University of Michigan Associates • SUMMER SHORT COURSES

These courses can be 2-week 16-hour (1-credit), 2-week 32-hour (2-credit), or 4-week 32-hour (2-credit), which creates great flexibility in how to make a 2-4 week course schedule of 4 credits. Professor Brian Coppola is the main contact for helping to identify and recruit a group of excellent classroom professors who are available for summer teaching.

<u>Courses in Chemistry</u>

Professor Brian Coppola — ***University of Michigan***
- Organic chemistry mechanisms (undergraduates who have completed organic chemistry)
- Bio-Organic mechanisms (undergraduates who have completed organic chemistry)

Professor Eitan Geva — ***University of Michigan***
- The mathematical tools of quantum mechanics (undergraduate level)
- Chemical Dynamics (graduate level)
- Introduction to nonlinear spectroscopy and its applications to Chemistry (graduate level)

Professor Mark Banaszak Holl — ***University of Michigan***
- Biology for Chemists
- Symmetry, Group Theory, and Molecular Orbital Theory (undergraduates)
- Coordination chemistry and organometallic chemistry (undergraduates who have completed organic chemistry)
- Polymer Synthesis and Design (undergraduates that have completed organic chemistry and graduate students)
- Polymer Synthesis
- Polymer Characterization

Professor Ryan Baxter — ***University of California at Merced***
- Modern Kinetic Analysis of Organic Reactions (graduate)
- Reaction Mechanisms of Complex Catalytic Systems (upper level undergraduate, graduate)
- Modern Physical Organic Techniques (upper level undergraduate, graduate)

Professor Megan Frost — ***Michigan Technological University***
- Bio-analytical: In vivo measurement of clinically important physiological analytes (upper level undergraduate)
- Impact of surface properties on biocompatibility (upper level undergraduate/graduate)
- Approaches to fabricating synthetic vascular grafts (upper level undergraduate/graduate)

Professor Melissa Reynolds — ***Colorado State University***
- Bio-analytical: In vivo measurement of clinically important physiological analytes (upper level undergraduate)
- Impact of surface properties on biocompatibility (upper level undergraduate/graduate)
- Approaches to fabricating synthetic vascular grafts (upper level undergraduate/graduate)

Professor Julie Biteen — ***University of Michigan***
- Methods in Biophysical Chemistry (Advanced Undergraduate/Graduate; 1 credit)
- Super-Resolution Imaging (Advanced Undergraduate/Graduate; 1 credit)

Professor Alan Kiste — ***California Polytechnic University at San Luis Obispo***
- Organic chemistry of biological molecules (lower level undergraduate)
- Introduction to the chemistry education research literature (teaching faculty; strong English reading comprehension skills needed).
- Organic chemistry mechanisms (undergraduates who have completed organic chemistry)

Professor JP Desaulniers — ***University of Ontario Institute of Technology***
- Introduction to Chemical Biology (undergraduates who have completed organic chemistry & biology)
- Organic chemistry mechanisms (undergraduates who have completed organic chemistry)

Professor John Henssler — ***New York University***
- Polymer Synthesis and Design (undergraduates that have completed organic chemistry and graduate students)
- Characterization of Small Molecules and Macromolecules (undergraduates that have completed organic chemistry and graduate students)
- Organic chemistry mechanisms (undergraduates who have completed organic chemistry)

Professor Edmund Palermo ***Rensselaer Polytechnic University***

Macromolecules I: Synthesis of Polymers
Macromolecules II: Physical Chemistry of Polymers
Bio-macromolecules and Biomimicry

Professor Joanne Stewart ***Hope College***

Symmetry, Group Theory, and Molecular Orbital Theory (undergraduates)
Coordination chemistry and organometallic chemistry (undergraduates who have completed organic chemistry)

Professor Zhan Chen ***University of Michigan***

Introduction to Chemical Analysis (For lower level undergraduates)
Instrumental analysis (For upper level undergraduates)

Professor James Penner-Hahn ***University of Michigan***

Introduction to Biophysics
Bioinorganic Chemistry (undergraduate level; should have completed inorganic chemistry)
Physical methods in Inorganic Chemistry (advanced undergraduate /graduate)
X-ray Spectroscopy (advanced undergraduate /graduate)

Professor Casey Dougherty ***Iona College***

Biology for Chemists (coming in 2019)

