Chemistry

The Department of Chemistry, in conjunction with other departments of the university, offers a broad education and the opportunity to do research in chemistry and related fields. The great diversity of the field of chemistry, ranging between physics and biology, is reflected in the research interests of the faculty. Undergraduate chemistry majors usually go on to graduate study in chemistry, chemical engineering, biology, oceanography, geochemistry, biophysics, environmental sciences, or medicine, while others enter the chemical industry. The Ph.D. in chemistry leads to professional careers in colleges and universities, research institutes, industry, and government laboratories.

The Faculty

Kit H. Bowen, E. Emmet Reid Professor: experimental chemical physics—photoelectron spectroscopy of negative ions, structure and dynamics of gas phase, weakly bound molecular clusters.

Paul J. Dagdigian, Arthur D. Chambers Professor: experimental chemical physics—dynamics of gas-phase chemical reactions, collisional energy transfer, molecular electronic spectroscopy, laser-induced fluorescence and ionization.

John P. Doering, Research Professor: experimental chemical physics and geophysics—electronic and ionic collision phenomena including electron energy loss spectroscopy, electron ionization coincidence spectroscopy, planetary atmospheres.

David E. Draper, Vernon Kriebel Professor: physical biochemistry—RNA folding, RNA-ligand interactions, NMR of protein and RNA, translational control of gene expression.

D. Howard Fairbrother, Associate Professor: physical chemistry—the structure of chemically protective surfaces, chemistry of adhesives, environmental surface chemistry.

David Goldberg, Associate Professor: inorganic and bioinorganic chemistry—structure/function relationships in heme proteins, artificial enzyme design, biomimetic molybdenum and tungsten coordination compounds, redox active ligands, synthesis of tetrapyrrolic macrocycles (phthalocyanine and porphyrin-based systems) for small-molecule activation and materials applications.

Marc M. Greenberg, Professor: organic and bioorganic chemistry—application of chemical, biochemical, and biological techniques to studies on DNA damage and repair, independent generation and study of reactive intermediates, development and application of methods for modified oligonucleotide synthesis, design of mechanistically inspired enzyme inhibitors radiosensitizing agents, and sensors.

Tamara Hendrickson, Assistant Professor: bioorganic chemistry and enzymology—chemical, biochemical, and mechanistic studies of complex enzyme systems, including C-terminal protein glycosylation, microbial protein biosynthesis, and tRNA-protein molecular recognition.

Kenneth D. Karlin, Ira Remsen Professor: inorganic and bioinorganic chemistry—synthetically derived structural, spectroscopic and functional models for copper and iron proteins, copper-dioxygen reversible binding and metal-mediated substrate oxidation, O_2-reduction with copper cluster compounds, porphyrin-iron and copper chemistry relevant to heme-copper oxidases, metal-catalyzed ester and amide hydrolysis, metal complex protein and DNA interactions.

Walter S. Koski, Bernard N. Baker Professor: physical chemistry—nuclear and hot atom chemical phenomena, nuclear and electron resonance spectroscopy, ion molecule reactions, scattering of low energy ions.

Thomas Lectka, Professor: organic chemistry—the design and synthesis of theoretically interesting nonnatural products with applications in bioorganic and physical organic chemistry, materials science and supramolecular chemistry, novel approaches to asymmetric catalysis, theoretical organic chemistry.

Gerald Meyer, Professor: inorganic chemistry—photochemistry and electrochemistry of metal complexes and inorganic solids, light-induced electron and energy transfer, materials science, artificial photosynthesis.

Douglas Poland, Professor: theoretical chemistry—statistical mechanics, kinetics of cooperative biological and physical-chemical phenomena, use of moments to calculate energy and ligand-binding distributions.

Gary H. Posner, Jean and Norman Scowe Professor: organic, medicinal, and organometallic chemistry—new synthetic methods, asymmetric synthesis of natural products having pharmacological (e.g., anti-tumor, contraceptive, antimalarial) activity, chemical carcinogenesis, and cancer chemotherapy and chemoprotection.

