

# Biology

In the College of Sciences

BIOL

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## Faculty

Emeritus: Alexander, Alfred, Atkins, Avila, Barnett, Baxter, Bohnsack, Breindl, Carmichael, Carpenter, Chen, Clark, Cohn, Collier, B., Collier, G., Cox, Davis, C., Davis, R., Dexter, Diehl, Dowler, Ebert, Etheridge, Fisher, Ford, Futch, Hanscom, Hazen, Hemmingsen, Huffman, Hunsaker, Johnson, A., Johnson, K., Kelly, Krekorian, Krisans, Kummerow, Monroe, Moore, Neel, Norland, Olson, Paolini, Parsons, Phelps, Phleger, Plymale, Ratty, Rinehart, Schapiro, Shepard, Taylor, Thwaites, Van Steenberg, Wedberg, Wilson, Zedler, J., Zedler, P., Zyskind

Chair: Frey

Professors: Archibald, Bernstein, Berta, Bizzoco, Buono, Franklin, Frey, Glembotski, Gottlieb, Harris, Maloy, McClenaghan, McGuire, Oechel, Perrault, Pozos, Sabbadini, R., Segall, Simpson, Sussman, Tsoukas

Associate Professors: Anderson, Bohonak, Burns, Deutschman, Hedin, Hentschel, Reeder, Williams

Assistant Professors: Arenas-Mena, Edwards, Feuer, Hovel, Kelley, Lai, Lewison, Lipson, Regan, Rohwer, Waters, Wolkowicz, Zeller

Lecturers: Garver, Martin, Norgard-Sumnicht, Paolini, M.

## Offered by the Department

Doctor of Philosophy degree in biology and ecology.

Master of Arts degree in biology.

Master of Science degree in biology.

Master of Science degree in microbiology.

Major in biology with the B.A. degree in liberal arts and sciences.

Major in biology with the B.S. degree in applied arts and sciences.

Emphasis in bioengineering.

Emphasis in cellular and molecular biology.

Emphasis in ecology.

Emphasis in evolution and systematics.

Emphasis in marine biology.

Emphasis in zoology.

Major in microbiology with the B.A. degree in liberal arts and sciences.

Major in microbiology with the B.S. degree in applied arts and sciences.

Emphasis in clinical laboratory science and public health microbiology.

Program of study in biology in preparation for the single subject teaching credential in science.

Minor in biology.

Certificate in biotechnology.

## The Majors

**Biology.** The Department of Biology offers a dynamic and modern program in biology which prepares students both academically and practically for vocations in science and science-related fields or for entry into graduate studies. The major is designed to present a basic background in modern biology and in the supportive disciplines of chemistry, mathematics and physics, and to provide specialized training selected by the student from a variety of areas. The wide range of faculty expertise and research interest allows the department to offer a curriculum which includes general and advanced courses in

plant and animal sciences, marine sciences, genetics and physiology, ecology, molecular biology, microbiology, immunology, endocrinology, entomology, evolution, and systematics. Formal programs of study within the major include Emphases in Bioengineering, Cell and Molecular Biology, Ecology, Evolution and Systematics, Marine Biology, and Zoology. Special studies opportunities with SDSU faculty and scientists at cooperating institutions allow qualified students to gain research experience on an individual basis.

The department offers a specific program of courses to fulfill the state of California's science requirements for the Single Subject Teaching Credential in Biological Science. Students successfully completing one of these programs may be certified by the department as having demonstrated subject competency as required in part for acceptance into College of Education single subject credential program.

The department also offers a program leading to the Biotechnology Certificate. The purpose of this program is to prepare undergraduate and graduate students for employment in public and private organizations utilizing biotechnology.

