5.03 Principles of Inorganic Chemistry I
Prereq: 5.12
U (Spring)
5-0-7
Presents principles of chemical bonding and molecular structure, and their application to the chemistry of representative elements of the periodic system.
C. C. Cummins, S. Lippard

5.04 Principles of Inorganic Chemistry II
Prereq: 5.03
U (Fall)
4-0-8
Systematic presentation of the chemical applications of group theory. Emphasis on the formal development of the subject and its applications to the physical methods of inorganic chemical compounds. Against the backdrop of electronic structure, the electronic, vibrational, and magnetic properties of transition metal complexes are presented and their investigation by the appropriate spectroscopy described.
Y. Surendranath

5.05 Principles of Inorganic Chemistry III
Prereq: 5.03, 5.04
G (Spring; partial term)
3-0-6 H-LEVEL Grad Credit
Principles of main group (s and p block) element chemistry with an emphasis on synthesis, structure, bonding, and reaction mechanisms.
C. C. Cummins, C. Landis

5.061 Principles of Organometallic Chemistry
Prereq: 5.03
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Fall; partial term)
2-0-4 H-LEVEL Grad Credit
A comprehensive treatment of organometallic compounds of the transition metals with emphasis on structure, bonding, synthesis, and mechanism.
R. Schrock

5.062 Principles of Bioinorganic Chemistry
Prereq: 5.03
G (Fall)
3-0-9 H-LEVEL Grad Credit
Delineates principles that form the basis for understanding how metal ions function in biochemistry. Includes the choice, uptake and assembly of metal-containing units; metal-induced folding of biomolecules; control of metal ion concentrations in cells; electron-transfer chemistry; atom and group transfer chemistry; protein tuning of metal properties; and applications to diagnosis and treatment of disease. Introduces additional topics to expose students to exciting new advances in the field, such as medicinal application of inorganic chemistry; multi-component enzyme systems (e.g., nitrogenase, hydrogenase, and photosystem II); and metalloprotein engineering and design (e.g., the conversion by mutagenesis of existing metalloprotein scaffolds to achieve novel functions).
S. Lippard, E. Nolan

5.063 Organometallic Compounds in Catalytic Reactions
Prereq: 5.061
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
An exploration of organometallic chemistry from the perspective of catalytic reactions in organic and polymer chemistry.
R. Schrock

5.067 Crystal Structure Refinement
Prereq: 5.068, 5.069, or permission of instructor
G (Fall)
2-3-1 H-LEVEL Grad Credit
Practical aspects of crystal structure determination from data collection strategies to data reduction and advanced refinement problems of organic and inorganic molecules.
P. Mueller

5.068 Physical Inorganic Chemistry
Prereq: 5.03, 5.04
G (Spring; second half of term)
3-0-3 H-LEVEL Grad Credit
Discusses the physical methods used to probe the electronic and geometric structures of inorganic compounds, with additional techniques employed in the characterization of inorganic solids and surfaces. Includes vibrational spectroscopy, solid state and solution magnetochemical methods, Mossbauer spectroscopy, electron paramagnetic resonance spectroscopy, electrochemical methods, and a brief survey of surface techniques. Applications to current research problems in inorganic and solid-state chemistry.
M. Dinca

5.069 Crystal Structure Analysis
Prereq: 5.03, 5.04
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
Introduction to X-ray crystallography: symmetry in real and reciprocal space, space and Laue groups, geometry of diffraction, structure factors, phase problem, direct and Patterson methods, electron density maps, structure refinement, crystal growth, powder methods, limits of diffraction methods, structure data bases.
P. Mueller

5.07 Biological Chemistry I
(Subject meets with 7.80J)
Prereq: 5.12; 5.07 or 7.05
U (Fall)
5-0-7 REST
Credit cannot also be received for 7.05
Chemical and physical properties of the cell and its building blocks. Structures of proteins and principles of catalysis. The chemistry of organic/inorganic cofactors required for chemical transformations within the cell. Basic principles of metabolism and regulation in pathways, including glycolysis, gluconeogenesis, fatty acid synthesis/degradation, pentose phosphate pathway, Krebs cycle and oxidative phosphorylation, DNA replication, and transcription and translation.
A. Ting, A. Klibanov

5.08 Biological Chemistry II
(Subject meets with 7.08J)
Prereq: 5.12; 5.07 or 7.05
U (Spring)
4-0-8
More advanced treatment of biochemical mechanisms that underlie biological processes. Topics include macromolecular machines such as the ribosome, the proteosome, fatty acid synthases as a paradigm for polyketide synthases and non-ribosomal polypeptide synthases, and polymerases. Emphasis is on experimental methods used to unravel these processes and
how these processes fit into the cellular context and coordinate regulation.

