AS.250 (BIOPHYSICS)

AS.250.105. Science and Film. 2 Credits.
From the origins of cinema to the present, science and technology have remained the most reliably popular subjects for filmmakers and audiences alike. This course will address that enduring fascination, exploring the meanings and uses of science and technology in film through guest lectures and discussion of cinematic examples both recent and historic. Lectures and discussion will focus on a range of questions: How does film both reflect and shape our understanding of scientific concepts and technologies, from artificial intelligence to genetic engineering? How does science fiction reveal contemporary cultural anxieties and address ethical questions? How “fictional” is the science in science fiction film, and how have science fiction films inspired science and technology? What can we learn about “real” science from the movies? In addition to exploring science through film, students will learn the tools of film analysis through lecture, close viewing, and completion of a series of short written responses. In lieu of a short written response, student may choose to work in a team to create a short (1-3 minute) video response. Possible scientific topics: Genetics and Bioethics, Psychological and Brain Sciences, Artificial Intelligence and Robotics, Climate Change and Public Health and Astrophysical and Planetary Sciences. Possible films to be discussed: 2001: A Space Odyssey, Eternal Sunshine of the Spotless Mind, Blade Runner, GATTACA, The Martian, Interstellar, WALL-E, Children of Men and more. Attendance at weekly screenings at the Parkway Theater is required.

AS.250.205. Introduction to Computing. 3 Credits.
This course is useful for many disciplines not only the life sciences. It will introduce students to basic computing concepts and tools useful in many applications. Students will learn to work in the Unix environment, and write bash shells scripts. They will learn to program using the Python programming language, including Python libraries for graphing, fitting and for numerical and statistical computing, such as NumPy, SciPy, and Matplotlib. At the end of the semester, students will complete a project coupling all components of the semester together. Brief lectures followed by extensive hands-on computer laboratories with examples from many disciplines. No prerequisites. Course offered every semester.
Prerequisite(s): You cannot take AS.250.205 if you have already taken AS.250.206.
Area: Natural Sciences, Quantitative and Mathematical Sciences

AS.250.253. Protein Engineering and Biochemistry Lab. 3 Credits.
This laboratory examines the relationship between genes and proteins in the context of disease and evolution. It is a research project lab in which the structural and functional consequences of mutations are determined for a model protein. Students will learn basic protein science and standard biochemical techniques and methods in protein engineering. They will perform experiments in site-directed mutagenesis, protein purification, and structural, functional and physical characterization of proteins. No prerequisites. Courses offered in Fall and Spring semesters.
Prerequisite(s): You cannot take AS.250.253 if you have already taken AS.250.254.;Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.
Area: Natural Sciences
Writing Intensive

AS.250.254. Protein Biochemistry and Engineering Laboratory. 4 Credits.
A project laboratory where students will use the techniques of protein engineering to attempt to modify existing proteins to endow them with new structural or physical properties. This course will provide an introduction to standard biochemistry laboratory practice and to protein science, including experiments in site-directed mutagenesis, protein purification and characterization of proteins in regard to structure, function and stability.
Prerequisite(s): You cannot take AS.250.254 if you have already taken AS.250.253.
Area: Natural Sciences

AS.250.302. Modeling the Living Cell. 4 Credits.
Previously titled "Models and Algorithms in Biophysics." Introduction to physical and mathematical models used to represent biophysical systems and phenomena. Students will learnalgorithms for implementing models computationally and perform basic implementations. We will discuss the types of approximations made to develop useful models of complex biological systems, and the comparison of model predictions with experiment.
Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.
Area: Engineering, Natural Sciences

