Examples and fundamental properties of the daily biological clock in humans, animals, and microbes. Experimental approaches employed to understand how organisms keep time and how this applies to human health. *Prerequisite: BILD 1 or Psych. 106 or consent of instructor.* (F)

**BIMM 118. Pharmacology (4)**
Basics of pharmacology such as drug absorption, distribution, metabolism, and elimination. Concepts in toxicology and pharmacognosy are used to survey the major drug categories. *Prerequisites BIBC 100 or BIBC 102; BIPN 100.* (S)

**BIMM 120. Bacteriology (4)**
A discussion of the structure, growth, molecular genetics, and physiology of procaryotic microorganisms, with emphasis on the diverse activities of bacteria and on the interaction of various bacterial species with their environment. Three hours of lecture and one hour recitation. *Prerequisites: organic chemistry; BIBC 100 or BIBC 102 (may be taken concurrently).* (W,S)

**BIMM 121. Laboratory in Microbiology (4)**
This course emphasizes fundamental principles of microbiology. Studies with bacteria include comparative morphology and physiology; pure culture techniques; bacterial growth; spore germination; and bacteriophage infection, replication, and release. Additional studies on antibiotics and the use of bioassays are included. One hour of demonstration and seven hours of laboratory. *Prerequisite: BIMM 120.* Attendance at the first lecture/lab is required. Nonattendance will result in the student's being dropped from the course roster. It is the student's responsibility to officially drop the course at the Registrar's Office. (F,W,S)

**BIMM 122. Microbial Genetics (4)**
Organization and function of procaryotic genetic systems including sex factors, transduction, transformation, phage genetics, transposons, genetic engineering. Three hours of lecture. *Prerequisites: BIMM 100, BICD 100, or consent of instructor.* (W)

**BIMM 124. Medical Microbiology (4)**
This course covers basic principles and detailed aspects of microbial infectious diseases. Biochemical properties underlying microbial spread, host antimicrobial and inflammatory response, immunity, and recovery are emphasized. Emphasis is placed upon viral and bacterial diseases, including molecular principles of pathogenesis, of host immune responses, of drug resistance, and of viral and plasmid replication. Three hours of lecture and one hour of discussion. *Prerequisites: BIMM 100 and 120, BICD 140 is recommended.* (S)

**BIMM 126. Marine Microbiology (4)**
The role of microorganisms in the oceans: metabolic diversity, methods in marine microbiology, interactions of microbes with other microbes, plants and animals, biogeochemical cycling, pollution and water quality, microbe-mineral interactions, extremophiles. *Prerequisite: BIBC 102 and BIMM 120 recommended.* (W)

**BIMM 127. Marine Microbiology Laboratory (4)**
Techniques and theory in environmental microbiology. Students perform experiments concerning a) enrichment, enumeration, and identification and b) metabolic and physiochemical adaptations, along with an independent project. Graduate students submit an additional report and take a modified final exam. *Prerequisite: upper-division standing.* (S)

**BIMM 130. Microbial Physiology (4)**
Prokaryotic microbial physiology will be discussed primarily from a biochemical standpoint with emphasis on mechanism. Topics will vary from year to year but will include the following themes: Central metabolism, bioenergetics, biosynthesis, regulation, differentiation, prokaryotic structure-function relationships. *Prerequisites: BIBC 100 or BIBC 102 or equivalent.* (S)

**BIMM 132. Molecular Biology of Human Retroviruses (4)**
Replication cycle and gene regulation of HIV. Molecular approaches to therapy and vaccines. Three hours of lecture. *Prerequisite: BIMM 100.* (S)

**BIMM 134. Biology of Cancer (4)**
This course covers basic processes of transformation and tumor formation in a two-part format. The first section is focused on molecular and cellular mechanisms of carcinogenesis. The second section discusses tumor pathology and metastasis. Open to upper-division students only. *Prerequisites: BICD 110 and BIMM 100.* (S)

**BIMM 140. Introduction to Bioinformatics (4)**
Introduction to basic methods used in bioinformatics and computational biology. Survey of methods used in computational analysis of DNA such as sequence assembly, sequence comparison, gene modeling, and sequence databases. Survey methods used in the computational analysis of protein sequences such as alignments, motif and pattern recognition, family classification, and protein structure prediction. Survey of organismic database methods. Emphasis is on a broad survey of current approaches with an introduction to statistical and computational techniques for analyzing, comparing, and validating methods. *Prerequisites: BIBC 100 or 102, BIMM 100, and BICD 100. (BIMM 100 may be taken concurrently.)*

