

# BIOCHEMISTRY & MOLECULAR BIOPHYSICS (BMB)

## **BMB 5080 Macromolecular Biophysics: Principles and Methods**

This course introduces students to the physical and chemical properties of biological macromolecules, including proteins and nucleic acids. It surveys the biophysical techniques used to study the structure and thermodynamics of macromolecules. It is intended to be a first course for graduate students with an undergraduate background in either physics, chemistry or biology, and no necessary background in biochemistry. Prerequisite: Senior undergraduate or graduate level biochemistry of biophysics.

Fall

1 Course Unit

## **BMB 5090 Structural and Mechanistic Biochemistry**

The course will focus on the key biochemical task areas of living cells. The course progresses from primarily molecular level events, such as storage and translation of genetic information, creation, control and removal of proteins, to higher organization levels such as metabolic pathways, signaling pathways, regulation and homeostasis. Each section will cover structure details of the relevant molecules, appropriate binding/catalysis events, regulatory aspects, and how they fit into the relevant pathway(s) and cell function. Material will be covered with a combination of formal lectures and student presentations. Prerequisite: If course requirements not met, permission of course director required.

Spring

1 Course Unit

## **BMB 5100 Data Analysis and Scientific Inference**

An introductory course in the analysis of data and scientific inference for graduate students in Biochemistry, Molecular Biophysics, and related quantitative biomedical research areas. The course will stress fundamental principles of data analysis, best practice in presenting data, and how to draw sound scientific inferences from the data. The overall goal is to provide students the tools to carry out rigorous and reproducible scientific research.

Spring

1 Course Unit

## **BMB 5180 Protein Conformation Diseases**

Protein misfolding and aggregation has been associated with over 40 human diseases, including Alzheimer's disease, Parkinsons disease, amyotrophic lateral sclerosis, prion diseases, alpha (1)-antitrypsin deficiency, inclusion body myopathy, and systemic amyloidoses. This course will include lectures, directed readings and student presentations to cover seminal and current papers on the cell biology of protein conformational diseases including topics such as protein folding and misfolding, protein degradation pathways, effects of protein aggregation on cell function, model systems to study protein aggregation and novel approaches to prevent protein aggregation. Target audience is primarily 1st year CAMB, other BGS graduate students, or students interested in acquiring a cell biological perspective on the topic. MD/PhDs and Postdoc are welcome. MS and undergraduate students must obtain permission from course directors. Class size is limited to 14 students.

Fall

Also Offered As: CAMB 6150

1 Course Unit

## **BMB 5540 Macromolecular Crystallography: Methods and Applications**

This is an introductory course on methods and applications of macromolecular structure determination using X-ray crystallography. The course will be broken up into three parts: 1) Principles of X-ray crystallography involving didactic lectures on the technique with weekly problem sets; 2) Workshops on macromolecular structure determination involving hands-on experience with the technology; 3) Student "journal club" presentations on current high impact publications involving X-ray crystal structure determination. Prerequisite: Undergraduate calculus and trigonometry.

Fall

Also Offered As: CHEM 5550

1 Course Unit

## **BMB 5580 Biomolecular Spectroscopy and Microscopy**

CHEM 5580 covers basic fluorescence spectroscopy and microscopy, as well as advanced topics such as single molecule spectroscopy and non-linear and super-resolution microscopies. There are weekly homework assignments that include problems based on the lectures as well as journal club style reports on by pairs of students on papers relevant to the course material.

Fall

Also Offered As: CHEM 5580

0.5 Course Units

## **BMB 5670 Bio-inorganic Chemistry**

The course covers selected topics in bioinorganic chemistry; special emphasis is placed on dioxygen chemistry and electron transfer processes. Course topics include: (i) oxygen uptake and utilization; (ii) diatomic oxygen transport; (iii) diatomic and monoatomic oxygen incorporation into substrates; (iv) metalloenzyme-catalyzed C-C bond formation; (v) the metallobiochemistry of DNA; (vi) metal-sulfide proteins; (vii) manganese-containing metalloproteins; (viii) Photosystem II: light-driven electron transfer and the biological water-splitting reaction; (ix) biological electron transfer; (x) electron transfer theory; (xi) mechanisms of energy storage and release; and (xii) long-distance electron transfer reactions.

Fall or Spring

Also Offered As: CHEM 5670

1 Course Unit

## **BMB 5810 Techniques of Magnetic Resonance Imaging**

Detailed introduction to the physics and engineering of magnetic resonance imaging as applied to medical diagnosis. Covered are magnetism spatial encoding principles, Fourier analysis, spin relaxation, imaging pulse sequences and pulse design, contrast mechanisms, chemical shift, flow encoding, diffusion and perfusion, and a discussion of the most relevant clinical applications.

