BIOLOGY

PROGRAMS OFFERED
- Bachelor of Science in Biology
- Bachelor of Science in Biology with an Emphasis in Cell and Molecular Biology
- Bachelor of Science in Biology with an Emphasis in Medical Imaging
- Bachelor of Arts in Biology with an Emphasis in General Biology
- Bachelor of Arts in Biology with an Emphasis in Pre-Professional Studies
- Bachelor of Arts in Biology with an Emphasis in Subject Matter Preparation in Teaching Biology
- Master of Science in Biotechnology and Bioinformatics
- Minor in Biology
- Certificate in Biotechnology
- Honors in Biology

PROGRAM DESCRIPTION
Biology is the study of life, its origins, diversity and intricacies. It emphasizes the relationship between structure and function in living systems and the processes by which organisms grow, reproduce and interact with each other and their environment.

The discipline is dynamic and rapidly advancing, particularly in the areas of biotechnology and information technology. The Biology Program provides its undergraduate and graduate students with a strong theoretical foundation in biology, combined with extensive hands-on laboratory experiences using state-of-the-art technology. Students take a series of core courses augmented by electives selected from areas of special interest.

CAREERS
The Bachelor of Science in Biology and the Bachelor of Science in Biology with an Emphasis in Cell and Molecular Biology are designed for students who wish to enter medical, dental or other health professional or graduate schools, or to seek careers in business, industry or government.

The Bachelor of Science in Biology with an Emphasis in Cell and Molecular Biology offers students an opportunity to study the exciting developments in genetics, molecular biology, cloning, biotechnology and bioinformatics. Such programs lead to careers in biotechnology, pharmaceuticals, research and development, intellectual property and patent law.

The Bachelor of Science in Biology with an Emphasis in Medical Imaging prepares students for graduate or professional study in the medical sciences (medical imaging, medical physics, health physics, dosimetry, nuclear medicine, radiology, oncology, biomedical engineering), or for entry into professional positions in the clinical environment and in medical imaging research and development.
The Bachelor of Arts degree is designed to obtain a general background in both the concepts and the technical skills of modern biology. Students completing the Bachelor of Arts major will find that their strong general background will allow them flexibility in both completing minor fields of study and career choices. The degree prepares graduates for careers in medical and other health professions, science education, industry or government.

Biology as a discipline has been rapidly advancing in the last decade. With the information derived from the sequencing of the genomes of many organisms, it will have far-reaching impacts on the environment, public health, and on local, regional, and global economies. The Biology Minor allows students in majors other than biology to gain an understanding of these exciting developments. It will provide a solid background in biology and the opportunity to explore selected area(s) at a greater depth. Equipped with a minor in biology, students with a major in other disciplines will have a greater understanding and knowledge of the latest advances in many areas of biology and will therefore be more versatile in their career paths. The requirement for a Minor in Biology is 21 units.

The Certificate in Biotechnology will provide students with advanced knowledge and skills in modern biotechnology that will lead to careers in biotech as well as pharmaceutical industries.

PROGRAM LEARNING OUTCOMES
Students graduating from the Biology program will be able to:
• explain the basic structures and fundamental processes of life at molecular, cellular and organismal levels;
• identify the evolutionary processes that lead to adaptation and biological diversity;
• describe the relationship between life forms and their environment and ecosystems;
• collect, organize, analyze, interpret and present quantitative and qualitative data and incorporate them into the broader context of biological knowledge;
• effectively apply current technology and scientific methodologies for problem solving;
• find, select and evaluate various types of scientific information including primary research articles, mass media sources and world-wide web information; and
• communicate effectively in written and oral forms.

REQUIREMENTS FOR HONORS IN BIOLOGY
Candidacy for honors in biology is voluntary. To be eligible, a student must fulfill the following requirements:
1. Achieve a minimum grade point average of 3.5 for all courses satisfying the requirements for the major as defined above;
2. Take at least seven courses in the major at this university;
3. Satisfactorily complete a Service Learning course from BIOL 492, 494 or 497;
4. Satisfactorily complete a Senior Capstone course.

