

# CHEMISTRY

Department Website: <http://chemistry.uchicago.edu/kb> (<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, pre-medicine, and education, as well as the ability to double major with many other departments in a straightforward way.

## 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: ACS-Accredited 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 ACS-Accredited BS degree.

**Program Requirements: BS (with Specialized Track)** The BS with the Physical Chemistry Track requires a minimum of nine courses in Chemistry beyond the general education requirement (which should be taken in the first year), one of which has to be a graduate course. The BS with the Organic Chemistry, Inorganic Chemistry, Materials Chemistry, or Chemical Biology Track all require a minimum of ten courses in Chemistry beyond the general education requirement (which should be taken in the first year), one of which has to be a graduate course.

### Tracks:

- Physical Chemistry
- Organic Chemistry
- Inorganic Chemistry
- Materials Chemistry
- Chemical Biology

Please note that while the lower course requirement for the BA degree makes double majoring with many other programs of study feasible, double majoring with a BA and BS both in Chemistry is not allowed, as the BA in Chemistry is contained within the BS degree. Students who wish to double major with a BS in Biological Chemistry and a BA in Chemistry or a BS in Chemistry (with specialized track) must fulfill the 30000-level Biochemistry course requirements in a Chemistry 30000-level course.

## SUMMARY OF REQUIREMENTS: BA IN CHEMISTRY

### GENERAL EDUCATION

CHEM 11100-11200	Comprehensive General Chemistry I-II <sup>††</sup>	200
One of the following sequences:		200
MATH 15100-15200	Calculus I-II	
MATH 16100-16200	Honors Calculus I-II <sup>†</sup>	
MATH 13100-13200	Elementary Functions and Calculus I-II	

Total Units 400

### MAJOR

One of the following: <sup>††</sup>		100
CHEM 11300	Comprehensive General Chemistry III	
CHEM 12300	Honors General Chemistry III	
MATH 18300-18400-18500	Mathematical Methods in the Physical Sciences I-II-III <sup>§</sup>	300
PHYS 13100-13200	Mechanics; Electricity and Magnetism (or higher)	200
CHEM 20100	Inorganic Chemistry	100

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 26100 & CHEM 26200	Introductory Quantum Mechanics and Thermodynamics	200
One of the following:		100
CHEM 26700	Experimental Physical Chemistry	
CHEM 26800	Quantum Molecular and Materials Modeling	
CHEM 22700	Advanced Organic/Inorganic Laboratory	
CHEM 29900	Advanced Research in Chemistry	
Total Units		1300

## SUMMARY OF REQUIREMENTS: ACS-ACCREDITED BS IN CHEMISTRY

The ACS-Accredited BS is the most comprehensive degree in Chemistry.

## GENERAL EDUCATION

CHEM 11100-11200	Comprehensive General Chemistry I-II <sup>++†</sup>	200
One of the following sequences:		200
MATH 15100-15200	Calculus I-II	
MATH 16100-16200	Honors Calculus I-II <sup>†</sup>	
MATH 13100-13200	Elementary Functions and Calculus I-II (MATH 15000s or higher is strongly recommended)	
Total Units		400

## MAJOR

One of the following: <sup>++</sup>		100
CHEM 11300	Comprehensive General Chemistry III	
CHEM 12300	Honors General Chemistry III	
MATH 18300-18400-18500	Mathematical Methods in the Physical Sciences I-II-III <sup>§</sup>	300
CHEM 20100	Inorganic Chemistry	100
One of the following:		100
CHEM 20200	Organometallic Chemistry	
CHEM 20300	Chemistry of Materials	
PHYS 13100-13200-13300	Mechanics; Electricity and Magnetism; Waves, Optics, and Heat (or higher)	300
CHEM 22000-22100-22200	Organic Chemistry I-II-III	300
CHEM 23300	Introduction to Chemical Biology	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	Quantum Molecular and Materials Modeling	
Total Units		1800

## SUMMARY OF REQUIREMENTS: BS IN CHEMISTRY (WITH SPECIALIZED TRACK)

The BS in Chemistry (with Specialized Track) includes a set of required foundational courses, which do not constitute a degree by themselves, plus additional courses for the different tracks as outlined below. The BS in Chemistry (with Specialized Track) carries 1500 units of credit.

## FOUNDATIONAL COURSES

## GENERAL EDUCATION

CHEM 11100-11200	Comprehensive General Chemistry I-II <sup>++†</sup>	200
One of the following sequences:		200
MATH 15100-15200	Calculus I-II	
MATH 16100-16200	Honors Calculus I-II <sup>†</sup>	

MATH 13100-13200	Elementary Functions and Calculus I-II	
Total Units		400
MAJOR		
One of the following: <sup>+</sup>		100
CHEM 11300	Comprehensive General Chemistry III	
CHEM 12300	Honors General Chemistry III	
MATH 18300-18400-18500	Mathematical Methods in the Physical Sciences I-II-III <sup>§</sup>	300
PHYS 13100-13200	Mechanics; Electricity and Magnetism (or higher)	200
CHEM 20100	Inorganic Chemistry	100
One of the following sequences:		200
CHEM 22000 & CHEM 22100	Organic Chemistry I and Organic Chemistry II	
CHEM 23000 & CHEM 23100	Honors Organic Chemistry I and Honors Organic Chemistry II	
CHEM 26100 & CHEM 26200	Introductory Quantum Mechanics and Thermodynamics	200
Total Units		1100
TRACKS		
PHYSICAL CHEMISTRY TRACK		
PHYS 13300 or PHYS 14300	Waves, Optics, and Heat Honors Waves, Optics, and Heat	100
One of the following:		
CHEM 29900 or CHEM 26700 or CHEM 26800	Advanced Research in Chemistry Experimental Physical Chemistry Quantum Molecular and Materials Modeling	100
One of the following:		100
CHEM 20300	Chemistry of Materials	
CHEM 26300	Chemical Kinetics and Dynamics	
CHEM 26700	Experimental Physical Chemistry	
CHEM 26800	Quantum Molecular and Materials Modeling	
One of the following:		100
CHEM 36100	Wave Mechanics and Spectroscopy	
CHEM 36200	Quantum Mechanics	
CHEM 36300	Statistical Thermodynamics	
CHEM 36400	Advanced Statistical Mechanics	
CHEM 31358	Simulation, Modeling, and Computation in Biophysics	
CHEM 36500	Chemical Dynamics	
CHEM 39000	Solids, Materials, Surfaces	
CHEM 39300	Electronic and Quantum Materials for Technology	
Total Units		400
ORGANIC CHEMISTRY TRACK		
CHEM 22200 or CHEM 23200	Organic Chemistry III Honors Organic Chemistry III	100
One of the following:		100
CHEM 22700	Advanced Organic/Inorganic Laboratory	
CHEM 29900	Advanced Research in Chemistry	
Two of the following:		200
CHEM 23300	Introduction to Chemical Biology	
CHEM 30400	Organometallic Chemistry	
CHEM 32100	Physical Organic Chemistry I	
CHEM 32200	Organic Synthesis and Structure	

