

Biological Sciences, Division of

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1128 Pacific Hall
(858) 534-0557

FINANCIAL AND ADMINISTRATIVE OFFICES
1610 Urey Hall, Revelle College
<http://biology.ucsd.edu/>

DIVISION OF BIOLOGICAL SCIENCES UNDERGRADUATE ADMISSIONS

Because of the large number of students interested in biological sciences undergraduate programs, and the limited resources available to accommodate this demand, the university has declared all majors in the Division of Biological Sciences as "impacted."

Effective fall 2009, freshmen admission to any of the Biological Sciences majors will be limited. Students will be selected by the UC San Diego Office of Undergraduate Admissions based on the students' comprehensive review scores and availability of slots in the Division of Biological Sciences. All potential freshmen must indicate on the UC application if they wish to major in biology.

Effective fall 2011, new transfer students will be selected by the UCSD Office of Undergraduate Admissions based on the students' demonstrated academic performance at the community college or previous university and availability of slots in the Division of Biological Sciences. All potential transfers must indicate on the UC application if they wish to major in biology.

Refer to the UCSD Division of Biological Sciences Web site for specific details and requirements (<http://biology.ucsd.edu>).

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 within the major.

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 Biology Student and Instructional Services 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 and Instructional Services office (1128 Pacific Hall) *before* your priority enrollment to be pre-authorized.

CONCURRENT ENROLLMENT IN BIOLOGY COURSES

For more information on concurrent enrollment, please call (858) 534-3400 or e-mail 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 and Instructional Services 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 grade requirements for all biology majors, effective fall 2008, are

- All courses required and used toward any biology major requirements must be passed with a grade of C- or better.
- The minimum grade requirement applies to all lower-division, upper-division, required courses taken in other departments, as well as courses transferred and used toward major requirements.
- Exceptions will be made only for those required courses that have a P/NP only grading option (i.e., BISP 199).

The minimum GPA requirement (for both the major and overall UC) for graduation is 2.0. Students who received D and/or F grades should contact one of the Division of Biological Sciences undergraduate advisors 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, and 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 and Instructional Services office prior to taking courses

outside of UCSD (for example, students wishing to take a BILD 1 equivalent at another institution must consult with Biology Student and Instructional Services *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 Student Petition. Contact Biology Student and Instructional Services (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 advisor 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 and Instructional Services 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.
- *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 and Instructional Services.

- *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 and Instructional Services.
- 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 and Instructional Services. 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 or NP only.

Application to the Honors Thesis Program

1. Students interested in the program who are eligible as of 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 advisor and inform the Biology Student Affairs Office of their intent.
2. After an advisor is selected, the student and the advisor 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 and Instructional Services 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 advisor 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 advisor.

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://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 and Instructional Services 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 and Instructional Services.

BIOCHEMISTRY AND CELL BIOLOGY MAJOR

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. Capstone Course: (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: BICD 101, 111, 123, 131, 145, BIMM 101, 121, 127, 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 to apply towards major requirements.

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.

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.

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](#)."

ECOLOGY, BEHAVIOR AND EVOLUTION MAJOR

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. Biostatistics (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 121-176 are required. At least two of these courses must be laboratory or field courses (BIEB 121, 123, 131, 145, 147, 165, 167). Laboratory courses may be taken concurrently with the prerequisite lecture course *if Biostatistics (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

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, BICD 101, 111, 123, 131, 145, BIEB 121, 165, 167, BIMM 101, 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)
- Circadian Rhythms—Biological Clocks (BIMM 116)
- Mammalian Physiology II (BIPN 102)
- Cellular Basis of Learning and Memory (BIPN 148)

Human Disease

- Virology (BIMM 114)
 - Pharmacology (BIMM 118)
 - Bacteriology (BIMM 120)
 - Medical Microbiology (BIMM 124)
 - Biology of Cancer (BIMM 134)
 - Environmental and Molecular Toxicology (BIMM 166)
9. Two of the following lab courses: Biochemical Techniques (BIBC 103); Cell Biology Lab (BICD 111); Embryology Lab (BICD 131); 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