**BIMM 141. Bioinformatics Laboratory (4)**
Laboratory course giving hands-on exposure to topics covered in BIMM 140. Survey of methods used in computational analysis of DNA such as sequence assembly, sequence comparison, gene modeling, and sequence databases. Survey of methods used in the computational analysis of protein sequences such as alignments, motif and pattern recognition, family classification, and protein structure prediction. *Prerequisites: BIBC 100 or 102, BIMM 100, BICD 100, and BIMM 140.*

**BIMM 142. Advanced Bioinformatics (4)**
Continuation of BIMM 140 emphasizing advanced topics in bioinformatics and computational biology. Emphasis is on computational approaches at the level needed to design and implement new approaches. Topics: computational and statistical approaches to computational biology including probablistic models, machine learning approaches, and using federated resources to develop integrated approaches to bioinformatic problems. *Prerequisites: BIBC 100 or 102, BIMM 100, BICD 100, and BIMM 140.*

**BIMM 150. Post-Genomics Biology (2)**
This course will focus on large-scale analysis of post-genomics biological systems. Students will be introduced to methods for analyzing changes in gene expression, identifying protein-protein interactions, screening for pathway inhibitors, characterizing multi-protein complexes, and probing protein localization and function. *Prerequisite: consent of instructor.*

**BIMM 181. Molecular Sequence Analysis (4)**
This course covers the analysis of nucleic acid and protein sequences, with an emphasis on the application of algorithms to biological problems. Topics include sequence alignments, database searching, comparative genomics, and phylogenetic and clustering analysis. Pairwise alignment, multiple alignment, DNA sequencing, scoring functions, fast database search, comparative genomics, clustering, phylogenetic trees, gene finding/DNA statistics. This course open to bioinformatics majors only. *Prerequisites: CSE 100 or Math. 176, CSE 101 or Math. 188, BIMM 100 or Chem. 114C.*

**BIMM 182. Biological Databases (4)**
This course provides an introduction to the features of biological data, how that data are organized efficiently in databases, and how existing data resources can be utilized to solve a variety of biological problems. Relational databases, object oriented databases, ontologies, data modeling and description, survey of current biological database with respect to above, implementation of database focused on a biological topic. This course open to bioinformatics majors only. *Prerequisite: CSE 100 or Math 176.*

**BIMM 184. Computational Molecular Biology (4)**
This advanced course covers the application of machine learning and modeling techniques to biological systems. Topics include gene structure, recognition of DNA and protein sequence patterns, classification, and protein structure prediction. Pattern discovery, hidden Markov models/support vector machines/neural network/profiles, protein structure prediction, functional characterization or proteins, functional

genomics/proteomics, metabolic pathways/gene networks. This course open to bioinformatics majors only. *Prerequisite: BIMM 181 or BENG 181 or CSE 181, BIMM 182 or BENG 182 or CSE 182 or Chem. 182. Bioinformatics majors only.*

**BIMM 185. Bioinformatics Laboratory (Advanced) (4)**
This course emphasizes the hands-on application of bioinformatics methods to biological problems. Students will gain experience in the application of existing software, as well as in combining approaches to answer specific biological questions. Sequence alignment, fast database search, profiles and motifs, comparative genomics, gene finding, phylogenetic trees, protein structure, functional characterization of proteins, expression anaylysis, computational proteomics. This course open to bioinformatics majors only. *Prerequisite: two courses out of: BIMM 181 or BENG 181 or CSE 181, BIMM 182 or BENG 182 or CSE 182, BENG 183, BIMM 184 or BENG 184 or CSE 184.*

## Animal Physiology and Neuroscience

**BIPN 100. Mammalian Physiology I (4)**
This course introduces the concepts of physiological regulation, controlled and integrated by the nervous and endocrine systems. It then examines the muscular, cardiovascular, and renal systems in detail and considers their control through the interaction of nervous activity and hormones. Three hours of lecture and one hour of discussion. *Prerequisites: BILD 1; BILD 2.* (F,W,S)

**BIPN 102. Mammalian Physiology II (4)**
This course completes a survey of organ systems begun in BIPN 100 by considering the respiratory and gastrointestinal systems. Consideration is given to interactions of these systems in weight and temperature regulation, exercise physiology, stress, and pregnancy and reproduction. Three hours of lecture and one hour of section per week. *Prerequisite: BIBC 102; BIPN 100.* (F,W,S)

**BIPN 105. Animal Physiology Lab (6)**
Experiments are performed on membrane physiology; nerve muscle function; cardiovascular physiology; respiratory, gastrointestinal and renal physiology. Subjects include experimental animals and humans. *Prerequisite: BIPN 100 (may be taken concurrently).* Three hours of lecture and ten hours of laboratory each week. In addition to the formal lab hours, there will be at least eight hours in which students will be required to work in the class laboratory to complete experiments and prepare for presentations. Attendance at the first lecture/lab is required. Non-attendance will result in the student's being dropped from the course roster. It is the student's responsibility to officially drop the course. (F,W,S)

