Department of Chemistry

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Associate Professor: *Haines[A], Miwa*

Assistant Professor: *Flynn, Elmore[A1], Vardar-Ulu, Carrico-Moniz, Radhakrishnan, Virgo*

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Senior Instructor in Chemistry Laboratory: *Turnbull, Doe, Hall, McCarthy*

Instructor in Chemistry Laboratory: *Hart, Oakes, Trainor*

Chemistry has often been referred to as "The Central Science." Knowledge of the properties and behavior of atoms and molecules is crucial to our understanding of medicine, biological systems, neuroscience, nanotechnology, environmental science and a myriad of other areas. All of the traditional divisions of chemistry—analytical chemistry, biochemistry, inorganic chemistry, organic chemistry and physical chemistry—are represented on the faculty, in the course offerings and in opportunities for student-faculty collaborative research.

Unless otherwise noted, all courses meet for three periods of lecture/discussion and one 3.5 hour laboratory appointment weekly. CHEM 306 and the selected topics courses will generally be taught without laboratory, but may include laboratory for some topics.

The chemistry department reviews elections of introductory chemistry students and places them in 105, 205, or 120 according to their previous preparation, Advanced Placement (AP) scores, International Baccalaureate (IB) scores and department placement exams. Students with a 5 on the Chemistry AP exam (or the equivalent on the IB exam) typically elect CHEM 120. They may elect CHEM 211 if they demonstrate sufficient mastery of material from CHEM 105 and CHEM 205 on the department's placement exam. Details of the AP/IB policy and the placement exam are on the department's Web site, www.wellesley.edu/Chemistry/chem.html. Students who have taken one year of high school chemistry should elect CHEM 105 followed by either CHEM 205 or 211. A non-credit high school chemistry review will be offered during the wintersession.

CHEM 102 Contemporary Problems in Chemistry with Laboratory
Reisberg
Topic for 2008-09: Understanding Drugs. A study of a wide variety of drugs, both legal and illegal. The focus will be on how these molecules affect our minds and bodies based on an understanding of their biochemistry. Topics will include antibiotics, steroids, stimulants, intoxicants, narcotics, and hallucinogens. The history, discovery, development, testing, regulation and prohibition of these substances will also be considered. The laboratory will include synthesis and analysis of an analgesic and an intoxicant, plus the detection of drugs in our bodies and on currency.

Prerequisite: Open to all students except those who have taken any other chemistry course.
Distribution: Natural and Physical Science
Semester: Spring Unit: 1.25

CHEM 105 Fundamentals of Chemistry with Laboratory
Staff
This course is designed for students majoring in the physical and biological sciences as well as those wishing an introduction to modern molecular science. Core principles and applications of chemistry are combined to provide students with a conceptual understanding of chemistry that will help them in both their professional and everyday lives. Topics include principles of atomic and molecular structure, nuclear chemistry, molecular energetics, and an introduction to chemical equilibrium, chemical kinetics and classes of chemical reactions. The laboratory work introduces students to synthesis and structural determination by IR and other spectroscopic techniques, molecular modeling, periodic properties, computational chemistry, statistical analysis and various quantitative methods of analysis.

Prerequisite: 105 is designed for students who have completed one year of high school chemistry and mathematics equivalent to two years of algebra. Students who do not meet these prerequisites and who wish to take 105 should plan on taking the non-credit wintersession high school chemistry review course. Students must have fulfilled the basic skills component of the Quantitative Reasoning requirement. Students who have AP or IB credit in Chemistry, and who elect CHEM 105, forfeit the AP or IB credit
Distribution: Natural and Physical Science or Mathematical Modeling
Semester: Fall, Spring Unit: 1.25

CHEM 120 Intensive Introductory Chemistry with Laboratory
Kolodny
A one-semester course for students who have completed more than one year of high school chemistry, replacing CHEM 105 and 205 as a prerequisite for more advanced chemistry courses. It presents the topics of nuclear chemistry, atomic structure and bonding, periodicity, kinetics, thermodynamics, electrochemistry, equilibrium, acid/base chemistry, solubility and transition metal chemistry. All of these topics are presented in the context of both historical and contemporary applications. The laboratory includes experiments directly related to topics covered in lecture, an introduction of statistical analysis of data, molecular modeling and computational chemistry, instrumental and classical methods of analysis, thermochemistry and solution equilibria. The course meets for four periods of lecture/discussion and one 3.5 hour laboratory.