*J. Stubbe, E. Nolan*

**5.111 Principles of Chemical Science**
Prereq: None
U (Fall, Spring)
5-0-7 CHEMISTRY
Credit cannot also be received for 3.091, 5.112, CC.5111, ES.3091, ES.5111, ES.5112

Introduction to chemistry, with emphasis on basic principles of atomic and molecular electronic structure, thermodynamics, acid-base and redox equilibria, chemical kinetics, and catalysis. Introduction to the chemistry of biological, inorganic, and organic molecules.

*Fall: C. Drennan
Spring: M. Shoulders, T. Van Voorhis*

**5.112 Principles of Chemical Science**
Prereq: None
U (Fall)
5-0-7 CHEMISTRY
Credit cannot also be received for 3.091, 5.111, CC.5111, ES.3091, ES.5111, ES.5112

Introduction to chemistry for students with an unusually strong background in chemistry. Knowledge of calculus equivalent to 18.01 is recommended. Emphasis on basic principles of atomic and molecular electronic structure, thermodynamics, acid-base and redox equilibria, chemical kinetics, and catalysis. Applications of basic principles to problems in metal coordination chemistry, organic chemistry, and biological chemistry.

*R. Schrock, K. Nelson*

**5.12 Organic Chemistry I**
Prereq: Chemistry (GIR)
U (Fall, Spring)
5-0-7 REST

Introduction to organic chemistry. Development of basic principles to understand the structure and reactivity of organic molecules. Emphasis on substitution and elimination reactions and chemistry of the carbonyl group. Introduction to the chemistry of aromatic compounds.

*Fall: E. Vogel Taylor, M. Movassaghi
Spring: R. L. Danheiser, T. Swager*

**5.13 Organic Chemistry II**
Prereq: 5.12
U (Fall)
5-0-7

Focuses on synthesis, structure determination, mechanism, and the relationships between structure and reactivity. Selected topics illustrate the role of organic chemistry in biological systems and in the chemical industry.

*T. Jamison, S. L. Buchwald*

**5.24 Archaeological Science**
(Same subject as 3.985J, 12.011J)
Prereq: Chemistry (GIR) or Physics I (GIR)
U (Spring)
3-1-5 HASS-S

See description under subject 3.985J.

*H. N. Lechtmann*

**5.301 Chemistry Laboratory Techniques**
Prereq: Chemistry (GIR), permission of instructor
U (IAP)
1-4-1 [P/D/F]

Practical training in basic chemistry laboratory techniques. Intended to provide freshmen with the skills necessary to undertake original research projects in chemistry. Freshmen only. Enrollment limited.

*J. Dolhun*

**5.310 Laboratory Chemistry**
Prereq: None. Coreq: 5.12
U (Fall, Spring)
2-8-2 Institute LAB

Introduces experimental chemistry for students who are not majoring in Course V. Principles and applications of chemical laboratory techniques, including preparation and analysis of chemical materials, measurement of pH, gas and liquid chromatography, visible-ultraviolet spectrophotometry, infrared spectroscopy, kinetics, data analysis, and elementary synthesis. Enrollment limited.

*J. Dolhun*

**5.35 Introduction to Experimental Chemistry**
(Subject meets with 5.35U)
Prereq: See module descriptions under subject 5.35
U (Fall, Spring)
Units arranged Institute LAB
Can be repeated for credit

This 12-unit subject consists of 3 modules, which may be taken during different terms. Modules and prerequisites are as follows:

—Module 1 (Prereq: 5.111, 5.112 or 3.091)
Survey of spectroscopy.

—Module 2 (Prereq: 5.111, 5.112 or 3.091; Module 1) Synthesis of coordination compounds and kinetics.