**BIPN 106. Comparative Physiology (4)**
This course examines the physiological adaptation of animals, invertebrates and vertebrates, to their particular environmental and behavioral niches. Structural, functional, and molecular adaptions of the basic organ systems are discussed. *Prerequisites: BILD 2, Chem. 6A-B-C or Chem. 7A-B-C. BILD 3 is recommended.* (W)

**BIPN 108. Integrative Biology of Exercise (4)**
Course will integrate the organ system biology learned in Mammalian Physiology I and II through the study of the human body's response to exercise. Specifically, the multi-organ system reaction to both acute and chronic exercise will be studied from the functional to the basic mechanistic level. Thus, the role of exercise in both health and disease will be addressed. *Prerequisites: BIPN 100; BIPN 102.*

**BIPN 140. Cellular Neurobiology (4)**
This course covers the biophysics of the resting and active membranes of nerve cells. It also covers the mechanisms of sensory transduction and neuromodulation, as well as the molecular basis of nerve cell function. *Prerequisites: BILD 1, 2; BIBC 100 or 102 recommended.* (F,W)

**BIPN 142. Systems Neurobiology (4)**
This course covers integrated networks of nerve cells, including simple circuits like those involved in spinal reflexes. We will study how information and motor output is integrated and processed in the brain. We will also discuss higher-level neural processing. *Prerequisites: BILD 1, 2, and BIBC 100 or 102.* (W)

**BIPN 144. Developmental Neurobiology (4)**
Cellular and molecular basis of cell determination, neurite outgrowth, specificity, synaptogenesis, and cell death in the brain. *Prerequisites: BILD 1, 2, and BIBC 100 or 102, BICD 100, BIPN 142 recommended.* (S)

**BIPN 145. Neurobiology Laboratory (6)**
Basic principles of nerve and muscle physiology will be taught through weekly exercises and individual projects. One hour of lecture and nine hours of laboratory each week. *Prerequisite: BIPN 140 or BIPN 142 or BIPN 146 (may be taken concurrently).*

**BIPN 146. Computational Neurobiology (4)**
An exploration of computational brain models, including biophysical models of single neurons, small neural circuits, and larger scale network models. *Prerequisite: BILD 12 or BIPN 140 or Psych. 106 or Cog. Sci. 107 recommended.* (S)

**BIPN 148. Cellular Basis of Learning and Memory (4)**
Cellular and molecular mechanisms that underlie learning and memory. Synapse formation and synaptic plasticity, neurotransmitter systems and their receptors, mechanisms of synaptic modification, and effect of experience on neuronal connectivity, and gene expression. *Prerequisites: BILD 1; BILD 2; BIBC 100 or BIBC 102 (may be taken concurrently).* (S)

## Special Courses

**BISP 190. Advanced Biology Seminars for Seniors (2)**
Experts in diverse areas of biology from major universities in the U.S. and abroad will describe current research activities being conducted in their laboratories. Relevant readings will be assigned. P/NP grades only. *Prerequisites: seniors only; concurrent enrollment in BISP 199 or consent of instructor.* (F,W,S)

**BISP 194. Advanced Topics in Modern Biology (2)**
Course will vary in title and content. When offered, the current description and title are found in the *Schedule of Classes* and the Biological Sciences Web site. Can be taken a total of four times as topics vary. Students may not receive credit for the same topic. *Prerequisites: BIBC 102; BICD 100; upper-division standing.* (F,W,S)

**BISP 195. Introduction to Teaching in Biology (4)**
Introduction to the teaching of the basic course in biology. A student under the direction of the instructor of the course is assigned one class section and will meet one time per week with the section. A student is required to attend the course lecture and meet with the instructor of the course at least one time per week. Limited to upper-division students who have a B average or higher. Three hours' lecture. (P/NP grades only.) *Prerequisites: consent of instructor and approval of department chair.* (**Note**: Applications for a BISP 195 are to be submitted to the Division of Biological Sciences by the end of the sixth week of the quarter preceding the quarter in which the BISP 195 will be completed.) (F,W,S) This course may be counted as one of the upper-division electives for a biology major. (F,W,S)

**BISP 196. Honors Thesis in Biology (4)**
Senior thesis research program. Research is conducted under the supervision of a biology faculty member. This one-year program is taken in addition to the major requirements for graduation. Upon satisfactory completion of the program, students will receive "Distinction in Biology" on their transcripts. *Prerequisites: senior standing, 3.7 GPA or above; prior selection for the program by a faculty member and approval by program coordinator. A department stamp will be used to monitor during registration.* (F,W,S)