Professor Christopher Kelly ***Wayne State University***

Introduction to Biophysics
Computational methods for the physical modeling
Optics for biomedical sciences

Courses in the use of Technical English Skills and Professional Language Development

Professor India Plough ***Michigan State University***

Academic Presentations (lower level undergraduate students)
Argumentation and Negotiation (upper level undergraduate students)

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2018

Professor Brian Coppola ***University of Michigan***

Bio-Organic Mechanisms (can be combined easily with the Introduction to Chemical Biology)

Mechanistic organic chemistry is a powerful tool. There is no biological reaction of organic compounds that does not follow the basic rules of organic chemistry. In each of the class sessions, there will be problems that begin with a review of a fundamental area of mechanism in organic chemistry followed by an application of that area to biological molecules. The focus is on organic chemistry, not biochemistry!

Organic Mechanisms (can be combined easily with the Introduction to Chemical Biology)

Mechanistic organic chemistry is a powerful tool. In each of the class sessions, there will be problems that begin with a review of a fundamental area of mechanism in organic chemistry followed by an application of that area to interesting organic chemistry puzzles. Rigorous attention to detail for depicting and discussion organic mechanisms, including experimental design methods, will be included.

Professor Eitan Geva University of Michigan

The mathematical tools of quantum mechanics (undergraduate level)

We will introduce the mathematical toolbox needed for quantum mechanics. The mathematical building blocks of quantum mechanics are complex functions and operators. An overview of the relevant properties of those mathematical objects is provided and the postulates of quantum mechanics will be presented in terms of them and demonstrated via simple examples.

The postulates of classical mechanics vs. the postulates of quantum mechanics (undergraduate level)

Classical mechanics can be described as being based on three postulates the define the state of a classical system, its dynamics and the process of extracting predictions of measurable quantities from it. Similarly, quantum mechanics can be described as being based on three (state, dynamics and measurement) postulates. We will contrast the classical and quantum postulates with emphasis on their their consequences for the Chemical sciences.

Chemical Dynamics (graduate level)

Chemistry is a science that deals with change. Chemical reactions correspond to energy transfer processes that lead to changes in molecular structure (either conformational or via breaking and forming chemical bonds). Competing processes involve nonreactive energy transfer processes within and between molecules that do not lead to significant structural changes. Importantly, knowledge of the initial and final classical structure or quantum state does not dictate the manner and rate by which such changes occur. For example, knowledge of the molecular structure of the reactants and products of a chemical reaction tells us relatively little on its rate and mechanism. Furthermore, the environment in which a chemical reaction takes place can have a dramatic effect on its mechanism and rate. For example, the rate of diffusion in liquid solution can determine the reaction rate and the ability of a polar solvent to stabilize a charge-separated state can be the driving force in charge transfer (redox) reactions. The goal of this course is to provide understanding, on he molecular level, of the rates of such reactive and nonreactive processes in molecular systems and of how they are affected by basic molecular parameters and the environment. The theoretical framework that provides the most general and powerful tools for modeling the dynamics of complex molecular systems is non-equilibrium statistical mechanics (NESM). NESM builds upon, but is also distinctly different from, equilibrium statistical mechanics (ESM). More specifically, ESM provides a general framework for modeling the equilibrium structure of molecular systems. A such, ESM does not include time explicitly as a variable, and thus cannot account for dynamical fluctuation around the average at equilibrium or rates of processes that occur when the system is perturbed out of equilibrium. On the other hand, NESM is all about modeling the dynamics of systems in and out of equilibrium. This implies the dynamics of fluctuations around the equilibrium average and the rates of processes that occur when the system is perturbed out of equilibrium. In this course, you will learn about the basic tools and concepts of NESM and how to apply them in order to get insight into the rates of chemically relevant processes.

Introduction to nonlinear spectroscopy and its applications to Chemistry (graduate level)

Time and frequency resolved nonlinear optical spectroscopic techniques make it possible to probe processes in complex molecular systems in real time and with an unprecedented level of detail. Extracting an accurate picture of the underlying structure and dynamics from these measurements in terms of the underlying molecular dynamics requires modeling that range: from phenomenological to atomistically detailed. This class introduces modern optical response theory, which provides a unifying platform for modeling practically all nonlinear spectral signals. Implementation of optical response theory within the framework of different types of models and demonstrations of its applicability via applications to multidimensional vibrational and electronic spectroscopies of chemically relevant systems will be provided.