Justine P. Roth, Assistant Professor: inorganic chemistry and enzymology—rational design of redox catalysts, selective bond activation/oxidation by enzymes and transition metal complexes, synthetic systems for light to chemical energy transduction.

Harris J. Silverstone, Professor: theoretical chemistry—development of mathematical techniques for applying quantum mechanics to chemical problems, high-order perturbation theory, semiclassical methods, divergent expansions, photoionization, LoSurdo-Stark effect, magnetic resonance spectral simulation, hyperasymptotics.

Joel R. Tolman, Assistant Professor: biophysical chemistry—protein-protein interactions, protein dynamics and structure, NMR methodology.

John P. Toscano, Professor (Chair): organic chemistry—photochemistry and photobiology, time-resolved IR spectroscopy, structure/reactivity relationships for reactive intermediates, the design of phototriggered nitric oxide-releasing drugs for applications in medicine.

John D. Tovar, Assistant Professor: organic chemistry-organic electronics, conjugated and conducting polymers, electrochemistry, nanostructured materials, polymer chemistry bioinspired self assembly and supramolecular chemistry.

Craig A. Townsend, Alsoph H. Corwin Professor: organic and bioorganic chemistry—biosynthesis and chemistry of natural products, stereochemical and mechanistic studies of enzyme action, small molecule/DNA interactions, application of spectroscopic techniques to the solution of biological problems.

David R. Yarkony, D. Mead Johnson Professor: theoretical chemistry—electronic structure theory, multi-configuration self-consistent-field methods, excited state chemistry, electronic energy transfer in chemical reactions, spin-forbidden processes and electronically nonadiabatic processes.

Adjunct, Emeritus, and Joint Appointments

Alsoph Corwin, Professor Emeritus.

Dwaine O. Cowan, Professor Emeritus.

David Gracias, Assistant Professor (Chemical and Biomolecular Engineering).

John W. Gryder, Professor Emeritus.

Blake Hill, Assistant Professor (Biology).

Howard E. Katz, Professor (Materials Science and Engineering).

Albert S. Mildvan, Professor (Biological Chemistry, School of Medicine).

Brown L. Murr, Professor Emeritus.

Alex Nickon, Vernon Krieble Professor Emeritus.

Lawrence M. Principe, Professor (joint appointment in History of Science and Technology).

Dean W. Robinson, Professor Emeritus.

Michael (Seungju) Yu, Assistant Professor (Materials Science and Engineering).

Lecturers

David Klein, Senior Lecturer.

Louise Pasternack, Senior Lecturer.

Tina Trapane, Senior Lecturer.

Facilities

The Department of Chemistry is well-equipped with the instrumentation to perform modern chemical research. Major routine instrumentation is housed in the Instruments Facility in Remsen Hall and is maintained by staff within the department. In addition, there is a large variety of custom-built equipment in individual research laboratories. Nuclear magnetic resonance instrumentation includes 300, 400, and 500 MHz spectrometers. The lower-field instruments are used for more routine synthetic chemistry applications, while the high-field instrument is primarily dedicated to multidimensional analysis of proteins and nucleic acids. In addition, the undergraduate instructional laboratories house a Varian Mercury 200 MHz spectrometer, which is also available for research use. The department also has a wide range of mass spectrometric instrumentation, including a laser desorption time-of-flight (MALDI-TOF) mass spectrometer, a gas chromatograph (GC) mass spectrometer, and an electrospray ionization mass spectrometer (ESI-MS) fitted with a liquid chromatography and having capability of multiple mass spectral analyses, as well as a high-resolution GC-mass spectrometer. The department also maintains an electron paramagnetic spectrometer (X band and low temperature).

Many of the faculty research laboratories have purchased or constructed highly specialized instrumentation tailored to their specific research objectives. These include the following: several molecular beam apparatus, negative ion photoelectron spectrometers, ultra-high vacuum surface analysis chambers with Auger electron and X-ray photoelectron spectrometers, atomic-force microscope, time-resolved infrared spectrometer, numerous laser systems (Nd: YAG, excimer, dye, optical parametric oscillator, argon ion), phase fluorimeter, fluorescence microscope, and nanophase material generators.

