BIOCHEMISTRY AND MOLECULAR BIOPHYSICS (BMB)

**BMB 508 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.

Taught by: Sharp
Course usually offered in fall term
Prerequisite: Senior undergraduate or graduate level biochemistry or biophysics
Activity: Lecture
1 Course Unit

**BMB 509 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.

Taught by: Van Duyne
Course usually offered in spring term
Prerequisite: BMB 508 and BIOM 600 or permission of course director
Activity: Lecture
1 Course Unit

**BMB 518 Protein Conformation Diseases**
Protein misfolding and aggregation has been associated with over 40 human diseases, ranging from Alzheimer’s disease, Parkinson’s disease, amyotrophic lateral sclerosis, prion diseases, alpha(1)-antitrypsin deficiency, inclusion body myopathy, and systemic amyloidosis. This course will include lectures, directed readings and student presentations to cover seminal and current papers on the cell biology of conformational diseases including topics such as protein folding and misfolding, protein degradation pathways, the effects of protein aggregation on cell function, model systems to study protein aggregation and novel approaches to prevent protein aggregation.

Taught by: Argon and Ischiropoulos
Course offered fall; odd-numbered years
Also Offered As: CAMB 615, NGG 615
Prerequisite: BIOM 600 or equivalent
Activity: Lecture
1 Course Unit

**BMB 544 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.

Taught by: Marmorstein and Skordalakes
Course usually offered in fall term
Also Offered As: CHEM 555
Prerequisites: Undergraduate calculus and trigonometry
Activity: Lecture
1 Course Unit

**BMB 560 Methods of Scientific Inquiry in Biological Systems**
The foundational, social and methodological aspects of scientific reasoning in biomedical disciplines are discussed, including: 1) theories, laws, causal-functional explanation and experimental methodology in biology and medicine; 2) case studies in selected fields of biomedical sciences with special regards to strategies in concept and hypothesis formation, discovery, gathering evidence and testing, and 3) social and moral factors pertinent to the research enterprise.

Taught by: Wilson and Domotor
Course usually offered in spring term
Prerequisite: Graduate students in biological sciences or permission of instructors
Activity: Lecture
1 Course Unit

**BMB 567 Bioinorganic Chemistry**
This course covers selected topics in bioinorganic chemistry. Special emphasis is placed on dioxygen chemistry and electron transfer processes. Course topics include: 1) oxygen uptake and utilization; 2) oxygen transport; 3) oxygen and O atom incorporation into substrates; 4) metalloenzyme-catalyzed C-C bond formation; 5) the metallobiochemistry of DNA; 6) metal-sulfide proteins; 7) manganese containing metalloproteins; 8) photosystem II, light-driven electron transfer and the biological water-splitting reaction; 9) biological electron transfer; 10) electron transfer theory; 11) mechanisms of energy storage and release; and 12) long-distance electron transfer reactions.

Taught by: Dmochowski
One-term course offered either term
Also Offered As: CHEM 567
Activity: Lecture
1 Course Unit

**BMB 581 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.

Taught by: Song and Wehrli
Course offered spring; odd-numbered years
Also Offered As: BE 581
Activity: Lecture
1 Course Unit
BMB 585 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. Taught by: Skordalakes and Murphy
Course usually offered in fall term
Also Offered As: GCB 585
Prerequisites: Undergraduates and Master’s degree candidates require permission from the course directors
Activity: Lecture
1 Course Unit

BMB 598 Tutorial
The tutorial course is designed for in-depth study of a specific topic thorough 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)
Taught by: Kim Sharp and staff
Course offered summer, fall and spring terms
Activity: Independent Study
1 Course Unit

BMB 601 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.mmrccc.upenn.edu
Taught by: Reddy
Course offered fall; odd-numbered years
Activity: Lecture
0.5 Course Units

BMB 602 Imaging Biomarkers
Introduction to principles of imaging based biomarkers for studying metabolic and functional integrity of biological tissues in vivo. Topics covered include a general overview of multimodal imaging biomarkers and a special emphasis on theoretical and practical aspects of MRI biomarkers based on magnetic resonance relaxation, chemical exchange, and metabolic spectroscopy as well as functional responses and their applications in diagnostic imaging of different diseases. Taught by: Reddy (course director), Borthakur, Elliot, Hariharan
Course offered spring; odd-numbered years
Prerequisites: BMB 601 or permission of course director; students with prior NMR and MRI background will be given priority. Activity: Lecture
0.5 Course Units
Notes: Course meets for eight weeks (1/2 credit)

BMB 605 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.
Taught by: Dr. Ben E. Black, UPenn and Dr. Craig A. Leach, GlaxoSmithKline
Course usually offered in spring term
Activity: Lecture
1 Course Unit
Notes: 2 X 1.5 hr sessions per week

