

# AS.250 (BIOPHYSICS)

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## 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? 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. Possible films to be discussed: 2001: A Space Odyssey, Her, Ex Machina, GATTACA, Minority Report, Eternal Sunshine of the Spotless Mind, Forbidden Planet, The Matrix, and more. Attendance at weekly screenings required.

## AS.250.106. Introduction to Biomedical Research and Careers I. 1 Credit.

Lecture Series designed for those curious about a career in life sciences, medicine and public health. A novel format combining presentation with didactic interviews gives a broad view of a range of research topics, experimental approaches and logistics, and practical applications as well as career paths. Emphasis is on the excitement of scientific explorations not an abundance of the technical facts and figures. Freshmen and non-science majors. Co-listed with AS.250.300 and AS.250.306.

Area: Natural Sciences

## AS.250.131. Freshman Seminar in Biophysics. 1 Credit.

Introduction of contemporary biophysics research topics through presentations, discussion and hands-on exercise. Freshmen only. S/U grading only.

Area: Natural Sciences

## AS.250.205. Introduction to Computing. 3 Credits.

This course will introduce students to basic computing concepts and tools useful in many applications and disciplines, not only the life sciences. Students learn to work in the Unix environment, to write shells scripts, and to make use of powerful Unix commands (e.g. grep, awk, and sed). They will learn to program using the Python programming language, graphing software, and a package for numerical and statistical computing, such as Mathematica or MATLAB. 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

## AS.250.206. Practical Programming: UNIX and PYTHON. 4 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 learn to work in the Unix environment, to write shells scripts, and to make use of powerful Unix commands (e.g. grep, awk, and sed). They will learn to program using the Python programming language, graphing software, and a package for numerical and statistical computing, such as Mathematica or MATLAB. 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.250.206 if you have already taken AS.250.205.

Area: Natural Sciences

## AS.250.212. The RNA world: from discovery to application. 3 Credits.

What is the first molecule of life? RNA embodies both informational and catalytic function, making it an ideal candidate for the first genetic biomolecule. In this course, we will explore the RNA world hypothesis by introducing different RNA molecules and discussing their functions. Students will learn the history of RNA biology discoveries through current topics in the field, such as RNA interference and CRISPR. Also, we will discuss the roles of essential cellular RNA-protein complexes, such as the ribosome and spliceosome. By the end of the class, students will have a general understanding of RNA biology and be familiar with RNA biotechnology techniques. Students will also gain experience reading scientific literature to learn advances in the field, discuss current applications, ethics and social impact of RNA biotechnology. Students' performance will be evaluated by short written essays and student-led seminars on promising new directions for the field. Recommended Course Background: (AS.250.135 or AS.020.305) or equivalent knowledge of molecular biology.

## 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.250.300. Introduction to Biomedical Research and Careers II. 1 Credit.**

Lecture Series designed for those curious about a career in life sciences, medicine and public health. A novel format combining presentation with didactic interviews gives a broad view of a range of research topics, experimental approaches and logistics, and practical applications as well as career paths. Emphasis is on the excitement of scientific explorations not an abundance of the technical facts and figures. Freshmen and non-science majors. Co-listed with AS.250.106 and AS.250.306

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 learn algorithms 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: Natural Sciences

**AS.250.306. Introduction to Biomedical Research and Careers III. 1 Credit.**

Lecture Series designed for those curious about a career in life sciences, medicine and public health. A novel format combining presentation with didactic interviews gives a broad view of a range of research topics, experimental approaches and logistics, and practical applications as well as career paths. Emphasis is on the excitement of scientific explorations not an abundance of the technical facts and figures. Freshmen and non-science majors. Co-listed with AS.250.106 and AS.250.300

Area: 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 as 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):** 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.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.

**AS.250.313. Molecular and Cellular System Biology. 4 Credits.**

This course covers the principles of biological networks, with an emphasis on computational analysis. Networks ranging from simple biochemical pathways to genome-scale metabolic, regulatory, and signaling networks will be studied. Topics include dynamic modeling of biochemical pathways, steady-state analysis of cellular metabolic networks, inference of gene regulatory networks using -omics data, and systems biology approaches to studying signal transduction. Recommended course background: Calculus (AS.110.106 and AS.110.107), Biochemistry (AS.250.315 or AS.020.305 or equivalent). Prior exposure to programming is recommended.

**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.250.314. Research in Protein Design and Evolution. 3 Credits. Writing Intensive****AS.250.315. Biochemistry I. 3 Credits.**

Foundation for advanced classes in Biophysics and other quantitative biological disciplines. Lecture and computer laboratory. 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. Computer labs include extensive use of molecular graphics and modelling of reaction kinetics and pathway flux. 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

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 Mathematica and 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.

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):** 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.250.372 OR AS.030.370) AND AS.250.205  
Writing Intensive

**AS.250.403. Bioenergetics: Origins, Evolution and Logic of Living Systems. 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 earth's 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.250.411. 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.250.421. 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 &gt; 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 &gt; 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 &gt; Online Forms.

**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.250.603. Nonequilibrium Physics of Molecules and Cells.**

Living systems require a constant flux of energy to perform their various functions. As such, they provide a unique opportunity to study the physics of systems out of equilibrium. This course covers topics in nonequilibrium biological physics including modeling fluctuations using Langevin, Fokker-Planck, and master equation formalisms, dissipation in driven systems, liquid-liquid phase separation, chromatin dynamics, epigenetic landscapes, and information flow in complex networks. Emphasis is placed on biological examples from cell and molecular biology and several lectures by domain experts will be interspersed with the course material. Recommended course background: Knowledge of equilibrium statistical mechanics.

