CHEMISTRY (CHEM)

CHEM118 DNA
This course provides an interdisciplinary view of the DNA molecule and its impact upon medicine, law, philosophy, agriculture, ethics, politics, and society at large. The course has two parts. In the first part, we will learn the chemistry and physics of DNA and the processes by which the information stored in DNA is expressed. In the second part of the course, we will discuss what DNA has done and still can do for us—for example, treat and prevent genetic diseases, improve our food through genetic engineering, achieve criminal justice through genetic fingerprinting, understand the evolutionary origin of humans, and enrich our idea of what it is to be human. The course assumes basic knowledge of chemistry and biology at the general high school level. Independent exploration and inquiry are encouraged.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: None

CHEM119 Biology and Chemistry in the Modern World: A Survey of Drugs and Disease
This course will cover a wide range of topics of current interest that are at the intersection of biology and chemistry. In particular, the molecular basis of issues related to drugs and disease will form a focus of the course. Topics to be discussed will include psychoactive and performance-enhancing drugs, mad cow, cancer, viral and bacterial diseases, and the chemistry of foods.
Offering: Crosslisting
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Identical With: MB&B119
Prereq: None

CHEM120 Science and Humanity
This course will provide an introduction to the important concepts of writing in science. We will discuss the major components of scientific writing while viewing scientific issues from an analytical and interdisciplinary perspective. We will discuss contemporary problems influenced by technological advantages and the effects they have on science and humanity. This course assumes basic knowledge in chemistry and biology at the high school level.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: None

CHEM141 Introductory Chemistry I
CHEM 141 is the first half of an introductory course in general chemistry intended for science majors and for premedical studies. The topics covered will include measurement and dimensional analysis; atomic theory; chemical nomenclature; mass relationships and the mole concept; stoichiometry; aqueous reactions; gases; thermochemistry; the quantum mechanical model of the atom; periodic trends; bonding theory; and molecular geometry. The full-year course can be completed by continuing on to CHEM 142.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: None

CHEM142 Introductory Chemistry II
This course is a continuation of CHEM141. CHEM152, the associated laboratory course, may be taken concurrently. The lab should be taken by those who plan to take more than one year of chemistry.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: CHEM141

CHEM143 Principles of Chemistry I
An introduction to chemistry intended for motivated students with a solid high school chemistry background and some exposure to basic calculus, this course will emphasize the fundamental principles of chemistry and is recommended for students interested in pursuing majors in science or mathematics. The topical focus will be on the concepts of electronic structure, molecular geometry, and equilibrium thermodynamics, with applications to current research on, for example, the carbon cycle and nanomaterials. CHEM143 and CHEM144 provide the best basic foundation for further study of chemistry and is strongly recommended for Chemistry, MB&B, and NS&B majors. Completion of CHEM143 and CHEM144 also satisfies premedical general chemistry requirements.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: None

CHEM144 Principles of Chemistry II
This second semester general chemistry course is a continuation of the Principles of Chemistry sequence that is recommended for science students. The focus of the course is the fundamentals of structure and bonding, with an emphasis on predicting reactivity. Major topical coverage includes the reactivity of ions in aqueous solution, kinetics, modern electronic structure, and the chemistry of transition metal complexes, with applications to current research on, for example, food chemistry, functional materials, and artificial photosynthesis.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: CHEM143

CHEM152 Introductory Chemistry Laboratory
This course provides an introduction to the application of chemical concepts in the laboratory. It is required for Chemistry or MB&B majors and satisfies the general chemistry laboratory requirements for pre-medical studies. Chem 152 is usually taken concurrently with CHEM 141, 142, 143, or 144.
Offering: Host
Grading: A-F
Credits: 0.50
Gen Ed Area: NSM-CHEM
Prereq: None

CHEM241 Informal Science Education for Elementary School Students I
This service-learning course will focus on designing and implementing original, effective, and engaging science-based lesson plans for elementary age children in an afterschool program setting at five local elementary schools. The classroom component includes writing, testing, and critiquing lesson plans and organizing a once-a-semester event, Science Saturday. Members of the class are required to volunteer weekly, co-lead Science Saturday, complete individual work, and organize meetings for projects outside of class.
Offering: Host
Grading: BMS
Credits: 1.00
Gen Ed Area: None
This course presents laboratory techniques of organic chemistry.

