

# 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

CHEM 11100-11200	Comprehensive General Chemistry I-II <sup>†**‡</sup>	200
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One of the following sequences:		200
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MATH 15100-15200	Calculus I-II	
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MATH 16100-16200	Honors Calculus I-II <sup>†</sup>	
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MATH 13100-13200	Elementary Functions and Calculus I-II (requires a grade of A- or higher)	
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Total Units		400
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### MAJOR

One of the following: <sup>†*</sup>		100
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CHEM 11300	Comprehensive General Chemistry III	
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CHEM 12300	Honors General Chemistry III	
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One of the following:		100
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MATH 15300	Calculus III	
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MATH 16300	Honors Calculus III	
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MATH 19620	Linear Algebra <sup>†</sup>	
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MATH 13300	Elementary Functions and Calculus III (requires a grade of A- or higher)	
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MATH 20000-20100	Mathematical Methods for Physical Sciences I-II	200
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PHYS 13100-13200-13300	Mechanics; Electricity and Magnetism; Waves, Optics, and Heat (or higher)	300
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CHEM 20100	Inorganic Chemistry I	100
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One of the following sequences:		300
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CHEM 22000-22100-22200	Organic Chemistry I-II-III	
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CHEM 23000-23100-23200	Honors Organic Chemistry I-II-III	
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CHEM 26100-26200	Quantum Mechanics; Thermodynamics	200
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CHEM 26700	Experimental Physical Chemistry	100
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Total Units		1400
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## Summary of Requirements: BS in Chemistry

### GENERAL EDUCATION

CHEM 11100-11200	Comprehensive General Chemistry I-II <sup>†**‡</sup>	200
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One of the following sequences:		200
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MATH 15100-15200	Calculus I-II	
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MATH 16100-16200	Honors Calculus I-II <sup>†</sup>	
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MATH 13100-13200	Elementary Functions and Calculus I-II (requires a grade of A- or higher)	
Total Units		400
<b>MAJOR</b>		
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 †	
MATH 13300	Elementary Functions and Calculus III (requires a grade of A- or higher)	
MATH 20000-20100	Mathematical Methods for Physical Sciences I-II	200
PHYS 13100-13200-13300	Mechanics; Electricity and Magnetism; Waves, Optics, and Heat (or higher)	300
CHEM 20100-20200	Inorganic Chemistry I-II	200
One of the following sequences:		300
CHEM 22000-22100-22200	Organic Chemistry I-II-III	
CHEM 23000-23100-23200	Honors Organic Chemistry I-II-III	
CHEM 23300	Organic Chemistry of Proteins	100
CHEM 26100-26200-26300	Quantum Mechanics; Thermodynamics; Chemical Kinetics and Dynamics	300
CHEM 26700	Experimental Physical Chemistry	100
One of the following:		100
CHEM 22700	Advanced Organic/Inorganic Laboratory	
CHEM 26800	Computational Chemistry and Biology	
Total Units		1800

† 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 earn a score of 5 on the AP test in chemistry are given credit for CHEM 11100 Comprehensive General Chemistry I. Students with CHEM 11100 Comprehensive General Chemistry I credit may join CHEM 11200 Comprehensive General Chemistry II in the Winter Quarter. A score of 5 on the AP exam also permits students to take CHEM 12100-12200-12300 Honors General Chemistry I-II-III; students may opt to begin with CHEM 12100 Honors General Chemistry I in the Autumn Quarter or CHEM 12200 Honors General Chemistry II in the Winter Quarter. Students who complete the first quarter of Comprehensive General Chemistry or Honors General Chemistry forgo the 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

Students majoring in Chemistry must earn (1) a major GPA of 2.0 or higher and (2) a C- or higher in all courses required by the Chemistry major, including those courses counting toward general education requirements in the mathematical and physical sciences. 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/kb](http://chemistry.uchicago.edu/kb).

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 Proteins, 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 Proteins 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](mailto:kayeelee@uchicago.edu) and Vera Dragisich at [vdragisi@uchicago.edu](mailto:vdragisi@uchicago.edu) in the Chemistry Department and Pete Segall at [psegall@uchicago.edu](mailto: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; Comprehensive General Chemistry 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): B. Ratliff. 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): B. Ratliff. 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): Y. Weizmann, L. Yu. 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): S. Kozmin; L. Butler; 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): N. Scherer, A. Tokmakoff. 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): Y. Weizmann, L. Yu. 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): K.Y.C. Lee, 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): B. Roux, 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): J. Anderson 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): S. Kozmin; 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 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): B. Dickinson, 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): R. Moellering, 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 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): V. Rawal. 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): S. Snyder. 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 Proteins. 100 Units.**

Proteins are the dominant natural products of the 21st century. This course will explore the organic chemistry of protein molecules: their chemical structure and biological functions, protein biosynthesis, intein-mediated protein splicing, and the use of chemistry to probe the molecular basis of the remarkable properties of proteins and enzymes.

Instructor(s): S. Kent 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): D. Mazziotti 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): S. Vaikuntanathan 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): T. Berkelbach 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. L.

Instructor(s): J. Park 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. L.

Instructor(s): G. Voth 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. Because this is a 000 credit course, students must submit a written report covering their research activities to the undergraduate counselor, and this course may be taken as a fifth course without additional charge. Research activities undertaken in this course may be used towards the writing of a thesis for consideration for departmental honors.

Instructor(s): K. Y. C. Lee Terms Offered: Autumn, Spring, Winter

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. Research activities undertaken in this course may be used towards the writing of a thesis for consideration for departmental honors.

Instructor(s): Staff Terms Offered: Autumn, Spring, Summer, Winter

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 2017-18.