—Module 3 (Prereq: 5.111, 5.112 or 3.091; 5.12, Module 2) Fabrication of a polymeric light emitting device.

Enrollment limited; preference to Course 5 majors.

*Fall: K. Nelson (Module 1), M. Twardowski (Module 2), T. Jamison (Module 3)
Spring: K. Nelson (Module 1), M. Twardowski (Module 2), T. Swager (Module 3)*

**5.35U Introduction to Experimental Chemistry**
(Subject meets with 5.35U)
Prereq: See module descriptions
U (Fall, Spring)
Units arranged Institute LAB

Can be repeated for credit

For students who might not take all modules of 5.35. Consult department when choosing a version of 5.35. See description for 5.35.

*Fall: K. Nelson (Module 1), M. Twardowski (Module 2), T. Jamison (Module 3)
Spring: K. Nelson (Module 1), M. Twardowski (Module 2), T. Swager (Module 3)*

**5.36 Biochemistry and Organic Laboratory**
(Subject meets with 5.36U)
Prereq: See module descriptions
U (Fall, Spring)
Units arranged
Can be repeated for credit

This 12-unit subject consists of 3 modules, which may be taken during different terms. Instruction and practice in the written and oral presentation of experimental results provided. Modules and prerequisites are as follows:

—Module 4 Spring (Prereq: 5.07 or 7.05, Module 2 or 5.310, Module 5) Expression and Purifica-
tion of Enzyme Mutants. Must be taken simultaneously with Module 5.

—Module 5 Spring (Prereq: 5.07 or 7.05, Module 2 or 5.310, Module 4) Kinetics of Enzyme Inhibition. Must be taken simultaneously with Module 4.

—Module 6 Fall (Prereq: 5.12, Module 2 or 5.310, 5.13) Organic Structure Determination. Enrollment limited; preference to Course 5 majors.

Fall: R. L. Danheiser (Module 6)
Spring: B. Pentelute (Modules 4 & 5)

5.36U Biochemistry and Organic Laboratory
(Subject meets with 5.36)
Prereq: See module descriptions under subject 5.36
U (Fall, Spring)
Units arranged
Units arranged (May be taken for 8 or 4 units)
Can be repeated for credit up to a total of 12 units
For students who might not take all modules of 5.36. Consult department when choosing a version of 5.36. See description for 5.36.

Fall: R. L. Danheiser (Module 6)
Spring: B. Pentelute (Modules 4 & 5)

5.37 Organic and Inorganic Laboratory
(Subject meets with 5.37U)
Prereq: See module descriptions under subject 5.37
U (Fall, Spring)
Units arranged
Can be repeated for credit
This 12-unit subject consists of 3 modules, which may be taken during different terms. Instruction and practice in the written and oral presentation of experimental results provided. Modules and prerequisites are as follows:

—Module 7 Spring (Prereq: 5.13, Module 6) Continuous Flow Organic Synthesis.
—Module 8 Fall (Prereq: 5.03, Module 6, 5.61) Two Electron Bond.
—Module 9 Fall (Prereq: 5.03, Module 6, 5.61) Dinitrogen Cleavage. Enrollment limited; preference to Course 5 majors.

Fall: M. Dinca, Y. Surendranath (Module 8), C. C. Cummins (Module 9)
Spring: T. Jamison (Module 7)

5.37U Organic and Inorganic Laboratory
(Subject meets with 5.37)
Prereq: See module descriptions under subject 5.37
U (Fall, Spring)
Units arranged
Units arranged (May be taken for 8 or 4 units)
Can be repeated for credit up to a total of 12 units
For students who might not take all modules of 5.37. Consult department when choosing a version of 5.37. See description for 5.37.

Fall: M. Dinca, Y. Surendranath (Module 8), C. C. Cummins (Module 9)
Spring: T. Jamison (Module 7)

5.38 Physical Chemistry Laboratory
Prereq: See module descriptions
U (Spring)
Units arranged
Can be repeated for credit
This 12-unit subject consists of 3 modules, which may be taken during different terms. Instruction and practice in the written and oral presentation of experimental results provided. Modules and prerequisites are as follows:

—Module 10 (Prereq: 5.61, Module 6) Quantum Dots.
—Module 11 (Prereq: 5.61, 5.07 or 7.05, Module 5) Time Resolved Molecular Spectroscopy.
—Module 12 (Prereq: 5.61, 5.07 or 7.05, Module 6) Fast Flow Peptide Synthesis for Biotechnology.

