CHEMISTRY (Div III)

Chairs: Professor Lee Park (Fall) / Professor Thomas Smith (Spring)

- Anthony J. Carrasquillo, Assistant Professor of Chemistry
- Stephanie Christau, Visiting Assistant Professor of Chemistry
- Amy Gehring, Philip and Dorothy Schein Professor of Chemistry, Director of the Science Center
- Christopher Goh, Associate Dean for Institutional Diversity, Equity and Inclusion, Professor of Chemistry; affiliated with: Chemistry Department
- Sarah L. Goh, Professor of Chemistry
- Kerry-Ann Green, Assistant Professor of Chemistry
- Katie M. Hart, Assistant Professor of Chemistry; on leave Fall 2022
- Michael H. Ihde, Visiting Assistant Professor of Chemistry
- Jenna Maclntire, Lecturer in Chemistry
- Lee Y. Park, Chair and William R. Kenan, Jr. Professor of Chemistry; on leave Spring 2023
- Enrique Peacock-López, Halford R Clark Professor of Natural Sciences
- Bob Rawle, Assistant Professor of Chemistry
- Jennifer K. Rosenthal, Instructor in Chemistry
- Thomas E. Smith, J. Hodge Markgraf ’52 Professor of Chemistry; on leave Fall 2022
- Laura R. Strauch, Lecturer in Chemistry
- Ben W. Thuronyi, Assistant Professor of Chemistry; on leave 2022-2023
- Amanda K. Turek, Assistant Professor of Chemistry; on leave 2022-2023

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 their 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 responses on the departmental survey and consultation with the faculty; 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. Only one course designated as pass/fail may be counted towards the major. Starting at the 300 level, at least three of the courses taken must have a laboratory component. For all majors, at least one must be selected from Chemistry 361, 364, 366, 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 and Synthetic Biology
- 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
- 344 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
- 373 Environmental Fate of Organic Chemicals

**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 Gehring, Hart, Rawle, or Thuronyi.
**Chemistry 341, Chemistry 342, Chemistry 343, Chemistry 344, Chemistry 348, Chemistry 364, Chemistry 361, Chemistry 366, Chemistry 373.** Students interested in organic chemistry should consult with Professors S. Goh, Green, Smith, Thuronyi, or Turek.

**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 Cararasquillo or Peacock-López. Students interested in inorganic chemistry should consult with Professors C. Goh, Green, or Park. Students interested in materials science should consult with Professors S. Goh or Park. Students interested in environmental chemistry should consult with Professor Cararasquillo.

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 3 courses (all of which must have a laboratory component or at least one must be a research course of 393 or above) from our remaining upper level electives: 319, 322, 324, 326, 336, 341, 342, 343, 344T, 348, 361, 366, 367, 368T, 393, 394, 397, 398, 493, 494, 497, 498, BIMO 401. Students are strongly encouraged (though not required) to pursue independent research in some form. In addition, students have also completed 2 semesters of calculus and 2 semesters of physics. Students completing these requirement 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.

**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 their 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.
FAQ

Students MUST contact departments/programs BEFORE assuming study away credit will be granted toward the major or concentration.

Can your department or program typically pre-approve courses for major/concentration credit?

Yes, in some cases, if appropriate course information is available in advance (e.g. syllabi and/or course descriptions), though students should be sure to contact the department. We can give provisional approval in some cases if enough detail is available, but we always ask to see the details after the course is completed before signing off on the major credit.

What criteria will typically be used/required to determine whether a student may receive major/concentration credit for a course taken while on study away?

Course title and description, complete syllabus, including readings/assignments, and complete description of laboratory program. The biggest question is whether or not there is a lab component of the course and whether it is sufficient to fulfill the equivalent lab experience of Williams courses.

Does your department/program place restrictions on the number of major/concentration credits that a student might earn through study away?

No official restrictions, but we advise our students to take the majority of their chemistry courses at Williams.

Does your department/program place restrictions on the types of courses that can be awarded credit towards your major?

Yes. We have several special requirements. Only one non-lab class can be used toward the upper-level major requirements. This is usually the restriction that causes difficulty with study abroad—where appropriate lab courses may not be available. One of the lab courses must also meet our departmental "quantitative requirement." In principle, this could be met by a course taken abroad, but we would likely be more conservative in authorizing this equivalency.

Are there specific major requirements that cannot be fulfilled while on study away?

No. In principle, all major requirements could be filled abroad, but laboratory programs abroad are not always sufficiently rigorous to meet our standards. We look for at least 40 hours of wet-lab time for the lab component. Importantly, this cannot be work in a professor's research lab, but must be "exercises" giving our students practice with standard techniques and methods of analysis.

Are there specific major requirements in your department/program that students should be particularly aware of when weighing study away options? (Some examples might include a required course that is always taught in one semester, laboratory requirements.)

Yes. The lab requirements that I've mentioned above are the main complicating factors. Also our first two years of ("introductory") chemistry courses are taught in an unconventional way. If a student had not yet completed all four of those courses before studying abroad, they would need to be aware of special timing that might complicate things. For our first two years of instruction, we teach one semester of introductory chemistry followed by two semesters of organic chemistry, and top things off with a final semester of a course that is somewhat specific to Williams. There are ways to take "equivalent" courses elsewhere, but we would need to work very closely with the student to ensure that all of the pieces fit together appropriately.

Give examples in which students thought or assumed that courses taken away would count toward the major or concentration and then learned they wouldn't:

None to date, but there may have been times when the lab component of a course was not sufficient and we were only able to assign major credit for a non-lab course instead of a course-with-a-lab.

CHEM 114 (S) The Science Behind Materials: Shaping the Past and Future of Society (QFR)

We are surrounded by materials. They have fulfilled human needs since ancient times. From Phoenician glass to flexible OLED displays, materials have impacted society and changed the way humans lead their lives. What makes materials the way they are? Why are some brittle while others are ductile? How can we design materials with specific properties that will solve tomorrow's problems? To answer these questions, we have to think about materials at the atomic scale, looking at how their smallest building blocks organize into specific structures. In this course, we will explore the relationships between structure, processing, and properties for a range of materials including metals, ceramics, polymers, and composites. We will talk about some of the cutting-edge research that materials scientists are working on today, concluding with an outlook to potential applications of emerging technologies.

Requirements/Evaluation: Weekly quizzes and problem sets, two exams, and oral presentations.

