

# Chemical Biology

## Bachelor of Science (BS)

The Bachelor of Science (BS) degree in Chemical Biology is intended for students who are interested in careers as professional chemists, or in the biological sciences including the biomedical, biotechnology, and pharmaceutical industries. Chemical Biology offers a solid background in chemistry, so that students understand the chemical principles of biological functions. In addition to an introductory set of math and physics courses and a broad selection of chemistry courses similar to those required for the chemistry major, students pursuing the chemical biology major take courses in general and cell biology, biochemistry, biological macromolecular synthesis, and bioinorganic chemistry. There is a strong emphasis on organic chemistry, quantitative thermodynamics, and kinetics necessary for understanding the logic of biological systems.

## Admission to the Major

For information on admission to the major, please see the College of Chemistry Admissions page (<http://guide.berkeley.edu/undergraduate/colleges-schools/chemistry/#admissionstext>) in this Guide.

## Minor Program

There is no minor program in Chemical Biology.

In addition to the University, campus, and college requirements, listed on the College Requirements tab, students must fulfill the below requirements specific to their major program.

## General Guidelines

1. A minimum grade point average (GPA) of 2.0 must be maintained in all courses undertaken at UC Berkeley, including those from UC Summer Sessions, UC Education Abroad Program, UC Berkeley in Washington Program, and XB courses from University Extension.
2. A minimum GPA of 2.0 in all courses taken in the college is required in order to advance and continue in upper division courses.
3. A minimum GPA of 2.0 in all upper division courses taken at the University is required to satisfy major requirements.
4. Chemical Biology majors who receive a grade of D+ or lower in a chemistry course for which a grade of C- or higher is required must repeat the course at UC Berkeley.

For information regarding grade requirements in specific courses, please see the notes sections below.

For information regarding residence requirements and unit requirements, please see the College Requirements tab.

Please note, the Academic Guide is updated once a year. For the most up to date requirements information, please take a look at the College of Chemistry website (<https://chemistry.berkeley.edu/ugrad/degrees/chembio/>).

## Lower Division Requirements

CHEM 4A & CHEM 4B	General Chemistry and Quantitative Analysis and General Chemistry and Quantitative Analysis	10
CHEM 96	Introduction to Research and Study in the College of Chemistry	1
CHEM 12A	Organic Chemistry	5

CHEM 12B	Organic Chemistry	5
MATH 1A	Calculus	4
MATH 1B	Calculus	4
MATH 53	Multivariable Calculus	4
MATH 54	Linear Algebra and Differential Equations	4
PHYSICS 7A	Physics for Scientists and Engineers	4
PHYSICS 7B	Physics for Scientists and Engineers	4
BIOLOGY 1A	General Biology Lecture	3
BIOLOGY 1AL	General Biology Laboratory	2

## Notes

1. Students should take CHEM 4A and CHEM 4B during their freshmen year, and CHEM 12A and CHEM 12B during their sophomore year.
2. A grade of C- or better is required in CHEM 4A before taking CHEM 4B, in CHEM 4B before taking more advanced courses, and in CHEM 12A before taking CHEM 12B.
3. A grade of C- or better is recommended in CHEM 12A before taking BIOLOGY 1A.
4. Students who join the program after completing a general chemistry sequence that does not include quantitative analysis are required to take CHEM 4B or CHEM 105.
5. Students who join the program after completing CHEM 3A plus CHEM 3AL and CHEM 3B plus CHEM 3BL at Berkeley are allowed to substitute those courses for CHEM 12A and CHEM 12B. Students who join the program after completing only CHEM 3A plus CHEM 3AL at Berkeley are recommended to take CHEM 12B.
6. Students must take CHEM 96 during the fall term of their sophomore year at Berkeley.
7. Students should start MATH 1A in the first semester of their freshman year. MATH 10A and MATH 10B may be substituted for MATH 1A and MATH 1B.
8. Students should start PHYSICS 7A in the second semester of the freshman year. Substitution of PHYSICS 8A and PHYSICS 8B is allowed, but PHYSICS 7A and PHYSICS 7B are recommended. PHYSICS 5A and PHYSICS 5B plus PHYSICS 5BL may be substituted for PHYSICS 7A and PHYSICS 7B.
9. Students may substitute PHYSICS 89 for MATH 54.

## Upper Division Requirements

CHEM 103	Inorganic Chemistry in Living Systems	3
CHEM C110L	General Biochemistry and Molecular Biology Laboratory	4
CHEM 120A	Physical Chemistry <sup>1</sup>	3
CHEM 120B	Physical Chemistry <sup>1</sup>	3
CHEM 135	Chemical Biology <sup>2</sup>	3
MCELLBI 110	Molecular Biology: Macromolecular Synthesis and Cellular Function <sup>2</sup>	4

Select one of the following:

CHEM 105	Instrumental Methods in Analytical Chemistry [4]
CHEM 115	Organic Chemistry--Advanced Laboratory Methods [4]
CHEM 125	Physical Chemistry Laboratory [3]
CHEM C170L	Biochemical Engineering Laboratory [3]
CHEM C182	Atmospheric Chemistry and Physics Laboratory [3]

Select 7 units of upper division chemistry and allied subjects (see below for list)<sup>3</sup>

One must be an additional lecture course (or laboratory/lecture course) in chemistry as approved by your staff adviser

<sup>1</sup> A grade of C- or higher is required in CHEM 120A and CHEM 120B if taken before CHEM 125 or CHEM C182. It is strongly recommended to take Chem 120A and Chem 120B in sequence (<https://chemistry.berkeley.edu/ugrad/degrees/why-take-chem-120A-before-120B/>).

<sup>2</sup> BIOLOGY 1A plus BIOLOGY 1AL and CHEM 135 satisfy the prerequisites for MCELLBI 110.

<sup>3</sup> Advanced Placement, Advanced Level, and International Baccalaureate credit cannot be applied to this requirement. No more than 4 units of research (e.g., CHEM H194 and CHEM 196) may be used to satisfy this requirement.

If a course is used to satisfy another requirement, the course cannot also be used to satisfy the upper division Chemistry and Allied Subjects requirement.

## Upper Division Chemistry and Allied Subjects List

ASTRON C162	Planetary Astrophysics	4
BIO ENG 100	Ethics in Science and Engineering	3
BIO ENG 104	Biological Transport Phenomena	4
BIO ENG 111	Functional Biomaterials Development and Characterization	4
BIO ENG C112	Molecular Biomechanics and Mechanobiology of the Cell	4
BIO ENG 115	Tissue Engineering Lab	4
BIO ENG 116	Course Not Available	
BIO ENG C117	Structural Aspects of Biomaterials	4
BIO ENG C118	Biological Performance of Materials	4
BIO ENG C119	Orthopedic Biomechanics	4
BIO ENG 121	BioMEMS and Medical Devices	4
BIO ENG 131	Introduction to Computational Molecular and Cell Biology	4
BIO ENG 132	Course Not Available	
BIO ENG 143	Computational Methods in Biology	4
BIO ENG 147	Principles of Synthetic Biology	4
BIO ENG 150	Introduction of Bionanoscience and Bionanotechnology	4
BIO ENG 151	Micro/Nanofluidics for Bioengineering and Lab-On-A-Chip	4
BIO ENG 163	Principles of Molecular and Cellular Biophotonics	4
BIO ENG C181	The Berkeley Lectures on Energy: Energy from Biomass	3
CHM ENG 140	Introduction to Chemical Process Analysis	4
CHM ENG 141	Chemical Engineering Thermodynamics	4
CHM ENG 142	Chemical Kinetics and Reaction Engineering	4
CHM ENG 150A	Transport Processes	4
CHM ENG 150B	Transport and Separation Processes	4
CHM ENG 154	Chemical Engineering Laboratory	4
CHM ENG 160	Chemical Process Design	4
CHM ENG 162	Dynamics and Control of Chemical Processes	4
CHM ENG 170A	Biochemical Engineering	4
CHM ENG 170B	Biochemical Engineering	4
CHM ENG C170L	Biochemical Engineering Laboratory	3
CHM ENG 171	Transport Phenomena	3
CHM ENG 176	Principles of Electrochemical Processes	3
CHM ENG C178	Polymer Science and Technology	3
CHM ENG 179	Process Technology of Solid-State Materials Devices	3
CHM ENG 180	Chemical Engineering Economics	3
CHM ENG H194	Research for Advanced Undergraduates <sup>2</sup>	2-4
CHM ENG 195	Special Topics	2-4
CHM ENG C195A	The Berkeley Lectures on Energy: Energy from Biomass	3
CHM ENG 196	Special Laboratory Study <sup>2</sup>	2-4
CHEM 100	Communicating Chemistry (limited to 2 units)	2
CHEM 104A	Advanced Inorganic Chemistry (limited to 2 units) <sup>1</sup>	3
CHEM 104B	Advanced Inorganic Chemistry (limited to 2 units) <sup>1</sup>	3
CHEM 105	Instrumental Methods in Analytical Chemistry	4
CHEM 108	Inorganic Synthesis and Reactions	4
CHEM C110L	General Biochemistry and Molecular Biology Laboratory	4
CHEM 113	Advanced Mechanistic Organic Chemistry	3
CHEM 114	Advanced Synthetic Organic Chemistry	3
CHEM 115	Organic Chemistry--Advanced Laboratory Methods	4
CHEM 122	Quantum Mechanics and Spectroscopy	3
CHEM 125	Physical Chemistry Laboratory	3
CHEM C130	Biophysical Chemistry: Physical Principles and the Molecules of Life	4
CHEM 130B	Biophysical Chemistry (limited to 2 units) <sup>1</sup>	3
CHEM C138	The Berkeley Lectures on Energy: Energy from Biomass	3
CHEM 143	Nuclear Chemistry	2
CHEM C150	Introduction to Materials Chemistry	3
CHEM C170L	Biochemical Engineering Laboratory	3
CHEM C178	Polymer Science and Technology	3
CHEM C182	Atmospheric Chemistry and Physics Laboratory	3
CHEM C191	Introduction to Quantum Computing	4
CHEM 192	Individual Study for Advanced Undergraduates	1-3
CHEM H194	Research for Advanced Undergraduates <sup>2</sup>	2-6
CHEM 195	Special Topics	3
CHEM 196	Special Laboratory Study <sup>2</sup>	2-6
CIV ENG C106	Air Pollution	3
CIV ENG 111	Environmental Engineering	3
CIV ENG 112	Water & Wastewater Systems Design and Operation	3
CIV ENG 114	Environmental Microbiology	3
CIV ENG 115	Water Chemistry	3
CIV ENG C116	Chemistry of Soils	3
CIV ENG C133	Engineering Analysis Using the Finite Element Method	3
COMPSCI 160	User Interface Design and Development	4
COMPSCI 162	Operating Systems and System Programming	4