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.

Instructor(s): Staff Terms Offered: Not offered in 2017-18

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): G. Dong 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.

Instructor(s): Staff Terms Offered: Not offered in 2017-18

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 2017-18

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.

Instructor(s): Staff Terms Offered: Not offered in 2017-18

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.

Instructor(s): Staff Terms Offered: Not offered in 2017-18

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.

Instructor(s): Staff Terms Offered: Not offered in 2017-18

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.

Instructor(s): Staff Terms Offered: Not offered in 2017-18

**CHEM 33500. Chemistry of Enzyme Catalysis. 100 Units.**

The course will cover a series of topics illustrating and exploring aspects of the chemistry of enzyme catalysis, and will use case studies based on the primary scientific literature--both classic and current papers. For each class, there will be primary scientific papers assigned that the student will be expected to have studied in depth prior to class, including "reading around" on the same and related topics; suggestions for supplementary reading will be given. Classes will be conducted as discussion sessions; guided by the Instructor--all students will be expected to be prepared to answer questions from the instructor, and to take active part in class discussions. Participation in class will count for a portion of the grade for each student.

Instructor(s): Stephen Kent Terms Offered: Winter 2015

Prerequisite(s): CHEM 23300

**CHEM 33600. Biological Chemistry of Materials: Principles and Applications. 100 Units.**

This course will focus on principles of bioconjugation techniques; preparation of immobilized-enzymes/proteins: adsorption, occlusion, cross-linking and covalent binding. Applications of cofactor-dependent enzymes: building of enzymatic electrodes and biofuel cells. Development of immunosensors based on ELISA, electrochemistry, optics, carbon nanotubes and piezoelectric methods. Principles and design of DNA/RNA based sensors (Ribozymes, SELEX, Aptamers, DNAszymes, Molecular Beacons). Amplification methods for nucleic acids detection in test tube and in cells. Preparation and characterization of nanoparticles in nucleic acids and proteins sensing processes.

Instructor(s): Yossi Weizmann Terms Offered: Winter 2015

Prerequisite(s): CHEM 23300 or consent of instructor

**CHEM 33700. RNA Structure, Function, and Biology. 100 Units.**

Students will learn principles of RNA structure and function, RNA catalysis, and RNA molecular cell biology as they relate to the field of RNA metabolism. In recent years it has become apparent that much of an organisms genome is transcribed, yielding a far more expansive collection of RNA molecules than previously thought: many of these RNAs are classic messenger RNAs that code for proteins but many serve functions other than protein coding (noncoding RNAs). These RNAs are processed, modified, and usually interact with RNA binding proteins (RBPs) to form ribonucleoprotein (RNP) complexes. We will consider emerging themes in noncoding RNA biology and investigate methods for interrogating their cellular structure and function.

Instructor(s): Prof. Joseph Piccirilli Terms Offered: Spring

**CHEM 33800. Organotransition Metal Chemistry. 100 Units.**

Transition-metal catalysis becomes one of the most important tools in organic synthesis. In this course, we will start to review the fundamental knowledge in organo-transition metal chemistry, such as bonding, coordination chemistry of metal-ligand complexes, in detail. The main focus will be the basic elementary reactions of organometallic complexes, such as oxidative addition, migratory insertion, reductive elimination etc. Lastly, we will study the subject of catalysis, and examine various catalytic transformations through the course.

Instructor(s): Guangbin Dong Terms Offered: Spring

**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): N. Scherer 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. L.

Instructor(s): K. Freed Terms Offered: Not offered in 2017-18

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 2017-18

**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.

Instructor(s): P. Guyot-Sionnest Terms Offered: Winter

**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 37300. Advanced Special Topics in Theory and Computation. 100 Units.**

This course introduces topics in theoretical and computational chemistry beyond those in the traditional graduate physical chemistry sequence. Specific topics will vary from year to year based on the interests of the instructor and students. Representative topics are diagrammatic methods, field theories, renormalization, nonequilibrium statistical mechanics, and quantum dynamics.

Instructor(s): Aaron Dinner Terms Offered: Spring 2017-2018

**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 39000. Materials Chemistry I. 100 Units.**

This course is an introduction to modern materials chemistry. It covers basic chemistry and physics of condensed systems, such as solids, polymers, and nanomaterials. The electronic structure of metals, semiconductors and magnetically ordered phases will be discussed. We will review optical and electronic properties of different classes of materials using examples of hard and soft condensed matter systems and drawing structure-property relationships for conventional solids, polymers, and nanomaterials. Finally, the course will cover the fundamentals of surface science and material synthesis, applying modern understanding of nucleation and growth phenomena.

Instructor(s): Prof. Dmitri Talapin Terms Offered: Autumn

Prerequisite(s): CHEM 26100, CHEM 26200, and CHEM 26300, or equivalent

**CHEM 39100. Materials Chemistry II. 100 Units.**

This course will focus on the physical properties and kinetics of materials. The chemically-enabled properties of many different materials will be described, including linear and nonlinear elasticity, piezoelectricity, magnetic phenomena, diffusion and other transport properties, nonlinear optical properties, linear and nonlinear acoustic wave phenomena, and biological impacts. Selected applications associated with these properties will be included. Additionally, the course will discuss complex motion of dislocations and interfaces, morphological evolution, and phase transformations in materials synthesis.

Instructor(s): Prof. Bozhi Tian Terms Offered: Spring

Prerequisite(s): CHEM 26100 and CHEM 26300 or equivalent

**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





#### Font Notice

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

Times was used instead of Trajan.

Times was used instead of Palatino.

The editor may contact Leepfrog for a draft with the correct fonts in place.