CHEM 32300	Strategies and Tactics of Organic Synthesis	
Total Units		400
INORGANIC CHEMISTRY TRACK		
One of the following:		100
CHEM 22700	Advanced Organic/Inorganic Laboratory	
CHEM 29900	Advanced Research in Chemistry	
Three of the following (at least one has to be a 30000-level course):		300
CHEM 20200	Organometallic Chemistry	
CHEM 20300	Chemistry of Materials	
CHEM 22200 or CHEM 23200	Organic Chemistry III Honors Organic Chemistry III	
CHEM 30100	Inorganic Chemistry	
CHEM 30200	Synthesis and Physical Methods in Inorganic Chemistry	
CHEM 30400	Organometallic Chemistry	
CHEM 30600	Chemistry Of The Elements and Materials	
CHEM 30900	Bioinorganic Chemistry	
CHEM 39000	Solids, Materials, Surfaces	
Total Units		400
MATERIALS CHEMISTRY TRACK		
CHEM 20300	Chemistry of Materials	100
One of the following:		100
CHEM 22700	Advanced Organic/Inorganic Laboratory	
CHEM 29900	Advanced Research in Chemistry	
One of the following:		100
CHEM 22200 or CHEM 23200	Organic Chemistry III Honors Organic Chemistry III	
CHEM 26700	Experimental Physical Chemistry	
CHEM 26800	Quantum Molecular and Materials Modeling	
One of the following:		100
CHEM 30100	Inorganic Chemistry	
CHEM 30200	Synthesis and Physical Methods in Inorganic Chemistry	
CHEM 30600	Chemistry Of The Elements and Materials	
CHEM 39000	Solids, Materials, Surfaces	
CHEM 39100	Polymer Synthesis	
CHEM 39300	Electronic and Quantum Materials for Technology	
Total Units		400
CHEMICAL BIOLOGY TRACK		
CHEM 22200 or CHEM 23200	Organic Chemistry III Honors Organic Chemistry III	100
CHEM 23300	Introduction to Chemical Biology	100
One of the following:		100
CHEM 22700	Advanced Organic/Inorganic Laboratory	
CHEM 29900	Advanced Research in Chemistry	
One of the following:		100
CHEM 31358	Simulation, Modeling, and Computation in Biophysics	
CHEM 30900	Bioinorganic Chemistry	
CHEM 33900	Discovery and Translation of Molecular Therapeutics	
Total Units		400

† Credit may be granted by examination.

\* See following sections on Chemistry Placement Test, Advanced Placement Credit, and Optional Chemistry Advanced Placement Exam. Note that no credit is given for IB chemistry.

- ‡ CHEM 10100-CHEM 10200 Introductory General Chemistry I-II and CHEM 12100-CHEM 12200 Honors General Chemistry I-II also satisfy this requirement. Enrollment into a particular sequence is based on students' Chemistry Placement Test score.
- § The sequence MATH 18300-18400-18500 (<http://collegecatalog.uchicago.edu/search/?P=MATH%2018300-18400-18500>) Mathematical Methods in the Physical Sciences I-II-III is the recommended course of study for Chemistry majors. Students who switch into the major later in their studies may also substitute MATH 15300/16300, MATH 19620, MATH 20250, or STAT 24300 for MATH 18300. Students who wish to double major or minor in Mathematics may consider alternative substitutions. The three-quarter sequence MATH 20300-20400-20500 (<http://collegecatalog.uchicago.edu/search/?P=MATH%2020300-20400-20500>) Analysis in Rn I-II-III or the honors variation of this sequence (MATH 20700-20800-20900 (<http://collegecatalog.uchicago.edu/search/?P=MATH%2020700-20800-20900>)) Honors Analysis in Rn I-II-III) may be substituted for MATH 18400 (<http://collegecatalog.uchicago.edu/search/?P=MATH%2018400>)-MATH 18500 (<http://collegecatalog.uchicago.edu/search/?P=MATH%2018500>) Mathematical Methods in the Physical Sciences II-III; please note that MATH 20250 (<http://collegecatalog.uchicago.edu/search/?P=MATH%2020250>) Abstract Linear Algebra or STAT 24300 (<http://collegecatalog.uchicago.edu/search/?P=STAT%2024300>) Numerical Linear Algebra is a prerequisite for MATH 20400. MATH 18600 (<http://collegecatalog.uchicago.edu/search/?P=MATH%2018600>) is recommended for Chemistry majors who plan to pursue advanced study in physical chemistry.

## CHEMISTRY PLACEMENT TEST

The Chemistry Placement Test, taken online in the summer via Canvas (<https://canvas.uchicago.edu/>), is required for all first-year and transfer students intending to enroll in General, Honors, or Introductory Chemistry. Without a Chemistry Placement Test score, students will not be able to pre-register in Chemistry courses. The Mathematics Placement Test is also required in order to receive a Chemistry placement. After the Chemistry Placement Test is scored, the results will be visible in the Student Portal (<https://my.uchicago.edu/>). For more information on placement examinations, please consult the New Student Advising website (<https://college.uchicago.edu/new-student-advising/placement-ap-tests/>).