Prerequisites: not appropriate for CHEM, BIOL, PHYS majors, or for those who have taken CHEM 151, 153, or 155

Enrollment Limit: 20

Enrollment Preferences: juniors and seniors; not appropriate for CHEM, BIOL, PHYS majors, or for those who have taken CHEM 151, 153, or 155
CHEM 117  (S)  Roses are Red, Violets are Blue: The Origins, Perception, and Impact of Color  (QFR)

Have you ever been tickled pink? Felt blue? Seen red?, Been green with envy? The course will consider color, starting with the physical and chemical origins of color (the electromagnetic spectrum, the absorption and emission of electromagnetic radiation, refraction, diffraction, incandescence, fluorescence, phosphorescence, iridescence). We will develop an understanding of chemical bonding and how that influences color. We will cover how we measure and describe color from a scientific perspective as well as how we can generate materials and devices with different color properties (liquid crystal displays, light emitting diodes for instance). From there we will discuss pigments used in works of art and textiles over time, the characteristics that make certain pigments suitable for particular applications. If we have time, we will touch on the historical and cultural impacts and meanings of different pigments and hues, the biological perception of color, and some color theory.

Requirements/Evaluation:  exams, problem sets, quizzes, a paper, brief laboratory exercises, and a final paper/project
Prerequisites:  non-science students; students who have taken any introductory chemistry or physics courses are ineligible
Enrollment Limit:  16
Enrollment Preferences:  first-years and sophomores
Expected Class Size:  16
Grading:  no pass/fail option,  no fifth course option
Distributions:  (D3)  (QFR)
Quantitative/Formal Reasoning Notes:  This course will require students to become comfortable with some quantitative descriptions of light and its interaction with matter.

Not offered current academic year

CHEM 151  (F)  Introductory Chemistry  (QFR)

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. This course may be taken pass/fail; however, students who are considering graduate study in science or in the health professions should elect to take this course for a grade.

Class Format:  lecture, three times per week and laboratory, four hours per week
Requirements/Evaluation:  electronic and written weekly problem set assignments, laboratory work and analysis, quizzes, two tests, and a final exam
Prerequisites:  Students are required to take the online Chemistry Placement Survey prior to registering for the course (chemistry.williams.edu/placement).
Enrollment Limit:  16/lab
Enrollment Preferences:  first-year students; students who have studied chemistry for one or more years are directed to CHEM 153 or 155
Expected Class Size:  32
Grading:  yes pass/fail option,  no fifth course option
Unit Notes:  CHEM 151 may be taken concurrently with MATH 102—see under Mathematics; CHEM 151 or its equivalent is a prerequisite to CHEM 156; one of CHEM 151 or 153 or 155 required for the BIMO concentration
Distributions:  (D3)  (QFR)
Quantitative/Formal Reasoning Notes: This course fulfills the QFR requirement with regular and substantial problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

Attributes: BIMO Required Courses

Fall 2022

LEC Section: 01  MWF 8:30 am - 9:45 am  Stephanie Christau

LAB Section: 02  M 1:00 pm - 5:00 pm  Laura R. Strauch

LAB Section: 03  T 1:00 pm - 5:00 pm  Stephanie Christau

CHEM 153  (F)  Concepts of Chemistry  (QFR)
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 periods will largely focus on experiment design, data analysis, literature, scientific writing, ethics, and other skills critical to students' development as scientists. 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 fundamentals of chemistry as part of their general education. This course may be taken pass/fail; however, students who are considering graduate study in science or in the health professions should elect to take this course for a grade.

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

Requirements/Evaluation: problem sets and/or quizzes, laboratory work, and exams

Prerequisites: Students are required to take the online Chemistry Placement Survey prior to registering for the course (chemistry.williams.edu/placement).

Enrollment Limit: 45/lecture

Enrollment Preferences: first-year students

Expected Class Size: 90

Grading: yes pass/fail option, no fifth course option

Unit Notes: CHEM 153 or its equivalent is a prerequisite to CHEM 156; one of CHEM 151 or 153 or 155 required for the BIMO concentration

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course fulfills the QFR requirement with regular and substantial problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

Attributes: BIMO Required Courses

Fall 2022

LEC Section: 01  MWF 9:00 am - 9:50 am  Bob Rawle

LEC Section: 02  MWF 11:00 am - 11:50 am  Bob Rawle

LAB Section: 03  M 1:00 pm - 5:00 pm  Jennifer K. Rosenthal

LAB Section: 04  T 1:00 pm - 5:00 pm  Jennifer K. Rosenthal

LAB Section: 05  W 1:00 pm - 5:00 pm  Jennifer K. Rosenthal

LAB Section: 06  R 1:00 pm - 5:00 pm  Jennifer K. Rosenthal

LAB Section: 07  T 8:00 am - 12:00 pm  Laura R. Strauch

LAB Section: 08  W 7:00 pm - 11:00 pm  Enrique Peacock-López

CHEM 155  (F)  Principles of Modern Chemistry  (QFR)
This course is designed for students with a strong preparation in chemistry (including laboratory experience) in secondary school, such as provided by an Advanced Placement chemistry course (or equivalent) with a corresponding AP Chemistry Exam score of 5 (or a 6 or 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, catalysis, environmental, biological, and medicinal chemistry. Laboratory periods will focus on hands-on skills, data representation and analysis, scientific writing, exploration of the scientific literature, and other skills critical to students’ development as scientists. This course is designed for students who are anticipating further 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 times per week and laboratory, four hours per week

Requirements/Evaluation: frequent short assignments in preparation for class, quantitative weekly problem sets, laboratory work and reports, an hour test, and a final exam

Prerequisites: Students are required to take the online Chemistry Placement Survey prior to registering for the course (chemistry.williams.edu/placement).

Enrollment Limit: 16/lab

Enrollment Preferences: first-year students and sophomores

Expected Class Size: 32

Grading: no pass/fail option, no fifth course option

Unit Notes: CHEM 155 or its equivalent is a prerequisite to CHEM 156; one of CHEM 151 or 153 or 155 required for the BIMO concentration

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course fulfills the QFR requirement with regular and substantial problem sets in which quantitative/formal reasoning skills are practiced and evaluated.