Professor Mark Banaszak Holl University of Michigan

Biology for Chemists (undergraduates)

Description coming soon

Symmetry, Group Theory, and Molecular Orbital Theory (undergraduates)

Students will learn to use molecular orbital (MO) theory as a basis for understanding electronic structure, molecular geometry, chemical properties, and chemical reactivity. We will first study molecular symmetry and its applications to gain a qualitative understanding of molecular orbital theory. We will also use group theory to predict the vibrational spectra of small molecules, applying this to examples from the recent chemical literature. Then we will learn the Fragment Orbital method to gain an intuitive understanding of complex molecular orbital interactions and their implications on chemical structure and reactivity.

Coordination chemistry and organometallic chemistry (undergraduates who have completed organic chemistry)

Students will learn to use crystal field theory and molecular orbital theory to describe the geometry and electronic structure of transition metal complexes. Through in-class activities, students will learn to count electrons in organometallic complexes with sigma and pi ligands. Students will read recent papers in the chemical literature to learn about organometallic reactions and catalytic cycles.

Polymer Synthesis and Design (undergraduates that have completed organic chemistry and graduate students)

Participants in this course will be introduced to the most utilized methods of polymer synthesis. An overview of essential polymer characterization techniques will also be presented. Structure-property relationships and thus polymer design strategies for specific applications will be a primary focus of the course. Further, recent literature will be used to highlight methods for post-polymerization modification of polymer architectures that have been developed to form nanostructures with applications ranging from biomaterials to electronics. Participants will learn in a lecture format, as well as literature-based collaborative problem solving. Throughout the course many examples of basic and advanced uses of polymeric materials in everyday life will be demonstrated, which participants will be encouraged to share with their colleagues as well as non-professional communities.

Polymer Synthesis

This course will cover the basic principles underpinning the synthesis of high molecular weight polymers, starting from a historical perspective and culminating in present day cutting-edge research. Kinetics of step- and chain- growth processes will be used to predict the molecular weight distribution of a synthetic polymer. Classical techniques including polycondensation, free radical, cationic, and anionic polymerization will be discussed. Modern methods in controlled "living" polymerization (RAFT, ATRP, NMP) will also be introduced as powerful pathways to access macromolecules with complex microstructure and chain architectures. Finally, cutting-edge synthetic strategies toward precision control of copolymer sequence, as well as regio- and stereo-regular polymers will be explored.

Polymer Characterization

This course will introduce the most commonly utilized laboratory techniques for quantification of the chemical composition, molecular weight, and microstructure of macromolecules. Nuclear magnetic resonance spectroscopy (NMR) will be used to determine polymer chemical structure, copolymer composition and sequence, as well microstructural features such as tacticity, chain branching, and regioregularity. Exact and relative experimental methods for the determination of polymer molecular weight distributions including viscometry, osmometry, static light scattering, gel permeation chromatography (GPC), and MALDI mass spectroscopy will be covered.

Professor Ryan Baxter   University of California at Merced

Modern Kinetic Analysis of Organic Reactions (graduate)

This course covers an introduction to modern kinetic techniques that utilize recent advances in analytical tools. Traditional kinetic analysis via initial rate measurements will be compared to the more modern method of Reaction Progress Kinetic Analysis (RPKA). Students will be taught to recognize and understand the kinetic behavior of reaction systems through visual inspection of concentration data, and will learn how changes in experimental design will predictably alter kinetic behavior.

Reaction Mechanisms of Complex Catalytic Systems (upper level undergraduate, graduate)

This course covers the study of reaction mechanisms of complex catalytic systems; including organocatalytic and organometallic reactions. We will discuss how several experimental techniques may be used to identify elementary steps of catalytic cycles, as well as identify catalyst resting states and off-cycle species. Students will be taught how to apply these experimental techniques to the study of new reactions systems.

Modern Physical Organic Techniques (upper level undergraduate, graduate)

This course covers the study of modern advances in experimental techniques used to study the physical behavior of chemical reactions. This will include discussions of advances in spectroscopic techniques such as NMR, IR, UV-Vis, etc. as they relate to fundamental changes in traditional physical organic techniques. Kinetic isotope effects and free-energy relationships will be primary focuses of the course. Students will be taught the theoretical background to the new experimental techniques, and shown several authentic examples from recent literature. Students will also be taught the skills necessary to critically evaluate the use of these experimental techniques and judge their utility in literature reports.

