

## **CHEMISTRY (DIV III)**

Chair: Professor AMY GEHRING

Professors: A. GEHRING, L. KAPLAN\*\*\*, C. LOVETT\*\*, L. PARK\*, E. PEACOCK-LÓPEZ, D. RICHARDSON, T. SMITH, J. THOMAN\*\*\*. Associate Professors: C. GOH, S. GOH. Assistant Professors: J. BLAIR. Visiting Assistant Professor: P. BARBER. Lecturer Emerita: A. SKINNER. Lecturer: J. MACINTIRE. Lab Instructors: A. NDUWUMWAMI, L. STRAUCH.

### **MAJOR**

Through a variety of individual courses and sequential programs, the department provides an opportunity for students to explore the nature and significance of chemistry, an area of important achievement in our quest for knowledge about ourselves and the world around us. The student of chemistry is able to become aware of the special viewpoint of chemists, the general nature of chemical investigation, some of its important results, how these results are expressed, and something of their significance within the fields of science and in the area of human endeavor as a whole. The Chemistry major provides excellent preparation for graduate study in chemistry, biochemistry, chemical engineering, environmental science, materials science, medicine, and the medical sciences.

A major in chemistry can be achieved in several ways, preferably beginning in the student's first year at Williams, but also beginning in the sophomore year. Building on a foundation in general chemistry, organic chemistry, and physical chemistry, a student elects additional advanced courses to complete a major that is consistent with his or her background in other sciences, interests, and goals. A student's program might emphasize biochemistry, organic chemistry, physical chemistry, or inorganic chemistry, with additional courses available in analytical chemistry, environmental science, and materials science. Students considering a major in chemistry should consult with a member of the department as early as possible in order to plan a program which best suits their interests and abilities and which makes full use of their previous preparation.

All students begin their study in the department with either Chemistry 151, 153, or 155. Placement at the introductory level is based upon performance on the departmental placement test results and consultation with the chair; results of the College Board Advanced Placement Test or the International Baccalaureate Exam are also taken into account. The first year is completed with Chemistry 156. In the second year at the introductory level, students take Chemistry 251 (or 255) and Chemistry 256 (those students who complete 155 are exempted from 256). Completion of a Chemistry major requires either nine semester chemistry courses or eight semester chemistry courses plus two approved courses from among the following: Biology 101; Computer Science 134; Mathematics 130, 140, 150, 151; Physics 131, 141; or any courses in these departments for which the approved courses are prerequisites. CHEM 155 counts for two courses toward the major, but a single course toward graduation credit. Starting at the 300 level, at least three of the courses taken must have a laboratory component, and at least one must be selected from Chemistry 361, 366, 364, or 367. (The specific course elected, in consultation with the chair or major advisor, will depend on the student's future plans.) In addition, the department has a number of "Independent Research Courses" which, while they do not count toward completion of the major, provide a unique opportunity to pursue an independent research project under the direction of a faculty member.

### **Foundational Courses**

#### **First Year**

Fall: 151, 153 or 155 Gateway courses

Spring: 156 Organic Chemistry: Introductory Level

#### **Second Year**

Fall: 251 (or 255) Organic Chemistry: Intermediate Level

Spring: 256 Advanced Chemical Concepts (or 300-level if completed 155)

### **Elective Courses**

319 Integrative Bioinformatics, Genomics, and Proteomics Lab  
321 Biochemistry I-Structure and Function of Biological Molecules  
322 Biochemistry II-Metabolism  
324 Enzyme Kinetics and Reaction Mechanisms  
326 Chemical Biology: Discoveries at the Interface  
335 Inorganic/Organometallic Chemistry  
336 Materials Chemistry  
338 Bioinorganic Chemistry: Metals in Living Systems  
341 Toxicology and Cancer  
342 Synthetic Organic Chemistry  
343 Medicinal Chemistry  
344T Physical Organic Chemistry  
348 Polymer Chemistry  
361 Quantum Chemistry and Chemical Dynamics  
364 Instrumental Methods of Analysis  
366 Thermodynamics and Statistical Mechanics  
367 Biophysical Chemistry  
368T Computational Chemistry and Molecular Spectroscopy

### **Independent Research Courses**

393-W31-394 Junior Research and Thesis  
397, 398 Independent Study, for Juniors  
493-W31-494 Senior Research and Thesis  
497, 498 Independent Study, for Seniors

For the purpose of assisting students in selecting a program consistent with their interests and possible continuation of their studies at the graduate level, the following groupings of electives and faculty advisors are suggested. However, a case can be made for selecting courses from the different groups.

**Biochemistry:** Chemistry 321, Chemistry 322, Chemistry 324, Chemistry 326, Chemistry 341, Chemistry 364, Chemistry 367. Students interested in biochemistry should consult with Professors Blair, Gehring, Kaplan, or Lovett.

**Organic Chemistry:** Chemistry 341, Chemistry 342, Chemistry 343, Chemistry 344T, Chemistry 348, Chemistry 364, Chemistry 361, Chemistry 366. Students interested in organic chemistry should consult with Professors Blair, S. Goh, Richardson, or Smith.

**Physical and Inorganic Chemistry:** Chemistry 335, Chemistry 336, Chemistry 338, Chemistry 361, Chemistry 364, Chemistry 366, Chemistry 368T. Students interested in physical chemistry should consult with Professors Peacock-López, or Thoman. Students interested in inorganic chemistry should consult with Professors Barber, C. Goh, or Park. Students interested in materials science should consult with Professors Barber, C. Goh, or Park.

While any accepted route through the major would permit a student to proceed to graduate study in chemistry, four electives should be considered a minimum, and at least a semester of research is strongly recommended.

The department's curriculum is approved by the American Chemical Society (A.C.S.), a professional body of academic, industrial, and research chemists. The A.C.S. suggests the following courses for someone considering graduate study or work in chemistry or a related area: 151 (153 or 155), 156, 251 (255), 256, 321, 335, 364, 361 (366 or 367) and at least 4 courses (two of which must have a laboratory component) from our remaining upper level electives: 319, 322, 324, 326, 336, 338, 341, 342, 343, 344T, 348, 361, 366, 367, 368T, 493, 494, 497, 498, BIMO 401. In addition, students are strongly encouraged (though not required) to pursue independent research in some form. Students completing these requirements can be designated Certified A.C.S. Majors.

#### **BIOCHEMISTRY AND MOLECULAR BIOLOGY (BIMO)**

Students interested in Biochemistry and Molecular Biology should consult with the general statement under the Biochemistry and Molecular Biology Program (BIMO) in the Courses of Instruction. Students interested in completing the BIMO program are also encouraged to complete the biochemistry courses within the chemistry major by taking 321, 322, 324, and 367 in addition to the first and second year required courses.

#### **BIOINFORMATICS, GENOMICS, AND PROTEOMICS (BIGP)**

Students interested in Bioinformatics, Genomics, and Proteomics should consult the general statement under Bioinformatics, Genomics, and Proteomics in the Courses of Instruction. Students interested in these areas are also encouraged to complete the biochemistry courses within the chemistry major by taking 319, 321, 322, 324 and 367 in addition to the first and second year required courses.

#### **MATERIALS SCIENCE**

Students interested in Materials Science are encouraged to elect courses from the Materials Science program offered jointly with the Physics Department, and should consult that listing.