Spring, even numbered years only

Also Offered As: BE 5810

1 Course Unit

**BMB 5850 Wistar Institute Cancer Biology Course: Signaling Pathways in Cancer**

This course is intended to provide foundational information about the molecular basis of cancer. When necessary the significance of this information for clinical aspects of cancer is also discussed. The main theme centers around cell cycle checkpoints with specific emphasis on the biochemistry and genetics of DNA damage signaling pathways, DNA damage checkpoints, mitotic checkpoints and their relevance to human cancer. The course is taught by the organizers and guest lecturers from universities and research institutions in the Northeast. Following every lecture, students present a research paper related to the topic of that lecture. The course is intended for first and second year graduate students but all graduate students are welcome to attend. Prerequisite: Undergraduates and Master's degree candidates require permission from the course directors.

Fall

Also Offered As: GCB 5850, PHRM 6500

1 Course Unit

**BMB 5980 Tutorial**

The tutorial course is designed for in-depth study of a specific topic through one-on-one meetings and discussions between the student and a selected BMB faculty member. The intent of the course is to broaden the students knowledge, thus the tutorial may not be taken with the student's current rotation advisor or thesis advisor. Choice of faculty member and topic is by prior mutual agreement between the student and faculty member, subject to approval by the course director. Student and faculty member will typically meet for an hour or so 2 - 3 times per week. The course may take the form of literature study, or where appropriate, a mini-project (typically computer-based) A tutorial can be used by students to become more deeply acquainted with the literature related to their thesis project or to help prepare students for their Candidacy Exam. Upon completion of the tutorial, students must prepare a written description of the area studied (5-10 typewritten pages)

Fall, Spring, and Summer Terms

1 Course Unit

**BMB 6010 Fundamentals of Magnetic Resonance**

This course introduces basic theoretical and experimental concepts of magnetic resonance and its applications in biochemistry, biology and medicine. Topics covered include description of the phenomenon of magnetic resonance, and classical and quantum strategies to compute nuclear spin responses in liquids, solids and biological tissues, polarization transfer and multiple quantum effects and their applications in biomedicine. Nuclear spin relaxation in solid-state materials and in biological systems will be discussed. Concepts of magnetic resonance imaging, imaging strategies, image contrast, and diagnostic applications are discussed. The course includes several practicals dealing with the demonstration of NMR hardware and experiments to compute basic NMR parameters on high resolution and clinical MRI scanners. For further details of this course, visit [www.mmrrcc.upenn.edu](http://www.mmrrcc.upenn.edu)

Fall, odd numbered years only

0.5 Course Units

**BMB 6050 Drug Discovery and Development**

This course will expose graduate-level students to the process of drug discovery and development. The course will be structured to cover topics from the identification of a disease-relevant target through to Phase III Clinical Trials. The course will be lecture based and there will also be student-led journal club presentations as part of the course. There will also be a writing project consisting of a 3 page proposal of how to advance one of the areas of Drug Discovery & Development covered in the course.

Spring

Also Offered As: CAMB 7100, PHRM 6050

1 Course Unit

**BMB 6180 Applications of High Resolution NMR Spectroscopy to Problems in Structural Biology**

A lecture-based course designed to introduce graduate students to applications of modern high-resolution multinuclear and multidimensional NMR spectroscopy to problems in structural biology. The course will first introduce classical definitions and descriptions of nuclear magnetic resonance and a convenient formalism for the analysis of advanced NMR experiments. Concepts and applications of multidimensional homonuclear <sup>1</sup>H NMR and multidimensional heteronuclear spectroscopy of proteins and nucleic acids will be described. Resonance assignment strategies including analysis of triple resonance spectroscopy will be covered. The origin, measurement and extraction of structural restraints and their use in structure determination will be surveyed and illustrated with recent examples. Undergraduate biochemistry and physical chemistry background required.

Fall, odd numbered years only

0.5 Course Units

**BMB 6220 Physical Principles of Mechano-Enzymes**

This course will provide an introduction to the biochemical, structural, and mechanical properties of energy-transducing enzymes. We will emphasize the relationships of mechanical, thermal, and chemical forces in mechano-enzyme function.

Spring, odd numbered years only

1 Course Unit

**BMB 6240 Molecular and Physical Basis of Ion Channels**

The course is a journal club format, targeted to graduate and MD/PhD students interested in ion channels from graduate programs in Physiology, Pathology, Neuroscience, Pharmacology, Biochemistry & Molecular Biophysics. It meets for two hours on alternate weeks and is coupled to the Ion Channel Journal Club, which also meets for one hour on the same alternate weeks. A faculty member meets with students to discuss and review the contents of each selected article earlier in the week in preparation for the subsequent Journal Club presentation. The day following the Journal Club the person who discussed the paper meets with the students to answer questions and to discuss the research that goes on in his lab. This elective course is meant to introduce students to the latest advances in ion channel research and includes topics extending from biophysics, structure, and physiology to cell biology and medical applications.

