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 bioorganic 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 better 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

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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<tbody>
<tr>
<td>CHEM 4A</td>
<td>General Chemistry and Quantitative Analysis</td>
<td>5</td>
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<tr>
<td>&amp; CHEM 4B</td>
<td>and General Chemistry and Quantitative Analysis</td>
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<tr>
<td>CHEM 96</td>
<td>Introduction to Research and Study in the College of Chemistry</td>
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<tr>
<td>CHEM 12A</td>
<td>Organic Chemistry</td>
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Upper Division Requirements

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<tr>
<td>CHEM 12B</td>
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<tr>
<td>MATH 1A</td>
<td>Calculus</td>
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<tr>
<td>MATH 53</td>
<td>Multivariable Calculus</td>
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<td>Linear Algebra and Differential Equations</td>
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<td>PHYSICS 7A</td>
<td>Physics for Scientists and Engineers</td>
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<td>BIOLOGY 1A</td>
<td>General Biology Lecture</td>
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<tr>
<td>BIOLOGY 1AL</td>
<td>General Biology Laboratory</td>
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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.
Select 7 units of upper division chemistry and allied subjects (see below for list) \(^3\)

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

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/).

1 BIOLOGY 1A plus BIOLOGY 1AL and CHEM 135 satisfy the prerequisites for MCELLBI 110.

2 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.