**BISP 197. Biology Internship Program (4)**
Under the joint supervision of a biology faculty adviser and a selected industry mentor, the student will conduct independent research on a problem in an industrial biotech laboratory. The student will gain insight into industry research and practical biotech experience. *Prerequisites: BIBC 103 or BIMM 101, BIBC 102, BICD 100, BIMM 100, overall GPA 3.0, and consent of the biology faculty coordinator.* (W,S)

**BISP 199. Individual Research for Undergraduates (2 or 4)**
Individual research on a problem by special arrangement with a faculty member. Projects are expected to involve primary, experimental approaches that augment training in basic biology and that echo the curricular focus of the Division of Biological Sciences. (P/NP grades only.) *Prerequisites: Students must have an overall UCSD GPA of at least 3.0, a minimum of ninety units complete, and approval by division chair.* Students must complete a "Special Studies" form and a Division of Biological Sciences "Research Plan." (**Note**: Applications for a BISP 199 must be submitted to the Division of Biological Sciences prior to the eighth week of the quarter preceding the quarter in which the BISP 199 will be completed.) This course may be counted as one of the upper-division electives for a biology major, providing that no other special studies courses have already been counted toward the major.

# GRADUATE

**BGGN 204. Topics in Community and Population Ecology (3)**
This course teaches a different topic each quarter on the theoretical or conceptual side of community and population ecology. Students will read materials in depth, attend weekly discussions, and explore theories and models with statistical, analytical, and algorithmic tools of the trade. *Prerequisite: graduate standing or consent of instructor.* (S/U grades only) (Quarter offered varies and course is not offered every year.)

**BGGN 206. Topics in Biophysics and Physical Biochemistry (4)**
Selection of topics of current interest. Examples: primary processes of photosynthesis; membrane biophysics; applications of physical methods to problems in biology and chemistry, e.g., magnetic resonance, X-ray diffraction, fluctuation spectroscopy, optical techniques (fluorescence, optical rotary dispersion, circular dichroism). Topics may vary from year to year. *Prerequisite: consent of instructor.* (S/U grades permit-

ted.) This course is cross-listed with Physics 206 and Chemistry 206. (Quarter offered varies, and course is not offered every year.)

**BGGN 212. Special Topics in Microbiology (3)**
Recent developments in prokaryotic and eukaryotic microbial research. Topics vary from year to year but may include the following subjects: the molecular basis of (a) sex determination, expression, and interconversion; (b) differentiation, morphogenesis, and programmed death; (c) transcriptional and metabolic regulation; and (d) chemical macromolecular and energy-mediated reception, transmission, and response processes. The main thesis of the course is that examples of complex regulatory phenomena in higher organisms can be found in single celled organisms. This course is open to enrollment by undergraduates. *Prerequisites: BIBC 102 and BICD 100.* (S/U grades permitted.) (Quarter offered varies, and course is not offered every year.)

**BGGN 213. Topics in Conservation Biology (3)**
Provides in depth coverage of topics in population genetics and ecology, community ecology, biogeography, human ecology, and ecosystem management relevant to conservation biology. Topics vary from year to year and have included pedigree analysis, inbreeding depression, minimum viable population size, problems of overabundance, fragmented populations, key-stone species, in-situ and ex-situ conservation techniques. One two-hour meeting weekly. *Prerequisite: graduate standing or consent of instructor.* (S/U/ grades only.) (S)

**BGGN 215. Phylogenetics (3)**
This course provides the theoretical and practical basis of phylogenetic analysis (the estimation of phylogenetic trees). Students will understand the assumptions made in phylogenetic analysis, be able to identify the strengths and weaknesses of various methods, and perform a phylogenetic analysis on DNA sequence data. *Prerequisite: one semester of calculus is recommended.* (S)

**BGGN 218. Post-Genomics Biology (2)**
This course will focus on large-scale analysis of post-genomics biological systems. Students will be introduced to methods for analyzing changes in gene expression, identifying protein-protein interactions, screening for pathway inhibitors, characterizing multi-protein complexes, and probing protein localization and function.