#### **THE DEGREE WITH HONORS IN CHEMISTRY**

The degree with honors in Chemistry provides students with an opportunity to undertake an independent research project under the supervision of a faculty member, and to report on the nature of the work in two short oral presentations and in a written thesis.

Chemistry majors who are candidates for the degree with honors take the following in addition to a major outlined above:

Chemistry 493-W31-494 Senior Research and Thesis

The principal considerations in admitting a student to a program of independent research are mastery of fundamental materials and skills, ability to pursue independent study successfully, and demonstrated student interest and motivation. In addition, to enroll in these courses leading to a degree with honors, a student must have at least a B- average in all chemistry courses or the permission of the chair. At the end of the first semester of the senior year, the department reviews the student's progress and determines whether the student is a candidate for a degree with honors. The designation of a degree with honors in Chemistry or a degree with highest honors in Chemistry is based primarily on a departmental evaluation of the accomplishments in these courses and on the quality of the thesis. Completion of the research project in a satisfactory manner and preparation of a well-written thesis usually results in a degree with honors. In cases where a student has demonstrated unusual commitment and initiative resulting in an outstanding thesis based on original results, combined with a strong record in all of his or her chemistry courses, the department may elect to award a degree with highest honors in Chemistry.

#### **EXCHANGE AND TRANSFER STUDENTS**

Students from other institutions wishing to register for courses in chemistry involving college-level prerequisites should do so in person with a member of the Chemistry Department. Registration should take place by appointment during the spring semester prior to the academic year in which courses are to be taken. Students are requested to have with them transcripts of the relevant previous college work.

#### **COURSES FOR NON-MAJORS WITH NO PREREQUISITES**

Students with principal interests outside of the sciences may extend a secondary school foundation in chemistry by electing a basic two-semester introductory course of a general nature or they may elect semester courses designed for non-majors. All courses in chemistry satisfy the divisional distribution requirement.

### **STUDY ABROAD**

Students who wish to complete a chemistry major (or chemistry requirements for pre-medical study) as well as to study abroad during their junior year are encouraged to begin taking chemistry in their first semester at Williams, and should consult with members of the department as early as possible. You can find general study away guidelines for Chemistry [here](#).

### **CHEM 113 Chemistry and Crime: From Sherlock Holmes to Modern Forensic Science**

In this course, designed for students who do not plan to major in the natural sciences, we use a case-oriented approach to explore selected topics of forensic science. These include: (1) the scientific and technological foundation for the examination of physical, chemical, and biological items of evidence, and (2) the scope of expert qualifications and testimony, the legal status of scientific techniques, and the admissibility of the results in evidence. The analysis of trace evidence, including glass, soil, gunpowder residues and bullet fragments, and inorganic and heavy metal poisons are discussed through an understanding of the basic concepts of chemistry and analytical chemistry. Forensic toxicology and pharmacology are applied to the analysis of alcohol, poisons, and drugs based upon the principles of organic chemistry and biochemistry. The characterization of blood and other body fluids necessitate an understanding of serology and molecular genetics. The cases which stimulate the exploration of these areas include: the John and Robert Kennedy assassinations, the Jeffrey MacDonald case (*Fatal Vision*), the Wayne Williams case, the deaths of celebrities Marilyn Monroe, John Belushi, and Janis Joplin, the authenticity of the Shroud of Turin, the Casey Anthony case, the Tylenol poisonings, and the identity of Anastasia. Interactive demonstration sessions provide an appreciation of scientific experimentation in general and the work of a crime lab in particular. It includes an analysis of evidence and provides an opportunity to learn forensic techniques such as chromatography (for ink, drug, and fire accelerant analysis), spectroscopy (for alcohol and drug analysis), and electrophoresis (for DNA fingerprinting).

**Class Format:** lecture, three times per week

**Requirements/Evaluation:** evaluation is based on problem sets and/or quizzes, hour tests, a final exam, and papers

**Prerequisites:** none; designed for the non-science major who does not intend to pursue a career in the natural sciences; not open to students who have taken CHEM 151, 153, 155, 156/251, or 256

**Class Format:** lecture, three times per week

**Requirements/Evaluation:** evaluation is based on problem sets and/or quizzes, hour tests, a final exam, and papers

**Prerequisites:** none; designed for the non-science major who does not intend to pursue a career in the natural sciences; not open to students who have taken CHEM 151, 153, 155, 156/251, or 256

**Enrollment Preferences:** seniors and juniors

**Enrollment Limit:** 30

**Expected Class Size:** 30

**Distributional Requirements:**

Division 3

**Other Attributes:**

JLST Enactment/Applications in Institutions

SCST Elective Courses

*Not Offered Academic Year 2017*

LEC Instructor: Lawrence Kaplan

### **CHEM 115 AIDS: The Disease and Search for a Cure**

Since the discovery of the human immunodeficiency virus (HIV-1) in 1983, modern techniques of molecular biology have revealed much about its structure and life cycle. The intensity of the scientific investigation directed at HIV-1 is unprecedented in history. We now know more about this virus than any other known pathogen. However, the early optimism concerning the prospects for an effective AIDS vaccine has now waned and HIV strains that are resistant to drug therapies are common. We are now three decades into the AIDS pandemic and the World Health Organization estimates that there are more than 34 million HIV-infected persons worldwide. After an introduction to chemical structure, we examine the molecular biology of the HIV virus, the molecular targets of anti-HIV drugs, and the prospects for a cure. We look at how HIV-1 interacts with the human immune system and discuss prospects for developing an effective HIV vaccine.

**Class Format:** lecture, three hours per week

**Requirements/Evaluation:** evaluation is based on problem sets, a midterm, quizzes, a final exam, and a paper/discussion

**Prerequisites:** none; designed for the non-science major who does not intend to pursue a career in the natural sciences

**Enrollment Limit:** 45

**Expected Class Size:** 45

**Distributional Requirements:**

Division 3

**Other Attributes:**

PHLH Biomedical Determinants of Health

SCST Related Courses

*Not Offered Academic Year 2017*

LEC Instructor: Rebecca Taurog

### **CHEM 116 Chemistry and Physics of Cooking (Q)**

Cooking is a creative and artistic process, but it is based on fundamental chemical and physical principles. In this course, which is intended for students who do not plan to major in the natural sciences, we explore these scientific principles and their application to the kitchen. We draw on edible examples such as chemical bonding and intermolecular forces (salting, emulsification, and spherification), acid-base chemistry (leavening, making jam, and macaroni and cheese), kinetics and thermodynamics (cooking styles and times), states of matter (carbonation, ices, foams, and gels), types of chemical reactions (baking bread, grilling vegetables, tenderizing meat), and energy transfer (kitchen equipment and gadgets). The kitchen is a laboratory—in the classroom, we carry out experiments to demonstrate and to test these scientific concepts. This course also considers the science behind contemporary ideas in cooking known as "modernist cuisine" and/or "molecular gastronomy". Bon appetit!