## ADVANCED PLACEMENT CREDIT

Students who earn a score of 5 on the Advanced Placement (AP) Examination in Chemistry are still required to take the Chemistry Placement Test. Students with an AP score of 5 in Chemistry are given credit for CHEM 11100 Comprehensive General Chemistry I. Students who receive this credit through AP have two options:

1. Take CHEM 11200 Comprehensive General Chemistry II or CHEM 12200 Honors General Chemistry II in the Winter Quarter. (Students considering CHEM 12200 are strongly encouraged to self-review material prior to starting the course.)
2. Forfeit their AP credit and take CHEM 11100 Comprehensive General Chemistry I or CHEM 12100 Honors General Chemistry I in the Autumn Quarter.

Note that no credit is given for IB Chemistry, but students may pursue the Chemistry Advanced Placement option described below.

## CHEMISTRY ADVANCED PLACEMENT EXAM

Incoming first-year and transfer students with a strong Chemistry background (i.e., those who place into CHEM 12100 Honors General Chemistry I on the Chemistry Placement Test) will be automatically granted access to the Chemistry Advanced Placement Exam (CAPE). *This exam is optional and offered online via Canvas only at the time of matriculation.*

Eligible students will receive an email during the summer outlining how to sit for the CAPE. Performing well on this exam may qualify a student to place out of the General Chemistry I-II-III course sequence and into more advanced coursework in Chemistry. While their original placement will remain available, the option to begin in CHEM 22000 Organic Chemistry I, CHEM 23000 Honors Organic Chemistry I, or CHEM 26100 Introductory Quantum Mechanics (the latter upon also meeting MATH and PHYS course prerequisites) will also be provided.

Students with the Advanced Placement who take advantage of direct enrollment into the aforementioned advanced coursework will be awarded back credit for CHEM 11100-11200-11300 Comprehensive General Chemistry I-II-III upon completion of any three of the following courses:

- CHEM 20100-20200 Inorganic Chemistry I-II
- CHEM 20300 Chemistry of Materials
- CHEM 22700 Advanced Organic/Inorganic Laboratory
- CHEM 23300 Introduction to Chemical Biology
- CHEM 26100-26200-26300 Quantum Mechanics; Thermodynamics; Chemical Kinetics and Dynamics
- CHEM 26700 Experimental Physical Chemistry
- CHEM 26800 Quantum Molecular and Materials Modeling

This placement option provides the opportunity to fast-track well-prepared students who wish to advance their studies into the various sub-fields of Chemistry, double major or minor in Chemistry, or enroll in advanced courses that require completion of General Chemistry I-II-III as a prerequisite.

### JOINT DEGREE PROGRAM

Students interested in the Joint BS/MS Degree Program in Chemistry and Biological Chemistry (<https://chemistry.uchicago.edu/undergraduate-major-and-research/joint-bsms-degree-program/>) should contact Vera Dragisich ([v-dragisich@uchicago.edu](mailto:v-dragisich@uchicago.edu)) for detailed information and discussion of eligibility.

Students who achieve advanced academic standing through their performance on the Department of Chemistry's advanced placement examinations, and have sufficient space in their schedule, may consider the formulation of a four-year joint degree program that leads to the concurrent award of the BS in either Chemistry or Biological Chemistry and the MS in Chemistry. In consultation with Vera Dragisich, special programs are developed for such students. Following consultation, students who are interested in pursuing the joint degree will fill out an application.

The Department requires students who are admitted as prospective candidates for the Joint BS/MS Degree Program in Chemistry or Biological Chemistry to pass a series of Basic Examinations. These examinations are based on material covered at most accredited universities and four-year colleges: one year of general chemistry (including qualitative and quantitative analysis), organic chemistry, inorganic chemistry, and physical chemistry. Exams must be taken prior to Spring quarter of the graduation year and students have three opportunities to pass each exam. Exams are regularly scheduled the first week of each quarter. However, special testing arrangements can be made with a week's prior notice to Vera Dragisich.

In addition to satisfying the Basic Examination requirement, the following are specific departmental requirements for the Master of Science degree in Chemistry:

- Each candidate shall satisfactorily complete nine courses selected from the graduate offerings (300-level for lecture courses; 200, 300 or 400-level for research courses) in the Department of Chemistry and related departments in the Physical and Biological Sciences Divisions. Six of these shall be 300-level courses with grades of C or better from the offerings of the Department of Chemistry or related departments in the Physical and Biological Sciences Divisions. Four of these courses must be taken in Chemistry, and at least two of these four courses must be a Chemistry course designated as foundational. The two courses that may be taken outside the department to satisfy this requirement must be approved in advance. Absolutely no undergraduate level courses can be used to satisfy the six graduate level course requirement. Three courses will be research courses in order to satisfy the nine required courses.
- Grades of C or better are required for all courses except research courses, where a grade of P is acceptable.
- Candidates must do an honors BS paper and participate in the Spring honors symposium.
- All required core classes must be completed by the end of the third year and before start of the fourth year.

### UNDERGRADUATE RESEARCH AND HONORS

Students majoring in Chemistry are strongly encouraged to participate in research with a faculty member (<https://chemistry.uchicago.edu/faculty/>). Research can be either independent or taken for course credit. To participate in research coursework, a student is required to have the consent of a faculty sponsor and the Director of Undergraduate Studies (DUS) ([chem-dus@lists.uchicago.edu](mailto:chem-dus@lists.uchicago.edu)), and to submit the College Reading/Research Course Form (<https://humanities-web.s3.us-east-2.amazonaws.com/college-prod/s3fs-public/documents/College%20Reading%20&%20Research%20Form%20Fillable.pdf>). For more information on research opportunities, the Honors Program in Chemistry, and/or how to fill out the College Reading/Research Course Form, please visit the Department of Chemistry website (<https://chemistry.uchicago.edu/undergraduate-chemistry-major-and-research/>).