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

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 Eucaryotic 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

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 three laboratories (BICD 131, BIPN 105, BIPN 145)
8. One upper-division biology lab to be chosen from the following: BIBC 103, BICD 101, 111, 123, 131, 145, BIEB 121, 131, 165, 167, BIMM 101, 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

1. Any five upper-division biology courses offered by the Division of Biological Sciences at UCSD
2. Students may apply transferable biology courses from another institution toward the lower-division requirements, after obtaining approval from the UCSD Division of Biological Sciences.
3. No courses taken outside of the Division of Biological Sciences may be applied toward the biology minor.
4. All courses must be taken for a letter grade.

5. The minimum GPA requirement for the biology minor is 2.0 in the upper-division courses.
6. Advanced placement (AP) biology scores may be applied toward the minor.
7. BISP 195 may not be used toward the biology minor. One quarter of BISP 196, 197, or 199 may be counted toward the minor.
8. Students may not minor and major in the Division of Biological Sciences.

SECONDARY SCHOOL BIOLOGY TEACHING

UCSD's Division of Biological Science 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 Education Studies (EDS) for information about the prerequisite and professional preparation requirements. It is recommended that you contact EDS and the Biology Student and Instructional Services 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.

<http://www-tep.ucsd.edu/>

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.

CONTIGUOUS BACHELOR'S/ MASTER'S DEGREE PROGRAM

A contiguous 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 UC San Diego. 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/M.S. advisor in the Biology Student and Instructional Services 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 although other sources of financial aid may be available to qualified students through the UCSD Financial Aid Office.

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 advisor and in whose laboratory the student would complete at least twenty-four units of research over a two-year period. The units of research that 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 only), 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 and Instructional Services 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 period.
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 advisor.
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. Only ladder rank faculty in the Biological Sciences or an adjunct faculty in the Biological Sciences may serve as advisor and chair of the 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.

- At least three complete, separate, and consecutive quarters of residency as a graduate student that 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.)
- 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 advisors 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 advisor 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 a "Boot Camp" that helps develop fundamental lab skills in biology, and 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 advisor 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.

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 San Diego State University, 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.

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

SPECIALIZATION IN ANTHROPOGENY

<http://carta.anthropogeny.org/training/specialization-track>

A transdisciplinary graduate specialization in anthropogeny is available for doctoral students in the Division of Biological Sciences. The aim of the specialization is to provide graduate students the opportunity to specialize their research and education in addressing the origins of the human phenomenon. The student's research will be related to one of the oldest questions known to humankind,

namely, the origins of humans and humanity. This specialization is not a stand-alone program, but will provide graduate students the opportunity to interact and communicate with peers in radically different disciplines throughout the duration of their Ph.D. projects. Such communication across disciplines from the outset is key to fostering a capacity for interdisciplinary "language" skills and conceptual flexibility.

ADMISSION TO THE SPECIALIZATION

Students are admitted into the Division of Biological Sciences doctoral program. During the early stages of their program, currently enrolled biology students with an interest in human origins are eligible to apply for admission to the specialization in anthropogeny. Selected applicants will have the opportunity to enroll in the specialization.

SPECIALIZATION REQUIREMENTS

Students pursuing this specialization must satisfy the requirements of both the biology doctoral program and the specialization in anthropogeny. For the anthropogeny specialization, students will be required to take a series of courses and participate in research rounds over four years of study. It is advised that students begin their course work in their second year.

- Course work: Introduction to Anthropogeny (BIOM 225) and Advanced Anthropogeny (BIOM 229) are each taken once, in the winter and spring of the students' second year. Current Topics in Anthropogeny (BIOM 218) is to be taken every quarter for four years.
- Research Rounds: Monthly seminars during which all participating students talk about their respective research.

