Chemistry

Department Website: http://chemistry.uchicago.edu/kb

Program of Study

Chemistry is concerned with the preparation, composition, and structure of matter and with the equilibrium and kinetic laws that govern its transformations. The BA and BS degrees in chemistry are designed to provide a broad foundation in the three principal branches of the science: inorganic, organic, and physical chemistry. Analytical chemistry, often regarded as an independent branch, is incorporated into the program. Both curricula discuss experimental and theoretical work and emphasize their interdependence. Both degree programs prepare the student for a career in chemistry. However, the BS degree offers a more intensive program of study. The BA degree also offers thorough study in the field of chemistry, but it provides a wide opportunity for elective freedom and for the pursuit of interdisciplinary interests in areas such as biochemistry, biophysics, chemical physics, geochemistry, premedicine, and education.

Program Requirements

The principal distinction between the BA and BS programs is the number of chemistry courses required.

Program Requirements: BA A minimum of eight courses in chemistry beyond the general education requirement (which should be taken in the first year) is required for the BA degree.

Program Requirements: BS A minimum of twelve courses in chemistry beyond the general education requirement (which should be taken in the first year) is typically required for the BS degree.

Summary of Requirements: BA in Chemistry

GENERAL EDUCATION

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Units</th>
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<tbody>
<tr>
<td>CHEM 11100-11200</td>
<td>Comprehensive General Chemistry I-II</td>
<td>200</td>
</tr>
<tr>
<td>One of the following sequences:</td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>MATH 15100 &amp; MATH 15100</td>
<td>Calculus I and Calculus I</td>
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<tr>
<td>MATH 16100 &amp; MATH 16100</td>
<td>Honors Calculus I and Honors Calculus I</td>
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<tr>
<td>MATH 13100 &amp; MATH 13100</td>
<td>Elementary Functions and Calculus I and Elementary Functions and Calculus I (requires a grade of A- or higher)</td>
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</table>

Total Units: 400

MAJOR

One of the following: 1

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
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<tr>
<td>CHEM 11300</td>
<td>Comprehensive General Chemistry III</td>
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<tr>
<td>CHEM 12300</td>
<td>Honors General Chemistry III</td>
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<td>One of the following:</td>
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<tr>
<td>MATH 15300</td>
<td>Calculus III</td>
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<td>MATH 16300</td>
<td>Honors Calculus III</td>
</tr>
<tr>
<td>MATH 19620</td>
<td>Linear Algebra †</td>
</tr>
<tr>
<td>MATH 13300</td>
<td>Elementary Functions and Calculus III (requires a grade of A- or higher)</td>
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<tr>
<td>MATH 20000-20100</td>
<td>Mathematical Methods for Physical Sciences I-II</td>
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<tr>
<td>PHYS 13100-13200-13300</td>
<td>Mechanics; Electricity and Magnetism; Waves, Optics, and Heat (or higher)</td>
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<tr>
<td>CHEM 20100</td>
<td>Inorganic Chemistry I</td>
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<tr>
<td>One of the following sequences:</td>
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<tr>
<td>CHEM 22000-22100-22200</td>
<td>Organic Chemistry I-II-III</td>
</tr>
<tr>
<td>CHEM 23000-23100-23200</td>
<td>Honors Organic Chemistry I-II-III</td>
</tr>
<tr>
<td>CHEM 26100-26200</td>
<td>Quantum Mechanics; Thermodynamics</td>
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<tr>
<td>CHEM 26700</td>
<td>Experimental Physical Chemistry</td>
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<td><strong>Total Units</strong></td>
<td><strong>1400</strong></td>
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</table>

**Summary of Requirements: BS in Chemistry**

**General Education**

| CHEM 11100-11200 | Comprehensive General Chemistry I-II † ‡ | 200 |
| One of the following sequences: | 200 |
| MATH 15100 & MATH 15100 | Calculus I and Calculus I |
| MATH 16100 & MATH 16100 | Honors Calculus I and Honors Calculus I † |
| MATH 13100 & MATH 13100 | Elementary Functions and Calculus I and Elementary Functions and Calculus I (requires a grade of A- or higher) |
| **Total Units** | **400** |

**Major**

<p>| One of the following: † ‡ | 100 |
| CHEM 11300 | Comprehensive General Chemistry III |
| CHEM 12300 | Honors General Chemistry III |
| One of the following: | 100 |
| MATH 15300 | Calculus III |
| MATH 16300 | Honors Calculus III |
| MATH 19620 | Linear Algebra † |</p>
<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
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<tr>
<td>MATH 13300</td>
<td>Elementary Functions and Calculus III (requires a grade of A- or higher)</td>
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<tr>
<td>MATH 20000-20100</td>
<td>Mathematical Methods for Physical Sciences I-II</td>
<td>200</td>
</tr>
<tr>
<td>PHYS 13100-13200-13300</td>
<td>Mechanics; Electricity and Magnetism; Waves, Optics, and Heat (or higher)</td>
<td>300</td>
</tr>
<tr>
<td>CHEM 20100-20200</td>
<td>Inorganic Chemistry I-II</td>
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<td>CHEM 22000-22100-22200</td>
<td>Organic Chemistry I-II-III</td>
<td>300</td>
</tr>
<tr>
<td>CHEM 23000-23100-23200</td>
<td>Honors Organic Chemistry I-II-III</td>
<td></td>
</tr>
<tr>
<td>CHEM 23300</td>
<td>Organic Chemistry of Life Processes</td>
<td>100</td>
</tr>
<tr>
<td>CHEM 26100-26200-26300</td>
<td>Quantum Mechanics; Thermodynamics; Chemical Kinetics and Dynamics</td>
<td>300</td>
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<tr>
<td>CHEM 26700</td>
<td>Experimental Physical Chemistry</td>
<td>100</td>
</tr>
<tr>
<td>CHEM 22700</td>
<td>Advanced Organic/Inorganic Laboratory</td>
<td>100</td>
</tr>
<tr>
<td>CHEM 26800</td>
<td>Computational Chemistry and Biology</td>
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</tr>
<tr>
<td><strong>Total Units</strong></td>
<td></td>
<td><strong>1800</strong></td>
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</table>

† Credit may be granted by examination.

