Requirements for Chemistry and Biochemistry Majors - Class of 2023

College and University Requirements:

Critical Thinking & Writing: ___ ___ Adv Writing ___
Cultures and Ideas: ___ ___ ___
Religions, Theology & Culture: ___ ___ ___
Second Language: ___

Ethics: ___
Civic Engagement: ___
Diversity: ___
Arts: ___

Science, Technology & Society: ___
Social Science: ___
Pathways: ___ ___ ___ ___
Experiential Learning

Lower-Division Requirements for All Chemistry/Biochemistry Degrees

Chemistry: 11 ___ 12 ___ (or 14 __, instead of 11 and 12 based on AP credit) 15 ___ 50___ 31 ___ 32 ___ 33 ___
Physics: 11 ___ 12 ___13 ___; or 31 ___ 32 ___ 33___ (PHYS 31-33 required for an ACS Certified degree)
Math: 11 ___ 12 ___ 13 ___ or 35___ 36 ___ 13 ___

Chemistry and Biochemistry majors must choose one of the degree options listed below:

Bachelor of Arts in Chemistry

Upper-Division Chemistry:
CHEM 141 ___
CHEM 111 ___
Four quarters of CHEM 115:
___ ___ ___ ___
CHEM 101 or 102 ___
CHEM 150 or 151 or 152 ___
Two upper-division chemistry/biochemistry electives*: ___ ___
30 hours of upper-division lab:
CHEM 102 ___ or 143 ___ or 154 ___ or 182 (1 unit) ___

**Chem 182 does not count as an elective. Chem 183 and 184 do count.*

Chemistry Minor

CHEM 11 ___ 12 ___ (or 14 __, instead of 11 and 12 based on AP credit)
CHEM 31 ___ 32 ___ 33 ___
Twenty (20) units of additional, upper-division chemistry/biochemistry electives *(Chem 50 can count as one of the UD electives)*
___ ___ ___ ___

**CHEM 115 and CHEM 182 do not count as electives. Chem 50, 183 and 184 do count.*

Bachelor of Science in Chemistry

Upper-Division Chemistry:
CHEM 141 ___
CHEM 111 ___
Four quarters of CHEM 115:
___ ___ ___ ___
CHEM 102 ___
CHEM 151 ___ 152 ___154 ___
Three upper-division chemistry/biochemistry electives*: ___ ___ ___

**Chem 182 does not count as an elective. Chem 183 and 184 do count.*

Bachelor of Science in Chemistry – ACS Certified

Upper-Division Chemistry:
CHEM 141 ___
CHEM 111 ___
Four quarters of CHEM 115:
___ ___ ___ ___
CHEM 102 ___
CHEM 150 ___ 151 ___ 152 ___154 ___
Two upper-division chemistry/biochemistry electives*: ___ ___
Senior Research: CHEM 183 ___ 184 ___

**Chem 182 does not count as an elective.*

Bachelor of Science in Biochemistry

BIOL 1A ___ 1B ___ 1C ___ 175 ___
Upper-Division Chemistry:
CHEM 141 ___ 142 ___ 143 ___
CHEM 111 ___
Four quarters of CHEM 115:
___ ___ ___ ___
CHEM 101 ___
CHEM 150 ___, 151 or 152 ___
Two upper-division chemistry/biochemistry electives*#: ___ ___

**Chem 182 does not count as an elective. Chem 183 and 184 do count. #BIOL 110, 113, 172, 174, or 178 may be taken to satisfy one of these two electives.*

Bachelor of Science in Biochemistry – ACS Certified

BIOL 1A ___, 1B ___, 1C ___, 175 ___
Upper-Division Chemistry:
CHEM 141 ___, 142 ___, 143 ___
CHEM 111 ___
Four quarters of CHEM 115:
___ ___ ___ ___
CHEM 101 ___
CHEM 150 ___ 151 or 152 ___ 154 ___
Two upper-division chemistry/biochemistry electives*#: ___ ___
Senior Research: CHEM 183 ___ 184 ___

**Chem 182 does not count as an elective.*

#BIOL 110, 113, 172, 174, or 178 may be taken to satisfy one of these two electives.