Professor Melissa Reynolds Colorado State University

Bioanalytical chemistry

This course will provide students with a background in bioanalytical chemistry that is sufficient to understand the major types of measurement methods that are used and the most significant problems associated with the field. The course will combine fundamental principles of sensing with practical aspects of making biological measurements. An additional goal is provide an introduction to some of the current research areas in bioanalytical chemistry from both a fundamental and applied research perspective. As such, the course will have multiple components including discussion, lectures, activities, problem-solving, and presentations.

Julie Biteen *University of Michigan*

Methods in Biophysical Chemistry (Advanced Undergraduate/Graduate; 1 credit)

This course will focus on the modern techniques that are used to characterize the structure and dynamics of biological molecules. The goal of this class is to provide a practical understanding that is grounded in current biophysical chemistry research. We will cover methods ranging from sedimentation and electrophoresis to X-ray diffraction, spectroscopy and microscopy, and we will go beyond the basic concepts by reading and understanding recent, high-impact papers. Overall, this class covers topics selected to provide a framework for understanding research across Biochemistry and Biophysics.

Super-Resolution Imaging (Advanced Undergraduate/Graduate; 1 credit)

This course will cover the basics of fluorescence microscopy and then introduce modern methods in optical microscopy including single-molecule imaging and structured illumination. We will learn about super-resolution approaches including Photoactivated Localization Microscopy (PALM), Stochastic Optical Reconstruction Microscopy (STORM), and Stimulated Emission Depletion Microscopy (STED). We will cover applications including dual-color, three-dimensional, and live-cell imaging, and we will discuss which types of microscopy are best suited for current limitations.

Professor John Henssler - New York University

Polymer Synthesis and Design (undergraduates that have completed organic chemistry and graduate students)

Participants in this course will be introduced to the most utilized methods of polymer synthesis. An overview of essential polymer characterization techniques will also be presented. Structure-property relationships and thus polymer design strategies for specific applications will be a primary focus of the course. Further, recent literature will be used to highlight methods for post-polymerization modification of polymer architectures that have been developed to form nanostructures with applications ranging from biomaterials to electronics. Participants will learn in a lecture format, as well as literature-based collaborative problem solving. Throughout the course many examples of basic and advanced uses of polymeric materials in everyday life will be demonstrated, which participants will be encouraged to share with their colleagues as well as non-professional communities.

Characterization of Small Molecules and Macromolecules (undergraduates that have completed organic chemistry and graduate students)

This course will focus on the acquisition, interpretation, and reporting of characterization data for organic molecules. Essential methods used for the characterization of small molecules (e.g. IR, UV-vis, and 1D and 2D NMR spectroscopies, GC, HR/MS, and elemental analysis) will be presented and utilized to identify molecular structures. The structure determination of macromolecules requires different methods (e.g. MALDI/TOF, GPC) as well as specific changes to strategies used for small molecules (e.g. NMR spectroscopy pulse sequence/relaxation time). For both small molecule and macromolecule structure determination, NMR spectroscopy is arguably the most dynamic tool and thus strategies for optimization of data collection and interpretation will be an important part of this course. Participants will learn in a lecture format, literature-based collaborative problem solving of experimental data, and the presentation of a complex structure determination.

Organic chemistry mechanisms (undergraduates who have completed organic chemistry)

Students will collaborate on a set of daily homework and in-class problems and present their solutions to the class in order to discover and explain the general principles of fundamental organic mechanisms (S_N/E, addition reactions, acylations, etc.) A final exam will be given.

Professor Edmund Palermo – Rensselaer Polytechnic University

Macromolecules I: Synthesis of Polymers

This course will cover the basic principles underpinning the synthesis of high molecular weight polymers, starting from a historical perspective and culminating in present day cutting-edge research. Kinetics of step- and chain- growth processes will be used to predict the molecular weight distribution of a synthetic polymer. Classical techniques including polycondensation, free radical, cationic, and anionic polymerization will be discussed. Modern methods in controlled "living" polymerization (RAFT, ATRP, NMP) will also be introduced as powerful pathways to access macromolecules with complex microstructure and chain architectures. Finally, cutting-edge synthetic strategies toward precision control of copolymer sequence, as well as regio- and stereo-regular polymers will be explored.