Application for candidacy must be made at the beginning of the senior year. Approval of candidacy and of the Service Learning project and project advisor rests with the Biology Program. The project advisor will have the sole responsibility for acceptance of the completed project.

The Biology Program may grant honors to exceptional students who have not met the above requirements, but who have in the judgment of the Program brought distinction upon themselves and the Program in some other significant and appropriate manner.

FACULTY
Ching-Hua Wang, MD, PhD, Professor and Chair, Biology Program
Phone: (805) 437-8870
Email: ching-hua.wang@csuci.edu

Amy Denton, PhD, Assistant Professor of Biology
Phone: (805) 437-8458
Email: amy.denton@csuci.edu

Geoff Dougherty, PhD, Professor of Physics
Phone: (805) 437-8990
Email: geoffrey.dougherty@csuci.edu

Nancy Mozingo, PhD, Assistant Professor of Biology
Phone: (805) 437-8989
Email: nancy.mozingo@csuci.edu

CONTACT INFORMATION
http://biology.csuci.edu
biology@csuci.edu
REQUIREMENTS FOR THE BACHELOR OF SCIENCE DEGREE IN BIOLOGY (120 UNITS)

Common Lower Division Requirements for All Emphases of the Bachelor of Science Degree in Biology (8 Units)

BIOL 200* Principles of Organismal and Population Biology, GE-B2 (4)
BIOL 201 Principles of Cell and Molecular Biology (4)

FOR BACHELOR OF SCIENCE IN BIOLOGY

Upper Division Requirements in the Major (39 Units)

1. Required Biology Courses (25 units)
   BIOL 300 Cell Biology (4)
   BIOL 301 Genetics (4)
   BIOL 302 Evolutionary Biology (3)
   BIOL 303 Comparative Animal Physiology (3)
   BIOL 304 Molecular Biology (4)
   BIOL 433* Ecology and the Environment, GE-B2, UDID (4)
   BIOL 499 Senior Capstone (3)

2. Electives in Biology (14 units)
   Select from the following list of courses, one of which must be a lab course.
   BIOL 301 Microbiology (4)
   BIOL 310 Animal Biology and Ecology (4)
   BIOL 311 Plant Biology and Ecology (4)
   BIOL 312 Marine Biology (4)
   BIOL 313 Conservation Biology (4)
   BIOL 316 Invertebrate Zoology (4)
   BIOL 317 Parasitology (4)
   BIOL 401 Biotechnology and Recombinant DNA Techniques (5)
   BIOL 402 Toxicology (3)
   BIOL 420 Cellular and Molecular Immunology (4)
   BIOL 421 Virology (3)
   BIOL 422 Molecular Plant Physiology (4)
   BIOL 423 Cellular and Molecular Neurobiology (3)
   BIOL 424 Human Physiology (3)
   BIOL 425 Human Genetics (3)
   BIOL 427 Developmental Biology (4)
   BIOL 428 Biology of Cancer (3)
   BIOL 431* Bioinformatics, GE-B2, B4, UDID (4)
   BIOL 432* Principles of Epidemiology and Environmental Health, GE-B2, D, UDID (3)
   BIOL 450 Ichthyology: The Biology of Fishes
   No more than 2 units taken from the following:
   BIOL 492 Internship (2-3)
   BIOL 494 Independent Research (1-3)
   BIOL 497 Directed Study (1-3)

Required Supporting and Other GE Courses (73 Units)

1. Chemistry (16 units)
   CHEM 121* General Chemistry I, GE-B1 (4)
   CHEM 122 General Chemistry II (4)
   CHEM 311 Organic Chemistry I (3)
   CHEM 312 Organic Chemistry I Laboratory (1)
   CHEM 314 Organic Chemistry II (3)
   CHEM 315 Organic Chemistry II Laboratory (1)

2. Physics (8 units)
   Select either
   PHYS 100 Introduction to Physics I (4)
   PHYS 101 Introduction to Physics II (4)
   or
   PHYS 200 General Physics I (4)
   PHYS 201 General Physics II (4)