COMPSCI 164	Programming Languages and Compilers	4	MATH H113	Honors Introduction to Abstract Algebra	4
COMPSCI 170	Efficient Algorithms and Intractable Problems	4	MATH 114	Second Course in Abstract Algebra	4
COMPSCI 174	Combinatorics and Discrete Probability	4	MATH 115	Introduction to Number Theory	4
COMPSCI 184	Foundations of Computer Graphics	4	MATH 121A	Mathematical Tools for the Physical Sciences	4
COMPSCI C191	Introduction to Quantum Computing	4	MATH 121B	Mathematical Tools for the Physical Sciences	4
EPS 103	Introduction to Aquatic and Marine Geochemistry	4	MATH 123	Ordinary Differential Equations	4
EPS C129	Biometeorology	3	MATH 125A	Mathematical Logic	4
EPS 131	Geochemistry	4	MATH 126	Introduction to Partial Differential Equations	4
EPS C162	Planetary Astrophysics	4	MATH 128A	Numerical Analysis	4
EPS C180	Air Pollution	3	MATH 128B	Numerical Analysis	4
EPS C181	Atmosphere, Ocean, and Climate Dynamics	3	MATH 130	Groups and Geometries	4
EPS C182	Atmospheric Chemistry and Physics Laboratory	3	MATH 135	Introduction to the Theory of Sets	4
EPS C183	Carbon Cycle Dynamics	3	MATH 136	Incompleteness and Undecidability	4
ECON C103	Introduction to Mathematical Economics	4	MATH 140	Metric Differential Geometry	4
EDUC 223B	Special Problems in Mathematics, Science and Technology Education (graduate-level; requires consent of instructor)	2-6	MATH 142	Elementary Algebraic Topology	4
EDUC 224A	Mathematical Thinking and Problem Solving (graduate-level; requires consent of instructor)	3	MATH 170	Mathematical Methods for Optimization	4
ENGIN 117	Methods of Engineering Analysis	3	MATH 185	Introduction to Complex Analysis	4
ENGIN 128	Advanced Engineering Design Graphics	3	MATH H185	Honors Introduction to Complex Analysis	4
ESPM 120	Science of Soils	3	MATH 189	Mathematical Methods in Classical and Quantum Mechanics	4
ESPM C128	Chemistry of Soils	3	MEC ENG C115	Molecular Biomechanics and Mechanobiology of the Cell	4
ESPM C129	Biometeorology	3	MEC ENG C117	Structural Aspects of Biomaterials	4
ESPM C138	Introduction to Comparative Virology	4	MEC ENG 118	Introduction to Nanotechnology and Nanoscience	3
ESPM C148	Pesticide Chemistry and Toxicology	3	MEC ENG C176	Orthopedic Biomechanics	4
ESPM 162	Bioethics and Society	4	MEC ENG C180	Engineering Analysis Using the Finite Element Method	3
ESPM 162A	Health, Medicine, Society and Environment	4	MCELLBI C100A	Biophysical Chemistry: Physical Principles and the Molecules of Life	4
ESPM C180	Air Pollution	3	MCELLBI C103	Bacterial Pathogenesis	3
IND ENG 172	Probability and Risk Analysis for Engineers	4	MCELLBI 104	Genetics, Genomics, and Cell Biology	4
MAT SCI 102	Bonding, Crystallography, and Crystal Defects	3	MCELLBI 110	Molecular Biology: Macromolecular Synthesis and Cellular Function	4
MAT SCI 103	Phase Transformations and Kinetics	3	MCELLBI C110L	General Biochemistry and Molecular Biology Laboratory	4
MAT SCI 104	Materials Characterization	3	MCELLBI C112	General Microbiology	4
MAT SCI 111	Properties of Electronic Materials	4	MCELLBI C112L	General Microbiology Laboratory	3
MAT SCI 112	Corrosion (Chemical Properties)	3	MCELLBI C114	Introduction to Comparative Virology	4
MAT SCI 113	Mechanical Behavior of Engineering Materials	3	MCELLBI C116	Microbial Diversity	3
MAT SCI 117	Properties of Dielectric and Magnetic Materials	3	MCELLBI 133L	Physiology and Cell Biology Laboratory	4
MAT SCI C118	Biological Performance of Materials	4	MCELLBI 135A	Topics in Cell and Developmental Biology: Molecular Endocrinology	3
MAT SCI 120	Materials Production	3	MCELLBI 140	General Genetics	4
MAT SCI 121	Metals Processing	3	MCELLBI 140L	Genetics Laboratory	4
MAT SCI 122	Ceramic Processing	3	MCELLBI 141	Developmental Biology	4
MAT SCI 123	ELECTRONIC MATERIALS PROCESSING	4	MCELLBI 143	Evolution of Genomes, Cells, and Development	3
MAT SCI 125	Thin-Film Materials Science	3	MCELLBI C148	Microbial Genomics and Genetics	4
MAT SCI 130	Experimental Materials Science and Design	3	MCELLBI 150	Molecular Immunology	4
MAT SCI 140	Nanomaterials for Scientists and Engineers	3	MCELLBI 150L	Immunology Laboratory	4
MAT SCI 151	Polymeric Materials	3	MCELLBI 160L	Neurobiology Laboratory	4
MATH C103	Introduction to Mathematical Economics	4	NUC ENG 101	Nuclear Reactions and Radiation	4
MATH 104	Introduction to Analysis	4	NUC ENG 104	Radiation Detection and Nuclear Instrumentation Laboratory	4
MATH H104	Honors Introduction to Analysis	4			
MATH 105	Second Course in Analysis	4			
MATH 110	Abstract Linear Algebra	4			
MATH H110	Honors Linear Algebra	4			
MATH 113	Introduction to Abstract Algebra	4			

NUC ENG 107	Introduction to Imaging	3
NUC ENG 120	Nuclear Materials	4
NUC ENG 124	Radioactive Waste Management	3
NUC ENG 130	Analytical Methods for Non-proliferation	3
NUC ENG 150	Introduction to Nuclear Reactor Theory	4
NUC ENG 161	Nuclear Power Engineering	4
NUC ENG 162	Radiation Biophysics and Dosimetry	3
NUC ENG 170A	Nuclear Design: Design in Nuclear Power Technology and Instrumentation	3
NUC ENG 170B	Nuclear Design: Design in Bionuclear, Nuclear Medicine, and Radiation Therapy	3
NUC ENG 180	Introduction to Controlled Fusion	3
NUSCTX 103	Nutrient Function and Metabolism	4
NUSCTX 108A	Introduction and Application of Food Science	3
NUSCTX 110	Toxicology	4
NUSCTX 115	Principles of Drug Action	2
NUSCTX 160	Metabolic Bases of Human Health and Diseases	4
NUSCTX 171	Nutrition and Toxicology Laboratory	4
PHYSICS 7C	Physics for Scientists and Engineers (must be completed with a grade of C- or better)	4
PHYSICS 105	Analytic Mechanics	4
PHYSICS 110A	Electromagnetism and Optics	4
PHYSICS 110B	Electromagnetism and Optics	4
PHYSICS 112	Introduction to Statistical and Thermal Physics	4
PHYSICS 130	Quantum and Nonlinear Optics	3
PHYSICS 137B	Quantum Mechanics	4
PHYSICS 138	Modern Atomic Physics	3
PHYSICS 141A	Solid State Physics	4
PHYSICS 141B	Solid State Physics	3
PHYSICS C191	Introduction to Quantum Computing	4
PLANTBI C103	Bacterial Pathogenesis	3
PLANTBI C112	General Microbiology	4
PLANTBI C112L	General Microbiology Laboratory	3
PLANTBI C114	Introduction to Comparative Virology	4
PLANTBI C116	Microbial Diversity	3
PLANTBI 120	Biology of Algae	2
PLANTBI 120L	Laboratory for Biology of Algae	2
PLANTBI 122	Bioenergy	2
PLANTBI C124	The Berkeley Lectures on Energy: Energy from Biomass	3
PLANTBI 135	Physiology and Biochemistry of Plants	3
PLANTBI C148	Microbial Genomics and Genetics	4
PLANTBI 150	Plant Cell Biology	3
PLANTBI 160	Plant Molecular Genetics	3
PLANTBI 170	Modern Applications of Plant Biotechnology	2
PLANTBI 180	Environmental Plant Biology	2
PB HLTH 142	Introduction to Probability and Statistics in Biology and Public Health	4
PB HLTH 162A	Public Health Microbiology	4
STAT 134	Concepts of Probability	4
STAT 135	Concepts of Statistics	4

<sup>1</sup> For CHEM 104A, CHEM 104B, and CHEM 130B only 2 of the 3 units will count towards Allied Subject requirement since there are overlapping concepts with required major courses. However, students will receive the full 3 units of credit towards their GPA and the 120 unit graduation requirement.

<sup>2</sup> No more than 4 units of research (e.g., CHEM H194 and CHEM 196) may be used to satisfy this requirement.

All students in the College of Chemistry are required to complete the University requirements of American Cultures (<http://guide.berkeley.edu/undergraduate/colleges-schools/chemistry/american-cultures-requirement/>), American History and Institutions (<http://guide.berkeley.edu/undergraduate/colleges-schools/chemistry/american-history-institutions-requirements/>), and Entry-Level Writing (<http://guide.berkeley.edu/undergraduate/colleges-schools/chemistry/entry-level-writing-requirement/>). In addition, they must satisfy the following College requirements:

### Reading and Composition (<http://guide.berkeley.edu/undergraduate/colleges-schools/chemistry/reading-composition-requirement/>)

In order to provide a solid foundation in reading, writing, and critical thinking the College requires lower division work in composition.

