

# BACHELOR OF SCIENCE IN BIOLOGY: CONCENTRATION IN CELL AND MOLECULAR BIOLOGY

Coursework in biology, chemistry, physics and mathematics prepares students for advanced studies in cell and molecular biology. The program is also recommended for pre-medical students because it allows students to take the majority of courses required for admission to medical school in the process of completing this major. (For more information, see Pre-health Professions. (<https://bulletin.sfsu.edu/colleges/extended-learning/pre-health-professions/>))

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 (<https://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/) (<http://biology.sfsu.edu/>).

## Program Learning Outcomes

1. Understanding the process of science: students can design an experiment with the appropriate control groups to test a hypothesis.
2. Quantitative reasoning: students can interpret a graph or dataset to determine if the results of an experiment support or reject a hypothesis.
3. Relationship between science and society: students can weigh the costs and benefits to society of the use of recent scientific and technological developments.
4. Evolution: students can explain the role that variation between individuals plays in the processes of natural selection and evolution.

5. 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.
6. Information flow and storage: students can describe the mechanisms of information flow in classical and molecular genetics and predict the outcomes of crosses.
7. Pathways and transformation of matter and energy: students can explain how a carbon molecule flows through a biological process or system.
8. 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 Cell and Molecular Biology – minimum 58 units

- Students must earn a C- or better in a GVAR course to satisfy the GVAR requirement. Cell & Molecular Biology majors should take BIOL 351GW. 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 5B (Biological Science) is satisfied upon completion of BIOL 240.
- Area 5UD (Upper-Division Science) is satisfied upon completion of BIOL 355.

## Lower-Division Requirements (30-38 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 <sup>1</sup>	4
CHEM 215	General Chemistry II	4
Select one organic chemistry sequence: <sup>1</sup>		3-6
CHEM 130	General Organic Chemistry <sup>1</sup>	
CHEM 233 & CHEM 235	Organic Chemistry I and Organic Chemistry II <sup>1</sup>	
MATH 226	Calculus I <sup>1</sup>	4
PHYS 111 & PHYS 112	General Physics I and General Physics I Laboratory	4

## Upper-Division Requirements (19 units)

Code	Title	Units
BIOL 337	Evolution	3
BIOL 350	Cell Biology	3

BIOL 351GW & BIOL 351	Experiments in Cell and Molecular Biology - GVAR and Experiments in Cell and Molecular Biology Discussion	4
BIOL 355	Genetics	3
BIOL 357	Molecular Genetics	3
Select one:		3
CHEM 340	Biochemistry I	
CHEM 349	General Biochemistry	

### Upper-Division Electives (9 units)

One elective must be a lab course.

Code	Title	Units
BIOL 328	Human Anatomy <sup>2</sup>	4
BIOL 332	Health Disparities in Cancer	3
BIOL 349	Bioethics	3
BIOL 356	Honors Genetics	2
BIOL 358	Forensic Genetics: Math Matters	4
BIOL 380	Evolutionary Developmental Biology	3
BIOL 382	Developmental Biology	3
BIOL 401	General Microbiology	3
BIOL 420	General Virology	3
BIOL 425	Emerging Diseases	3
BIOL 430	Medical Microbiology	3
BIOL 431	Medical Microbiology Laboratory <sup>2</sup>	2
BIOL 435	Immunology	3
BIOL 436	Immunology Laboratory <sup>2</sup>	2
BIOL 442	Microbial Physiology	3
BIOL 443	Microbial Physiology Laboratory <sup>2</sup>	2
BIOL 446	Microbial Genomics	4
BIOL 453	General Parasitology	3
BIOL 454	Parasitology Laboratory <sup>2</sup>	1
BIOL 458	Biometry	4
BIOL 482	Ecology <sup>2</sup>	4
BIOL 490	Ecology of Infectious Diseases	4
BIOL 525	Plant Physiology	3
BIOL 526	Plant Molecular Physiology Laboratory <sup>2</sup>	2
BIOL 612	Human Physiology	3
BIOL 619	Pathophysiology	3
BIOL 620	Endocrinology	3
BIOL 621	Reproductive Physiology	3
BIOL 622	Hormones and Behavior	3
BIOL 627	Biophysics	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 615	Molecular Pathophysiology	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 667	Optical Engineering for the Biological Sciences <sup>2</sup>	3
BIOL 699	Independent Study in Biology	1-3

CSC 306	An Interdisciplinary Approach to Computer Programming <sup>2</sup>	3
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<sup>1</sup> Students who plan to pursue a Ph.D. should complete at least two semesters of calculus and one semester of physical chemistry.

<sup>2</sup> Fulfills upper-division laboratory class requirement.

### General Education Requirements

Requirement	Course Level	Units	Area Designation
English Composition	LD	3	1A
Critical Thinking	LD	3	1B
Oral Communication	LD	3	1C
Mathematical Concepts and Quantitative Reasoning	LD	3	2
Arts	LD	3	3A
Humanities	LD	3	3B
Social and Behavioral Sciences	LD	6	4
Physical Science	LD	3	5A
Biological Science	LD	3	5B
Laboratory	LD	1	5C
Ethnic Studies	LD or UD	3	6
Science or Math/ Quantitative Reasoning	UD	3	5UD or 2UD
Arts or Humanities	UD	3	3UD
Social and Behavioral Sciences	UD	3	4UD

#### 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 and Climate Action	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 \(https://registrar.sfsu.edu/degreeplanner/\)](https://registrar.sfsu.edu/degreeplanner/) tool found in your [Student Center](#).

Students should use their Pathway/Category (<https://gatorsmartstart.sfsu.edu/pathways/>) to determine which roadmap to follow. For directions on how to view your Pathway/Category, visit [how to find your pathway \(https://gatorsmartstart.sfsu.edu/howtofindyourpathways/\)](https://gatorsmartstart.sfsu.edu/howtofindyourpathways/). Questions? Contact Gator Smart Start. (<https://gatorsmartstart.sfsu.edu/>)

[First-Time Student Roadmap – QR Pathway 1/2 \(https://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-cell-molecular-biology/roadmap-i-ii-eng/\)](https://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-cell-molecular-biology/roadmap-i-ii-eng/)

[First-Time Student Roadmap – QR Pathway 3/4 \(https://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-cell-molecular-biology/roadmap-math-pathway/\)](https://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-cell-molecular-biology/roadmap-math-pathway/)

## Transfer Student Roadmap (2 Year)

For students with an AS-T in **Biology**. [BIOL ADT Roadmap \(https://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-cell-molecular-biology/adt-roadmap/\)](https://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-cell-molecular-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 3 and 3 units in lower-division GE area 4 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

1. Before transfer, complete as many lower-division requirements or electives for this major as possible.
2. 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 GE Areas 1A/A2, 1B/A3, 1C/A1, and 2/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 (1B/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 1B/A3 requirement, please visit [bulletin.sfsu.edu/undergraduate-education/general-education/lower-division/#AAEL](http://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.