The rapid advances in theoretical and applied biology, the growing demands in health care and the expansion of general interest in and concern for the environment are just a few of the factors which continue to increase society's need for biologists. Some examples: a biology degree is the common precursor for the medical, dental, veterinarian and allied health professions; government agencies involved in environment protection, public health and conservation need ecologists, inspectors, laboratory technicians and wildlife, forest, coast and park managers; government and private agriculture agencies need entomologists and botanists; private companies, government laboratories and universities involved in biotechnology need microbiologists and molecular biologists; zoos, wild animal parks and aquaria need zoologists; the secondary school system needs biology teachers; textbook and scientific supply companies need science majors. Whether your goal is to work in a laboratory or a forest, there is opportunity for fulfillment and growth in the field of biology.

**Microbiology.** Microbiology is the study of bacteria, viruses, yeasts, molds, algae and protozoa. These microorganisms are found associated with plants and animals, in soil, and in fresh and marine waters. Many of the free-living species participate in maintaining the quality of our environment. Certain species affect the health and well-being of plants and animals, including humans, by causing infectious diseases. Microorganisms are often used in the molecular biology laboratory as research tools, for experiments in genetic engineering, and in the manufacture of food and chemicals.

The microbiology major is designed to provide the student with a background in basic biology, microbiology, and the disciplines of chemistry, mathematics and physics. The curriculum includes introductory and advanced courses (most with laboratories) in general and pathogenic microbiology, immunology, virology, physiology, and genetics as well as courses in food and industrial microbiology, marine microbiology, and molecular biology.

Microbiologists find positions with governmental agencies, in university and private research laboratories, in biotechnology, medical and industrial laboratories, in schools as teachers, with scientific supply companies, or with textbook companies. Depending on the situation, a microbiologist may conduct fundamental and applied research, identify disease-causing microorganisms in medical or veterinary specimens, participate in studies of the environment (e.g., soil, ocean, lakes), aid in the manufacture of pharmaceuticals, food, or beverages, or provide quality and safety control. The microbiology major is excellent preparation for entrance into medical, dental, veterinarian, and graduate schools. The Emphasis in Clinical Laboratory Science and Public Health Microbiology prepares students to become, after a post-graduate internship, licensed medical technologists or certified public health microbiologists.

### Impacted Programs

The biology and microbiology majors are impacted programs. To be admitted to the biology or microbiology major, students must meet the following criteria:

- Complete with a minimum GPA of 2.70 and a grade of C or higher: Biology 201A, 201B, 215; Chemistry 200, 201, 231 or 232 and 232L; Mathematics 121 and 122; and Physics 180A, 180B, 182A, and 182B. These courses cannot be taken for credit/no credit (Cr/NC);
- Have a cumulative GPA of 2.60 or higher;
- Students choosing an emphasis in bioengineering have a different set of courses to complete in the preparation for the major. To be admitted to the major, bioengineering students must complete Biology 201A, 201B; Chemistry 200, 201, 231 or 232 and 232L; Mathematics 150, 151; Physics 195, 196, 197 with at least a C in each course; and have a cumulative GPA of 2.70 or higher. Students may not elect credit/no credit grading for coursework needed to satisfy preparation for the major requirements.

To complete the major, students must fulfill the degree requirements for the major described in the catalog in effect at the time they are accepted into the premajor at SDSU (assuming continuous enrollment).

### Major Academic Plans (MAPs)

Visit <http://www.sdsu.edu/mymap> for the recommended courses needed to fulfill your major requirements. The MAPs Web site was created to help students navigate the course requirements for their majors and to identify which General Education course will also fulfill a major preparation course requirement.

### Biology Major

#### With the B.A. Degree in Liberal Arts and Sciences (Major Code: 04011)

All candidates for a degree in liberal arts and sciences must complete the graduation requirements listed in the section of this catalog on "Graduation Requirements." A total of 40 upper division units must be taken, of which 24 must be selected from the General Biology Degree Requirements and the list of courses acceptable for electives. No more than 48 units in biology courses can apply to the degree.

A minor is not required with this major.

**Language Requirement.** Competency (successfully completing the third college semester or fifth college quarter) is required in one foreign language to fulfill the graduation requirement. Refer to section of catalog on "Graduation Requirements."