**BGGN 219. Classic Papers in Genetics (3)**
The course explores, through classic papers, how genetic approaches in the distant and near past have opened up novel areas of biology. The goal of the course is to teach students the type of approach that allowed these researchers to break out of old paradigms and form new ones of their own based on genetic pathfinding. (W)

**BGGN 220. Graduate Molecular Biology (6)**
Provides a broad, advanced-level coverage of modern molecular biology for first-year graduate students. Topics include prokaryotic and eukaryotic gene structure and regulation, chromatin structure, DNA replication, translation, mechanisms of transcription, and an introduction to viruses. OPEN ONLY TO STUDENTS ENROLLED IN A GRADUATE DEGREE PROGRAM. (Letter grades only.) (F)

**BGGN 221. Graduate Protein Biochemistry (4)**
Topics include general aspects of protein structure and biochemical approaches to the isolation and study of proteins. This course also covers the relationship between the structure and function of selected proteins. Detailed discussion of modern biophysical methods to study protein-protein interactions will be included. *BGGN 220 is a co-requisite.* OPEN ONLY TO STUDENTS ENROLLED IN A GRADUATE DEGREE PROGRAM. (Letter grades only.) *Corequisite: BGGN 220.* (F)

**BGGN 222. Graduate Cell Biology (6)**
A coverage of modern cell biology for first year graduate students. There is an up-to-date discussion of topics such as: structure and function of membranes; ion pumps, ion channels, transmembrane signalling; receptor mediated endocytosis; protein targeting; the role of RER and Golgi apparatus; the biosynthesis of intracellular organelles in animal and plant cells; the cytoskeleton, motility, molecular motors, cell-cell interactions, mitosis; and the control of cell division. Also included are extensive coverage of cell signalling mechanisms and discussions on molecular approaches to cell biology. *Prerequisites: BGGN 220 and 221.* OPEN ONLY TO STUDENTS ENROLLED IN A GRADUATE DEGREE PROGRAM. (Letter grades only.) (W)

**BGGN 223. Graduate Genetics (6)**
Provides a broad and extensive advanced-level coverage of molecular and formal aspects of genetics for first-year graduate students. Topics covered include: bacterial genetics, recombination in prokaryotes and eukaryotes, mammalian somatic-cell genetics, developmental genetics, sex determination, dosage compensation, and immunogenetics. Extensive coverage of the use of model systems like Drosophila and C. elegans is included. General and specific aspects of cellular signalling mechanisms will be covered. *Prerequisites: BGGN 220, 221 and 222.* OPEN ONLY TO STUDENTS ENROLLED IN A GRADUATE DEGREE PROGRAM. (Letter grades only.) (S)

**BGGN 224. Graduate Neurobiology (4)**
Course covers modern molecular, cellular, developmental, and physiological aspects of neurobiology. Extensive discussion of original research articles will be included. *Prerequisites: BGGN 220 and 221.* OPEN ONLY TO STUDENTS ENROLLED IN A GRADUATE DEGREE PROGRAM. (Letter grades only.) (F)

**BGGN 225. Graduate Immunology (4)**
The course is devoted to immunology and is organized as a combined lecture-tutorial course stressing classical as well as current literature. Each week will compose an independent section. Topics will include cellular interactions involved in the immune response and the molecular biology unique to lymphoid factor and receptors. *Prerequisites: BGGN 220 and 221.* OPEN ONLY TO STUDENTS ENROLLED IN A GRADUATE DEGREE PROGRAM. (Letter grades only.) (S)

**BGGN 226. Graduate Animal Virology (4)**
This course consists of a review of fundamental concepts together with an in-depth analysis of the structure, genetics, multiplication and oncogenicity of animal viruses. Particular emphasis will be given to the DNA and RNA tumor viruses. The format of this section includes lectures and discussion of selected papers. *Prerequisites: BGGN 220 and 221.* OPEN ONLY TO STUDENTS ENROLLED IN A GRADUATE DEGREE PROGRAM. (Letter grades only.) (W)

**BGGN 227. Graduate Topics in Plant Biology (4)**
This course covers advanced topics in plant biology in the areas of molecular genetic developmental, and physiological biology. We will discuss plant-microbe interactions, transposable elements, protein trafficking, ion transport, and organ development. The format of this section includes lectures and discussion of selected papers. *Prerequisites: BGGN 220, 221, and 222.* OPEN ONLY TO STUDENTS ENROLLED IN A GRADUATE DEGREE PROGRAM. (Letter grades only.) (W)

**BGGN 228. Graduate Developmental Biology (4)**
This course covers graduate level lectures on developmental biology, emphasizing the use of genetically tractable model systems. Discussion of recent research articles is an integral aspect of this course. Students are introduced to classical experiments and given detailed coverage of recent fundamental findings in developmental biology. *Prerequisites: BGGN 220 and 221.* (Letter grades only.) (S)

**BGGN 229. Graduate Oncogenes (4)**
This course provides detailed coverage of the cellular and molecular basis of cellular transformation and oncogenesis. There will be extensive discussion on the role of oncogenes and their cellular counterparts. The course also provides in-depth analysis of intracellular signal transduction mechanisms. *Prerequisites: BGGN 220, 221, and 222.* (Letter grades only.) (S)

**BGGN 230. Graduate Signal Transduction (4)**
The course will introduce students to a variety of signal transduction pathways and their function in the regulation of cellular processes. Special emphasis will be given to signaling cascades regulating immunological responses and alterations of signaling pathways during oncogenesis. (W)

**BGGN 233. Cellular Immunology (3)**
This course covers the molecular and cellular events in the humoral and cellular response to antigen, transplantation biology, the structure and function of the major histocompatibility gene complex, the T-cell receptor, lymphokines, and the induction of immunological tolerance. It serves as the second course in a two-part sequence. May be taken by undergraduates who have taken Part 1 (BICD 140) and by graduate students (S/U grades only.) (Quarter offered varies and course is not offered every year.)

