BIOCHEMISTRY AND MOLECULAR BIOPHYSICS (MD) {BMB}

508. Macromolecular Biophysics I. (A) Van Duyne/Wand.

This course introduces students to the physical and chemical properties of proteins, nucleic acids and membranes. The emphasis of the course is on thermodynamics and structure, with several lectures devoted to the biophysical methods used to study biological macromolecules. This is intended to be a first course for graduate students with an undergraduate background in physics, chemistry or biology. The companion course, BMB 509, which is taught in the spring, builds on this course and covers kinetics, dynamics, and catalysis.

509. Macromolecular Biophysics II. (B) Van Duyne and Wand. Prerequisite(s): BMB 508 or permission of instructors.

This course introduces fundamental concepts in chemical kinetics and their application to problems in biochemistry such as protein folding and enzymoloyg. There is an emphasis on dynamic processes in proteins and the techniques used to characeterize them over a wide range of timescales. The latter half of the course focuses on emerging areas in biochemistry and biophysics including membrane biochemistry, single molecule methods and proteomics with an emphasis on mass spectrometry

518. (CAMB615) Topics in Conformation Disease. (A) Yair Argon, Harry Ischiropoulos. Prerequisite(s): BIOM 600.

Protein misfolding and aggregation has been associated with a number of human diseases, ranging from Alzhemier's and Parkinson's Disease to Respiratory Distress Syndrome, alppha(1)-antitrypsin deficiency and Mad Cow Disease. 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 aggresome formation, protein degradation pathways (proteosome vs. ER-associated degradation), effects of protein aggregation on cell function and mutations which lead to autosomal dominant diseases.

550. Molecular Mechanisms of Signal Transduction and Control. (B) Lemmon. Prerequisite(s): General biochemistry or cell biology, and BIOM 600 or permission of instructor.

Molecular structure and function of receptors, GTP binding proteins, second messengers, kinases, lipases, phosphatases etc. given at the current research level. Specific signaling cycles and their coupling mechanisms are examined with the aim of understanding what and how molecular communication chains mediate sensory, hormone and neurotransmitter action that control cellular physiologic functions like growth, secretion, electrical activity, cell cycle, gene expression, etc. and how so many interacting cycles are kept coordinated in health. Biochemical, molecular biological and structural chemical approaches are developed and used to achieve both a broad and deep understanding of cellular events that constitute the life force that we know and love so well and knowledge of which will be used to explain associated disease states.

554. (CHEM555) Macromolecular Crystallography: Methods and Applications. (A) Emmanuel Skordalakes and Ronen Marmorstein. Prerequisite(s): undergraduate calculus and trigonometry.

The first half of the course covers the principles and techniques of macromolecular structure determination using X-ray crystallography. The second half of the course covers extracting biological information from X-ray crystal structures with special emphasis on using structures reported in the literature and presented by faculty and students.

560. Methods of Scientific Inquiry in Biological Systems. (B) Wilson and Domotor. Prerequisite(s): Graduate students in biological sciences or permission of instructors.

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.

567. (CHEM567) Bio-Inorganic Chemistry. (A) Dmochowski.

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.

SM 571. Seminar. (B) Staff.

Student seminars on selected topics from current scientific literature

580. (BE 567) Mathematical Computational Methods for Modeling Biological Systems. (B) Schotland. Prerequisite(s): Graduate Standing or instructor's permission.

This course will present a comprehensive account of the application of modeling methodology to the investigation of biological systems. The emphasis will be on an organized overview of the tools and techniques rather than the detailed mathematical structures upon which they may rely. The course will draw examples widely from the current literature in an attempt to not only show the topical relevance of the subject matter but also to equip participants with an understanding of the diversity of domains to which the techniques and methodologies apply.

581. (BE 581) Techniques of Magnetic Resonance Imaging. (K) Wehrli and Song.

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.

585. Wistar Institute Cancer Biology Course: Cell Cycle Checkpoints and Cancer Course. (A) Kissil & Dahmane. Prerequisite(s): Undergraduate students require permission from the course director.

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 key signaling pathways that drive tumorigenesis with emphasis on biochemistry and genetic model systems and their relevance to human cancer. The course is taught by the organizer and guest lecturers from universities and research institutes in the Northeast. Following every lecture, the 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 invited to attend.

598. Tutorial. (C) Black.

Literature studies in a specific research area under supervision of Biochemistry and Molecular Biophysics Graduate Group faculty, concluded by a written summary and a seminar presentation. May be taken in fall, spring and summer semesters.

601. Fundamentals of Magnetic Resonance. (A) Reddy.

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 resonses in liquids,solids and biological tissues, polarization transfer and mujltiple 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

603. Advanced Topics in Magnetic Resonance. (K) Reddy.

Advanced topics in theory and applications of magnetic resonance spectroscopy and imaging (Nuclear Magnetic Resonance - NMR; and Electron Spin Resonance - EPR) of biological tissues and solid-state materials to problems in biochemistry, biology, bioengineering and medicine.

604. (BE 619) Statistical Mechanics. (H) Schotland. Prerequisite(s): CBE 618 or equivalent.

A modern introduction to statistical mechanics with biophysical applications. Theory of ensembles. Noninteracting systems. Liquid theory. Phase transitions and critical phenomena. Nonequilibrium systems. Applications to reaction kinetics, polymers and membranes.

610. Life and the Electronmagnetic Spectrum. (H) Vanderkooi. Course meets for 8 weeks and is offered for 1/2 credit.

Spectroscopy applied to biological molecules. Emphasis is placed on the common principles of absorption and relaxation techniques for infrared and visible light and includes discussion of light absorption and emission processes used by living organisms.