**Graduation Writing Assessment Requirement.** Passing the Writing Proficiency Assessment with a score of 10 or above or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

### Biology Major

#### With the B.S. Degree in Applied Arts and Sciences (Major Code: 04011)

All candidates for a degree in applied arts and sciences must complete the graduation requirements listed in the section of this catalog on "Graduation Requirements." A total of 36 upper division units must be selected from the General Biology Degree Requirements and the list of courses acceptable for electives.

A minor is not required with this major.

#### General Biology Degree Requirements

**Preparation for the Major.** Biology 201A, 201B, 215; Chemistry 200, 201, and 231 or 232 and 232L; Mathematics 121 and 122; Physics 180A, 180B, 182A, 182B. (39 units)

These prerequisite courses may not be taken Cr/NC and must be completed with a minimum GPA of 2.70 and a grade of C or higher in each class.

**Graduation Writing Assessment Requirement.** Passing the Writing Proficiency Assessment with a score of 10 or above or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 24 upper division units for the B.A. degree or 36 upper division units for the B.S. degree to include Biology 352, 354, 366, 366L, and Chemistry 365. Elective courses include all upper division biology courses numbered 350 and above, and all upper division chemistry courses (except Chemistry 300, 308, 361, 497, 499, 560). A minimum of two elective courses must be biology laboratory courses, at least one of which must be an organismal level course selected from Biology 350, 460, 512, 514, 515, 520, 523, 524, 525, 526, 528, 530, 531, 535.

All courses not included above must have specific approval of the department.

All upper division transfer courses in biology will calculate in the major GPA but will not fulfill any major requirements without specific department approval. This approval must be filed with the Office of Advising and Evaluations.

**Time Limitation.** All courses for the major must be completed within seven years of the granting of the undergraduate degree. Exceptions for individual courses must be approved by the department and be filed with the Office of Advising and Evaluations.

#### Emphasis in Bioengineering

**Preparation for the Major.** Biology 201A, 201B; Chemistry 200, 201, and 231 or 232 and 232L; Electrical Engineering 203; Engineering Mechanics 200; Mechanical Engineering 101, 240; Mathematics 150, 151, 252; Physics 195, 196, 197. (54 units)

Prerequisite courses, listed in item c. of Impacted Programs, may not be taken Cr/NC and must be completed with a minimum GPA of 2.70 and a grade of C or higher in each class.

**Graduation Writing Assessment Requirement.** Passing the Writing Proficiency Assessment with a score of 10 or above or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 38 upper division units to include Biology 366, 366L and either Biology 350 or 590; Chemistry 365; Civil Engineering 301; Mathematics 342A; Mechanical Engineering 352, 490A\*, 490B; 12 units selected from the following courses, at least six of which must be biology courses: Biology 497 and 499 or Mechanical Engineering 499 (maximum 3 units); Biology 350, 474, 555, 567; either 556 or 557, 560, 575 or 590; Chemistry 431; Electrical Engineering 303, 503; Exercise and Nutritional Sciences 306; Mechanical Engineering 310, 312, 540, 580. Approval of the Emphasis in Bioengineering adviser is required for credit in Biology 497, 499, and other courses not listed above to be included in the emphasis. This approval must be filed with the Office of Advising and Evaluations.

All upper division transfer courses in biology will calculate in the major GPA but will not fulfill any major requirements without specific department approval. This approval must be filed with the Office of Advising and Evaluations.

**Time Limitation.** All courses for the major must be completed within seven years of the granting of the undergraduate degree. Exceptions for individual courses must be approved by the department adviser and be filed with the Office of Advising and Evaluations.

\*Additional prerequisites may be required.

#### Emphasis in Cellular and Molecular Biology

**Preparation for the Major.** Biology 201A, 201B, 215; Chemistry 200, 201, and 231 or 232 and 232L; Mathematics 121 and 122; Physics 180A, 180B, 182A, 182B. (39 units)

These prerequisite courses may not be taken Cr/NC and must be completed with a minimum GPA of 2.70 and a grade of C or higher in each class.