CHEM242 Informal Science Education for Elementary School Students II
This service-learning course will focus on designing and implementing original, effective, and engaging science-based lesson plans for elementary age children in an afterschool program setting at five local elementary schools. The classroom component includes writing, testing, and critiquing lesson plans and organizing a once-a-semester event, Science Saturday. Members of the class are required to volunteer weekly, co-lead Science Saturday, complete individual work, and organize meetings for projects outside of class. This course is a continuation of CHEM241.
Offering: Host
Grading: Cr/U
Credits: 1.00
Gen Ed Area: NSM-CHEM
Identical With: MB&B242
Prereq: None

CHEM250 Pre-Organic Chemistry: Key Concepts and Fundamental Principles
This course is designed to assist students in the transition from CHEM 142 & CHEM 144 to CHEM 251. This course will review key General Chemistry concepts and apply them to organic molecules. Thematic presentation of material will use visual lecture and demonstration methods, small-group problem solving, peer-group workshops and lecture format. A broad understanding of Organic Chemistry terminology, structures, nomenclature, applications and basic concepts will provide students with a firm foundation for success in CHEM 251.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: CHEM142 OR CHEM144

CHEM251 Principles of Organic Chemistry I
This course offers an introduction to the chemistry of carbon compounds with emphasis on the relationship between structure and reactivity. The laboratory course CHEM257 is normally elected concurrently but is not required.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: CHEM142 OR CHEM144

CHEM252 Principles of Organic Chemistry II
This course is a continuation of the chemistry of carbon compounds with emphasis on the chemistry of important functional groups. The laboratory course CHEM258 is normally elected concurrently but is not required.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: CHEM251

CHEM257 General Chemistry Laboratory
Normally taken along with CHEM251, this course provides laboratory work in quantitative chemical procedures and introductory chemical laboratory practices. This course is required by most medical, dental, and veterinary schools and is a prerequisite for CHEM258.
Offering: Host
Grading: A-F
Credits: 0.50
Gen Ed Area: NSM-CHEM
Prereq: (CHEM141 AND CHEM142 AND CHEM152) OR (CHEM143 AND CHEM144 AND CHEM152)

CHEM258 Organic Chemistry Laboratory
This course presents laboratory techniques of organic chemistry.
The focus of the course will be on understanding the complex interplay of small molecules and proteins that keep neurons healthy and functional. In this course, we will use current primary literature and lecture to understand the varied topics. This course aims to improve skills in reading and analysis of primary literature as well as the written and oral presentation of scientific findings.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Identical With: NS&B323
Prereq: BIOL181 AND CHEM252

CHEM325 Introduction to Biomolecular Structure
This course aims to provide a framework for understanding three-dimensional structures of proteins, nucleic acids, and their complexes. The first half of the course emphasizes structural modules and topological patterns in major classes of proteins and nucleic acids. The second part of the course covers novel structural motifs, such as helix-turn-helix, zinc-finger, and leucine zipper, that are responsible for recognition of specific nucleotide sequences in nucleic acids by proteins. Analysis of structures using tools available on the Web and independent exploration of protein and nucleic acid databases are strongly encouraged.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Identical With: MB&B325
Prereq: [MB&B181 or BIO1181] OR [MB&B191 or BIO191]

CHEM335 Protein Folding: From Misfolding to Disease
Amyloidogenesis, the process by which proteins and peptides misfold to form amyloid fibers, is at the root of several different diseases, including Parkinson's disease, Alzheimer's disease, mad cow disease, and type II diabetes to name a few. This course will focus on current research in the field that seeks to understand why a functional, well-folded protein adopts the misfolded amyloid form. In the course of discussing the misfolded nature of these proteins, we will review central elements of protein structure and stability to better understand the protein-folding landscape and the process of misfolding. We will also discuss how the process of misfolding leads to the different diseases and disease pathologies. We will read current literature that studies the molecular nature of these diseases and discuss the strategies used to detect, identify and study these misfolded proteins in the body and in the test-tube.