Prerequisite: Open to students who have a score of 5 on the Chemistry AP exam or an IB score of 5 or above; open also to students with two years of chemistry but without the requisite AP or IB score who perform sufficiently well on the Chemistry 120 Placement Exam. Students must have fulfilled the basic skills component of the Quantitative Reasoning requirement. Not open to students who have completed 105 and/or 205. Students who have AP or IB credit in Chemistry, and who elect CHEM 120, forfeit the AP or IB credit.

Distribution: Natural and Physical Science or Mathematical Modeling. Fulfills the Quantitative Reasoning overlay course requirement.
Semester: Fall Unit: 1.25

CHEM 205 Chemical Analysis and Equilibrium with Laboratory
Staff
This course builds on the principles introduced in CHEM 105, with an emphasis on chemical equilibrium and analysis, and their role in the chemistry of the environment. Topics include chemical reactions in aqueous solution with particular emphasis on acids and bases, solubility and complexation, electrochemistry, atmospheric chemistry, photochemistry and smog, global warming and acid deposition, sampling and separations, modeling of complex equilibrium and kinetic systems, statistical analysis of data, and solid state chemistry of ceramics, zeolites and new novel materials. The laboratory work includes additional experience with instrumental and noninstrumental methods of analysis, sampling, computational chemistry and solution equilibria.

Prerequisites: 105 and fulfillment of the basic skills component of the Quantitative Reasoning requirement or permission of the department. Not open to students who have taken 120.
Distribution: Mathematical Modeling or Natural and Physical Science. Fulfills the Quantitative Reasoning overlay course requirement.
Semester: Fall, Spring Unit: 1.25

CHEM 211 Organic Chemistry I with Laboratory
Staff
Topics covered include: stereochemistry, synthesis and reactions of alkanes, alkenes, alkynes, alkyl halides, alcohols and ethers, nomenclature of organic functional groups, IR, and GC/MS.

Prerequisite: 105, or 120 or permission of the department.
Distribution: Natural and Physical Science
Semester: Fall, Spring Unit: 1.25

CHEM 212 Organic Chemistry II with Laboratory
Staff
A continuation of CHEM 211. Includes NMR spectroscopy, synthesis, reactions of aromatic and carbonyl compounds, amines, and carbohydrates. In addition, students are expected to study the chemical literature and write a short chemistry review-paper.

Prerequisite: 211..
Distribution: Natural and Physical Science
Semester: Fall, Spring Unit: 1.25

CHEM 221 Biochemistry I with Laboratory
Vardar-Ulu
A study of the chemistry of biomolecules and macromolecular assemblies with emphasis on the structure of proteins, nucleic acids, carbohydrates, and lipids, as well as methodologies for studying them. This course is the first half of a year-long course sequence in biochemistry that continues with CHEM 328. Students who only intend to take a single semester of biochemistry should enroll in CHEM 222.

Prerequisite: 205, 211 and BISC 220; or 120, 211 and BISC 220
Distribution: Natural and Physical Science
Semester: Fall Unit: 1.25

CHEM 222 Introduction to Biochemistry with Laboratory
Vardar-Ulu, Elmore
A study of the chemistry of biomolecules and macromolecular assemblies, with emphasis on structure-function relationships; an introduction to bioenergetics, enzyme kinetics, and metabolism. This course is intended for students who plan to complete only one semester of biochemistry coursework at Wellesley. Students who plan to continue in Biochemistry II (CHEM328) should enroll in CHEM 221.

Prerequisite: 205, 211 and 212; or 120, 211 and 212
Distribution: Natural and Physical Science
Semester: Fall, Spring Unit: 1.25

CHEM 232 Physical Chemistry for the Life Sciences with Laboratory
Radhakrishnan
An examination of several topics in physical chemistry, with an emphasis on their applications to the life sciences. Topics include quantum chemistry and spectroscopy, electrochemistry, chemical thermodynamics, and kinetics. Does not count toward the chemistry major but counts toward the biological chemistry major and chemistry minor.