3 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

<p>| 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 | Cell and Tissue Engineering | 4 |
| 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 | Genetic Devices | 4 |
| 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 (^2) | 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 (^2) | 2-4 |
| CHEM 100 | Communicating Chemistry (limited to 2 units) | 2 |
| CHEM 104A | Advanced Inorganic Chemistry (limited to 2 units) (^1) | 3 |
| CHEM 104B | Advanced Inorganic Chemistry (limited to 2 units) (^1) | 3 |
| CHEM 105 | Instrumental Methods in Analytical Chemistry | 4 |
| CHEM 108 | Inorganic Chemistry | 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) (^1) | 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 (^2) | 2-6 |
| CHEM 195 | Special Topics | 3 |
| CHEM 196 | Special Laboratory Study (^2) | 2-6 |
| CIV ENG C106 | Air Pollution | 3 |
| CIV ENG 111 | Environmental Engineering | 3 |
| CIV ENG 112 | Water &amp; 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 |</p>
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<td>COMPSCI 164</td>
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<td>COMPSCI 170</td>
<td>Efficient Algorithms and Intractable Problems</td>
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<td>COMPSCI 174</td>
<td>Combinatorics and Discrete Probability</td>
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<td>COMPSCI 184</td>
<td>Foundations of Computer Graphics</td>
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<td>Introduction to Aquatic and Marine Geochemistry</td>
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<td>EPS C180</td>
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<td>Atmospheric Physics and Dynamics</td>
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<td>Carbon Cycle Dynamics</td>
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<td>EDUC 223B</td>
<td>Special Problems in Mathematics, Science and</td>
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<td>EDUC 224A</td>
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<td>Methods of Engineering Analysis</td>
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<td>ENGIN 128</td>
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<td>Science of Soils</td>
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<td>ESPM C128</td>
<td>Chemistry of Soils</td>
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<td>Biometeorology</td>
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<td>ESPM C138</td>
<td>Introduction to Comparative Virology</td>
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<td>ESPM C148</td>
<td>Pesticide Chemistry and Toxicology</td>
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<td>ESPM 162</td>
<td>Bioethics and Society</td>
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<td>ESPM 162A</td>
<td>Health, Medicine, Society and Environment</td>
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<td>Air Pollution</td>
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<td>Probability and Risk Analysis for Engineers</td>
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<td>MAT SCI 102</td>
<td>Bonding, Crystallography, and Crystal Defects</td>
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<td>MAT SCI 103</td>
<td>Phase Transformations and Kinetics</td>
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<td>MAT SCI 104</td>
<td>Materials Characterization</td>
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<td>MAT SCI 111</td>
<td>Properties of Electronic Materials</td>
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<td>MAT SCI 112</td>
<td>Corrosion (Chemical Properties)</td>
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<td>MAT SCI 113</td>
<td>Mechanical Behavior of Engineering Materials</td>
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<td>MAT SCI 117</td>
<td>Properties of Dielectric and Magnetic Materials</td>
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<td>Biological Performance of Materials</td>
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<td>Materials Production</td>
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<td>Metals Processing</td>
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<td>MAT SCI 122</td>
<td>Ceramic Processing</td>
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<td>ELECTRONIC MATERIALS PROCESSING</td>
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<td>MAT SCI 125</td>
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<td>MAT SCI 130</td>
<td>Experimental Materials Science and Design</td>
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<td>MAT SCI 140</td>
<td>Nanomaterials for Scientists and Engineers</td>
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<td>Abstract Linear Algebra</td>
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<td>Introduction to Number Theory</td>
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<td>Mathematical Tools for the Physical Sciences</td>
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<td>Ordinary Differential Equations</td>
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<td>Introduction to Partial Differential Equations</td>
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<td>MATH 128B</td>
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<tr>
<td>MATH 130</td>
<td>Groups and Geometries</td>
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<td>Introduction to the Theory of Sets</td>
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<td>Incompleteness and Undecidability</td>
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<td>Metric Differential Geometry</td>
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<td>Molecular Biomechanics and Mechanobiology of the</td>
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<td>Orthopedic Biomechanics</td>
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<td>Engineering Analysis Using the Finite Element</td>
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<td>Bacterial Pathogenesis</td>
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<td>MCELLBI 104</td>
<td>Genetics, Genomics, and Cell Biology</td>
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<td>MCELLBI 110</td>
<td>Molecular Biology: Macromolecular Synthesis and</td>
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<td>MCELLBI C110L</td>
<td>General Biochemistry and Molecular Biology</td>
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<td>MCELLBI C112</td>