Attributes: BIMO Required Courses

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Fall 2022

LEC Section: 01 MWF 8:00 am - 8:50 am Lee Y. Park

LAB Section: 02 M 1:00 pm - 5:00 pm Anthony J. Carrasquillo

LAB Section: 03 T 1:00 pm - 5:00 pm Anthony J. Carrasquillo

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CHEM 156 (S) Organic Chemistry: Introductory Level (QFR)

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, elimination and addition reactions. 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 times per week and laboratory, four hours per week

Requirements/Evaluation: quantitative problem solving, laboratory performance, three midterm exams, and a final exam

Prerequisites: CHEM 151 or 153 or 155 or permission of instructor

Enrollment Limit: 55/lecture

Enrollment Preferences: Seniors, juniors, sophomores, first-year students

Expected Class Size: 100

Grading: no pass/fail option, no fifth course option

Distributions: (D3) (QFR)

Quantitative/Formal Reasoning Notes: This course fulfills the QFR requirement with regular and substantial problem solving in which quantitative/formal reasoning skills are practiced and evaluated.

Attributes: BIMO Required Courses

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Spring 2023

LEC Section: 01 MWF 8:00 am - 8:50 am Thomas E. Smith

LEC Section: 02 MWF 9:00 am - 9:50 am Kerry-Ann Green
CHEM 251 (F) Organic Chemistry: Intermediate Level

This course is a continuation of Chemistry 156 and it concludes 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 times per week and laboratory, four hours per week

Requirements/Evaluation: midterm exams, problem sets, laboratory performance, including written lab reports, and a final exam

Prerequisites: CHEM 156 or permission of instructor

Enrollment Limit: 40/lecture

Enrollment Preferences: seniors, juniors, then sophomores

Expected Class Size: 90

Grading: no pass/fail option, no fifth course option

Distributions: (D3)

Attributes: BIMO Required Courses

Fall 2022

LEC Section: 01  MWF 9:00 am - 9:50 am  Sarah L. Goh
LEC Section: 02  MWF 10:00 am - 10:50 am  Sarah L. Goh
LAB Section: 03  M 1:00 pm - 5:00 pm  Kerry-Ann Green
LAB Section: 04  T 1:00 pm - 5:00 pm  Michael H. Ihde
LAB Section: 05  W 1:00 pm - 5:00 pm  Laura R. Strauch
LAB Section: 06  R 1:00 pm - 5:00 pm  Laura R. Strauch
LAB Section: 07  Cancelled
LAB Section: 08  W 1:00 pm - 5:00 pm  Michael H. Ihde

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.
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 the 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, and kinetics. Laboratory sections will give students hands-on experience involving synthesis, characterization, and reactivity studies of coordination and organic complexes; spectroscopic analyses; thermodynamics; electrochemistry; and kinetics. Students will hone their skills in the presentation of results through written reports and worksheets.

Class Format: lecture, three times per week and laboratory, four hours per week
Requirements/Evaluation: homework assignments, laboratory work, quizzes, midterm exam, and a final exam
Prerequisites: CHEM 251/255, or permission of instructor
Enrollment Limit: 30/lecture
Enrollment Preferences: seniors, juniors, then sophomores
Expected Class Size: 60
Grading: no pass/fail option, no fifth course option
Unit Notes: for the BIMO concentration, CHEM 256 not required if CHEM 155 was taken
Distributions: (D3)
Attributes: BIMO Required Courses

Spring 2023
LEC Section: 01  MWF 10:00 am - 10:50 am  Katie M. Hart
LEC Section: 02  MWF 11:00 am - 11:50 am  Katie M. Hart
LAB Section: 03  M 1:00 pm - 5:00 pm
LAB Section: 04  T 1:00 pm - 5:00 pm
LAB Section: 05  W 1:00 pm - 5:00 pm
LAB Section: 06  R 1:00 pm - 5:00 pm

CHEM 319 (S) Integrative Bioinformatics, Genomics, and Proteomics Lab (QFR)

Cross-listings: MATH 319  CHEM 319  BIOL 319  PHYS 319  CSCI 319
Secondary Cross-listing

What can computational biology teach us about cancer? In this lab-intensive 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, and phylogenetics 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 inflammatory and MAPK signal transduction pathways 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 may also be used to study networks of interacting proteins in colon tumor cells.

**Class Format:** The lab for this course will meet for two afternoons per week. Some lab sessions will be shorter than 3 hours.

**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 a CSCI course, or CSCI/PHYS 315, may enroll with permission of instructor. No prior computer programming experience is required.

**Enrollment Limit:** 12

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

**Expected Class Size:** 12

**Grading:** yes pass/fail option, no fifth course option

**Distributions:** (D3) (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:

MATH 319 (D3) CHEM 319 (D3) BIOL 319 (D3) PHYS 319 (D3) CSCI 319 (D3)

**Quantitative/Formal Reasoning Notes:** Through lab work, homework sets and a major project, students will learn or further develop their skills in programming in Python, and about the basis of Bayesian approaches to phylogenetic tree estimation.

**Attributes:** BIGP Courses  BIMO Interdepartmental Electives
This course fulfills the QFR requirement with regular problem sets in which quantitative/formal reasoning skills are practiced.

Attributes: BIGP Courses  BIMO Required Courses

Fall 2022

LEC Section: 01    MWF 10:00 am - 10:50 am     Amy  Gehring
LAB Section: 02    M 1:00 pm - 5:00 pm     Amy  Gehring
LAB Section: 03    T 1:00 pm - 5:00 pm     Jenna L. MacIntire
LAB Section: 04    R 1:00 pm - 5:00 pm     Jenna L. MacIntire

CHEM 322  (S)  Biochemistry II: Metabolism  (QFR)

Cross-listings: BIOL 322  CHEM 322  BIMO 322

Secondary Cross-listing

This lecture course provides an in-depth presentation of the complex metabolic reactions that 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 and laboratory three hours per week.

Requirements/Evaluation: several exams and performance in the laboratories including lab reports that emphasize conceptual and quantitative and/or graphic analysis of data

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

Enrollment Limit: 60

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

Expected Class Size: 60

Grading: no pass/fail option, no fifth course option

Unit Notes: cannot be counted towards the Biology major in addition to BIOL 222

Distributions: (D3)  (QFR)

This course is cross-listed and the prefixes carry the following divisional credit:
BIO 322  CHEM 322  BIMO 322

Quantative/Formal Reasoning Notes: The laboratory program is quantitative covering data analyses, numerical transformations, graphical displays.