Offering: Crosslisting
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MBB
Identical With: MB&B335, MB&B535, CHEM535
Prereq: MB&B208 OR MB&B325

CHEM337 Physical Chemistry I: Quantum Mechanics and Spectroscopy
A rigorous introduction to quantum mechanics, this course covers wave mechanics, operator methods, matrix mechanics, perturbation theory, angular momentum, molecular vibrations, atomic and molecular structure, symmetry, and spectroscopy.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: [CHEM141 AND CHEM142 AND MATH121 AND MATH122] OR [CHEM143 AND CHEM144 AND MATH121 AND MATH122]
CHEM338 Physical Chemistry II: Thermodynamics, Statistical Mechanics, and Kinetics
This course investigates chemical aspects of statistical mechanics and the laws of thermodynamics including free energy, chemical potential and chemical equilibria, and rates of chemical reactions.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: (MATH121 AND MATH122 AND CHEM141 AND CHEM142) OR (MATH121 AND MATH122 AND CHEM143 AND CHEM144)

CHEM340 Physical Chemistry IV: Introduction to Quantum Chemistry
This course is an introduction to modern concepts of atomic and molecular quantum mechanics, molecular orbital theory, and qualitative and quantitative concepts of molecular electronic structure. The second half of the course will emphasize numerical calculations with commonly used approximations in many electron calculations on atomic and molecular systems using currently popular computer programs.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: CHEM337 OR PHYS214

CHEM342 Molecules to Medicine
This course will explore the process of drug development, including target selection, lead discovery using computer-based methods and combinatorial chemistry/high-throughput screening, organic synthesis, bioavailability, clinical trials, and other factors (some economics and politics) involved in bringing a drug to the marketplace. Critical consideration of the variables to contend with at each step will be described and discussed, including aspects of research ethics and patent law. The basic science of molecular recognition, computer-aided drug design, and the role of factors from synthetic chemistry to toxicology will be presented. Case studies of the development of drugs recently successful in making the journey from molecule to medicine will be discussed, as well as the story of some that did not, and why. Emerging new design strategies such as fusion-protein therapies, crisper technology, and enhanced use of rational design and combinatorial methods will be emphasized, and how pharmaceutical research is evolving in the postgenomic era, particularly with biologics. Job opportunities in the pharmaceutical industry will be discussed.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: CHEM337 OR CHEM143 OR CHEM251

CHEM353 Applications of Spectroscopic Methods in Organic Chemistry
The use of NMR infrared and mass spectroscopy in structure determinations will be discussed.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: CHEM141 OR CHEM143 OR CHEM251

CHEM358 Structure and Mechanism
This course will cover several important aspects of traditional and contemporary physical organic and mechanistic chemistry, including frontier molecular orbital theory and pericyclic reactions, organic photochemistry reactive intermediates (carbocations, carbanions, radicals, and carbenes), the thermodynamics and kinetics of organic reactions, and polymer chemistry.
Offering: Host
Grading: A-F

CHEM359 Advanced Organic Synthesis
The control of reactivity and selectivity to achieve specific syntheses is one of the overarching goals of organic chemistry. This course is intended to provide advanced undergraduate and graduate students in chemistry with a sufficient foundation to comprehend and use research literature in organic chemistry. Concentrating on the most important reactions and efficient synthetic methods used for organic synthesis, this course presents the material by reaction type. The planning and execution of multistep synthesis will also be included.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: CHEM251 AND CHEM252