- Chemical Engineering majors: A-level Reading and Composition course (e.g., English R1A) by end of the first year
- Chemical Biology and Chemistry majors: A- and B-level courses by end of the second year (<http://guide.berkeley.edu/undergraduate/colleges-schools/chemistry/reading-composition-requirement/>)
- R&C courses must be taken for a letter grade
- English courses at other institutions may satisfy the requirement(s); check with your Undergraduate Adviser
- After admission to Berkeley, credit for English at another institution will not be granted if the Entry Level Writing requirement has not been satisfied

### Humanities and Social Sciences Breadth Requirement: Chemistry & Chemical Biology majors

The College of Chemistry's humanities and social sciences breadth requirement promotes educational experiences that enrich and complement the technical requirements for each major.

- 15 units total; includes Reading & Composition and American Cultures courses
- Remaining units must come from the following L&S breadth areas, excluding courses which only teach a skill (such as drawing or playing an instrument):

Arts and Literature  
 Foreign Language (<http://guide.berkeley.edu/undergraduate/colleges-schools/chemistry/approved-foreign-language-courses/>)<sup>1,2</sup>  
 Historical Studies  
 International Studies  
 Philosophy and Values

### Social and Behavioral Sciences

To find course options for breadth, go to the Berkeley Academic Guide Class Schedule (<http://classes.berkeley.edu/>), select the term of interest, and use the 'Breadth Requirements' filter to select the breadth area(s) of interest.

- Breadth courses may be taken on a *Pass/No Pass* basis (excluding Reading and Composition)
- AP, IB, and GCE A-level exam credit (<http://chemistry.berkeley.edu/students/current-undergraduates/exam-credit-info/>) may be used to satisfy the breadth requirement

<sup>1</sup> Elementary-level courses may not be in the student's native language and may not be structured primarily to teach the reading of scientific literature.

<sup>2</sup> For Chemistry and Chemical Biology majors, elementary-level foreign language courses are not accepted toward the 15 unit breadth requirement if they are used (or are duplicates of high school courses used) to satisfy the Foreign Language requirement.

### Foreign Language (Language Other Than English [LOTE]) Requirement

**Applies to Chemistry and Chemical Biology majors only.**

The LOTE requirement may be satisfied with one language other than English, in one of the following ways:

- By completing in high school the third year of one language other than English with minimum grades of C-.
- By completing at Berkeley the second semester of a sequence of courses in one language other than English, or the equivalent at another institution. Only LOTE courses that include reading and composition, as well as conversation, are accepted in satisfaction of this requirement. LOTE courses may be taken on a *Pass/No Pass* basis.
- By demonstrating equivalent knowledge of a language other than English through examination, including a College Entrance Examination Board (CEEB) Advanced Placement Examination with a score of 3 or higher (if taken before admission to college), an SAT II: Subject Test with a score of 590 or higher, or a proficiency examination offered by some departments at Berkeley or at another campus of the University of California.

### Humanities and Social Sciences Breadth Requirement: Chemical Engineering major

- 22 units total; includes Reading and Composition and American Cultures courses
- Breadth Series requirement: As part of the 22 units, students must complete two courses, at least one being upper division, in the same or very closely allied humanities or social science department(s). AP credit may be used to satisfy the lower division aspect of the requirement.
- Breadth Series courses and all remaining units must come from the following lists of approved humanities and social science courses, excluding courses which only teach a skill (such as drawing or playing an instrument):

### Arts and Literature

Foreign Language (<http://guide.berkeley.edu/undergraduate/colleges-schools/chemistry/approved-foreign-language-courses/>)<sup>1,2</sup>

Historical Studies  
International Studies  
Philosophy and Values

To find course options for breadth, go to the Berkeley Academic Guide Class Schedule (<http://classes.berkeley.edu/>), select the term of interest, and use the 'Breadth Requirements' filter to select the breadth area(s) of interest.

- Breadth courses may be taken on a *Pass/No Pass* basis (excluding Reading and Composition)
- AP, IB, and GCE A-level exam (<http://chemistry.berkeley.edu/students/current-undergraduates/exam-credit-info/>) credit may be used to satisfy the breadth requirement

<sup>1</sup> Elementary-level courses may not be in the student's native language and may not be structured primarily to teach the reading of scientific literature.

<sup>2</sup> For chemical engineering majors, no more than six units of language other than English may be counted toward the 22 unit breadth requirement.

### Class Schedule Requirements

- Minimum units per semester: 13
- Maximum units per semester: 19.5
- 12 units of course work each semester must satisfy degree requirements
- Chemical Engineering freshmen and Chemistry majors are required to enroll in a minimum of one chemistry course each semester
- After the freshman year, Chemical Engineering majors must enroll in a minimum of one chemical engineering course each semester

### Semester Limit

- Students who entered as freshmen: 8 semesters
- Chemistry & Chemical Biology majors who entered as transfer students: 4 semesters
- Chemical Engineering and Joint majors who entered as transfer students: 5 semesters

Summer sessions are excluded when determining the limit on semesters. Students who wish to delay graduation to complete a minor, a double major, or simultaneous degrees must request approval for delay of graduation before what would normally be their final two semesters. The College of Chemistry does not have a rule regarding maximum units that a student can accumulate.

### Senior Residence

After 90 units toward the bachelor's degree have been completed, at least 24 of the remaining units must be completed in residence in the College of Chemistry, in at least two semesters (the semester in which the 90 units are exceeded, plus at least one additional semester).

To count as a semester of residence for this requirement, a program must include at least 4 units of successfully completed courses. A summer

session can be credited as a semester in residence if this minimum unit requirement is satisfied.

Juniors and seniors who participate in the UC Education Abroad Program (EAP) for a *full year* may meet a modified senior residence requirement. After 60 units toward the bachelor's degree have been completed, at least 24 (excluding EAP) of the remaining units must be completed in residence in the College of Chemistry, in at least two semesters. At least 12 of the 24 units must be completed after the student has already completed 90 units. Undergraduate Dean's approval for the modified senior residence requirement must be obtained before enrollment in the Education Abroad Program.

## Minimum Total Units

A student must successfully complete at least 120 semester units in order to graduate.

## Minimum Academic Requirements

A student must earn at least a C average (2.0 GPA) in all courses undertaken at UC, including those from UC Summer Sessions, UC Education Abroad Program, and UC Berkeley Washington Program, as well as XB courses from University Extension.

## Minimum Course Grade Requirements

Students in the College of Chemistry who receive a grade of D+ or lower in a chemical engineering or chemistry course for which a grade of C- or higher is required must repeat the course at Berkeley.

Students in the College of Chemistry must achieve:

- C- or higher in CHEM 4A before taking CHEM 4B
- C- or higher in CHEM 4B before taking more advanced courses
- C- or higher in CHEM 12A before taking CHEM 12B
- GPA of at least 2.0 in all courses taken in the college in order to advance to and continue in the upper division

Chemistry or chemical biology majors must also achieve:

- C- or higher in CHEM 120A and CHEM 120B if taken before CHEM 125 or CHEM C182
- 2.0 GPA in all upper division courses taken at the University to satisfy major requirements

Chemical engineering students must also achieve:

- C- or higher in CHM ENG 140 before taking any other CBE courses
- C- or higher in CHM ENG 150A to be eligible to take any other course in the 150 series
- 2.0 GPA in all upper division courses taken at the University to satisfy major requirements

Chemical engineering students who do not achieve a grade of C- or higher in CHM ENG 140 on their first attempt are advised to change to another major. If the course is not passed with a grade of C- or higher on the second attempt, continuation in the Chemical Engineering program is normally not allowed.

## Minimum Progress

To make normal progress toward a degree, undergraduates must successfully complete 30 units of coursework each year. The continued enrollment of students who do not maintain normal progress will be subject to the approval of the Undergraduate Dean. To achieve minimum academic progress, the student must meet two criteria:

1. Completed no fewer units than 15 multiplied by the number of semesters, less one, in which the student has been enrolled at Berkeley. Summer sessions do not count as semesters for this purpose.
2. A student's class schedule must contain at least 13 units in any term, unless otherwise authorized by the staff adviser or the Undergraduate Dean.

## Mission

Each Chemistry graduate will have completed an integrated, rigorous program which includes foundational course work in chemistry and in-depth course work in chemistry or chemistry-related fields. The ACS-certified degree further emphasizes laboratory experience and the development of professional skills. Advanced coursework and educational activities outside the traditional classroom, such as independent research, provide students the opportunity to conduct individual research projects or participate as a member of a research team. Many undergraduate students also benefit from taking our graduate courses in synthetic and physical chemistry.

At graduation, Chemistry majors will have a set of fundamental competencies that are knowledge-based, performance/skills-based, and effective.

## Learning Goals for the Major

All our graduates will be able to:

1. Master a broad set of chemical knowledge concerning the fundamentals in the basic areas of the discipline (organic, inorganic, analytical, physical, and biological chemistry).
2. Solve problems competently by identifying the essential parts of a problem and formulating a strategy for solving the problem. They will be able to rationally estimate the solution to a problem, apply appropriate techniques to arrive at a solution, test the correctness of the solution, and interpret their results.
3. Use computers in data acquisition and processing and use available software as a tool in data analysis.
4. Employ modern library search tools to locate and retrieve scientific information about a topic, chemical, chemical technique, or an issue relating to chemistry.
5. Successfully pursue their career objectives in advanced education in professional and/or graduate schools, in a scientific career in government or industry, in a teaching career in the school systems, or in a related career following graduation.

## Skills

All our graduates will demonstrate the ability to:

1. Understand the objective of their chemical experiments, properly carry out the experiments, and appropriately record and analyze the results.

2. Use standard laboratory equipment, modern instrumentation, and classical techniques to carry out experiments.
3. Know and follow the proper procedures and regulations for safe handling and use of chemicals.
4. Communicate the concepts and results of their laboratory experiments through effective writing and oral communication skills.