**Class Format:** lecture

**Requirements/Evaluation:** weekly quizzes and problem sets, two exams, and a paper

**Prerequisites:** none, but students who have not taken high school chemistry should consult the instructor

**Enrollment Preferences:** seniors and juniors; not appropriate for CHEM, BIOL, or PHYS majors, or for those who have taken CHEM 151, 153, or 155

**Enrollment Limit:** 45

**Expected Class Size:** 45

**Distributional Requirements:**

Division 3

Quantitative/Formal Reasoning

*Not Offered Academic Year 2017*

LEC

### **CHEM 151(F) Introductory Chemistry (Q)**

This course provides an introduction to chemistry for those students with little or no high school chemistry. Students will be introduced to concepts fundamental to studying matter at the molecular level. Principal topics include introductions to the nature of atoms and molecules, stoichiometry, solubility rules and equilibria, gas laws, chemical equilibrium, acid-base reactions, periodic relationships, chemical bonding, molecular structure, intermolecular forces, oxidation-reduction reactions, and related applications. Laboratory work comprises a system of qualitative analysis and quantitative techniques. The course provides preparation for further study of organic chemistry, biochemistry, physical and inorganic chemistry and is intended for students who are anticipating professional study in chemistry, in related sciences, or in one of the health professions, as well as for those students who are interested in exploring the fundamental ideas of chemistry as part of their general education.

**Class Format:** lecture, three times per week; laboratory, four hours per week

**Requirements/Evaluation:** evaluation is based on frequent electronic and quantitative written weekly problem set assignments, laboratory work and reports, quizzes, two tests, and a final exam

**Extra Info:** information about the Chemistry Placement Test can be found at <http://chemistry.williams.edu/placement/> may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** students planning to enroll required to take online Chemistry Placement Test prior to registering for the course & to meet with a faculty member during First Days; students who have studied chemistry for one or more years are directed to CHEM 153 or 155

**Enrollment Limit:** 48

**Expected Class Size:** 48

**Dept. Notes:** CHEM 151 may be taken concurrently with MATH 102—see under Mathematics; CHEM 151 or its equivalent is prerequisite to CHEM 156; one of CHEM 151 or 153 or 155 required for the BIMO concentration

**Distributional Requirements:**

Division 3

Quantitative/Formal Reasoning

**Other Attributes:**

BIMO Required Courses

ENVS Group EC-A Electives

*Fall 2016*

LEC Section: 01 MWF 08:30 AM 09:45 AM Instructor: David Richardson

LAB Section: 02 M 01:00 PM 05:00 PM

LAB Section: 03 T 01:00 PM 05:00 PM

LAB Section: 04 R 01:00 PM 05:00 PM

### **CHEM 153(F) Concepts of Chemistry (Q)**

This course broadens and deepens the foundation in chemistry of students who have had typically one year of chemistry at the high school level. Most students begin study of chemistry at Williams with this course. Familiarity with stoichiometry, basic concepts of equilibria, and the model of an atom is expected. Principal topics for this course include kinetic theory of gases, modern atomic theory, molecular structure and bonding, states of matter, chemical equilibrium (acid-base and solubility), and an introduction to atomic and molecular spectroscopies. Laboratory work includes synthesis, qualitative and quantitative chemical analysis, and molecular modeling. The course is of interest to students who anticipate professional study in chemistry, related sciences, or one of the health professions, as well as to those who want to explore the fundamental ideas of chemistry as part of their general education.

**Class Format:** lecture, three hours per week; laboratory, four hours per week

**Requirements/Evaluation:** evaluation is based on quantitative weekly problem set assignments, laboratory work and reports, hour tests, and a final exam

**Extra Info:** information about the Chemistry Placement Test can be found at <http://chemistry.williams.edu/placement/> may not be taken on a pass/fail basis

**Prerequisites:** students are required to take the online Chemistry Placement Test prior to registering for the course & to meet with a faculty member during First Days

**Enrollment Limit:** none

**Expected Class Size:** 60

**Dept. Notes:** one of CHEM 151 or 153 or 155 required for the BIMO concentration

**Distributional Requirements:**

Division 3

Quantitative/Formal Reasoning

**Other Attributes:**

BIMO Required Courses

ENVS Group EC-A Electives

*Fall 2016*

LEC Section: 01 MWF 09:00 AM 09:50 AM Instructor: Amy Gehring

LAB Section: 02 M 01:00 PM 05:00 PM

LAB Section: 03 T 01:00 PM 05:00 PM

LAB Section: 04 W 01:00 PM 05:00 PM

LAB Section: 05 R 01:00 PM 05:00 PM

LAB Section: 06 T 08:00 AM 12:00 PM

### **CHEM 155(F) Principles of Modern Chemistry (Q)**

This course is designed for students with strong preparation in secondary school chemistry, including a laboratory experience, such as provided by an Advanced Placement chemistry course (or equivalent) with a corresponding score of 5 of the AP Chemistry Exam (or a 7 on the IB Exam, or equivalent). Topics include chemical thermodynamics, kinetics, structure and bonding, coordination chemistry, electrochemistry and spectroscopy and their application to fields such as materials science, industrial, environmental, biological, and medicinal chemistry. Laboratory work includes synthesis, characterization, and reactivity of coordination complexes, electrochemical analysis, materials chemistry, qualitative analysis, and molecular modeling. This course is of interest for students who are anticipating professional study in chemistry, related sciences, or one of the health professions, as well as for students who want to explore the fundamental ideas of chemistry as part of their general education.

**Class Format:** lecture, three hours per week; laboratory, four hours per week

**Requirements/Evaluation:** evaluation is based on weekly problem sets, laboratory work and reports, an hour test, and a final exam

**Extra Info:** information about the Chemistry Placement Test can be found at <http://chemistry.williams.edu/placement/> may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** students are required to take the online Chemistry Placement Test prior to registering for the course and to meet with a faculty member during First Days

**Enrollment Preferences:** none

**Enrollment Limit:** none

**Expected Class Size:** 36

**Dept. Notes:** one of CHEM 151 or 153 or 155 required for the BIMO concentration

**Distributional Requirements:**

Division 3

Quantitative/Formal Reasoning

**Other Attributes:**

BIMO Required Courses

ENVS Group EC-A Electives

ENVS Group EC-B Electives

MTSC Related Courses

*Fall 2016*

LEC Section: 01 MWF 08:00 AM 08:50 AM Instructor: John Thoman

LAB Section: 02 M 01:00 PM 05:00 PM

LAB Section: 03 T 01:00 PM 05:00 PM

LAB Section: 04 W 01:00 PM 05:00 PM

### **CHEM 156(S) Organic Chemistry: Introductory Level (Q)**

This course provides the necessary background in organic chemistry for students who are planning advanced study or a career in chemistry, the biological sciences, or the health professions. It initiates the systematic study of the common classes of organic

compounds with emphasis on theories of structure and reactivity. The fundamentals of molecular modeling as applied to organic molecules are presented. Specific topics include basic organic structure and bonding, isomerism, stereochemistry, molecular energetics, the theory and interpretation of infrared and nuclear magnetic spectroscopy, substitution and elimination reactions, and the addition reactions of alkenes and alkynes. The coordinated laboratory work includes purification and separation techniques, structure-reactivity studies, organic synthesis, IR and NMR spectroscopy, and the identification of unknown compounds.

