

Chemistry

Website: chemistry.sewanee.edu

Chemistry is often referred to as the central science. As such, it interfaces with and illuminates numerous disciplines including physics, biology, forestry, and geology. Sewanee's course in general chemistry serves future majors and students from such other disciplines by providing a solid foundation in the central organizational principles of chemistry. Courses in the major amplify this understanding by providing an in-depth exploration of the major sub-disciplines: organic, inorganic, analytical, environmental, physical and biochemistry. Majors are encouraged to participate in research projects with faculty members, during the school year and in the summer and are also encouraged to participate in research groups at other schools during the summers. An active seminar series allows students to gain proficiency in oral presentation of technical material as well as learn about the frontiers of chemical research from eminent scientists.

Entering students with an interest in the chemistry major are strongly encouraged to discuss their academic planning with faculty in the Department of Chemistry as early as possible in their academic career.

Faculty

Professors: Bachman, Durig, Miles (Chair)

Associate Professors: Pongdee, Seballos, Shibata, R. Summers

Assistant Professor: Joslin

Major

Requirements for the Major in Chemistry

The major requires successful completion of the following:

| Code | Title | Semester Hours |
|---|--|----------------|
| Course Requirements | | |
| CHEM 120 or CHEM 150 | General Chemistry (Lab) ¹ Advanced General Chemistry (Lab) | 4 |
| CHEM 201 | Organic Chemistry I (Lab) ² | 4 |
| CHEM 202 | Organic Chemistry II (Lab) | 4 |
| CHEM 210 | Solution and Solid State Chemistry (Lab) | 4 |
| CHEM 301 | Junior Seminar | 2 |
| CHEM 307 or CHEM 316 | Mechanistic Biochemistry (Lab) Biochemistry of Metabolism and Molecular Biology (Lab) | 4 |
| CHEM 308 | Inorganic Chemistry (Lab) | 4 |
| CHEM 311 | Instrumental Analysis (Lab) | 4 |
| CHEM 352 | Thermodynamics and Kinetics (Lab) | 4 |
| CHEM 401 | Senior Seminar | 2 |
| Select one additional course in chemistry (CHEM) numbered above 401 | | 4 |
| MATH 102 or MATH 207 | Calculus II ³ Multidimensional Calculus | 4 |
| Select one of the following: | | 8 |
| PHYS 101 and PHYS 102 | General Physics I (Lab) and General Physics II (Lab) | |
| PHYS 103 and PHYS 104 | Modern Mechanics (Lab) and Electric and Magnetic Interactions (Lab) | |
| Total Semester Hours | | 52 |

| Code | Title | Semester Hours |
|------|-------|----------------|
|------|-------|----------------|

Additional Requirements

A comprehensive examination

- ¹ Completion of this requirement is a prerequisite to all chemistry courses numbered 201 or higher.
- ² Students interested in advanced placement into CHEM 201 should consult the department chair.
- ³ MATH 207 is strongly recommended.

Honors

In order to receive honors in the chemistry program, a student must have a 3.00 or higher GPA in the major, take two advanced electives in chemistry at the 400 level, and complete a research project that the chemistry faculty considers worthy of honors. The research project may be done as part of a course (usually CHEM 494), or it may be done in the context of a summer research program at this University or at another institution. The honors project must involve some original work. A formal written report and a seminar presentation on the research are required. Students must inform the department of their intention to seek honors no later than the middle of the first semester of their senior year. Please see the departmental web page for additional information about honors.

Pre-engineering Program

A chemistry major in the pre-engineering track is for students who intend to pursue engineering. The major is slightly abbreviated to accommodate a student's shortened time at Sewanee and is completed during the subsequent two years of study at the relevant engineering institution. Scheduling of courses during the three years at Sewanee is often complex; students should consult departmental advisors within their major of interest in their first year to avoid scheduling conflicts. Research participation and laboratory assistantships are encouraged.

