

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

Biology is no longer an impacted major effective Fall 2020.

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.
- At least 12 units in biology must be completed at SF State.
- 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

Core Competencies

1. Understanding the Process of Science: Students will demonstrate how a theory is supported or can be rejected based on data from experiments.
2. Quantitative Reasoning: Students will be able to create graphs and perform simple statistical tests to determine whether or not differences between groups are significant.
3. Relationship Between Science and Society: Students will be able to explain a biological process or phenomenon as it relates to a societal issue.

Core Concepts

1. Evolution: Students will be able to understand the fundamental concepts of evolution, role of selective pressures, how genes change
2. Relationship Between Structure and Function: Students will be able to describe how variation in the structure of an organ in a plant or animal contributes to variation in its function
3. Information Flow and Storage: Students will be able to explain the transmission of heritable traits

Graduation Writing Assessment Requirement (GWAR)

Students must earn a C or better in a GWAR course to satisfy the requirement.

Biology majors have the flexibility for which GWAR course they can take to meet their requirement, as long as the prerequisites for the course have been completed.

In general,

- Cell & Molecular Biology majors should take BIOL 351GW;
- Microbiology majors should take BIOL 402GW;
- Botany, Ecology, and Zoology majors may choose between BIOL 475GW, BIOL 478GW, or BIOL 529GW;
- Marine Biology majors may choose between BIOL 570GW or BIOL 631GW; and
- Physiology majors may choose between BIOL 613GW or BIOL 631GW.
- General Biology majors may take any BIOL GWAR class.

See also the Department of Biology home page for GWAR in Biology: biology.sfsu.edu/content/gwar (<http://biology.sfsu.edu/content/gwar/>) or contact a departmental advisor for further information.

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.

Concentration in Cell and Molecular Biology

Fundamental coursework in allied sciences and mathematics prepares the student for advanced studies in cell and molecular biology. The program is also recommended for pre-medical students because it includes many of the courses required for admission to medical school. (For more information, see Pre-health Professions. (<http://bulletin.sfsu.edu/colleges/extended-learning/pre-health-professions/>))

Biology (B.S.): Concentration in Cell and Molecular Biology – 68-69 units

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 B1 (Physical Science) is satisfied upon completion of CHEM 130 or CHEM 233.
- Areas B2 (Life Science) and B3 (Laboratory Science) are 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 (38–39 units)

Code	Title	Units
BIOL 230	Introductory Biology I	5
BIOL 240	Introductory Biology II	5

CHEM 115	General Chemistry I: Essential Concepts of Chemistry	5	BIOL 458	Biometry (if not already taken to satisfy another major requirement)	4
CHEM 215 & CHEM 216	General Chemistry II: Quantitative Applications of Chemistry Concepts and General Chemistry II Laboratory: Quantitative Applications of Chemistry Concepts	5	BIOL 490	Ecology of Infectious Diseases	4
CHEM 233	Organic Chemistry I	3	BIOL 525	Plant Physiology	3
MATH 226	Calculus I	4	BIOL 526	Plant Molecular Physiology Laboratory ³	2
PHYS 111 & PHYS 112	General Physics I and General Physics I Laboratory	4	BIOL 615	Molecular Pathophysiology	3
PHYS 121 & PHYS 122	General Physics II and General Physics II Laboratory	4	BIOL 618	Biology of Aging	3
Select one of the following:		3-4	BIOL 623	Pharmacology	3
MATH 227	Calculus II ¹		BIOL 630	Animal Physiology	3
CSC 210	Introduction to Computer Programming		BIOL 631GW	Animal Physiology Laboratory - GVAR ³	4
BIOL 358	Forensic Genetics: Math Matters		BIOL 638	Bioinformatics and Genome Annotation ³	4
BIOL 458	Biometry		BIOL 640	Cellular Neurosciences	3
			BIOL 652	Science Education Partners in Biology	4
			BIOL 699	Independent Study in Biology (requires faculty mentor's approval) ³	3
			CHEM 343	Biochemistry I Laboratory ³	3

Upper-Division Requirements (30 units)

Code	Title	Units
BIOL 350	Cell Biology	3
BIOL 351GW	Experiments in Cell and Molecular Biology - GVAR	4
BIOL 355	Genetics	3
BIOL 357	Molecular Genetics	3
CHEM 335	Organic Chemistry II	3
CHEM 349	General Biochemistry ²	3

Electives

Chose 11 units upon advisement. At least one elective must have an upper-division laboratory component. Graduate level courses may be used upon advisement.

