Appendix #2

PROGRAM IN BIOMEDICAL SCIENCES ELECTIVE CLASSES

The following classes are offered as electives during the first year in PiBS. Some of the classes may be requirements for some of the participating departments/programs. Each department/program has designed a curriculum that will allow students who enter the program at the end of the first year in PiBS to complete these requirements after acceptance into a dissertation lab and department or program *i.e.* the choice of department or program isn't dictated by the program-specific requirements fulfilled during the first year.

Fall semester

GMS BI 777 Techniques in Biochemistry, Cell, and Molecular Biology
Prerequisites: consent of instructor. Success in biomedical research requires proposing, developing and testing a novel hypothesis. The generation of a novel hypothesis in turn requires the ability to apply the scientific method and then implement the appropriate techniques to address the experimental question. This course will complement the Foundations in Biomedical Sciences (FiBS) curriculum by providing students with a comprehensive understanding of the core experimental methods used in biomedical research. By the end of this course students will master the concepts behind a wide range of experimental techniques and technologies and then be prepared to apply the most appropriate experimental system to a given biological question. Biochemical knowledge regarding "how things work" and "how to cook from scratch in the lab" will enable students to develop their own experimental research strategies. Specific topics to be covered in the Fall 2014 include: the scientific method/lab basics, cell culture and gene transfer, protein extraction and analysis, DNA and cloning, PCR, DNA-protein interactions and chromatin, RNA and quantitative PCR, lipids, transgenic and knockout mice, mass spectrometry, flow cytometry, microarray and next generation sequencing, histology and confocal microscopy. This course is team taught and will use lectures, in class discussions, and focused problem sets. A concise final written assignment is designed to test the students' mastery of the subject matter. Layne. 2 cr, Fall sem.

GMS BY 762 Foundations of Biophysics and Structural Biology I
This course provides a thorough grounding in the theory and major experimental methods of Biophysics and Structural Biology. The course covers x-ray diffraction, crystallography, electron microscopy and image processing. Topics include:• Macromolecular conformation and the principles of symmetry, • Fourier transforms, • Structural electron microscopy and image processing, • X-ray diffraction, scattering and crystallography. Atkinson. 2 cr, Fall sem.

GMS BY 776 Macromolecular Assemblies I
This course covers the concepts of the assembly of biomacromolecules, their structure and stabilizing forces, and biological function as related to structure. Examples are drawn from protein and proteinnucleic acid assemblies, and membrane proteins.Topics include:• Protein Folding Motifs and Quaternary Assembly, • Protein Assemblies: Hemoglobin,Clathrin, Spectrin, Actin, Myosin and Tubulin,• Protein-Nucleic Acid Assemblies: Chromatin, Ribosomes, Rod-shaped and Spherical Viruses. Shipley, 2 cr, Fall sem.

GMS GE 701 Principles of Genetics and Genomics
This course will serve as a foundation for understanding the heritable basis of numerous biological traits, the relationships among genes, and the regulation of their expression. Focus on the ability to use genetic systems to probe these problems, and therefore will heavily explore the experimental aspects of these investigations. Includes discussion of the impact of the genome sequences' availability on the practice of modern science. Use of case study approach to investigate the rich variety of scientific insights gained through genetic studies of cell-cell communication, aging, addiction, obesity, and others. Dasgupta. 4 cr, Fall sem.

GMS MI 713 Comprehensive Immunology
Comprehensive introduction to immunologic principles and applications. This course consists of both interactive lectures and discussion sessions. Emphasis is placed on analysis and interpretation of data from the primary literature. Prior coursework in genetics and biochemistry is strongly recommended. Corley. 4 cr, Fall sem.

GMS NU 755 Molecular, Biochemical and Physiologic Bases of Nutrition I: Energy Balance and Micronutrients
Prereq: at least one semester each of Biochemistry and Physiology, or equivalent, and permission of the instructor. This is the first semester of a 2 semester sequence (that can be taken in either order) that focuses on the Physiological, Biochemical and Molecular Bases of Nutrition. This semester will cover concepts of essential nutrients and methods for determining their requirements (DRIs), body composition, nutrition and growth, energy expenditure, regulation of energy intake, vitamins and macro-mineral metabolism (Ca, P) and micronutrients. Functions and roles of micronutrients in signaling from gene to whole organism will be discussed. Implications for nutrient requirements through the life cycle and in health and disease will be addressed. A discussion session will teach students to critically evaluate cutting-edge and seminal papers addressing each topic, and introduce students to state of the art research approaches and methodologies -- basic (cell and molecular), clinical and epidemiological. Weekly writing assignments on the papers will provide experience and hone skills with scientific writing. Fried. 4 cr, Fall sem.

