BACHELOR OF SCIENCE IN BIOCHEMISTRY

High school preparation for the chemistry and biochemistry degree programs should include two years of algebra, one year of geometry, one-half year of trigonometry, one year of chemistry, and one year of physics. Calculus is highly recommended.

Program Learning Outcomes

a. Demonstrate an understanding of key concepts and an ability to solve problems in the five chemistry sub-disciplines: analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, and physical chemistry.

b. Perform basic chemistry laboratory procedures, including the use of modern instrumentation, for the synthesis, separation, isolation, analysis, and characterization of molecules.

c. Effectively communicate the results of scientific experiments in oral reports, technical graphics, and written reports.

d. Demonstrate the retention and synthesis of prior learning in advanced classes.

e. Search the chemical literature for published work relevant to a project of interest, read and understand technical literature related to the discipline.

f. Draw on classroom knowledge to contribute to solutions to problems encountered in a laboratory.

g. Articulate an understanding of the relationship between chemistry and related disciplines such as biological science, materials science, and environmental science.

h. Contribute to solving problems encountered in chemistry as part of a team.

i. Understand the key experiments that led to the development of chemical theories and models.

Code	Title	Units
CHEM 115	General Chemistry I	5
CHEM 233	Organic Chemistry I	3
CHEM 321	Quantitative Chemical Analysis	3
CHEM 300	Physical Chemistry for Life Sciences I	3
CHEM 351	Physical Chemistry I: Thermodynamics and Kinetics	3

Biochemistry (B.S.) — 72 units

- All courses used in the major must be completed with letter grades (CR/NC not allowed) and a minimum GPA of 2.0 (SF State Major GPA).
- Grades of C or better are required in chemistry prerequisite courses.
- Grades of C- or better are required in CHEM 341 and CHEM 343.
- Other courses for the major must be completed with grades of C- or better with one exception.

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 233.
- Area B2 (Life Science) is satisfied upon completion of either BIOL 240 or CHEM 341.
- Area B3 (Laboratory Science) is satisfied upon completion of CHEM 234.

Lower-Division Requirements (36 units)

Code	Title	Units
BIOL 230	Introductory Biology I	5
CHEM 115	General Chemistry I	5
CHEM 215 & CHEM 216	General Chemistry II: Quantitative Applications of Chemistry Concepts and General Chemistry II Laboratory: Quantitative Applications of Chemistry Concepts	5
CHEM 233 & CHEM 234	Organic Chemistry I and Organic Chemistry I Laboratory	5
MATH 226	Calculus I	4
MATH 227	Calculus II	4
Select one of the following:		8
PHYS 111 & PHYS 112 & PHYS 121 & PHYS 122	General Physics I and General Physics I Laboratory and General Physics II and General Physics II Laboratory	
PHYS 220 & PHYS 222 & PHYS 230 & PHYS 232	General Physics with Calculus I and General Physics with Calculus I Laboratory and General Physics with Calculus II and General Physics with Calculus II Laboratory	
PHYS 220 & PHYS 222 & PHYS 240 & PHYS 242	General Physics with Calculus I and General Physics with Calculus I Laboratory and General Physics with Calculus III and General Physics with Calculus III Laboratory	

Upper-Division Requirements (21 units)

Code	Title	Units
CHEM 300	Physical Chemistry for Life Sciences I [1]	3
CHEM 301	Physical Chemistry for Life Sciences II [1]	3
CHEM 321	Quantitative Chemical Analysis	3
CHEM 335	Organic Chemistry II	3
CHEM 340	Biochemistry I	3
CHEM 341	Biochemistry II	3
CHEM 343	Biochemistry I Laboratory	3

Upper-Division Electives (15 units)

- Students must complete at least 15 units of upper-division chemistry and biology electives selected from the lists below. Courses from community colleges cannot be substituted for the courses on the list below.
- Electives must include at least:

i. one course with a CHEM prefix,
ii. one GWAR (GW) course, and
iii. three laboratory courses.

- Note that many biology electives have a BIOL 240 prerequisite.
- Students wishing to enroll in BIOL 350, BIOL 355, and BIOL 612 without completing the BIOL 240 prerequisite should contact the instructor of record before registration.
- Students should consult an advisor regarding the selection of elective courses and check course co- and pre-requisites before enrolling.
- Graduate-level courses in chemistry or appropriate courses in biology, physics, geosciences, and computer science may be substituted upon prior approval of an advisor.