Major Maps help undergraduate students discover academic, co-curricular, and discovery opportunities at UC Berkeley based on intended major or field of interest. Developed by the Division of Undergraduate Education in collaboration with academic departments, these experience maps will help you:

- **Explore** your major and gain a better understanding of your field of study
- **Connect** with people and programs that inspire and sustain your creativity, drive, curiosity and success
- **Discover** opportunities for independent inquiry, enterprise, and creative expression
- **Engage** locally and globally to broaden your perspectives and change the world
- **Reflect** on your academic career and prepare for life after Berkeley

Use the major map below as a guide to planning your undergraduate journey and designing your own unique Berkeley experience.

View the Chemical Biology Major Map PDF. ([https://ue.berkeley.edu/sites/default/files/chemistry\\_-\\_chemical\\_biology.pdf](https://ue.berkeley.edu/sites/default/files/chemistry_-_chemical_biology.pdf))

## Chemical Biology

Expand all course descriptions [+] Collapse all course descriptions [-]

## CHEM 1A General Chemistry 3 Units

Terms offered: Fall 2024, Summer 2024 8 Week Session, Spring 2024  
Stoichiometry of chemical reactions, quantum mechanical description of atoms, the elements and periodic table, chemical bonding, real and ideal gases, thermochemistry, introduction to thermodynamics and equilibrium, acid-base and solubility equilibria, introduction to oxidation-reduction reactions, introduction to chemical kinetics.

General Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** High school chemistry recommended

**Credit Restrictions:** Students will receive no credit for CHEM 1A after completing CHEM 1AD or CHEM 4A. A deficient grade in CHEM 1A may be removed by taking CHEM 1AD.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3-3 hours of lecture, 1-1 hours of discussion, and 0-2 hours of voluntary per week

**Summer:** 8 weeks - 6-6 hours of lecture, 2-2 hours of discussion, and 0-2 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

General Chemistry: Read Less [-]

## CHEM 1AD General Chemistry (Digital) 3 Units

Terms offered: Spring 2016

An interactive general chemistry course that uses modern digital technology, offered in a smaller classroom setting to facilitate student participation and foster an engaging learning environment. Topics cover the Chemistry 1A curriculum, ranging from quantum mechanics and interactions of atoms and molecules to properties and equilibria of bulk materials. The course involves a blend of classroom lectures and peer learning with substantial web-based assignments and resources including web access to lecture videos. Lecture time is also devoted to ChemQuiz peer discussions and live demos of chemical properties and processes, which students generally find to be illuminating and valuable learning experiences.

General Chemistry (Digital): Read More [+]

### Rules & Requirements

**Prerequisites:** High school chemistry recommended

**Credit Restrictions:** Students will receive no credit for Chemistry 1AD after completing Chemistry 1A or 4A. A deficient grade in Chemistry 1A may be removed by taking Chemistry 1AD.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

**Summer:** 8 weeks - 6 hours of lecture and 2 hours of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructors:** Pines, Slack

General Chemistry (Digital): Read Less [-]

## CHEM 1AL General Chemistry Laboratory 2 Units

Terms offered: Fall 2024, Summer 2024 8 Week Session, Spring 2024

An experimental approach to chemical sciences with emphasis on developing fundamental, reproducible laboratory technique and a goal of understanding and achieving precision and accuracy in laboratory experiments. Proper use of laboratory equipment and standard wet chemical methods are practiced. Areas of investigations include chemical equilibria, spectroscopy, nanotechnology, green chemistry, and thermochemistry. Completion of, or concurrent enrollment in 1A is required.

General Chemistry Laboratory: Read More [+]

### Rules & Requirements

**Prerequisites:** CHEM 1A, with min grade of C-; or co-enrollment in CHEM 1A; or AP CHEM with min score of 4; or CHEM HL IB with min score of 5; or GCE A-Level CHEM with min grade of C

**Credit Restrictions:** Students will receive no credit for 1AL after taking 4A.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of lecture, 3 hours of laboratory, and 0 hours of voluntary per week

**Summer:** 8 weeks - 2 hours of lecture, 6 hours of laboratory, and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

General Chemistry Laboratory: Read Less [-]

## CHEM 1B General Chemistry 4 Units

Terms offered: Spring 2023, Spring 2022, Spring 2021

Introduction to chemical kinetics, electrochemistry, properties of the states of matter, binary mixtures, thermodynamic efficiency and the direction of chemical change, quantum mechanical description of bonding introduction to spectroscopy. Special topics: Research topics in modern chemistry and biochemistry, chemical engineering.

General Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** CHEM 1A and CHEM 1AL with min grades of C-; or CHEM 4A with min grade of C-; or AP CHEM with min score of 4; or CHEM HL IB with min score of 5; or GCE A-Level CHEM with min grade of C

**Credit Restrictions:** Students will receive no credit for Chemistry 1B after completing Chemistry 4B.

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture, 4 hours of laboratory, and 0 hours of voluntary per week

**Summer:** 8 weeks - 6 hours of lecture, 8 hours of laboratory, and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

General Chemistry: Read Less [-]

## CHEM W1A General Chemistry 3 Units

Terms offered: Summer 2013 10 Week Session, Summer 2013 8 Week Session, Summer 2012 8 Week Session

Stoichiometry of chemical reactions, quantum mechanical description of atoms, the elements and periodic table, chemical bonding, real and ideal gases, thermochemistry, introduction to thermodynamics and equilibrium, acid-base and solubility equilibria, introduction to oxidation-reduction reactions, introduction to chemical kinetics. This course is web-based.

General Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** High school chemistry is recommended

**Credit Restrictions:** Students will receive no credit for CHEM W1A after passing CHEM 1A or CHEM 4A. A deficiency in CHEM 1A may be removed by taking CHEM W1A.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of web-based lecture and 1 hour of web-based discussion per week

**Summer:** 8 weeks - 6 hours of web-based lecture and 2 hours of web-based discussion per week

**Online:** This is an online course.

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

General Chemistry: Read Less [-]

## CHEM 3A Chemical Structure and Reactivity 3 Units

Terms offered: Fall 2024, Summer 2024 8 Week Session, Spring 2024

Introduction to organic chemical structures, bonding, and chemical reactivity. The organic chemistry of alkanes, alkyl halides, alcohols, alkenes, alkynes, and organometallics.

Chemical Structure and Reactivity: [Read More](#) [+]

### Rules & Requirements

**Prerequisites:** CHEM 1A with min grade of C-; or AP Chem with min score of 4; or Chem HL IB with min score of 5; or GCE A-Level Chem with min grade of C

**Credit Restrictions:** Students will receive no credit for CHEM 3A after completing CHEM 12A; a deficient grade in CHEM 12A may be removed by taking CHEM 3A- will restrict credit if completed before Chemistry 3A.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture, 1 hour of discussion, and 0 hours of voluntary per week

**Summer:** 8 weeks - 6 hours of lecture, 2 hours of discussion, and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Chemical Structure and Reactivity: [Read Less](#) [-]

## CHEM 3AL Organic Chemistry Laboratory 2 Units

Terms offered: Fall 2024, Summer 2024 8 Week Session, Spring 2024

Introduction to the theory and practice of methods used in the organic chemistry laboratory. An emphasis is placed on the separation and purification of organic compounds. Techniques covered will include extraction, distillation, sublimation, recrystallization, and chromatography. Detailed discussions and applications of infrared and nuclear magnetic resonance spectroscopy will be included.

Organic Chemistry Laboratory: [Read More](#) [+]

### Rules & Requirements

**Prerequisites:** CHEM 1A and CHEM 1AL with min grades of C-; or CHEM 4A with min grade of C-; or AP CHEM with min score of 4; or CHEM HL IB with min score of 5; or GCE A-Level CHEM with min grade of C. Corequisite: CHEM 3A with min grade of C- or coenrollment in CHEM 3A

**Credit Restrictions:** Students will receive no credit for CHEM 3AL after taking CHEM 12A.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of lecture and 4 hours of laboratory per week

**Summer:** 8 weeks - 2 hours of lecture and 8 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

Organic Chemistry Laboratory: [Read Less](#) [-]

## CHEM 3B Chemical Structure and Reactivity 3 Units

Terms offered: Fall 2024, Summer 2024 8 Week Session, Spring 2024  
Conjugation, aromatic chemistry, carbonyl compounds, carbohydrates, amines, carboxylic acids, amino acids, peptides, proteins, and nucleic acid chemistry. Ultraviolet spectroscopy and mass spectrometry will be introduced.

Chemical Structure and Reactivity: [Read More](#) [+]

### Rules & Requirements

**Prerequisites:** CHEM 3A with min grade of C-

**Credit Restrictions:** Students will receive no credit for 3B after taking 12B.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture, 1 hour of discussion, and 0 hours of voluntary per week

**Summer:** 8 weeks - 6 hours of lecture, 2 hours of discussion, and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Chemical Structure and Reactivity: [Read Less](#) [-]

## CHEM 3BL Organic Chemistry Laboratory 2 Units

Terms offered: Fall 2024, Summer 2024 8 Week Session, Spring 2024  
The synthesis and purification of organic compounds will be explored. Natural product chemistry will be introduced. Advanced spectroscopic methods including infrared, ultraviolet, and nuclear magnetic resonance spectroscopy and mass spectrometry will be used to analyze products prepared and/or isolated. Qualitative analysis of organic compounds will be covered.

Organic Chemistry Laboratory: [Read More](#) [+]

### Rules & Requirements

**Prerequisites:** CHEM 3AL with min grade of C-. Co-requisite: CHEM 3B with min grade of C- or co-enrollment in CHEM 3B

**Credit Restrictions:** Students will receive no credit for CHEM 3BL after taking CHEM 12B.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of lecture and 4 hours of laboratory per week

**Summer:** 8 weeks - 2 hours of lecture and 8 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

Organic Chemistry Laboratory: [Read Less](#) [-]

## CHEM N3AL Organic Chemistry Laboratory 2 Units

Terms offered: Summer 2018 8 Week Session, Summer 2017 8 Week Session, Summer 2015 8 Week Session

Introduction to the theory and practice of methods used in the organic chemistry laboratory. An emphasis is placed on the separation and purification of organic compounds. Techniques covered will include extraction, distillation, sublimation, recrystallization, and chromatography. Detailed discussions and applications of infrared and nuclear magnetic resonance spectroscopy will be included.