In addition to computers and workstations dispersed throughout all the individual research groups, a dedicated computer lab is housed in Remsen Hall, with access available to students.

Undergraduate Programs

Programs for undergraduate majors can be tailored to individual interests so that a major in chemistry is excellent preparation not only for further work in chemistry, but also for any field that rests on a

chemical foundation. It is a good choice for a premedical student interested in medical research.

Requirements for the B.A. Degree
(See also General Requirements for Departmental Majors, page 46.)

Core Courses:
030.101-102 Introductory Chemistry I, II
030.105 Introductory Chemistry Lab
030.205-206 Intro Organic Chemistry I, II
030.225 Organic Chemistry Lab
030.228 Intermediate Organic Chemistry Lab
030.356 Advanced Inorganic Lab
030.301-302 Physical Chemistry I, II
030.305-306 Physical Chemistry Instrumentation Lab I, II

Outside Courses:
Outside courses required for both of the sample programs are
171.101-102 General Physics or 171.103-104
173.111-112 General Physics Lab
Differential and integral calculus, preferably 110.108-109 Calculus I, II

Advanced Elective Courses:
Six credits of advanced chemistry beyond 030.305-306.

Nine additional credits composed of advanced chemistry, science electives at the 300-level or higher approved by a Department of Chemistry adviser, and/or mathematics beyond Calculus II.

None of the advanced course requirements may be fulfilled with research. Although a student may take more than 12 credits of independent research, only 12 may count toward the 120 required credits.

Lecture and laboratory courses should be taken in sequence. In particular, 030.228 Intermediate Organic Chemistry Lab must be taken before 030.356 Advanced Inorganic Lab.

To allow maximum flexibility in choosing electives, students should complete both physics and organic chemistry by the end of the sophomore year. 030.449 Chemistry of Inorganic Compounds is required for an American Chemical Society accredited degree.

Sample Program A
A typical program might include the following sequence of courses:

- **Freshman/Fall Term**
  030.101 Introductory Chemistry I
  030.105 Introductory Chemistry Lab
  Calculus
  Language
- **Freshman/Spring Term**
  030.102 Introductory Chemistry II
  Calculus
  Language
- **Sophomore/Fall Term**
  030.205 Introductory Organic Chemistry I
  030.225 Organic Chemistry Lab
  171.101 *or* 171.103 General Physics
  173.111 General Physics Lab
- **Sophomore/Spring Term**
  030.206 Introductory Organic Chemistry II
  030.228 Intermediate Organic Chemistry Lab
  171.102 *or* 171.104 General Physics
  173.112 General Physics Lab
- **Junior/Fall Term**
  030.301 Physical Chemistry I
  030.305 Physical Chemistry Lab I
  Electives
- **Junior/Spring Term**
  030.302 Physical Chemistry II
  030.306 Physical Chemistry Lab II
  Electives
- **Senior/Fall Term**
  030.356 Advanced Inorganic Lab
  Electives
- **Senior/Spring Term**
  Electives

Sample Program B
A premedical student majoring in chemistry might take the following sequence of courses:

- **Freshman/Fall Term**
  030.101 Introductory Chemistry I
  030.105 Introductory Chemistry Lab
  Calculus
  Language
- **Freshman/Spring Term**
  030.102 Introductory Chemistry II
  Calculus
  Language
- **Sophomore/Fall Term**
  030.205 Introductory Organic Chemistry I
  030.225 Organic Chemistry Lab
  171.101 *or* 171.103 General Physics
  173.111 General Physics Lab
- **Sophomore/Spring Term**
  030.206 Introductory Organic Chemistry II
  030.228 Intermediate Organic Chemistry Lab
  171.102 *or* 171.104 General Physics
  173.112 General Physics Lab

- **Junior/Fall Term**
  020.305 Biochemistry
  020.315 Biochemistry Lab
  030.356 Advanced Inorganic Lab
  Electives