**BGGN 235. Biology and Biochemistry of Cancer Cells (2)**
This course covers recent advances in cell biology, biochemistry, immunology, and virology as they relate to cancer cells and their interaction with the host. Cancer research specialists from outside will be brought in to discuss the most recent evidence and interpretations in key areas of cancer research. This course meets two hours per week for lecture and discussion. It will be at an advanced graduate level but open to a limited number of seniors (with permission of instructor) on a P/NP basis. (S/U grades only) (Quarter offered varies, and course is not offered every year.)

**BGGN 236. Essentials of Glycobiology (2)**
Molecular glycobiology encompasses studies of the structure, biosynthesis, and biological roles of oligosaccharide units on glycoconjugates. This course provides an overview of this rapidly evolving field with an emphasis on the glycoconjugates of eukaryotic organisms in the animal kingdom. (S/U grades only.) (S) This course is cross-listed with Medicine 222.

**BGGN 238A. Integrative Microbiology I (4)**
To introduce students with structural and functional properties of microorganisms and with the role of microbes in the world. Course will emphasize the integrative aspects of microbiology. First course in series. *Prerequisite: graduate standing.*

**BGGN 238B. Integrative Microbiology II (4)**
To introduce students with structural and functional properties of microorganisms and with the role of microbes in the world. Course will emphasize the integrative aspects of microbiology. Second course in series. *Prerequisite: graduate standing.*

**BGGN 240. Cellular Neurobiology (2)**
Students read classic and modern papers that form the basis of the undergraduate lectures (BIPN 240), which they are encouraged to attend. These papers are presented by the students at weekly discussion sessions. *Prerequisite: consent of instructor.* (S/U grades only.) (F)

**BGGN 242. Systems Neurobiology (2)**
Students read classic and modern papers that form the basis of the undergraduate lectures (BIPN 142), which they are encouraged to attend. These papers are presented by the students at weekly discussion sessions. *Prerequisite: consent of instructor.* (S/U grades only.) (W)

**BGGN 243. Systems Neurophysiology (3)**
Ways in which neurons are assembled into circuits to achieve perception and patterned movement. *Prerequisites: graduate standing or consent of instructor.* (S/U grades only.)

**BGGN 244. Molecular/Developmental Neurobiology (2)**
Students read classic and modern papers that form the basis of the undergraduate lectures (BIPN 144), which they are encouraged to attend. These papers are presented by the students at weekly discussion sessions. *Prerequisite: consent of instructor.* (S/U grades only.) (S)

**BGGN 246 A-B. Computational Neurobiology (2-2)**
Students read classic and modern papers that form the basis of the undergraduate lectures (BIPN 146), which they are encouraged to attend. Students present these papers at weekly discussion sessions. The focus of 246A is cellular neuronal properties and the focus of 246B is properties of neuronal systems. *Prerequisites: graduate student or consent of instructor.* (S/U grades only.)

**BGGN 247. Development of Neural Systems (4)**
Course emphasizes current molecular and physiological approaches used to study the development of neural circuits including the processes of neuronal migration, axon pathfinding, and synapse and circuit formation in different systems. Topics include development of the visual system, olfactory system, spinal cord and cerebellum. *Prerequisite: graduate standing or consent of instructor.* (S/U grades only.)

**BGGN 248. Molecular Mechanisms of Neural Development (4)**
The cellular and molecular basis of neural development, focusing on primary papers. Topics include: neural induction and neurogenesis, cell patterning, neuronal and glial differentiation, neuronal migration, axon pathfinding, synapogenesis, neuronal cell death, regeneration, activity-dependent events, topographic maps, invertebrate and vertebrate model systems. *Prerequisite: graduate standing or consent of instructor.*

**BGGN 249B-C. Basic Neuroscience (4-4)**
These courses are designed for graduate students in the neurosciences and other departments that are part of the interdisciplinary program (i.e., Biology, Cog. Sci.). These courses have been designed to cover as much basic neuroscience as possible in three quarters of study. They will combine two three-hour meetings each week with a 1.5 hour lecture and a 1.5 hour discussion of papers. These are required courses for all first-year neurosciences graduate students. *Prerequisite: graduate student or consent of instructor.* (F,W,S)