**Graduation Writing Assessment Requirement.** Passing the Writing Proficiency Assessment with a score of 10 or above or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 36 upper division units to include Biology 350, 352, 354, 366, 366L, 567, Chemistry 365 and 467L, and at least 11 units of electives selected from Biology and Chemistry 496 and/or 596 (maximum 3 units), Biology 497 and 499 and/or Chemistry 498 (maximum 3 units), Biology 511, 521, 521L, 528, 549, 551, 554, 555, 556, 557, 568, 570, 575, 576, 584, 485 or 585, 590, 594, 595, and Chemistry 431. At least one course must be an organismal level course. Approval of the Emphasis in Cellular and Molecular Biology adviser is required for credit in Biology 497, Chemistry 498, Biology or Chemistry 496, 499, and 596 and other courses not listed above to be included in the emphasis. This approval must be filed with the Office of Advising and Evaluations.

Other than Biology 352, 354, 366, 366L and Chemistry 365, only one course in this emphasis may be used for credit in another emphasis offered by the department.

All upper division transfer courses in biology will calculate in the major GPA but will not fulfill any major requirements without specific department approval. This approval must be filed with the Office of Advising and Evaluations.

**Time Limitation.** All courses for the major must be completed within seven years of the granting of the undergraduate degree. Exceptions for individual courses must be approved by the department adviser and be filed with the Office of Advising and Evaluations.

### Emphasis in Ecology

**Preparation for the Major.** Biology 201A, 201B, 215; Chemistry 200, 201, and 231 or 232 and 232L; Mathematics 121 and 122; Physics 180A, 180B, 182A, 182B. A computer programming course (e.g. Computer Science 106 or 107) is recommended. (39 units)

These prerequisite courses may not be taken Cr/NC and must be completed with a minimum GPA of 2.70 and a grade of C or higher in each class.

**Graduation Writing Assessment Requirement.** Passing the Writing Proficiency Assessment with a score of 10 or above or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 36 upper division units to include Biology 352, 354, 354L, 366, 366L, Chemistry 365, and at least 15 units of electives selected from Biology 496 and/or 596 (maximum 3 units), 497 and 499 (maximum 3 units), 508, 509, 512, 517, 526, 535, 537, 538, 540, 541, 560, 597A. At least one of the above electives must be a laboratory course. The remaining units must include an organismal level course selected from Biology 350, 460, 512, 515, 520, 523, 524, 525, 526, 528, 530, 531, 535. Other electives include all biology courses numbered 350 and above (except Biology 452), and all upper division chemistry courses (except Chemistry 300, 308, 361, 497, 499, 560). Approval of the Emphasis in Ecology adviser is required for credit in Biology 496, 497, 499, 596, and other courses not listed above to be included in the 15 units of ecology electives. This approval must be filed with the Office of Advising and Evaluations.

Other than Biology 352, 354, 366, 366L, and Chemistry 365, only one course in this emphasis may be used for credit in another emphasis offered by the department.

All upper division transfer courses in biology will calculate in the major GPA but will not fulfill any major requirements without specific department approval. This approval must be filed with the Office of Advising and Evaluations.

**Time Limitation.** All courses for the major must be completed within seven years of the granting of the undergraduate degree. Exceptions for individual courses must be approved by the department adviser and be filed with the Office of Advising and Evaluations.

### Emphasis in Evolution and Systematics

**Preparation for the Major.** Biology 201A, 201B, 215; Chemistry 200, 201, and 231 or 232 and 232L; Mathematics 121 and 122; Physics 180A, 180B, 182A, 182B. (39 units)

These prerequisite courses may not be taken Cr/NC and must be completed with a minimum GPA of 2.70 and a grade of C or higher in each class.