3. Statistics and Mathematics (7 units)
   BIOL 203* Quantitative Methods for Biology, GE-B3 (3)
   MATH 150* Calculus I, GE-B3 (4)

4. Other Required GE Courses in Categories A-E (36 units)
   Category A (9)
   Category C (12)
   Category D (12)
   Category E (3)

5. American Institutions Requirement (6 units)

FOR EMPHASIS IN CELL AND MOLECULAR BIOLOGY

Upper Division Requirements in the Major (40 Units)

1. Required Biology Courses (31 units)
   BIOL 300 Cell Biology (4)
   BIOL 301 Microbiology (4)
   BIOL 302 Genetics (4)
   BIOL 303 Evolutionary Biology (3)
   BIOL 304 Comparative Animal Physiology (3)
   BIOL 400 Molecular Biology (4)
   BIOL 401 Biotechnology and Recombinant DNA Techniques (5)
   BIOL 402 Toxicology (3)
   BIOL 416 Radiobiology and Radionuclides (3)
   BIOL 420 Cellular and Molecular Immunology (4)
   BIOL 421 Virology (3)
   BIOL 422 Molecular Plant Physiology (4)
   BIOL 423 Cellular and Molecular Neurobiology (3)
   BIOL 424 Human Physiology (3)
   BIOL 425 Human Genetics (3)
   BIOL 427 Developmental Biology (4)
   BIOL 428 Biology of Cancer (3)
   BIOL 431* Bioinformatics, GE-B2, B4, UDID (4)
   BIOL 499 Senior Capstone (3)

2. Electives in Biology (9 units)
   Select from the following list of courses:
   BIOL 402 Toxicology (3)
   BIOL 416 Radiobiology and Radionuclides (3)
   BIOL 420 Cellular and Molecular Immunology (4)
   BIOL 421 Virology (3)
   BIOL 422 Molecular Plant Physiology (4)
   BIOL 423 Cellular and Molecular Neurobiology (3)
   BIOL 424 Human Physiology (3)
   BIOL 425 Human Genetics (3)
   BIOL 427 Developmental Biology (4)
   BIOL 428 Biology of Cancer (3)
   BIOL 432* Principles of Epidemiology and Environmental Health, GE-B2, D, UDID (3)
BIOL 433* Ecology and the Environment, GE-B2, UDID (4)

No more than 2 units taken from the following:
BIOL 492 Internship (2-3)
BIOL 494 Independent Research (1-3)
BIOL 497 Directed Study (1-3)

Required Supporting and Other GE Courses (72 Units)
1. Chemistry (minimum 15 units)
   CHEM 121* General Chemistry I, GE-B1 (4)
   CHEM 122 General Chemistry II (4)
   CHEM 311 Organic Chemistry I (3)
   CHEM 312 Organic Chemistry I Laboratory (1)
   and select either
   CHEM 318 Biological Chemistry (3)
   or
   CHEM 314 Organic Chemistry II (3)
   CHEM 315 Organic Chemistry II Laboratory (1)
   (A year-long organic chemistry sequence with laboratory taken at a community college may be accepted for the Biology major in lieu of CHEM 311, 312, 314, 315.)

2. Physics (8 units)
   Select either
   PHYS 100 Introduction to Physics I (4)
   PHYS 101 Introduction to Physics II (4)
   or
   PHYS 200 General Physics I (4)
   PHYS 201 General Physics II (4)

3. Statistics and Mathematics (7 units)
   BIOL 203* Quantitative Methods for Biology, GE-B3 (3)
   MATH 150* Calculus I, GE-B3 (4)

4. Other Required GE Courses in Categories A-E (36 units)
   Category A (9)
   Category C (12)
   Category D (12)
   Category E (3)

5. American Institutions Requirement (6 units)

FOR EMPHASIS IN MEDICAL IMAGING

Additional Lower Division Requirements in the Major (8 Units)
BIOL 210 Human Anatomy and Physiology I (4)
BIOL 211 Human Anatomy and Physiology II (4)