* See following sections on Advanced Placement and Accreditation Examinations.

‡ CHEM 10100-10200 Introductory General Chemistry I-II and CHEM 12100-12200 Honors General Chemistry I-II also satisfy this requirement. Enrollment into a particular sequence is based on chemistry placement or AP score.

NOTE: The three-quarter sequence MATH 20300-20400-20500 Analysis in Rn I-II-III may be substituted for MATH 20000 Mathematical Methods for Physical Sciences I; please note that MATH 20250 Abstract Linear Algebra or STAT 24300 Numerical Linear Algebra is a prerequisite for MATH 20400. MATH 27300 Basic Theory of Ordinary Differential Equations may be substituted for MATH 20100 Mathematical Methods for Physical Sciences II. MATH 19620 Linear Algebra is recommended for Chemistry majors who plan to pursue advanced study in physical chemistry.

Advanced Placement

Students who earned a score of 5 on the AP test in chemistry are given credit for CHEM 11100-11200-11300 Comprehensive General Chemistry I-II-III. Many such students elect to take CHEM 12100-12200-12300 Honors General Chemistry I-II-III. Students who complete one to three quarters of Comprehensive General Chemistry or Honors General Chemistry forgo partial or full AP credit. **Note that no credit is given for IB chemistry.**
Accreditation

The Department of Chemistry also administers accreditation examinations for CHEM 11100-11200-11300 Comprehensive General Chemistry I-II-III to entering college students. Only incoming first-year and transfer students are eligible to take these examinations, which are offered at the beginning of Autumn Quarter. Students may receive credit on the basis of their performance on accreditation examinations.

GRADING

In order to qualify for the BA or BS degree, a GPA of 2.0 or higher (with no grade lower than C-) is needed in all courses required in the major. Students majoring in chemistry must receive quality grades in all courses required in the degree program. Nonmajors may take chemistry courses on a P/F basis; only grades of C- or higher constitute passing work.

UNDERGRADUATE RESEARCH AND HONORS

By their third year, students majoring in chemistry are strongly encouraged to participate in research with a faculty member. For more information on research opportunities, visit chemistry.uchicago.edu/page/degree-programs-and-admissions.html.

Excellent students who pursue a substantive research project with a faculty member of the Department of Chemistry should plan to submit an honors thesis based on their work. Students usually begin this research program during their third year and continue through the following summer and their fourth year. Students who wish to be considered for honors are expected to complete their arrangements with the departmental counselor before the end of their third year and to register for one quarter of CHEM 29900 Advanced Research in Chemistry or one year of CHEM 29600 Research in Chemistry during their third or fourth years.

To be eligible to receive honors, students in the BA or BS degree program in chemistry must write a creditable honors paper describing their research. The paper must be submitted before the deadline established by the departmental counselor and must be approved by the Department of Chemistry. In addition, an oral presentation of the research is required. The research paper or project used to meet this requirement may not be used to meet the BA paper or project requirement in another major.

To earn a BA or BS degree with honors in chemistry, students must also have an overall GPA of 3.0 or higher.

SAMPLE PROGRAM

The following is a suggested schedule for completing a BA or BS degree in chemistry:

First Year

CHEM 10100-10200-11300 Introductory General Chemistry I-II; Comprehensive General Chemistry III or CHEM 11100-11200-11300 Comprehensive General Chemistry I-II-III or CHEM 12100-12200-12300 Honors General Chemistry I-II-III

MATH 15100-15200-15300 Calculus I-II-III or equivalent
Second Year
CHEM 22000-22100-22200 Organic Chemistry I-II-III or CHEM 23000-23100-23200 Honors Organic Chemistry I-II-III
MATH 20000-20100 Mathematical Methods for Physical Sciences I-II
Physics sequence (three quarters)

Third Year
CHEM 26100-26200-26300 Quantum Mechanics; Thermodynamics; Chemical Kinetics and Dynamics (if physics is taken in the second year)
CHEM 20100 Inorganic Chemistry I
CHEM 20200 Inorganic Chemistry II, CHEM 23300 Organic Chemistry of Life Processes, or CHEM 26300 Chemical Kinetics and Dynamics (for BS)

Fourth Year
CHEM 26100-26200-26300 Quantum Mechanics; Thermodynamics; Chemical Kinetics and Dynamics (if physics taken in the third year)
CHEM 23300 Organic Chemistry of Life Processes or CHEM 26300 Chemical Kinetics and Dynamics (for BS)
CHEM 22700 Advanced Organic/Inorganic Laboratory or CHEM 26800 Computational Chemistry and Biology (for BS)

Joint Degree Programs
Students who achieve advanced standing through their performance on placement examinations or accreditation examinations may consider the formulation of a four-year degree program that leads to the concurrent award of the BS and MS degrees in chemistry. For more information, consult Ka Yee Lee at kayeelee@uchicago.edu and Vera Dragisich at vdragisi@uchicago.edu in the Chemistry Department and Pete Segall at psegall@uchicago.edu in the College advising office.