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. Honors thesis work constitutes a sustained, and in many cases multi-year, project, with students typically beginning no later than their third year and continuing through the following summer and their fourth year. Students who wish to be considered for honors are expected to complete their arrangements with the Director of Undergraduate Studies (DUS) ([chem-dus@lists.uchicago.edu](mailto:chem-dus@lists.uchicago.edu)) before the end of the 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 Director of Undergraduate Studies (DUS) ([chem-dus@lists.uchicago.edu](mailto:chem-dus@lists.uchicago.edu)) 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-CHEM 10200-CHEM 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

MATH 18400 Mathematical Methods in the Physical Sciences II and MATH 18500 Mathematical Methods in the Physical Sciences III

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 26700 Experimental Physical Chemistry

CHEM 20100 Inorganic Chemistry

CHEM 20200 Organometallic Chemistry or CHEM 20300 Chemistry of Materials, CHEM 23300 Introduction to Chemical Biology, 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 26700 Experimental Physical Chemistry

CHEM 23300 Introduction to Chemical Biology or CHEM 26300 Chemical Kinetics and Dynamics (for BS)

CHEM 22700 Advanced Organic/Inorganic Laboratory or CHEM 26800 Quantum Molecular and Materials Modeling (for BS)

#### GRADING

##### Chemistry and Biological Chemistry Majors

Students majoring in Chemistry and/or Biological Chemistry must earn (1) a major GPA of 2.0 or higher, (2) a C average or higher in the General Chemistry sequence, and (3) 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

Nonmajors can continue onto the next course in the General Chemistry sequence if they receive a letter grade higher than an F. An average grade of C or higher in the General Chemistry sequence, CHEM 10100-CHEM 10200-CHEM 11300 or CHEM 11100-11200-11300 Comprehensive General Chemistry I-II-III or CHEM 12100-12200-12300 Honors General Chemistry I-II-III, is a prerequisite for enrollment in Organic Chemistry. Students who do not meet these criteria should please contact the Director of Undergraduate Studies (DUS) (chem-dus@lists.uchicago.edu). Nonmajors may also take Chemistry courses on a P/F basis.

#### 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.

#### MINOR IN CHEMISTRY

Before a student can declare the minor in Chemistry, the student must complete the general education requirements in Chemistry. A student must receive the Director of Undergraduate Studies (DUS) (chem-dus@lists.uchicago.edu) approval for the minor program; this is done through the Consent to Complete a Minor Program ([https://humanities-web.s3.us-east-2.amazonaws.com/college-prod/s3fs-public/documents/Consent\\_Minor\\_Program.pdf](https://humanities-web.s3.us-east-2.amazonaws.com/college-prod/s3fs-public/documents/Consent_Minor_Program.pdf)) form, which can be obtained from the student's College adviser. Once signed by

the Director of Undergraduate Studies (chem-dus@lists.uchicago.edu), this form must then be returned to the student's College adviser by the end of Spring Quarter of the student's third year.

To earn the minor in Chemistry, a student must complete five courses as outlined below. All lecture courses in the 20000 level (or above) in Chemistry can be used as electives for the minor; the student has to make sure that prerequisites for the chosen courses are fulfilled. Before meeting with the director, students should invest some thought into which courses they would like to complete for the minor and how those courses relate as a set.

Courses in the minor program may not be (1) double counted with the student's major(s) or with other minors, or (2) counted toward general education requirements. Courses in the minor must be taken for quality grades, and more than half of the requirements for the minor must be met by registering for courses bearing University of Chicago course numbers. Students minoring in Chemistry must earn (1) a minor GPA of 2.0 or higher and (2) a C- or higher in all courses required by the Chemistry minor.

#### SUMMARY OF REQUIREMENTS: MINOR IN CHEMISTRY

One of the following *	100
CHEM 11300                      Comprehensive General Chemistry III	
CHEM 12300                      Honors General Chemistry III	
Four additional 20000-level (or higher) courses in Chemistry	400
Total Units	500

\* If this course is already counted toward the student's major, a 20000-level (or higher) Chemistry course can be used as a substitution for this requirement.

Below are some examples of courses that would work as a set:

#### 1. Organic Chemistry Courses

CHEM 22000                      Organic Chemistry I	100
CHEM 22100                      Organic Chemistry II	100
CHEM 22200                      Organic Chemistry III	100
CHEM 23300                      Introduction to Chemical Biology	100

#### 2. Organic/Inorganic Chemistry Courses

CHEM 22000                      Organic Chemistry I	100
CHEM 22100                      Organic Chemistry II	100
CHEM 20100                      Inorganic Chemistry	100
CHEM 20200                      Organometallic Chemistry	100
OR	
CHEM 22000                      Organic Chemistry I	100
CHEM 22100                      Organic Chemistry II	100
CHEM 20100                      Inorganic Chemistry	100
CHEM 20300                      Chemistry of Materials	100
OR	
CHEM 22000                      Organic Chemistry I	100
CHEM 22100                      Organic Chemistry II	100
CHEM 22200                      Organic Chemistry III	100
CHEM 20100                      Inorganic Chemistry	100

#### 3. Physical Chemistry Courses

CHEM 26100                      Introductory Quantum Mechanics	100
CHEM 26200                      Thermodynamics	100
CHEM 26300                      Chemical Kinetics and Dynamics	100
CHEM 26700                      Experimental Physical Chemistry	100
OR	
CHEM 26100                      Introductory Quantum Mechanics	100
CHEM 26200                      Thermodynamics	100
CHEM 26300                      Chemical Kinetics and Dynamics	100
CHEM 26800                      Quantum Molecular and Materials Modeling	100

## 4. Organic/Physical Chemistry Courses

CHEM 22000	Organic Chemistry I	100
CHEM 22100	Organic Chemistry II	100
CHEM 26100	Introductory Quantum Mechanics	100
CHEM 26200	Thermodynamics	100
OR		
CHEM 22000	Organic Chemistry I	100
CHEM 26100	Introductory Quantum Mechanics	100
CHEM 26200	Thermodynamics	100
CHEM 26300	Chemical Kinetics and Dynamics	100

## 5. Inorganic/Physical Chemistry Courses

CHEM 20100	Inorganic Chemistry	100
CHEM 26100	Introductory Quantum Mechanics	100
CHEM 26200	Thermodynamics	100
CHEM 26300	Chemical Kinetics and Dynamics	100
OR		
CHEM 20100	Inorganic Chemistry	100
CHEM 20200	Organometallic Chemistry	100
CHEM 26200	Thermodynamics	100
CHEM 26300	Chemical Kinetics and Dynamics	100
OR		
CHEM 20100	Inorganic Chemistry	100
CHEM 20300	Chemistry of Materials	100
CHEM 26200	Thermodynamics	100
CHEM 26300	Chemical Kinetics and Dynamics	100

## CHEMISTRY 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.**

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.

