

# CHEMISTRY

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The study of chemistry is concerned with the composition, structure, properties, and transformations of matter. Chemistry is the central science, having foundation in mathematics and physics and, in turn, underlying the life sciences. It is theoretical and yet practical; it emphasizes analytical skills and yet depends on creativity and problem solving.

The chemistry program prepares students for graduate study and professional careers in academic research, industry, and engineering. A major in the chemistry program is also an excellent choice for students in the health sciences and preprofessional programs, including medicine, dentistry, law, and pharmacy.

**Advanced Placement:** The Chemistry Department (<https://www.bethel.edu/undergrad/academics/chemistry/>) requires a score of 4 or better on the AP exam in order for the exam to be used to fulfill course requirements in the majors it offers. Students with a score of 3 will receive elective credit or receive credit toward General Education requirements. Students should consult the department chair with questions about AP exams and requirements for majors.

## Pre-medicine and Other Healthcare Professional Programs

(See Healthcare (<http://catalog.bethel.edu/arts-sciences/academic-programs-departments/healthcare-endorsement/>) section)

## Chemical Engineering

A bachelor's degree in chemical engineering is available through a special dual degree program described in the Engineering section of this catalog.

## Majors in Chemistry

- B.A. in Biochemistry (<http://catalog.bethel.edu/arts-sciences/academic-programs-departments/chemistry/biochemistry-ba/>)
- B.A. in Chemistry (<http://catalog.bethel.edu/arts-sciences/academic-programs-departments/chemistry/chemistry-ba/>)
- B.S. in Biochemistry/Molecular Biology (<http://catalog.bethel.edu/arts-sciences/academic-programs-departments/biochemistry-molecular-biology/>)
- B.S. in Chemistry (<http://catalog.bethel.edu/arts-sciences/academic-programs-departments/chemistry/chemistry-bs/>)

## Minor in Chemistry

- Chemistry (<http://catalog.bethel.edu/arts-sciences/academic-programs-departments/chemistry/chemistry-minor/>)

### CHE 101 • Introduction to Chemistry 3 Credits

Overview of atoms—their composition, ability to form bonds, and ability to interact as molecules. Open to all students but tailored for nursing and allied health fields.

*Corequisites:* Concurrent registration in CHE 101D is required. Offered: Fall, Spring.

### CHE 101D • Introduction to Chemistry Lab 1 Credit

Laboratory experience accompanying CHE 101.

*Corequisites:* Concurrent registration in CHE 101 is required. Offered: Fall, Spring.

## Chemistry 2

### **CHE 102 • Intermediate Chemistry 3 Credits**

Students explore chemical theories related to atomic structure, molecular orbitals, thermodynamics, and states of matter. Examination of three dimensional structures of molecules and build quantitative skills.

*Prerequisites: CHE 101/CHE 101D. Offered: January.*

### **CHE 113 • General Chemistry I 3 Credits**

Chemical properties and principles, structure and reactivity, stoichiometry, thermodynamics, atomic and molecular theory, and states of matter.

*Prerequisites: Two years of High school math; High school chemistry or Consent of instructor. Corequisites: Concurrent registration in CHE 113D is required. Offered: Fall, Occasionally summer.*

### **CHE 113D • General Chemistry I Lab 1 Credit**

Laboratory experience accompanying CHE 113 to improve experimental skills such as accurate observation, data collection, and analysis while mastering techniques used by chemists for the precise measurements of mass, volume, and concentration. Small group collaboration and experimental design are included.

*Corequisites: Concurrent registration in CHE 113 is required. Offered: Fall, Occasionally summer.*

### **CHE 200 • Laboratory Safety and Chemical Hygiene 1 Credit**

High standards of safety and chemical hygiene make the science laboratory a safe, comfortable, interesting place to work. Standards and federal/state guidelines pertaining to safety and hygiene in the laboratory are reviewed.

*Prerequisites: One year of High school chemistry and One semester of college-level science. Offered: Fall, Spring.*

### **CHE 214 • General Chemistry II 3 Credits**

Study of solutions, chemical kinetics, thermodynamics, solution equilibria, acids and bases, electrochemistry, descriptive inorganic chemistry, and nuclear chemistry.

*Prerequisites: CHE 113/CHE 113D. Corequisites: Concurrent registration in CHE 215 is required. Offered: Spring, Occasionally summer.*

### **CHE 215 • General Chemistry II Lab 1 Credit**

Laboratory experience accompanying CHE 214.