CHEM361 Advanced Inorganic Chemistry
This course is a survey of the chemistry of the inorganic elements, focusing on the relationship between electronic structure, physical properties, and reactivity across the periodic table.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: CHEM252

CHEM375 Integrated Chemistry Laboratory I
This advanced laboratory course in chemistry involves work from the major subdisciplines: organic, inorganic, biochemistry, physical, and instrumental. Emphasis will be placed on integrating aspects of chemical synthesis, spectroscopic characterization, and determination of physical properties in each exercise.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: (CHEM251 AND CHEM252 AND CHEM257 AND CHEM258)

CHEM376 Integrated Chemistry Laboratory II
This advanced laboratory course in chemistry involves work from the major subdisciplines: organic, inorganic, biochemistry, physical, and instrumental. Emphasis will be placed on integrating aspects of chemical synthesis, spectroscopic characterization, and determination of physical properties in each exercise.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: CHEM375

CHEM377 Chemistry of Materials and Nanomaterials
This course will provide an introduction to materials chemistry, with a special emphasis on nanomaterials. Topics covered will include colloidal metal nanomaterials; semiconductors and quantum dots; carbon nanotubes, fullerenes, and graphene; metal-organic frameworks; self-assembly and metamaterials; electron and scanning probe microscopies; and lithography. The course will also discuss applications of these materials and techniques in areas such as plasmonics and sensing, catalysis, energy generation, and medicine.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Identical With: PHYS377
Prereq: CHEM251

CHEM379 Nanomaterials Lab
This course will be a combination of weekly lecture and laboratory exercises designed to introduce students to new developments in the chemistry of materials and nanomaterials. Concepts and theoretical background will be discussed during weekly lectures. Students will then apply those concepts to the preparation of materials/nanomaterials in weekly lab sections. Students will synthesize quantum dots, build solar cells, pattern surfaces using both photolithography and soft lithography, make conductive carbon nanofiber films, prepare high-temperature superconductors, and learn scanning probe microscopy techniques.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM

CHEM381 Physical Chemistry for the Life Sciences
The course is concerned with the basic physicochemical principles and model systems essential to understanding, explaining, and predicting the behavior of biological systems in terms of molecular forces. The course integrates fundamental concepts in thermodynamics, kinetics, and molecular spectroscopy with the structures, functions, and molecular mechanisms of biological processes. The objectives of the course are to (1) familiarize life science students at the advanced undergraduate and beginning graduate level with basic physicochemical laws, theories, and concepts important to the life sciences; (2) provide a working knowledge of mathematical methods useful in life science research; (3) develop a critical perspective on explanation of biological processes and understanding biological systems; and (4) survey the main applications of physical chemistry in the life sciences. Theory, methodology, and biophysical concepts are distributed throughout the course.
Offering: Crosslisting
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MBB

CHEM382 Practical NMR
This course will cover how a spectrometer works as well as the theory and application of NMR experiments. The topics will include one-dimensional proton and heteronuclear experiments as well as decoupling. The course will begin with how the spectrometer works and how data processing is carried out, as well as how to calibrate the spectrometer and shim the magnet. The one-dimensional TOCSY and NOESY experiments will then be covered. The course will also cover heteronuclear and homonuclear two-dimensional NMR experiments. The experiments will include two-dimensional DQFCOSY, TOCSY, NOESY, and ROESY proton experiments as well as heteronuclear experiments to correlate the chemical shifts of protons and heteronuclei, as well as how to select heteronuclear resonances on the basis of the number of directly attached protons.