611. Advanced X-ray Diffraction Methods. (J) Van Duyne. Prerequisite(s): BMB 554/CHEM 555 or equivalent,or permission of instructor. Course meets for 8 weeks and is offered for 1/2 credit.

Advanced topics in macromolecular x-ray diffraction. Crystallization, synchrotron data collection, data processing, anomalous diffraction, phasing methods, density modification methods, refinement. Emphasis is on applications and currently available methodology.

614. Membrane Structural Biology. (A) Lemmon. Course meets for 8 weeks and is offered for 1/2 credit.

The composition, structure,and physical properties of cell membranes will be considered, as will recent advances in structural studies of membrane proteins. Topics will range from membrane structure to membrane protein folding, combining biophysical and cellullar perspectives.

616. Medical Problems in Modern Biochemistry. (K) Nelson. Prerequisite(s): Undergraduate biochemistry; undergraduates need permission of course director.

This course on metabolic pathways will focus on diseases and other clinical conditions that have biochemical basis. We will try to understand the mechanisms and manifestations of the biochemical defects, ranging from biochemical dysregulation of the pathways to the implications of organ specificity of the defects._ Clinical case topics will include familiar diseases such as diabetes, gout, and hypercholesterolemia, as well as rarer diseases such as: MCAD and CPT deficiencies (i.e. fatty acid oxidation defects); von Gierke's and McArdles disease (i.e. glycogen storage diseases); and propionic acidemias (i.e. amino acid degradation diseases).

618. Applications of High Resolution NMR Spectroscopy to Problems in Structural Biology. (I) Wand. Prerequisite(s): Undergraduate biochemistry and physical chemistry and BMB 601, or permission of instructor. Course meets for 8 weeks and is offered for 1/2 credit.
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.

619. Protein Folding. (I) Axelsen and Englander. Course meets for 8 weeks and is offered for 1/2 credit.

Introduction to the folding of especially soluble proteins but also membrane proteins; critical readings in current literature and important earlier literature; class discussion of papers interspersed with didactic lectures as required. Exposure to equilibium, kinetics, thermodynamics principles and use as they occur in the real literature. Exposure to the range of biophysical technologies as used in the literature.

622. Physical Principles of Mechano-Enzymes. (J) Goldman and Ostap. Prerequisite(s): Biochemistry. Course meets for 8 weeks and is offered for 1/2 credit.

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

624. Ion Channels and Pumps. (H) Kallen and Lu. Prerequisite(s): permission of course directors. Course meets for 8 weeks and is offered for 1/2 credit.

This course will introduce students to the fundamentals of ion channel function, with the course loosely organized around major classes of ion channels (voltage, mechanical and ligand gated). Discussion will focus on methods of study, mechanisms of ion selectivity and gating, and pathophysiology of human diseases (channelopathies). Intended for 2nd year graduate students or 1st year students with a strong background in biophysics or physiology.

625. Optical Methods in Cell Physiology. (J) Salzberg. Prerequisite(s): Undergraduate physics; calculus. Course offered for 8 weeks for 1/2 credit.

This course will provide an introduction to the principles and application of modern optical methods to the investigation of physiological processes. These include optical measurement of membrane potential, fluorescent indicator measurement of intracellular ion concentrations, single moleccule fluorescence measurements, TIRF, FRET, LRET, confocal and multi-photon microscopy, and dynamic light scattering. The course will consist of lectures and discussions of original literature. Intended for 2nd year graduate students, but MD/PhDs and postdocs are welcome.

626. Mass Spectrometry and Proteomics. (J) Speicher. Course meets for 8 weeks and is offered for 1/2 credit.

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.

627. Computer Programming for Biochemists and Biophysicists. (I) Sharp and Van Duyne. Prerequisite(s): Familiarity with Unix recommended. Permission of instructor for nonBGS students. Course meets for eight weeks and is offered for 1/2 credit.

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.

628. Principles of Scientific Instruments. (J) Liebman. Course meets for eight weeks and is offered for 1/2 credit.

Proper use of the tools of one's trade is essential to quality assurance. General confidence in the infallibility of scientific instruments can be the cause of serious misapplication of research effort. This course systematically reviews first principles of instrument detection, operation, calibration, truth testing, trouble shooting and data analysis. Approaches to error appraisal and avoidance are developed using common laboratory examples. Anyone who cares is welcome. And we should all care.

SM 650. Current Biochemical Topics. (C) Black and Shorter.

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.

699. Laboratory Rotation. (C) Shorter.

Supervised "mini-projects" for graduate students in Biochemistry and Molecular Biophysics. May be taken in fall, spring and summer semesters.

700. (CHEM700, PHRM630) Selected Topics in Chemistry (Bioinorganic and Bioorganic Chemistry). (C) Cooperman/DeGrado.

Course topics include: 1) oxygen uptake and utilization, O2 transport, O2 and 0 atom incorporation into substrates; 2) the bioinorganic chemistryof C-C bond formation; 3) metallobiochemistry and DNA; 4) metal-sulfide proteins: 5) manganese containing metalloproteins, photosystem II, the biological water splitting reaction; 6) biological electron transfer, electron transfer theory; mechanisms of energy storage and release, long-distance electron transfer reactions.

SM 705. Prelim Exam Preparation Course. (B) DeGrado.

This course is designed for second year BMB students to prepare them for the Preliminary Exam, which must be completed before May 31st of their second year. The course is usually given for 6 weeks in the spring semester.

990. Master's Thesis Research. (C) Staff. See Department for section numbers.

995. Dissertation Research. Staff. See Department for section numbers.