Prerequisite: 205 or 120, or permission of the department; and MATH 116, 116Z, or 120 and PHYS 104 or 107. Not open to students who have taken 231, 233, 332, 333, 334 or 335..
Distribution: Natural and Physical Science or Mathematical Modeling. Fulfills the Quantitative Reasoning overlay course requirement.
Semester: Spring Unit: 1.25

CHEM 233 Physical Chemistry I with Laboratory
Arumainayagam
This foundation course in physical chemistry establishes and develops the physical principles that are used to explain and interpret the observations made in other branches of chemistry. All four major physical chemistry topics, quantum mechanics, chemical thermodynamics, statistical mechanics, and kinetics, are introduced. Applications to other areas of chemistry will be discussed. The laboratory segment of the course incorporates statistical analysis of measured data.

Prerequisite: 205 or 120, or by permission of the department; and MATH 116, 116Z, or 120 and PHYS 104 or 107. Not open to students who have taken [231], 232, [332], [333], 334, or 335.
Distribution: Natural and Physical Science or Mathematical Modeling. Fulfills the Quantitative Reasoning overlay course requirement.
Semester: Fall Unit: 1.25

CHEM 250 Research or Individual Study

Prerequisite: Open by permission to students who have taken 205 or 120. This course cannot be counted toward a minimum major in chemistry. Students seeking to fulfill the chemistry major research requirement with a 200-level research course should enroll in CHEM 251.
Distribution: None
Semester: Fall, Spring Unit: 1.0

CHEM 251 Research or Individual Study

This course may count toward the research requirement for the chemistry major if the following criteria are met: the student registers for 251, writes an 8-10 page (minimum) paper on the research and gives a presentation to the chemistry department during one of the two research seminar presentation periods. The paper must contain substantial literature references, demonstrating a familiarity with searching the chemical literature.

Prerequisite: Open by permission to students who have taken 211 or 205 or 120.
Distribution: None
Semester: Fall, Spring Unit: 1.0

CHEM 306 Seminar
Kolodny
Topic A: Medical and Biological Applications of Magnetic Resonance. Applications of magnetic resonance in chemistry, biology and medicine include both nuclear magnetic resonance (NMR) spectroscopy and magnetic resonance imaging (MRI). Uses of NMR and MRI range from the determination of structures of macromolecules using multi-dimensional NMR spectroscopy to the observation of brain activation using functional MRI. The theoretical and instrumental basis of these techniques will be discussed. Examples of their applications will be taken from the current scientific literature. The seminar will be participatory, with each student making formal class presentations.

Prerequisites: 212 and PHYS 106 or 108
Distribution: Natural and Physical Science
Semester: Fall Unit: 1.0

CHEM 306/ES 306 Seminar
Coleman
Topic B: Green Chemistry. A study of the impact of chemicals and the chemical industry, broadly defined, on the global environment, and on emerging approaches to reducing that impact. The major focus will be on the fundamentals of designing chemical processes that produce smaller amounts of harmful by-products, reduce the use of toxic solvents, exploit catalysis, and maximize the conversion of reactants to the desired product. We will also examine the economic and political issues that surround green chemistry. *Students may register for either CHEM 306 or ES 306 and credit will be granted accordingly.*

Prerequisites: 205 and 211, or 120 and 211, or permission of instructor
Distribution: Natural and Physical Science
Semester: Spring Unit: 1.0

CHEM 328 Biochemistry II with Laboratory
Vardar-Ulu
A further study of the function and regulation of biomolecules and macromolecular assemblies introduced in CHEM221, with special emphasis on enzymes and metabolic pathways. Both the lecture and laboratory components of the course emphasize the development of independent research proposals to further students' conceptual and experimental understanding of biochemistry.

Prerequisite: 221 (students with 222 should get permission of the instructor to enroll in 328)
Distribution: Natural and Physical Science
Semester: Spring Unit: 1.25

CHEM 329 Seminar. Selected Topics in Biochemistry
Elmore
Topic for 2008-09: Molecular Modeling of Biochemical Systems. Although once the realm of specialized computational chemists using rare supercomputers, molecular modeling methods have become quite accessible in recent years to experimental biochemists working with standard personal computers. This course will provide students with practical experience using contemporary modeling techniques along with a basic understanding of the theoretical underpinnings of these methods. Specific methods considered in the course will include molecular dynamics simulations, drug docking, and homology modeling. The course will include weekly computer-based exercises, and will culminate in students' proposing and completing an independent project.

Prerequisites: 205, 212, and BISC 110, or permission of instructor
Distribution: Natural and Physical Science
Semester: Spring Unit: 1.0

CHEM 334 Physical Chemistry II without Laboratory
Virgo
Topics include statistical mechanics, quantum chemistry, spectroscopy, computational chemistry, and structure of solids. This course cannot be counted toward the physical chemistry requirement of the chemistry major.