Laboratory Safety
In chemistry labs, safety goggles must be worn at all times. Students who require prescriptive lenses may wear prescription glasses under goggles; contact lenses may not be worn. Exceptions for medical reasons must be obtained from the lab director.
COURSES

CHEM 00111-00112-00113. Collaborative Learning in General Chemistry I-II-III. This is an optional, limited enrollment workshop for students concurrently enrolled in CHEM 11100-11200-11300 Comprehensive General Chemistry I-II-III. Undergraduate Team Leaders guide small groups of students in weekly workshops. The workshops focus on the analysis of problem sets designed to augment and complement the Comprehensive General Chemistry material. Instead of tutoring or lecturing, Team Leaders coach students as they work collaboratively in small groups on the assigned problems by referencing class lectures and assigned reading materials. The workshops do not repeat but extend the substantive discussions and lectures of the Comprehensive General Chemistry course. Additionally, these workshops aim to develop communication skills, cooperative attitudes, and promote a teamwork environment. Because the benefits of collaborative learning can only be gained through consistent effort and attendance, this zero-credit course is graded P/F based on the student’s level of participation and attendance.

CHEM 00111. Collaborative Learning in General Chemistry I. 000 Units.
Instructor(s): B. Ratliff Terms Offered: Autumn
Prerequisite(s): Corequisite: Concurrent enrollment in CHEM 11100
Note(s): Enrollment in CHEM 00111 is section specific: CHEM 11100-01 students should enroll in CHEM 00111-01 while CHEM 11100-02 students should enroll in CHEM 00111-02.

CHEM 00112. Collaborative Learning in General Chemistry II. 000 Units.
Instructor(s): B. Ratliff Terms Offered: Winter
Prerequisite(s): Corequisite: Concurrent enrollment in CHEM 11200
Note(s): Enrollment in CHEM 00112 is section specific: CHEM 11200-01 students should enroll in CHEM 00112-01 while CHEM 11200-02 students should enroll in CHEM 00112-02. CHEM 00111 is not a prerequisite for this course.

CHEM 00113. Collaborative Learning in General Chemistry III. 000 Units.
Instructor(s): B. Ratliff Terms Offered: Spring
Prerequisite(s): Corequisite: Concurrent enrollment in CHEM 11300
Note(s): Enrollment in CHEM 00113 is section specific: CHEM 11300-01 students should enroll in CHEM 00113-01 while CHEM 11300-02 students should enroll in CHEM 00113-02. CHEM 00111 and CHEM 00112 are not prerequisites for this course.
CHEM 00220-00221-00222. Collaborative Learning in Organic Chemistry I-II-III.  
This is an optional, limited enrollment workshop for students concurrently enrolled in CHEM 22000-22100-22200 Organic Chemistry I-II-III. Undergraduate Team Leaders guide small groups of students in weekly workshops. The workshops focus on the analysis of problem sets designed to augment and complement the Organic Chemistry material. Instead of tutoring or lecturing, Team Leaders coach students as they work collaboratively in small groups on the assigned problems by referencing class lectures and assigned reading materials. The workshops do not repeat but extend the substantive discussions and lectures of the Organic Chemistry course. Additionally, these workshops aim to develop communication skills, cooperative attitudes, and promote a teamwork environment. Because the benefits of collaborative learning can only be gained through consistent effort and attendance, this zero-credit course is graded P/F based on the student’s level of participation and attendance.

CHEM 00220. Collaborative Learning in Organic Chemistry I. 000 Units.  
Instructor(s): B. Ratliff Terms Offered: Autumn
Prerequisite(s): Corequisite: Concurrent enrollment in CHEM 22000

CHEM 00221. Collaborative Learning in Organic Chemistry II. 000 Units.  
Instructor(s): B. Ratliff Terms Offered: Winter
Prerequisite(s): Corequisite: Concurrent enrollment in CHEM 22100
Note(s): CHEM 00220 is not a prerequisite for this course.

CHEM 00222. Collaborative Learning in Organic Chemistry III. 000 Units.  
Instructor(s): B. Ratliff Terms Offered: Spring
Prerequisite(s): Corequisite: Concurrent enrollment in CHEM 22200
Note(s): CHEM 00220 and CHEM 00221 are not prerequisites for this course.

CHEM 10100-10200-11300. Introductory General Chemistry I-II-III.  
This three-quarter sequence is a systematic introduction to chemistry for beginning students in chemistry or for those whose exposure to the subject has been moderate. We cover atomic and molecular theories, chemical periodicity, chemical reactivity and bonding, chemical equilibria, acid-base equilibria, solubility equilibria, phase equilibria, thermodynamics, electrochemistry, kinetics, quantum mechanics, and nuclear chemistry. Examples are drawn from chemical, biological, and materials systems. The laboratory portion includes an introduction to quantitative measurements, investigation of the properties of the important elements and their compounds, and experiments associated with the common ions and their separation and identification. Apart from one discussion session per week and a laboratory component, special emphasis on scientific problem-solving skills is made through two additional structured learning sessions per week devoted to quantitative reasoning. Attendance at discussion, structured learning, and laboratory sessions is mandatory. FOR THE THIRD (SPRING) QUARTER OF THE SEQUENCE, STUDENTS WILL ENROLL IN CHEM 11300.
CHEM 10100. Introductory General Chemistry I. 100 Units.
No description available.
Instructor(s): Staff. L: M. Zhao. Terms Offered: Autumn
Prerequisite(s): Enrollment limited to first-year students
Note(s): Enrollment by placement only. The first two courses in this sequence meet the general education requirement in the physical sciences.