**Class Format:** lecture, three hours per week; laboratory, four hours per week

**Requirements/Evaluation:** evaluation will be based on quantitative problem sets, laboratory performance, including written lab reports, three midterm exams, and a final exam

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** CHEM 151 or 153 or 155 or placement exam or permission of instructor

**Enrollment Limit:** 16 per lab

**Expected Class Size:** 120

**Distributional Requirements:**

Division 3

Quantitative/Formal Reasoning

**Other Attributes:**

BIMO Required Courses

ENVS Group EC-B Electives

MTSC Related Courses

*Spring 2017*

LEC Section: 01 MWF 09:00 AM 09:50 AM Instructor: Jimmy Blair

LAB Section: 02 M 01:00 PM 05:00 PM

LAB Section: 03 T 01:00 PM 05:00 PM

LAB Section: 04 W 01:00 PM 05:00 PM

LAB Section: 05 R 01:00 PM 05:00 PM

LAB Section: 06 T 08:00 AM 12:00 PM

LAB Section: 07 M 07:00 PM 11:00 PM

LAB Section: 08 M 01:00 PM 05:00 PM

LAB Section: 09 W 01:00 PM 05:00 PM

### **CHEM 251(F) Organic Chemistry: Intermediate Level**

This course is a continuation of Chemistry 156 and it includes the systematic study of the common classes of organic compounds with emphasis on theories of structure and reactivity. Specific topics include radical chemistry, an introduction to mass spectrometry and ultraviolet spectroscopy, the theory and chemical reactivity of conjugated and aromatic systems, the concepts of kinetic and thermodynamic control, an extensive treatment of the chemistry of the carbonyl group, alcohols, ethers, polyfunctional compounds, the concept of selectivity, the fundamentals of organic synthesis, an introduction to carbohydrates, carboxylic acids and derivatives, acyl substitution reactions, amines, and an introduction to amino acids, peptides, and proteins. The coordinated laboratory work includes application of the techniques learned in the introductory level laboratory, along with new functional group analyses, to the separation and identification of several unknown samples. Skills in analyzing NMR, IR, and MS data are practiced and further refined.

**Class Format:** lecture, three hours per week; laboratory, four hours per week

**Requirements/Evaluation:** evaluation is based on midterm exams, problem sets, laboratory performance, including written lab reports, and a final exam

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** CHEM 156 or permission of instructor

**Enrollment Limit:** 16 per lab

**Expected Class Size:** 100

**Distributional Requirements:**

Division 3

**Other Attributes:**

BIMO Required Courses

ENVS Group EC-B Electives

MTSC Related Courses

*Fall 2016*

LEC Section: 01 MWF 10:00 AM 10:50 AM Instructor: Thomas Smith

LAB Section: 02 M 01:00 PM 05:00 PM Instructor: Thomas Smith

LAB Section: 03 T 01:00 PM 05:00 PM

LAB Section: 04 W 01:00 PM 05:00 PM

LAB Section: 05 R 01:00 PM 05:00 PM

LAB Section: 06 T 08:00 AM 12:00 PM

LAB Section: 07 M 07:00 PM 11:00 PM

LAB Section: 08 W 01:00 PM 05:00 PM

### **CHEM 255(F) Organic Chemistry: Intermediate Level—Special Laboratory Section**

*This course is a continuation of CHEM 156 and contains the same material as CHEM 251 except for the laboratory program described below:*

The aim of this advanced laboratory section is to enrich and enhance the laboratory experiences of motivated students of recognized ability by providing a laboratory program that more closely resembles the unpredictable nature and immediacy of true chemical research. Students synthesize, isolate, and characterize (using a range of modern physical and spectroscopic techniques) a family of unknown materials in a series of experiments constituting an integrated, semester-long investigation. A flexible format is employed in which the students are responsible for helping to plan the course of their laboratory work based upon discussions with the instructor about the previous week's experimental results. Students are drawn from CHEM 156 with placement based upon student selection and nomination by the CHEM 156 instructor. Participants attend their regular CHEM 251 lecture but attend the special laboratory section instead of a CHEM 251 laboratory section.

**Class Format:** lecture, three hours per week; laboratory, four hours per week; weekly one-hour discussion

**Requirements/Evaluation:** evaluation is based on the requirements for the CHEM 251 lecture and performance in this special laboratory section including written laboratory reports and participation in discussions

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** permission of instructor

**Enrollment Preferences:** sophomores

**Enrollment Limit:** 12

**Expected Class Size:** 12

**Dept. Notes:** course was developed under a grant from the Ford Foundation

#### **Distributional Requirements:**

Division 3

#### **Other Attributes:**

ENVS Group EC-B Electives

MTSC Related Courses

#### *Fall 2016*

LEC Section: 01 MWF 10:00 AM 10:50 AM Instructor: Thomas Smith

LAB Section: 02 R 01:00 PM 05:00 PM Instructor: Christopher Goh

### **CHEM 256(S) Advanced Chemical Concepts**

This course treats an array of topics in modern chemistry, emphasizing broad concepts that connect and weave through the various subdisciplines of the field—biochemistry, inorganic chemistry, organic chemistry, and physical chemistry. It provides necessary background in chemical science for students who are planning advanced study or a career in chemistry, biological science, geoscience, environmental science, or a health profession. Topics include coordination complexes, thermodynamics, electrochemistry, kinetics, and nuclear chemistry. Laboratory work includes experiments involving synthesis, characterization, and reactivity studies of coordination and organic complexes, spectroscopic analyses, thermodynamics, electrochemistry, kinetics, and nuclear chemistry.

**Class Format:** lecture, three hours per week; laboratory, four hours per week

**Requirements/Evaluation:** evaluation is based on homework assignments, laboratory work, hour tests, and a final exam

**Extra Info:** may not be taken on a pass/fail basis

**Prerequisites:** CHEM 251/255, or permission of instructor

**Enrollment Limit:** none

**Expected Class Size:** 100

**Dept. Notes:** for the BIMO concentration, CHEM 256 not required if CHEM 155 was taken

#### **Distributional Requirements:**

Division 3

#### **Other Attributes:**

BIMO Required Courses

ENVS Group EC-B Electives

MTSC Related Courses

#### *Spring 2017*

LEC Section: 01 MWF 10:00 AM 10:50 AM Instructor: Charles Lovett

LAB Section: 02 M 01:00 PM 05:00 PM

LAB Section: 03 T 01:00 PM 05:00 PM

LAB Section: 04 W 01:00 PM 05:00 PM

LAB Section: 05 R 01:00 PM 05:00 PM

LAB Section: 06 T 08:00 AM 12:00 PM

### **CHEM 319(F) Integrative Bioinformatics, Genomics, and Proteomics Lab (Q)**

**Crosslistings:** BIOL 319/MATH 319/CHEM 319/PHYS 319/CSCI 319

What can computational biology teach us about cancer? In this capstone experience for the Genomics, Proteomics, and Bioinformatics program, computational analysis and wet-lab investigations will inform each other, as students majoring in biology, chemistry, computer science, mathematics/statistics, and physics contribute their own expertise to explore how ever-growing gene and protein data-sets can provide key insights into human disease. In this course, we will take advantage of one well-studied system, the highly conserved Ras-related family of proteins, which play a central role in numerous fundamental processes within the cell. The course will integrate bioinformatics and molecular biology, using database searching, alignments and pattern matching, phylogenetics, and recombinant DNA techniques to reconstruct the evolution of gene families by focusing on the gene duplication events and gene rearrangements that have occurred over the course of eukaryotic speciation. By utilizing high through-put approaches to investigate genes involved in the MAPK signal transduction pathway in human colon cancer cell lines, students will uncover regulatory mechanisms that are aberrantly altered by siRNA knockdown of putative regulatory components. This functional genomic strategy will be coupled with independent projects using phosphorylation-state specific antisera to test our hypotheses. Proteomic analysis will introduce the students to de novo structural prediction and threading algorithms, as well as data-mining approaches and Bayesian modeling of protein network dynamics in single cells. Flow cytometry and mass spectrometry will be used to study networks of interacting proteins in colon tumor cells.