A student must complete all core curriculum requirements of the College.

| Code | Title | Semester Hours |
|------|-------|----------------|
|------|-------|----------------|

Course Requirements ¹

| | | |
|-------------------------|--|---|
| CHEM 120 or CHEM 150 | General Chemistry (Lab) Advanced General Chemistry (Lab) | 4 |
| CHEM 201 | Organic Chemistry I (Lab) | 4 |
| CHEM 202 | Organic Chemistry II (Lab) | 4 |
| CHEM 210 | Solution and Solid State Chemistry (Lab) | 4 |
| CHEM 301 | Junior Seminar | 2 |
| CHEM 308 or CHEM 311 | Inorganic Chemistry (Lab) Instrumental Analysis (Lab) | 4 |
| CHEM 352 | Thermodynamics and Kinetics (Lab) | 4 |
| MATH 102 | Calculus II | 4 |
| PHYS 103 or PHYS 101 | Modern Mechanics (Lab) General Physics I (Lab) | 4 |
| PHYS 104 or PHYS 102 | Electric and Magnetic Interactions (Lab) General Physics II (Lab) | 4 |

| Code | Title | Semester Hours |
|------|-------|----------------|
|------|-------|----------------|

Additional Requirements

A comprehensive examination ²

- ¹ PHYS 103 and PHYS 104 are recommended for first-year students who are interested in the pre-engineering track.
- ² The comprehensive exam is only required for 4-2 engineering students, and is not required for 3-2 engineering students.

Course Sequencing

For a first-year student planning to major in physics, the following curriculum is recommended. The second-year program should be planned in consultation with the department chair. Students may seek advanced placement in chemistry, mathematics, and foreign language.

Sample Schedule

| Code | Title | Semester Hours |
|--|---|----------------|
| Advent (fall) Semester | | |
| CHEM 120 or CHEM 150 | General Chemistry (Lab) Advanced General Chemistry (Lab) | 4 |
| PHYS 103 | Modern Mechanics (Lab) | 4 |
| MATH 102 | Calculus II | 4 |
| General Education requirement/elective | | 4 |
| Easter (spring) Semester | | |
| CHEM 201 | Organic Chemistry I (Lab) | 4 |
| PHYS 104 | Electric and Magnetic Interactions (Lab) | 4 |
| MATH 207 | Multidimensional Calculus | 4 |
| General Education requirement/elective | | |

Minor

Requirements for the Minor in Chemistry

The minor requires successful completion of the following:

| Code | Title | Semester Hours |
|--|---|----------------|
| Course Requirements | | |
| CHEM 120 or CHEM 150 | General Chemistry (Lab) Advanced General Chemistry (Lab) | 4 |
| CHEM 201 | Organic Chemistry I (Lab) | 4 |
| Select three additional chemistry (CHEM) courses numbered above 200. | | 12 |
| Total Semester Hours | | 20 |

Courses

Chemistry Courses

CHEM 100 Foundations of Chemistry (4)

This course explores the foundational principles of chemistry within the context of contemporary topics in the chemical sciences and society. In addition to introducing the central models and theories of chemistry, the course develops a student's skills in analytical reasoning and problem-solving.

CHEM 110 The Science of Food and Cooking (4)

An introduction to the science of food and food preparation. Students learn the scientific method through the examination of food and cooking in the laboratory setting. Recent food-related controversies, such as low-carbohydrate diets, are considered. The course is designed for the general student. *Open only to new first-year students.*

CHEM 112 Chemistry of Art and Artifacts (4)

This course addresses both of these intersections between science and the arts by considering the role of chemistry in the production and interpretation of art and artifacts from theoretical and practical perspectives. The course also examines the application of chemistry to art conservation and archaeology.

CHEM 114 Life, Energy, and the Atomic Bomb: How the Science of Metals Shapes Society (4)

This course provides an understanding of how chemistry and metals influence everyday lives. Using the periodic table as a touchstone, the course examines the role of metals and their chemistry in society. Specific themes include the use of metals in medicine and health; the role of metals in the production of modern materials and products; the use of metals in both traditional and alternative fuels; and the ways in which metals have been used to influence global political power through the atomic bomb and other devices.