Prerequisite: 233, PHYS 106 or 108; and MATH 215. Not open to students who have taken [333] or 335; (232 by permission of the instructor).
Distribution: Natural and Physical Science or Mathematical Modeling
Semester: Spring Unit: 1.0

CHEM 335 Physical Chemistry II with Laboratory
Virgo
Topics include statistical mechanics, quantum chemistry, spectroscopy, computational chemistry, and structure of solids.

Prerequisite: 233, PHYS 106 or 108; and MATH 215. Not open to students who have taken 332, 333, or 334; (232 by permission of the instructor).
Distribution: Natural and Physical Science or Mathematical Modeling
Semester: Spring Unit: 1.25

CHEM 341 Inorganic Chemistry with Laboratory
Coleman
Review of atomic structure, multi-electron atoms, the periodic table and periodicity, chemical applications of group theory, molecular orbital theory, the chemistry of ionic compounds, generalized acid/base theories, transition metal complexes, organometallic chemistry, catalysis, and bioinorganic chemistry. The laboratory introduces a number of experimental and computational techniques used in inorganic chemistry.

Prerequisites: 205 and 212, or 120 and 212
Distribution: Natural and Physical Science
Semester: Spring Unit: 1.25

CHEM 350 Research or Individual Study

Prerequisite: Open by permission to students who have taken at least three units in chemistry above the introductory level. Students seeking to fulfill the chemistry major research requirement with a 300-level research course should enroll in CHEM 351.
Distribution: None. Does not count toward the research requirement for the chemistry major.
Semester: Fall, Spring Unit: 1.0

CHEM 350H Research or Individual Study

Prerequisite: Open by permission to students who have taken at least two units in chemistry above the introductory level.
Distribution: None. Does not count toward the research requirement for the chemistry major.
Semester: Fall, Spring Unit: 0.5

CHEM 351 Research or Individual Study

This course may count toward the research requirement for the chemistry major if the following criteria are met: the student registers for 351, performs research during the semester or summer, writes an 8-10 page (minimum) paper on the research and gives a presentation to the chemistry department during one of the two research seminar presentation periods. The paper must contain a substantial review of the literature, demonstrating a familiarity with searching the chemical literature. Students electing to do off-campus summer research (8 weeks minimum) must arrange to have the research project approved by a faculty member in the chemistry department before starting the program.

Prerequisite: Open by permission to students who have taken at least three units in chemistry above the introductory level.
Distribution: None
Semester: Fall, Spring Unit: 1.0

CHEM 355 Chemistry Thesis Research

The first course in a two-semester investigation of a significant research problem, culminating in the preparation of a thesis and defense of that thesis before a committee of faculty from the chemistry department. Students will participate in a regular weekly seminar program, in which they will discuss their research progress informally with faculty and student colleagues and gain familiarity with contemporary research through presentations by outside seminar speakers. *This route does not lead to departmental honors. Counts toward the research requirement for the Chemistry major.*

Prerequisite: Open only to seniors by permission of the instructor.
Distribution: None
Semester: Fall, Spring Unit: 1.0

CHEM 360 Senior Thesis Research

Students in 360 and 370 will be expected to attend the weekly departmental honors seminar, listed in the schedule of classes. The seminar provides a forum for students conducting independent research to present their work to fellow students and faculty. See Academic Distinctions. *Counts toward the research requirement for the Chemistry major.*

Prerequisite: By permission of department.
Distribution: None
Semester: Fall, Spring Unit: 1.0

CHEM 361 Analytical Chemistry with Laboratory
Flynn
Classical and instrumental methods of chemical analysis. Topics include statistical analysis, electronics and circuitry, electrochemistry, spectroscopy, and separations science with special attention to instrument design and function. The course work emphasizes the practical applications of chemical instrumentation and methods to address questions in areas ranging from art history to biochemistry to materials science. The laboratory work focuses on the design, construction, and utilization of chemical instrumentation along with the interfacing of instruments with computers.