**Class Format:** two afternoons of lab, with one hour of lecture, per week

**Requirements/Evaluation:** lab participation, several short homework assignments, one lab report, a programming project, and a grant proposal

**Prerequisites:** BIOL 202; students who have not taken BIOL 202 but have taken BIOL 101 and CSCI 315 or PHYS 315, may enroll with permission of instructor. No prior computer programming experience is required.

**Enrollment Preferences:** seniors, then juniors, then sophomores

**Enrollment Limit:** 12

**Expected Class Size:** 12

**Dept. Notes:** does not satisfy the distribution requirement in the Biology major

**Distributional Requirements:**

Division 3

Quantitative/Formal Reasoning

**Other Attributes:**

BGNP Core Courses

BIMO Interdepartmental Electives

*Fall 2016*

LEC Section: 01 W 12:25 PM 01:00 PM Instructor: Lois Banta

LAB Section: 02 WR 01:00 PM 04:00 PM Instructor: Lois Banta

LAB Section: 03 Cancelled

### **CHEM 321(F) Biochemistry I: Structure and Function of Biological Molecules (Q)**

**Crosslistings:** BIMO 321/BIOL 321/CHEM 321

This course introduces the basic concepts of biochemistry with an emphasis on the structure and function of biological macromolecules. Specifically, the structure of proteins and nucleic acids are examined in detail in order to determine how their chemical properties and their biological behavior result from those structures. Other topics covered include catalysis, enzyme kinetics, mechanism and regulation; the molecular organization of biomembranes; and the flow of information from nucleic acids to proteins. In addition, the principles and applications of the methods used to characterize macromolecules in solution and the interactions between macromolecules are discussed. The laboratory provides a hands-on opportunity to study macromolecules and to learn the fundamental experimental techniques of biochemistry including electrophoresis, chromatography, and principles of enzymatic assays.

**Class Format:** lecture, three hours per week; laboratory, four hours per week

**Requirements/Evaluation:** evaluation is based on quizzes, a midterm exam, a final exam, problem sets and performance in the laboratories including lab reports

**Extra Info:** may not be taken on a pass/fail basis

**Prerequisites:** BIOL 101 and CHEM 251/255 and CHEM 155/256

**Enrollment Preferences:** junior and senior Biology and Chemistry majors and BIMO concentrators

**Enrollment Limit:** 48

**Expected Class Size:** 48

**Dept. Notes:** does not satisfy the distribution requirement in the Biology major

**Distributional Requirements:**

Division 3

Quantitative/Formal Reasoning

**Other Attributes:**

BGNP Related Courses

BIMO Required Courses

Fall 2016

LEC Section: 01 MWF 10:00 AM 10:50 AM Instructor: Lawrence Kaplan

LAB Section: 02 M 01:00 PM 05:00 PM

LAB Section: 03 W 01:00 PM 05:00 PM

LAB Section: 04 R 01:00 PM 05:00 PM

### **CHEM 322(S) Biochemistry II: Metabolism (Q)**

**Crosslistings:** BIMO 322/BIOL 322/CHEM 322

This lecture course provides an in-depth presentation of the complex metabolic reactions which are central to life. Emphasis is placed on the biological flow of energy including alternative modes of energy generation (aerobic, anaerobic, photosynthetic); the regulation and integration of the metabolic pathways including compartmentalization and the transport of metabolites; and biochemical reaction mechanisms including the structures and mechanisms of coenzymes. This comprehensive study also includes the biosynthesis and catabolism of small molecules (carbohydrates, lipids, amino acids, and nucleotides). Laboratory experiments introduce the principles and procedures used to study enzymatic reactions, bioenergetics, and metabolic pathways.

**Class Format:** lecture, three hours per week; laboratory, three hours per week

**Requirements/Evaluation:** evaluation is based on several exams and performance in the laboratories including lab reports that emphasize conceptual and quantitative and/or graphic analysis of the data generated

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** BIOL 101 and CHEM 251/255 or permission of instructor

**Enrollment Preferences:** junior and senior Biology and Chemistry majors and BIMO concentrators

**Enrollment Limit:** 64

**Expected Class Size:** 64

**Dept. Notes:** does not satisfy the distribution requirement in the Biology major

**Distributional Requirements:**

Division 3

Quantitative/Formal Reasoning

**Other Attributes:**

BGNP Related Courses

BIMO Required Courses

Spring 2017

LEC Section: 01 MWF 10:00 AM 10:50 AM Instructor: Daniel Lynch

LAB Section: 02 T 01:00 PM 04:00 PM

LAB Section: 03 W 01:00 PM 04:00 PM

LAB Section: 04 R 01:00 PM 04:00 PM

### **CHEM 324 Enzyme Kinetics and Reaction Mechanisms**

Enzymes are complex biological molecules capable of catalyzing chemical reactions with very high efficiency, stereo-selectivity and specificity. The study of enzymatically-catalyzed reactions gives insight into the study of organic reaction mechanisms in general, and into the topic of catalysis especially. This course explores the methods and frameworks for determining enzymatic reaction mechanisms. These methods are based on a firm foundation of organic reaction mechanisms and chemical kinetics. We will investigate the major types of biochemical reactions, focusing on their catalytic mechanisms and how those mechanisms can be elucidated. We will lay the foundation for this mechanistic consideration with discussion of transition state theory, structure-reactivity relationships, steady state and pre-steady kinetics, use of isotopes, genetic modification, and other tools for probing enzymatic reactions. We will also examine the catalytic roles of a variety of vitamins and cofactors.

**Class Format:** lecture, three hours per week

**Requirements/Evaluation:** evaluation is based on problem sets, quizzes, a midterm exam, a paper, and a final exam

**Prerequisites:** CHEM/BIOL/BIMO 321 or permission of instructor

**Enrollment Limit:** none

**Expected Class Size:** 10

**Distributional Requirements:**

Division 3

**Other Attributes:**

BIMO Interdepartmental Electives

Not Offered Academic Year 2017

LEC Instructor: Rebecca Taurog

### **CHEM 326 Chemical Biology: Discoveries at the Interface**

Complex biological behavior is driven by the chemistry of biological molecules including secondary messengers, lipids, proteins, and nucleic acids. Chemists and biologists have recognized that manipulating the chemistry of these systems affords a powerful method to regulate and study cellular activity. The burgeoning field of chemical biology encompasses these efforts. This course introduces the tools of chemical biology, focusing on how small chemical molecules directed at biological systems facilitate answering important

questions in biology. Building upon this foundation of chemical and biological techniques, this course will study current applications of these techniques through case studies of recent discoveries. Topics covered include bioconjugation, chemical genetics, extending the genetic code, activity-based probes, and fragment-based drug discovery.