**BGGN 251. Molecular Biology (3)**
The first section of this course consists of a review of fundamental concepts in molecular biology together with an in-depth analysis of molecular biological topics of medical importance. The second section covers the structure, genetics, and multiplication of animal viruses, with particular emphasis on the DNA and RNA tumor viruses. Other subjects discussed include viral persistence, latency, and approaches to viral chemo-therapy. Three hours of lecture. *Prerequisite: biochemistry.* (Not open to undergraduates.) (S/U grades only) (F)

**BGGN 252. Genetics (3)**
Human genetics, with emphasis on basic principles. Topics covered include chromosome abnormalities, the mechanisms of dominant and recessive diseases, pedigree analysis, ascertainment of linkage, the interaction of genotype with diseases. Mechanisms of maintaining genetic diversity in human populations will be discussed along with recent approaches to genetic counseling and intervention. *Prerequisite: consent of instructor.* (Not open to undergraduates.) (S/U grades only) (F)

**BGGN 253. Immunology (3)**
Graduate students will explore topics in specialized areas of immunochemistry and cellular immunology, antigenic and molecular structure of immunoglobulin molecules; antigenantibody interactions; cellular events in the humoral and cellular immune responses; translation immunology. *Prerequisite: consent of instructor.* The course is similar in content to BICD 140 but is accelerated in pace. (S/U grades permitted.) This course is cross-listed with Chemistry 217.(F)

**BGGN 254. Cell and Membrane Physiology (3)**
This course is a survey covering current subjects in membrane biology relevant to medicine. Subjects are: 1) membrane isolation, composition, and structure; 2) consequences of membrane fluidity (mode of action of anesthetics, intercellular communication, eso- and endo-cytosis biogenesis); 3) sensory perception and response (chemo- and energy reception, cellular neurophysiology, muscle; physiology); 4) regulation of membrane function (hormone reception, intercellular adhesion, neoplastic transformation). *Prerequisites: biochemistry and genetics.* (S/U grades only)

**BGGN 260. Neurodynamics (4)**
Introduction to the nonlinear dynamics of neurons and simple neural systems through nonlinear dynamics, bifurcation theory, and chaotic motions. The dynamics of single cells is considered at different levels of abstraction, e.g., biophysical and "reduced" models for analysis of regularly spiking and bursting cells, their dynamical properties, and their representation in phase space. Laboratory exercises will accompany the lectures. *Prerequisites: graduate student or consent of instructor.*

**BGGN 266. Advanced Laboratory in Biophysical Techniques (6)**
Experiments that emphasize biophysical principles through hands-on experience, with an emphasis on the blending of physical measurements with a clearly identified biological problem. Exercises include the use of optical tweezers to measure viscous forces at the level of cellular organelles, the characterization of sensorimotor control in the fly during visually guided flight, and the use of microscopic imaging techniques to characterize cell motility and organelle transport. Includes instruction in LabView. Students are encouraged to attend the Phys. 173 undergraduate lectures. *Prerequisites: graduate student or consent of instructor. Phys. 120A, BILD 1, and Chem. 6CL for undergraduates.*

**BGGN 269. Mathematics for Neurobiologists (6)**
An intensive course to introduce the mathematical concepts and techniques used in modern neurobiology. Intended for beginning graduate students in the neurosciences, but is also available to advanced undergraduates, with the consent of the instructor. *Prerequisites: graduate student or consent of instructor.*

**BGGN 271. Advanced Experimental Methods in Biology (4-12)**
Advanced laboratory and/or field experience in contemporary biological methodology. Open only to students enrolled in the integrated Bachelor's/Master's Degree Program. *Prerequisites: consent of instructor and approval of division chair.* (F,W,S) (Graduate students: letter grades only.)

**BGGN 297. Research Conference (1-3)**
Group and individual discussion of research activities and of current literature. *Prerequisite: graduate standing.* (S/U grades only.) (F,W,S)

**BGGN 298. Laboratory Projects in Biology (3-12)**
An introduction to contemporary laboratory techniques and research interests through independent, original projects under the direction of individual faculty members. *Prerequisite: consent of instructor.* (Letter grades only) (F,W,S)

**BGGN 299. Thesis Research in Biology (1-12)**
(F,W,S)

**BGGN 500. Apprentice Teaching (4)**
This course involves participation in upper-division undergraduate teaching at the level of assuming responsibility for recitation sections or laboratories under the supervision of the responsible faculty member. Some experience in lecturing to upper-division classes will occasionally be provided. (S/U grades only.) (F,W,S)

**BGJC 201. Journal Club in Cell Biology (1)**
Weekly presentations and discussions pertaining to research results reported in recently published literature. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.) (F,W,S)

**BGJC 202. Journal Club in Developmental Biology (1)**
Weekly presentations and discussions pertaining to research results reported in recently published literature. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.) (Quarter offered is varies, and course is not offered every year.)