- **Junior/Spring Term**
  020.306 Cell Biology
  020.316 Cell Biology Lab
  Electives

- **Senior/Fall Term**
  030.301 Physical Chemistry I
  030.305 Physical Chemistry Lab I
  Electives

- **Senior/Spring Term**
  030.302 Physical Chemistry II
  030.306 Physical Chemistry Lab II
  Electives

Honors in Chemistry
Each year, the Chemistry faculty will award honors in Chemistry to graduating seniors with a major in chemistry who have achieved an outstanding academic record in science and chemistry, or who have completed a distinguished research project carried out under the supervision of a faculty member in the Department of Chemistry. To carry out an honors research project, formal application to the department advising coordinator (currently Professor Poland) must be made by the beginning of the senior year, submitting a transcript and a letter of sponsorship by the faculty member under whom a research project will be carried out. A written thesis based on one year of research must be submitted to the faculty adviser.

Graduate Programs

Each student's background and interests determine the course of study. The normal program leads to the Ph.D. degree. A student is not usually accepted for a terminal M.A. degree.

Requirements for the M.A. and Ph.D. Degrees
Normally, the minimum course requirement for both the M.A. and the Ph.D. degrees is eight one-semester graduate courses in chemistry and related sciences. Exceptionally well-prepared students may ask for a reduction of these requirements.

Requirements for the Ph.D. degree include a research dissertation worthy of publication, and a knowledge of chemistry and related material as demonstrated in an oral examination. Each student must teach for at least one year.

Requirements for the M.A. degree, in addition to completion of formal course work, include a satisfactory performance on an oral examination.

Financial Aid and Admissions
About 80 fellowships, research appointments, and teaching assistantships are available for graduate students. There are no fixed admission requirements. Undergraduate majors in chemistry, biology, earth sciences, mathematics, or physics may apply as well as well-qualified individuals who will have received a B.A. degree.

For further information about graduate study in chemistry, contact Secretary, Committee for Graduate Admission, Department of Chemistry, or visit the Web site **www.jhu.edu/~chem/**.

Undergraduate Courses

030.101 (N) Introductory Chemistry I
An introduction to the fundamental principles of chemistry. The main topics to be covered are atomic and molecular structure at the level of dot structures and VSEPR geometries, the periodic table, stoichiometry and the balancing of chemical equations, the gas laws, the law of mass action and chemical equilibrium, acids and bases, and elementary chemical thermodynamics. Corequisite: 030.105.
Staff 3 credits fall

030.102 (N) Introductory Chemistry II
A continuation of 030.101 with an emphasis on chemical kinetics and chemical bonding. Topics will include the energy levels and wavefunctions for the particle-in-a-box and the hydrogen atom and approximate wavefunctions for molecules including an introduction to hybrid orbitals. Prerequisite: 030.101.
Staff 3 credits spring

030.105-106 (N) Introductory Chemistry Laboratory
Laboratory in the fundamental methods of chemistry with related calculations. Corequisites: 030.101-102. Prerequisite: 030.105 is prerequisite for 030.106.
Pasternack 1 credit fall and spring

030.205 (N) Introductory Organic Chemistry I
The fundamental chemistry of the compounds of carbon. Methods of structure determination and synthesis. The mechanisms of typical organic reactions and the relations between physical and chemical properties and structures. Prerequisites: 030.101-102, 030.105.
Staff 4 credits fall

030.206 (N) Introductory Organic Chemistry II
A continuation of 030.205. Prerequisite: 030.205.
Staff 4 credits spring

030.225 (N) Organic Chemistry Laboratory
Techniques for the organic chemistry laboratory including methods of purification, isolation, synthesis, and analysis. Prerequisites: 030.101-102, 030.105. Corequisite: 030.205 or 030.104. Chemistry majors should take this course in the fall semester.
Klein 3 credits fall and spring

030.228 Intermediate Organic Chemistry Laboratory
Laboratory skills acquired in the introductory organic chemistry laboratory will be further developed for the synthesis, isolation, purification, and identification of organic compounds. Spectroscopic techniques and their applications will be emphasized. Prerequisite: 030.225.
Greenberg 3 credits spring