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.

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.**

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. 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.

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.**

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.

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.**

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. Prerequisite(s): Corequisite: Concurrent enrollment in CHEM 22000

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.**

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.

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, 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. The first two courses in this sequence meet the general education requirement in the physical sciences. FOR THE THIRD (SPRING) QUARTER OF THE SEQUENCE, STUDENTS WILL ENROLL IN CHEM 11300.

### **CHEM 10100. Introductory General Chemistry I. 100 Units.**

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. 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.

Instructor(s): Weatherston, J. 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. THE DEADLINE FOR LAB SECTION SWAP OR JOINING THE CLASS IS FRIDAY AT 5:00 PM, THE FIRST WEEK OF THE QUARTER. An average grade of C or higher in the General Chemistry sequence, CHEM 10100-CHEM 10200-CHEM 11300 or CHEM 11100-11200-11300 Comprehensive General Chemistry I-II-III or CHEM 12100-12200-12300 Honors General Chemistry I-II-III, is a prerequisite for enrollment in Organic Chemistry.

### **CHEM 10200. Introductory General Chemistry II. 100 Units.**

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. 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.

Instructor(s): Weatherston, J. 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. THE DEADLINE FOR LAB SECTION SWAP OR JOINING THE CLASS IS FRIDAY AT 5:00 PM, THE FIRST WEEK OF THE QUARTER. An average grade of C or higher in the General Chemistry sequence, CHEM 10100-CHEM 10200-CHEM 11300 or CHEM 11100-11200-11300 Comprehensive

General Chemistry I-II-III or CHEM 12100-12200-12300 Honors General Chemistry I-II-III, is a prerequisite for enrollment in Organic Chemistry.

**CHEM 11300. Comprehensive General Chemistry III. 100 Units.**

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.

Instructor(s): H. Lant; 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. THE DEADLINE FOR LAB SECTION SWAP OR JOINING THE CLASS IS FRIDAY AT 5:00 PM, THE FIRST WEEK OF THE QUARTER. An average grade of C or higher in the General Chemistry sequence, CHEM 10100-CHEM 10200-CHEM 11300 or CHEM 11100-11200-11300 Comprehensive General Chemistry I-II-III or CHEM 12100-12200-12300 Honors General Chemistry I-II-III, is a prerequisite for enrollment in Organic Chemistry.

**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.**

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. 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.

Instructor(s): McLeod, Shaunna 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. THE DEADLINE FOR LAB SECTION SWAP OR JOINING THE CLASS IS FRIDAY AT 5:00 PM, THE FIRST WEEK OF THE QUARTER. An average grade of C or higher in the General Chemistry sequence, CHEM 10100-CHEM 10200-CHEM 11300 or CHEM 11100-11200-11300 Comprehensive General Chemistry I-II-III or CHEM 12100-12200-12300 Honors General Chemistry I-II-III, is a prerequisite for enrollment in Organic Chemistry.

**CHEM 11200. Comprehensive General Chemistry II. 100 Units.**

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.

Instructor(s): McLeod, Shaunna; Zhao, M. 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. THE DEADLINE FOR LAB SECTION SWAP OR JOINING THE CLASS IS FRIDAY AT 5:00 PM, THE FIRST WEEK OF THE QUARTER. An average grade of C or higher in the General Chemistry sequence, CHEM 10100-CHEM 10200-CHEM 11300 or CHEM 11100-11200-11300 Comprehensive General Chemistry I-II-III or CHEM 12100-12200-12300 Honors General Chemistry I-II-III, is a prerequisite for enrollment in Organic Chemistry.

#### **CHEM 11300. Comprehensive General Chemistry III. 100 Units.**

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.

Instructor(s): H. Lant; 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. THE DEADLINE FOR LAB SECTION SWAP OR JOINING THE CLASS IS FRIDAY AT 5:00 PM, THE FIRST WEEK OF THE QUARTER. An average grade of C or higher in the General Chemistry sequence, CHEM 10100-CHEM 10200-CHEM 11300 or CHEM 11100-11200-11300 Comprehensive General Chemistry I-II-III or CHEM 12100-12200-12300 Honors General Chemistry I-II-III, is a prerequisite for enrollment in Organic Chemistry.

#### **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.**

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. Please note that individual sections in the Honors (120's) General Chemistry sequence may vary in some content and foci based on the instructor in a given quarter. If you are curious about specific content please reach out to the instructor. Attendance at one discussion session per week and laboratory sessions is required.

Instructor(s): S. Sibener. 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. THE DEADLINE FOR LAB SECTION SWAP OR JOINING THE CLASS IS FRIDAY AT 5:00 PM, THE FIRST WEEK OF THE QUARTER. An average grade of C or higher in the General Chemistry sequence, CHEM 10100-CHEM 10200-CHEM 11300 or CHEM 11100-11200-11300 Comprehensive General Chemistry I-II-III or CHEM 12100-12200-12300 Honors General Chemistry I-II-III, is a prerequisite for enrollment in Organic Chemistry.

#### **CHEM 12200. Honors General Chemistry II. 100 Units.**

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. Please note that individual sections in the Honors (120's) General Chemistry sequence may vary in some content and foci based on the instructor in a given quarter. If you are curious about specific content please reach out to the instructor. Attendance at one discussion session per week and laboratory sessions is required.

Instructor(s): S. King. 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. THE DEADLINE FOR LAB SECTION SWAP OR JOINING THE CLASS IS FRIDAY AT 5:00 PM, THE FIRST WEEK OF THE QUARTER. An average grade of C or higher in the General Chemistry sequence, CHEM 10100-CHEM 10200-CHEM 11300 or CHEM 11100-11200-11300 Comprehensive General Chemistry I-II-III or CHEM 12100-12200-12300 Honors General Chemistry I-II-III, is a prerequisite for enrollment in Organic Chemistry.