**Class Format:** lecture, three hours per week

**Requirements/Evaluation:** evaluation is based on class participation, several short papers, and a final research paper

**Extra Info:** may not be taken on a pass/fail basis

**Prerequisites:** CHEM/BIOL/BIMO 321

**Enrollment Limit:** 19

**Expected Class Size:** 16

**Distributional Requirements:**

Division 3

**Other Attributes:**

BIMO Interdepartmental Electives

*Not Offered Academic Year 2017*

LEC Instructor: Jimmy Blair

### **CHEM 335(F) Inorganic/Organometallic Chemistry**

This course covers fundamental aspects of the chemistry of transition metals and main group elements and highlights how these properties are key to understanding the roles of these elements in a range of applications, from the catalysis of synthetic organic transformations, the functions of enzymatic processes, the production of commodity chemicals such as plastics, to the actions of metal-based drugs such as cis-platin. The course introduces concepts of symmetry and group theory, and applies them in a systematic approach to the study of the structure, bonding, and spectroscopy of coordination and inorganic compounds. The course also covers the kinetics and mechanism of selected inorganic and organometallic reactions. Through exploration of primary literature and review articles we will discuss recent developments and applications in inorganic chemistry, such as finding molecular solutions to the capture of solar energy, to cancer treatments and to optimizing industrial-scale reactions.

**Class Format:** lecture, three hours per week

**Requirements/Evaluation:** evaluation is based on problem sets, exams, presentations, and group-based literature reviews

**Extra Info:** may not be taken on a pass/fail basis

**Prerequisites:** CHEM 155 or 256 and 251/255

**Enrollment Limit:** 16

**Expected Class Size:** 16

**Distributional Requirements:**

Division 3

**Other Attributes:**

MTSC Related Courses

*Fall 2016*

LEC Section: 01 MWF 09:00 AM 09:50 AM Instructor: Christopher Goh

### **CHEM 336(F) Materials Chemistry**

Materials Science focuses on the study of bulk physical properties such as hardness, electrical conductivity, optical behavior, and elasticity. Materials chemists bridge the gap between traditional synthetic chemists and materials scientists, by working to understand the relationships between bulk physical properties, length scale (mesoscale, nanoscale), and molecular structure. This course will cover a variety of different types of materials and their properties including solids (insulators, semiconductors, conductors, superconductors, magnetic materials), soft materials (polymers, gels, liquid crystals), nanoscale structures, and organic electronics. We'll examine some of the latest developments in materials chemistry, including new strategies for the synthesis and preparation of materials on different length scales, as well as a variety of potential applications of emerging technologies. Laboratory work will include analysis of thermal properties, optical properties, force curves, as well as the preparation and measurement of mesoscale and nanoscale structures and their properties.

**Class Format:** lecture, three hours per week

**Requirements/Evaluation:** evaluation is based on problem sets, reviews of research articles, hour exams, and a final exam

**Extra Info:** may not be taken on a pass/fail basis

**Prerequisites:** CHEM 155 or 256 and 251/255

**Enrollment Limit:** 24

**Expected Class Size:** 16

**Distributional Requirements:**

Division 3

**Other Attributes:**

MTSC Core Courses

*Fall 2016*

LEC Section: 01 TR 08:30 AM 09:45 AM Instructor: Patrick Barber

### **CHEM 338(S) Bioinorganic Chemistry: Metals in Living Systems**

Bioinorganic chemistry is an interdisciplinary field that examines the role of metals in living systems. Metals are key components of a wide range of processes, including oxygen transport and activation, catalytic reactions such as photosynthesis and nitrogen-fixation, and electron-transfer processes. Metals perform regulatory roles and stabilize the structures of proteins. In medical applications, the metals are central to many diagnostic and therapeutic tools. To understand the role metals in these biological processes, we will cover

principles of coordination chemistry: topics such as structure and bonding, spectroscopic methods, electrochemistry, kinetics and reaction mechanisms. Building on this fundamental understanding of the nature of metals, students explore topics of current interest in the field.

**Class Format:** lecture and tutorial-style meetings, 3 hours per week

**Requirements/Evaluation:** evaluation based on problem sets, two exams, tutorial participation, a class presentation, and a final project

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** CHEM 155 or CHEM 256 and 251/255

**Enrollment Limit:** 10

**Expected Class Size:** 10

**Distributional Requirements:**

Division 3

**Other Attributes:**

BIMO Interdepartmental Electives

*Spring 2017*

LEC Section: 01 MW 07:00 PM 08:15 PM Instructor: Christopher Goh

### **CHEM 341(S) Toxicology and Cancer**

**Crosslistings:** CHEM 341/ENVI 341

What is a poison and what makes it poisonous? Paracelsus commented in 1537: "What is not a poison? All things are poisons (and nothing is without poison). The dose alone keeps a thing from being a poison." Is the picture really this bleak; is modern technology-based society truly swimming in a sea of toxic materials? How are the nature and severity of toxicity established, measured and expressed? Do all toxic materials exert their effect in the same manner, or can materials be poisonous in a variety of different ways? Are the safety levels set by regulatory agencies low enough for a range of common toxic materials, such as mercury, lead, and certain pesticides? How are poisons metabolized and how do they lead to the development of cancer? What is cancer and what does it take to cause it? What biochemical defense mechanisms exist to counteract the effects of poisons? This course attempts to answer these questions by surveying the fundamentals of modern chemical toxicology and the induction and progression of cancer. Topics will range from description and quantitation of the toxic response, including risk assessment, to the basic mechanisms underlying toxicity, mutagenesis, carcinogenesis, and DNA repair.

**Class Format:** lecture, three times per week

**Requirements/Evaluation:** evaluation is based on two hour tests, a class presentation and paper, participation in discussion sessions, a self-exploration of the current toxicological literature, and a final exam

**Extra Info:** may not be taken on a pass/fail basis

**Prerequisites:** CHEM 156; may be taken concurrently with CHEM 251/255; a basic understanding of organic chemistry

**Enrollment Limit:** 30

**Expected Class Size:** 24

**Dept. Notes:** required for the Chemistry track through the Environmental Science major and satisfies the Natural World requirement for the Environmental studies concentration

**Distributional Requirements:**

Division 3

**Other Attributes:**

BIMO Interdepartmental Electives

ENVI Natural World Electives

ENVS Group EB-A Electives

ENVS Group EC-B Electives

PHLH Biomedical Determinants of Health

*Spring 2017*

LEC Section: 01 MWF 11:00 AM 12:15 PM Instructor: David Richardson

### **CHEM 342(S) Synthetic Organic Chemistry (W)**

The origins of organic chemistry are to be found in the chemistry of living things and the emphasis of this course is on the chemistry of naturally-occurring compounds. This course presents the logic and practice of chemical total synthesis while stressing the structures, properties and preparations of terpenes, polyketides and alkaloids. Modern synthetic reactions are surveyed with an emphasis on the stereochemical and mechanistic themes that underlie them. To meet the requirements for the semester's final project, each student chooses an article from the recent synthetic literature and then analyzes the logic and strategy involved in the published work in a final paper. A summary of this paper is also presented to the class in a short seminar. Laboratory sessions introduce students to techniques for synthesis and purification of natural products and their synthetic precursors.