DEGREE REQUIREMENTS (QUALIFYING EXAMINATION, DISSERTATION)

Biological sciences students in the anthropogeny specialization must meet the departmental requirement for advancement to candidacy. In addition, students must meet internal deadlines, mentoring provisions, and proposal standards of the anthropogeny specialization track.

Ph.D. students must complete a dissertation, which meets all requirements of the biological sciences program. In addition, it is expected that the Ph.D. dissertation is broadly related to human origins and will be interdisciplinary in nature. Time Limits

Students admitted to the specialization in anthropogeny must meet the time limit requirements as all other doctoral students in the Division of Biological Sciences. It is expected that students will retain the same time to degree as students not pursuing this specialization. Additional course load consists only of two regular courses (two quarters, twenty lectures each). The third proposed course takes place only three times a year, from Friday noon to Saturday evening.

SPECIALIZATION IN MULTI-SCALE BIOLOGY

<http://interfaces.ucsd.edu/>

As of fall 2009, the UCSD campus is offering a new Ph.D. specialization in Multi-Scale Biology that

will be available to doctoral candidates in participating programs that span four divisions: Biological Sciences, Physical Sciences, Jacobs School of Engineering, and Health Sciences at UCSD.

The Ph.D. specialization is designed to allow students to obtain standard basic training in their chosen field within the biological sciences, physical sciences, engineering, and health sciences with training in integrative and quantitative analysis across multiple scales of biological organization from molecule to organism in health and disease into their graduate studies. It trains a new cadre of Ph.D. scientists and provides a unique interdisciplinary education at the interfaces between the biological, medical, physical, and engineering sciences.

The specific objectives of this program are

- 1. Focused Collaboration** across nine graduate degree programs at UCSD to train a new generation of cross-disciplinary scientists.
- 2. State-of-the-art Interdisciplinary Training** through a new technology-centered hands-on graduate laboratory course curriculum.
- 3. Novel Emphasis on Research** aimed at integrative and quantitative analysis across multiple scales of biological organization from molecule to organism in health and disease.

Prospective students must apply and be admitted into the Ph.D. program in biology described previously. (For more information, see the [Biological Sciences Graduate Program](#) and/or the [Interfaces Graduate Training Program](#) administered within the Department of Chemistry & Biochemistry, 4010 York Hall, Revelle College.)

COURSES

For course descriptions not found in the UC San Diego General Catalog, 2010–11, please contact the department for more information.

Note: The division will endeavor to offer many of the courses as outlined below; however, unforeseen circumstances sometimes mandate a change of scheduled offerings. Students are strongly advised to check the *Schedule of Classes* or the division's Student and Instructional Services Office (1128 Pacific Hall) to obtain current information. 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 and Instructional Services 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 may ensure a space.

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 prokaryotic and eukaryotic organisms, and to the elements of molecular biology. Three hours of lecture and one hour of recitation. **Prerequisite:** Chem. 6A; Chem. 6B may be taken concurrently.

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.

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. **Prerequisite:** none. (**Note:** E.B.E. majors should complete this course during their first year at UCSD.)

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.

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.

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.

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.

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. 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.

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. 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.

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.

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.)

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. Students may not receive credit for BILD 36 after receiving credit for 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.

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.

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 polysaccharides; and nucleic acids. Three hours of lecture and one hour of recitation. **Prerequisite:** Chem. 140A; Chem. 140B may be taken concurrently. (Note: Students may not receive credit for both BIBC 100 and Chem. 114A.)

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, nucleotide metabolism, and metabolism of macromolecules. **Prerequisite:** Chem. 140A; Chem. 140B may be taken concurrently. (Note: Students may not receive credit for both BIBC 102 and Chem. 114B.)

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 (renumbered to Chem. 108). Attendance at the first lecture/lab is required. Nonattendance will result in the student's being dropped from the course roster.

BIBC 104. Biochemistry and Biotechnology of Plants (4)

The biochemical and molecular basis of plant genetic engineering to understand modern approaches to crop improvement. **Prerequisites:** BILD 1; Chem. 140A. BIBC 102 and Chem. 140B may be taken concurrently.