030.301 (N) Physical Chemistry I
The laws of thermodynamics, their statistical foundation, and application to chemical phenomena. Prerequisites: general physics, general chemistry, and calculus (two semesters recommended).
Staff 3 credits fall

030.302 (N) Physical Chemistry II
An introduction to quantum mechanics and its application to simple problems for which classical mechanics fails. Topics include the harmonic oscillator, the hydrogen atom, very approximate treatments of atoms and molecules, and the theoretical basis for spectroscopy. Prerequisite: 030.301. Recommended: 110.302 Differential Equations.
Silverstone 3 credits spring

030.305-306 (N) Physical Chemistry Instrumentation Laboratory I, II
This course is designed to illustrate the principles of physical chemistry and to introduce the student to techniques and instruments used in modern chemical research. Chemistry majors are expected to take this sequence of courses, rather than 030.307. Pre- or corequisites: 030.301-302.
Fairbrother, Tolman 3 credits fall and spring

030.307 (N) Physical Chemistry Instrumentation Laboratory III
This is a one-semester course which selects experiments which are most relevant to chemical engineering. Prerequisites: 030.301-302 or equivalent.
Trapane 3 credits fall

030.345 (N) Chemical Applications of Group Theory
The theory of the representations of finite and continuous groups will be applied to problems in chemistry.
Yarkony 3 credits spring

030.356 (N) Advanced Inorganic Laboratory
Laboratory designed to illustrate the principles and practice of inorganic chemistry through the synthesis and characterization of transition metal and organometallic compounds. Methods used include vacuum and inert atmosphere techniques. Instrumental approaches and modern spectroscopic techniques are applied to the characterization of compounds generated. Prerequisite: 030.225.
Roth 3 credits fall

030.425 (N) Advanced Mechanistic Organic Chemistry I
The course covers the application of techniques in physical chemistry to the study of organic reaction mechanisms. Topics include chemical bonding and structure, stereochemistry, conformational effects, molecular orbital theory, methods to determine reaction mechanisms, reactive intermediates, and photochemistry. Prerequisites: 030.205-206.
Staff 3 credits fall

030.426 (N) Advanced Mechanistic Organic Chemistry II
This course covers advanced organic reactions and their mechanisms. Emphasis is given both to methods of postulating mechanisms for rationalizing reaction results and to the use of mechanistic thinking for designing reactions and reagents. This course is intended to be taken in sequence with 030.425. Prerequisites: 030.205-206.
Staff 3 credits spring

030.441 (N) Spectroscopic Methods of Organic Structure Determination
The course provides fundamental theoretical background for and emphasizes practical application of ultraviolet/visible and infrared spectroscopy, proton and carbon-13 nuclear magnetic resonance and mass spectrometry to the structure proof of organic compounds.
Hendrickson 3 credits fall

030.442 (N) Organometallic Chemistry
An introduction to organometallic chemistry beginning with structure, bonding and reactivity and continuing into applications to fine chemical synthesis and catalysis. Chemistry 030.449 or the equivalent is required as a co-or prerequisite.
Roth 3 credits spring

030.445 (N,Q) Applied Mathematics
Numerical methods useful in physical sciences will be developed. Topics include linear algebra, differential equations, quadrature and function approximation. Knowledge of a programming language is required.
Yarkony 3 credits not offered yearly

030.449 (N) Chemistry of Inorganic Compounds
The physical and chemical properties of inorganic, coordination and organometallic compounds are discussed in terms of molecular orbital, ligand field, and crystal field theories. Emphasis is placed on the structure and reactivity of these inorganic compounds. Other topics to be discussed include magnetic properties, electronic spectra, magnetic resonance spectra, and reaction kinetics. Corequisites: 030.301-302.
Staff 3 credits fall

030.451 (N) Spectroscopy
The spectroscopy and structure of molecules starting from rotational, vibrational, and electronic spectra of diatomic molecules and extending to polyatomic molecules as time permits. Prerequisites: 030.301-302 or equivalent.
Dagdigian 3 credits not offered yearly