CHEM 10200. Introductory General Chemistry II. 100 Units.
No description available.
Instructor(s): Staff. L: M. Zhao. Terms Offered: Winter
Prerequisite(s): Enrollment limited to first-year students
Note(s): Enrollment by placement only. The first two courses in this sequence meet the general education requirement in the physical sciences.

CHEM 11300. Comprehensive General Chemistry III. 100 Units.
No description available.
Instructor(s): K.Y.C. Lee, B.Roux. L: M. Zhao Terms Offered: Spring
Prerequisite(s): Good performance on the mathematics/calculus and chemistry placement tests
Note(s): Enrollment by placement only. The first two courses in this sequence meet the general education requirement in the physical sciences.

CHEM 11100-11200-11300. Comprehensive General Chemistry I-II-III.
Enrollment by placement only. The first two courses in this sequence meet the general education requirement in the physical sciences. This three-quarter sequence is a comprehensive survey of modern descriptive, inorganic, and physical chemistry for students with a good secondary school exposure to general chemistry. We cover atomic and molecular theories, chemical periodicity, chemical reactivity and bonding, chemical equilibria, acid-base equilibria, solubility equilibria, phase equilibria, thermodynamics, electrochemistry, kinetics, quantum mechanics, and nuclear chemistry. Examples are drawn from chemical, biological, and materials systems. The laboratory portion includes an introduction to quantitative measurements, investigation of the properties of the important elements and their compounds, and experiments associated with the common ions and their separation and identification. Attendance at one discussion session per week and laboratory sessions is required.

CHEM 11100. Comprehensive General Chemistry I. 100 Units.
No description available.
Instructor(s): N. Scherer, D. Mazziotti. L: M. Zhao Terms Offered: Autumn
Prerequisite(s): Good performance on the mathematics/calculus and chemistry placement tests
Note(s): Enrollment by placement only. The first two courses in this sequence meet the general education requirement in the physical sciences.
CHEM 11200. Comprehensive General Chemistry II. 100 Units.
No description available.
Instructor(s): G. Engel, B. Tian. L: M. Zhao. Terms Offered: Winter
Prerequisite(s): Good performance on the mathematics/calculus and chemistry placement tests
Note(s): Enrollment by placement only. The first two courses in this sequence meet the general education requirement in the physical sciences.

CHEM 11300. Comprehensive General Chemistry III. 100 Units.
No description available.
Instructor(s): K.Y.C. Lee, B.Roux. L: M. Zhao Terms Offered: Spring
Prerequisite(s): Good performance on the mathematics/calculus and chemistry placement tests
Note(s): Enrollment by placement only. The first two courses in this sequence meet the general education requirement in the physical sciences.

CHEM 12100-12200-12300. Honors General Chemistry I-II-III.
Enrollment by placement only. The first two courses in this sequence meet the general education requirement in the physical sciences. The subject matter and general program of this sequence is similar to that of the Comprehensive General Chemistry sequence. However, this accelerated course on the subject matter is designed for students deemed well prepared for a thorough and systematic study of chemistry. Introductory materials covered in the Comprehensive General Chemistry sequence are not part of the curriculum for this sequence; instead, special topics are included in each quarter to provide an in-depth examination of various subjects of current interest in chemistry. Attendance at one discussion session per week and laboratory sessions is required.

CHEM 12100. Honors General Chemistry I. 100 Units.
No description available.
Instructor(s): S. Sibener. L: M. Zhao Terms Offered: Autumn
Prerequisite(s): Good performance on the chemistry placement test or a score of 5 on the AP chemistry test
Note(s): Enrollment by placement only. The first two courses in this sequence meet the general education requirement in the physical sciences.

CHEM 12200. Honors General Chemistry II. 100 Units.
No description available.
Instructor(s): A. Tokmakoff. L: M. Zhao Terms Offered: Winter
Prerequisite(s): Good performance on the chemistry placement test or a score of 5 on the AP chemistry test
Note(s): Enrollment by placement only. The first two courses in this sequence meet the general education requirement in the physical sciences.
CHEM 12300. Honors General Chemistry III. 100 Units.
No description available.
Instructor(s): G. Voth. L: M. Zhao Terms Offered: Spring
Prerequisite(s): Good performance on the chemistry placement test or a score of 5 on the AP chemistry test
Note(s): Enrollment by placement only. The first two courses in this sequence meet the general education requirement in the physical sciences.

CHEM 20100-20200. Inorganic Chemistry I-II.
The extraordinarily diverse chemistry of the elements is organized in terms of molecular structure, electronic properties, and chemical reactivity. CHEM 20100 concentrates on structure and bonding, solid state chemistry, and selected topics in the chemistry of the main group elements and coordination chemistry. CHEM 20200 focuses on organometallic chemistry, reactions, synthesis, and catalysis, as well as bioinorganic chemistry.

CHEM 20100. Inorganic Chemistry I. 100 Units.
No description available.
Instructor(s): D. Talapin Terms Offered: Winter
Prerequisite(s): CHEM 11100-11200-11300 or equivalent, CHEM 22000 and CHEM 22100, or concurrent enrollment in CHEM 22100 or equivalent.