Upper Division Requirements in the Major (38 Units)
1. Required Biology and Physics Courses (30 units)
   BIOL 300 Cell Biology (4)
   BIOL 301 Microbiology (4)
   BIOL 302 Genetics (4)
   BIOL 400 Molecular Biology (4)
   BIOL/PHYS 416 Radiobiology and Radionuclides (3)
   NG 434* Introduction to Biomedical Imaging, GE-B1, E, UDID (4)
   BIOL/PHYS 464 Biomedical Instrumentation (4)
   PHYS 499 Senior Capstone (3)

2. Electives in Biology and Physics (8 units):
   Select from the following list of courses:
   BIOL/PHYS 315 Introduction to Biophysics (4)
   PHYS 401 Biotechnology and Recombinant DNA Techniques (5)
   BIOL 420 Cellular and Molecular Immunology (4)
   BIOL 421 Virology (3)
   BIOL 423 Cellular and Molecular Neurobiology (3)
   BIOL 424 Human Physiology (3)
   BIOL 425 Human Genetics (3)
   BIOL 427 Developmental Biology (4)
   BIOL 428 Biology of Cancer (3)
   BIOL 431* Bioinformatics, GE-B2, B4, UDID (4)
   BIOL 432* Principles of Epidemiology and Environmental Health, GE-B2, D, UDID (3)
   BIOL 433* Ecology and the Environment, GE-B2, UDID (4)
   PHYS 445* Image Analysis and Pattern Recognition, GE-B1, B4, UDID (4)
   No more than 2 units taken from the following:
   PHYS 492 Physics Internship (3)
   BIOL 494 Independent Research (1-3)
   or
   PHYS 497 Directed Study (1-3)
   or
   PHYS

Required Supporting and Other GE Courses (66 Units)
1. Chemistry (15 units)
   CHEM 121* General Chemistry I, GE-B1 (4)
   CHEM 122 General Chemistry II (4)
   CHEM 311 Organic Chemistry I (3)
   CHEM 312 Organic Chemistry I Laboratory (1)
   CHEM 318 Biological Chemistry (3)
   (An organic chemistry I-equivalent course with laboratory taken at a community college may be accepted for the Biology major in lieu of CHEM 311 and 312.)
2. Mathematics (4 units)
   MATH 150  Calculus I, GE-B3 (4)

3. Physics (8 units)
   Select either
   PHYS 100  Introduction to Physics I (4)
   PHYS 101  Introduction to Physics II (4)
   or
   PHYS 200  General Physics I (4)
   PHYS 201  General Physics II (4)

4. Other Required GE Courses in Categories A-D (33 units)
   Category A (9)
   Category C (12)
   Category D (12)
   Category E - covered by a required GE course for the degree program

5. American Institutions Requirement (6 units)

(Courses with * are double-counted toward GE credits.)

**REQUIREMENTS FOR THE BACHELOR OF ARTS DEGREE IN BIOLOGY (120 UNITS)**

**Common Lower Division Requirements for All Emphases (8 Units)**

- BIOL  200*  Principles of Organismal and Population Biology, GE-B2 (4)
- BIOL  201 Principles of Cell and Molecular Biology (4)

**FOR EMPHASIS IN GENERAL BIOLOGY**

**Upper Division Requirements in the Major (37 Units)**

1. Required Biology Courses (25 units)
   - BIOL  300  Cell Biology (4)
   - BIOL  302  Genetics (4)
   - BIOL  303  Evolutionary Biology (3)
   - BIOL  304  Comparative Animal Physiology (3)
   - BIOL  400  Molecular Biology (4)
   - BIOL  433*  Ecology and the Environment, GE-B2, UDID (4)
   - BIOL  499  Senior Capstone (3)

