# BACHELOR OF SCIENCE IN BIOLOGY: CONCENTRATION IN ECOLOGY, EVOLUTION, AND CONSERVATION BIOLOGY

## Concentration in Ecology, Evolution, and Conservation Biology

This program provides students with a broad background in systematic biology and conservation biology through coursework in evolutionary biology, ecology, botany, and physiology. It prepares students for graduate school as well as work in the public sector with agencies such as state and national park services and in the private sector in fields such as environmental consulting and conservation. It is recommended that students work closely with an academic advisor to select courses that best suit their career goals.

The department does not permit multiple concentrations within the biology degree program. All of the curricula require preliminary work in physics and chemistry because many important biological concepts are based squarely upon principles in the physical sciences. Also, each curriculum includes upper-division work in the biological sciences so that students will receive reasonable breadth and depth in their degree program. Because of the sequential arrangement of courses students are urged to consult the descriptions for the prerequisites of all their courses.

Although course electives are listed for most of the majors, new electives are always being added to various programs. Therefore, we highly recommend that students seek advisement prior to enrolling in elective courses in their major.

## General Information and Requirements

- Candidates entering the bachelor's programs in biology should have completed three years of high school mathematics and one year of high school chemistry to allow completion of the curriculum in a timely fashion (see Undergraduate Admission Requirements (http://bulletin.sfsu.edu/undergraduate-admissions/application-procedures/#UAR)).
- All major coursework must be completed with letter grades (CR/NC is not acceptable).
- A minimum grade point average of 2.0 in all coursework is required to receive a degree in these programs.
- To remain enrolled in a biology course, students must be prepared to provide copies of transcripts demonstrating completion of prerequisite courses with a grade of C- or better.
- Early in the first semester, and at regular intervals thereafter, students must consult with a biology advisor to plan a program of study. For the most current advising information, go to biology.sfsu.edu (http://biology.sfsu.edu/).

## Program Learning Outcomes

a. UNDERSTANDING THE PROCESS OF SCIENCE: Students can design an experiment with the appropriate control groups to test a hypothesis
b. QUANTITATIVE REASONING: Students can interpret a graph or dataset to determine if the results of an experiment support or reject a hypothesis
c. RELATIONSHIP BETWEEN SCIENCE AND SOCIETY: Students can weigh the costs and benefits to society of the use of recent scientific and technological developments
d. EVOLUTION: Students can explain the role that variation between individuals plays in the processes of natural selection and evolution.
e. RELATIONSHIP BETWEEN STRUCTURE AND FUNCTION: Students can explain how a change in the structural characteristics of a molecule, tissue or organism will affect its function
f. INFORMATION FLOW AND STORAGE: Students can describe the mechanisms of information flow in classical and molecular genetics and predict the outcomes of crosses
g. PATHWAYS AND TRANSFORMATION OF MATTER AND ENERGY: Students can explain how a carbon molecule flows through a biological process or system
h. SYSTEMS (i.e. living systems are interconnected and interacting): Students can predict the consequences of how a change in one aspect of a biological or complex system will affect other aspects of the system

## Biology (B.S.): Concentration in Ecology, Evolution, and Conservation Biology — 58 units minimum

- Students must earn a C- or better in a GWAR course to satisfy the GWAR requirement. Ecology, Evolution, and Conservation Biology majors should choose between BIOL 475GW, BIOL 478GW, BIOL 529GW, BIOL 570GW, or BIOL 670GW. Contact a departmental advisor for further information.
- All major coursework must be completed with letter grades (CR/NC is not acceptable).
- A minimum grade point average of 2.0 in all coursework is required.
- At least 12 units in biology must be completed at SF State.

### General Education Requirements Met in the Major

The requirements below are deemed "met in the major" upon completion of the courses listed (even though the courses and their prerequisites are not approved for GE). This is true whether or not the student completes the major.

- Area B2 (Life Science) is satisfied upon completion of BIOL 240.
- Upper-Division General Education: Physical and Life Sciences (UD-B) is satisfied upon completion of BIOL 355.