Organic Chemistry Laboratory: [Read More](#) [+]

### Rules & Requirements

**Prerequisites:** CHEM 1A and CHEM 1AL with min grades of C-; or CHEM 4A with min grade of C-; or AP CHEM with min score of 4; or CHEM HL IB with min score of 5; or GCE A-Level CHEM with min grade of C. Co-requisite: CHEM 3A with min grade of C- or co-enrollment in CHEM 3A. CHEM 4A with approval of instructor

**Credit Restrictions:** Students will receive no credit for CHEM N3AL after taking CHEM 12A.

### Hours & Format

**Summer:** 8 weeks - 2 hours of web-based lecture and 8 hours of laboratory per week

**Online:** This is an online course.

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

**Instructor:** Pedersen

Organic Chemistry Laboratory: [Read Less](#) [-]

## CHEM 4A General Chemistry and Quantitative Analysis 5 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

Series is intended for majors in physical, biological sciences, and engineering. It presents the foundation principles of chemistry, including stoichiometry, ideal and real gases, acid-base and solubility equilibria, oxidation-reduction reactions, thermochemistry, entropy, nuclear chemistry and radioactivity, the atoms and elements, the periodic table, quantum theory, chemical bonding, molecular structure, chemical kinetics, and descriptive chemistry. Examples and applications will be drawn from diverse areas of interest such as atmospheric, environmental, materials, polymer and computational chemistry, and biochemistry. Laboratory emphasizes quantitative work. Equivalent to 1A-1B plus 15 as prerequisite for further courses in chemistry.

General Chemistry and Quantitative Analysis: [Read More \[+\]](#)

### Rules & Requirements

**Prerequisites:** High school chemistry; calculus (may be taken concurrently); high school physics is recommended

**Credit Restrictions:** Students will receive no credit for 4A after taking 1A. Deficiency in 4A may be removed by successfully completing 1A and 1AL together in the same semester.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture, 4 hours of laboratory, and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

General Chemistry and Quantitative Analysis: [Read Less \[-\]](#)

## CHEM 4B General Chemistry and Quantitative Analysis 5 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

Series is intended for majors in physical, biological sciences, and engineering. It presents the foundation principles of chemistry, including stoichiometry, ideal and real gases, acid-base and solubility equilibria, oxidation-reduction reactions, thermochemistry, entropy, nuclear chemistry and radioactivity, the atoms and elements, the periodic table, quantum theory, chemical bonding, molecular structure, chemical kinetics, and descriptive chemistry. Examples and applications will be drawn from diverse areas of interest such as atmospheric, environmental, materials, polymer and computational chemistry, and biochemistry. Laboratory emphasizes quantitative work. Equivalent to 1A-1B plus 15 as prerequisite for further courses in chemistry.

General Chemistry and Quantitative Analysis: [Read More \[+\]](#)

### Rules & Requirements

**Prerequisites:** High school chemistry; calculus (may be taken concurrently); high school physics is recommended

**Credit Restrictions:** Deficiency in 4B may be removed by successfully completing 15.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3-3 hours of lecture, 4-4 hours of laboratory, and 0-2 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

General Chemistry and Quantitative Analysis: [Read Less \[-\]](#)

## CHEM 12A Organic Chemistry 5 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

A study of all aspects of fundamental organic chemistry, including nomenclature, chemical and physical properties, reactions and syntheses of the major classes of organic compounds. The study includes theoretical aspects, reaction mechanisms, multistep syntheses, and the chemistry of polycyclic and heterocyclic compounds. This course is more extensive and intensive than 3A-3B and includes a greater emphasis on reaction mechanisms and multistep syntheses. 12A (F); 12B (SP)  
Organic Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** 12A: 1B or 4B with grade of C- or higher; 12B: 12A with grade of C- or higher. For students majoring in chemistry or a closely related field such as chemical engineering or molecular and cell biology

**Credit Restrictions:** Students will receive no credit for 12A after taking both 3A and 3AL. Deficiency in 12A may be removed by successfully completing 3A and 3AL in the same semester. Students will receive no credit for 12A after taking 112A. Chem 12A is formerly known as Chem 112A.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3-3 hours of lecture, 1-1 hours of discussion, 5-5 hours of laboratory, and 0-2 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Formerly known as:** Chemistry 112A

Organic Chemistry: Read Less [-]

## CHEM 12B Organic Chemistry 5 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

A study of all aspects of fundamental organic chemistry, including nomenclature, chemical and physical properties, reactions and syntheses of the major classes of organic compounds. The study includes theoretical aspects, reaction mechanisms, multistep syntheses, and the chemistry of polycyclic and heterocyclic compounds. This course is more extensive and intensive than 3A-3B and includes a greater emphasis on reaction mechanisms and multistep syntheses. 12A (F); 12B (SP)  
Organic Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** 12A: 1B or 4B with grade of C- or higher. 12B: 12A with grade of C- or higher. For students majoring in chemistry or a closely related field such as chemical engineering or molecular and cell biology

**Credit Restrictions:** Students will receive no credit for 12B after taking both 3B and 3BL. Deficiency in 12B may be removed by successfully completing 3B and 3BL in the same semester. Students will receive no credit for 12B after taking 112B. Chem 12B is formerly known as Chem 112B.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture, 1 hour of discussion, 5 hours of laboratory, and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Formerly known as:** Chemistry 112B

Organic Chemistry: Read Less [-]

## CHEM 15 Analytical and Bioanalytical Chemistry 3 Units

Terms offered: Fall 2018, Fall 2017, Fall 2016

An introduction to analytical and bioanalytical chemistry including background in statistical analysis of data, acid-base equilibria, electrochemical, spectrometric, and chromatographic methods of analysis and some advanced topics in bioanalytical chemistry such as microfluidics, bioassay techniques, and enzymatic biosensors.  
Analytical and Bioanalytical Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** 1A and 1AL or equivalent

**Credit Restrictions:** Deficiency in 15 may be removed by successfully completing 4B.

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 4 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Analytical and Bioanalytical Chemistry: Read Less [-]

## CHEM 24 Freshman Seminar 1 Unit

Terms offered: Fall 2024, Spring 2024, Fall 2023

The Freshman Seminar Program has been designed to provide new students with the opportunity to explore an intellectual topic with a faculty member in a small seminar setting. Freshman seminars are offered in all campus departments, and topics may vary from department to department and semester to semester. Enrollment limited to 15 freshmen. Freshman Seminar: Read More [+]

### Rules & Requirements

**Repeat rules:** Course may be repeated for credit when topic changes.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of seminar per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** The grading option will be decided by the instructor when the class is offered. Final Exam To be decided by the instructor when the class is offered.

Freshman Seminar: Read Less [-]

## CHEM 32 Preparation for General Chemistry 2 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

Foundation and preparation for General Chemistry. Topics and concepts include elements, atoms, molecules, chemical reactions, chemical calculations, properties of gases and gas laws; thermodynamics, acid/base chemical equilibrium, and periodic trends. In addition, by practicing learning as a process, students will cultivate the habits, strategies, and mindset necessary to succeed in the sciences. Through rigorous practice and guided reflection, students will grow in their ability to master the subject matter and hone their disposition toward scientific learning.

Preparation for General Chemistry: Read More [+]

### Rules & Requirements

**Credit Restrictions:** Students will receive no credit for CHEM 32 after taking and passing any other Chemistry course.

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 1 hour of discussion per week

### Summer:

6 weeks - 5 hours of lecture and 2 hours of discussion per week  
10 weeks - 3 hours of lecture and 3 hours of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam required, with common exam group.

Preparation for General Chemistry: Read Less [-]

## CHEM 32L Preparation for General Chemistry Laboratory 1 Unit

Terms offered: Prior to 2007

An introduction to the experimental nature of chemistry. An emphasis is placed on gaining familiarity with equipment and experience with the rigorous approaches used in Chemistry laboratory courses. Areas of investigation include scientific calculations and statistical analysis, analytical measurements, acid-base chemistry, titration, equilibrium, solubility, and green chemistry.

Preparation for General Chemistry Laboratory: Read More [-]

### Rules & Requirements

**Prerequisites:** Must be concurrently enrolled in Chem 32

**Credit Restrictions:** Students will receive no credit for CHEM 32L after completing CHEM 1AL. A deficient grade in CHEM 32L may be removed by taking CHEM 1AL.

### Hours & Format

**Summer:** 6 weeks - 6 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

Preparation for General Chemistry Laboratory: Read Less [-]

## CHEM 34 Preparation for General Chemistry for CoC Majors 4 Units

Terms offered: Summer 2022 Second 6 Week Session

This course is designed to help develop fundamental laboratory techniques, study habits, chemical vocabulary, and knowledge of chemistry concepts needed to succeed in CHEM 4A. Students in the course will also come to know and belong to the larger College of Chemistry community, through panel discussions with CoC faculty, students, and staff, and immersion in current research via weekly lab tours and research talks from professors and graduate students. After completing the course, you will understand essential chemistry concepts relevant to CHEM 4A, including chemical calculations, statistics, quantitative analysis, models of atoms, the periodic table, molecules and chemical bonds, acid-base chemistry, thermochemistry, and equilibrium.

Preparation for General Chemistry for CoC Majors: Read More [+]

### Rules & Requirements

**Prerequisites:** Students must be enrolled in a College of Chemistry major (Chemistry, Chemical Biology, or Chemical Engineering) to take CHEM 34. Nonmajors should enroll in CHEM 32

### Hours & Format

**Summer:** 6 weeks - 8 hours of lecture and 3 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

Preparation for General Chemistry for CoC Majors: Read Less [-]

## CHEM 49 Supplementary Work in Lower Division Chemistry 1 - 4 Units

Terms offered: Fall 2024, Fall 2023, Fall 2017

Students with partial credit in lower division chemistry courses may, with consent of instructor, complete the credit under this heading.

Supplementary Work in Lower Division Chemistry: Read More [+]

### Rules & Requirements

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-4 hours of independent study per week

### Summer:

6 weeks - 1-6 hours of independent study per week

8 weeks - 1-4 hours of independent study per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

Supplementary Work in Lower Division Chemistry: Read Less [-]

## CHEM 96 Introduction to Research and Study in the College of Chemistry 1 Unit

Terms offered: Fall 2024, Fall 2023, Fall 2022

Introduces sophomores and new transfer students to research activities and programs of study in the College of Chemistry. Includes lectures by faculty, an introduction to college library and computer facilities, the opportunity to meet alumni and advanced undergraduates in an informal atmosphere, and discussion of college and campus resources.