Enrollment limited; preference to Course 5 majors.

M. G. Bawendi (Module 10), K. Nelson (Module 11), B. Pentelute (Module 12)

5.43 Advanced Organic Chemistry
Prereq: 5.13
U (Fall)
4-0-8
Credit cannot also be received for 5.53

Reaction mechanisms in organic chemistry: methods of investigation, relation of structure to reactivity, and reactive intermediates. Photochemistry and organometallic chemistry, with an emphasis on fundamental reactivity, mechanistic studies, and applications in organic chemistry.

J. Johnson

5.44 Organometallic Chemistry
Prereq: 5.43, 5.47, 5.061, or permission of instructor
G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit

Examination of the most important transformations of organotransition-metal species. Emphasizes basic mechanisms of their reactions, structure-reactivity relationships, and applications in synthesis.

S. L. Buchwald

5.45 Heterocyclic Chemistry
Prereq: 5.511, 5.53
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit

Provides an introduction to the chemistry of heterocyclic compounds. Surveys synthesis and reactivity of the major classes of heterocyclic organic compounds. Discusses the importance of these molecules in the pharmaceutical and other industries.

S. L. Buchwald

5.46 NMR Spectroscopy and Organic Structure Determination
Prereq: 5.43
G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit

Applications of 1-D and 2-D 1H and 13C NMR spectroscopy to organic structure determination.

J. H. Simpson

5.47 Tutorial in Organic Chemistry
Prereq: 5.43, permission of instructor
G (Fall; first half of term)
2-0-4 [P/D/F] H-LEVEL Grad Credit

Systematic review of basic principles concerned with the structure and transformations of organic molecules. Problem-solving workshop format. The program is intended primarily for first-year graduate students with a strong interest in organic chemistry. Meets during the month of September.

R. L. Danheiser

5.48j Protein Folding and Human Disease
(Same subject as 7.88j, 10.543j)
Prereq: 7.51 or permission of instructor
G (Spring)
3-0-6 H-LEVEL Grad Credit

See description under subject 7.88j.

J. A. King
5.50 Enzymes: Structure and Function
Prereq: 5.07 or 7.05; 5.12, 5.13
G (Spring)
3-0-9 H-LEVEL Grad Credit

Introduction to methods used to elucidate the mechanism of enzyme-catalyzed reactions. Application of steady-state and presteady-state kinetics, isotope effect measurements, site-directed mutagenesis, and mechanism-based inhibitors as tools to investigate the mechanisms of enzymes that have been well-characterized structurally.
J. Stubbe

5.511 Synthetic Organic Chemistry I
Prereq: 5.43
G (fall; partial term)
3-0-9 H-LEVEL Grad Credit

Introduction to the design of syntheses of complex organic compounds.
R. L. Danheiser

5.512 Synthetic Organic Chemistry II
Prereq: 5.511
G (spring; second half of term)
2-0-4 H-LEVEL Grad Credit

General methods and strategies for the synthesis of complex organic compounds.
M. Movassaghi

5.52 Advanced Biological Chemistry
Prereq: Permission of instructor
G (fall)
2-2-8 H-LEVEL Grad Credit

Concepts and methods of biochemistry, with emphasis on quantitative aspects of problem analysis and fundamentals of experimental methods. Intended for first-year graduate students with a strong interest in biological chemistry.
A. M. Klubanov

5.53 Molecular Structure and Reactivity
Prereq: 5.13, 5.60
G (fall; partial term)
3-0-6 H-LEVEL Grad Credit

Credit cannot also be received for 5.43
Reaction mechanisms in organic chemistry: methods of investigation, relation of structure to reactivity, and reactive intermediates.
J. Van Humbeck

5.531 Organometallic Reaction Mechanisms
Prereq: 5.53
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (fall; second half of term)
3-0-3 H-LEVEL Grad Credit