030.452 (N) Materials and Surface Characterization
The chemistry associated with surfaces and interfaces as well as a molecular level understanding of their essential roles in many technologically. The first half of this course addresses various analytical techniques used to study surfaces including X-ray, photoelectron spectroscopy and scanning tunneling microscopy. The second half of this course uses a number of case studies to illustrate the application of surface analytical techniques in contemporary research.
Fairbrother 3 credits spring

030.453 (N) Intermediate Quantum Chemistry
The principles of quantum mechanics are developed and applied to chemical problems. Prerequisites: 030.301-302 or equivalent.
Silverstone 3 credits fall

030.466 (N) Physical and Analytical Methods
This course surveys a number of commonly used spectroscopic and analytical techniques with the objective of showing how each method works and what kinds of information can be obtained. The course reviews basic theory and instrumentation underlying each method along with a review of data reduction and error analysis. Illustrative examples are presented from a range of disciplines. Prerequisite: 030.302 or equivalent.
Meyer 3 credits not offered yearly

030.480 (N) Mathematical Models in Chemistry
This course explores the wide range of behavior in nonlinear chemical reaction schemes in open systems. The main mathematical tools used are nonlinear differential equations and matrix algebra. Among the topics covered are linear stability analysis, oscillating reactions, limit cycles, chemical waves, pattern formation, chaotic behavior, and enzyme cycles. Prerequisite: 030.301.
Poland 3 credits not offered yearly

030.501-502 Independent Research in Physical Chemistry I
Research under the direction of members of the physical chemistry faculty.
Staff 1-3 credits

030.503-504 Independent Research in Inorganic Chemistry I
Research under the direction of members of the inorganic chemistry faculty.
Staff 1-3 credits

030.505-506 Independent Research in Organic Chemistry I
Research under the direction of members of the organic chemistry faculty.
Staff 1-3 credits

030.507-508 Independent Research in Biochemistry I
Research under the direction of members of the biochemistry faculty.
Staff 1-3 credits

030.509-510 Independent Research in Biochemistry II
Research under the direction of members of the biochemistry faculty. Prerequisites: 030.507-508 and permission of instructor.
Staff 1-3 credits

030.521-522 Independent Research in Inorganic Chemistry II
Research under the direction of the inorganic chemistry faculty. Prerequisites: 030.503-504 and permission of instructor.
Staff 1-3 credits

030.523-524 Independent Research in Physical Chemistry II
Research under the direction of the physical chemistry faculty. Prerequisites: 030.501-502 and permission of instructor.
Staff 1-3 credits

030.525-526 Independent Research in Organic Chemistry II
Research under the direction of the organic chemistry faculty. Prerequisites: 030.505-506 and permission of instructor.
Staff 1-3 credits

Cross-Listed

250.326 Biological Macromolecules: Structure and Function
Woodson, Garcia-Moreno 3 credits spring

570.306 Chemistry of Environmental Issues
Roberts 3 credits

Graduate Courses

Advanced graduate courses are open to qualified undergraduate students. Not all 600-level courses are offered every year.

030.601 Statistical Mechanics
An introduction to the statistical mechanics of cooperative phenomena using lattice gases and polymers as the main models. Topics to be covered will include phase transitions and critical phenomena, scaling laws, and the use of statistical mechanics to describe time dependent phenomena. Prerequisite: 030.301.
Poland 3 hours spring

030.603 Organic Photochemistry
The fundamental principles and methods of investigating photochemical reactions are developed and applied to physical organic, synthetic organic, and biological systems. Topics covered include the study of reactive intermediates,

photoinitiated organic transformations, singlet oxygen chemistry, and photomedicine. Prerequisite: 030.425.
Toscano 3 hours not offered yearly

030.610 Chemical Kinetics
The molecular mechanism of elementary physical and chemical rate processes will be studied. Topics such as elastic scattering, collisional vibrational and rotational energy transfer, chemically reactive collisions, and the theory of unimolecular decay will be covered. Pre- or corequisite: one year of quantum mechanics.
Bowen 3 hours fall