Macromolecules II: Physical Chemistry of Polymers

This course will highlight the structure-property relationships in polymeric materials from a physical chemistry perspective. Characterization of polymer composition, molecular weight, and microstructure by NMR and IR will be discussed. Molecular weight distribution analysis by viscometry, osmometry, static light scattering, GPC, and MALDI will be covered. Furthermore, we will examine the statistical mechanics of unperturbed polymer chain dimensions (characteristic ratio, radius of gyration, persistence length), thermodynamics and kinetics of crystallization, melting, and the glass transition, phase diagrams for polymer-polymer blends, polymer solutions, and block copolymers, as well as morphology of polymer materials in the solid state. The course will conclude with a discussion of how polymer chain physics influences the mechanical properties of polymers, including rubber elasticity and linear viscoelasticity.

Biomacromolecules and Biomimicry

Nature's design principles endow naturally-occurring polymers with exceedingly complex structure and function. Such elegant functional sophistication has always been the envy of chemists and materials scientists. In this course, we will first cover the structure and property of natural biopolymers, including polysaccharides, DNA/RNA, and proteins from a polymer scientist's viewpoint. Classical and cutting-edge methods to control synthetic comonomer sequence, regioregularity, and stereoregularity in advanced polymer synthesis will be discussed. Specific topics will include polymer single chain folding, template polymerization, and polymer self-assembly. Furthermore, we will review modern advances in side chain functionalization of synthetic polymers to confer desired properties. In particular, synthetic polymers designed to mimic the structure and function of biopolymers including spider silk, mussel adhesive protein, and antibacterial host defense peptides, will be reviewed using the current scientific literature.

Professor Megan Frost   Michigan Technological University

In vivo measurement of clinically important physiological analytes (upper level undergraduate)

The course will introduce students to specific challenges that impact directly monitoring physiological analytes of different types (oxygen, pH/CO_2, and glucose) within the in vivo environment, why such monitoring is important to improving patient care, relevant time scales for collecting information and current approaches under development. Information will be presented in case study format and based on current primary scientific and clinical literature. Different analytical measurements will be utilized highlighting common and unique challenges to electrochemical, optical and spectroscopic analysis methods.

Impact of surface properties on biocompatibility (upper level undergraduate/graduate)

The course will explore how different surface properties effect the biological response to implanted devices. Specific properties that will be explored include bulk properties of materials vs. surface properties, effects of grain barriers and processing conditions, texture, stiffness, dimensions of the surface features. Examples will specifically include a ceramic, a metal and a polymer system. Information will be presented in case study format and based on current primary scientific and clinical literature.

Approaches to fabricating synthetic vascular grafts (upper level undergraduate/graduate)

The course will explore current approaches to developing small diameter artificial vascular graft. The underlying causes for the failure of small diameter grafts will be discussed, design criteria that must be met for successful graft performance, followed by discussing current approaches (such as cell sheets, electrospun fiber grafts, biologically derived materials, cell-seeded technology) to reaching the needed performance. Information presented will be based on current primary scientific and clinical literature.

Professor Alan Kiste   California Polytechnic University at San Luis Obispo

Organic chemistry of biological molecules (lower level undergraduate)

Students will collaborate on a daily set of problems designed to apply structural and mechanistic principles of introductory-level organic chemistry to reactions of biological monomers (carbohydrates, amino acids, nucleotides) & polymers (polysaccharides, proteins, DNA/RNA). Students will present their ideas to the class daily in order to critique and explain the application of the general organic principles involved. A final exam will be given.

Introduction to the chemistry education research literature (teaching faculty; strong English reading comprehension skills needed).

Faculty will read and summarize a carefully curated set of research articles focusing on research results in chemistry education that have significantly impacted pedagogy. The goal is to introduce participants to chemistry education research literature as a tool that is useful in their professional development. Participants will apply the ideas from the readings to produce a single day's learning activity (not a lecture; an activity) for an undergraduate class and will critique and discuss each other's work. The experience will culminate with members of the class giving oral presentations about their activities.