The course will consist of lectures as well as a laboratory component in which the Mercury 300 will be used to obtain data that will be analyzed using the methods developed in the lecture part of the course. This course is specifically aimed at general users of the Mercury spectrometer who wish to learn how to carry out and analyze advanced one-dimensional and two-dimensional NMR experiments.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Identical With: MB&B382
Prereq: None

CHEM383 Biochemistry
This introductory course to the principles and concepts of contemporary biochemistry presents both the biological and chemical perspectives. The major themes will be the structure of proteins and the basis of enzymatic activity, cellular metabolism and the generation and storage of metabolic energy, and general principles of the biosynthesis of cellular components.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Identical With: MB&B383
Prereq: (CHEM251 AND CHEM252)

CHEM386 Biological Thermodynamics
This course is addressed to undergraduate and graduate students interested in biological chemistry and structural biology. The course presents thermodynamic methods currently used to relate structure to function in biological molecules. Topics include binding curves, chemical ligand linkages, binding polynomial, cooperativity, site-specific binding processes, and allosteric effects. Several models for allosteric systems, such as the Monod-Wyman-Changeux model, the induced-fit model, and the Pauling model, are analyzed in detail. Applications of these models are illustrated for functional regulation of respiratory proteins and for protein-nucleic-acid complexes involved in control of gene expression.
Offering: Host
Grading: OPT
Credits: 1.00
Gen Ed Area: NSM-CHEM
Identical With: MB&B386
Prereq: (MATH121 AND MATH122)

CHEM387 Enzyme Mechanisms
The chemical mechanisms involved in the action of a series of typical enzymes will be considered.
Offering: Host
Grading: A-F
Credits: 0.50
Gen Ed Area: NSM-CHEM
Identical With: MB&B387
Prereq: [CHEM383 or MB&B383]

CHEM390 Practical Methods in Biochemistry
This course centers on currently used techniques for protein separation, characterization, and purification, such as ultracentrifugation, gel electrophoresis, and chromatography. These topics will be introduced within the general context of the behavior of macromolecules in solution. The relative stability of proteins in different media, the forces stabilizing protein structure, and the interaction of proteins will be discussed. We will explicitly consider different techniques used to study proteins. Relatively novel techniques to be discussed include surface plasmon resonance, microarray methods and mass spectrometry, and single molecule microscopy. In the course, we will go through three or four different protein purification protocols and discuss the methods used in each one. We will also touch upon the commonly used spectroscopic techniques used to characterize proteins, including absorption, fluorescence, and circular dichroism. The course will focus on biochemical techniques and understanding the physical principles underlying these techniques and will also discuss tactics for optimizing established isolation and purification procedures and for isolating and characterizing an unknown protein.