### Lower-Division Requirements (23 units)

| Code | Title | Units |
|---|---|---|
| BIOL 230 | Introductory Biology I | 5 |
| BIOL 231 | Advising for Success as a Biology Major | 1 |
| BIOL 240 | Introductory Biology II | 5 |
| CHEM 115 | General Chemistry I | 4 |
| PHYS 111 & PHYS 112 | General Physics I and General Physics I Laboratory | 4 |
| MATH 226 | Calculus I | 4 |

## Upper-Division Requirements (17-20 units)

| Code | Title | Units |
|---|---|---|
| BIOL 337 | Evolution | 3 |
| BIOL 355 | Genetics | 3 |
| BIOL 458 | Biometry | 4 |
| BIOL 482 | Ecology | 4 |
| Choose one of the following on advisement (3-6 units): | | 3-6 |
| BIOL 475GW | Herpetology - GWAR | |
| BIOL 478GW | Ornithology - GWAR | |
| BIOL 529GW | Plant Ecology - GWAR | |
| BIOL 570GW | Biology of Fishes - GWAR | |
| BIOL 670GW | Ecology and Evolution of Marine Systems I - GWAR | |

## Ecology and Evolution Electives (Select 9 units on advisement)

| Code | Title | Units |
|---|---|---|
| BIOL 380 | Evolutionary Developmental Biology | 3 |
| BIOL 453 | General Parasitology | 3 |
| BIOL 460 | General Entomology | 4 |
| BIOL 470 | Natural History of Vertebrates | 4 |
| BIOL 475GW | Herpetology - GWAR [1] | 3 |
| BIOL 478GW | Ornithology - GWAR [1] | 4 |
| BIOL 490 | Ecology of Infectious Diseases | 4 |
| BIOL 500 | Evolution and Diversity of Plants | 4 |
| BIOL 502 | Biology of the Algae | 3 |
| BIOL 504 | Biology of the Fungi | 4 |
| BIOL 505 | Plant Structure and Function | 4 |
| BIOL 514 | Plant Biodiversity and California Field Botany | 5 |
| BIOL 529GW | Plant Ecology - GWAR [1] | 4 |
| BIOL 530 | Conservation Biology | 3 |
| BIOL 532 | Restoration Ecology | 3 |
| BIOL 534 | Wetland Ecology | 4 |
| BIOL 555 | Marine Invertebrate Zoology | 4 |
| BIOL 570GW | Biology of Fishes - GWAR [1] | 4 |
| BIOL 577 | Climate and Ecological Interactions | 4 |
| BIOL 580 | Limnology | 3 |
| BIOL 582 | Biological Oceanography & Limnology | 4 |
| BIOL 585 | Marine Ecology | 3 |
| BIOL 600 | Animal Behavior | 3 |
| BIOL 670GW | Ecology and Evolution of Marine Systems I - GWAR [1] | 6 |
| BIOL 671 | Ecology and Evolution of Marine Systems II | 6 |

## Physiology and Additional Electives (9 units)

Select 9 units on advisement. Courses used to satisfy the electives above may not be double-counted here.