Discusses the key elementary steps in organometallic chemistry with an emphasis on studies of reaction mechanism. Credit cannot also be received for 5.43; meets with 5.43 second half of term.
Staff

5.54J Frontiers in Chemical Biology
(Same subject as 7.540J, 20.554J)
Prereq: 5.13, 5.07, 7.06, permission of instructor
G (fall)
4-0-8 H-LEVEL Grad Credit

Introduction to current research at the interface of chemistry, biology, and bioengineering. Topics include imaging of biological processes, metabolic pathway engineering, protein engineering, mechanisms of DNA damage, RNA structure and function, macromolecular machines, protein misfolding and disease, metabolomics, and methods for analyzing signaling network dynamics. Lectures are interspersed with class discussions and student presentations based on current literature.
B. Pentelute, M. Shoulders

5.55J Thermodynamics and Kinetics
Prereq: Calculus II (GIR), Chemistry (GIR)
U (fall, spring)
5-0-7 REST

Equilibrium properties of macroscopic systems. Basic thermodynamics: state of a system, state variables. Work, heat, first law of thermodynamics, thermochemistry. Second and third law of thermodynamics: entropy and free energy, including the molecular basis for these thermodynamic functions. Phase equilibrium and properties of solutions. Chemical equilibrium of reactions in gas and solution phases. Rates of chemical reactions. Special attention to thermodynamics related to global energy issues.
Fall: M. Bawendi, A. Shahlek
Spring: R. Field, M. Bawendi, S. Solomon

5.60 Thermodynamics and Kinetics
Prereq: Physics II (GIR), Calculus II (GIR), Chemistry (GIR)
U (fall)
5-0-7 REST

Introductory quantum chemistry; particles and waves; wave mechanics; atomic structure and the Periodic Table; valence and molecular orbital theory; molecular structure; and photochemistry.
R. Griffin, R. Field

5.64 Biophysical Chemistry
Prereq: 5.13, 5.60; 5.07 or 7.05
G (fall)
3-0-9 H-LEVEL Grad Credit

Introduction to the major principles and concepts of biophysical chemistry, with emphasis on the conformational changes and interactions of biological macromolecules, biochemical reaction dynamics, and membranes. Incorporates current experimental methods, thermodynamics, statistical mechanics, and kinetics.
A. Ting

5.68J Kinetics of Chemical Reactions
(Same subject as 10.652J)
Prereq: 5.62, 10.37, or 10.65
G (spring)
3-0-6 H-LEVEL Grad Credit

Experimental and theoretical aspects of chemical reaction kinetics, including transition-state
theories, molecular beam scattering, classical techniques, quantum and statistical mechanical estimation of rate constants, pressure-dependence and chemical activation, modeling complex reacting mixtures, and uncertainty/sensitivity analyses. Reactions in the gas phase, liquid phase, and on surfaces are discussed with examples drawn from atmospheric, combustion, industrial, catalytic, and biological chemistry. W. H. Green

5.70 Statistical Thermodynamics
(Same subject as 10.546)
Prereq: 5.60 or permission of instructor
G (Fall)
3-0-9 H-LEVEL Grad Credit
Develops classical equilibrium statistical mechanical concepts for application to chemical physics problems. Basic concepts of ensemble theory formulated on the basis of thermodynamic fluctuations. Examples of applications includeising models, lattice models of binding, ionic and non-ionic solutions, liquid theory, polymer and protein conformations, phase transition, and pattern formation. Introduces computational techniques with examples of liquid and polymer simulations.
A. Willard

5.72 Statistical Mechanics
Prereq: 5.70, 5.73, 18.075
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring; second half of term)
2-0-4 H-LEVEL Grad Credit
Staff

5.73 Introductory Quantum Mechanics I
Prereq: 5.61, 8.03, 18.03
G (Fall)
3-0-9 H-LEVEL Grad Credit
Presents the fundamental concepts of quantum mechanics: wave properties, uncertainty principles, Schrodinger equation, and operator and matrix methods. Includes applications to one-dimensional potentials (harmonic oscillator), three-dimensional centrosymmetric potentials (hydrogen atom), and angular momentum and spin. Approximation methods include WKB, variational principle, and perturbation theory.
R. G. Griffin, M. Hong