The course content is appropriate for advanced undergraduates (juniors/seniors) and beginning graduate students from chemistry, biology, molecular biophysics or MB&B.
Offering: Crosslisting
Grading: A-F
Credits: 1.00
CHEM395 Structural Biology Laboratory
One of the major catalysts of the revolution in biology that is now under way is our current ability to determine the physical properties and three-dimensional structures of biological molecules by x-ray diffraction, nuclear magnetic resonance (NMR) spectroscopy, and other spectroscopic methods. This course is designed to familiarize students with current research techniques in biochemistry and molecular biophysics. Students will perform spectroscopic investigations on a protein that they have isolated and characterized using typical biochemical techniques, such as electrophoresis, enzyme extraction, and column chromatography. The course will provide hands-on experience with spectroscopic methods such as NMR, fluorescence, UV-Vis absorption, and Raman as well as bioinformatic computational methods. All of these methods will be applied to the study of biomolecular structure and energetics. This course provides a broad knowledge of laboratory techniques valuable for independent research at the undergraduate level and beyond.
Offering: Crosslisting
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MBB
Identical With: MBB395, PHYS395
Prereq: (MB&B208 or BIOL208) AND CHEM141 AND CHEM142) OR ([MB&B208 or BIOL208) AND CHEM143 AND CHEM144)
CHEM396 Molecular Modeling and Design
This course will introduce students to the practical and theoretical aspects of computationally modeling and designing biological macromolecules, with a particular emphasis on protein structures. Students will run molecular dynamics simulations with Gromacs (http://www.gromacs.org) and do protein structure prediction/design with Rosetta (https://www.rosettacommons.org). Over the course of the semester students will embark on a group research project, likely related to redesigning proteins that show potential for use as drugs. Both Gromacs and Rosetta use the Mac/Linux command-line, so having some familiarity with that prior to the course would be helpful but not required.
Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Identical With: CHEM596
Prereq: MB&B208 OR BIOL265 OR CHEM381 OR CHEM325 OR MB&B335 OR CHEM338 OR CHEM383 OR PHYS316 OR PHYS340 OR BIOL266
CHEM401 Individual Tutorial, Undergraduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT
CHEM402 Individual Tutorial, Undergraduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT
CHEM407 Senior Tutorial (downgraded thesis)
Downgraded Senior Thesis Tutorial - Project to be arranged in consultation with the tutor. Only enrolled in through the Honors Coordinator.
Offering: Host
Grading: A-F
CHEM408 Senior Tutorial (downgraded thesis)
Downgraded Senior Thesis Tutorial - Project to be arranged in consultation with the tutor. Only enrolled in through the Honors Coordinator.
Offering: Host
Grading: A-F
CHEM409 Senior Thesis Tutorial
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT
CHEM410 Senior Thesis Tutorial
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT
CHEM411 Group Tutorial, Undergraduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT
CHEM412 Group Tutorial, Undergraduate
Topic to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT
CHEM419 Student Forum
Student-run group tutorial, sponsored by a faculty member and approved by the chair of a department or program.
Offering: Host
Grading: Cr/U
CHEM420 Student Forum
Student-run group tutorial, sponsored by a faculty member and approved by the chair of a department or program.
Offering: Host
Grading: Cr/U
CHEM421 Undergraduate Research, Science
Individual research projects for undergraduate students supervised by faculty members.
Offering: Host
Grading: OPT
CHEM422 Undergraduate Research, Science
Individual research projects for undergraduate students supervised by faculty members.
Offering: Host
Grading: OPT
CHEM423 Advanced Research Seminar, Undergraduate
Advanced research tutorial; project to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT
CHEM424 Advanced Research Seminar, Undergraduate
Advanced research tutorial; project to be arranged in consultation with the tutor.
Offering: Host
Grading: OPT
CHEM491 Teaching Apprentice Tutorial
The teaching apprentice program offers undergraduate students the opportunity to assist in teaching a faculty member's course for academic credit.
Offering: Host
Grading: OPT
CHEM492 Teaching Apprentice Tutorial
The teaching apprentice program offers undergraduate students the opportunity to assist in teaching a faculty member's course for academic credit.
Offering: Host
Grading: OPT
CHEM495 Research Apprentice, Undergraduate
Project to be arranged in consultation with the tutor.
CHEM509 Molecular and Cellular Biophysics
This course is an integrated consideration of the biophysics and biophysical chemistry of biological systems from molecules to cells. The objective is to develop a critical sense of the quantitative data currently being obtained from microscopy to spectroscopy, considering both ensemble and single-molecule experiments, and to gain familiarity and facility with interpretation using mathematical and computational models. Biological systems are inherently complex, and some form of modeling is always involved in developing an explanation of how they work. However, these models typically involve only a few basic constructs (simple harmonic motion, ideal fluids, two-state Ising models, random walks, electrostatic interactions, classical dynamics, rate equations, QM energy levels, distribution functions, and network analysis) and only elementary aspects of linear algebra, calculus, differential equations, and statistics. This course deals with how these constructs are integrated in the framework of Boltzmann statistic mechanics to formulate mathematical models of biological phenomena, how these models are validated and refined, and how they are used to form explanations and make testable predictions. Model systems to be considered include the nucleosome, the ribosome, membrane dynamics and ion channels, molecular devices and motors, prototype signal transduction systems, and regulatory processes. This course is suitable for physics and chemistry students who wish to learn about biological applications and for molecular and cellular biology students to develop skills with quantitative physicochemical modes of inquiry applied to the life sciences.