**CHEM 12300. Honors General Chemistry III. 100 Units.**

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. Please note that individual sections in the Honors (120's) General Chemistry sequence may vary in some content and foci based on the instructor in a given quarter. If you are curious about specific content please reach out to the instructor. Attendance at one discussion session per week and laboratory sessions is required.

Instructor(s): S. Vaikuntanathan. 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. THE DEADLINE FOR LAB SECTION SWAP OR JOINING THE CLASS IS FRIDAY AT 5:00 PM, THE FIRST WEEK OF THE QUARTER. An average grade of C or higher in the General Chemistry sequence, CHEM 10100-CHEM 10200-CHEM 11300 or CHEM 11100-11200-11300 Comprehensive General Chemistry I-II-III or CHEM 12100-12200-12300 Honors General Chemistry I-II-III, is a prerequisite for enrollment in Organic Chemistry.

**CHEM 12900. The Chemistry of Artists' Materials. 100 Units.**

The goal of this course is to understand the fundamentals of molecular structure as applied to dyes, pigments, and other materials used in art and crafts. Students will gain general scientific literacy skills and engage with fundamental laboratory techniques in an inherently interdisciplinary way. The first part of the course will delve into molecular structure of organic dyes and inorganic pigments as well as principles behind how visible light interacts with these compounds to produce the colors we see. The fundamental set of techniques used to probe and explore these processes is called spectroscopy; these techniques will play a large role in the laboratory component. Throughout the rest of the course, a number of case studies of these principles will be investigated, including natural v. synthetic dyes and historical dye extraction processes, conservation and restoration of fine art, pigments and materials used in pottery, and the chemistry of stained glass. Additional topics will be driven by student interest. Course assignments will include readings, class discussions, homework sets, lab reports, and a final written paper

Instructor(s): Lant, Hannah Terms Offered: Autumn

Note(s): PHSC 12200 The Chemistry of Food and Cooking PHSC 12400 The Chemistry of Big Problems, and PHSC 12500 Molecular Mechanisms of Human Disease. Students who have credit for CHEM 10100, 11100, or 12100 by either taking the course or by AP credit (for CHEM 11100) and do not wish to take CHEM 10200, 11200, or 12200 may complete the general education requirement with any of the PHSC courses offered by the Department of Chemistry.

Equivalent Course(s): PHSC 12900

**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. 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 11100-11200-11300 or equivalent, CHEM 22000 and CHEM 22100, or concurrent enrollment in CHEM 22100 or equivalent.

Equivalent Course(s): CHEM 30100

**CHEM 20200. 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. Anderson Terms Offered: Spring

Prerequisite(s): CHEM 20100 and CHEM 26100

Equivalent Course(s): CHEM 30400

**CHEM 20300. Chemistry of Materials. 100 Units.**

This course is an introduction to modern materials chemistry. It covers basic chemistry and physics of condensed systems, primarily solids and their various relatives. The electronic structure of solids will be discussed. We will review optical and electronic properties of different classes of materials using examples of semiconductors, magnetic materials, etc. We will be drawing structure-property relationships for solids. The course will also cover the fundamentals of material synthesis.

Instructor(s): Talapin, D. Terms Offered: Spring

Prerequisite(s): CHEM 20100 or equivalent

**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.**

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.

Instructor(s): J. Piccirilli. L. V. Keller. Terms Offered: Autumn

Prerequisite(s): An average grade of C or higher in CHEM 10100-10200-11300 or CHEM 11100-11200-11300 or CHEM 12100-12200-12300, or consent of the Dept.; lab and discussion linked.

Note(s): THE DEADLINE FOR LAB SECTION SWAP OR JOINING THE CLASS IS FRIDAY AT 5:00 PM, THE FIRST WEEK OF THE QUARTER.

**CHEM 22100. Organic Chemistry II. 100 Units.**

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.

Instructor(s): S. Snyder. 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 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. THE DEADLINE FOR LAB SECTION SWAP OR JOINING THE CLASS IS FRIDAY AT 5:00 PM, THE FIRST WEEK OF THE QUARTER.

**CHEM 22200. Organic Chemistry III. 100 Units.**

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.

Instructor(s): W. Tang. 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 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. THE DEADLINE FOR LAB SECTION SWAP OR JOINING THE CLASS IS FRIDAY AT 5:00 PM, THE FIRST WEEK OF THE 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. Students who have previously taken Chem 299 in conjunction with conducting experimental research in organic or inorganic chemistry may, in certain circumstances, substitute the Chem 227 degree requirement with their Chem 299 credit. If this applies and is of interest to you, please contact The Director of Undergraduate Studies (chem-dus@lists.uchicago.edu) as soon as possible to discuss your situation.

Instructor(s): V. Rawal Terms Offered: Spring

Prerequisite(s): CHEM 20100 and 23300, or consent of instructor

Note(s): Consent required. Priority given to 4th and then 3rd year Chemistry/Biochemistry majors. Students in other majors will be considered only if the course has not met capacity by the start of the term.

**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.**

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.

Instructor(s): G. Dong, L. V. Keller Terms Offered: Autumn

Prerequisite(s): An average grade of B+ or higher in CHEM 11100-11200-11300 or equivalent or consent of the department, and/or via The Chemistry Advanced 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. THE DEADLINE FOR LAB SECTION SWAP OR JOINING THE CLASS IS FRIDAY AT 5:00 PM, THE FIRST WEEK OF THE QUARTER.

**CHEM 23100. Honors Organic Chemistry II. 100 Units.**

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.

Instructor(s): B. Dickinson, L. V. Keller Terms Offered: Winter

Prerequisite(s): An average grade of B+ or higher in CHEM 11100-11200-11300 or equivalent or consent of the department, and/or via The Chemistry Advanced 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. THE DEADLINE FOR LAB SECTION SWAP OR JOINING THE CLASS IS FRIDAY AT 5:00 PM, THE FIRST WEEK OF THE QUARTER.