AS.250.310. Exploring Protein Biophysics using Nuclear Magnetic Resonance (NMR) Spectroscopy. 3 Credits.
NMR is a spectroscopic technique which provides unique, atomic level insights into the inner workings of biomolecules in aqueous solution and solid state. A wide variety of biophysical properties can be studied by solution state NMR, such as the three dimensional structures of biological macromolecules, their dynamical properties in solution, interactions with other molecules and their physical and chemical properties which modulate structure-function relationships (such electrostatics and redox chemistry). NMR exploits the exquisite sensitivity of magnetic properties of atomic nuclei to their local electronic (and therefore, chemical) environment. As a result, biophysical properties can be studied at atomic resolution, and the global properties of a molecule can be deconstructed in terms of detailed, atomic level information. In addition, interactions between nuclei can be exploited to enhance the information content of NMR spectra via multidimensional (2D and 3D) spectroscopy. Since these properties can be studied in solution, NMR methods serve as an effective complement to X-Ray crystallography and electron microscopy. In this course, we will learn about the basics of NMR spectroscopy, acquire 1D and 2D NMR spectra and use various NMR experiments to characterize and probe biophysical properties of proteins at an atomic level.
Prerequisite(s): ((AS.030.101 AND AS.030.105) OR (AS.030.103 OR AS.030.204)) AND (AS.030.370 OR AS.250.372) AND (AS.020.305 OR AS.030.315 OR AS.250.315) AND AS.030.205 or permission of the instructor.;Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.

AS.250.315. Biochemistry I. 3 Credits.
Foundation for advanced classes in Biophysics and other quantitative biological disciplines. This class is the first semester of a two semester course in biochemistry. Topics in Biochemistry I include chemical and physical properties of biomolecules and energetic principles of catabolic pathways. Co-listed with AS.030.315
Prerequisite(s): If you have completed AS.250.307 you may not register for AS.250.315.;(AS.030.206 OR AS.030.212) AND (AS.250.372 OR AS.030.301)
Area: Natural Sciences

AS.250.316. Biochemistry II. 3 Credits.
Biochemical anabolism, nucleic acid structure, molecular basis of transcription, translation and regulation, signal transduction with an emphasis on physical concepts and chemical mechanisms. Format will include lectures and class discussion of readings from the literature.
Prerequisite(s): (AS.250.315 OR AS.030.315 OR AS.020.305) AND (AS.030.206 OR AS.030.212) or permission of the instructor.

AS.250.320. Macromolecular Binding. 3 Credits.
All biological processes require the interactions of macromolecules with each other or with ligands that activate or inhibit their activities in a controlled manner. This course will discuss theoretical principles, logic, approaches and practical considerations used to study these binding processes from a quantitative perspective. Topics will include thermodynamics, single and multiple binding equilibria, linkage relationships, cooperativity, allostery, and macromolecular assembly. Some biophysical methods used in the study of binding reactions will be discussed. Computer simulation and analysis of binding curves will be used to analyze binding data, and binding schemes and examples from the scientific literature will be reviewed and discussed.Recommended Course Background: AS.250.372 Biophysical Chemistry
Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.
Writing Intensive

AS.250.335. Single Molecule & Cell Biophysics. 3 Credits.
This (elective) course offers an introduction to the field of single molecule and single cell biophysics to second and third year undergraduate students in biophysics. We will examine technologies such as single molecule fluorescence, force measurements and single cell fluorescence detections that enable high precision molecular visualizations in vitro and in cells. In addition, we will cover topics of genome engineering, cell mechanics and optogenetics toward the end of the semester. Each student is expected to read two articles assigned for each week and submit a written summary. All students will take turns presenting the assigned articles to class.

AS.250.351. Reproductive Physiology. 2 Credits.
Focuses on reproductive physiology and biochemical and molecular regulation of the female and male reproductive tracts. Topics include the hypothalamus and pituitary, peptide and steroid hormone action, epididymis and male accessory sex organs, female reproductive tract, menstrual cycle, ovulation and gamete transport, fertilization and fertility enhancement, sexually transmitted diseases, and male and female contraceptive methods. Introductory lectures on each topic followed by research-oriented lectures and readings from current literature.
Area: Natural Sciences

AS.250.372. Biophysical Chemistry. 4 Credits.
Course covers classical and statistical thermodynamics, spanning from simple to complex systems. Major topics include the first and second law, gases, liquids, chemical mixtures and reactions, partition functions, conformational transitions in peptides and proteins, ligand binding, and allostery. Methods for thermodynamic analysis will be discussed, including calorimetry and spectroscopy. Students will develop and apply different thermodynamic potentials, learn about different types of ensembles and partition functions. Students will learn to use Pythonand will use it for data fitting and for statistical and mathematical analysis. Background: Calculus, Introductory Organic Chemistry, and Introductory Physics.
Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.
Area: Natural Sciences