Offering: Crosslisting
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Identical With: CHEM309, MB&B309, MB&B509, PHYS339, PHYS539
Prereq: (CHEM251 AND CHEM252)

CHEM519 Structural Mechanisms of Protein-Nucleic Acid Interactions
This course focuses on recent advances in the understanding of the structural basis of the recognition of nucleic acids by proteins. Macromolecular systems to be discussed include site-specific DNA endonucleases, topoisomerases, the histone fold, helicases, site-specific recombinases, nuclear RNA-protein complexes, tRNA-binding proteins, and the ribosome.

Offering: Host
Grading: OPT
Credits: 0.50
Gen Ed Area: None
Identical With: CHEM309
Prereq: CHEM251 AND CHEM252

CHEM520 Scientific Research Ethics
This course involves critical consideration of the ethical issues that arise in the conduct of scientific research. The course will begin with an overview of the ethical issues commonly encountered in research, including what is and is not an ethical issue and how ethical issues are dealt with in principle and in practice. Initial topics include record keeping, conflict of interest, responsible authorship, ownership of projects, policies for handling misconduct, policies regarding the the
use of human and animal subjects, and data management and distribution. The course proceeds to consider a series of case studies based on instances in the recent scientific literature in which ethical problems were encountered.

Offering: Crosslisting
Grading: A-F
Credits: 0.50
Gen Ed Area: NSM-CHEM
Identical With: CHEM320
Prereq: None

CHEM521 Chemistry Symposium I
Weekly seminars by distinguished national and international chemists.
Offering: Host
Grading: Cr/U
Credits: 0.25
Gen Ed Area: None
Prereq: None

CHEM522 Chemistry Symposium II
Weekly seminars by distinguished national and international chemists.
Offering: Host
Grading: Cr/U
Credits: 0.25
Gen Ed Area: None
Prereq: None

CHEM535 Protein Folding: From Misfolding to Disease
Amyloidogenesis, the process by which proteins and peptides misfold to form amyloid fibers, is at the root of several different diseases, including Parkinson's disease, Alzheimer's disease, mad cow disease, and type II diabetes to name a few. This course will focus on current research in the field that seeks to understand why a functional, well-folded protein adopts the misfolded amyloid form. In the course of discussing the misfolded nature of these proteins, we will review central elements of protein structure and stability to better understand the protein-folding landscape and the process of misfolding. We will also discuss how the process of misfolding leads to the different diseases and disease pathologies. We will read current literature that studies the molecular nature of these diseases and discuss the strategies used to detect, identify and study these misfolded proteins in the body and in the test-tube.

Offering: Crosslisting
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-MBB
Identical With: MB&B335, MB&B355, CHEM335
Prereq: MB&B208 OR MB&B325

CHEM540 Physical Chemistry IV: Advanced Quantum Chemistry
This course covers electron wave function theory, operator formalisms and second quantization; fundamentals of restricted and unrestricted Hartree-Fock theory; electron correlation methods; pair and coupled pair theories; many-body perturbation theory; and coupled-cluster theory. This course is suitable for advanced graduate students in physical chemistry and chemical physics.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: None
Prereq: CHEM340 OR [PHYS315 or PHYS515]

CHEM541 Physical Chemistry IV: Quantum Chemistry
Second half of the semester, computer lab.

Offering: Host
Grading: A-F
Credits: 0.50
Gen Ed Area: None
Prereq: CHEM337 OR PHYS214

CHEM545 Modern High-Resolution Spectroscopy
This is a graduate-level lecture/discussion course in selected topics in modern high-resolution spectroscopy. Topics to be covered include microwave spectroscopy, angular momentum theory, electronic spectroscopy of diatomic molecules, and vibrational normal mode analysis. While there are no formal prerequisites for this course, a working knowledge of quantum mechanics will be assumed.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: None

CHEM547 Seminar in Chemical Physics
Weekly seminars presented jointly with the Department of Physics under the auspices of the Chemical Physics Program. These informal seminars will be presented by students, faculty, and outside visitors on current research and other topics of interest.