Students are personally responsible for knowing all the academic regulations affecting their program of study and for completing all degree requirements as set forth by the University, their College or School, and academic department. Failure to understand these regulations and requirements does not relieve a student of responsibility (Undergraduate Bulletin).

LOWER-DIVISION COURSES

11. Bonding and Energy. Topics include chemical properties and structure, quantitative problem-solving, chemical bonding, ions, stoichiometry, and an introduction to thermodynamics. Recitation is offered by placement based on a readiness exam.. Laboratory 3 hrs/wk. (5 units) *Offered Fall quarter.*

***12.* Molecules in Motion.** Topics include gases, intermolecular forces, kinetics, and acid-base chemistry. 1 hour per week. Laboratory 3 hrs/wk. *Prerequisite: CHEM 11.* Recitation offered to students based on their performance in Chem 11. *Students who received a passing grade of a D+ or below in CHEM 11 are required to enroll in the CHEM 12 Recitation section and encouraged to meet with their instructor. Students who received a grade of C– in CHEM 11 are encouraged to enroll in the Chem 12 Recitatiion section and meet with their instructor during the first week of class.* (5 units) Offered Winter quarter.

12H. General Chemistry II Honors. Accelerated treatment of CHEM 12 material and other topics not normally covered in general chemistry. Laboratory 3 hrs/wk. *Prerequisites: permission of instructor and a strong performance in Chem 11.* (5 units)

14. Advanced Chemical Principles. Subjects include accelerated treatment of topics covered in CHEM 11 and CHEM 12. This course is open to students with AP scores in chemistry of 4 or 5 who will be taking chemistry courses beyond CHEM 14. Laboratory 3 hours per week. (5 units)

15. Introduction to Research. This course introduces students to opportunities for undergraduate research in the department. Departmental faculty present their current research. Also, an overview of typical tools used in pursuing scientific research projects is provided. Students interested in the chemistry major/minor should ordinarily take this course before the end of their sophomore year. (1 unit) *Offered Spring quarter.*

31. Organic Chemistry I. Topics include organic structure and conformations, stereochemistry, structure-reactivity relationships, and the chemistry of alkyl halides and alkenes. Special emphasis is placed on understanding reaction mechanisms. Laboratory 3 hrs/wk. Preequisite: Chem 12 or 14. *A grade of C- or higher in Chem 12 or 14 is strongly recommended before taking Chem 31. Students receiving a lower grade are urged to meet with a Chem 31 instructor before continuing with this course.* (5 units) *Offered Spring quarter*

32. Organic Chemistry II. Topics include spectroscopy and the chemistry of alkynes, ethers, alcohols, and carbonyl compounds. Laboratory 3 hrs/wk. Prerequisite: CHEM 31. *Students receiving a lower grade than a C- in Chem 31 are urged to meet with their instructor before continuing with Chem 32* (5 units) *Offered Fall quarter.*

33. Organic Chemistry III. Topics include carbonyl condensation reactions, aromatic substitutions, amines, carbohydrates, and peptide and protein synthesis. Other advanced topics may include pericyclic reactions and natural product synthesis. Laboratory 3 hrs/wk. Prerequisite: Chem 32. *Students receiving a grade lower than a C-in Chem 32 are strongly urged to meet with their instructor before continuing with Chem 33.* (5 units) *Offered Winter quarter.*

50. Quantitative Analysis. Topics include quantitatively rigorous treatment of thermodynamics and kinetics, gases, and electrochemistry. Laboratory focuses on quantitative analysis of titrations, spectroscopy, and equilibria. Laboratory 3 hours per week. Prerequisite: CHEM 33 and MATH 12. (5 units)

UPPER-DIVISION COURSES

101. Bioinorganic Chemistry. Structure, properties, and reactivity of metal complexes and the function of metal ions in biological processes. *Prerequisite: CHEM 32.* (5 units) *Offered Spring quarter.*