CHEM 20200. Inorganic Chemistry II. 100 Units.
No description available.
Instructor(s): R. Jordan Terms Offered: Spring
Prerequisite(s): CHEM 20100 and CHEM 22200

CHEM 22000-22100-22200. Organic Chemistry I-II-III.
The fundamental structures of organic molecules and the spectroscopic methods used to define them are studied. A comprehensive understanding of the reactions and properties of organic molecules (from kinetic, thermodynamic, and mechanistic viewpoints) is developed and applied to the synthesis of organic compounds and to an appreciation of nature's important molecules.

CHEM 22000. Organic Chemistry I. 100 Units.
No description available.
Instructor(s): V. Rawal. L: V. Keller Terms Offered: Autumn
Prerequisite(s): An average grade of C or higher in CHEM 10100-10200-10300 or CHEM 11100-11200-11300 or CHEM 12100-12200-12300, a 5 on the AP Chemistry exam, or consent of the department
Note(s): Students who receive a grade of B+ or higher in CHEM 22000 have the option of moving into honors organic chemistry for Winter/Spring. See following listing for CHEM 23100-23200. NOTE: Most medical schools require a full academic year of organic chemistry. A lab is one afternoon a week in addition to scheduled class time each quarter.
CHEM 22100. Organic Chemistry II. 100 Units.
No description available.
Instructor(s): L. Yu. L: V. Keller Terms Offered: Winter
Prerequisite(s): An average grade of C or higher in CHEM 10100-10200-10300 or CHEM 11100-11200-11300 or CHEM 12100-12200-12300, a 5 on the AP Chemistry exam, or consent of the department
Note(s): (Students who receive a grade of B+ or higher in CHEM 22000 have the option of moving into honors organic chemistry for Winter/Spring. See following listing for CHEM 23100-23200. NOTE: Most medical schools require a full academic year of organic chemistry. A lab is one afternoon a week in addition to scheduled class time each quarter.

CHEM 22200. Organic Chemistry III. 100 Units.
No description available.
Instructor(s): J. Piccirilli. L: V. Keller Terms Offered: Spring
Prerequisite(s): An average grade of C or higher in CHEM 10100-10200-10300 or CHEM 11100-11200-11300 or CHEM 12100-12200-12300, a 5 on the AP Chemistry exam, or consent of the department
Note(s): Students who receive a grade of B+ or higher in CHEM 22000 have the option of moving into honors organic chemistry for Winter/Spring. See following listing for CHEM 23100-23200.) NOTE: Most medical schools require a full academic year of organic chemistry. A lab is one afternoon a week in addition to scheduled class time each quarter.

CHEM 22700. Advanced Organic/Inorganic Laboratory. 100 Units.
This course combines a project approach with exposure to the more advanced techniques of organic and inorganic chemistry. Multistep synthesis, the synthesis of air-sensitive compounds, advanced chromatographic and spectroscopic characterization of products, and the handling of reactive intermediates are a part of the lab.
Instructor(s): M. Hopkins Terms Offered: Spring
Prerequisite(s): CHEM 20100 and 23300, or consent of instructor

CHEM 23000-23100-23200. Honors Organic Chemistry I-II-III.
This course combines a project approach with exposure to the more advanced techniques of organic and inorganic chemistry. Multistep synthesis, the synthesis of air-sensitive compounds, advanced chromatographic and spectroscopic characterization of products, and the handling of reactive intermediates are a part of the lab.
Instructor(s): M. Hopkins Terms Offered: Spring
Prerequisite(s): CHEM 20100 and 23300, or consent of instructor

CHEM 23000-23100-23200. Honors Organic Chemistry I-II-III.
This course studies the fundamental structures of organic molecules and the spectroscopic methods used to define. A comprehensive understanding of the reactions and properties of organic molecules (from kinetic, thermodynamic, and mechanistic viewpoints) is developed and applied to the synthesis of organic compounds and to an appreciation of nature’s important molecules.
CHEM 23000. Honors Organic Chemistry I. 100 Units.
No description available.
Instructor(s): Y. Krishnan. L: V. Keller Terms Offered: Autumn
Prerequisite(s): An average grade of B+ or higher in CHEM 11100-11200-11300 or equivalent, a 5 on the AP Chemistry exam, or consent of the department, and/or via placement exam.
Note(s): Students who have taken CHEM 22000 or 22100 with an average grade of B+ or higher may petition the department to move into the Honors sequence. Most medical schools require a full academic year of organic chemistry. A lab is one afternoon a week in addition to scheduled class time each quarter.

CHEM 23100. Honors Organic Chemistry II. 100 Units.
No description available.
Instructor(s): S. Kozmin. L: V. Keller Terms Offered: Winter
Prerequisite(s): An average grade of B+ or higher in CHEM 11100-11200-11300 or equivalent, a 5 on the AP Chemistry exam, or consent of the department, and/or via placement exam.
Note(s): Students who have taken CHEM 22000 or 22100 with an average grade of B+ or higher may petition the department to move into the Honors sequence. Most medical schools require a full academic year of organic chemistry. A lab is one afternoon a week in addition to scheduled class time each quarter.

CHEM 23200. Honors Organic Chemistry III. 100 Units.
No description available.
Instructor(s): J. Lewis. L: V. Keller Terms Offered: Spring
Prerequisite(s): An average grade of B+ or higher in CHEM 11100-11200-11300 or equivalent, a 5 on the AP Chemistry exam, or consent of the department, and/or via placement exam. Students who have taken CHEM 22000 or 22100 with an average grade of B+ or higher may petition the department to move into the Honors sequence. Most medical schools require a full academic year of organic chemistry. A lab is one afternoon a week in addition to scheduled class time each quarter.