Code	Title	Units
BIOL 332	Health Disparities in Cancer	3
BIOL 337	Evolution	3
BIOL 344GW	Research Skills - GVAR	3
BIOL 349	Bioethics	3
BIOL 356	Honors Genetics	2
BIOL 358	Forensic Genetics: Math Matters (if not already taken to satisfy another major requirement)	4
BIOL 380	Evolutionary Developmental Biology	3
BIOL 382	Developmental Biology	3
BIOL 401	General Microbiology	3
BIOL 402GW	General Microbiology Laboratory - GVAR ³	3
BIOL 411	Environmental Microbiology	3
BIOL 420	General Virology	3
BIOL 425	Emerging Diseases	3
BIOL 436	Immunology Laboratory ³	2
BIOL 442	Microbial Physiology	3
BIOL 443	Microbial Physiology Laboratory ³	2
BIOL 435	Immunology	3
BIOL 446	Microbial Genomics	4
BIOL 453	General Parasitology	3
BIOL 454	Parasitology Laboratory ³	1

Note: A minimum of 30 upper-division units must be completed for the degree (including upper-division units required for the major, general education, electives, etc.). A student can complete this major yet not attain the necessary number of upper-division units required for graduation. In this case, additional upper-division courses will be needed to reach the required total.

¹ Students who plan to pursue a Ph.D. should complete at least two semesters of calculus and one semester of physical chemistry.

² Students may take CHEM 340 and CHEM 341 in lieu of CHEM 349 upon advisement. In this case, CHEM 341 counts towards the upper-division elective unit requirement.

³ Course fulfills the upper-division laboratory elective requirement.

General Education Requirements

Requirement	Course Level	Units	Area Designation
Oral Communication	LD	3	A1
Written English Communication I	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
Social Sciences: US & CA Government	LD	3	D3

Lifelong Learning LD and Self-Development (LLD)		3	E
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)

Find the correct roadmap (A, B, C, or D):

1. Select the row that matches your English Course choice for A2.*
2. Select the column that matches your QR Category (found at your student center under Math Alert).
3. Click the Roadmap that lines up with your row and column.

For example, if you are taking ENG 104 as your first English course and your student center math alert says you are QR Category III, you should choose Roadmap D.

Pathway	QR Cat I/II	QR Cat III/IV
ENG 114	Roadmap A (http://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-cell-molecular-biology/roadmap-i-ii-eng/)	Roadmap C (http://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-cell-molecular-biology/roadmap-iii-iv-eng/)
ENG 104/ENG 105	Roadmap B (http://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-cell-molecular-biology/roadmap-i-ii-stretch/)	Roadmap D (http://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-cell-molecular-biology/roadmap-iii-iv-stretch/)

*Composition for Multilingual Students: If taking ENG 209 as your first English course, choose the ENG 114 row. If taking ENG 204 for your first English course, choose the ENG 104/ENG 105 row.

Transfer Student Roadmap (2 Year)

For students with an AS-T in **Biology**. [This roadmap opens in a new tab \(http://bulletin.sfsu.edu/colleges/science-engineering/biology/bs-biology-concentration-cell-molecular-biology/adt-roadmap/\)](http://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 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

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 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.

All Students Must Meet the Transfer Eligibility Requirements Outlined Below for Admission.

For more information, visit the Undergraduate Admissions section (<http://bulletin.sfsu.edu/undergraduate-admissions/>).

- Complete 60 or more transferable semester units or 90 or more quarter units.
- Earn a college grade point average of 2.0 or better in all transferable courses. Non-local area residents may be held to a higher GPA standard.
- Be in good standing at the last college or university attended.
- Complete 30-semester units (45-quarter units) of General Education, including four basic skills courses:
 - a. One course in oral communication (same as CSU GE Area A1)
 - b. One course in written composition (same as CSU GE Area A2)
 - c. One course in critical thinking (same as CSU GE Area A3)
 - d. One course in mathematics or quantitative reasoning (same as CSU GE Area B4)
- The four basic skills courses and a minimum of 60 transferable semester units (90-quarter units) must be completed by the spring semester prior to fall admission, or by the fall semester prior to spring admission. Earn a C- or better grade in each basic skills course.