**Class Format:** lecture, three hours per week; laboratory, four hours per week

**Requirements/Evaluation:** evaluation is based on problem sets, midterm exams, laboratory work, a final project, and class participation

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** CHEM 256 or permission of instructor

**Enrollment Limit:** 12

**Expected Class Size:** 12

**Distributional Requirements:**

Division 3

Writing Intensive

**Other Attributes:**

BIMO Interdepartmental Electives

*Spring 2017*

LEC Section: 01 TR 09:55 AM 11:10 AM Instructor: Thomas Smith

LAB Section: 02 M 01:00 PM 05:00 PM Instructor: Thomas Smith

**CHEM 343 Medicinal Chemistry**

This course explores the design, development, and function of pharmaceuticals. Fundamental concepts of organic chemistry are extended to the study of pharmacodynamics—the interactions between drugs and their targets that elicit a biological effect—and pharmacokinetics—the study of how the body absorbs, distributes, metabolizes, and eliminates drugs. The path of drug development is traced from discovery of an initial lead, through optimization of structure, to patenting and production. Mechanisms by which drugs target cell membranes, nucleic acids, and proteins are discussed. Drug interactions with enzyme and receptor targets are studied extensively. Specific drug classes selected for detailed analysis may include opiate analgesics, aspirin and other NSAIDs, antibacterial agents, cholinergic & adrenergic agents, CNS agents, as well as antiviral, antiulcer, and anticholesterol drugs.

**Class Format:** lecture, three hours per week**Requirements/Evaluation:** evaluation is based on problem sets, midterm exams, class participation, and a final project**Prerequisites:** CHEM 251 & BIOL 101 or permission of instructor; not open to students who have taken CHEM 111 or CHEM 112**Enrollment Limit:** 36**Expected Class Size:** 24**Distributional Requirements:**

Division 3

**Other Attributes:**

BIMO Interdepartmental Electives

PHLH Biomedical Determinants of Health

*Not Offered Academic Year 2017*

LEC Instructor: Thomas Smith

**CHEM 344T(S) Physical Organic Chemistry**

This course extends the background derived from previous chemistry courses to the understanding of organic reaction mechanisms. Correlations between structure and reactivity are examined in terms of kinetic and thermodynamic parameters including: solvent effects, isotope effects, stereochemical specificity, linear free energy relationships, acid/base theory, delocalized bonding, and aromaticity. For the first 7 weeks, the class meets once a week for an introductory lecture. A second tutorial meeting between the instructor and 2 other students occurs early the following week, for example during the laboratory time period. During this time, students work through and present solutions to an assigned problem set. For the remaining 5 weeks, students execute a self-designed set of laboratory experiments that revolve around physical organic methods. Students present and critique results each week (in the hour time slot). The experiments culminate in a final paper.

**Class Format:** tutorial, 90 minutes per week; lecture, one hour per week; laboratory, four hours per week**Requirements/Evaluation:** evaluation is based on problem sets, participation, laboratory work, and a final laboratory paper**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option**Prerequisites:** CHEM 251/255**Enrollment Preferences:** Chemistry majors**Enrollment Limit:** 10**Expected Class Size:** 10**Distributional Requirements:**

Division 3

**Other Attributes:**

BIMO Interdepartmental Electives

*Spring 2017*

TUT Section: T1 MWF 12:00 PM 12:50 PM Instructor: Sarah Goh

LAB Section: T2 W 01:00 PM 05:00 PM Instructor: Sarah Goh

**CHEM 348 Polymer Chemistry**

From synthetic to natural macromolecules, we encounter polymers everywhere and everyday. This course explores the multitude of synthetic techniques available and discusses how structure defines function. Topics include condensation and chain (anionic, cationic, radical) polymerizations, dendrimers, controlling molecular weight, ring opening, and biopolymer syntheses. Fundamentals of composition and physical properties of polymers, and methods of characterization are also covered.

**Class Format:** lecture, two meetings per week; laboratory, four hours per week**Requirements/Evaluation:** evaluation is based on problem sets, participation, exams, laboratory work, and a final project**Prerequisites:** CHEM 251/255**Enrollment Preferences:** Chemistry majors**Enrollment Limit:** 12**Expected Class Size:** 12**Distributional Requirements:**

Division 3

**Other Attributes:**

BIMO Interdepartmental Electives  
MTSC Related Courses

*Not Offered Academic Year 2017*

LEC Instructor: Sarah Goh

**CHEM 361(F) Quantum Chemistry and Chemical Dynamics**

This course provides an introduction to quantum mechanics which serves as the basis for understanding atomic and molecular structure as well as spectroscopic methods. This leads to a discussion of chemical kinetics and molecular reaction dynamics in the gas phase and in solution. Computational chemistry methods are used to illustrate chemical concepts, to interpret experimental data, and to extend hypotheses. Applications of these principles are chosen from contemporary research fields, including polymer chemistry, photochemistry, atmospheric chemistry, and solid and liquid state chemistry. Quantitative laboratory experiments and consultation with the scientific literature provide the background necessary for carrying out an independent theoretical or experimental project.

**Class Format:** lecture, three hours per week; laboratory, four hours per week

**Requirements/Evaluation:** evaluation is based on class participation, problem sets, exams, laboratory work, and an independent project.

**Extra Info:** may not be taken on a pass/fail basis

**Prerequisites:** CHEM 155 or 256

**Enrollment Limit:** none

**Expected Class Size:** 12

**Distributional Requirements:**

Division 3

**Other Attributes:**

MTSC Related Courses

*Fall 2016*

LEC Section: 01 MWF 11:00 AM 12:15 PM Instructor: Enrique Peacock-Lopez

LAB Section: 02 W 01:00 PM 05:00 PM Instructor: Enrique Peacock-Lopez

**CHEM 364(S) Instrumental Methods of Analysis**

**Crosslistings:** CHEM 364/ENVI 364

This course provides the student an understanding of the applicability of current laboratory instrumentation both to the elucidation of fundamental chemical phenomena and to the measurement of certain atomic and molecular parameters. Student will gain knowledge and understanding of the theory and practical use of a variety of instrumental techniques; including, but not limited to, chromatography, mass spectrometry, thermal methods, electroanalytical techniques, atomic and molecular absorption and emission spectroscopy, X-ray diffraction, and optical and electron microscopies, with examples drawn from the current literature. Analytical chemical and instrumental techniques will be developed in the lecture and extensively applied within the laboratory. These skills are useful in a wide variety of scientific areas. Through exploration of primary literature and review articles we will discuss recent developments in instrumental methods and advances in the approaches used to address modern analytical questions.