Offering: Crosslisting
Grading: Cr/U
Credits: 0.25
Gen Ed Area: None
Identical With: PHY5588
Prereq: None

CHEM548 Seminar in Chemical Physics
Weekly seminars presented jointly with the Chemistry Department under the auspices of the Chemical Physics Program. These informal seminars will be presented by students, faculty, and outside visitors on current research and other topics of interest.

Offering: Crosslisting
Grading: Cr/U
Credits: 0.25
Gen Ed Area: None
Identical With: PHY5588
Prereq: None

CHEM549 Advanced Research Seminar, Graduate
Advanced research tutorial; project to be arranged in consultation with the tutor.

Offering: Host
Grading: OPT

CHEM550 Advanced Research Seminar, Graduate
Advanced research tutorial; project to be arranged in consultation with the tutor.

Offering: Host
Grading: OPT

CHEM557 Seminar in Organic and Inorganic Chemistry
This graduate-level seminar in organic and inorganic chemistry will include weekly presentations and discussions based on current research. Speakers will present the details of their topic using specific examples and will place the research in a broader context with respect to the current literature while also providing adequate background information and drawing concepts together with critical concluding analysis.

Offering: Host
Grading: Cr/U
Credits: 0.25
Gen Ed Area: None
Prereq: None

CHEM558 Seminar in Organic and Inorganic Chemistry
This graduate-level seminar in organic and inorganic chemistry will include weekly presentations and discussions based on current research. Speakers will present the details of their topic using specific examples and will place the research in a broader context with respect to the current literature while also
Chemistry (CHEM)

providing adequate background information and drawing concepts together with critical concluding analysis.

Offering: Host
Grading: Cr/U
Credits: 0.25
Gen Ed Area: None
Prereq: None

CHEM561 Graduate Field Research
Research in the field, normally on thesis project.
Offering: Host
Grading: OPT

CHEM565 Physical Methods in Chemistry
An introduction to the use of physical methods to characterize the structures and dynamics of chemical systems with a particular emphasis on applications in inorganic chemistry. Topics will include a variety of spectroscopies (e.g., optical absorption, circular dichroic techniques, infrared and Raman spectroscopies, NMR techniques), small molecule X-ray crystallography, and magnetic susceptibility measurements. Group theoretical techniques will be used extensively to develop selection rules.

Offering: Host
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Prereq: CHEM361 OR CHEM337

CHEM587 Seminar in Biological Chemistry
This course involves weekly presentations and discussions based on current research.

Offering: Host
Grading: Cr/U
Credits: 0.25
Gen Ed Area: None
Identical With: MB&B587
Prereq: [CHEM383 or MB&B383] OR (CHEM383 or MB&B383 or CHEM325 or MB&B325 or MB&B208)

CHEM588 Seminar in Biological Chemistry
This course involves weekly presentations and discussions based on current research.

Offering: Host
Grading: Cr/U
Credits: 0.25
Gen Ed Area: None
Identical With: MB&B588
Prereq: [CHEM383 or MB&B383] OR (CHEM383 or MB&B383 or CHEM325 or MB&B325 or MB&B208)

CHEM596 Molecular Modeling and Design
This course will introduce students to the practical and theoretical aspects of computationally modeling and designing biological macromolecules, with a particular emphasis on protein structures. Students will run molecular dynamics simulations with Gromacs (http://www.gromacs.org) and do protein structure predication/design with Rosetta (https://www.rosettacommons.org). Over the course of the semester students will embark on a group research project, likely related to redesigning proteins that show potential for use as drugs. Both Gromacs and Rosetta use the Mac/Linux command-line, so having some familiarity with that prior to the course would be helpful but not required.

Offering: Crosslisting
Grading: A-F
Credits: 1.00
Gen Ed Area: NSM-CHEM
Identical With: CHEM396
Prereq: MB&B208 OR BIOL265 OR CHEM381 OR CHEM325 OR MB&B335 OR CHEM338 OR CHEM383 OR PHYS316 OR PHYS340 OR BIOL266