5.74 Introductory Quantum Mechanics II
Prereq: 5.73
G (Spring; first half of term)
3-0-3 H-LEVEL Grad Credit
Time-dependent quantum mechanics and spectroscopy. Topics include perturbation theory, two-level systems, light-matter interactions, relaxation in quantum systems, correlation functions and linear response theory, and nonlinear spectroscopy.
M. Stopa

5.78 Biophysical Chemistry Techniques
Prereq: 5.07 or 7.05
Acad Year 2014–2015: Not offered
Acad Year 2015–2016: G (Spring; first half of term)
2-0-4 H-LEVEL Grad Credit
Credit cannot also be received for 7.71
Presents principles of macromolecular crystallography that are essential for structure determinations. Topics include crystallization, diffraction theory, symmetry and space groups, data collection, phase determination methods, model building, and refinement. Discussion of crystallography theory complemented with exercises such as crystallization, data processing, and model building. Meets with 7.71 when offered concurrently. Enrollment limited.
C. Drennan, T. Schwartz

5.80 Advanced Topics of Current Special Interest
Prereq: 5.61 or 8.04; 18.03
G (Fall, Spring)
3-0-9 H-LEVEL Grad Credit
Advanced topics of current special interest.
Staff

5.891 Independent Study in Chemistry for Undergraduates
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged
Can be repeated for credit
5.892 Independent Study in Chemistry for Undergraduates
Prereq: None
U (Fall, IAP, Spring, Summer)
Units arranged [P/D/F]
Can be repeated for credit
Program of independent study under direction of Chemistry faculty member. May not substitute for required courses for the Chemistry major or minor.
Staff

5.90 Problems in Chemistry
Prereq: Permission of instructor
G (Fall, Spring, Summer)
Units arranged [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Directed research and study of special chemical problems. For Chemistry graduate students only.
R. W. Field

5.913 Seminar in Organic Chemistry
Prereq: Permission of instructor
G (Fall, Spring)
2-0-1 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Discusses current journal publications in organic chemistry by graduate students and staff members.
R. L. Danheiser

5.921 Seminar in Biological Chemistry
Prereq: Permission of instructor
G (Fall, Spring)
2-0-1 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Discusses topics of current interest in biological chemistry by graduate students and staff.
Fall: C. Drennan
Spring: J. Stubbe

5.931 Seminar in Physical Chemistry
Prereq: 5.60
G (Fall, Spring)
2-0-1 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Discusses topics of current interest in physical chemistry by staff members and students.
J. Cao

5.941 Seminar in Inorganic Chemistry
Prereq: 5.03
G (Fall, Spring)
2-0-1 [P/D/F] H-LEVEL Grad Credit
Can be repeated for credit
Discusses current research in inorganic chemistry by graduate students and staff.
C. C. Cummins

5.95J Teaching College-Level Science and Engineering
(Same subject as 1.95J, 6.982J, 7.59J, 8.395J, 18.094J)
(Subject meets with 2.978)
Prereq: None
G (Fall)
2-0-2 [P/D/F]
Participatory seminar focuses on the knowledge and skills necessary for teaching science and
Bachelor of Science in Chemistry/Course 5

<table>
<thead>
<tr>
<th>General Institute Requirements (GIRs)</th>
<th>Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Requirement</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>Humanities, Arts, and Social Sciences Requirement</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Restricted Electives in Science and Technology (REST) Requirement (one subject can be satisfied by 5.03, 5.07 или 5.61 in the Departmental Program)</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Laboratory Requirement (can be satisfied by completing all three modules in 5.35 in the Departmental Program)</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Total GIR Subjects Required for SB Degree</td>
<td></td>
<td>17</td>
</tr>
</tbody>
</table>

Communication Requirement
The program includes a Communication Requirement of 4 subjects:
2 subjects designated as Communication Intensive in Humanities, Arts, and Social Sciences (CI-H); and
2 subjects designated as Communication Intensive in the Major (CI-M).

PLUS Departmental Program
Subject names below are followed by credit units, and by prerequisites, if any (corequisites in italics).