CHEM 115 Crime Scene Chemistry (Lab) (4)

A studio course designed for students who would like to learn about forensic chemistry and the basic science needed to understand it. Chemical concepts, on the level of an introductory chemistry course and their applications to forensic science are explored. Topics include the collection and analysis of physical evidence such as drugs, fibers, glass, fingerprints, and documents. Other topics may include arson investigation, DNA analysis, and how forensic science is portrayed in literature and media. This course cannot be used to fulfill the requirements for a Chemistry major or minor.

CHEM 120 General Chemistry (Lab) (4)

A survey of the basic chemical principles and theories, with emphasis on applying these concepts to chemically related fields such as environmental science and biological chemistry. Topics considered include atomistic and molecular structure, kinetics, thermodynamics, and chemical equilibrium. The course's laboratory portion emphasizes the collection and interpretation of data, as well as the formation and testing of hypotheses. Lecture, three hours; laboratory, three hours.

CHEM 150 Advanced General Chemistry (Lab) (4)

Development of chemistry's foundational concepts in greater detail than "General Chemistry" and with special emphasis on both theoretical understanding and analytical reasoning. The course focuses on the molecular basis of matter and its transformation as well as the role of chemistry in the broader scientific and societal enterprise. The laboratory portion of the course emphasizes the collection and interpretation of empirical data. Open only to new first-year students. *Open only to new first-year students. Prerequisite: Two years of high school chemistry and/or an AP score of 4 or 5 or IB scores of 5, 6, or 7.*

CHEM 201 Organic Chemistry I (Lab) (4)

A study of the nomenclature and the properties of the most important classes of organic compounds with an emphasis on concepts relating molecular structure and properties. Stereochemistry, functional group transformations and reaction mechanisms are studied in depth. Lecture, three hours; laboratory, three hours. *Prerequisite: CHEM 102 or CHEM 111 or CHEM 120 or CHEM 150.*

CHEM 202 Organic Chemistry II (Lab) (4)

A continuation of CHEM 201. A portion of the course is devoted to the study of important classes of biochemical compounds. Lecture, three hours; laboratory, three hours. *Prerequisite: CHEM 201.*

CHEM 210 Solution and Solid State Chemistry (Lab) (4)

Solution and solid chemistry is fundamental in a variety of contexts from biological to geological systems. This course explores the behavior of these systems as well as applications of chemical theory in a variety of contexts. Students engage in a studio laboratory to gain experience with the measurements and analysis necessary to characterize both solution and solid samples. *Prerequisite: CHEM 120 or CHEM 150.*

CHEM 301 Junior Seminar (2)

A series of lectures by faculty, students, and invited speakers. Junior majors will give talks on topics agreed upon with a faculty mentor. Talks describing student research are encouraged. *Open only to juniors pursuing majors in chemistry.*

CHEM 307 Mechanistic Biochemistry (Lab) (4)

An examination of all aspects of protein science, including protein biosynthesis, protein structure, and the mechanisms of enzyme catalysis, with particular emphasis on the biochemistry of enzyme catalysis. Lecture, three hours; laboratory, three and one-half hours. *Prerequisite: CHEM 202.*

CHEM 308 Inorganic Chemistry (Lab) (4)

A detailed examination of the chemistry of the elements, with a particular emphasis on structure and bonding, structure-property relationships, and reaction energetics. Course topics include organometallics and catalysis, aquatic chemistry of the metals, solid-state chemistry, and the role of metals in biology. *Prerequisite: CHEM 201 and CHEM 210.*

CHEM 311 Instrumental Analysis (Lab) (4)

An introduction to the theory and practice of the fundamental principles of chemical analysis and the use of chemical instrumentation in research. Course topics include spectrophotometric and spectroscopic methods; electrochemical fundamentals and electroanalytical techniques; chromatographic and separation methods; and statistical analysis of data. *Prerequisite: CHEM 201 and CHEM 210.*

CHEM 316 Biochemistry of Metabolism and Molecular Biology (Lab) (4)