Introduction to Research and Study in the College of Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** Sophomore or junior standing in the College of Chemistry, or consent of instructor

**Credit Restrictions:** Students will receive no credit for CHEM 96 after completing CHEM C96.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of seminar per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam required.

Introduction to Research and Study in the College of Chemistry: Read Less [-]

## CHEM 98 Supervised Group Study 1 - 4 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

Group study of selected topics.

Supervised Group Study: Read More [+]

### Rules & Requirements

**Prerequisites:** Consent of instructor

**Credit Restrictions:** Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-4 hours of directed group study per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam not required.

Supervised Group Study: Read Less [-]

## CHEM 98W Directed Group Study 1 Unit

Terms offered: Fall 2020, Fall 2019, Fall 2018

Topics vary with instructor. Enrollment restrictions apply.

Directed Group Study: Read More [+]

### Rules & Requirements

**Credit Restrictions:** Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of directed group study per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam not required.

Directed Group Study: Read Less [-]

## CHEM 100 Communicating Chemistry 2 Units

Terms offered: Spring 2011, Spring 2010, Spring 2009

For undergraduate and graduate students interested in improving their ability to communicate their scientific knowledge by teaching chemistry in elementary schools. The course will combine instruction in inquiry-based chemistry teaching methods and learning pedagogy with 10 weeks of supervised teaching experience in a local school classroom. Thus, students will practice communicating scientific knowledge and receive mentoring on how to improve their presentations. Approximately three hours per week, including time spent in school classrooms.

Communicating Chemistry: [Read More](#) [+]

### Rules & Requirements

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 1 hour of fieldwork per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Formerly known as:** 20

Communicating Chemistry: [Read Less](#) [-]

## CHEM 101 Greener Solutions: A Safer Design Partnership 3 Units

Terms offered: Prior to 2007

Green chemistry seeks to promote the design and adoption of safer chemicals and materials. Their development and adoption depends on solving a number of design and selection challenges. The Greener Solutions course guides interdisciplinary teams undergraduate students to solve these challenges in a specific application

Greener Solutions: A Safer Design Partnership: [Read More](#) [+]

### Objectives & Outcomes

- Course Objectives:**
1. Understand the principles of green chemistry and bio-inspired design and be able to apply them in developing safer alternatives to a hazardous chemical or material in a specific application;
  2. Understand principles of chemical exposure, hazard and risk and be able to apply them in the process of evaluating alternatives to a chemical of concern;
  3. Effectively access information and use tools to evaluate and compare the hazard profiles of chemicals and materials;
  4. Frame research questions and propose solutions, working in the applied setting of a partner company's challenge; and
  5. Communicate complex technical ideas clearly and effectively in written and oral form.

This 4-unit interdisciplinary, project-based course is intended for undergraduate students in public health, chemical engineering, chemistry, environmental studies, and engineering. The course draws on students' disciplinary expertise and teaches new skills to identify safer alternatives to hazardous chemicals currently used in a product or manufacturing process

**Student Learning Outcomes:** Student teams complete interim assignments during the six-week, session-long research project, which culminates in a final report and presentation. While class lectures, discussion and assignments support the technical aspects of the project, significant emphasis is also placed on developing the requisite processoriented skills: gathering information, working in teams, and communicating effectively in both written and oral forms.

### Rules & Requirements

**Prerequisites:** Advanced undergraduate; general chemistry or equivalent knowledge. Recommended: General Chemistry (CHEM 1A, 1B, 4A, 4B)

**Repeat rules:** Course may be repeated for credit with instructor consent.

### Hours & Format

**Summer:** 6 weeks - 3 hours of lecture, 3 hours of demonstration, and 3 hours of directed group study per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

Greener Solutions: A Safer Design Partnership: [Read Less](#) [-]

## CHEM 102 Foundations of Discovery Learning for College of Chemistry Transfer Students 1 Unit

Terms offered: Fall 2024, Fall 2023, Fall 2022

This course is offered to incoming junior transfer students majoring in chemistry, chemical biology, or chemical and biomolecular engineering within the College of Chemistry (CoC) at UC Berkeley. The course is designed to assist transfer students with their transition into the CoC through: 1) discussions around best learning practices, stress management, CoC coursework, and careers, 2) interactions with the CoC community, including personalized mentorship from graduate students and faculty, and 3) rigorous preparation for creating and participating in discovery learning experiences, such as research or industrial internships. Students in the course will complete assignments relating to professional development and discovery learning. Foundations of Discovery Learning for College of Chemistry Transfer Students: Read More [+]

### Rules & Requirements

**Prerequisites:** Students must be junior transfers enrolled in a College of Chemistry major (Chemistry, Chemical Biology, or Chemical Engineering)

### Hours & Format

**Fall and/or spring:** 15 weeks - 1.5 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

Foundations of Discovery Learning for College of Chemistry Transfer Students: Read Less [-]

## CHEM 103 Inorganic Chemistry in Living Systems 3 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021

The basic principles of metal ions and coordination chemistry applied to the study of biological systems.

Inorganic Chemistry in Living Systems: Read More [+]

### Rules & Requirements

**Prerequisites:** Chemistry 3A or 112A. Chemistry majors can only count 2 of the 3 units towards their Allied Subject requirement

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Inorganic Chemistry in Living Systems: Read Less [-]

## CHEM 104A Advanced Inorganic Chemistry 3 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

The chemistry of metals and nonmetals including the application of physical chemical principles.

Advanced Inorganic Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** 1B, 4B, or 3A; 104A is prerequisite to 104B

**Credit Restrictions:** 104A: No restrictions; 104B: Chemical Biology majors can only count 2 of the 3 units towards their Allied Subject requirement for 104B after taking 103.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 0 hours of voluntary per week

**Summer:** 8 weeks - 6 hours of lecture and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Advanced Inorganic Chemistry: Read Less [-]

## CHEM 104B Advanced Inorganic Chemistry 3 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

The chemistry of metals and nonmetals including the application of physical chemical principles.

Advanced Inorganic Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** 104A or consent of instructor. Chemical Biology majors can only count 2 of the 3 units towards their Allied Subject requirement for 104B after taking 103

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

**Summer:** 8 weeks - 6 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Advanced Inorganic Chemistry: Read Less [-]

## CHEM 105 Instrumental Methods in Analytical Chemistry 4 Units

Terms offered: Fall 2024, Spring 2024, Fall 2023

Principles, instrumentation and analytical applications of atomic spectroscopies, mass spectrometry, separations, electrochemistry and micro-characterization. Discussion of instrument design and capabilities as well as real-world problem solving with an emphasis on bioanalytical, environmental, and forensic applications. Hands-on laboratory work using modern instrumentation, emphasizing independent projects involving real-life samples and problem solving.

Instrumental Methods in Analytical Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** 4B; or 1B and 15; or 1B and a UC GPA of 3.3 or higher

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 8 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Instrumental Methods in Analytical Chemistry: Read Less [-]

## CHEM 108 Inorganic Synthesis and Reactions 4 Units

Terms offered: Fall 2022, Spring 2022, Fall 2019

The preparation of inorganic compounds using vacuum line, air-and moisture-exclusion, electrochemical, high-pressure, and other synthetic techniques. Kinetic and mechanistic studies of inorganic compounds.

Inorganic Synthesis and Reactions: Read More [+]

### Rules & Requirements

**Prerequisites:** 4B or 15; 104B with grade of C- or higher, or 103

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 8 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Inorganic Synthesis and Reactions: Read Less [-]

## CHEM C110L General Biochemistry and Molecular Biology Laboratory 4 Units

Terms offered: Fall 2024, Spring 2024, Fall 2023

Experimental techniques of biochemistry and molecular biology, designed to accompany the lectures in Molecular and Cell Biology 100B and 110.

General Biochemistry and Molecular Biology Laboratory: Read More [+]

### Rules & Requirements

**Prerequisites:** 110 (may be taken concurrently)

### Hours & Format

**Fall and/or spring:** 15 weeks - 2-2 hours of lecture and 6-8 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

**Also listed as:** MCELLBI C110L

General Biochemistry and Molecular Biology Laboratory: Read Less [-]

## CHEM 113 Advanced Mechanistic Organic Chemistry 3 Units

Terms offered: Fall 2022, Fall 2020, Fall 2018

Advanced topics in mechanistic and physical organic chemistry typically including kinetics, reactive intermediates, substitution reactions, linear free energy relationships, orbital interactions and orbital symmetry control of reactions, isotope effects, and photochemistry.

Advanced Mechanistic Organic Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** 3B or 112B with a minimum grade of B- or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Advanced Mechanistic Organic Chemistry: Read Less [-]

## CHEM 114 Advanced Synthetic Organic Chemistry 3 Units

Terms offered: Spring 2024, Spring 2022, Spring 2020

Advanced topics in synthetic organic chemistry with a focus on selectivity. Topics include reductions, oxidations, enolate chemistry and the aldol reaction, reactions of non-stabilized anions, olefination reactions, pericyclic reactions and application to the synthesis of complex structures.

Advanced Synthetic Organic Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** 3B or 112B with a minimum grade of B- or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Advanced Synthetic Organic Chemistry: Read Less [-]

## CHEM 115 Organic Chemistry--Advanced Laboratory Methods 4 Units

Terms offered: Fall 2024, Summer 2024 Second 6 Week Session, Spring 2024

Advanced synthetic methods, chemical and spectroscopic structural methods, designed as a preparation for experimental research.

Organic Chemistry--Advanced Laboratory Methods: Read More [+]

### Rules & Requirements

**Prerequisites:** 112B with a grade of C- or higher

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of lecture and 11 hours of laboratory per week

### Summer:

6 weeks - 2.5 hours of lecture and 27.5 hours of laboratory per week

8 weeks - 2 hours of lecture and 20.5 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

Organic Chemistry--Advanced Laboratory Methods: Read Less [-]

## CHEM 120A Physical Chemistry 3 Units

Terms offered: Fall 2024, Spring 2024, Fall 2023

Kinetic, potential, and total energy of particles and forces between them; principles of quantum theory, including one-electron and many-electron atoms and its applications to chemical bonding, intermolecular interactions, and elementary spectroscopy.