CHEM 23300. Organic Chemistry of Life Processes. 100 Units.
This course addresses the chemical foundations of the biosynthetic pathways for amino acids, carbohydrates, lipids, and natural products. We emphasize reaction mechanisms in the biosynthesis of these naturally occurring molecules.
Instructor(s): Y. Weizmann Terms Offered: Autumn
Prerequisite(s): A grade of C or higher in CHEM 22200 or 23200, or consent of instructor

CHEM 26100-26200-26300. Quantum Mechanics; Thermodynamics; Chemical Kinetics and Dynamics.
This three-quarter sequence studies the application of physical and mathematical methods to the investigation of chemical systems.
CHEM 26100. Quantum Mechanics. 100 Units.
This course presents quantum mechanics, the Schrödinger wave equation with exact and approximate methods of solution, angular momentum, and atomic spectra and structure.
Instructor(s): K.Y.C. Lee
Terms Offered: Autumn
Prerequisite(s): CHEM 11300 or equivalent; MATH 20100 and PHYS 13300

CHEM 26200. Thermodynamics. 100 Units.
This course continues the sequence with the study of thermodynamic principles and applications, as well as statistical mechanics.
Instructor(s): P. Guyot-Sionnest
Terms Offered: Winter
Prerequisite(s): CHEM 11300 or equivalent; MATH 20100 and PHYS 13300

CHEM 26300. Chemical Kinetics and Dynamics. 100 Units.
This course is a discussion of chemical kinetics and dynamics for processes in gases, in liquids, and at interfaces.
Instructor(s): L. Butler
Terms Offered: Spring
Prerequisite(s): CHEM 11300 or equivalent; MATH 20100 and PHYS 13300

CHEM 26700. Experimental Physical Chemistry. 100 Units.
This course introduces the principles and practice of physical chemical measurements. Techniques used in the design and construction of apparatus are discussed in lectures, and practice is provided through lab exercises and experiments. Subjects covered include vacuum techniques, electronics, optics, use of computers in lab instrumentation, materials of construction, and data analysis.
Instructor(s): N. Scherer
Terms Offered: Winter
Prerequisite(s): CHEM 26100

CHEM 26800. Computational Chemistry and Biology. 100 Units.
The theme for this course is the identification of scientific goals that computation can assist in achieving. We examine problems such as understanding the electronic structure and bonding in molecules, interpreting the structure and thermodynamic properties of liquids, protein folding, enzyme catalysis, and bioinformatics. The lectures deal with aspects of numerical analysis and with the theoretical background relevant to calculations of the geometric and electronic structure of molecules, molecular mechanics, molecular dynamics, and Monte Carlo simulations. The lab consists of computational problems drawn from a broad range of chemical and biological interests.
Instructor(s): A. Dinner
Terms Offered: Spring
Prerequisite(s): CHEM 26100-26200, or PHYS 19700 and 23400
CHEM 29600. Research in Chemistry. 000 Units.
Students conduct advanced, individually-guided research. Students must submit a written report covering their research activities to the undergraduate counselor. Because this is a 000 credit course, it may be taken as a fifth course without additional charge.
Instructor(s): K.Y.C. Lee Terms Offered: Autumn, Winter, Spring
Prerequisite(s): Consent of a faculty sponsor and/or the undergraduate counselor
Note(s): Graded P/F; Students are required to submit the College Reading/Research Course Form

CHEM 29900. Advanced Research in Chemistry. 100 Units.
Students conduct advanced, individually guided research. Students may submit a written report covering their research activities for consideration for departmental honors.
Terms Offered: Summer, Autumn, Winter, Spring
Prerequisite(s): Consent of a faculty sponsor and the undergraduate counselor
Note(s): Open only to students majoring in chemistry who are eligible for honors. Available for either quality grades or for P/F grading. Students are required to submit the College Reading and Research Course Form.

CHEM 30100. Advanced Inorganic Chemistry. 100 Units.
Group theory and its applications in inorganic chemistry are developed. These concepts are used in surveying the chemistry of inorganic compounds from the standpoint of quantum chemistry, chemical bonding principles, and the relationship between structure and reactivity.
Instructor(s): W. Lin Terms Offered: Autumn
Prerequisite(s): CHEM 20100 and CHEM 26100

CHEM 30200. Synthesis and Physical Methods in Inorganic Chemistry. 100 Units.
This course covers theoretical and practical aspects of important physical methods for the characterization of inorganic molecules. Topics may include NMR, IR, RAMAN, EPR, and electronic and photoelectron spectroscopy; electrochemical methods; and single-crystal X-ray diffraction.
Instructor(s): W. Lin Terms Offered: Winter
Prerequisite(s): CHEM 30100