102. Inorganic Chemistry. Introduction to inorganic chemistry with emphasis on the nonmetals. Laboratory 3 hrs/wk. *Prerequisite: CHEM 50.* (5 units) *Offered Spring quarter.*

103. Environmental Chemistry. Sources, reactions, and transport of contaminants in soil, water, and air. Kinetic and thermodynamic models for smog formation, ozone layer depletion, acid rain, and the transport and degradation of contaminants in natural waters and soil, plus a brief look at global climate modeling. This course satisfies the Science, Technology and Society requirement. *Prerequisite: Must be enrolled in, or have taken, CHEM 150, 151, or 152.* (5 units)

111. Instrumental Analysis. Principles and use of instrumentation. Focus on electronics, spectroscopic methods, mass spectrometry, and chemical separations. Laboratory 4 hrs/wk. *Prerequisite: CHEM 13. Co-requisite: CHEM 32.* (5 units) *Offered Winter quarter.*

112. Bioanalytical Chemistry. A focused investigation of the application of modern methods of analytical chemistry to understanding biological systems at molecular level. Topics depend on recent developments in bioanalytical research but may include sub-cellular analyses, proteomics, electrochemical methods, and nanoparticle-based approaches to analysis. The course stresses extensive reading of recent literature in bioanalytical chemistry, critical evaluation of published scientific papers, and development of skills in scientific writing. Fulfills advance writing requirement. *Prerequisite: CHEM 111 or consent of instructor* (5 units). *Offered spring quarter in alternate years.*

115. Chemistry and Biochemistry Seminar. Active areas of research in university, industrial, and government laboratories, presented by guest speakers. May be repeated for credit. P/NP. (0.5 units) *Offered every quarter.*

130. Organic Syntheses. Modern synthetic methods applied to the preparation of structurally complex target compounds, such as bioactive natural products and pharmaceuticals. Extensive discussion of synthetic planning, known as retrosynthetic analysis, emphasizing the standard bond-forming methods learned in CHEM 31–33. *Prerequisite: CHEM 33* (5 units)

131. Bioorganic Chemistry. Chemical synthesis of carbohydrates, nucleic acids, peptides, proteins, and reaction mechanisms of biological cofactors. *Prerequisite: CHEM 33.* (5 units)

132. Polymer Chemistry. Synthesis and characterization of polymers and complex macromoleculrs. Special emphasis on polymerization mechanisms, kinetic, and thermodynamic aspects of these reactions, and also applications of polymers in society. Much of the course content will come from current literature. This course satisfies the Advanced Writing requirement. Prerequisite: CTW 1 and 2, CHEM 33; or CHEM 32 with consent of instructor. (5 units)

133. Medicinal Chemistry Medicinal chemistry will engage students in the study of the scientific processes and experiments involved in drug discovery. By examining case studies, students will appreciate how drug discovery has shaped historical events, how and why drug regulation processes have evolved, and how societal forces influence which therapeutic areas are targeted for drug discovery. Students will become familiar with experiments that clarify drug interactions with biomolecules and biological systems and drug efficacy. In-depth study of specific drugs will analyze societal influences that contributed to their discovery, their scientific development, and their impact (or potential impact) on society. This course satisfies the Science, Technology and Societies requirement. Prerequisite: Chem 33. (5 units)

134. Drug Synthesis and its Impact on Society This course will develop student's skills in designing viable syntheses of drug targets and understanding of how drug synthesis plays a critical role in healthcare and society. This course satisfies the Science, Technology and Societies requirement. Prerequisite: Chem 33. (5 units)

141. Biochemistry I. An introduction to structure/function relationships of biologically important molecules, enzymology, membrane biochemistry, and selected aspects of the intermediary metabolism of carbohydrates. *Co-requisite: CHEM 33.* (5 units) *Offered Fall and Spring quarters.*