**CHEM 23200. Honors Organic Chemistry III. 100 Units.**

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.

Instructor(s): S. Rowan, L. V. Keller Terms Offered: Spring

Prerequisite(s): CHEM 22100 and received an A or higher, or CHEM 23100 and received an B or higher, or Organic Chemistry Accreditation exam.

Note(s): THE DEADLINE FOR LAB SECTION SWAP OR JOINING THE CLASS IS FRIDAY AT 5:00 PM, THE FIRST WEEK OF THE QUARTER.

**CHEM 23300. Introduction to Chemical Biology. 100 Units.**

This course will introduce biomolecules, chemical biology approaches and genomics from chemistry perspectives. The course will be an introduction to genomics and genomics tools in research and medicine, and will provide a well-rounded view of cell structure and function, the main signaling pathways in cells, and modern methods to chemically probe, program and reprogram cells.

Instructor(s): Y. Krishnan. Terms Offered: Autumn

Prerequisite(s): A grade of C or higher in CHEM 22200 or 23200, or consent of instructor  
Equivalent Course(s): CHEM 33200

**CHEM 25000. The Drug Discovery Process: from Lead to the Clinic. 100 Units.**

Over the course of the past century, advances in the medical arts have substantially changed the arc of the human experience. Indeed, average lifespans have more than doubled, some ailments like polio and smallpox have essentially been eradicated, and overall quality of life has substantively improved. Yet, despite our current abilities, innumerable challenges remain. They include cases of antibiotic resistance for which we have no available treatments, our inability to cure cancer, and the increased incidence of ailments such as obesity and depression that might result, in part, from elements of modern life. This course seeks to provide a full perspective on the current state of the drug discovery process, from how initial lead compounds are identified, to how they are optimized through both rational design as well as computational modelling methods, to how process-level scale chemistry is achieved to fuel clinical trials, to intellectual property and the FDA approval process, to the clinic, to ultimately addressing the ramifications of unintended side-effects discovered once used in a large population of patients. Examples that will be discussed include antibiotics like Penicillin, the anticancer agent Taxol, the morning sickness pill Thalidomide, weight-loss and diabetes-fighting drugs such as Ozempic, immunosuppressants such as FK506, pain modulating medicines such as Aspirin and Oxycontin, depression treatments like Zoloft, and anti-HIV agents such as Truvada.

Terms Offered: Summer

**CHEM 26000. Light, Vision, and Matter. 100 Units.**

This integrated lecture-and-lab course provides a novel introduction to matter-radiation interactions, image formation as a photon statistical process and inference problem, both single photon (statistical) and rate equation descriptions of light absorption and emission, (Fermi's) Golden Rule for energy transfer processes, and "applications" in photo-chemistry and photo-physical processes such as photosynthesis and the first steps in vision. The labs involve single molecule/quantum dot detection and lifetime measurements, aspects of "super-resolution" microscopy, quantum interference and fluorescence resonance energy transfer (FRET); topics that are at the heart of current research in biophysics, cell biology, neuroscience and quantum physics. The course will favor physical and intuitive descriptions of topics complemented by essential mathematics vs. lengthy derivations. The course material is and labs are distinct from the Physical Chemistry sequence (Chem 261-263) and also Experimental Physical Chemistry (Chem 267), yet is complementary.

Instructor(s): Course Instructor: N. F. Scherer Lab Instructor: Dr. Z. Gasyna Terms Offered: Spring 2021

Prerequisite(s): General Chemistry (Chem 110's or higher), Physics (Phys 130's or > higher), Calculus (Math 130's or higher). Concurrent registration with > Math 200 sequence recommended.

**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. Introductory 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. A. Mazziotti. Terms Offered: Autumn

Prerequisite(s): CHEM 11300 or equivalent; MATH 18500 or MATH 20100; PHYS 13300 (PHYS 12300 is accepted for Biological Chemistry majors). MATH 18600 recommended.

**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. M. Guyot-Sionnest Terms Offered: Winter

Prerequisite(s): CHEM 11300 or equivalent; MATH 18500 or MATH 20100, and PHYS 13300 (PHYS 12300 is accepted for Biological Chemistry majors)

**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): B. Tian Terms Offered: Spring

Prerequisite(s): CHEM 11300 or equivalent; MATH 18500 or MATH 20100, and PHYS 13300 (PHYS 12300 is accepted for Biological Chemistry majors)

**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): Staff. Terms Offered: Winter

Prerequisite(s): CHEM 26100

**CHEM 26800. Quantum Molecular and Materials Modeling. 100 Units.**

Quantum mechanical methods, including quantum chemistry, density functional theory (DFT), and many body perturbation theory, for simulating the properties of molecules and materials will be explored in this course. Numerical algorithms and techniques will be introduced that allow for solution of approximate forms of the Schroedinger and Boltzmann Equations that model structural and transport properties of molecules and materials. The coupling of DFT with molecular dynamics will be detailed for determining finite temperature properties. Coupling of DFT with spin Hamiltonians to study dynamical spin correlations in materials will also be described. Examples of the application of quantum mechanical methods to materials for energy conversion and quantum information technologies will be provided.

Instructor(s): Laura Gagliardi, Giulia Galli Terms Offered: Spring

Prerequisite(s): MENG 26100, PHYS 23510, CHEM 26100, or instructor consent

Equivalent Course(s): CHEM 36800, MENG 25510, MENG 35510

**CHEM 29600. Research in Chemistry. 000 Units.**

CHEM 296 is an individually-guided, year-long, 0-credit research course and is meant to be a substitute for students who are otherwise unable to take CHEM 299. Some examples of students who should use CHEM 296 include students on a fellowship that precludes them from doing research for credit or students who don't have room in their schedule for 299. Students must submit a written report covering their research activities to the Director of Undergraduate Studies (DUS). Research activities undertaken in this course can be used towards the writing of a thesis for the consideration of departmental honors.

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

Prerequisite(s): Consent of a faculty sponsor and Director of Undergraduate Studies (DUS)

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.