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, sedimentation, 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.

BIBC 116. Evolution of Genes and Proteins (4)

The history of an organism can be found in its genome. Analyses 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 modern mosaics. Where possible, specific motifs and folds will be traced to their ancestral beginnings. **Prerequisites:** BIBC 100, BIMM 100.

BIBC 120. Nutrition (4)

Elaborates the relationship between diet and human metabolism, physiology, health, and disease. Covers the functions of carbohydrates, lipids, proteins, vitamins, and minerals, and discusses dietary influences on cardiovascular disease, diabetes, obesity, and cancer. **Prerequisite:** BIBC 102.

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. **Prerequisite:** BIBC 102 or consent of instructor.

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.

BICD 101. Eucaryotic Genetics Laboratory (4)

Students will implement forward and reverse genetic methodologies widely used in contemporary biological research, focusing primarily on model organisms. Lab work is complemented by computer work that includes utilization of genome sequence databases and basic bioinformatics. **Prerequisite:** BIMM 100. Attendance at the first lecture/lab is required. Nonattendance will result in the student's being dropped from the course roster.

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.

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. Nonattendance will result in the student's being dropped from the course roster.

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.

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 BILD 2.

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; BICD 120 recommended.

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. **Prerequisite:** upper-division standing; BICD 120 strongly recommended. Attendance at the first lecture/lab is required. Nonattendance will result in the student's being dropped from the course roster.

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:** upper-division standing; BICD 100; BIBC 100 or BIBC 102; BICD 110 strongly recommended.

BICD 131. Embryology Laboratory (6)

Descriptive and experimental embryology of various animal species. One and one-half hours of lecture and ten hours of laboratory each week. **Prerequisites:** BILD 1; BILD 2. Attendance at the first lecture/lab is required. Nonattendance will result in the student's being dropped from the course roster.

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.

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.

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.

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.

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).

BICD 170. Topics in Human Genetics (4)

An advanced course covering human genetics using papers from the scientific literature as the major source of information. A review of basic genetics as applied to the human species. Consideration of recent genetic insights into a number of human conditions. **Prerequisite:** BICD 100, BIMM 100 is strongly recommended.

ECOLOGY, BEHAVIOR, AND EVOLUTION**BIEB 100. Biostatistics (4)**

Application of statistics to biological problems. Topics: descriptive statistics, parametric statistics, (t-test, correlation, regression, ANOVA, GLM), non-parametric statistics, experimental design. Mandatory homework to apply theory

requires knowledge and application of statistics software. Mandatory one- to two-hour discussion in computer lab. **Prerequisite:** BILD 3.

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.

BIEB 121. Ecology Laboratory (6)

A laboratory course to familiarize students with ecological problem solving and methods. Students will perform outdoor field work and use the Macintosh computer for data exploration and analysis. Two hours of lecture and eight hours of laboratory each week. **Prerequisite:** BIEB 100. Attendance at the first lecture/lab is required. Nonattendance will result in the student's being dropped from the course roster.

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 BIEB 101 and BIEB 123. **Prerequisite:** BILD 3. Attendance at the first lecture/lab is required. Nonattendance will result in the student's being dropped from the course roster.

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 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. **Prerequisites:** BILD 3; BIEB 100. Attendance at the first lecture/lab is required. Nonattendance will result in the student's being dropped from the course roster.

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.

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.

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.

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.

BIEB 145. Spatial Analyses in Ecology and Conservation (4)

Course familiarizes students with the concept and application of geographic analyses in biology and, specifically, the use of GIS as analytical tool. Example studies will be performed that range from global ecology to conservation in San Diego county. **Prerequisites:** BILD 3, BIEB 100, BIEB 102. Attendance at the first lecture/lab is required. Nonattendance will result in the student's being dropped from the course roster.

BIEB 147. Introduction to Phylogenetics (4)

Course will review some of the methods for constructing phylogenetic trees using morphological and molecular data. Topics to be covered will include evolutionary and ecological transformations, biodiversity measurements, biogeography, systematics, and taxonomy among others. **Prerequisite:** BILD 3.