CHEM 30400. Organometallic Chemistry. 100 Units.
This course covers preparation and properties of organometallic compounds (notably those of the transition elements, their reactions, and the concepts of homogeneous catalysis).
Instructor(s): J. Lewis Terms Offered: Autumn
Prerequisite(s): CHEM 20100
CHEM 30500. Nanoscale Materials. 100 Units.
This course provides an overview of nanoscale phenomena in metals, semiconductors, and magnetic materials (e.g., the fundamental aspects of quantum confinement in semiconductors and metals, superparamagnetism in nanoscale magnets, electronic properties of nanowires and carbon nanotubes, surface plasmon resonances in nanomaterials, photonic crystals). Special attention is paid to preparative aspects of nanomaterials, colloidal and gas-phase syntheses of nanoparticles, nanowires, and nanotubes. Engineered nanomaterials and their assemblies are considered promising candidates for a variety of applications, from solar cells, electronic circuits, light-emitting devices, and data storage to catalysts, biological tags, cancer treatments, and drug delivery. The course covers state-of-the art in these and other areas. Finally, the course provides an overview of the experimental techniques used for structural characterization of inorganic nanomaterials (e.g., electron microscopy, X-ray diffractometry, small-angle X-ray scattering, STM, AFM, Raman spectroscopy).
Instructor(s): B. Tian Terms Offered: Not offered in 2016-17.
Prerequisite(s): CHEM 20200 and 26300, or consent of instructor

CHEM 30600. Chemistry of the Elements and Materials. 100 Units.
This course surveys the descriptive chemistries of the main-group elements and the transition metals from a synthetic perspective, and reaction chemistry of inorganic molecules is systematically developed.
Instructor(s): J. Anderson Terms Offered: Winter
Prerequisite(s): CHEM 20100

CHEM 30900. Bioinorganic Chemistry. 100 Units.
This course covers various roles of metals in biology. Topics include coordination chemistry of bioinorganic units, substrate binding and activation, electron-transfer proteins, atom and group transfer chemistry, metal homeostasis, ion channels, metals in medicine, and model systems.
Instructor(s): C. He Terms Offered: Spring
Prerequisite(s): CHEM 20200 and 22200/23200

CHEM 31100. Supramolecular Chemistry. 100 Units.
This course develops the concepts of supramolecular chemistry (both organic and metal-based systems) and its applications. Coordination chemistry is introduced as a background to metal-based supramolecular systems. The chemistry and physical properties of transition metal complexes are presented, including crystal field theory, molecular orbital theory, magnetism, and electronic spectra. The mechanisms by which molecular motors operate are presented and reference is made to synthetic systems that attempt to emulate biological molecular motors.
Terms Offered: Not offered in 2016–17
Prerequisite(s): CHEM 20200 and 22200/23200
CHEM 32100. Physical Organic Chemistry I. 100 Units.
This course focuses on the quantitative aspects of structure and reactivity, molecular orbital theory, and the insight it provides into structures and properties of molecules, stereochemistry, thermochemistry, kinetics, substituent and isotope effects, and pericyclic reactions.
Instructor(s): L. Yu Terms Offered: Autumn
Prerequisite(s): CHEM 22200/23200 and 26200, or consent of instructor

CHEM 32200. Organic Synthesis and Structure. 100 Units.
This course considers the mechanisms, applicability, and limitations of the major reactions in organic chemistry, as well as of stereochemical control in synthesis.
Instructor(s): S. Kozmin Terms Offered: Autumn
Prerequisite(s): CHEM 22200/23200 or consent of instructor

CHEM 32300. Strategies and Tactics of Organic Synthesis. 100 Units.
This course discusses the important classes for organic transformation. Topics include carbon-carbon bond formation; oxidation; and reduction using a metal, non-metal, or acid-base catalyst. We also cover design of the reagents and the scope and limitation of the processes.
Instructor(s): S. Snyder Terms Offered: Winter
Prerequisite(s): CHEM 22200/23200 or consent of instructor

CHEM 32400. Physical Organic Chemistry II. 100 Units.
Topics covered in this course include the mechanisms and fundamental theories of free radicals and the related free radical reactions, biradical and carbene chemistry, and pericyclic and photochemical reactions.
Terms Offered: Not offered in 2016–17
Prerequisite(s): CHEM 32100

CHEM 32500. Bioorganic Chemistry. 100 Units.
A goal of this course is to relate chemical phenomena with biological activities. We cover two main areas: (1) chemical modifications of biological macromolecules and their potential effects; and (2) the application of spectroscopic methods to elucidate the structure and dynamics of biologically relevant molecules.
Terms Offered: Not offered in 2016–17
Equivalent Course(s): BCMB 32500

CHEM 32900. Polymer Chemistry. 100 Units.
This course introduces a broad range of polymerization reactions and discusses their mechanisms and kinetics. New concepts of polymerization and new materials of current interest are introduced and discussed. We also discuss the physical properties of polymers, ranging from thermal properties to electrical and optical properties in both a solution state and a solid state. Our emphasis is on structure/property relationship.
Terms Offered: Not offered in 2016–17
Prerequisite(s): CHEM 22200/23200 and 26300
CHEM 33000. Complex Chemical Systems. 100 Units.
This course describes chemical systems in which nonlinear kinetics lead to unexpected (emergent) behavior of the system. Autocatalytic and spatiotemporal pattern forming systems are covered, and their roles in the development and function of living systems are discussed.
Terms Offered: Not offered in 2016–17
Prerequisite(s): CHEM 22200/23200 and MATH 20100, or consent of instructor

CHEM 33100. New Synthetic Reactions and Catalysts. 100 Units.
This course presents recent highlights of new synthetic reactions and catalysts for efficient organic synthesis. Mechanistic details and future possibilities are discussed.
Terms Offered: Not offered in 2016–17
Prerequisite(s): CHEM 23300

CHEM 33200-33300. Chemical Biology I-II.
This course emphasizes the concepts of physical organic chemistry (e.g., mechanism, molecular orbital theory, thermodynamics, kinetics) in a survey of modern research topics in chemical biology. Topics, which are taken from recent literature, include the roles of proteins in signal transduction pathways, the biosynthesis of natural products, strategies to engineer cells with novel functions, the role of spatial and temporal inhomogeneities in cell function, and organic synthesis and protein engineering for the development of molecular tools to characterize cellular activities.