| Code | Title | Units |
|---|---|---|
| BIOL 315 | Field Methods in Ecology and Evolution | 1 |
| BIOL 327 | HIV, AIDS, and the Science to End the Epidemic | 3 |
| BIOL 328 | Human Anatomy | 4 |
| BIOL 349 | Bioethics | 3 |
| BIOL 350 | Cell Biology | 3 |
| BIOL 356 | Honors Genetics | 2 |
| BIOL 357 | Molecular Genetics | 3 |
| BIOL 358 | Forensic Genetics: Math Matters | 4 |
| BIOL 382 | Developmental Biology | 3 |
| BIOL 401 | General Microbiology | 3 |
| BIOL 420 | General Virology | 3 |
| BIOL 425 | Emerging Diseases | 3 |
| BIOL 435 | Immunology | 3 |
| BIOL 436 | Immunology Laboratory | 2 |
| BIOL 442 | Microbial Physiology | 3 |
| BIOL 443 | Microbial Physiology Laboratory | 2 |
| BIOL 446 | Microbial Genomics | 4 |
| BIOL 454 | Parasitology Laboratory | 1 |
| BIOL 475GW | Herpetology - GWAR | 3 |
| BIOL 478GW | Ornithology - GWAR | 4 |
| BIOL 490 | Ecology of Infectious Diseases | 4 |
| BIOL 500 | Evolution and Diversity of Plants | 4 |
| BIOL 502 | Biology of the Algae | 3 |
| BIOL 504 | Biology of the Fungi | 4 |
| BIOL 505 | Plant Structure and Function | 4 |
| BIOL 508 | Plants and Human Affairs | 3 |
| BIOL 514 | Plant Biodiversity and California Field Botany | 5 |
| BIOL 525 | Plant Physiology | 3 |
| BIOL 526 | Plant Molecular Physiology Laboratory | 2 |
| BIOL 430 | Medical Microbiology | 3 |
| BIOL 532 | Restoration Ecology | 3 |
| BIOL 534 | Wetland Ecology | 4 |
| BIOL 555 | Marine Invertebrate Zoology | 4 |
| BIOL 570GW | Biology of Fishes - GWAR | 4 |
| BIOL 572 | Colloquium in Ecology, Evolution, and Conservation | 2 |
| BIOL 577 | Climate and Ecological Interactions | 4 |
| BIOL 580 | Limnology | 3 |
| BIOL 585 | Marine Ecology | 3 |
| BIOL 586GW | Marine Ecology Laboratory - GWAR | 4 |
| BIOL 600 | Animal Behavior | 3 |
| BIOL 612 | Human Physiology | 3 |
| BIOL 617 | Environmental Physiology | 3 |
| BIOL 620 | Endocrinology | 3 |
| BIOL 621 | Reproductive Physiology | 3 |
| BIOL 622 | Hormones and Behavior | 3 |
| BIOL 630 | Animal Physiology | 3 |
| BIOL 638 | Bioinformatics and Sequence Analysis | 4 |
| BIOL 640 | Cellular Neurosciences | 3 |
| BIOL 642 | Neural Systems Physiology | 3 |
| BIOL 644 | LEADerS Service Learning Course: Learners Engaged in Advocating for Diversity in Science | 4 |
| or BIOL 654 | Peer Assistants for Learning Science (PALS) | |
| BIOL 670GW | Ecology and Evolution of Marine Systems I - GWAR | 6 |
| BIOL 671 | Ecology and Evolution of Marine Systems II | 6 |
| BIOL 699 | Independent Study in Biology | 1-3 |

[1] May be used as an Ecology and Evolution or Physiology elective if not taken as one of the upper-division required courses.

## First-Time Student Roadmap (4 Year)

The roadmaps presented in this Bulletin are intended as suggested plans of study and do not replace meeting with an advisor. For a more personalized roadmap, please use the Degree Planner (https://registrar.sfsu.edu/degreeplanner/) tool found in your Student Center.

First-Time Student Roadmap (http://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-ecology-evolution-conservation-biology/roadmap-i-ii-eng/)

## Transfer Student Roadmap (2 Year)

For students with an AS-T in **Biology**.
BIOL ADT Roadmap (http://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-ecology-evolution-conservation-biology/adt-roadmap/)

## This degree program is an approved pathway ("similar" major) for students earning the ADT in Biology

California legislation SB 1440 (2009) mandated the creation of the Associate Degree for Transfer (ADT) to be awarded by the California Community Colleges. Two types of ADTs are awarded: Associate in Arts for Transfer (AA-T) and Associate in Science for Transfer (AS-T).

Note: no specific degree is required for admission as an upper-division student. However, the ADT includes specific guarantees related to admission and graduation and is designed to clarify the transfer process and strengthen lower-division preparation for the major.