Prerequisites: 205 and 211 or 120 and 211.
Distribution: Natural and Physical Science. Fulfills the Quantitative Reasoning overlay course requirement.
Semester: Fall Unit: 1.25

CHEM 365 Chemistry Thesis

The second course in a two-semester investigation of a significant research problem, culminating in the preparation of a thesis and defense of that thesis before a committee of faculty from the chemistry department. Students will participate in a regular weekly seminar program, in which they will discuss their research progress informally with faculty and student colleagues and gain familiarity with contemporary research through presentations by outside seminar speakers. *This route does not lead to Departmental Honors.*

Prerequisite: 355
Distribution: None
Semester: Fall, Spring Unit: 1.0

CHEM 370 Senior Thesis

Prerequisite: 360 and permission of department.
Distribution: None
Semester: Fall, Spring Unit: 1.0

Directions for Election

Any student who plans to take chemistry beyond 205 or 120 should consult one or more members of the chemistry department faculty. The department Web site (http://www.welles-ley.edu/Chemistry/chem.html) contains specific suggestions about programs and deals with a variety of topics including preparation in mathematics and physics, graduate programs, and careers of former majors.

The chemistry major may follow either of two paths:

Path 1 (Recommended option for students planning to go to graduate school)

- 105 and 205, or 120;
- 211 and 212;

- [231] 233 and [333] 335;
- two from among: 222 or 221; 341; 361;
- one unit of research/independent study (CHEM 251, 351, 355, or 360)
- one additional non-research/thesis chemistry course at the 300 level (excluding research/thesis courses).
- MATH 215 and PHYS 108.

Path 2

- 105 and 205, or 120;
- 211 and 212;
- 233; 341; 361;
- either 222 or 221;
- one unit of research/independent study (CHEM 251, 351, 355, or 360)
- one additional non-research/thesis chemistry course at the 300 level (excluding research/thesis courses).
- MATH 116 or MATH 120; and PHYS 106 or PHYS 108

Students planning to study physical chemistry in graduate school should consider taking Chemistry 335 in their junior year and Physics 349 in their senior year.

Students interested in an independent major in chemical physics should consult the department chair.

The required mathematics and physics courses (Physics 108 but not Physics 106) may also be counted toward a major or a minor in those departments. Early completion of the mathematics and physics requirements is strongly encouraged.

Normally no more than three units of chemistry taken at another institution may be counted towards the major.

Students interested in the interdepartmental major in biological chemistry are referred to the section of the catalog where that major is described. They should also consult with the director of the biological chemistry program.

A minor in chemistry includes: 105 and 205, or 120; 211; 233 [231] or 232; a choice of 221 or 222 or 341 or 361; one additional 200- or 300 level unit, excluding 350/351. The mathematics and physics prerequisites for 233 [231]/232 must also be satisfied. Normally no more than one unit in chemistry from another institution may be counted toward the minor.

Chemist Accreditation

The American Chemical Society has established a set of requirements in various areas which it considers essential for the training of chemists. Students wishing to meet the standard of an accredited chemist as defined by this society should consult the chair of the chemistry department.

Teacher Certification

Students interested in obtaining certification to teach chemistry in the Commonwealth of Massachusetts should consult the chair of the education department.

Engineering
Students interested in engineering should consult the course listings in Extradepartmental.

Placement and Exemption Examinations
If a student scores a 5 on the AP or IB examinations, she automatically qualifies for CHEM 120. The department offers two placement examinations at the beginning of the fall semester. If a student scores a 5 and does well on the CHEM 120 **exemption** exam, she can go directly into CHEM 211. If a student scores below a 5 on the Chemistry AP, but performs well on the CHEM 120 **placement** exam she will be placed into CHEM 120. A student who has one year of high school chemistry can take CHEM 105 without taking AP chemistry or a placement exam.

Credit for Courses Taken at Other Institutions
In order to obtain Wellesley credit for any chemistry course taken at another institution, during the summer or the academic year, approval must be obtained from the chair of the department prior to enrolling in the course. In general, courses from two-year colleges will not be accepted at any level. These restrictions normally apply only to courses taken after enrollment at Wellesley. Transfer students wishing to obtain credit for chemistry courses taken prior to enrollment at Wellesley should consult the chair of the department.

Withdrawal from Courses with Laboratory
Students who withdraw from a course which includes laboratory, and then elect that course in another semester, must complete both the lecture and laboratory portions of the course the second time.

Honors
The only route to honors in the major is writing a thesis and passing an oral examination (CHEM 360 and 370). To be admitted to the thesis program, a student must have a grade point average of at least 3.5 in all work in the major field above the 100 level; the department may petition on her behalf if her GPA in the major is between 3.0 and 3.5. See Academic Distinctions.