Attributes: BIGP Courses  BIMO Required Courses

Spring 2023

LEC Section: 01    TR 11:20 am - 12:35 pm     Pei-Wen  Chen
LAB Section: 02    T 1:00 pm - 4:00 pm     Janis E. Bravo
LAB Section: 03    W 1:00 pm - 4:00 pm     Pei-Wen  Chen
LAB Section: 04    R 1:00 pm - 4:00 pm     Janis E. Bravo

CHEM 324  (S)  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: three hours per week
Requirements/Evaluation: problem sets, quizzes, a midterm exam, a paper, and a final exam
Prerequisites: CHEM/BIOL/BIMO 321 or permission of instructor
Enrollment Limit: 20
Enrollment Preferences: Chemistry majors or BIMO concentrators
Expected Class Size: 10
Grading: no pass/fail option, yes fifth course option
Distributions: (D3)
Attributes: BIMO Interdepartmental Electives

Not offered current academic year

CHEM 326 (S) Chemical and Synthetic Biology
This course surveys the rapidly evolving, interdisciplinary and interconnected fields of chemical and synthetic biology. Chemical biology uses precise molecular-level manipulations to influence living systems from the bottom up, often by introducing components that are foreign to nature. Synthetic biology takes advantage of existing molecular technology and adopts an engineering mindset to reprogram life. Students will achieve literacy through immersion in chemical and synthetic biology. We will prioritize broad exposure to these fields, their vocabulary, culture, practices and ideas, through extensive engagement with the primary literature that expert practitioners use to teach themselves. The instructor will guide, facilitate, and give feedback, but de-emphasize direct instruction. Students take on the agency and responsibility for assimilating meaning from the material and working together effectively to advance everyone's understanding. This model prioritizes skills important for autonomous and collaborative work in real-world scientific and professional fields. Topics we will cover include synthetic genomes, metabolic engineering, chemical synthesis and manipulation of biomacromolecules, directed evolution, and reworking of the central dogma.

Class Format: lecture, three hours per week
Requirements/Evaluation: Course work includes consistent and intensive engagement with primary literature, weekly short presentations, informal writing assignments, response papers/problem sets, and an independent research project with presentation and writing components. The workload is designed to be distributed evenly throughout the semester. There are no exams.
Prerequisites: CHEM/BIOL/BIMO 321
Enrollment Limit: 20
Enrollment Preferences: senior and junior Chemistry and Biology majors with a demonstrated interest in chemical or synthetic biology
Expected Class Size: 20
Grading: no pass/fail option, no fifth course option
Distributions: (D3)
Attributes: BIMO Interdepartmental Electives

Not offered current academic year

CHEM 335 (F) Inorganic/Organometallic Chemistry
This course covers fundamental aspects of the chemistry of main group elements and transition metals, and highlights how these properties are key to understanding the roles of these elements in applications such as the catalysis of synthetic organic transformations, the functions of enzymatic processes, the production of commodity chemicals such as plastics, and the actions of metal-based drugs such as cis-platin. The course introduces concepts of symmetry and group theory, and their systematic application to the study of the structure, bonding, and spectroscopy of inorganic and organometallic compounds. The course also covers the kinetics and mechanism of selected inorganic and organometallic reactions. Class discussions will involve exploration of the primary literature and review articles around recent developments and applications in inorganic chemistry, such as finding molecular solutions to water oxidation, the capture of solar energy, to cancer treatments and the optimization of industrial-scale reactions.

Class Format: lecture, three hours per week and laboratory, four hours per week
Requirements/Evaluation: problem sets, two exams, presentations, and group-based literature reviews
**CHEM 336 (F) Materials Chemistry**

Materials have defined much of what is possible in our daily lives. Materials scientists are at the center of imagining and delivering progress, as they improve existing materials and develop new ones to meet today's needs. Materials science focuses on the relationships between the structure, processing, properties, and performance of materials. In this course, we will explore how the properties and potential applications of a solid are related to its atomic and molecular structure, as well as to its organization on larger length scales than are traditionally considered in chemistry. We will cover a variety of different types of materials including metals, ceramics, polymers, and composites. We will examine some of the latest developments in materials science, including new strategies for the synthesis of materials on different length scales, as well as a variety of potential applications of emerging technologies.

**Class Format:** three hours per week

**Requirements/Evaluation:** problem sets, reviews of research articles, two exams, and oral presentations

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

**Enrollment Limit:** 20

**Enrollment Preferences:** Chemistry majors

**Expected Class Size:** 20

**Grading:** no pass/fail option, yes fifth course option

**Distributions:** (D3)

**Attributes:** MTSC Courses

*Not offered current academic year*

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**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 furthermore perform regulatory roles and stabilize the structures of proteins. In medical applications, they are central to many diagnostic and therapeutic tools, and some metals are highly toxic. The course begins with a review and survey of the 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, we will explore the current literature in fields of interest in small groups, presenting our findings to the class periodically.

**Class Format:** The course will begin with a series of lectures on principles of coordination chemistry, followed by tutorial meetings to discuss journal articles and book materials.

**Requirements/Evaluation:** Evaluation based on problem sets, two exams, class engagement, a class presentation, and a final project.

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

**Enrollment Limit:** 10

**Enrollment Preferences:** Chemistry majors and BIMO concentrators

**Expected Class Size:** 10

**Grading:** no pass/fail option, no fifth course option
CHEM 342 (S) Synthetic Organic Chemistry

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. There will be no laboratory component in 2022. Instead, one of the three class meetings each week will focus on discussion and presentation of reactions, mechanisms, and syntheses from the chemical literature.

Class Format: lecture, three hours per week and conference, 1.5 hours per week

Requirements/Evaluation: problem sets, midterm exams, class participation, class presentations, and a final project

Prerequisites: CHEM 256 or permission of instructor

Enrollment Limit: 16

Enrollment Preferences: Chemistry majors, seniors and juniors

Expected Class Size: 12

Grading: no pass/fail option, no fifth course option

Distributions: (D3)

Attributes: BIMO Interdepartmental Electives

Not offered current academic year

CHEM 344 (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 6 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 6 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

Prerequisites: CHEM 251/255/256

Enrollment Limit: 10

Enrollment Preferences: Chemistry majors: seniors, juniors, sophomores

Expected Class Size: 10

Grading: no pass/fail option, no fifth course option

Distributions: (D3)

Attributes: BIMO Interdepartmental Electives

Spring 2023

TUT Section: T1    F 8:30 am - 9:45 am    Sarah L. Goh
LAB Section: T2    M 1:00 pm - 5:00 pm   Sarah L. Goh