An ADT totals 60 units and in most cases includes completion of all lower-division General Education requirements and at least 18 units in a specific major. (The Biology, Chemistry, and Environmental Science AS-T degrees defer 3 units in lower-division GE area C and 3 units in lower-division GE area D until after transfer.) Students pursuing an ADT are guaranteed admission to the CSU if minimum eligibility requirements are met, though not necessarily to the CSU campus of primary choice.

Upon verification that the ADT has been awarded prior to matriculation at SF State, students are guaranteed B.A. or B.S. completion in 60 units if pursuing a "similar" major after transfer. Determinations about "similar" majors at SF State are made by faculty in the discipline.

Degree completion in 60 units cannot be guaranteed when a student simultaneously pursues an additional major, a minor, certificate, or credential.

A sample advising roadmap for students who have earned an ADT and continue in a "similar" major at SF State is available on the Roadmaps tab on the degree requirements page for the major. The roadmap displays:

- How many lower-division units required for the major have been completed upon entry based on the award of a specific ADT;
- Which lower-division requirements are considered complete upon entry based on the award of a specific ADT;
- How to complete the remaining 60 units for the degree in four semesters.

Students who have earned an ADT should seek advising in the major department during the first semester of attendance.

## General Advising Information for Transfer Students

a. Before transfer, complete as many lower-division requirements or electives for this major as possible.
b. The following courses are not required for admission but are required for graduation. Students are strongly encouraged to complete these units before transfer; doing so will provide more flexibility in course selection after transfer.
    - a course in U.S. History
    - a course in U.S. & California Government

For information about satisfying the requirements described in (1) and (2) above at a California Community College (CCC), please visit http://www.assist.org (http://assist.org). Check any geographically accessible CCCs; sometimes options include more than one college. Use ASSIST to determine:

- Which courses at a CCC satisfy any lower-division major requirements for this major;
- Which courses at a CCC satisfy CSU GE, US History, and US & CA Government requirements.

Remedial courses are not transferable and do not apply to the minimum 60 semester units/90 quarter units required for admission.

Additional units for courses that are repeated do not apply to the minimum 60 units required for upper-division transfer (for example, if a course was not passed on the first attempt or was taken to earn a better grade).

Before leaving the last California Community College of attendance, obtain a summary of completion of lower-division General Education units (IGETC or CSU GE Breadth). This is often referred to as a GE certification worksheet. SF State does not require delivery of this certification to Admissions, but students should retain this document for verifying degree progress after transfer.

Credit for Advanced Placement, International Baccalaureate, or College-Level Examination Program courses: AP/IB/CLEP credit is not automatically transferred from the previous institution. Units are transferred only when an official score report is delivered to SF State. Credit is based on the academic year during which exams were taken. Refer to the University Bulletin in effect during the year of AP/IB/CLEP examination(s) for details regarding the award of credit for AP/IB/CLEP.

Students pursuing majors in science, technology, engineering, and mathematics (STEM) disciplines often defer 6-9 units of lower-division General Education in Areas C and D until after transfer to focus on preparation courses for the major. This advice does not apply to students pursuing associate degree completion before transfer.

## Transferring From Institutions Other Than CCCs or CSUs

Review SF State's lower-division General Education requirements. Note that, as described below, the four basic skills courses required for admission meet A1, A2, A3, and B4 in the SF State GE pattern. Courses

that fulfill the remaining areas of SF State's lower-division GE pattern are available at most two-year and four-year colleges and universities.

Of the four required basic skills courses, a course in critical thinking (A3) may not be widely offered outside the CCC and CSU systems. Students should attempt to identify and take an appropriate course no later than the term of application to the CSU. To review more information about the A3 requirement, please visit bulletin.sfsu.edu/undergraduate-education/general-education/lower-division/#AAEL.

Waiting until after transfer to take a single course at SF State that meets both US and CA/local government requirements may be an appropriate option, particularly if transferring from outside of California.