<td>General Microbiology</td>
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<td>General Microbiology Laboratory</td>
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<td>MCELLBI C114</td>
<td>Introduction to Comparative Virology</td>
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<td>Microbial Diversity</td>
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<td>MCELLBI 133L</td>
<td>Physiology and Cell Biology Laboratory</td>
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<td>MCELLBI 135A</td>
<td>Topics in Cell and Developmental Biology:</td>
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<td>Molecular Endocrinology</td>
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<td>MCELLBI 140</td>
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<td>MCELLBI 140L</td>
<td>Genetics Laboratory</td>
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<td>MCELLBI 141</td>
<td>Developmental Biology</td>
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<td>MCELLBI 143</td>
<td>Evolution of Genomes, Cells, and Development</td>
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<td>MCELLBI C148</td>
<td>Microbial Genomics and Genetics</td>
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<td>MCELLBI 150</td>
<td>Molecular Immunology</td>
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<td>MCELLBI 150L</td>
<td>Immunology Laboratory</td>
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<td>MCELLBI 160L</td>
<td>Neurobiology Laboratory</td>
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<td>NUC ENG 101</td>
<td>Nuclear Reactions and Radiation</td>
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<td>NUC ENG 104</td>
<td>Radiation Detection and Nuclear Instrumentation</td>
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<td>NUC ENG 107</td>
<td>Introduction to Imaging</td>
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<td>NUC ENG 120</td>
<td>Nuclear Materials</td>
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<td>NUC ENG 124</td>
<td>Radioactive Waste Management</td>
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<td>NUC ENG 130</td>
<td>Analytical Methods for Non-proliferation</td>
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<td>NUC ENG 150</td>
<td>Introduction to Nuclear Reactor Theory</td>
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<td>NUC ENG 161</td>
<td>Nuclear Power Engineering</td>
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<td>NUC ENG 162</td>
<td>Radiation Biophysics and Dosimetry</td>
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<td>NUC ENG 170A</td>
<td>Nuclear Design: Design in Nuclear Power Technology and Instrumentation</td>
<td>3</td>
</tr>
<tr>
<td>NUC ENG 170B</td>
<td>Nuclear Design: Design in Bionuclear, Nuclear Medicine, and Radiation Therapy</td>
<td>3</td>
</tr>
<tr>
<td>NUC ENG 180</td>
<td>Introduction to Controlled Fusion</td>
<td>3</td>
</tr>
<tr>
<td>NUSCTX 103</td>
<td>Nutrient Function and Metabolism</td>
<td>4</td>
</tr>
<tr>
<td>NUSCTX 108A</td>
<td>Introduction and Application of Food Science</td>
<td>3</td>
</tr>
<tr>
<td>NUSCTX 110</td>
<td>Toxicology</td>
<td>4</td>
</tr>
<tr>
<td>NUSCTX 115</td>
<td>Principles of Drug Action</td>
<td>2</td>
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<tr>
<td>NUSCTX 160</td>
<td>Metabolic Bases of Human Health and Diseases</td>
<td>4</td>
</tr>
<tr>
<td>NUSCTX 171</td>
<td>Nutrition and Toxicology Laboratory</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 7C</td>
<td>Physics for Scientists and Engineers (must be completed with a grade of C- or better)</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 105</td>
<td>Analytic Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 110A</td>
<td>Electromagnetism and Optics</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 110B</td>
<td>Electromagnetism and Optics</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 112</td>
<td>Introduction to Statistical and Thermal Physics</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 130</td>
<td>Quantum and Nonlinear Optics</td>
<td>3</td>
</tr>
<tr>
<td>PHYSICS 137B</td>
<td>Quantum Mechanics</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 138</td>
<td>Modern Atomic Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYSICS 141A</td>
<td>Solid State Physics</td>
<td>4</td>
</tr>
<tr>
<td>PHYSICS 141B</td>
<td>Solid State Physics</td>
<td>3</td>
</tr>
<tr>
<td>PHYSICS C191</td>
<td>Introduction to Quantum Computing</td>
<td>4</td>
</tr>
<tr>
<td>PLANTBI C103</td>
<td>Bacterial Pathogenesis</td>
<td>3</td>
</tr>
<tr>
<td>PLANTBI C112</td>
<td>General Microbiology</td>
<td>4</td>
</tr>
<tr>
<td>PLANTBI C112L</td>
<td>General Microbiology Laboratory</td>
<td>2</td>
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<tr>
<td>PLANTBI C114</td>
<td>Introduction to Comparative Virology</td>
<td>4</td>
</tr>
<tr>
<td>PLANTBI C116</td>
<td>Microbial Diversity</td>
<td>3</td>
</tr>
<tr>
<td>PLANTBI C120</td>
<td>Biology of Algae</td>
<td>2</td>
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<tr>
<td>PLANTBI C120L</td>
<td>Laboratory for Biology of Algae</td>
<td>2</td>
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<tr>
<td>PLANTBI C122</td>
<td>Bioenergy</td>
<td>2</td>
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<tr>
<td>PLANTBI C124</td>
<td>The Berkeley Lectures on Energy: Energy from Biomass</td>
<td>3</td>
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<tr>
<td>PLANTBI C135</td>
<td>Physiology and Biochemistry of Plants</td>
<td>3</td>
</tr>
<tr>
<td>PLANTBI C148</td>
<td>Microbial Genomics and Genetics</td>
<td>4</td>
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<tr>
<td>PLANTBI C150</td>
<td>Plant Cell Biology</td>
<td>3</td>
</tr>
<tr>
<td>PLANTBI C160</td>
<td>Plant Molecular Genetics</td>
<td>3</td>
</tr>
<tr>
<td>PLANTBI C170</td>
<td>Modern Applications of Plant Biotechnology</td>
<td>2</td>
</tr>
<tr>
<td>PLANTBI C180</td>
<td>Environmental Plant Biology</td>
<td>2</td>
</tr>
<tr>
<td>PB HLTH 142</td>
<td>Introduction to Probability and Statistics in Biology and Public Health</td>
<td>4</td>
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<tr>
<td>PB HLTH 162A</td>
<td>Public Health Microbiology</td>
<td>4</td>
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<tr>
<td>STAT 134</td>
<td>Concepts of Probability</td>
<td>4</td>
</tr>
<tr>
<td>STAT 135</td>
<td>Concepts of Statistics</td>
<td>4</td>
</tr>
</tbody>
</table>