CHEM 345 (F) Supramolecular Organic Chemistry
Supramolecular chemistry is the study of chemical systems, often with practical applications, that are composed of two or more molecular components held together by non-covalent interactions. More specifically, we will focus on the use of "synthetic influence" over organic compounds and reactions to make tailor-made building blocks that will produce functional molecular assemblies. The various analytical methodologies used to probe these relatively weaker and more dynamic chemical systems will be studied. We will also examine (and be inspired by) the supramolecular chemistry found in nature, as the field was originally defined by the host-guest interactions used to explain receptor-substrate binding in many biological systems. Today, the field has intersected with numerous disciplines which we will explore; these include analytical molecular recognition and sensing, self-assembly molecular engineering, catalysis, and organic-based molecular devices, among others. We will also explore more complex supramolecular topics such as dynamic covalent chemistry and the mechanical bond. Students will be expected to delve into the chemical literature and analyze the research of pioneering chemists in the field (past and present) by choosing one prominent journal article, culminating in a final literature review paper.

Class Format: lecture/discussion
Requirements/Evaluation: Problem sets, research article review homework assignments, class/discussion participation, exams, and a final literature review paper.
Prerequisites: CHEM 251 and 256
Enrollment Limit: 20
Enrollment Preferences: Chemistry majors
Expected Class Size: 10
Grading: no pass/fail option, no fifth course option
Distributions: (D3)
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 times per week and laboratory, four hours per week

Requirements/Evaluation: class participation, problem sets, exams, laboratory work, and an independent project

Prerequisites: CHEM 155 or 256

Enrollment Limit: 8/lab

Enrollment Preferences: seniors, then juniors

Expected Class Size: 16

Grading: no pass/fail option, no fifth course option

Distributions: (D3)

Fall 2022

LEC Section: 01  MWF 9:00 am - 9:50 am  Enrique Peacock-López
LAB Section: 02  M 1:00 pm - 5:00 pm  Enrique Peacock-López

CHEM 364 (S) Instrumental Methods of Analysis

Instrumental methods of analysis provide scientists with different lenses to observe and elucidate fundamental chemical phenomena and to measure parameters and properties at the atomic, molecular, and bulk scales. This course introduces a framework for learning about a variety of instrumental techniques that typically include chromatography, mass spectrometry, thermal methods, atomic and molecular absorption and emission spectroscopy, X-ray diffraction, and optical and electron microscopies. Students complete two 5-6 week long laboratory projects and gain hands-on experience and project planning skills to study molecules and materials of interest. This practical experience is complemented by lectures that cover the theory and broader applications of these techniques. Students also explore the primary literature and highlight recent advances in instrumental methods that address today’s analytical questions. The skills learned are useful in a wide variety of scientific areas and will prepare you well for research endeavors.

Class Format: lecture, two times per week and laboratory, four hours per week; periodic small group meetings to plan laboratory research projects

Requirements/Evaluation: Weekly data analysis and project planning assignments for laboratory and analysis of readings for class, problem sets, two project reports and presentations, one oral presentation of an application of instrumental methods, a final independent literature project and presentation; demonstrated progress in research skills, and project engagement.

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

Enrollment Limit: 8/lab

Enrollment Preferences: Chemistry and Environmental Studies majors

Expected Class Size: 16

Grading: no pass/fail option, no fifth course option

Distributions: (D3)

Attributes: BIMO Interdepartmental Electives  ENVI Natural World Electives  MTSC Courses

Spring 2023

LEC Section: 01  TR 9:55 am - 11:10 am  Michael H. Ihde
LAB Section: 02  T 1:00 pm - 5:00 pm  Michael H. Ihde

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 times per week and laboratory, four hours per week

Requirements/Evaluation: class participation, oral presentations, problem sets, laboratory work, and an independent project

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

Enrollment Limit: 16/lab

Enrollment Preferences: Chemistry majors: seniors, juniors, then sophomores

Expected Class Size: 16

Grading: no pass/fail option, yes fifth course option

Distributions: (D3)

Attributes: BIMO Interdepartmental Electives

CHEM 367 (S) 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 such as spectroscopic, hydrodynamic, electrophoretic, or chromatographic; 3) the behavior of biological macromolecules including ligand interaction and conformational transitions.

Class Format: lecture/discussion three hours per week and laboratory four hours per week

Requirements/Evaluation: problem sets and/or quizzes, laboratory work, and exams

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

Enrollment Limit: 9/lab

Enrollment Preferences: junior and senior Chemistry majors

Expected Class Size: 27

Grading: no pass/fail option, no fifth course option

Distributions: (D3)

Attributes: BIMO Interdepartmental Electives

CHEM 368 (S) Computational Chemistry and Molecular Spectroscopy (QFR)
This tutorial 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 sessions 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.

Requirements/Evaluation: tutorial participation, presentations, and submitted papers

Prerequisites: CHEM 361 or equivalent background in Physics
Enrollment Limit: 10
Enrollment Preferences: Chemistry majors

Expected Class Size: 10
Grading: no pass/fail option, no fifth course option
Distributions: (D3) (QFR)
Quantitative/Formal Reasoning Notes: This course fulfills the QFC requirement with problem sets for assignments in which quantitative/formal reasoning skills are practiced.

Spring 2023
TUT Section: T1 TBA Enrique Peacock-López

CHEM 373 (F) Environmental Fate of Organic Chemicals
Cross-listings: CHEM 373 ENVI 373

Primary Cross-listing
This course introduces students to the methods used to assess the risks posed by organic chemicals to human, animal, and ecosystem health. Our goal is to develop a quantitative understanding for how specific features of organic molecular structure directly dictate a given molecule's environmental fate. We will begin by using thermodynamic principles to estimate the salient physiochemical properties of molecules (e.g., vapor pressure, solubility, charging behavior, etc.) that impact the distribution, or partitioning, of organic chemicals between air, water, soils, and biota. Then, using quantitative structure activity relationships, we will predict the degradation kinetics resulting from natural nucleophilic, photochemical, and biological processes that determine chemical lifetime in the environment.