Physical Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** 4B or equivalent; Physics 7B or 8B; Mathematics 53; Mathematics 54 or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Physical Chemistry: Read Less [-]

## CHEM 120B Physical Chemistry 3 Units

Terms offered: Fall 2024, Spring 2024, Fall 2023

Statistical mechanics, thermodynamics, equilibrium and applications to chemical systems: states of matter, solutions and solvation, chemical kinetics, molecular dynamics, and molecular transport.

Physical Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** 120A (or may be taken concurrently); 4B or equivalent; Mathematics 53; Mathematics 54 (may be taken concurrently); Physics 7B or 8B

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 0 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Physical Chemistry: Read Less [-]

## CHEM 121 Introduction to Computational Chemistry 3 Units

Terms offered: Spring 2023, Fall 2021, Fall 2020

This course demonstrates how computers are used to solve modern problems in physical chemistry. It focuses first on methods of electronic structure theory that reveal details of molecular structure and energetics, and secondly on simulation methods that explore fluctuations and dynamics of complex systems comprising many molecules. Students will use MATLAB to implement these numerical approaches for illustrative problems. No prior programming experience is required.

Introduction to Computational Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** Chem 120A and Chem 120B are very strongly recommended as prerequisites, or co-requisites

### Hours & Format

**Fall and/or spring:** 15 weeks - 3-3 hours of lecture and 1-2 hours of voluntary per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

Introduction to Computational Chemistry: Read Less [-]

## CHEM 122 Quantum Mechanics and Spectroscopy 3 Units

Terms offered: Fall 2023, Fall 2022, Fall 2021

Postulates and methods of quantum mechanics and group theory applied to molecular structure and spectra.

Quantum Mechanics and Spectroscopy: Read More [+]

### Rules & Requirements

**Prerequisites:** 120A

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Quantum Mechanics and Spectroscopy: Read Less [-]

## CHEM 125 Physical Chemistry Laboratory 3 Units

Terms offered: Fall 2024, Spring 2024, Fall 2023

Experiments in thermodynamics, kinetics, molecular structure, and general physical chemistry.

Physical Chemistry Laboratory: Read More [+]

### Rules & Requirements

**Prerequisites:** Two of the following: 120A, 120B, C130, or 130B with grades of C- or higher (one of which may be taken concurrently)

**Credit Restrictions:** Deficiency in 125 may be removed by successfully completing C182. Consent of instructor is required to enroll in 125 after completing C182 or EPS C182.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1 hour of lecture and 5 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Physical Chemistry Laboratory: Read Less [-]

## CHEM 130B Biophysical Chemistry 3 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

The weekly one-hour discussion is for problem solving and the application of calculus in physical chemistry. Molecular structure, intermolecular forces and interactions, biomolecular spectroscopy, high-resolution structure determinations.

Biophysical Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** Chemistry C130 or Molecular and Cell Biology C100A, or consent of instructor. Chemistry and Chemical Biology majors can only count 2 of the 3 units towards their Allied Subject requirement

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Biophysical Chemistry: Read Less [-]

## CHEM C130 Biophysical Chemistry: Physical Principles and the Molecules of Life 4 Units

Terms offered: Fall 2024, Spring 2024, Fall 2023

Thermodynamic and kinetic concepts applied to understanding the chemistry and structure of biomolecules (proteins, DNA, and RNA). Molecular distributions, reaction kinetics, enzyme kinetics. Bioenergetics, energy transduction, and motor proteins. Electrochemical potential, membranes, and ion channels.

Biophysical Chemistry: Physical Principles and the Molecules of Life:

Read More [+]

### Rules & Requirements

**Prerequisites:** Chemistry 3A or 112A, Mathematics 1A, Biology 1A and 1AL; Chemistry 3B or 112B recommended

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

**Summer:** 8 weeks - 5.5 hours of lecture and 2 hours of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Also listed as:** MCELLBI C100A

Biophysical Chemistry: Physical Principles and the Molecules of Life:

Read Less [-]

## CHEM 135 Chemical Biology 3 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

One-semester introduction to biochemistry, aimed toward chemistry and chemical biology majors.

Chemical Biology: Read More [+]

### Rules & Requirements

**Prerequisites:** 3B or 112B; Biology 1A; or consent of instructor

**Credit Restrictions:** Students will receive no credit for 135 after taking Molecular and Cell Biology 100B or 102.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Chemical Biology: Read Less [-]

## CHEM C138 The Berkeley Lectures on Energy: Energy from Biomass 3 Units

Terms offered: Fall 2015, Fall 2014, Fall 2013

After an introduction to the different aspects of our global energy consumption, the course will focus on the role of biomass. The course will illustrate how the global scale of energy guides the biomass research. Emphasis will be placed on the integration of the biological aspects (crop selection, harvesting, storage and distribution, and chemical composition of biomass) with the chemical aspects to convert biomass to energy. The course aims to engage students in state-of-the-art research.

The Berkeley Lectures on Energy: Energy from Biomass: Read More [+]

### Rules & Requirements

**Prerequisites:** Chemistry 1B or Chemistry 4B, Mathematics 1B, Biology 1A

**Repeat rules:** Course may be repeated for credit under special circumstances: Repeatable when topic changes with consent of instructor.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Instructors:** Bell, Blanch, Clark, Smit, C. Somerville

**Also listed as:** BIO ENG C181/CHM ENG C195A/PLANTBI C124

The Berkeley Lectures on Energy: Energy from Biomass: Read Less [-]

## CHEM C142 Machine Learning, Statistical Models, and Optimization for Molecular Problems 4 Units

Terms offered: Spring 2024, Spring 2023

An introduction to mathematical optimization, statistical models, and advances in machine learning for the physical sciences. Machine learning prerequisites are introduced including local and global optimization, various statistical and clustering models, and early meta-heuristic methods such as genetic algorithms and artificial neural networks. Building on this foundation, current machine learning techniques are covered including deep learning artificial neural networks, Convolutional neural networks, Recurrent and long short term memory (LSTM) networks, graph neural networks, decision trees.

Machine Learning, Statistical Models, and Optimization for Molecular Problems: Read More [+]

### Objectives & Outcomes

**Course Objectives:** To build on optimization and statistical modeling to the field of machine learning techniques

To introduce the basics of optimization and statistical modeling techniques relevant to chemistry students

To utilize these concepts on problems relevant to the chemical sciences.

**Student Learning Outcomes:** Students will be able to understand the landscape and connections between numerical optimization, stand-alone statistical models, and machine learning techniques, and its relevance for chemical problems

### Rules & Requirements

**Prerequisites:** MATH 53 and MATH 54; CHEM 120A or CHEM 120B or BIO ENG 103

**Credit Restrictions:** Students will receive no credit for BIO ENG C142 after completing BIO ENG 142. A deficient grade in BIO ENG C142 may be removed by taking BIO ENG 142.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternate method of final assessment during regularly scheduled final exam group (e.g., presentation, final project, etc.).

**Instructor:** Teresa Head-Gordon

**Formerly known as:** Bioengineering C142/Chemistry C142

**Also listed as:** BIO ENG C142

Machine Learning, Statistical Models, and Optimization for Molecular Problems: Read Less [-]

## CHEM 143 Nuclear Chemistry 2 Units

Terms offered: Fall 2019, Fall 2018, Fall 2017

Radioactivity, fission, nuclear models and reactions, nuclear processes in nature. Computer methods will be introduced.

Nuclear Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** Physics 7B or equivalent

### Hours & Format

**Fall and/or spring:** 15 weeks - 2 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Nuclear Chemistry: Read Less [-]

## CHEM C146 Radiochemical Methods in Nuclear Technology and Forensics 3 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

Experimental illustrations of the interrelation between chemical and nuclear science and technology and nuclear forensics; radioactive decay and counting techniques; nuclear spectroscopy; fundamental radiochemical techniques; radiochemical separations techniques; tracers; activation analysis; forensic applications of radiochemistry; fusion, fission and nuclear reactors.

Radiochemical Methods in Nuclear Technology and Forensics: Read More [+]

### Objectives & Outcomes

**Course Objectives:** Familiarize students with principles of nuclear and radiochemistry and its many important applications in our daily lives; provide hands-on training.

**Student Learning Outcomes:** A solid understanding of nuclear and radiochemistry; proficiency in safe handling of radioactive materials in the laboratory, and appreciation for the wide application of radiochemical techniques in chemistry, nuclear technology, and nuclear forensics.

### Rules & Requirements

**Prerequisites:** CHEM 4B or CHEM 15; and CHEM 143 is recommended

**Credit Restrictions:** Students will receive no credit for CHEM 146 after completing CHEM 144, or CHEM C144.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1.5 hours of lecture and 4.5 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Formerly known as:** Chemistry 146

**Also listed as:** NUC ENG C146

Radiochemical Methods in Nuclear Technology and Forensics: Read Less [-]

## CHEM 149 Supplementary Work in Upper Division Chemistry 1 - 4 Units

Terms offered: Spring 2016, Spring 2015, Spring 2014

Students with partial credit in upper division chemistry courses may, with consent of instructor, complete the credit under this heading.

Supplementary Work in Upper Division Chemistry: Read More [+]

### Rules & Requirements

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-4 hours of independent study per week

### Summer:

6 weeks - 2.5-10 hours of independent study per week

8 weeks - 1.5-7.5 hours of independent study per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Supplementary Work in Upper Division Chemistry: Read Less [-]

## CHEM C150 Introduction to Materials Chemistry 3 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

The application of basic chemical principles to problems in materials discovery, design, and characterization will be discussed. Topics covered will include inorganic solids, nanoscale materials, polymers, and biological materials, with specific focus on the ways in which atomic-level interactions dictate the bulk properties of matter.

Introduction to Materials Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** CHEM 104A. CHEM 104B recommended

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Also listed as:** MAT SCI C150

Introduction to Materials Chemistry: Read Less [-]

## CHEM C170L Biochemical Engineering Laboratory 3 Units

Terms offered: Fall 2024, Spring 2024, Fall 2023, Fall 2018, Spring 2014, Spring 2013

Laboratory techniques for the cultivation of microorganisms in batch and continuous reactions. Enzymatic conversion processes. Recovery of biological products.

