BACHELOR OF SCIENCE IN CHEMISTRY

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 of 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.

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.

Chemistry (B.S.) – 72 units minimum

- All courses used in the major program must be completed with letter grades (CR/NC not allowed) and a minimum GPA of 2.0 (SFSU Major GPA).
- Grades of C or better are required in chemistry prerequisite courses.
- 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 B3 (Laboratory Science) is satisfied upon completion of CHEM 234.

Lower-Division Requirements (34 units)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 115</td>
<td>General Chemistry I: Essential Concepts of Chemistry</td>
<td>5</td>
</tr>
<tr>
<td>CHEM 215 &amp; CHEM 216</td>
<td>General Chemistry II: Quantitative Applications of Chemistry Concepts and General Chemistry II Laboratory: Quantitative Applications of Chemistry Concepts</td>
<td>5</td>
</tr>
<tr>
<td>CHEM 233</td>
<td>Organic Chemistry I</td>
<td>5</td>
</tr>
<tr>
<td>CHEM 251</td>
<td>Mathematics and Physics for Chemistry</td>
<td>3</td>
</tr>
<tr>
<td>MATH 226</td>
<td>Calculus I</td>
<td>4</td>
</tr>
<tr>
<td>MATH 227</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>PHYS 111 &amp; PHYS 112, PHYS 121 &amp; PHYS 122, PHYS 222 &amp; PHYS 230</td>
<td>General Physics with Calculus I, General Physics with Calculus II Laboratory, and General Physics with Calculus II Laboratory</td>
<td>8</td>
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</table>

Upper-Division Requirements (29 units)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHEM 321</td>
<td>Quantitative Chemical Analysis</td>
<td>3</td>
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<tr>
<td>CHEM 322</td>
<td>Quantitative Chemical Analysis Laboratory</td>
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</tr>
<tr>
<td>CHEM 325</td>
<td>Inorganic Chemistry</td>
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</tr>
<tr>
<td>CHEM 335</td>
<td>Organic Chemistry II</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 336 &amp; CHEM 340</td>
<td>Organic Chemistry II Laboratory, Biochemistry I</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 351</td>
<td>Physical Chemistry I: Thermodynamics and Kinetics</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 353</td>
<td>Physical Chemistry II: Quantum Chemistry and Spectroscopy</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 390GW</td>
<td>Contemporary Chemistry and Biochemistry Research - GWAR</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 426</td>
<td>Advanced Inorganic Chemistry Laboratory</td>
<td>2</td>
</tr>
<tr>
<td>CHEM 451</td>
<td>Experimental Physical Chemistry Laboratory</td>
<td>2</td>
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</tbody>
</table>

Upper-Division Electives (9 units minimum)

A minimum of 9 units of electives must be selected from the following list of courses. Courses from community colleges cannot be substituted for the courses on the list below. Graduate-level courses in chemistry or appropriate courses in biology, physics, geosciences, and computer science may be substituted upon prior approval of an advisor. Students should keep in mind that non-Chemistry courses may require additional prerequisites that are not met in the Chemistry degree or permission of the instructor.
General Education Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Course Level</th>
<th>Units</th>
<th>Area Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral Communication</td>
<td>LD</td>
<td>3</td>
<td>A1</td>
</tr>
<tr>
<td>Written English</td>
<td>LD</td>
<td>3</td>
<td>A2</td>
</tr>
<tr>
<td>Critical Thinking</td>
<td>LD</td>
<td>3</td>
<td>A3</td>
</tr>
<tr>
<td>Physical Science</td>
<td>LD</td>
<td>3</td>
<td>B1</td>
</tr>
<tr>
<td>Life Science</td>
<td>LD</td>
<td>3</td>
<td>B2</td>
</tr>
<tr>
<td>Lab Science</td>
<td>LD</td>
<td>1</td>
<td>B3</td>
</tr>
<tr>
<td>Mathematics/Quantitative Reasoning</td>
<td>LD</td>
<td>3</td>
<td>B4</td>
</tr>
<tr>
<td>Arts</td>
<td>LD</td>
<td>3</td>
<td>C1</td>
</tr>
<tr>
<td>Humanities</td>
<td>LD</td>
<td>3</td>
<td>C2</td>
</tr>
<tr>
<td>Arts or Humanities</td>
<td>LD</td>
<td>3</td>
<td>C1 or C2</td>
</tr>
<tr>
<td>Social Sciences</td>
<td>LD</td>
<td>3</td>
<td>D1</td>
</tr>
<tr>
<td>Social Sciences: US History</td>
<td>LD</td>
<td>3</td>
<td>D2</td>
</tr>
<tr>
<td>Lifelong Learning and Self-Development (LLD)</td>
<td>LD</td>
<td>3</td>
<td>E</td>
</tr>
<tr>
<td>Ethnic Studies</td>
<td>LD</td>
<td>3</td>
<td>F</td>
</tr>
<tr>
<td>Physical and/or Life Science</td>
<td>UD</td>
<td>3</td>
<td>UD-B</td>
</tr>
</tbody>
</table>

Select One:

- CSC 306 An Interdisciplinary Approach to Computer Programming
- CSC 508 Machine Learning and Data Science for Personalized Medicine
- CSC 509 Data Science and Machine Learning for Medical Image Analysis

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

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

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. 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;

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.