Class Format: lecture, three hours per week and conference, 1.5 hours per week
Requirements/Evaluation: weekly problem sets, two midterm exams, a final exam, participation in conference, an independent research proposal
Prerequisites: CHEM 251 and either CHEM 155 or CHEM 256
Enrollment Limit: 16
Enrollment Preferences: junior and senior Chemistry and Environmental Studies majors with a demonstrated interest in environmental chemistry
Expected Class Size: 16
Grading: no pass/fail option, no fifth course option
Distributions: (D3)
This course is cross-listed and the prefixes carry the following divisional credit:
CHEM 373 (D3) ENVI 373 (D3)
Attributes: ENVI Natural World Electives EVST Environmental Science

Fall 2022
LEC Section: 01 MWF 11:00 am - 12:15 pm Anthony J. Carrasquillo

CHEM 393 (F) Junior Research and Thesis: Chemistry
Chemistry junior research and thesis.
Requirements/Evaluation: N/A
Prerequisites: N/A
Enrollment Limit: N/A
Enrollment Preferences: N/A
Expected Class Size: N/A
Grading: no pass/fail option, no fifth course option
Distributions: (D3)
CHEM 394  (S)  Junior Research and Thesis: Chemistry
Chemistry junior research and thesis.
Requirements/Evaluation:  N/A
Prerequisites:  N/A
Enrollment Limit:  N/A
Enrollment Preferences:  N/A
Expected Class Size:  N/A
Grading:  no pass/fail option,  no fifth course option
Distributions: (D3)

CHEM 397  (F)  Independent Study, for Juniors: Chemistry
Chemistry independent study for juniors.
Requirements/Evaluation:  N/A
Prerequisites:  N/A
Enrollment Limit:  N/A
Enrollment Preferences:  Junior chemistry majors only
Expected Class Size:  N/A
Grading:  no pass/fail option,  no fifth course option
Distributions: (D3)

CHEM 398  (S)  Independent Study, for Juniors: Chemistry
Chemistry independent study for juniors.
Requirements/Evaluation:  N/A
Prerequisites:  N/A
Enrollment Limit:  N/A
Enrollment Preferences:  Junior chemistry majors only
Expected Class Size:  N/A
Grading:  no pass/fail option,  no fifth course option
Distributions: (D3)

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; this is
part of a full-year thesis (493-494). Students in this program are strongly encouraged to keep 1:10 p.m. to 2:25 p.m. on Friday free for departmental colloquia.

**Requirements/Evaluation:** N/A

**Prerequisites:** N/A

**Enrollment Limit:** N/A

**Enrollment Preferences:** N/A

**Expected Class Size:** N/A

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D3)

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**Fall 2022**

HON Section: 01  F 1:10 pm - 2:25 pm  Lee Y. Park

HON Section: 05  TBA  Bob Rawle

**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; this is part of a full-year thesis (493-494). Students in this program are strongly encouraged to keep 1:10 p.m. to 2:25 p.m. on Friday free for departmental colloquia.

**Requirements/Evaluation:** N/A

**Prerequisites:** N/A

**Enrollment Limit:** N/A

**Enrollment Preferences:** N/A

**Expected Class Size:** N/A

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D3)

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**Spring 2023**

HON Section: 01  F 1:10 pm - 2:25 pm  Thomas E. Smith

**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.

**Requirements/Evaluation:** N/A

**Prerequisites:** N/A

**Enrollment Limit:** N/A

**Enrollment Preferences:** Senior chemistry majors only

**Expected Class Size:** N/A

**Grading:** no pass/fail option, no fifth course option

**Distributions:** (D3)

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**Fall 2022**

IND Section: 01  TBA  Lee Y. Park

**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
CHEM 12 (W) The Practice and Processes of Making Pottery

This course will introduce students to creative methods of working with clay and glazes to create functional pottery, and to the materials and processes of ceramics. Classes will take place in a working Williamstown pottery studio with potter's wheels and space for hand-building and discussions. Studio lessons are designed to stimulate creativity and discovery. Instruction and projects will be tailored to each student's interests, experiences, and abilities. Students will be encouraged to consider how value and beauty can be found in that which is incomplete, impermanent, and/or imperfect. Genuineness and authenticity will be encouraged and valued. We will learn about the origins and properties of clay and glaze materials and about how combinations of materials and the high temperature processes result in mature clay bodies and glazes. We will study the major components of glazes and how the manipulation of these materials changes how glazes appear and function. Evaluation for this course will include a final project, and the critical review of the same. Assessment will take place during individual discussion with the instructor during the construction and finishing processes and in a structured, group critique where finished work will be evaluated by all members of the class through a group discussion led by the instructor. No previous experience is necessary. The only prerequisite for this course is an honest interest in learning about the making and chemistry of pottery. Studio time will likely be afternoons and early evenings, with an optional weekend session to accommodate schedules. Class time is about 12 hours weekly, and may include some outside of class reading and other assignments.

Requirements/Evaluation: final project or presentation
Prerequisites: None; no pottery making experience or science background are necessary; students are encouraged to submit a brief description of their interest in participating
Enrollment Limit: 10
Enrollment Preferences: Level of enthusiasm for learning the craft, materials, and processes of pottery
Expected Class Size: NA
Grading: pass/fail only
Unit Notes: Tim Duncan has been making pottery for over 30 years. He teaches in a home studio that accommodates up to 10 students, and focuses on creating lessons that stimulate creativity and discovery.

Materials/Lab Fee: $130
Attributes: EXPE Experiential Education Courses SLFX Winter Study Self-Expression

Winter 2023
LEC Section: 01 MWR 4:00 pm - 7:00 pm Timothy Duncan

CHEM 13 (W) Ultimate Wellness: Concepts for a Happy Healthy Life

This course provides an opportunity to drastically improve your life by introducing concepts that can start making a difference in the way you feel today. We will approach nutrition, lifestyle, and happiness from a holistic perspective. Students will learn how to tune out mixed media messages and look within to find ultimate health and wellness. Topics include: Ayurveda, preventative medicine, mindfulness and meditation, healthy eating and meal planning, deconstructing cravings, sugar addiction, and finding happiness. Evaluation will be based on completion of assignments, class participation,
reflective 5-page paper or creative project, and final presentation that demonstrates a level of personal growth. After signing up for this course please email Nicole at nicole@zentreewellness.com with a brief statement describing your interest in the course. In the event of over-subscription, these statements will be used in the selection process. We will meet twice a week for three-hour sessions as a group. The course will include two individual sessions-an initial health assessment plus an additional session designed to personalize the course and assist the student in applying the learned techniques. There will be several books required for this class.