**Graduation Writing Assessment Requirement.** Passing the Writing Proficiency Assessment with a score of 10 or above or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 36 upper division units to include Biology 352, 354, 366, 366L, 509, Chemistry 365, and at least 12 units of electives selected from Biology 496 and/or 596 (maximum 3 units), 497 and 499 (maximum 3 units), 460, 508, 510, 511, 512, 515, 520, 521, 521L, 523, 524, 525, 526, 528, 530, 531, 568. Two of the above electives must be laboratory courses, one of which must be an organismal level course selected from Biology 512, 515, 520, 523, 524, 525, 526, 528, 530, 531. Other electives include all biology courses numbered 350 and above (except Biology 452), and all upper division chemistry courses (except Chemistry 300, 308, 361, 497, 499, 560). Approval of the Emphasis in Evolution and Systematics adviser is required for credit in Biology 496, 497, 499, 596, and other courses not listed above to be included in the 12 units of evolution and systematics electives. This approval must be filed with the Office of Advising and Evaluations.

Other than Biology 352, 354, 366, 366L, and Chemistry 365, only one course in this emphasis may be used for credit in another emphasis offered by the department.

All upper division transfer courses in biology will calculate in the major GPA but will not fulfill any major requirements without specific department approval. This approval must be filed with the Office of Advising and Evaluations.

**Time Limitation.** All courses for the major must be completed within seven years of the granting of the undergraduate degree. Exceptions for individual courses must be approved by the department adviser and be filed with the Office of Advising and Evaluations.

### Emphasis in Marine Biology

**Preparation for the Major.** Biology 201A, 201B, 215; Chemistry 200, 201, and 231 or 232 and 232L; Mathematics 121 and 122; Physics 180A, 180B, 182A, 182B. (39 units)

These prerequisite courses may not be taken Cr/NC and must be completed with a minimum GPA of 2.70 and a grade of C or higher in each class.

**Graduation Writing Assessment Requirement.** Passing the Writing Proficiency Assessment with a score of 10 or above or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 36 upper division units to include Biology 352, 354, 366, 366L, Chemistry 365, and at least 15 units of electives selected from Biology 496 and/or 596 (maximum 3 units), 497 and 499 (maximum 3 units), 512, 514, 515, 517, 520, 541. At least two of the above electives must be laboratory courses, at least one of which must be one of the organismal courses Biology 512, 514, 515, or 520. The remaining units must be selected from biology courses numbered 350 and above (except Biology 452), all upper division chemistry courses (except Chemistry 300, 308, 361, 497, 499, 560), and may include three units selected from Economics 454, Geography 504, Geological Sciences 540, 545. Approval of the Emphasis in Marine Biology adviser is required for credit in Biology 496, 497, 499, 596, and other courses not listed above to be included in the 15 units of marine biology electives. This approval must be filed with the Office of Advising and Evaluations.

Other than Biology 352, 354, 366, 366L, and Chemistry 365, only one course in this emphasis may be used for credit in another emphasis offered by the department.

All upper division transfer courses in biology will calculate in the major GPA but will not fulfill any major requirements without specific department approval. This approval must be filed with the Office of Advising and Evaluations.

**Time Limitation.** All courses for the major must be completed within seven years of the granting of the undergraduate degree. Exceptions for individual courses must be approved by the department adviser and be filed with the Office of Advising and Evaluations.

### Emphasis in Zoology

**Preparation for the Major.** Biology 201A, 201B, 215; Chemistry 200, 201, and 231 or 232 and 232L; Mathematics 121 and 122; Physics 180A, 180B, 182A, 182B. (39 units)

These prerequisite courses may not be taken Cr/NC and must be completed with a minimum GPA of 2.70 and a grade of C or higher in each class.