*Corequisites: Concurrent registration in CHE 214 is required. Offered: Spring, Occasionally summer.*

### **CHE 224 • Organic Chemistry I 3 Credits**

Structure, nomenclature, function, and reactivity of organic compounds. Topics include bonding theory, acid-base reactions, conformational analysis, stereochemistry, nucleophilic substitution and elimination reactions, addition reactions, radical reactions, organic reaction mechanisms, and energy relations.

*Prerequisites: CHE 214/CHE 215. Corequisites: Concurrent registration in CHE 225 is required. Offered: Fall.*

### **CHE 225 • Organic Chemistry I Lab 1 Credit**

Laboratory experience accompanying CHE 224.

*Corequisites: Concurrent registration in CHE 224 is required. Offered: Fall.*

### **CHE 226 • Organic Chemistry II 3 Credits**

Continues Organic Chemistry I by exploring the structure, nomenclature, function, and reactivity of additional organic compounds. Topics include the reactions of aromatic and carbonyl containing compounds, carbon-carbon bond-forming reactions, multi-step synthesis, and polymer chemistry. The chemistry of biological compounds such as carbohydrates, DNA, proteins, and lipids are also studied.

*Prerequisites: CHE 224/CHE 225. Corequisites: Concurrent registration in CHE 227 is required. Offered: Spring.*

**CHE 227 • Organic Chemistry II Lab 1 Credit**

Laboratory experience accompanying CHE 226. Laboratory includes single- and multi-step synthesis, purification, and identification of organic compounds. Infrared spectroscopy, 1D and 2D nuclear magnetic resonance spectroscopy, mass spectroscopy, and computational chemistry will be used to explore the outcomes of organic reactions and their mechanisms.

*Corequisites:* Concurrent registration in CHE 226 is required. *Offered:* Spring.

**CHE 304 • Essentials of Biochemistry 3 Credits**

A survey of the structure, function, interactions, and chemical properties of the four major macromolecules: proteins, nucleic acids, lipids, and carbohydrates. Examination of primary metabolic pathways, bioenergetics, regulation, and homeostasis.

*Prerequisites:* CHE 224/CHE 225 and BIO 120/BIO 120D or BIO 124/BIO 124D. *Offered:* Spring. *Special Notes:* Not open to students who have taken CHE 388/CHE 389.

**CHE 312 • Quantitative Analysis 3 Credits**

Principles and practice of modern quantitative analysis. Acid-base and ionic equilibria. Statistics, method selection and development, chromatography, and electrochemistry.

*Prerequisites:* CHE 214/CHE 215. *Corequisites:* Concurrent registration in CHE 313 is required. *Offered:* Spring.

**CHE 313 • Quantitative Analysis Lab 1 Credit**

Laboratory experience accompanying CHE 312.

*Corequisites:* Concurrent registration in CHE 312 is required. *Offered:* Spring.

**CHE 320 • Instrumental Analysis 3 Credits**

Methods of instrumental analysis. Study of chemical and physical principles and practical application of spectroscopy, spectrometry, chromatography and electroanalysis. Fundamental electronic circuitry and computer data acquisition and control.

*Prerequisites:* CHE 312/CHE 313 or CHE 226/CHE 227. *Corequisites:* Concurrent registration in CHE 321 is required. *Offered:* Occasionally.

**CHE 321 • Instrumental Analysis Lab 1 Credit**

Laboratory experience accompanying CHE 320.

*Corequisites:* Concurrent registration in CHE 320 is required. *Offered:* Occasionally.

**CHE 344 • Thermodynamics, Kinetics, and Statistical Mechanics 3 Credits**

Physical chemistry of the laws of thermodynamics and their application to phase and chemical equilibria. Chemical kinetics of reaction rates and reaction mechanisms. Statistical mechanics as it relates spectroscopy with thermodynamics and kinetics.

*Prerequisites:* CHE 214/CHE 215; PHY 202/PHY 202D; PHY 206/PHY 207 or PHY 292/PHY 292D; PHY 296/PHY 297; MAT 125. *Corequisites:* Concurrent registration in CHE 345 is required. *Offered:* Fall.

**CHE 345 • Thermodynamics, Kinetics, and Statistical Mechanics Lab 1 Credit**

Laboratory experience accompanying CHE 344. Includes hands-on experience with physiochemical systems and computational modeling.

*Corequisites:* Concurrent registration in CHE 344 is required. *Offered:* Fall.

**CHE 348 • Quantum Chemistry and Spectroscopy 3 Credits**

Physical chemistry of the laws of quantum mechanics applied to atoms and molecules. Quantum mechanical solutions of model systems and their application to chemical spectroscopy.