AS.250.381. Spectroscopy and Its Application in Biophysical Reactions. 3 Credits.
Continues Biophysical Chemistry (AS.250.372). Fundamentals of quantum mechanics underlying various spectroscopies (absorbance, circular dichroism, fluorescence, NMR); application to characterization of enzymes and nucleic acids.
Prerequisite(s): AS.250.372
Area: Natural Sciences

AS.250.383. Molecular Biophysics Laboratory. 3 Credits.
An advanced inquiry based laboratory course covering experimental biophysical techniques to introduce fundamental physical principles governing the structure/function relationship of biological macromolecules. Students will investigate a “model protein”, staphylococcal nuclease, the “hydrogen atom” of biophysics. Using a vast library of variants, the effect of small changes in protein sequence will be explored. A variety of techniques will be used to probe the equilibrium thermodynamics and kinetic properties of this system; chromatography, spectroscopy (UV-Vis, fluorescence, circular dichroism, nuclear magnetic resonance), calorimetry, analytical centrifugation, X-ray crystallography, mass spectroscopy, and computational methods as needed for analysis. These methods coupled with perturbations to the molecular environment (ligands, co-solvents, and temperature) will help to elucidate protein function. Prerequisite: Introduction to Scientific Computing (250.205) or equivalent. Biophysical Chemistry (250.372 or 020.370) or equivalent. Course taught in Fall and Spring.
Prerequisite(s): (AS.250.372 OR AS.030.370) AND AS.250.205;Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.
Writing Intensive

AS.250.403. Advanced Seminar in Bioenergetics. 3 Credits.
The trait shared by all living systems is the capacity to perform energy transduction. This biophysics/biochemistry course examines the physico-chemical and structural basis of biological energy transduction. Emphasis is on understanding the molecular and cellular logic of the flow of energy in living systems. The course explores the connection between fundamental physical requirements for energy transduction and the organization, evolution and possibly even the origins of biological molecules, cells, and organisms. Implications for planet earth¹s energy balance and for the design of synthetic organisms and of artificial energy transducing machines will be discussed, time permitting. Recommended Course Background: One semester of Biochemistry. Recommended Course Background: One semester of Biochemistry
Writing Intensive

AS.250.410. Genome Maintenance and Genome Engineering. 3 Credits.
Advanced seminar for biophysics undergraduates. We focus on topics of genome maintenance via telomere regulation and genome engineering by CRISPR-Cas systems. The course will have lecture, scientific article reading, small and large group discussion.

AS.250.411. Advanced Seminar in Structural Biology of Chromatin. 3 Credits.
Focus is on structural and physical aspects of DNA processes in cells, such as nucleosomal packaging, DNA helicases, RNA polymerase, and RNA inhibition machinery. Topics are meant to illustrate how the structural and chemical aspects of how proteins and nucleic acids are studied to understand current biological questions. Recommended Course Background: Biochemistry I (AS.250.315) and Biochemistry II (AS.250.316) or Biochemistry (AS.020.305) and Intro to Biophys Chem (AS.250.372)
Area: Natural Sciences
Writing Intensive

AS.250.420. Advanced Seminar in Macromolecular Binding. 3 Credits.
All biological processes require the interactions of macromolecules with each other or with ligands that activate or inhibit their activities in a controlled manner. This is a literature and skills-based course that will discuss theoretical principles, logic, approaches and practical considerations used to study these binding processes from a quantitative perspective. Topics will include thermodynamics, single and multiple binding equilibria, linkage relationships, cooperativity, allostery, and macromolecular assembly. Some biophysical methods used in the study of binding reactions will be discussed. Simulation and analysis of binding scenarios will be used to analyze illustrate binding schemes, and examples from the scientific literature will be reviewed and discussed. Basic working knowledge of Python is helpful. The writing component will be in one of the common formats employed in the professional biophysics field.Recommended Course Background: AS.250.372 Biophysical Chemistry
Writing Intensive

AS.250.421. Advanced Seminar in Membrane Protein Structure, Function & Pharmacology. 3 Credits.
Topics are meant to illustrate the physical basis of membranes and membrane proteins towards understanding their functions and pharmacological importance including aspects of drug design as it relates to membranes. Contemporary issues in the field will be covered using primary literature articles, structural manipulations in pymol, and computational binding simulations.Recommended Course Background: AS.030.205, AS.250.307, and AS.250.372
Writing Intensive

AS.250.514. Research in Protein Design and Evolution. 3 Credits.
Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration > Online Forms.
Writing Intensive

AS.250.520. Introduction to Biophysics Research. 3 Credits.
Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration > Online Forms.