BMB 618 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 1H 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.
Taught by: Wand
Course offered fall; odd-numbered years
Prerequisites: Undergraduate biochemistry and physical chemistry and BMB 601, or permission of instructor
Activity: Lecture
0.5 Course Units
Notes: Course meets for 8 weeks and is offered for 1/2 credit
BMB 619 Protein Folding
Introduction to the folding of mainly soluble proteins but also membrane proteins. Critical readings in the current literature and important earlier literature. Class discussion of papers from the literature with didactic lectures as required. Exposure to principles and use of equilibrium, kinetics, thermodynamics and the range of biophysical technologies as they occur in the scientific literature.
Taught by: Axelsen and Englander
Course offered spring; even-numbered years
Activity: Lecture
0.5 Course Units
Notes: Course meets for 8 weeks and is offered for 1/2 credit.

BMB 622 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.
Taught by: Dominguez, Goldman, Grishchuk and Ostap
Course offered spring; even-numbered years
Prerequisite: Biochemistry
Activity: Lecture
0.5 Course Units
Notes: Course meets for 8 weeks and is offered for 1/2 credit.

BMB 624 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 one hour, once a week on alternate weeks and is coupled to the Ion Channel Journal Club, which also meets for one hour on the same alternate weeks (9:30-10:30 a.m., Thursdays, B400 Richards Building). A faculty member meets with students to discuss and review the contents of each selected article early in the week in preparation for the subsequent Journal Club presentation. 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.
Taught by: Kallen
Course offered spring; odd-numbered years
Activity: Lecture
0.5 Course Units
Notes: Course meets all semester (half time) for 1/2 credit.

BMB 625 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.
Taught by: Speicher and Garcia
Course offered spring; even-numbered years
Activity: Lecture
0.5 Course Units
Notes: Course meets for 8 weeks and is offered for 1/2 credit

BMB 627 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.
Taught by: Sharp and Van Duyne
Prerequisites: Permission of instructor for nonBMB students.
Activity: Lecture
0.5 Course Units
Notes: Course meets for eight weeks and is offered for 1/2 credit.

BMB 628 Principles of Scientific Instruments
Proper use of the tools of one's trade is essential to quality assurance. General confidence in the infallibility of even simple scientific instruments (SI) can be the cause of serious misapplication of research effort. This course teaches how to think about and use all SI's intelligently. It reviews first principles of instrument detection, selection, operation, calibration, truth-testing, trouble shooting and data analysis. Error appraisal and avoidance are analyzed using common laboratory examples. Anyone who cares is welcome. And we should all care. Emphasis sculpted to student needs.
Taught by: Liebman
Course offered spring; even-numbered years
Activity: Lecture
0.5 Course Units
Notes: Course meets for eight weeks and is offered for 1/2 credit.

BMB 629 Quantitative Problems in Biochemistry
Students will be assigned problems in a range of topics, including thermodynamics, enzyme kinetics, redox potentials, and will present their answers in class. This course is intended to complement material covered in BMB 508 and 509, providing a rigorous review of quantitative methods.
Taught by: Kallen
Course offered fall; even-numbered years
Activity: Lecture
0.5 Course Units
Notes: Course meets for 8 weeks for 1/2 credit.

BMB 632 Probing Structure and Function of Complex RNA-Protein Machines
RNA-Protein complexes or RNP complexes 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 RNP complexes 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 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.
Taught by: Lynch
Course offered fall; even-numbered years
Activity: Lecture
1 Course Unit
**BMB 650 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.
Taught by: Black and Shorter
Course offered summer, fall and spring terms
Also Offered As: CAMB 702, PHRM 650
Prerequisite: Permission needed from Department
Activity: Seminar
1 Course Unit

**BMB 699 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.
Taught by: Kohli
Course offered summer, fall and spring terms
Activity: Laboratory
1 Course Unit

**BMB 705 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.
Taught by: Marmorstein, Lynch and Nelson
Course usually offered in spring term
Activity: Seminar
0.5 Course Units
Notes: Course meets for 8 weeks at the beginning of the spring semester, for 1/2 credit.

**BMB 751 Chemical Biology**
One-term course offered either term
Also Offered As: CHEM 751
Activity: Lecture
1 Course Unit

**BMB 799 Independent Study (Yrs 1 - 2)**
Activity: Independent Study
1 Course Unit

**BMB 899 Pre-Dissertation Lab**
One-term course offered either term
Activity: Independent Study
1 Course Unit

**BMB 990 Master's Thesis Research**
One-term course offered either term
Activity: Masters Thesis
1 Course Unit
Notes: See Department for section numbers

**BMB 995 Dissertation Research**
Activity: Dissertation
1 Course Unit
Notes: See Department for section numbers