Spring, even numbered years only

0.5 Course Units

**BMB 6260 Mass Spectrometry and Proteomics**

This course will provide a detailed introduction to proteomics and mass spectrometry. The role of mass spectrometry in both characterizing proteins for traditional protein structure-function studies and identification of proteins in proteome studies will be emphasized. Targeted and global proteomes, quantitative protein profiling and compositional proteomics, and applications of proteome studies will be discussed. Intended for first and second year graduate students and others with an interest in proteomics and mass spectrometry.  
Spring, odd numbered years only  
0.5 Course Units

**BMB 6270 Computer Programming for Biochemists and Biophysicists**

An introductory course on programming and algorithms for scientists with an emphasis on applications to biophysics. Students will learn to write, debug, and execute basic programs through lectures, in-class workshops, and programming projects outside of class. Prerequisite: Permission of instructor for nonBMB students.  
0.5 Course Units

**BMB 6320 Probing Structure and Function of Complex RNA-Protein Machines**

RNA-Protein complexes or RNPs can range from simple assemblies to megadalton enzymatic machines. The latter include two of the most abundant and essential enzymatic complexes for converting genes to functional protein -the ribosome and the spliceosome. Understanding the molecular interactions that hold these RNPs together and how these complexes function has required the development of new techniques and pushed the boundaries of quantitative biochemistry. In this course we will take an in-depth look at general concepts common to many RNA binding proteins, the methods used to study protein-RNA and RNA-RNA interactions, and how the complex nature of large RNPs uniquely allow them to achieve their precise functions. The course will be a combination of both lectures and student-lead discussion of recent literature. Students will be evaluated based on their presentations of primary literature and their participation in class discussion.  
Fall, even numbered years only  
1 Course Unit

**BMB 6340 Cryo-Em**

This is an introductory course on methods and applications of cryo-EM single-particle analysis and tomography. The course will be broken up into three parts: 1) Principles of single-particle reconstruction including hands-on experience with the technology; 2) Principles of cryo-EM tomography including data analysis; 3) Student presentations of their 3D reconstructions and research article  
Spring  
1 Course Unit

**BMB 6350 Computational Structural**

1 Course Unit

**BMB 6500 Current Biochemical Topics**

Participation in the "Dr. George W. Raiziss Biochemical Rounds", a weekly seminar program sponsored by the Department of Biochemistry and Biophysics. Program deals with a wide range of modern biochemical and biophysical topics presented by established investigators selected from our faculty, and by leading scientists from other institutions. Prerequisite: Permission needed from Department  
Fall, Spring, and Summer Terms  
Also Offered As: CAMB 7020  
1 Course Unit

**BMB 6990 Laboratory Rotation**

Supervised "mini-projects" for graduate students in Biochemistry and Molecular Biophysics. End of the semester requirements are 1) poster presentations; 2) written rotation summaries; or 3) talks. Course is offered fall, winter, spring, and summer semesters.  
Fall, Spring, and Summer Terms  
1 Course Unit

**BMB 7040 Structural Biology Tg**

1 Course Unit

**BMB 7050 Candidacy Exam Preparation Course**

This course is designed for second year BMB students to prepare them for the Candidacy Examination, which must be completed in the spring semester of the second year.  
Spring  
0.5 Course Units

**BMB 7510 Chemical Biology**

This course focuses on current topics in Chemical Biology, particularly experiments in which 1) chemical synthesis enables one to probe or control biological systems, or 2) manipulation of biological systems facilitates novel chemical syntheses. The course is broadly divided into two sections, one dealing with the study of individual proteins and nucleic acids, and one dealing with complex cellular systems. As the goal of the course is to familiarize students with innovative recent experimental approaches and to stimulate them to conceive of their own new methodology, students will be responsible for delivering presentations on topics selected from the literature, designing experiments to address currently unsolved problems in Chemical Biology (in take-home examinations), and generating several novel research proposal ideas, one of which will be elaborated into a full proposal.  
Fall or Spring  
Also Offered As: CHEM 7510  
1 Course Unit

**BMB 7990 Independent Study (Yrs 1 - 2)**

0.5-4 Course Units

**BMB 8990 Pre-Dissertation Research**

Fall or Spring  
0.5-4 Course Units

**BMB 9900 Master's Thesis Research**

Fall or Spring  
0 Course Units

**BMB 9950 Dissertation Research**

0 Course Units