Upper-Division Electives in Chemistry

Students should keep in mind that non-Biochemistry courses may require additional prerequisites that are not met in the Biochemistry degree or permission of the instructor.

Code	Title	Units
CHEM 322	Quantitative Chemical Analysis Laboratory [3,5]	2
CHEM 325	Inorganic Chemistry [3]	3
CHEM 336	Organic Chemistry II Laboratory [3,5]	2
CHEM 370	Computer Applications in Chemistry and Biochemistry [5]	3
CHEM 390GW	Contemporary Chemistry and Biochemistry Research - GWAR [6]	3
CHEM 420	Environmental Analysis [5]	3
CHEM 422	Instrumental Analysis [5]	4
CHEM 426	Advanced Inorganic Chemistry Laboratory [5]	2
CHEM 433	Advanced Organic Chemistry	3
CHEM 443	Biophysical Chemistry Laboratory [5]	4
CHEM 451	Experimental Physical Chemistry Laboratory [5]	2
CHEM 645GW	Research Trends in Chemistry and Biochemistry - GWAR	3
CHEM 667	Optical Engineering for the Biological Sciences	3
CHEM 680	Chemical Oceanography	3
CHEM 699	Independent Study [2,5]	3

Upper-Division Electives in Biology and Computer Science

Code	Title	Units
BIOL 350	Cell Biology	3
BIOL 351GW	Experiments in Cell and Molecular Biology - GWAR [5]	4
BIOL 355	Genetics	3
BIOL 357	Molecular Genetics	3
BIOL 358	Forensic Genetics: Math Matters [5]	4
BIOL 401	General Microbiology	3
BIOL 402GW	General Microbiology Laboratory - GWAR [5]	3
BIOL 420	General Virology	3
BIOL 435	Immunology	3
BIOL 436	Immunology Laboratory [5]	2
BIOL 612	Human Physiology	3
BIOL 613GW	Human Physiology Laboratory - GWAR [5]	3
BIOL 638	Bioinformatics and Genome Annotation [5]	4
BIOL 640	Cellular Neurosciences	3
Select One		3

Code	Title	Units
CSC 306	An Interdisciplinary Approach to Computer Programming [4]	
CSC 508	Machine Learning and Data Science for Personalized Medicine [4]	
CSC 509	Data Science and Machine Learning for Medical Image Analysis [4]	

[1] CHEM 351 may be substituted for CHEM 300 and CHEM 353 may be substituted for CHEM 301 if prerequisites for CHEM 351 and CHEM 353 are met.
[2] By petition only. To be used as an upper-division elective in Chemistry, a minimum of 3-units must be taken in a single semester.
[3] For students who pursue a double major in the BA Chemistry and BS Biochemistry programs, CHEM 322, CHEM 325, and CHEM 336 cannot be used as electives for the BS Biochemistry program. Students must choose other approved courses to satisfy the elective requirements.
[4] Students who complete any combination of CSC 306, CSC 508, and CSC 509 may count only one of those courses toward their electives. The elective course must be completed with a letter grade; CR is not allowed for elective credit.
[5] Can be used to fulfill the laboratory requirement.
[6] Cannot be used to fulfill the laboratory requirement.

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)

a. 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.

b. 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/chemistry-biochemistry/bs-biochemistry/roadmap-i-ii-eng/)

SF State Scholars

The San Francisco State Scholars program provides undergraduate students with an accelerated pathway to a graduate degree. Students in this program pursue a bachelor's and master's degree simultaneously. This program allows students to earn graduate credit while in their junior and/or senior year, reducing the number of semesters required for completion of a master's degree.

SF State Scholar Roadmap (http://bulletin.sfsu.edu/colleges/science-engineering/chemistry-biochemistry/bs-biochemistry/scholars-roadmap/)

Transfer Student Roadmap (2 year)

For students with an AS-T in **Chemistry**.
CHEM ADT Roadmap (http://bulletin.sfsu.edu/colleges/science-engineering/chemistry-biochemistry/bs-biochemistry/adt-roadmap/)

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

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.