<table>
<thead>
<tr>
<th>Required Subjects</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.03 Principles of Inorganic Chemistry I, 12; 5.12</td>
<td>120</td>
</tr>
<tr>
<td>5.07 Biological Chemistry I, 12, REST; 5.12</td>
<td></td>
</tr>
<tr>
<td>5.12 Organic Chemistry I, 12, REST; Chemistry (GIR)</td>
<td></td>
</tr>
<tr>
<td>5.13 Organic Chemistry II, 12; 5.12</td>
<td></td>
</tr>
<tr>
<td>5.35 Introduction to Experimental Chemistry, 12, LAB; Chemistry (GIR)</td>
<td></td>
</tr>
<tr>
<td>Module 1 Survey of Spectroscopy, 4</td>
<td></td>
</tr>
<tr>
<td>Module 2 Inorganic Synthesis and Kinetics, 4; Module 1</td>
<td></td>
</tr>
<tr>
<td>Module 3 Polymeric Light Emitting Devices, 4; 5.12, Module 2</td>
<td></td>
</tr>
<tr>
<td>5.36 Biochemistry and Organic Laboratory, 12, CI-M</td>
<td></td>
</tr>
<tr>
<td>Module 4 Expression and Purification of Enzyme Mutants, 4; 5.07 or 5.05; Module 2 or 5.310; Module 5</td>
<td></td>
</tr>
<tr>
<td>Module 5 Kinetics of Enzyme Inhibition, 4; 5.07 or 7.05; Module 2 or 5.310; Module 4</td>
<td></td>
</tr>
<tr>
<td>Module 6 Organic Structure Determination, 4; 5.12; Module 2 or 5.310; 5.13</td>
<td></td>
</tr>
<tr>
<td>5.37 Organic and Inorganic Laboratory, 12</td>
<td></td>
</tr>
<tr>
<td>Module 7 Introduction to Organic Synthesis, 4; 5.13, Module 6</td>
<td></td>
</tr>
<tr>
<td>Module 8 Two-Electron Bond, 4; 5.03, Module 6, 5.61</td>
<td></td>
</tr>
<tr>
<td>Module 9 Dinitrogen Cleavage, 4; 5.03, Module 6, 5.61</td>
<td></td>
</tr>
<tr>
<td>5.38 Physical Chemistry Laboratory, 12, CI-M</td>
<td></td>
</tr>
<tr>
<td>Module 10 Quantum Dots, 4; 5.61, Module 6</td>
<td></td>
</tr>
<tr>
<td>Module 11 Time Resolved Molecular Spectroscopy, 4; 5.64; 5.07 or 7.05; Module 5</td>
<td></td>
</tr>
<tr>
<td>Module 12 Solid State NMR, 4; 5.61; 5.07 or 7.05; Module 6</td>
<td></td>
</tr>
<tr>
<td>5.60 Thermodynamics and Kinetics, 12, REST; Calculus II (GIR), Chemistry (GIR)</td>
<td></td>
</tr>
<tr>
<td>5.61 Physical Chemistry, 12, REST; Physics II (GIR), Calculus II (GIR), Chemistry (GIR)</td>
<td></td>
</tr>
</tbody>
</table>

Restricted Electives
At least two of the following four subjects:
<table>
<thead>
<tr>
<th>Subject</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.04 Principles of Inorganic Chemistry II, 12; 5.12</td>
<td>24</td>
</tr>
<tr>
<td>5.08 Biological Chemistry II, 12; 5.12; 5.07 or 7.05</td>
<td></td>
</tr>
<tr>
<td>5.43 Advanced Organic Chemistry, 12; 5.13</td>
<td></td>
</tr>
<tr>
<td>5.62 Physical Chemistry, 12; 5.60, 5.61</td>
<td></td>
</tr>
</tbody>
</table>

Unrestricted Electives

<table>
<thead>
<tr>
<th>Departmental Program Units That Also Satisfy the GIRs</th>
<th>(24)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Units Beyond the GIRs Required for SB Degree</td>
<td>180</td>
</tr>
</tbody>
</table>

No subject can be counted both as part of the 17-subject GIRs and as part of the 180 units required beyond the GIRs. Every subject in the student's departmental program will count toward one or the other, but not both.

Notes
For an explanation of credit units, or hours, please refer to the online help of the MIT Subject Listing & Schedule, http://student.mit.edu/catalog/index.cgi.