BIEB 150. Evolution (4)

Evolutionary processes are discussed in their genetic, historical, and ecological contexts. Population genetics, agents of evolution, microevolution, speciation, macroevolution. **Prerequisites:** BILD 1 and BILD 3.

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 BIBM 100 recommended.

BIEB 156. Population Genetics (4)

Course on empirical and theoretical population genetics. The goal is to review basic models of population genetics, empirical tests of these models and gain intuitions about the population-level processes underlying genome evolution, phenotypic change and the origin of new species. A working knowledge of basic molecular genetics, algebra, and statistics is assumed. **Prerequisite:** BICD 100.

BIEB 159. Advanced Field Ecology Lab (4)

Course will familiarize students with the design, performance, analysis, and presentation of ecological experiments. Students will perform two field studies; one with terrestrial insects, the other with plant biodiversity. Field work in Mexico required during "spring break" for spring course and week prior to fall quarter for fall course. Students will continue on campus with lectures and laboratory sessions. **Prerequisites:** BIEB 100; departmental approval only (department will preauthorize student to enroll); restricted to students participating in NSF/REU program.

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.

BIEB 165. Behavioral Ecology Laboratory (6)

This course deals 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. **Prerequisites:** BIEB 100 and BIEB 164. (BIEB 164 may be taken concurrently.) Attendance at the first lecture/lab is required. Nonattendance will result in the student's being dropped from the course roster.

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. **Prerequisites:** BILD 3 and Physics 1A or 2A.

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 signaling. 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.) Attendance at the first lecture/lab is required. Nonattendance will result in the student's being dropped from the course roster.

BIEB 174. Ecosystems and Global Change (4)

Course will teach the principles of terrestrial ecosystem ecology, and will use examples from recent research to help students understand how global environmental changes are altering processes from leaf-level ecophysiology to global cycling of carbon, water, and nutrients. Field work may be required. **Prerequisites:** BILD 2 and BILD 3.

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. Examines issues from biological, cultural, historical, economic, social, political, and ethical perspectives emphasizing new approaches and new techniques for safeguarding the future of humans and other biosphere inhabitants. **Prerequisites:** upper-division standing and BILD 3 or consent of instructor.

MOLECULAR BIOLOGY, MICROBIOLOGY

BIBM 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. Prokaryotes and eukaryotes. **Prerequisites:** BIBC 100 or BIBC 102, BICD 100. (Note: Students may not receive credit for both BIBM 100 and Chem. 114C.)

BIBM 101. Recombinant DNA Techniques (4)

Theory and practice of recombinant DNA and molecular biology techniques. Includes construction and screening of DNA libraries, DNA sequencing, PCR and its applications, bioinformatics, and RNA analysis. **Prerequisite:** BILD 1. Students may not enroll in or receive credit for both BIBM 101 and BIEB 123, or BIBM 101 and Chem. 112B (renumbered to Chem. 109). BIBM 100 recommended.

BIBM 108. Adventures in Chromatin Structure and Gene Expression (4)

Chromatin, the natural state of DNA in eukaryotes, has recently emerged as a critical component of many important biological processes. Topics include histone modifications, chromatin dynamics, transcription factors, enhancers, CpG methylation, heterochromatin, epigenetics, and the role of chromatin in human biology. **Prerequisite:** BIBM 100.

BIBM 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.

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.

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.

BIMM 116. Circadian Rhythms—Biological Clocks (4) (Cross-listed with Psyc. 133; however, biology majors must take the course as BIMM 116.) 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.

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.

BIMM 120. Bacteriology (4)

A discussion of the structure, growth, molecular genetics, and physiology of prokaryotic 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:** Chem. 140A; Chem. 140B; BIBC 100 or BIBC 102 (may be taken concurrently).