Organic chemistry mechanisms (undergraduates who have completed organic chemistry)

Students will collaborate on a set of daily homework and in-class problems and present their solutions to the class in order to discover and explain the general principles of fundamental organic mechanisms (S_N/E, addition reactions, acylations, etc.) A final exam will be given.

Professor JP Desaulniers ***University of Ontario Institute of Technology***

Introduction to Chemical Biology (undergraduates who have completed organic chemistry & biology)

Chemical Biology encompasses chemical research that expands our understanding of biology, and biological research that expands our understanding of chemistry. In this course, I will emphasize the design and employment of molecules to understand and manipulate biological systems and processes at the molecular level. The course will explore micro and macromolecular structures with a focus on mechanistic organic chemistry. Examples will include peptide synthesis and glycobiology, synthetic nucleic acids, chemical strategies and tools to monitor biological systems, and research into stem cell biology. The course will consist of scientific literature readings, periodic assignments and an exam based on literature and lecture content, as well as group discussions and exercises. A textbook is not required, although retention of prerequisite course textbooks is recommended.

Professor Joanne Stewart ***Hope College***

Symmetry, Group Theory, and Molecular Orbital Theory (undergraduates)

Students will learn to use molecular orbital (MO) theory as a basis for understanding electronic structure, molecular geometry, chemical properties, and chemical reactivity. We will first study molecular symmetry and its applications to gain a qualitative understanding of molecular orbital theory. We will also use group theory to predict the vibrational spectra of small molecules, applying this to examples from the recent chemical literature. Then we will learn the Fragment Orbital method to gain an intuitive understanding of complex molecular orbital interactions and their implications on chemical structure and reactivity.

Coordination chemistry and organometallic chemistry (undergraduates who have completed organic chemistry)

Students will learn to use crystal field theory and molecular orbital theory to describe the geometry and electronic structure of transition metal complexes. Through in-class activities, students will learn to count electrons in organometallic complexes with sigma and pi ligands. Students will read recent papers in the chemical literature to learn about organometallic reactions and catalytic cycles.

Professor Zhan Chen University of Michigan

Introduction to Chemical Analysis (For lower level undergraduates)

This course introduces the principles and techniques of modern quantitative chemical analysis, especially methods that are utilized frequently for biomedical measurements (determination of physiologically relevant species in blood, urine, and other fluids). Throughout the course the fundamental concepts related statistical evaluation of analytical data, solution phase equilibria, acid-base chemistry, redox chemistry, as well as modern electrochemical, spectroscopic, separation-based analytical methods (including mass spectrometry) will be stressed.

Instrumental analysis (For upper level undergraduates)

This course introduces the principles and techniques of modern instrumental analysis. A variety of instrumental analytical techniques including atomic absorption and emission spectroscopy, fluorescence spectroscopy, infrared spectroscopy, Raman spectroscopy, surface plasma resonance, NMR, and mass spectrometry will be discussed. The current development and updated applications of these techniques will be introduced.

Professor James Penner-Hahn   University of Michigan

An Introduction to Biophysics (2 credits)

Biophysics, as a distinct discipline, traces its origins to 1847, when four leading physicians (Emil du Bois-Reymond, Ernst von Brücke, Hermann von Helmholtz, and Carl Ludwig) first proposed creating a research program based on the, at that time novel, proposition that living organisms are governed by the same laws that explain physical and chemical phenomena (in contrast to life being governed by special biological laws with vital forces that differ from those that operate in the domain of inorganic nature). An early focus was on neuro- and muscle physiology and, as quantitative tools improved, the characterization of enzyme kinetics. As new tools have been developed (crystallography, optical and electron microscopies, magnetic resonance, theoretical modeling, etc.) they have been added to the biophysicists toolbox. This course will review the basic building blocks of life and then explore modern biophysical methods with a focus on understanding how these tools can improve our understanding of biology, governed by the advice of A.V. Hill that "the employment of physical instruments in a biological laboratory does not make one a biophysicist," rather it is "the study of biological function, organization, and structure by physical and physicochemical ideas and methods"

1. Structures of biological molecules
    a. Proteins
    b. Carbohydrates
    c. Lipids
    d. Nucleic acids
2. Biological membranes
    a. Membrane functions
    b. Membrane components
    c. Membrane permeability and transport
3. Cells
    a. Cell structure
    b. Subcellular components
    c. Cell life-cycle
4. Biophysical tools
    a. Voltage and current measurements
    b. X-ray and electron scattering
    c. Scanning probe microscopies
    d. Magnetic spectroscopies
    e. Other spectroscopies
    f. Theoretical methods