142. Biochemistry II. Includes a study of various aspects of the intermediary metabolism of carbohydrates, lipids, and amino acids, as well as nucleic acid structure and function, protein synthesis, and subcellular sorting, and more advanced molecular physiology, including membrane biochemistry, signal transduction, and hormone action. *Prerequisite: CHEM 141.* (5 units) *Offered Winter quarter.*

143. Biochemical Techniques. A laboratory course emphasizing fundamental theory and practice in biochemical laboratory techniques, including preparation and handling of reagents; isolation, purification, and characterization of biomolecules; enzyme kinetics; spectrophotometric assays; and electrophoretic techniques. Laboratory 8 hrs/wk. *Prerequisites: CHEM 141 and consent of instructor.* (3 units) *Offered Spring quarter and, depending on demand, Fall quarter.*

150. Biophysical Chemistry. Introduction to the physical behavior of biomolecules. Topics include transport properties, reaction kinetics, sedimentation, electrophoresis, binding dynamics, and molecular motion. *Prerequisites: MATH 13 and CHEM 33 or consent of instructor.* (5 units) *Offered Fall quarter.*

151. Quantum Chemistry. Fundamentals of quantum mechanics, including wave functions and probability, rotational, vibrational, and electronic transitions, atomic and molecular electronic structure, and magnetic resonance. *Prerequisites: MATH 13 and CHEM 33.* (5 units) *Offered Spring quarter.*

152. Chemical Thermodynamics. Fundamental laws of thermodynamics, and applications to ideal and real gas equations of state, ideal and real solutions, phase equilibria, and electrochemistry. *Prerequisite: MATH 13 and CHEM 33.* (5 units) *Offered Winter quarter.*

154. Physical Chemistry Laboratory. Experimental applications of thermodynamics, kinetics, spectroscopy, and other aspects of physical chemistry. Laboratory 8 hrs/wk. *Prerequisite: Must be enrolled in, or have completed, CHEM 151 or CHEM 152.* (3 units) *Offered Winter quarter.*

182. Undergraduate Research. Experimental research project supervised by a faculty member in the department. Each unit requires a minimum of 30 hours of laboratory work. May be repeated for credit. *Prerequisite: Consent of instructor.* (1–3 units) *Offered every quarter.*

183. Senior Research Experience. Individual research supervised by a faculty member in the department, culminating in a comprehensive progress report. Laboratory at least 9 hrs/wk. *Prerequisites: Senior standing in chemistry and consent of instructor.* (3 units) *Offered every quarter.*

184. Capstone Research Experience. Continuation of individual research supervised by a faculty member in the department, culminating in a thesis and oral presentation. Laboratory at least 9 hrs/ wk. *Prerequisites: CHEM 182 or CHEM 183 and consent of instructor.* (3 units) *Offered every quarter.*

190. Special Topics in Chemistry. Special Topics courses may be offered as 2–5 unit courses covering advanced topics in any of the five areas of study in chemistry. These courses may be offered as once a week seminars or follow more traditional course schedules. The course units will vary based on the number of course meetings per quarter and the course workload. Possible course topics are organic mechanisms, transition metals in organic synthesis, materials, nanotechnology, photochemistry, electrochemistry, environmental chemistry, molecular physiology, and membrane biochemistry. This course with a different topic may be repeated for credit. (2–5 units) *Offered on an occasional basis.*

199. Independent Study. Directed study under the supervision of a faculty member in an area or topic in chemistry or biochemistry not covered in regular courses. *Registration by permission by the professor directing the study only.* (1–5 units)

Biology Course Titles and Prerequisites

1A. Transformations of Energy and Matter L&L. How do organisms obtain elements from their environment, change them to suit their growth needs, and acquire the energy necessary to sustain life? How do changing environments impact organisms and ecosystems? Students will explore the global cycle of critical elements and dissect the chemical reactions that incorporate these elements into biological molecules and new biological structures. They will discuss the implications of nutrient availability on growth of a variety of organisms and on interacting populations in an ecosystem. Core to this class is the exploration of the habits of mind that will form the basis of critical scientific thinking throughout the biology curriculum. Laboratory 15 hours. Prerequisite: concurrent enrollment in or completion of CHEM 12. (4 units)