BIMM 121. Laboratory in Microbiology (4)

Course emphasizes fundamental principles of microbiology, including comparative bacterial morphology and physiology, pure culture techniques, and bacterial growth. Additional studies include bacteriophage interactions, antibiotics, the use of bio-assays, natural microbial communities through metagenomics and enrichment, and bacteria in biotechnology. **Prerequisites:** BIBC 102 or BIMM 120 strongly recommended; upper-division standing.

BIMM 122. Microbial Genetics (4)

Organization and function of prokaryotic 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.

BIMM 124. Medical Microbiology (4)

Encompasses the increasingly important areas of viral, bacterial, and parasitic diseases and understanding the complex interaction between humans and infectious agents. Covers human-pathogen interactions, mechanisms and molecular principles of infectious diseases, immune responses, countermeasures by pathogens and hosts, epidemiology, and cutting-edge approaches to therapy. **Prerequisites:** BIBC 100 or BIBC 102 recommended; upper-division standing.

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.

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 physicochemical adaptations, along with an independent project. Graduate students submit an additional report and take a modified final exam. **Prerequisite:** upper-division standing. Attendance at the first lecture/lab is required. Nonattendance will result in the student's being dropped from the course roster.

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. **Prerequisite:** BIBC 100 or BIBC 102 or equivalent.

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.

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.

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 multiprotein complexes, and probing protein localization and function. **Prerequisite:** consent of instructor.

BIMM 162. 3D Electron Microscopy of Macromolecules (4)

Biological macromolecules and supramolecular complexes as well as organelles, and small cells are being examined in three-dimensions by modern electron cryomicroscopy and image reconstruction techniques. The basic principles of transmission electron microscopy and 3D image reconstruction are discussed. **Prerequisites:** Physics 1A and 1B and 1C or Physics 2A and 2B and 2D.

BIMM 164. Structural Biology of Viruses (4)

An introduction to virus structures, how they are determined, and how they facilitate the various stages of the viral life cycle from host recognition and entry to replication, assembly, release, and transmission to uninfected host cells. **Prerequisites:** BIBC 100 or Chem. 114A; upper-division standing.

BIMM 166. Environmental and Molecular Toxicology (4)

(Cross-listed with CHEM 166; conjoined with BGGN 256, BIOM 266, and CHEM 266.) This course will investigate approaches to study the impact of environmental toxicants on human health. Other modern approaches that are being implemented to detect and remediate environmental toxicants will also be examined. Graduate students will be required to complete an additional paper and/or exam beyond that expected of undergraduate students. **Prerequisites:** upper-division standing for BIMM 166 and CHEM 166; graduate standing for BGGN 256, BIOM 266, and CHEM 266.

BIMM 171. Genomics Research Initiative (1)

This class will examine the theoretical and practical basis of modern genomics research. Students will learn the theoretical basis of genomics and tools used for the sequencing and annotation of genomic DNA, and computational and molecular methods for the study of evolution. **Prerequisite:** departmental approval required (department will preauthorize students to enroll). Restricted to students participating in the National Genomics Research Initiative Program.

BIMM 171A. Genomics Research Initiative Laboratory I (4)

Students will isolate bacterial viruses or other organisms from the environment and characterize them by methods including electron microscopy and nucleic acid analysis. The genomic DNA will be purified, and sent for sequencing. **Prerequisites:** departmental approval required. Restricted to students participating in the National Genomics Research Initiative Program.

BIMM 171B. Genomics Research Initiative Laboratory II (4)

Students will characterize the genomic sequence of the organisms isolated in BIMM 171A and use molecular and computational tools to resolve ambiguities and close gaps. They will then annotate the DNA sequence to identify protein and RNA coding regions. **Prerequisites:** BIMM 171 and BIMM 171A.

BIMM 171C. Genomics Research Initiative Laboratory III (4)

Computational methods will be used to characterize the annotated genome sequence produced in BIMM 171A-B to study the evolution of genes and their products. Various mechanisms shaping genome evolution will be discussed and the genome evaluated for evidence of these processes. **Prerequisites:** BIMM 171, BIMM 171A, and BIMM 171B.