030.611 Electron Transfer Processes
Electron transfer processes are distinguished by their ubiquity and essential roles in many physical, chemical, and biological processes. Rates of electron transfer in cytochromes and semiconductors span over 20 orders of magnitude. Therefore, it is important to understand the factors which underlie this large rate variation. This course is concerned primarily with this issue. Electron transfer theories will be developed from historic point of view. Basic concepts and terminology will be discussed as well as the spectroscopic and electrochemical techniques useful for quantitating electron transfer processes. The final third of this course will highlight recent electron transfer studies in biology, the solid state, and solution. Prerequisite: 030.356 or permission of instructor.
Meyer 3 hours spring

030.612 Nucleic Acids Chemistry
A survey of the physical properties of DNA and RNA. Areas to be explored include conformations of secondary and tertiary structures, polyelectrolyte properties, folding and unfolding reactions, and recognition by small molecules and proteins. Prerequisite: 030.301 or its equivalent.
Draper 3 hours spring

030.613-614 Chemistry-Biology Interface Program Forum
Chemistry-Biology Interface (CBI) program students and faculty will meet weekly in a forum that will host presentations from CBI faculty and students as well as invited guest speakers. These meetings will serve as a valuable opportunity for students to develop presentation skills and interact with CBI students and faculty. Enrollment is required for first and second year CBI students, and is recommended for advanced year graduate students.
Greenberg 1 hour fall and spring

030.615 Topics in Biological Inorganic Chemistry
This course is concerned with the chemistry of metals in biological systems. Major emphasis is placed on metalloproteins in which a transition metal is known to occupy the active site of the protein. Chemical approaches to modeling bioinorganic systems also are discussed. The lectures illustrate how chemical, spectroscopic, and structural methods have been used to understand the structure and function of metals in biology. Prerequisites: 030.301-302 or the equivalent; some background in biochemistry or inorganic chemistry is helpful but not required.
Goldberg 3 hours fall

030.617 Special Topics in Inorganic Chemistry
Topics from the recent primary literature in inorganic chemistry will be discussed, via instructor lectures and presentations by the graduate-undergraduate students enrolled in the course. The topics covered may range from bioinorganic to organometallic to solid-state inorganic chemistry. Prerequisite: 030.449 or equivalent.
Karlin 3 hours spring

030.619 Chemical Biology I
Parts I and II constitute the core course of the Chemistry-Biology Interface (CBI) Program. An introduction to the structure, synthesis, reactivity, and function of biological macromolecules (proteins, nucleic acids, carbohydrates, and lipids) will be provided using the principles of organic and inorganic chemistry. Discussion will incorporate a broad survey of molecular recognition and mechanistic considerations, and introduce the tools of molecular and cellular biology that are utilized in research at the interface of chemistry with biology and medicine. Prerequisite: 030.206 or equivalent.
Townsend 3 hours fall

030.620 Chemical Biology II
Beginning at the surface of cells, chemical events of protein-protein, protein-nucleic acid and carbohydrate recognition will be discussed proceeding to mechanisms of cell signaling and controls of metabolism in cells. The roles of metals in cellular homeostasis and oxidative stress, gene activation, control of the cell cycle, protein modification and engineering by rational and selection methods, and biotechnological tools as combinatorial chemistry, the use of arrays, biomaterials, proteomics and informatics will be discussed. Prerequisite: Chemical Biology I or permission from instructor.
Townsend 3 hours spring

030.621-622 Seminar on the Chemical Literature
Seminars are presented by advanced graduate students on topics from current chemical journals. Most first-year graduate students are expected to attend this course for credit. Undergraduate students may take the course on a satisfactory/unsatisfactory basis.
Staff 1 hour fall and spring

030.634 Topics in Bioorganic Chemistry
Each year, topics in modern bioorganic chemistry will be treated in depth, drawing from the current literature as a primary resource. Topics will include natural products chemistry, biosynthetic reaction mechanisms, and drug design. Methods of synthesis, combinatorial synthesis, and genetics will be described throughout. Carbohydrates, lipids, polyketides, polypeptides, terpenes, and alkaloids are some of the molecule classes to be examined. Prerequisites: Chemical Biology I or two semesters of organic chemistry and one of biochemistry.
Hendrickson 3 hours spring