1B. Information and Evolution. This course builds an introductory understanding of how information is transmitted and utilized in biological systems. Students will investigate how the genetic transmission of information at the molecular, organismal, and population level generates biodiversity and drives evolution. In their studies, students will continue to practice the habits of mind necessary to critically evaluate data and communicate with the greater scientific community. Laboratory 15 hours. Prerequisites: completion of BIOL 1A with a C- or better, and concurrent enrollment in or completion of CHEM 31 (4 units) *Prerequisites: BIOL1A and CHEM 31 (or concurrent enrollment).* (4 units) *Offered Fall quarter.*

1C. Systems L&L. Laboratory 30 hours. *Prerequisites: BIOL 1B and CHEM 31* (5 units) *Offered Winter quarter.* All biological phenomena are complex networks whose members comprise molecules, cells, organs, organisms, and ecosystems. An alteration affecting one of the members could affect the entire network. In this course, students will model biological systems (e.g., organismal body plans, human diseases, endangered natural habitats) in order to predict how they will respond and adapt. Students will also apply the process of science to collect, analyze, and interpret data across biological scales and communicate with the greater scientific community. Laboratory 30 hours. Prerequisites: completion of BIOL 1B with a C- or better and completion of CHEM 31 (or 13). (5 units)

110. Genetics L&L. Basic principles governing inheritance and gene expression in viruses, prokaryotes, and eukaryotes. Emphasis on molecular aspects. Laboratory 30 hours. Prerequisites: BIOL 1C and CHEM 31. (5 units)

113. Microbiology L&L. Basic principles governing inheritance and gene expression in viruses, prokaryotes, and eukaryotes. Emphasis on molecular aspects. Laboratory 30 hours. Prerequisites: BIOL 1C and CHEM 31. (5 units)Lab *Offered Fall quarter*

172. Molecular Modeling Molecular modeling is a powerful tool that allows scientists to explain and make predictions about molecular structures, dynamics, and interactions. In this course, students will use state-of-the-art software for protein structure prediction, molecular dynamics, and drug design. Students will design and complete their own modeling project and communicate the results through a journal-style report.Lab 30 hours *Prerequisites: BIOL 1C and CHEM 31. (5 units)*

174. Cell Biology L&L. Study of the function of cellular organelles and the signaling pathways that control cell reproduction. Topics include a detailed discussion of the structure of cell membranes, nuclear and chromosome structure, DNA replication, the microtubule and microfilament cytoskeleton, mitosis, mechanisms of cell motility, cell cycle regulation, and apoptosis. Laboratory experiments focus on cell cycle regulation and cell differentiation. Laboratory 30 hours. Prerequisites: BIOL 1C and CHEM 33. (5 units)
Offered Winter quarter

175. Molecular Biology L&L. An introduction to the maintenance and flow of genetic information at the level of protein-nucleic acid interactions. Lectures focus on basic molecular biology concepts and recombinant DNA technology. Laboratory 30 hours. *Prerequisite: BIOL 25.* (5 units) *Offered Fall and Spring quarter, but may be offered only once a year.*

178. Bioinformatics L&L Bioinformatics tools are important for storing, searching, and analyzing macromolecular sequences and structures. This course in applied bioinformatics provides an in-depth survey of modern bioinformatics tools. Students will become proficient at searching GenBank, downloading and analyzing sequences, and working with metadata. Software tools for functional and evolutionary analysis of nucleic acids and proteins will also be examined.
Lab 30 hours *Prerequisites: BIOL 1C (5 Units)*

SUMMER SESSION: Chemistry 11–12 and 31–33 are offered in Summer sessions as intensive three-week courses. These courses are particularly recommended for students who will miss a course in one of these sequences due to study abroad or need to catch up on lower-division chemistry courses due to a late change of major or not meeting the performance standards. Chemistry 141, if offered, spans over five weeks during one Summer session. Summer courses are fast-paced and challenging; consult with your advisor before registering for these classes.