**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.250.621. 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 Simulations Module.**

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 programming languages and packages for analyzing data from biochemical and biophysical experiments. The course covers fundamentals of UNIX, Python, Mathematica and MATLAB. 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.250.690. Methods in Molecular Biophysics.**

Introduction to methods employed in study of energetics, structure and function of biological macromolecules. Topics include optical spectroscopy, transport methods, NMR, X-ray crystallography. Theoretical understanding and knowledge through problem solving and literature discussion emphasized.

**Prerequisite(s):** AS.250.685 AND AS.250.689

**AS.250.801. Dissertation Research.****AS.250.802. Dissertation Research.****ME.100.300. Research Practicum in Biophysics.**

Provides an opportunity for students to actively conduct research in Biophysics.

**ME.100.699. Biophysics Elective.**

For Medical Students only. Specialized Topics in Biophysics. Refer to Medical Student Electives Book located at <https://www.hopkinsmedicine.org/som/students/academics/electives.html>.

**ME.100.705. Computer Modeling Of Biological Macromolecules.**

Lecture will offer an introduction to the mathematical aspects of computer representation and manipulation of macromolecules

**ME.100.706. Fundamentals Of Protein Crystallography.**

An introductory course designed to present the core knowledge and theoretical underpinnings of protein crystallography necessary to function in the laboratory. Assigned readings and problem sets will be given.

**ME.100.707. Advanced Topics in Protein Crystallography.**

An introductory course designed to present the core knowledge and theoretical underpinnings of protein crystallography necessary to function in the laboratory. Assigned readings and problem sets will be given.

**ME.100.709. Macromolecular Structure and Analysis.**

The course will cover the structure and properties of biological macromolecules and the key methods used to study them, including X-ray crystallography, nuclear magnetic resonance, spectroscopy, microscopy, and mass spectrometry.

**ME.100.710. Biochemical and Biophysical Principles.**

The physical and chemical principles underlying biological processes are presented and discussed. Topics include thermodynamics, chemical equilibrium, chemical and enzymatic kinetics, electrochemistry, physical chemistry of solutions, and structure and properties of water. Elementary concepts of statistical thermodynamics will be introduced as a way of correlating macroscopic and microscopic properties.

**ME.100.712. Computer Modeling Of Biological Macromolecules: Lab.**

The laboratory course will familiarize students with practical aspects of molecular modeling. It teaches the necessary tools to create and manipulate computer generated models of biological-interest molecules. Techniques such as comparative modeling will be introduced.

**ME.100.713. Using Structure to Understand Biology.**

The goal of this course is to teach students how to make use of structural information in the PDB using commonly available tools that are accessible to the non-expert. Students will learn how to read a structure paper, understand structure quality and limits of interpretation, and use coordinates from the Protein Data Bank to explore a structure and make figures. Topics covered will include non-covalent interactions, modeling point mutants, identifying binding pockets, making homology models, and calculating electrostatic surface potentials. Classes will combine lectures, hand-on computer demonstrations and critical reading of papers. A final project will require a short write-up and presentation that implements the programs and principles learned in the class

**ME.100.714. Single-Molecule Single-Cell Biophysics.**

This elective course offers an introduction to the field of single molecule and single cell biophysics to graduate students in Johns Hopkins University and will be delivered in the School of Medicine. We will examine technologies such as single molecule fluorescence and force measurements, super-resolution imaging and single cell fluorescence detections that enable high precision molecular visualizations in vitro and in cells.

**ME.100.715. Proteins and Nucleic Acids II.**

Critical reading and analysis of primary source literature is vital to scientific discourse and discovery. Students will be responsible for analyzing and critiquing papers in diverse topics and systems ranging from replication, transcription, and translation to enzyme mechanism, drug resistance, innate immunity, and signaling. Methods covered will include structural, biochemical, single-molecule, single-cell, and genomic approaches. Students will deliver analytic presentations on at least two ground-breaking papers relevant to these areas, and will be expected to actively participate in class discussion of experimental methodology and logic of other papers assigned in the course.

**ME.100.716. Analysis of Macromolecules.**

The course will cover (1) macromolecules, (2) physical chemical principles dictating their biological behavior, and (3) methods to study them. Lectures will focus on practical application of the methods, experimental design, data collection, and elementary aspects of data analysis.

**ME.100.801. Research.**

Thesis research

**ME.100.804. Topics in Macromolecular Structure and Function I.**

This is the first part of a seminar course covering a variety of topics involving the structure and function of proteins and nucleic acids. Recent topics have included: protein folding, evolutionary significance of introns, protein-DNA interactions, solution structure of peptides, prospects for designing novel proteins, and two-dimensional NMR.

**ME.100.807. Research.**

Thesis Research

**ME.100.808. Topics in Macromolecular Structure and Function II.**

This is the second part of a seminar course covering a variety of topics involving the structure and function of proteins and nucleic acids. Recent topics have included: protein folding, evolutionary significance of introns, protein-DNA interactions, solution structure of peptides, prospects for designing novel proteins, and two-dimensional NMR.