030.635 Methods in Nuclear Magnetic Resonance
This course will introduce the necessary theoretical background required for an appreciation of modern techniques in magnetic resonance. The concepts developed

will be extended into the context of current applications, with an emphasis on the practical aspects of solution-state NMR studies of macromolecules. Prerequisite: 030.302.
Tolman 3 hours fall

030.637 Computational Organic Chemistry
Topics to be covered include practical molecular orbital theory, molecular dynamics, and mechanics calculations for organic chemists. Emphasis will be on the interactive use of programs on SGI workstations. Prerequisite: 030.425.
Lectka 3 hours not offered yearly

030.638 Spectroscopy of Diatomic Molecules
A detailed study of diatomic molecules will be undertaken by rotational, vibrational, and electronic spectroscopy. The Born-Oppenheimer approximation, Hunds coupling cases, angular momentum coupling techniques. Wigner-Eckart theorem, selection rules, intensity factors, external fields, and other related topics will be discussed.
Dagdigian 3 hours not offered yearly

030.639 Catalysis in Chemistry
Chemical catalysis is directly and indirectly responsible for adding $500 billion a year of value to the U.S. economy. In this course, the principles of chemical catalysis will be discussed, accentuating kinetics and mechanistic experiments. Topics to be covered include catalysis in biological and organic systems, as well as inorganic and organometallic homogeneous and heterogeneous catalysis. The course will finish with a presentation on asymmetric catalysis. Practical aspects of industrial catalytic reactions will also be considered.
Lectka 3 hours fall

030.666-667 Organic Synthesis Research Seminar
Summaries and evaluations of research results and literature readings.
Posner 2 hours

030.676 Green Chemistry: An Inorganic Perspective
The course will provide background into green chemistry and the minimization of hazardous materials associated with chemical practices. Emphasis will be placed on recent literature on green inorganic chemistry.
Karlin 3 hours spring

030.677 Advanced Organic Synthesis I
The reactions and principles involved in the synthesis of simple and complex organic compounds. Discussion of famous natural product syntheses and practice in developing rational designs for organic syntheses. Problems in the design of syntheses and in the use of chemical literature.
Posner 3 hours fall

030.678 Advanced Organic Synthesis II
An advanced discussion of organic stereochemistry and its application to problems in asymmetric reactions and catalysis will be presented. Emphasis will be placed on the latest reports in the literature, especially with respect to the development of new catalytic, asymmetric processes. Prerequisite: 030.677.
Lectka 3 hours spring

030.679 Advanced Asymmetric Synthesis
The asymmetric synthesis of organic molecules using stoichimetric and catalytic methodology will be addressed, from the historical development of chiral auxiliaries to cutting-edge asymmetric catalysts. Prerequisite: 030.677.
Lectka 3 hours not offered yearly

030.682 Organic Chemistry of Nucleic Acids
Nucleic acids (DNA/RNA) are essential molecules for all living beings. Studies on their structure, synthesis, chemical properties, and noncovalent interactions with other molecules are critical for understanding their role in biological processes. More recently, these molecules have been used as therapeutic and diagnostic agents. This course focuses on the structure, reactivity, and molecular recognition of these molecules. The topic will be approached from the perspective of organic chemistry, but biochemical and biological concepts will be included (and explained).
Greenberg 3 hours not offered yearly

030.683-684 Inorganic Nights
Contemporary research topics in inorganic and bioinorganic chemistry will be discussed, including modern experimental methods, data analysis, and interpretation. An emphasis is placed on current research progress in electron-transfer and biomimetic chemistry.
Goldberg, Karlin, Meyer, Roth 1 hour

030.700-701 Research Seminar in Bioorganic Chemistry
Weekly meetings alternate between presentations of recent research progress and discussion of topics from the current literature.
Townsend 2 hours