**Graduation Writing Assessment Requirement.** Passing the Writing Proficiency Assessment with a score of 10 or above or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 36 upper division units to include Biology 352, 354, 366, 366L, Chemistry 365, and at least 15 units of electives selected from Biology 496 and/or 596 (maximum 3 units), 497 and 499 (maximum 3 units), and 515, 526 (invertebrate group), 512, 520, 523, 524, 525 (vertebrate group), 508, 509, 510, 511, 560, 576 (general zoology group). At least three units must be selected from each of the three groups. Two or more of the above electives must be laboratory courses, at least one of which must be an organismal level course selected from Biology 512, 515, 520, 523, 524, 525, 526. The remaining units must be selected from biology courses numbered 350 and above (except Biology 452), and all upper division chemistry courses (except Chemistry 300, 308, 361, 497, 499, 560). Approval of the Emphasis in Zoology adviser is required for credit in Biology 496, 497, 499, 596, and other courses not listed above to be included in the 15 units of zoology electives. This approval must be filed with the Office of Advising and Evaluations.

All upper division transfer courses in biology will calculate in the major GPA but will not fulfill any major requirements without specific department approval. This approval must be filed with the Office of Advising and Evaluations.

Other than Biology 352, 354, 366, 366L, and Chemistry 365, only one course in this emphasis may be used for credit in another emphasis offered by the department.

**Time Limitation.** All courses for the major must be completed within seven years of the granting of the undergraduate degree. Exceptions for individual courses must be approved by the department adviser and be filed with the Office of Advising and Evaluations.

### Microbiology Major

**With the B.A. Degree in Liberal Arts and Sciences  
(Major Code: 04111)**

All candidates for a degree in liberal arts and sciences must complete the graduation requirements listed in the section of this catalog on "Graduation Requirements." No more than 48 units in biology courses can apply to the degree.

A minor is not required with this major.

**Preparation for the Major.** Biology 201A, 201B, 215; Chemistry 200, 201, and 231 or 232 and 232L; Mathematics 121 and 122; Physics 180A, 180B, 182A, 182B. (39 units)

These prerequisite courses may not be taken Cr/NC and must be completed with a minimum GPA of 2.70 and a grade of C or higher in each class.

**Language Requirement.** Competency (successfully completing the third college semester or fifth college quarter) is required in one foreign language to fulfill the graduation requirement. It is recommended that students select French, German, or Russian to satisfy this requirement. Refer to section of catalog on "Graduation Requirements."

**Graduation Writing Assessment Requirement.** Passing the Writing Proficiency Assessment with a score of 10 or above or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 33 upper division units to include Biology 350, 352, 354, 366, 366L, 521 or 584, 521L, 549, 567, Chemistry 365 and 467L.

All courses not included above must have the prior approval of the Microbiology adviser and be filed with the Office of Advising and Evaluations.

All upper division transfer courses in biology will calculate in the major GPA but will not fulfill any major requirements without specific department approval. This approval must be filed with the Office of Advising and Evaluations.

**Time Limitation.** All courses for the major must be completed within seven years of the granting of the undergraduate degree. Exceptions for individual courses must be approved by the department and be filed with the Office of Advising and Evaluations.

### Microbiology Major

**With the B.S. Degree in Applied Arts and Sciences  
(Major Code: 04111)**

All candidates for a degree in applied arts and sciences must complete the graduation requirements listed in the section of this catalog on "Graduation Requirements."

A minor is not required with this major.

**Preparation for the Major.** Biology 201A, 201B, 215; Chemistry 200, 201, and 231 or 232 and 232L; Mathematics 121 and 122; Physics 180A, 180B, 182A, 182B. (39 units)

These prerequisite courses may not be taken Cr/NC and must be completed with a minimum GPA of 2.70 and a grade of C or higher in each class.

**Graduation Writing Assessment Requirement.** Passing the Writing Proficiency Assessment with a score of 10 or above or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 36 upper division units to include Biology 350, 352, 354, 366, 366L, 521 or 584, 521L, 549, 567, Chemistry 365, and at least four units of electives selected from Biology and Chemistry 496 and 596 (maximum 3 units), Biology 497 and 499 (maximum 3 units), Biology 521, 528, 551, 554, 555, 556, 557, 584, 485 or 585, 590, 595, Chemistry 431, 467L. Approval of the Microbiology adviser is required for credit in Biology 496, 497 and 499, 596, and other courses not listed above to be included in the electives. This approval must be filed with the Office of Advising and Evaluations.