BIMM 173. Undergraduate Research Explorations in Genomics (2)

Analyzing *Drosophila* dot chromosome sequences and making comparisons among species to discern patterns of genome organization related to control of gene expression. Computer analysis of finished sequence data, annotation of genes, assessment of repeats, exploration of evolutionary questions. **Prerequisites:** BIMM 100, upper-division standing, department authorization.

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 analyses. 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. Object-oriented databases, 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 of proteins, functional genomics/proteomics, metabolic pathways/gene networks. This course open to bioinformatics majors only. **Prerequisites:** 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 analysis, 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. Attendance at the first lecture/lab is required. Nonattendance will result in the student's being dropped from the course roster.

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.

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:** BIPN 100; BIBC 102 may be taken concurrently.

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. Nonattendance will result in the student's being dropped from the course roster.

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 adaptations of the basic organ systems are discussed. **Prerequisites:** BILD 2, Chem. 6A-B-C. BILD 3 is recommended.

BIPN 108. Physiology of Exercise (4)

Course addresses the human body's response to exercise, addressing energy metabolism and the effects of both acute and chronic exercise on function in several important organ systems. Designing training regimes and the role of exercise in health will be considered. **Prerequisite:** BIPN 100 required; BIPN 102 and BIBC 102 recommended.

BIPN 110. Organ Systems and Disease (4)

Course will offer in-depth instruction to human anatomy and diseases from the conceptual framework of organ systems. Central nervous system, cardiovascular system, and gastrointestinal system will be discussed in terms of normal anatomy, pathology, and relevant scientific frontiers. **Prerequisite:** BIPN 100.

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.

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.

BIPN 144. Developmental Neurobiology (4)

Molecular basis of neuronal cell fate determination, axon pathfinding, synaptogenesis experience-based refinement of connections, and learning in the brain will be examined. **Prerequisite:** upper-division standing.

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. Attendance at the first lecture/lab is required. Nonattendance will result in the student being dropped from the course roster.

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.

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).

BIPN 150. Diseases of the Nervous System (4)

Course will be taught from a research perspective, highlighting the biological pathways impacted by different neurological diseases. Each disease covered will be used to illustrate a key molecular/cellular pathway involved in proper neurological function. **Prerequisites:** BIBC 102 and BICD 100; BIPN 140 may be taken concurrently.

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.

BISP 192. Senior Seminar in Biology (1)

The Senior Seminar Program is designed to allow senior undergraduates to meet with faculty members in a small group setting to explore an intellectual topic in biology (at the upper-division level). Topics will vary from quarter to quarter. Senior Seminars may be taken for credit up to four times, with a change in topic and permission of the department. Enrollment is limited to twenty students, with preference given to seniors. **Prerequisites:** upper-division standing; department stamp and/or consent of instructor.

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.

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, lead a discussion section, 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.) This course may be counted as one of the upper-division electives for a biology major.

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.

BISP 197. Biology Internship Program (4)

Under the joint supervision of a biology faculty advisor 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.

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. May be taken for credit three times.

GRADUATE

BGGN 200. Graduate School Fundamentals: Introduction to Graduate Studies in the Division of Biological Sciences (2)

Course will cover fundamental issues in academia, including campus resources, research design, ethical issues in research, scientific publishing and review, grant preparation, etc. Required of all first year Ph.D. students in the Division of Biological Sciences. **Prerequisites:** graduate (Ph.D.) standing only; for students in the following major code B177, or consent of instructor. (S/U grades only.) (F)

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 205. Communicating Science to the Public (2)

Learn effective ways of communicating science to non-scientists. Develop an understanding of how people's views of science and background knowledge can influence their learning, and develop methods to tailor communication for different audiences. (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 permitted.) This course is cross-listed with Physics 206 and Chemistry 206. (Quarter offered varies, and course is not offered every year.)