AS.250.521. Research in Biophysics. 3 Credits.
Prerequisite(s): You must request Independent Academic Work using the Independent Academic Work form found in Student Self-Service: Registration > Online Forms.;AS.250.520

AS.250.601. Biophysics Seminar.
Graduate students only. Students and invited speakers present current topics in the field.

AS.250.602. Biophysics Seminar.
Graduate students only. Students and invited speakers present current topics in the field.

AS.250.610. Savvy Science Seminars.
Oral presentations are one of the main forms by which scientists communicate their results. Whether in the context of the classroom, the relatively informal lab meeting or as an invited speaker at an international colloquium, the ability to effectively present scientific results is an important skill to master. This course will cover the planning and execution steps necessary to produce an engaging oral presentation. Students will learn to articulate the big biological questions, tell a story that stimulates interest in their chosen subject, and effectively convey their experimental findings. Key methodological steps in planning will guide students on how to create slides with compelling visuals, and how to use technology to their advantage. Students will each prepare, present, and receive feedback on a 15-minute talk on their thesis project in the style of the Biophysical Society short talks. In addition, each student will receive and evaluate a video of their presentation so they can see themselves through the eyes of others.

AS.250.615. Biophysics Writing Workshop.
A series of writing workshops designed to help Biophysics Graduate Students develop a proposal of thesis work. Each student will write a specific aims page and a full (6 page) proposal.

AS.250.620. Optical Spectroscopy.
Basics of absorbance, CD, and fluorescence spectroscopy; calorimetric methods.

AS.250.621. X-ray Diffraction.
Basics of X-ray diffraction methods

AS.250.622. Statistics and Data Analysis.
Basics of statistics and data analysis

AS.250.623. Macromolecular Simulation.
Basics of molecular dynamics

AS.250.624. NMR Spectroscopy.
Basics of NMR spectroscopy

AS.250.625. Single Molecule Measurements.
Basic Principles of Single Molecule Measurements
Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.

AS.250.648. Physics of Cell Biology: From Mechanics to Information.
Cells are actively-driven soft materials but also efficient sensors and information processors. This course will cover the physics of those cellular functions, from the mechanics of DNA to the sensing of chemical signals. Questions answered include: How does polymer physics limit how quickly chromosomes move? Why do cells use long, thin flagella to swim? What limits the accuracy of a cell's chemotaxis?Some experience with partial differential equations required. No biology knowledge beyond the high school level necessary. Some problem sets will require minimal programming.
Prerequisite(s): Students must have completed Lab Safety training prior to registering for this class. To access the tutorial, login to myLearning and enter 458083 in the Search box to locate the appropriate module.
Area: Natural Sciences

AS.250.649. Introduction to Computing in Biology.
In this four week, intensive introductory course, students will gain a practical working knowledge of UNIX and Python programming languages and packages for analyzing data from biochemical and biophysical experiments. Brief daily lectures are followed by extensive hands-on experience in the computer laboratory.

AS.250.685. Proteins & Nucleic Acids.
The structure of proteins, DNA and RNA, and their functions in living systems. Students are required to participate in class discussions based on readings from the primary scientific literature. Co-requisite: AS 250.649 Introduction to Computing in Biology. Instructor permission for undergraduates.
Prerequisite(s): Prerequisite: AS.250.649,may be taken concurrently.

AS.250.689. Physical Chemistry of Biological Macromolecules.
Introduction to the principles of thermodynamics and kinetics as applied to the study of the relationship between structure, energy dynamics, and biological function of proteins and nucleic acids. Topics include of classical, chemical, and statistical thermodynamics, kinetics, theory of ligand binding, and conformational equilibria.

AS.250.801. Dissertation Research.

AS.250.802. Dissertation Research.

AS.250.803. Summer Dissertation Research.
Graduate Independent Academic Work