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

Prerequisite(s): Consent of a faculty sponsor and the Director of Undergraduate Studies (DUS)

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. 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 11100-11200-11300 or equivalent, CHEM 22000 and CHEM 22100, or concurrent enrollment in CHEM 22100 or equivalent.

Equivalent Course(s): CHEM 20100

**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): Anderson, John; Shevchenko, Elena 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. Anderson Terms Offered: Spring

Prerequisite(s): CHEM 20100 and CHEM 26100

Equivalent Course(s): CHEM 20200

**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): Staff. Terms Offered: Not offered in 2020-2021

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 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): M. Levin Terms Offered: Autumn

Prerequisite(s): CHEM 22200/23200 and 26200, or consent of instructor

**CHEM 32200. Organic Synthesis and Structure. 100 Units.**

This course seeks to introduce basic but important concepts in organic synthesis. Key coverage for this quarter includes stereoelectronic effects, conformational analysis, olefin reactions and synthesis, and enolate chemistry. By the end of this quarter, students are expected to have a deep understanding of the structure/reactivity

relationship of typical organic molecules, to be capable of learning new synthetic reactions and understanding the reaction mechanism on your own, and to master basic skills to design synthesis of complex molecules.

Terms Offered: Autumn

Prerequisite(s): CHEM 22200/23200 or consent of instructor

#### **CHEM 32300. Strategies and Tactics of Organic Synthesis. 100 Units.**

This course continues the study of key reaction types used in modern organic synthesis (see CHEM 322), with emphasis on orbital symmetry-controlled processes, reactive intermediates such as radicals and carbenes, and transformations mediated by photochemical and transition-metal catalysis. Students examine examples from the primary literature to see how these reactions are applied in the synthesis of complex target molecules, and are challenged to design effective routes to moderately intricate structures, with attention to chemo-, regio-, and stereo- and enantioselectivity as well as the scope and limitations of each transformation.

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 2020-2021

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.

Instructor(s): Staff Terms Offered: Not offered in 2020-2021

#### **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 2020-2021

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 2020-2021

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. Introduction to Chemical Biology. 100 Units.**

This course will introduce biomolecules, chemical biology approaches and genomics from chemistry perspectives. The course will be an introduction to genomics and genomics tools in research and medicine, and will provide a well-rounded view of cell structure and function, the main signaling pathways in cells, and modern methods to chemically probe, program and reprogram cells.

Instructor(s): Y. Krishnan. Terms Offered: Autumn

Prerequisite(s): A grade of C or higher in CHEM 22200 or 23200, or consent of instructor

Equivalent Course(s): CHEM 23300

##### **CHEM 33300. Chemical Biology II. 100 Units.**

This course will further explore the principles of biochemistry and cell biology from a chemical perspective. Molecular structure, reactivity and functional organization in biological systems - ranging from single molecules to whole organisms will be examined. Chemical concepts and tools will be applied to solve problems at the interface of chemistry, biology, and medicine. This course aims to develop and refine skills on experimental design, data analysis, interpretation and presentation while promoting the critical analysis of recent research in chemical biology. The focus of this course will be on the design, synthesis, validation and application of chemical probes, broadly defined, in modern biological research.

Instructor(s): W. Tang, Y. Krishnan Terms Offered: Winter

Prerequisite(s): CHEM 33200, or consent of instructor

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

The course will cover fundamental aspects of the physical organic chemistry of enzyme catalysis, with special emphasis on the role of pre-oriented local electric fields in 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): S. Kent Terms Offered: Winter

**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, DNazymes, 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.

Terms Offered: Not offered in 2020-2021

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 organism's 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.

Terms Offered: Not offered in 2020-2021

**CHEM 33800. Current Topics and Methods in Chemical Biology. 100 Units.**

The aim of this course is to teach modern chemical biology methods, technologies, and applications as applied to problems and challenges in human health and biotechnology. Both classics in translational chemical biology and emerging technologies will be used to teach general principles in the application of chemistry to therapeutic development and biotechnology. As compared to the Chemical Biology course track (Chem332/Chem333), this course is geared more toward non-experts in chemical biology or those with a less extensive chemistry background.

Instructor(s): B. Dickinson. R. Moellering Terms Offered: Winter

Prerequisite(s): CHEM 22200/23200

**CHEM 33900. Discovery and Translation of Molecular Therapeutics. 100 Units.**

The aim of this course is to broadly expose students to emerging classes of molecular therapeutics and diagnostics with a focus on the chemistry and molecular engineering underlying their discovery, development and translation into use by society. This material will be presented through the lens of academic, industrial and clinical experts, which will collectively expose students to the diverse disciplines that come together in the creation of new medicines and diagnostics.

Instructor(s): R. Moellering. Terms Offered: Spring

Prerequisite(s): CHEM 33200

**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): A. Dinner 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): D. Mazziotti 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): V. Goth 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): G. Voth Terms Offered: Spring

Prerequisite(s): CHEM 36100 required; 36300 recommended

**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 2020-2021

**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.

Terms Offered: Not offered in 2020-2021

**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): R. Benoit Terms Offered: Spring

Prerequisite(s): ONE of the following: CHEM 31358 Simulation, Modeling, and Computation in Biophysics; CHEM 36300 Statistical Thermodynamics; CHEM 36400 Advanced Statistical Mechanics. Knowledge of basic calculus, matrix algebra, statistical mechanics, and kinetics are recommended.

**CHEM 39000. Solids, Materials, Surfaces. 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): D. Talapin Terms Offered: Autumn

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

Equivalent Course(s): MENG 35200

**CHEM 39100. Polymer Synthesis. 100 Units.**

This course introduces the most important polymerization reactions, focusing on their reaction mechanisms and kinetic aspects. Topics include free radical and ionic chain polymerization, step-growth polymerization, ring-opening, insertion, controlled living polymerization, crosslinking, copolymerization, and chemical modification of preformed polymers.

Instructor(s): Stuart Rowan Terms Offered: Winter

Prerequisite(s): CHEM 22000 and CHEM 22100

Equivalent Course(s): MENG 25110, MENG 35110

- CHEM 20100-20200 Inorganic Chemistry I-II