Bioinorganic Chemistry (undergraduate level; should have completed inorganic chemistry)

1. Metal binding sites in proteins in and nucleic acids
2. Methods for characterizing metalloproteins
3. Structural roles for metal ions
4. Uses of metals in redox catalysis
5. Metal sensing and metalloregulation
6. Metal trafficking
7. Roles of metals in disease

Physical methods in Inorganic Chemistry (advanced undergraduate /graduate)

1. UV-visible absorption
2. Vibrational spectroscopy
3. Magnetic resonance spectroscopies 1 - EPR
4. Magnetic resonance spectroscopies 2 - NMR
5. Magnetic circular dichroism
6. Photo-emission spectroscopies
7. X-ray absorption and emission spectroscopy

X-ray Spectroscopy (advanced undergraduate /graduate)

1. Interaction of x-rays with matter; properties of synchrotron radiation
2. Theory of x-ray absorption/emission
3. Practical analysis of EXAFS data
4. Applications of XAS/XES in materials science
5. Applications of XAS/XES in biological sciences
6. Time-resolved measurements
7. Speciation resolved elemental imaging

Professor Casey Dougherty *Iona College*

Biology for Chemists

Description coming soon

Professor Christopher V. Kelly, Wayne State University

Introduction to Biophysics

This course will provide connections between the physical and life sciences for students interested in the field of Biophysics. We will apply basic physical concepts to understanding microscopic biological processes. For example, we will examine connections between diffusion, molecular dynamics, entropy, nerve impulses, and biological membranes. Students will introductory physics and/or introductory biology backgrounds will gain understanding in the physical rules that underlie life.

Computational methods for the physical modeling

This course will allow students with no prior programming experience to develop the fundamental skills for data analysis and modeling. We will use free Python software to perform importing/exporting of data, 2D and 3D plotting, data fitting, numerical analysis, and Monte Carlo simulations. The skills learned in this course will be applied to physical problems such as non-Brownian diffusion, molecular dynamics, Ising models, and reaction kinetics. Students will need to be familiar with calculus before this course.

Optics for biomedical sciences

This course will provide students with an introduction to fundamental principles of optics and the methods underlying advanced microscopy techniques. We will start with basic waves and thin lens optics towards developing a Fourier understanding of diffraction. The capabilities and limitations of conventional optical methods, such as fluorescence and confocal microscopy, will be mathematically explained. The class will conclude with discussing new super-resolution methods, such as PALM, STORM, and STED. Students will need to be familiar with multivariable calculus before this course.

Professor India Plough   Michigan State University

Academic Presentations (lower level undergraduate students)

This course is intended to improve the academic speaking and listening skills of **lower-level** undergraduate students. Groups of 2-4 students select a different "serious" scientific topic (from a pre-determined list) that they develop for presentation and discussion. Discourse areas covered include: organizational patterns for coherent and cohesive presentations; expressing and soliciting view points.

Pre-requisites:

- Students who have recently (i.e., within 1-6 months of the class offering) taken the CET-4 and plan to take the CET-6 are eligible for this course. Students may or may not have already taken the CET-SET. Students should provide score reports, if available.
- Before the course begins, students meet individually with the professor for a diagnostic test. Results are used to customize course emphasis as well as provide students with individualized self-study techniques to improve English proficiency.

Class size: 10-12 maximum

Argumentation and Negotiation (upper level undergraduate students)

This course is intended to improve the academic speaking and listening skills of **upper-level** undergraduate students. The class is divided into two groups, each taking opposing viewpoints on a "serious" scientific topic. Discourse areas covered include the use of pragmatically appropriate language for argumentation and negotiation.

Pre-requisites:

- Students who have recently (i.e., within 1-6 months of the class offering) taken the CET-6 are eligible for this course. Students may or may not have already taken the CET-SET. Students should provide score reports, if available.
- Before the course begins, students meet individually with the professor for a diagnostic test. Results are used to customize course emphasis as well as provide students with individualized self-study techniques to improve English proficiency.

Class size: 8-10 maximum