*Prerequisites:* CHE 214/CHE 215; PHY 292/PHY 292D; PHY 296/PHY 297; MAT 125. *Corequisites:* Concurrent registration in CHE 349 is required. *Offered:* Spring, even # years.

**CHE 349 • Quantum Chemistry and Spectroscopy Lab 1 Credit**

Laboratory experience accompanying CHE 348. Includes hands-on experience with physiochemical systems and computational modeling.

*Corequisites:* Concurrent registration in CHE 348 is required. *Offered:* Spring, even # years.

## Chemistry 4

### **CHE 364 • Advanced Inorganic Chemistry 3 Credits**

Chemistry of elements and their compounds, including symmetry, bonding theories, solid-state chemistry, coordination compounds, organometallics, and bioinorganic compounds.

*Prerequisites:* CHE 344/CHE 345 and One year of organic chemistry or Junior standing. *Corequisites:* Concurrent registration in CHE 365 is required. *Offered:* Spring, odd # years.

### **CHE 365 • Advanced Inorganic Chemistry Lab 1 Credit**

Laboratory experience accompanying CHE 364. Laboratory includes synthesis and characterization of inorganic compounds.

*Corequisites:* Concurrent registration in CHE 364 is required. *Offered:* Spring, odd # years.

### **CHE 388 • Biochemistry I 3 Credits**

Physical and chemical properties of living systems with an emphasis on macromolecular interaction, structure, and function. Structure, classification, purification, and function of nucleic acids, proteins, carbohydrates, and lipids, including membrane transport and enzymology.

*Prerequisites:* BIO 120/BIO 120D or BIO 124/BIO 124D; CHE 226/CHE 227 (BIO 128/BIO 128D recommended).

*Corequisites:* Concurrent registration in CHE 389 is required. *Offered:* Fall. *Special Notes:* Not open to students who have taken CHE 304. Carries cross-credit in biology.

### **CHE 389 • Biochemistry I Lab 1 Credit**

Laboratory experience accompanying CHE 388.

*Corequisites:* Concurrent registration in CHE 388 is required. *Offered:* Fall.

### **CHE 393 • Research 1-4 Credits**

Utilization of the techniques and understanding of chemical principles on a term project. Use of original literature to formulate and conduct an original laboratory or computational research project under the supervision of a chemistry faculty member.

*Prerequisites:* Consent of department. *Repeatable course:* May only be taken for credit once. *Offered:* Fall, January, Spring.

### **CHE 395 • Chemistry Seminar: Research and Professional Development 1 Credit**

Students search the chemical literature and develop a proposal for their capstone research project. Discussion of chemical careers, graduate and professional school preparation, and ethical conduct in science.

*Prerequisites:* CHE 200 (may be taken concurrently); Junior standing; Major in chemistry or biochemistry/molecular biology. *Offered:* Fall.

### **CHE 396 • Biochemistry II 3 Credits**

Metabolic pathways, bioenergetics, metabolic regulation, and metabolism of macromolecules (carbohydrates, lipids, proteins, and nucleotides). Macromolecular synthesis of RNA, DNA, and proteins, including an introduction to biotechnology.

*Prerequisites:* CHE 388/CHE 389. *Corequisites:* Concurrent registration in CHE 397 is required. *Offered:* Spring.

### **CHE 397 • Biochemistry II Lab 1 Credit**

Laboratory experience accompanying CHE 396. Laboratory includes mammalian cell culture techniques and bioassays, and plant biochemical techniques including lipid extraction and analysis. RNA and DNA, PCR, and gene expression.

*Corequisites:* Concurrent registration in CHE 396 is required. *Offered:* Spring.

### **CHE 490 • Chemistry Seminar: Research 2 Credits**

Students pursue an original research project in chemistry or biochemistry supported by a faculty mentor. Required time commitment is approximately 3.5 hours per week per credit, including a weekly meeting with faculty mentor.

*Prerequisites:* CHE 395 and Consent of instructor. *Offered:* Fall, Spring.

**CHE 491 • Research 1-4 Credits**

Students pursue an original research project in chemistry or biochemistry supported by a faculty mentor. Required time commitment is approximately 3.5 hours per week per credit, including a weekly meeting with faculty mentor.

*Prerequisites: CHE 490 and Consent of department. Offered: Fall, January, Spring.*

**CHE 494 • Chemistry Seminar: Research Presentation 1 Credit**

Students prepare and deliver formal presentations, both oral and written, of their research results. Seminar meets weekly for discussion of current topics.

*Prerequisites: CHE 490. Offered: Fall, Spring.*