

BACHELOR OF SCIENCE IN BIOLOGY: CONCENTRATION IN MICROBIOLOGY

Students may select courses emphasizing general microbiology or medical microbiology. The selection of an appropriate program not only prepares students for careers in research, industry, public health, clinical laboratory, or state or federal service but also provides the basis for graduate study in microbiology.

For students interested in applying to Clinical Laboratory Science programs, it is recommended that they complete the B.S. in Biology: Concentration in Microbiology which has been modified to meet most of the requirements for the discontinued Clinical Science degree (Clinical Science Track). Students are strongly recommended to meet with their Microbiology Major Advisor to discuss the specifics of this modified degree.

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>)).
- 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

- Understanding the process of science: students can design an experiment with the appropriate control groups to test a hypothesis.
- Quantitative reasoning: students can interpret a graph or dataset to determine if the results of an experiment support or reject a hypothesis.
- Relationship between science and society: students can weigh the costs and benefits to society of the use of recent scientific and technological developments.

- Evolution: students can explain the role that variation between individuals plays in the processes of natural selection and evolution.
- 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.
- Information flow and storage: students can describe the mechanisms of information flow in classical and molecular genetics and predict the outcomes of crosses.
- Pathways and transformation of matter and energy: students can explain how a carbon molecule flows through a biological process or system.
- 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 Microbiology – 60 units minimum

- Students must earn a C- or better in a GWAR course to satisfy the GWAR requirement. Microbiology majors should take BIOL 402GW. 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 BIOL 355 BIOL 355BIOL 355BIOL 355.

Lower-Division Requirements (34-37 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 | 5 |
| Select one organic chemistry sequence: | | 3-6 |
| CHEM 130 | General Organic Chemistry | |
| CHEM 233 & CHEM 335 | Organic Chemistry I and Organic Chemistry II | |
| CHEM 215 | General Chemistry II: Quantitative Applications of Chemistry Concepts | 3 |
| MATH 226 | Calculus I | 4 |
| PHYS 111 & PHYS 112 | General Physics I and General Physics I Laboratory | 4 |
| PHYS 121 & PHYS 122 | General Physics II and General Physics II Laboratory | 4 |

Upper-Division Requirements (15 units)

| Code | Title | Units |
|--------------------------|--------------------------------------------------------------------|-------|
| BIOL 337 | Evolution | 3 |
| BIOL 355 | Genetics | 3 |
| BIOL 401 & BIOL 402GW | General Microbiology and General Microbiology Laboratory - GEAR | 6 |
| Select One: | | 3 |
| CHEM 349 | General Biochemistry ¹ | |
| CHEM 340 | Biochemistry I | |

Upper-Division Electives (11 units)

Select 11 units from the following courses, including at least two laboratory courses. Consult an advisor to select electives that best align with your interests and future career goals. Any course taken as an elective that does not appear on this list will not be counted towards the completion of the Microbiology degree requirements unless it is approved by an advisor prior to enrolling in the course. Students who intend to apply for admission to Clinical Laboratory Science programs after graduation are strongly advised to speak with a Microbiology advisor for help in choosing their elective classes.

| Code | Title | Units |
|--------------------------------|------------------------------------------------------------------------------------------|-------|
| BIOL 420 | General Virology ² | 3 |
| BIOL 425 | Emerging Diseases | 3 |
| BIOL 430 | Medical Microbiology ¹ | 3 |
| BIOL 435 | Immunology ¹ | 3 |
| BIOL 442 | Microbial Physiology | 3 |
| BIOL 446 | Microbial Genomics | 4 |
| BIOL 453 | General Parasitology ² | 3 |
| BIOL 490 | Ecology of Infectious Diseases | 4 |
| BIOL 644 | LEADerS Service Learning Course: Learners Engaged in Advocating for Diversity in Science | 4 |
| BIOL 638 | Bioinformatics and Genome Annotation | 4 |
| Select two laboratory courses: | | |
| BIOL 431 | Medical Microbiology Laboratory ² | |
| BIOL 436 | Immunology Laboratory ² | |
| BIOL 443 | Microbial Physiology Laboratory | |
| BIOL 454 | Parasitology Laboratory ² | |
| BIOL 625 | Hematology ¹ | |
| BIOL 699 | Independent Study in Biology | |
| CHEM 343 | Biochemistry I Laboratory ² or CHEM 336 Organic Chemistry II Laboratory | |

¹ Required for admission to Clinical Laboratory Science graduate programs.

² Recommended for admission to Clinical Laboratory Science graduate programs.

General Education Requirements

| Requirement | Course Level | Units | Area Designation |
|-------------------------------|--------------|-------|------------------|
| Oral Communication | LD | 3 | A1 |
| Written English Communication | LD | 3 | A2 |
| Critical Thinking | LD | 3 | A3 |

| | | | |
|--------------------------------------------------------|----|---|----------|
| Physical Science | LD | 3 | B1 |
| Life Science | LD | 3 | B2 |
| Lab Science | LD | 1 | B3 |
| Mathematics/ Quantitative Reasoning | LD | 3 | B4 |
| Arts | LD | 3 | C1 |
| Humanities | LD | 3 | C2 |
| Arts or Humanities | LD | 3 | C1 or C2 |
| Social Sciences | LD | 3 | D1 |
| Social Sciences: US History | LD | 3 | D2 |
| Lifelong Learning and Self- Development (LLD) | LD | 3 | E |
| Ethnic Studies | LD | 3 | F |
| Physical and/or Life Science | UD | 3 | UD-B |
| Arts and/or Humanities | UD | 3 | UD-C |
| Social Sciences | UD | 3 | UD-D |

SF State Studies

Courses certified as meeting the SF State Studies requirements may be upper or lower division in General Education (GE), a major or minor, or an elective.

| | | | |
|---------------------------------------------|----------|---|------|
| American Ethnic and Racial Minorities | LD or UD | 3 | AERM |
| Environmental Sustainability | LD or UD | 3 | ES |
| Global Perspectives | LD or UD | 3 | GP |
| Social Justice | LD or UD | 3 | SJ |

Note: LD = Lower-Division; UD = Upper-Division.

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](#).
- In order to choose your English Composition A2 course and your QR/Math B4 course, please complete the online advising activities at writingadvising.sfsu.edu (<https://writingadvising.sfsu.edu>) and mathadvising.sfsu.edu. Questions? Contact Gator Smart Start (<https://gatorsmartstart.sfsu.edu>).

[First-Time Student Roadmap \(http://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-microbiology/roadmap-i-ii-eng/\)](http://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-microbiology/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-microbiology/adtr-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

- Before transfer, complete as many lower-division requirements or electives for this major as possible.
- 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>.

www.assist.org (<http://www.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/#AEL.

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.