Biochemical Engineering Laboratory: [Read More](#) [+]

### Rules & Requirements

**Prerequisites:** Chemical Engineering 170A (may be taken concurrently) or consent of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 7 hours of laboratory and 1 hour of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Also listed as:** CHM ENG C170L

Biochemical Engineering Laboratory: [Read Less](#) [-]

## CHEM 171H Berkeley Changemaker: The Green Materials Innovation Challenge 3 Units

Terms offered: Spring 2024, Spring 2023

Project-based course partnering students with companies, government, and non-profits interested in adopting safer green chemistry for their products. Students will learn the principles of green chemistry by identifying solutions to a real-world green chemistry challenge provided by the external partner. After completing the course students will understand essential concepts related to green chemistry, hazard assessment, bio-inspired design, and life cycle analysis, and how to apply these concepts to evaluate alternatives to a hazardous chemical. Students will know how to read and think critically about a scientific article, collaborate effectively, and hone their communication skills.

Berkeley Changemaker: The Green Materials Innovation Challenge: [Read More](#) [+]

### Rules & Requirements

**Prerequisites:** 1 semester of Chemistry 1A or Biology 1A

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

Berkeley Changemaker: The Green Materials Innovation Challenge: [Read Less](#) [-]

## CHEM C178 Polymer Science and Technology 3 Units

Terms offered: Spring 2023, Fall 2021, Fall 2020, Fall 2016, Spring 2016, Spring 2015

An interdisciplinary course on the synthesis, characterization, and properties of polymer materials. Emphasis on the molecular origin of properties of polymeric materials and technological applications. Topics include single molecule properties, polymer mixtures and solutions, melts, glasses, elastomers, and crystals. Experiments in polymer synthesis, characterization, and physical properties.

Polymer Science and Technology: [Read More](#) [+]

### Rules & Requirements

**Prerequisites:** Junior standing

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Also listed as:** CHM ENG C178

Polymer Science and Technology: [Read Less](#) [-]

## CHEM 179 Numerical Algorithms applied to Computational Quantum Chemistry 3 Units

Terms offered: Spring 2024

Introduction to numerical algorithms, their application to computational quantum chemistry, and best practices for software implementation and reuse. This course covers a toolbox of useful algorithms from applied mathematics that are used in physical simulations. Illustrated via computer implementation of density functional theory for modeling chemical reaction mechanisms from quantum mechanics. Topics covered include local optimization, numerical derivatives and integration, dense linear algebra the symmetric eigenvalue problem, the singular value decomposition, and the fast Fourier transform. Students are guided through principles of procedural and object-oriented programming C++ and usage of efficient numerical libraries.

Numerical Algorithms applied to Computational Quantum Chemistry:  
Read More [+]

### Rules & Requirements

**Prerequisites:** (1) Computing: Either (a) both CHEM 274A and CHEM 274B OR (b) CS 61A or CS/DATA C88C AND CS 9F; (2) Math: MATH 53 and MATH 54 or equivalent; (3) Familiarity with UNIX/Linux command line, and (4) An undergraduate physical chemistry course or permission of instructor

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 3 hours of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

Numerical Algorithms applied to Computational Quantum Chemistry:  
Read Less [-]

## CHEM C182 Atmospheric Chemistry and Physics Laboratory 3 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

Fluid dynamics, radiative transfer, and the kinetics, spectroscopy, and measurement of atmospherically relevant species are explored through laboratory experiments, numerical simulations, and field observations. Atmospheric Chemistry and Physics Laboratory: Read More [+]

### Rules & Requirements

**Prerequisites:** Earth and Planetary Science 50 and 102 with grades of C- or higher (one of which may be taken concurrently) or two of the following: Chemistry 120A, 120B, C130, or 130B with grades of C- or higher (one of which may be taken concurrently)

**Credit Restrictions:** Deficiency in C182 may be removed by successfully completing 125. Consent of instructor is required to enroll in C182 after completing 125.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1.5 hours of lecture and 5 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

**Formerly known as:** Chemistry C182/Earth and Planetary Science C182

**Also listed as:** EPS C182

Atmospheric Chemistry and Physics Laboratory: Read Less [-]

## CHEM C191 Introduction to Quantum Computing 4 Units

Terms offered: Spring 2024, Fall 2023, Spring 2023

This multidisciplinary course provides an introduction to fundamental conceptual aspects of quantum mechanics from a computational and informational theoretic perspective, as well as physical implementations and technological applications of quantum information science. Basic sections of quantum algorithms, complexity, and cryptography, will be touched upon, as well as pertinent physical realizations from nanoscale science and engineering.

Introduction to Quantum Computing: Read More [+]

### Rules & Requirements

**Prerequisites:** Linear Algebra (EECS 16A or PHYSICS 89 or MATH 54) AND either discrete mathematics (COMPSCI 70 or MATH 55), or quantum mechanics (PHYSICS 7C or PHYSICS 137A or CHEM 120A)

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture and 1 hour of discussion per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

**Also listed as:** COMPSCI C191/PHYSICS C191

Introduction to Quantum Computing: Read Less [-]

## CHEM 192 Individual Study for Advanced Undergraduates 1 - 3 Units

Terms offered: Spring 2016, Fall 2015, Spring 2015

All properly qualified students who wish to pursue a problem of their own choice, through reading or nonlaboratory study, may do so if their proposed project is acceptable to the member of the staff with whom they wish to work.

Individual Study for Advanced Undergraduates: Read More [+]

### Rules & Requirements

**Prerequisites:** Consent of instructor and adviser

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 0 hours of independent study per week

### Summer:

6 weeks - 1-5 hours of independent study per week

8 weeks - 1-4 hours of independent study per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

Individual Study for Advanced Undergraduates: Read Less [-]

## CHEM H193 Senior Honors Thesis 3 Units

Terms offered: Spring 2016, Fall 2015, Spring 2015

A senior honors thesis is written in consultation with the student's faculty research advisor. This is a required course for students wishing to graduate with honors in Chemistry or Chemical Biology.

Senior Honors Thesis: Read More [+]

### Rules & Requirements

**Prerequisites:** Senior standing, approval of faculty research advisor, overall GPA of 3.4 or higher at Berkeley

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 9-0 hours of independent study per week

**Summer:** 8 weeks - 16.5 hours of independent study per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Alternative to final exam.

Senior Honors Thesis: Read Less [-]

## CHEM H194 Research for Advanced Undergraduates 2 - 6 Units

Terms offered: Spring 2023, Fall 2022, Summer 2022 Second 6 Week Session

Students may pursue original research under the direction of one of the members of the staff.

Research for Advanced Undergraduates: Read More [+]

### Rules & Requirements

**Prerequisites:** Minimum GPA of 3.4 overall at Berkeley and consent of instructor and adviser

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 0-6 hours of independent study and 0-6 hours of laboratory per week

### Summer:

6 weeks - 0-15 hours of independent study and 0-15 hours of laboratory per week

8 weeks - 0-11.5 hours of independent study and 0-11.5 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

Research for Advanced Undergraduates: Read Less [-]

## CHEM 195 Special Topics 3 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

Special topics will be offered from time to time. Examples are: photochemical air pollution, computers in chemistry.

Special Topics: Read More [+]

### Rules & Requirements

**Prerequisites:** Consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

**Summer:** 10 weeks - 4.5 hours of lecture per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam required.

Special Topics: Read Less [-]

## CHEM 196 Special Laboratory Study 2 - 6 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

Special laboratory work for advanced undergraduates.

Special Laboratory Study: Read More [+]

### Rules & Requirements

**Prerequisites:** Consent of instructor and adviser

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-4 hours of independent study and 0-1 hours of laboratory per week

### Summer:

6 weeks - 2.5-10 hours of independent study and 0-2.5 hours of laboratory per week

8 weeks - 2-7.5 hours of independent study and 0-2 hours of laboratory per week

10 weeks - 1.5-6 hours of independent study and 0-1.5 hours of laboratory per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Letter grade. Final exam not required.

Special Laboratory Study: Read Less [-]

## CHEM 197 Field Study in Chemistry 1 - 4 Units

Terms offered: Spring 2021, Spring 2020, Summer 2016 8 Week Session  
Supervised experience in off-campus organizations relevant to specific aspects and applications of chemistry. Written report required at the end of the term. Course does not satisfy unit or residence requirements for the bachelor's degree.

Field Study in Chemistry: Read More [+]

### Rules & Requirements

**Prerequisites:** Upper division standing and consent of instructor

**Credit Restrictions:** Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 3 hours of fieldwork per week

**Summer:** 8 weeks - 6 hours of fieldwork per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam not required.

Field Study in Chemistry: Read Less [-]

## CHEM 198 Directed Group Study 1 - 4 Units

Terms offered: Fall 2022, Spring 2022, Fall 2021

Group study of selected topics.

Directed Group Study: Read More [+]

### Rules & Requirements

**Prerequisites:** Completion of 60 units of undergraduate study and in good standing

**Credit Restrictions:** Enrollment is restricted; see the Introduction to Courses and Curricula section of this catalog.

**Repeat rules:** Course may be repeated for credit without restriction.

### Hours & Format

**Fall and/or spring:** 15 weeks - 1-4 hours of directed group study per week

### Additional Details

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam not required.

Directed Group Study: Read Less [-]

## **CHEM 199 Supervised Independent Study and Research 1 - 4 Units**

Terms offered: Fall 2024, Fall 2023, Fall 2022

Enrollment is restricted by regulations listed in the .

Supervised Independent Study and Research: Read More [+]

### **Rules & Requirements**

**Repeat rules:** Course may be repeated for credit without restriction.

### **Hours & Format**

**Fall and/or spring:** 15 weeks - 0 hours of independent study per week

### **Summer:**

6 weeks - 1-5 hours of independent study per week

8 weeks - 1-4 hours of independent study per week

### **Additional Details**

**Subject/Course Level:** Chemistry/Undergraduate

**Grading/Final exam status:** Offered for pass/not pass grade only. Final exam not required.

Supervised Independent Study and Research: Read Less [-]