All upper division transfer courses in biology will calculate in the major GPA but will not fulfill any major requirements without specific department approval. This approval must be filed with the Office of Advising and Evaluations.

**Time Limitation.** All courses for the major must be completed within seven years of the granting of the undergraduate degree. Exceptions for individual courses must be approved by the department and be filed with the Office of Advising and Evaluations.

### Emphasis in Clinical Laboratory Science and Public Health Microbiology

The emphasis in clinical laboratory science and public health microbiology is a program of required and elective courses which prepares students for the Public Health Microbiologist and Clinical Laboratory Scientist academic certification and licensing examinations.

**Preparation for the Major.** Biology 201A, 201B, 215; Chemistry 200, 201, and 231 or 232 and 232L; Mathematics 121 and 122; Physics 180A, 180B, 182A, 182B. (39 units)

These prerequisite courses may not be taken Cr/NC and must be completed with a minimum GPA of 2.70 and a grade of C or higher in each class.

**Graduation Writing Assessment Requirement.** Passing the Writing Proficiency Assessment with a score of 10 or above or completing one of the approved upper division writing courses (W) with a grade of C (2.0) or better. See "Graduation Requirements" section for a complete listing of requirements.

**Major.** A minimum of 36 upper division units to include Biology 350, 352, 354, 366, 366L, 485 or 585, 521L, 549, 584, Chemistry 365. The remaining units to be selected from Biology 521, 528, 551, 554, 555, 556, 557, 590, 595, Chemistry 431, 467L. To be included in this major courses not listed above must have the prior approval of the Microbiology adviser and be filed with the Office of Advising and Evaluations.

All upper division transfer courses in biology will calculate in the major GPA but will not fulfill any major requirements without specific department approval. This approval must be filed with the Office of Advising and Evaluations.

**Time Limitation.** All courses for the major must be completed within seven years of the granting of the undergraduate degree. Exceptions for individual courses must be approved by the department and be filed with the Office of Advising and Evaluations.

## Biology Major

In preparation for the Single Subject Teaching Credential in Science/Biological Sciences

With the B.S. Degree in Applied Arts and Sciences

(Major Code: 04011)

Students applying to the College of Education's graduate program for the Single Subject Teaching Credential in Science/Biological Sciences must be certified by this department for subject matter competency. This certification requires earning a B or better in Biology 452 and either (1) passing the required examinations (CSET), or (2) completing the subject matter preparation program described below.

Certification through the accomplishment of appropriate coursework requires (1) completion of the courses described under the General Biology Degree Requirements, B.S. degree (preparation for the major and major) including the following electives in the major: Biology 436, 452, 460 or 530 or 531, 560 or 590, and at least one course from Biology 515, 520, 523, 524, 525, or 526 (it is recommended that Biology 497 and 499 and Chemistry 467L be included if the major is being sought); (2) earning a B or better in Biology 452, (3) completing Astronomy 101, Geography 103, Geological Sciences 100 and 101, Oceanography 320. The Department of Biology credential adviser (LS-135) must be consulted for certification.

Please refer to the Teacher Education section of this catalog for other requirements and prerequisites for the credential program.

**Time Limitation.** All courses for the major must be completed within seven years of the granting of the undergraduate degree. Exceptions for individual courses must be approved by the department and be filed with the Office of Advising and Evaluations.

All courses not included above must have the prior approval of the department and the substitution filed with the Office of Advising and Evaluations.

## Biology Minor

Biology 100 and 100L or 201A are prerequisites to the biology minor and do not count towards the units in the minor; some areas include additional prerequisites not counted towards the minor.