**Class Format:** lecture, three hours per week; laboratory, four hours per week

**Requirements/Evaluation:** evaluation is based on class participation, problem sets, oral presentation and discussion of selected topics, laboratory work, and an independent project

**Extra Info:** may not be taken on a pass/fail basis

**Prerequisites:** CHEM 155 or 256 and 251/255; may be taken concurrently with CHEM 256 with permission of instructor

**Enrollment Limit:** 18

**Expected Class Size:** 8

**Distributional Requirements:**

Division 3

**Other Attributes:**

BIMO Interdepartmental Electives

ENVI Natural World Electives

ENVS Group EB-A Electives

ENVS Methods Courses

MTSC Related Courses

*Spring 2017*

LEC Section: 01 TR 08:30 AM 09:45 AM Instructor: Patrick Barber

LAB Section: 02 T 01:00 PM 05:00 PM Instructor: Patrick Barber

**CHEM 366(S) Thermodynamics and Statistical Mechanics**

The thermodynamic laws provide us with our most powerful and general scientific principles for predicting the direction of spontaneous change in physical, chemical, and biological systems. This course develops the concepts of energy, entropy, free energy, temperature, heat, work, and chemical potential within the framework of classical and statistical thermodynamics. The principles developed are applied to a variety of problems: chemical reactions, phase changes, energy technology, industrial processes, and environmental science. Laboratory experiments provide quantitative and practical demonstrations of the theory of real and ideal systems studied in class.

**Class Format:** lecture, three hours per week; laboratory, four hours per week; discussion, one hour per week

**Requirements/Evaluation:** evaluation is based on class participation, oral presentations, problem sets, laboratory work and an independent project.

**Extra Info:** may not be taken on a pass/fail basis

**Prerequisites:** CHEM 155 or 256, and basic knowledge of applied integral and differential calculus

**Enrollment Limit:** none

**Expected Class Size:** 12

**Distributional Requirements:**

Division 3

**Other Attributes:**

BIMO Interdepartmental Electives

MTSC Related Courses

*Spring 2017*

LEC Section: 01 MWF 11:00 AM 12:15 PM Instructor: Enrique Peacock-Lopez

LAB Section: 02 W Cancelled Instructor: Enrique Peacock-Lopez

LAB Section: 03 M 01:00 PM 05:00 PM Instructor: Enrique Peacock-Lopez

### **CHEM 367(F) Biophysical Chemistry**

This course is designed to provide a working knowledge of basic physical chemistry to students primarily interested in the biochemical, biological, or medical professions. Topics of physical chemistry are presented from the viewpoint of their application to biochemical problems. Three major areas of biophysical chemistry are discussed: 1) the conformation of biological macromolecules and the forces that stabilize them; 2) techniques for the study of biological structure and function including spectroscopic, hydrodynamic, electrophoretic, and chromatographic; 3) the behavior of biological macromolecules including ligand interaction and conformational transitions.

**Class Format:** lecture, three hours per week; laboratory, four hours per week

**Requirements/Evaluation:** evaluation is based on problem sets and/or quizzes, laboratory work, hour tests, and a final exam

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** CHEM 155 or 256 and 251/255, and MATH 140 or equivalent

**Enrollment Preferences:** junior and senior Chemistry majors

**Enrollment Limit:** 18

**Expected Class Size:** 18

**Distributional Requirements:**

Division 3

**Other Attributes:**

BIMO Interdepartmental Electives

*Fall 2016*

LEC Section: 01 TR 09:55 AM 11:10 AM Instructor: Jimmy Blair

LAB Section: 02 T 01:00 PM 05:00 PM Instructor: Jimmy Blair

LAB Section: 03 R 01:00 PM 05:00 PM Instructor: Jimmy Blair

### **CHEM 368T(S) Computational Chemistry and Molecular Spectroscopy (Q)**

This course provides an introduction to the principles of computational quantum mechanics and their application to problems of chemical interest such as chemical bonding, chemical reactivity, and molecular spectroscopy. Emphasis is placed upon modern electronic structure calculations, their fundamentals, practical considerations, interpretation, and applications to current research questions. Under guidance in the laboratory session and through independent work, students will use computational methods to explore assigned weekly research problems. The research results will be presented to and discussed with the tutorial partner at the end of each week.

**Class Format:** tutorial, meeting time to be determined

**Requirements/Evaluation:** evaluation is based on tutorial participation, presentations, and submitted papers

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Prerequisites:** CHEM 361 or equivalent background in Physics

**Enrollment Limit:** 10

**Expected Class Size:** 10

**Distributional Requirements:**

Division 3

Quantitative/Formal Reasoning

*Spring 2017*

TUT Section: T1 MWF 12:00 PM 12:50 PM Instructor: Enrique Peacock-Lopez

### **CHEM 393(F) Junior Research and Thesis: Chemistry**

Chemistry junior research and thesis.

**Class Format:** independent study

**Extra Info:** may not be taken on a pass/fail basis

**Distributional Requirements:**

Division 3

*Fall 2016*

HON Section: 01 TBA Instructor: Amy Gehring

**CHEM 394(S) Junior Research and Thesis: Chemistry**

Chemistry junior research and thesis.

**Class Format:** independent study

**Extra Info:** may not be taken on a pass/fail basis

**Distributional Requirements:**

Division 3

*Spring 2017*

HON Section: 01 TBA Instructor: Amy Gehring

**CHEM 397(F) Independent Study, for Juniors: Chemistry**

Chemistry independent study for juniors.

**Class Format:** independent study

**Extra Info:** may not be taken on a pass/fail basis

**Distributional Requirements:**

Division 3

*Fall 2016*

IND Section: 01 TBA Instructor: Amy Gehring

**CHEM 398(S) Independent Study, for Juniors: Chemistry**

Chemistry independent study for juniors.

**Class Format:** independent study

**Extra Info:** may not be taken on a pass/fail basis

**Distributional Requirements:**

Division 3

*Spring 2017*

IND Section: 01 TBA Instructor: Amy Gehring

**CHEM 493(F) Senior Research and Thesis**

Individual research projects in a field of interest to the student are carried out under the direction of a faculty member and culminate in a thesis. Students in this program are strongly encouraged to keep 1:10 p.m. to 2:25 p.m. on Friday free for departmental colloquia.

**Class Format:** independent study

**Requirements/Evaluation:** this is part of a full-year thesis (493-494)

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Distributional Requirements:**

Division 3

*Fall 2016*

HON Section: 01 F 01:10 PM 01:25 PM Instructor: Amy Gehring

**CHEM 494(S) Senior Research and Thesis**

Individual research projects in a field of interest to the student are carried out under the direction of a faculty member and culminate in a thesis. Students in this program are strongly encouraged to keep 1:10 p.m. to 2:25 p.m. on Friday free for departmental colloquia.

**Class Format:** independent study

**Requirements/Evaluation:** this is part of a full-year thesis (493-494)

**Extra Info:** may not be taken on a pass/fail basis; not available for the fifth course option

**Distributional Requirements:**

Division 3

*Spring 2017*

HON Section: 01 F 01:10 PM 01:25 PM Instructor: Amy Gehring

**CHEM 497(F) Independent Study, for Seniors: Chemistry**

Chemistry independent study for seniors. Individual research projects in a field of interest to the student are carried out under the direction of a faculty member.

**Class Format:** independent study

**Distributional Requirements:**

Division 3

*Fall 2016*

IND Section: 01 TBA Instructor: Amy Gehring

**CHEM 498(S) Independent Study, for Seniors: Chemistry**

Chemistry independent study for seniors. Individual research projects in a field of interest to the student are carried out under the direction of a faculty member.

**Class Format:** independent study

**Distributional Requirements:**

Division 3

*Spring 2017*

IND Section: 01 TBA Instructor: Amy Gehring