BGGN 208. Biological Sciences Graduate Boot Camp (4)

Intensive lecture-, seminar-, and laboratory-based course for incoming first year students in the biological sciences Ph.D. program. Topics covered: evolution and quantitative biology, including biostatistics, image analysis, bioinformatics, genomics, evolution, analysis of DNA proteins. During the first two weeks in September, students commit to ten to fifteen hours per day. **Prerequisites:** graduate

(Ph.D.) standing only; for students in the following major code BI77 (S/U grades only.) (F)

BGGN 210. Neurobiology Boot Camp (4)

For incoming doctoral students in Neurobiology, Computational Neurobiology, and Neurosciences. During first two weeks in September, students commit to ten to fifteen hours per day in lectures and laboratories in electrophysiology, cellular anatomy, molecular biology, optical imaging, and computational neurobiology. Students also attend weekly seminars during fall quarter. **Prerequisite:** graduate standing; major codes BI77, BI79, NE75. (F)

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 analyses, 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 multiprotein 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 231. Current Concepts in Stem Cell Biology (4)

Research papers from all aspects of stem cell biology will be read, presented, and discussed. Papers will range from landmark to current studies, spanning many developmental organisms and cell types. Students will present one paper, provide relevant background, and lead discussions. **Prerequisite:** graduate standing or consent of instructor. (F)

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 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 241. Neurobiology Seminar (3)

Presentation of current research by local and visiting neurobiologists. (S/U grades only.)

BGGN 242. Graduate Cancer Biology (3)

Research-oriented approach to oncology topics and problems with an emphasis on interactions between tumor and the immune system. Prerequisite: graduate standing.

BGGN 243. Systems Neurophysiology (3)

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

BGGN 246A-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. **Prerequisite:** graduate standing or consent of instructor. (S/U grades only.)

BGGN 248. Molecular Mechanisms of Neural Development (4)

This course will cover the cellular and molecular basis of neural development. Focus is on primary research papers and topics include neural induction and neurogenesis, cell patterning, neuronal and glial differentiation, neuronal migration, axon pathfinding, synaptogenesis, neuronal cell death, regeneration, activity-dependent events, topographic maps, invertebrate and vertebrate model systems. **Prerequisites:** 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 standing 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 chemotherapy. 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; antigen-antibody 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 endocytosis 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. **Prerequisite:** graduate standing or consent of instructor.

BGGN 262. 3D Electron Microscopy Macromolecules (4)

Biological macromolecules and supramolecular complexes as well as organelles, and small cells are being examined in three dimensions by modern electron cryomicroscopy and image reconstruction techniques. The basic principles

of transmission electron microscopy and 3D image reconstruction are discussed. Chem. 265/BGGN 262 students will be required to complete an additional assignment/exam beyond that expected of students in Chem. 165/BIMM 162.

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. **Prerequisite:** graduate standing 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. **Prerequisite:** graduate standing 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 290. Advances in Cellular & Molecular Mechanisms

Students present and discuss papers on recent discoveries involving basic mechanistic research into biological phenomena. Papers are selected by instructors from visiting seminar speaker's research from the biological sciences and biochemistry seminar series. **Prerequisites:** graduate (Ph.D.) standing only; for students in the following major code B177, or consent of instructor. (S/U grades only.)

BGGN 292. Professional Pathways in Biological Sciences (1)

Students meet experienced science professionals from a wide variety of backgrounds, including academia, science industry, and allied roles. Through discussions with these professionals, students will refine and improve their professional skills, including communication and presentation expertise, and develop a personal career action plan. **Prerequisites:** graduate (Ph.D.) standing only; for students in the following major code B177; or consent of instructor. (S/U 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. **Prerequisite:** 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. **Prerequisite:** 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. **Prerequisite:** 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 literature. **Prerequisite:** 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. **Prerequisite:** 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. **Prerequisite:** 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. **Prerequisite:** 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. **Prerequisite:** 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. **Prerequisite:** 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. **Prerequisite:** 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. **Prerequisite:** 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. **Prerequisite:** none for graduate students. Undergraduates must be seniors or enrolled in BISP 199. (S/U grades only.)