   CHEM 33200. Chemical Biology I. 100 Units.
   No description available.
   Instructor(s): B. Dickinson Terms Offered: Autumn
   Prerequisite(s): Basic knowledge of organic chemistry and biochemistry

   CHEM 33300. Chemical Biology II. 100 Units.
   No description available.
   Instructor(s): R. Moellering Terms Offered: Winter
   Prerequisite(s): Basic knowledge of organic chemistry and biochemistry

CHEM 33400. High-Throughput Methods in Chemistry. 100 Units.
The course focuses on discovery of reactions, bioactive compounds, and materials by construction of chemical libraries and screening them for desired properties.
Terms Offered: Not offered in 2016–17

CHEM 36100. Wave Mechanics and Spectroscopy. 100 Units.
This course presents the introductory concepts, general principles, and applications of wave mechanics to spectroscopy.
Instructor(s): L. Butler Terms Offered: Autumn
Prerequisite(s): CHEM 26300

CHEM 36200. Quantum Mechanics. 100 Units.
This course builds upon the concepts introduced in CHEM 36100 with greater detail provided for the role of quantum mechanics in chemical physics.
Instructor(s): G. Voth Terms Offered: Winter
Prerequisite(s): CHEM 36100
CHEM 36300. Statistical Thermodynamics. 100 Units.
This course covers the thermodynamics and introductory statistical mechanics of systems at equilibrium.
Instructor(s): S. Vaikuntanathan Terms Offered: Autumn
Prerequisite(s): CHEM 26100-26200

CHEM 36400. Advanced Statistical Mechanics. 100 Units.
Topics covered in this course may include statistics of quantum mechanical systems, weakly and strongly interacting classical systems, phase transitions and critical phenomena, systems out of equilibrium, and polymers.
Instructor(s): D. Mazziotti Terms Offered: Winter
Prerequisite(s): CHEM 36300 or equivalent

CHEM 36500. Chemical Dynamics. 100 Units.
This course develops a molecular-level description of chemical kinetics, reaction dynamics, and energy transfer in both gases and liquids. Topics include potential energy surfaces, collision dynamics and scattering theory, reaction rate theory, collisional and radiationless energy transfer, molecule-surface interactions, Brownian motion, time correlation functions, and computer simulations.
Instructor(s): S. Sibener Terms Offered: Spring
Prerequisite(s): CHEM 36100 required; 36300 recommended

CHEM 36800. Advanced Computational Chemistry and Biology. 100 Units.
The theme for this course is the identification of scientific goals that computation can assist in achieving. The course is organized around the examination of exemplary problems, such as understanding the electronic structure and bonding in molecules and interpreting the structure and thermodynamic properties of liquids. The lectures deal with aspects of numerical analysis and with the theoretical background relevant to calculations of the geometric and electronic structure of molecules, molecular mechanics, molecular dynamics, and Monte Carlo simulations. The lab consists of computational problems drawn from a broad range of chemical and biological interests.
Instructor(s): K. Freed Terms Offered: Not offered in 2016–17
Prerequisite(s): CHEM 26100-26200, or PHYS 19700 and 23400
Note(s): This course may not be used to meet requirements for the BS degree.

CHEM 36900. Materials Chemistry. 100 Units.
This course covers structural aspects of colloidal systems, surfactants, polymers, diblock copolymers, and self-assembled monolayers. We also cover the electronic properties associated with organic conducting polymers, organic light-emitting devices, and transistors. More novel topics of molecular electronics, nanotubes, quantum dots, and magnetic systems are also covered. The aim of the course is to provide a broad perspective of the various contributions of chemistry to the development of functional materials.
Terms Offered: Not offered in 2016–17
CHEM 37100. Advanced Spectroscopies. 100 Units.
This linear and nonlinear spectroscopy course includes notions on matter-radiation interaction, absorption, scattering, and oscillator strength. They are applied mostly with the optical range, but we briefly touch upon microwave (NMR, ESR) and X-rays at the extreme. We cover nonlinear optical processes such as coherent Raman, harmonic, and sum-frequency; induced transparency; slow light; and X-ray generation. We also cover coherent and incoherent dynamical probes, such as pump-probe, echos, and two-dimensional spectroscopy.
Terms Offered: Not offered in 2016–17

CHEM 37200. Statistical Mechanics of Polymers/Glasses. 100 Units.
The material in this course is designed to describe the basic statistical mechanics of polymers in dilute and semi-dilute solutions, including the use of path integrals and renormalization group methods. Lattice models are used to describe polymer melts and blends, focusing on miscibility and the descent into glass formation.
Terms Offered: Not offered in 2016–17
Prerequisite(s): CHEM 36400 or equivalent

CHEM 38700. Biophysical Chemistry. 100 Units.
This course develops a physicochemical description of biological systems. Topics include macromolecules, fluid-phase lipid-bilayer structures in aqueous solution, biomembrane mechanics, control of biomolecular assembly, and computer simulations of biomolecular systems.
Instructor(s): A. Tokmakoff Terms Offered: Spring
Prerequisite(s): CHEM 23300, CHEM 26200.

CHEM 51100. Scientific Methods and Ethics. 100 Units.
This course prepares students for independent research by introducing them to the general methodology of scientific research.
Terms Offered: Not offered in 2016–17