The minor in biology consists of a minimum of 16-22 units to include Biology 201B and at least 12 units of upper division courses selected from one of the areas below. At least one of the selected courses must be a biology laboratory course numbered 350 or above. A maximum of three units of Biology 497 and 499 may be included in the minor with prior approval of the department. For courses requiring Biology 215 as a prerequisite, a college level course in statistics may be acceptable with the approval of the instructor. Basic chemistry, such as Chemistry 100, 105, or 200, is strongly recommended. Courses may be substituted for those in groupings below with approval of the biology adviser, and this approval must be filed with the Office of Advising and Evaluations.

### General Biology

Required: At least four courses with one course from each of the following areas: Evolution and Genetics (3 units): Biology 319 or 352; Ecology and the Environment (3 units): Biology 315, 324, 326, 327, or 354; Human Biology (3 units): Biology 307, 321, or 336; Biology Laboratory (2-4 units): Biology 354L, 436, 515, 517, 523, 524, 525, 526, 528, 530, 531, 535. Requirements for all biology minors (above) apply.

### Biology for Physiological Psychology

Required: Biology 336, 436, 570\*. Elective: Biology 307. At least one college course in chemistry is strongly recommended to complement this minor. Requirements for all biology minors (above) apply.

\*Additional prerequisites required.

## Cellular and Molecular Biology

Prerequisites: Biology 201A, Chemistry 200, 201, 231, 365. At least 12 units of the following electives: Biology 350, 352, 366, 366L, 499, 521, 521L, 549, 551, 554, 555, 567, 570, 575, 576, 584, 590, 594, 595, and 485 or 585, and 556 or 557. Requirements for all biology minors (above) apply.

### Ecology

Required: Biology 354. Electives: Biology 315, 324, 327, 354L, 509, 512, 514, 515, 517, 523, 524, 525, 526, 528, 531, 540, 541. Requirements for all biology minors (above) apply.

### Elementary Education

Required: Biology 315, 336, 436, at least two units of Biology 497 and 499, and a minimum of two units of electives selected from any upper division biology course. A college level course in chemistry is strongly recommended to complement this minor. Requirements for all biology minors (above) apply.

### Evolutionary Biology

Required: Biology 319 or 352 or 509. Electives: Biology 319, 352, 508, 509, 512, 523, 524, 525, 526, 530, 531. Requirements for all biology minors (above) apply.

### Human Biology

Required: Biology 261 or 336 or 590. Electives: Biology 307, 326, 336, 352, 436, and 590. Requirements for all biology minors (above) apply.

### Marine Biology

Required: Biology 514 or 515 or 520. Electives: Biology 324, 512, 514, 515, 517, 520, 524, and 541. Requirements for all biology minors (above) apply.

### Plant Biology

Required: Biology 460 or 530 or 531 or 535. Electives: Biology 326, 460, 530, 531, 535. Requirements for all biology minors (above) apply.

Courses in the minor may not be counted toward the major, but may be used to satisfy preparation for the major and general education requirements, if applicable. A minimum of six upper division units must be completed at San Diego State University.

### Secondary Education

Prerequisite: College level course in statistics. Required: Biology 354, 452. Electives (at least one course from each group): Biology 336, 560, 590; Biology 520, 524, 525. Basic courses in genetics, microbiology, and organic chemistry are recommended. (20-21 units)

Courses in the minor may not be counted toward the major, but may be used to satisfy preparation for the major and general education requirements, if applicable. A minimum of six upper division units must be completed at San Diego State University.

## Biotechnology Certificate

Matriculated students must apply for admission to the program before completion of 15 certificate units and must complete all prerequisite and required courses with a GPA of 2.5 or better.

The certificate requires 13 prerequisite units – Biology 350, 366, 366L, Chemistry 365 and 24-28 certificate units including Biology 497, 567, and 499 (5 units as approved by the certificate adviser), 594, Chemistry 467L, and three electives selected from Biology 521, 521L, 549, 554, 570, 575, 584, 585, 590. Prerequisite and certificate courses may be utilized in the biology, chemistry, and microbiology majors and minors as appropriate.

Courses in the certificate may not be counted toward the minor.