2. Electives in Biology (12 units)
   Select at least three courses from the following list, one of which must be a lab course.
   - BIOL  301  Microbiology (4)
   - BIOL  310  Animal Biology and Ecology (4)
   - BIOL  311  Plant Biology and Ecology (4)
   - BIOL  312  Marine Biology (4)
   - BIOL  313  Conservation Biology (4)
   - BIOL  316  Invertebrate Zoology (4)
   - BIOL  317  Parasitology (4)
   - BIOL  401  Biotechnology and Recombinant DNA Techniques (5)
   - BIOL  402  Toxicology (3)
   - BIOL  420  Cellular and Molecular Immunology (4)
   - BIOL  421  Virology (3)
   - BIOL  422  Molecular Plant Physiology (4)
   - BIOL  423  Cellular & Molecular Neurobiology (3)
   - BIOL  424  Human Physiology (3)
   - BIOL  425  Human Genetics (3)
   - BIOL  427  Developmental Biology (4)
   - BIOL  428  Biology of Cancer (3)
   - BIOL  431*  Bioinformatics, GE-B2, B4, UDID (4)
   - BIOL  432*  Principles of Epidemiology and Environmental Health, GE-B2, D, UDID (3)
   - BIOL  450  Ichthyology: The Biology of Fishes (4)

No more than 2 units taken from the following:
   - BIOL  492  Internship (2-3)
   - BIOL  494  Independent Research (1-3)
   - BIOL  497  Directed Study (1-3)

**Required Supporting and Other GE Courses (53-54 Units)**

1. Chemistry (8 units)
   - CHEM 121*  General Chemistry I, GE-B1 (4)
   - CHEM 122  General Chemistry II (4)

2. Mathematics and Statistics (3-4 units)
   Select one of the following:
   - BIOL  203*  Quantitative Methods for Biology, GE-B3 (3)
   - MATH 105  Pre-Calculus (4)
   - MATH 150*  Calculus I, GE-B3 (4)

3. Other Required GE Courses in Categories A-E (36)
   Category A (9)
   Category C (12)
   Category D (12)
   Category E (3)

4. American Institutions Requirements (6)

**Electives in Any Discipline (21-22 units)**

**FOR EMPHASIS IN PRE-PROFESSIONAL STUDIES**

**Upper Division Requirements in the Major (32 Units)**

1. Required Biology Courses (21-22 units)
   - BIOL  300  Cell Biology (4)
   - BIOL  302  Genetics (4)
   - BIOL  304  Comparative Animal Physiology (3)
   - BIOL  400  Molecular Biology (4)
   - AND Select one of the following:
     - BIOL  303  Evolutionary Biology (3)
     - BIOL  433*  Ecology and the Environment, GE-B2, UDID (4)
     - BIOL  499  Senior Capstone (3)

2. Electives in Biology (10-11 units)
   Select at least three courses from the following list, one of which must be a lab course.
   - BIOL  301  Microbiology (4)
   - BIOL  310  Animal Biology and Ecology (4)
   - BIOL  311  Plant Biology and Ecology (4)
**Required Supporting and Other GE Courses (69-70 Units)**

1. Chemistry (16 units)
   - CHEM 121* General Chemistry I, GE-B1 (4)
   - CHEM 122 General Chemistry II (4)
   - CHEM 311 Organic Chemistry I (3)
   - CHEM 312 Organic Chemistry I Laboratory (1)
   - CHEM 314 Organic Chemistry II (3)
   - CHEM 315 Organic Chemistry II Laboratory (1)

2. Mathematics and Statistics (3-4 units)
   - BIOL 203* Quantitative Methods for Biology, GE-B3 (3)
   - MATH 150* Calculus I, GE-B3 (4)

(Complete with professional schools or pre-professional advisor for specific requirements in this category.)