Requirements/Evaluation: final project or presentation

Prerequisites: no

Enrollment Limit: 10

Enrollment Preferences: email statement of interest to nicole@zentreewellness.com

Expected Class Size: NA

Grading: pass/fail only

Unit Notes: Nicole Anagnos is health educator and director at Zen Tree Wellness in Williamstown. She is co-founder of the skin care company, Klo Organic Beauty. She also holds a master's degree in education.

Attributes: WELL Winter Study Wellness

Winter 2023

LEC Section: 01 TR 10:00 am - 12:50 pm Nicole Anagnos

CHEM 14 (W) Forensic Science

Forensic science is the application of scientific principles to criminal and civil laws within a criminal justice system with the goal toward the establishment of guilt or innocence. This Winter Study course is designed to introduce some of the specialized fields of forensic science, to learn the principles of science and technology upon which they are based, and to apply them to a number of suspicious situations and criminal cases. During two 2-hour class sessions per week, we will examine physical, chemical, and biological items of evidence. The forensic analysis of substances such as glass, ink, bullets, fabric/fibers and drugs will be understood in the context of basic chemistry, analytical chemistry, and organic chemistry. The methods used for the analysis for alcohol and drugs and for the characterization of blood and other body fluids will be discussed in the context of the principles of biochemistry, toxicology, pharmacology, and serology. A variety of well-known historic cases stimulate the exploration of these scientific areas. These 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. Two 3-hour laboratory sessions per week will involve an analysis of evidence and provide an appreciation for the work of a crime lab. Experiments provide an opportunity to learn forensic techniques such as chromatography (for ink and drug analysis), spectroscopy (for alcohol and drug analysis), comparison microscopy (for bullet identification) and a variety of other experimental procedures such as fingerprinting. Outside of class, background reading for the content and preparation for the experimental work is expected.

Requirements/Evaluation: Short paper and final project or presentation

Prerequisites: Organic chemistry, CHEM 251/255 or permission of instructor

Enrollment Limit: 14

Enrollment Preferences: Sophomores first, then juniors and then seniors

Expected Class Size: NA

Grading: pass/fail only

Unit Notes: Professor Kaplan taught biochemistry and forensic science for 48 years at Williams. He taught a forensic science workshop for 20 years under the sponsorship of the NSF. He is a member of the American and British Academies of Forensic Science.

Attributes: EXPE Experiential Education Courses STUX Winter Study Student Exploration

Winter 2023

LEC Section: 01 TR 9:00 am - 11:00 am TR 1:00 pm - 4:00 pm Lawrence J. Kaplan

CHEM 16 (W) Glass and Glassblowing

This course provides an introduction to both a theoretical consideration of the glassy state of matter and the practical manipulation of glass. We do
flameworking with hand torches for at least 12 hours per week. While no previous experience is required, students with patience, good hand-eye coordination, and creative imagination will find the course most rewarding. The class is open to both artistically and scientifically oriented students. Note: if you are required to participate in a sustaining language program during Winter Study, this course meets at the same time. The first and last classes are required, so make your travel plans accordingly.

**Requirements/Evaluation:** class participation, exhibition of glass projects, a 10-page paper, and a presentation to the class

**Prerequisites:** none

**Enrollment Limit:** 10

**Enrollment Preferences:** preference is given to juniors, sophomores, and those who express the most and earliest interest and enthusiasm by email to Professor Thoman

**Expected Class Size:** NA

**Grading:** pass/fail only

**Materials/Lab Fee:** $75

**Attributes:** EXPE Experiential Education Courses  SLFX Winter Study Self-Expression  STUX Winter Study Student Exploration  WELL Winter Study Wellness

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**CHEM 17** (W) **Precision and Clarity! An Exploration of Scientific Writing**

Most scientific journals demand specific writing styles that include brevity, avoidance of duplication, proper grammar and clear, effective communication. Participants in this course will learn the elements of the scientific report (Title, Introduction, Materials and Methods, Results and Discussion) and understand that unique information is required for each section recognizing that information required for each section should not appear in the others. Participants will explore the "Question Driven Style". This style of reporting emphasizes brevity, logical flow of questions and answers and discourages unnecessary repetition and lack of clear and specific presentation. The application of this style to basic research in all scientific disciplines will be illustrated. A major focus of this course will be group discussions of manuscripts submitted for publication as well as some notable classics. (For example: Hill AB. The Environment and Disease: Association or Causation. Proc Royal Society Med 1965;58:295-300) The course instructor (Cornell) has collected a series of manuscripts submitted for publication with a wide range of writing quality. The discussions will be conducted in the style of a journal club. The class will meet for 2 hour sessions 3 times per week. Tuesday class will include a didactic presentation (60 minutes) followed by group discussion. Reading assignments will be made for the Wednesday and Thursday meetings. These sessions will be conducted in the manner of a journal club. The format for week 1 will be: Review of the journal club format. Question Driven Style: Special Emphasis on the Introduction, Rationale for a Study and Formulation of Study Aims/Questions. Week 2 will focus on the Methods Section. Week 3 will cover reporting of Results and the Discussion. Week 4 will explore internal and external validity and sources of bias in scientific reporting.

**Requirements/Evaluation:** Short paper and final project or presentation. Participants will mediate a journal club discussion of an assigned manuscript. Participants will submit a written peer review of the assigned paper.

**Prerequisites:** The course will be open to all science majors, and not restricted to Chemistry majors.

**Enrollment Limit:** 12

**Enrollment Preferences:** Junior level students majoring in the natural sciences and psychology will be the target audience.

**Expected Class Size:** NA

**Grading:** pass/fail only

**Unit Notes:** Dr. Cornell('76) is Professor of Orthopedic Surgery at Weill Cornell College of Medicine. He is Editor-In-Chief of the HSS Journal and Senior Associate Editor of the Journal of Bone and Joint Surgery and Clinical Orthopedics and Related Research

**Attributes:** EXPE Experiential Education Courses  STUX Winter Study Student Exploration

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Winter 2023

LEC Section: 01  M-F 10:00 am - 10:50 am  John W. Thoman

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Winter 2023

LEC Section: 01  Cancelled
CHEM 18  (W) Introduction to Research in Biochemistry

An independent experimental project in biochemistry is carried out in collaboration with a member of the Department with expertise in biochemistry. Biochemistry is a branch of chemistry that deals with the molecular details of living systems including the interaction of biologically important molecules. In the Chemistry Department, studies are underway to investigate the structure/function relationship of proteins, the interaction between proteins and RNA and DNA, the molecular basis of bacterial gene regulation, the lipid composition of model membranes, and the molecular underpinnings of viral infection.