A study of the biochemical reactions of eukaryotic cellular metabolism and bioenergetics, focusing on enzyme regulation and function, protein structure, nucleic acid structure and function, and selected topics in molecular biology and physiological biochemistry. Prior coursework in cell/molecular biology is recommended. Laboratory course. *Prerequisite: BIOL 233 and (BIOL 223 or BIOL 243) and CHEM 201.*

CHEM 352 Thermodynamics and Kinetics (Lab) (4)

An introduction to thermodynamics and kinetics. *Prerequisite: CHEM 201 and MATH 102. Prerequisite or Corequisite: PHYS 101 or PHYS 103.*

CHEM 401 Senior Seminar (2)

A series of lectures by faculty, students, and invited speakers. Senior majors will give talks on topics agreed upon with a faculty mentor. Talks describing student research are encouraged. *Open only to seniors pursuing majors in chemistry.*

CHEM 405 Organic Synthesis (4)

A comprehensive study of modern organic reactions and their application to the synthesis of biologically-active natural products. *Prerequisite: CHEM 202.*

CHEM 408 Advanced Topics in Inorganic Chemistry (4)

Selected topics in modern inorganic chemistry, such as bioinorganic chemistry, materials chemistry, and organometallic chemistry. The course surveys relevant primary literature. This course may be repeated for credit when the topic differs. *Prerequisite: CHEM 308.*

CHEM 412 Advanced Environmental Geochemistry (4)

An examination of the chemical principles that determine how natural systems work and how anthropogenic activities can have an impact on the function of these systems. Topics include both fundamental chemical principles and case studies of particular environmental systems. Lecture, three hours. *Prerequisite: CHEM 120 or CHEM 150.*

CHEM 417 Advanced Biochemistry (4)

An exploration of contemporary issues in biochemistry based largely on primary literature. Topics such as the biosynthesis and mode of action of antibiotics, protein engineering, signal transduction, chemical carcinogenesis, and isotope effects in enzyme kinetics will be addressed in detail. *Prerequisite: BIOL 306 or BIOL 307 or CHEM 316 or CHEM 306 or CHEM 307.*

CHEM 418 Structural Methods (4)

This course examines the theory and praxis of molecular and macromolecular structure determination via spectroscopic and physical methods. Lecture, three hours. *Prerequisite: CHEM 202.*

CHEM 422 Quantum Chemistry and Spectroscopy (4)

An introduction to quantum mechanics in chemistry and spectroscopy. Lecture, three hours. *Prerequisite: CHEM 201 and MATH 102 and (PHYS 102 or PHYS 104).*

CHEM 424 Topics in Physical Chemistry (4)

Prerequisite: (CHEM 120 or CHEM 150) and (MATH 102 or MATH 207) and (PHYS 102 or PHYS 104).

CHEM 425 Drug Design and Development (4)

An examination of the fundamental chemical aspects associated with the process of discovering new drugs. Both combinatorial and rational drug design methodologies are addressed. Emphasis is on the application of various structure-based and mechanism-based strategies for drug optimization. Additional topics include pharmacokinetics (how drugs move within the body), metabolism of drugs, and pharmacodynamics (effect of drugs and their molecular mechanism of action). *Prerequisite: CHEM 202.*

CHEM 428 Advanced Topics in Analytical Chemistry (4)

This course covers the theory and practice of analytical techniques and recent advances in the field. *Prerequisite: CHEM 311.*

CHEM 444 Directed Readings (2 or 4)

An in-depth investigation of an advanced topic or topics in chemistry conducted through readings from the primary and secondary literature and discussion with faculty mentor. This course may be repeated for credit when the topic differs. *Prerequisite: Instructor prerequisite override required.*

CHEM 494 Mentored Research (2 or 4)

Students engage in original research in chemistry under the mentorship of a faculty member. Students apply and integrate knowledge from their coursework while learning both specific laboratory techniques and practical problem-solving skills. Discussion of proper laboratory record-keeping, responsible conduct of research, presentation of research results, and laboratory safety are also emphasized. This course may be repeated for credit when the topic differs. *Prerequisite: Instructor prerequisite override required.*