---

**Upper Division Requirements in the Major (36 Units)**

1. Required Biology Courses (24 units)
   - BIOL 300 Cell Biology (4)
   - BIOL 302 Genetics (4)
   - BIOL 303 Evolutionary Biology (3)
   - BIOL 304 Comparative Animal Physiology (3)
   - BIOL 335* The Biosphere, GE-B2, UDID (3)
   - BIOL 433* Ecology and the Environment, GE-B2, UDID (4)
   - BIOL 499 Senior Capstone (3)

2. Electives in Biology (12 units)
   - Select at least three courses from the following list, one of which must be a lab course.
   - BIOL 301 Microbiology (4)
   - BIOL 310 Animal Biology and Ecology (4)
   - BIOL 311 Plant Biology and Ecology (4)
   - BIOL 312 Marine Biology (4)
   - BIOL 313 Conservation Biology (4)
   - BIOL 316 Invertebrate Zoology (4)
   - BIOL 317 Parasitology (4)
   - BIOL 400 Molecular Biology (4)
   - BIOL 401 Biotechnology and Recombinant DNA Techniques (5)
   - BIOL 402 Toxicology (3)
   - BIOL 420 Cellular and Molecular Immunology (4)
   - BIOL 421 Virology (3)
   - BIOL 422 Molecular Plant Physiology (4)
   - BIOL 423 Cellular and Molecular Neurobiology (3)
   - BIOL 424 Human Physiology (3)
   - BIOL 425 Human Genetics (3)
   - BIOL 427 Developmental Biology (4)
   - BIOL 428 Biology of Cancer (3)
   - BIOL 431* Bioinformatics, GE-B2, B4, UDID (4)
   - BIOL 432* Principles of Epidemiology and Environmental Health, GE-B2, D, UDID (3)
   - BIOL 450 Ichthyology: The Biology of Fishes (4)

(No more than 2 units taken from the following):
   - BIOL 492 Internship (2-3)
   - BIOL 494 Independent Research (1-3)
   - BIOL 497 Directed Study (1-3)
Required Supporting and Other GE Courses (76 units)

1. Required Education Course (3 units)
   EDUC 330* Introduction to Secondary Schooling,
   GE-D, UDID (3)

2. Mathematics and Statistics (7 units)
   BIOL 203* Quantitative Methods for Biology,
   GE-B3 (3)

   and
   MATH 105 Pre-Calculus (4)

   or
   MATH 150* Calculus I, GE-B3 (4)

3. Physical Sciences (24 units)
   CHEM 121* General Chemistry I, GE-B1 (4)
   CHEM 122 General Chemistry II (4)
   GEOL 121 Physical Geology (4)
   PHYS 100 Introduction to Physics I (4)
   PHYS 101 Introduction to Physics II (4)
   PHYS 105 Introduction to the Solar System (4)

4. Other Required GE Courses in Categories A-E (36)
   Category A (9)
   Category C (12)
   Category D (12)
   Category E (3)

5. American Institutions Requirements (6)

(Courses with * are double-counted toward GE credits.)
REQUIREMENTS FOR THE MINOR IN BIOLOGY (21 UNITS)

LOWER DIVISION REQUIREMENTS (8 UNITS)
BIOL 200* Principles of Organismal and Population Biology, GE-B2 (4)
BIOL 201 Principles of Cell and Molecular Biology (4)

UPPER DIVISION REQUIREMENTS (13 UNITS)
1. Biology (8 units)
   BIOL 300 Cell Biology (4)
   BIOL 302 Genetics (4)

2. Biology Electives (5 units)
   A minimum of 5 units of 300-400 level biology courses, with no more than one course selected from BIOL 331-342.
REQUIREMENTS FOR THE CERTIFICATE IN BIOTECHNOLOGY (23-24 UNITS)

(For students with a B.S. degree in biology pursuing a certificate in biotechnology)

1. B.S. degree in biology (may be concurrent);

2. Completion of the following courses with C or better grades:
   CHEM 318 or 460 Biological Chemistry or Biochemistry I (3-4)
   BIOL 401 Biotechnology and Recombinant DNA Techniques (5)
   BIOL 420 Cellular and Molecular Immunology (4)
   BIOL 431 Bioinformatics (4)

3. Complete another 4 units of upper-division biology course in consultation with the program;

4. Complete an internship course;

5. Complete the capstone course;

6. Approval by the Biology program.