Requirements/Evaluation: a 10-page paper
Prerequisites: completion of CHEM 151/3/5 and permission of the instructor and department; interested students must consult with the faculty instructor
Enrollment Limit: 4
Enrollment Preferences: expression of student interest
Expected Class Size: NA
Grading: pass/fail only
Attributes: EXPE Experiential Education Courses  STUX Winter Study Student Exploration

Winter 2023
RSC Section: 01    M-F 10:00 am - 4:00 pm     Amy  Gehring

CHEM 19  (W) Steps to a Healthier You

What is health and wellness? We all know how to be "healthy"...right? But why is it sometimes so hard to choose a salad over fries? We will explore these questions and more. This course is based on 2 assumptions: 1. We all have an inherent desire and innate ability to move towards healthier versions of ourselves. 2. This is a lifelong process that begins with understanding ourselves-our values, habits, likes/dislikes, upbringing, etc. In this class, we will work with practical tools for self-discovery and -reflection that will then inform how we set wellness goals to promote lasting healthy habits. We will use the 6 pillars of health from Lifestyle Medicine (nutrition, physical activity, sleep, stress management, relationships, decreasing substance use) as a guide with which to examine our current state of wellbeing to identify where we can begin to take specific and achievable steps towards health and wellness. Class time will be spent primarily on experiential learning through instructor-led exercises and discussions. Additionally, students will complete outside assignments aimed to develop self-awareness and integrate class material into their lives. We will use selected readings from a variety of books including Robert Lustig's Metabolical, Jon Kabat-Zinn's Full Catastrophe Living, Matthew Walker's Why We Sleep, Robert Sapolsky's Why Zebras Don’t Get Ulcers, Bessel van der Kolk's The Body Keeps the Score, Stephen Covey's The 7 Habits of Highly Effective People, and James Clear's Atomic Habits. Evaluation will be based on class participation, completion of assignments, final 10-page paper or equivalent project/presentation that demonstrates a level of engagement with class material. We will meet 10AM-1PM on 1/4, 1/6, 1/9, 1/11, 1/18, 1/20, 1/23, 1/25. One (minimum) individual meeting with the instructor will be scheduled to address personal concerns and/or help focus the final paper/project. Contact instructor at thhu210@gmail.com with any questions.

Requirements/Evaluation: 10-page paper or equivalent creative project/presentation
Prerequisites: Desire and interest in self-reflection, personal growth, and making healthier lifestyle changes.
Enrollment Limit: 12
Enrollment Preferences: Priority will be given to Seniors. If overenrolled, a statement of interest (a little bit about yourself and your interest in the course) will be used for student selection.
Expected Class Size: NA
Grading: pass/fail only
Unit Notes: Tracy Hu, MD ’13 will graduate in June 2023 from the John Muir Health Family Medicine Residency Program in Walnut Creek, CA. Afterwards, she plans to start a non-profit direct primary care clinic with a fellow residency colleague.
Attributes: EXPE Experiential Education Courses  WELL Winter Study Wellness

Winter 2023
LEC Section: 01    MWF 10:00 am - 12:50 pm     Tracy L. Hu
CHEM 20 (W) Introduction to Research in Inorganic Chemistry

Students in this course will carry out an independent research project in collaboration with a member of the Department with expertise in inorganic chemistry. Representative projects include the synthesis and study of polymers to encapsulate heavy metals with an eye to environmental remediation and the synthesis of coordination complexes as models of enzymes and as catalysts for the oxidation of organic compounds. The interdisciplinary nature of the project will expose students to a range of inorganic and organic synthetic protocols and analytical and spectroscopic techniques for the characterization of new materials and the monitoring of catalysis. In addition to lab work, participants will engage in an exploration of careers in chemistry and a discussion of topics of interest to chemists, such as ethics and creating a diverse workforce.

Requirements/Evaluation: a 10-page paper
Prerequisites: completion of CHEM 151/3/5 and permission of the instructor and department; interested students must consult with the faculty instructor
Enrollment Limit: 8
Enrollment Preferences: expression of student interest
Grading: pass/fail only
Materials/Lab Fee: none

Winter 2023
RSC Section: 01 TBA Cancelled

CHEM 23 (W) Introduction to Research in Organic Chemistry

An independent experimental project in polymer organic chemistry is carried out in collaboration with a member of the Department. Representative projects focus on controlled synthesis of block copolymers as self-assembled nanocarriers. Students involved in this work will learn techniques involved in organic synthesis, including analysis by NMR, IR, and SEC.

Requirements/Evaluation: 10-page paper
Prerequisites: completion of CHEM 151/3/5 and permission of the instructor and department; interested students must consult with the faculty instructor
Enrollment Limit: 12
Enrollment Preferences: expression of student interest
Grading: pass/fail only
Materials/Lab Fee: none

Winter 2023
RSC Section: 01 Cancelled

CHEM 24 (W) Introduction to Research in Physical Chemistry

An independent experimental or theoretical project in physical chemistry is carried out in collaboration with a member of the Department with expertise in physical chemistry. Current research projects in the Department include computer modeling of non-linear, chaotic chemical and biochemical systems, atmospheric chemical dynamics, molecular modeling of water clusters, molecular dynamics simulations, and laser spectroscopy of chlorofluorocarbon substitutes.

Requirements/Evaluation: 10-page paper
Prerequisites: completion of CHEM 151/3/5 and permission of the instructor and department; interested students must consult with the faculty instructor
Enrollment Limit: 6
Enrollment Preferences: expression of student interest
Expected Class Size: NA
Grading: pass/fail only
Attributes: EXPE Experiential Education Courses STUX Winter Study Student Exploration
CHEM 31 (W) Senior Research and Thesis: Chemistry
To be taken by students registered for Chemistry 493, 494.

Class Format: independent study
Grading: pass/fail only

Winter 2023
HON Section: 01 TBA Lee Y. Park

CHEM 99 (W) Independent Study: Chemistry
Open to upperclass students. Students interested in doing an independent project (99) during Winter Study must make prior arrangements with a faculty sponsor. The student and professor then complete the independent study proposal form available online. The deadline is typically in late September. Proposals are reviewed by the pertinent department and the Winter Study Committee. Students will be notified if their proposal is approved prior to the Winter Study registration period.

Class Format: independent study
Grading: pass/fail only

Winter 2023
IND Section: 01 TBA Lee Y. Park