**BGJC 203. Journal Club in HIV Molecular Biology (1)**
Weekly presentations and discussions pertaining to research results reported in recently published literature. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.) (F,W,S)

**BGJC 204. Journal Club in Molecular and Cellular Immunology (1)**
Weekly presentations and discussions pertaining to research results reported in recently published litera-

ture. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.) (F,W,S)

**BGJC 206. Journal Club in Microbial Physiology (1)**
Weekly presentations and discussions pertaining to research results reported in recently published literature. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.) (S)

**BGJC 208. Journal Club in Plant Molecular Biology (1)**
Weekly presentations and discussions pertaining to research results reported in recently published literature. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.) (F,W,S)

**BGJC 209. Journal Club in Molecular and Cellular Regulation in Biology (1)**
Weekly presentations and discussions pertaining to research results reported in recently published literature. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.) (F,W,S)

**BGJC 210. Journal Club in Cell Cycle Regulation (1)**
Weekly presentations and discussions pertaining to research results reported in recently published literature. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.) (F,W,S)

**BGJC 212. Journal Club in Genetics (1)**
Weekly presentations and discussions pertaining to research results reported in recently published literature. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.) (F,W,S)

**BGJC 213. Journal Club in Computational Neurobiology (1)**
Weekly presentations and discussions pertaining to research results reported in recently published literature. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 203. Research Discussion in Development of Dictyostelium (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 204. Molecular Biology of the Cell (1)**
Research reports and discussions based on recent experimental results in cell biology, oncogenesis, genetics, molecular biology and development. Students are expected to present and discuss their own new data and the recent data of others. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 205. Research Discussion in Plant Membrane Biology (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 206. Research Discussion in Metals in Biology (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 207. Research Discussion in Neuronal Pattern Generation (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 208. Research Discussion in Mammalian Molecular Biology (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 210. Research Discussion in Virology (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 211. Research Discussion in Developmental Cellular Neurobiology (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 212. Research Discussion in Behavior and Development of Simple Nervous Systems (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 214. Research Discussion in Development and Function of the Immune System (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 215. Research Discussion in Lymphocyte Biology (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 216. Research Discussion in Molecular and Cell Biology (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 217. Research Discussion in Plant Membranes and Organelles (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 218. Research Discussion in Plant Molecular Genetics (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 219. Research Discussion in Molecular Biophysics (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 220. Research Discussion in Advanced Evolutionary Biology (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 221. Research Discussion in Behavioral Ecology (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 222. Research Discussion in Evolutionary Molecular Ecology (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 223. Research Discussion in Ecology (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 224. Research Discussion in Plant Population Biology (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students.*

*Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 225. Research Discussion in Genetic Variation (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 226. Research Discussion in Conservation Genetics (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 227. Research Discussion in Intracellular Signalling (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 228. Research Discussion in Drosophila Developmental Biology (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 230. Research Discussion in Cell Signalling Pathways (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 231. Research Discussion in Nuclear Transport and Function (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 232. Research Discussion in Chromatin and Transcription Regulation (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 233. Research Discussion in Cell Cycle Motility (1)**
Presentations of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGRD 234. Research Discussion in Cell Signalling in Drosophila (3)**
Presentation of new research results and discussions of closely related published reports. All students are expected to report on their own research findings each quarter. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGSE 200. Seminar in Biology (1)**
Invited speakers from the U.S. and abroad, who are leaders in various aspects of biological research, describe their current research. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.) (F,W,S)

**BGSE 201. Seminar in Molecular Biology (1)**
Invited speakers from the U.S. and abroad, who are leaders in various aspects of biological research, describe their current research. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.) (F,W,S)

**BGSE 202. Seminar in Immunology (1)**
Invited speakers from the U.S. and abroad, who are leaders in various aspects of biological research, describe their current research. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.) (F,W,S)

**BGSE 203. Seminar in Population Biology (1)**
Invited speakers from the U.S. and abroad, who are leaders in various aspects of biological research, describe their current research. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.)

**BGSE 204. Seminar in Developmental Genetics (1)**
Invited speakers from the U.S. and abroad, who are leaders in various aspects of biological research, describe their current research. *Prerequisites: none for graduate students. Undergraduates must be seniors or enrolled in BISP 199.* (S/U grades only.) (F,W,S)

**BGSE 205. Graduate Research Seminar (1)**
Discussions of recent research in various aspects of biological research conducted by third- and fourth-year doctoral students in the Division of Biological Sciences. (S/U grades only.) (F,W,S)