1 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.

2 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/)
  - 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

1 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.

2 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/1,2)
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.

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:

1. C- or higher in CHEM 4A before taking CHEM 4B
2. C- or higher in CHEM 4B before taking more advanced courses
3. C- or higher in CHEM 12A before taking CHEM 12B
4. 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:

1. C- or higher in CHEM 120A and CHEM 120B if taken before CHEM 125 or CHEM C182
2. 2.0 GPA in all upper division courses taken at the University to satisfy major requirements

Chemical engineering students must also achieve:

1. C- or higher in CHM ENG 140 before taking any other CBE courses
2. C- or higher in CHM ENG 150A to be eligible to take any other course in the 150 series
3. 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)

**Chemical Biology**

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

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

CHEM 1AL General Chemistry Laboratory 2 Units
Terms offered: Fall 2023, Summer 2023 8 Week Session, Spring 2023
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.

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.
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.

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 2023, Summer 2023 8 Week Session, Spring 2023
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 [-]

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CHEM 3AL Organic Chemistry Laboratory 2
2 Units
Terms offered: Fall 2023, Summer 2023 8 Week Session, Spring 2023
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 2023, Summer 2023 8 Week Session, Spring 2023
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
2 Units
Terms offered: Fall 2023, Summer 2023 8 Week Session, Spring 2023
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.
Instructor: Pedersen
Organic Chemistry Laboratory: Read Less [-]

CHEM N3AL Organic Chemistry Laboratory 2
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 2023, Fall 2022, Fall 2021
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.

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.

CHEM 4B General Chemistry and Quantitative Analysis 5 Units
Terms offered: Spring 2023, Spring 2022, Spring 2021
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.

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.
CHEM 12A Organic Chemistry 5 Units
Terms offered: Fall 2023, Fall 2022, Fall 2021
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)

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 2023, Spring 2022, Spring 2021
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)

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 micro-fluidics, bioassay techniques, and enzymatic biosensors.

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 2023, Fall 2022, Fall 2021
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 2023, Fall 2022, Fall 2021
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 2023, Fall 2017, Fall 2016
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 2023, Fall 2022, Fall 2021
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 not required.

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

**CHEM 98 Supervised Group Study 1 - 4 Units**
Terms offered: Spring 2023, Spring 2022, Fall 2021
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. 

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.

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 process-oriented 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.
CHEM 102 Foundations of Discovery Learning for College of Chemistry Transfer Students 1 Unit
Terms offered: 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.

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.

CHEM 104A Advanced Inorganic Chemistry 3 Units
Terms offered: Fall 2023, Fall 2022, Fall 2021
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.

CHEM 104B Advanced Inorganic Chemistry 3 Units
Terms offered: Spring 2023, Spring 2022, Spring 2021
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.

Inorganic Chemistry in Living Systems: Read Less [-]
CHEM 105 Instrumental Methods in Analytical Chemistry 4 Units
Terms offered: Fall 2023, Spring 2023, Fall 2022
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 2023, Spring 2023, Fall 2022
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 2022, Spring 2020, Spring 2018
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 2023, Summer 2023 First 6 Week Session, Spring 2023
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 2023, Spring 2023, Fall 2022
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 2023, Fall 2022, Spring 2022
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 2023, Spring 2023, Fall 2022
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 2023, Spring 2022, Spring 2021
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 2023, Spring 2023, Fall 2022
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 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 135 Chemical Biology 3 Units
Terms offered: Fall 2023, Fall 2022, Fall 2021
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 C142 Machine Learning, Statistical Models, and Optimization for Molecular Problems 4 Units
Terms offered: 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.

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

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.

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.
CHEM C146 Radiochemical Methods in Nuclear Technology and Forensics 3 Units
Terms offered: Spring 2023, Spring 2022, Spring 2021
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

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.

CHEM C150 Introduction to Materials Chemistry 3 Units
Terms offered: Fall 2023, Fall 2022, Fall 2021, Spring 2021
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: NUC ENG C146
Radiochemical Methods in Nuclear Technology and Forensics: Read Less [-]
CHEM C170L Biochemical Engineering Laboratory 3 Units
Terms offered: Fall 2023, Spring 2023, Fall 2022, 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 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 171H Berkeley Changemaker: The Green Materials Innovation Challenge 3 Units
Terms offered: 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 179 Numerical Algorithms applied to Computational Quantum Chemistry 3 Units

Terms offered: Not yet offered
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.

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.

Atmospheric Chemistry and Physics Laboratory 3 Units

Terms offered: Spring 2023, Spring 2022, Spring 2021
Fluid dynamics, radiative transfer, and the kinetics, spectroscopy, and measurement of atmospherically relevant species are explored through laboratory experiments, numerical simulations, and field observations.

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

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

Rules & Requirements

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

Atmospheric Chemistry and Physics Laboratory: Read More [+]

Rules & Requirements

Atmospheric Chemistry and Physics Laboratory: Read Less [-]
CHEM C191 Introduction to Quantum Computing 4 Units
Terms offered: Fall 2023, Spring 2023, Fall 2021

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 2023, Spring 2022, Spring 2021
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 2023, Fall 2022, Spring 2021
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
10 weeks - 1.5-6 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 2023, Fall 2022, Fall 2021
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 [-]