GMS OB 763 Basic Processes in Oral Biology
This course examines biological processes at the cellular and molecular levels. Provides a basis to understand the events that regulate inflammation; wound healing; bone formation and resorption; salivary proteins, the relevance to mineral homeostasis and anti-microbial activity; tooth development, eruption, and movement; and oral immune system and oral immunology protective and destructive aspects of oral tissues. Mochida. 2 cr, Fall sem. (followed by the 2 cr, Spring sem. class; OB 764))

GMS PA 710 Principles of Basic and Applied Pathology
This course will serve as 1) an introduction to the methods used in the practice of pathology to study disease and pathophysiology; and 2) a survey of research currently conducted in the field of pathology. There are two separate activities for this course; the first is a weekly 90 minute lecture\discussion where research concepts will be presented by pathology faculty followed by a review of an assigned paper(s) from the basic literature. The second activity will be attendance at the weekly research seminar series in the Department of Pathology and Laboratory Medicine. The students will provide a written evaluation of four of the research seminars. Remick, Stearns-Kurosawa. 2 cr, Fall sem.

Spring semester

GMS BY 763 Foundations of Biophysics and Structural Biology II
This course provides a thorough grounding in the theory and major experimental methods of Biophysics and Structural Biology. The course covers thermodynamic and spectroscopic methods, computational biology and structural NMR. Topics include:• Macromolecular conformation and the principles of symmetry, • Thermodynamic methods, • Spectroscopic methods, • Structural nuclear magnetic resonance, • Computational biology. Atkinson, 2 cr, Spring sem.

GMS BY 777 Macromolecular Assemblies II
This course covers the concepts of the assembly of biomacromolecules, their structure and stabilizing forces, and biological function as related to structure. Examples are drawn from assemblies of lipoproteins, phospholipids, and membrane proteins.Topics include: • Lipid Assemblies: Thermodynamics, Surface behavior, Structure, Mesomorphic states and liquid crystals, • Plasma Lipoproteins: Lipid, Lipid phase behavior, Apoproteins, Assembly, Interconversions, and Uptake,• Biological Membranes: Organization, Bacteriorhodopsin, Photosynthetic Reaction Center, Porins, Bacterial Toxins, Influenza Virus Hemaggutinin, and Potassium Channel. Shipley, 2 cr, Spring sem.

GMS FC 705 Translational Genetics and Genomics
Prereq: consent of instructor. This course will explore the process by which insights from basic science research ultimately lead to new strategies for patient care with a focus on examples from genetics and more recent genome-wide experimental approaches. The course will cover examples of translational research using genetic, epigenomic, transcriptomic, proteomic, approaches in human and/or model systems. Research that leads to new approaches for establishing disease diagnosis, prognosis, therapy, and personalized medicine will be discussed. The ethical and societal implications of these developments will also be considered. TBD 2 cr, Spring sem. Offered alternate years (2016)

GMS FC 706 Molecular Metabolism
Prereq: consent of instructor. This optional module of the Foundations in Biomedical Sciences curriculum focuses on the biochemical, cellular and molecular mechanisms that regulate cell and tissue-specific fuel metabolism. The course will present an integrated view of biochemistry and the control of cellular and organismal functions with regard to nutrient utilization. Classes include small group discussions of key papers. Mechanisms that allow cells to survive variations in nutrient supply (starvation, feeding, nutrient excess/stress) and how these mechanisms contribute to metabolic derangements contribute to disease pathogenesis (e.g. diabetes, obesity, cancer) will be discussed. Pilch. 2cr, Spring sem. Offered alternate years (2015)

GMS FC 707 Physiology of Specialized Cells
Prereq: consent of instructor. This course is one of the elective course modules (Module V) of the Foundations in Biomedical Sciences curriculum. Knowledge of cellular and molecular physiology is critical to understanding the higher order of functioning of tissues, organs, and organs systems. The objective of the course is to discuss the specialized adaptations of cells that help them to function in their respective tissues and organs. This course will also provide a framework to bridge the gap between the biochemistry and the molecular and cellular biology that students have acquired in the core modules (I through IV) and organ physiology and pharmacology that will be addressed in the second year. Gabel, Moore. 2 cr, Spring sem.

GMS FC 762 Critical Thinking in Cell and Molecular Biology
Prereq: consent of instructor. The primary goal of this course is to use the framework of the scientific literature to develop Critical Thinking Skills to generate novel hypotheses with a focus on establishing novel biological mechanisms and pathways. Critical Thinking skills will be used to examine research findings and theories to uncover inconsistencies, bias, or faulty logic. The student will be expected to build on their careful evaluation and analysis of the papers to create a novel hypothesis each week and design a single experiment to address their question. The weekly course discussion will be student led and this will facilitate the development of teaching skills. Generally the papers to be discussed will be an older, classic paper, which established an important new concept and a newer paper that builds on that theme. Grading is based on weekly participation in class discussions, presentations, and a concise final written assignment. Layne. 2 cr, Spring sem.

GMS MI 701 Concepts in Virology
This course is designed to provide a fundamental understanding of viruses and their relationship with their host. It will involve an introduction to virus replication cycles and focus in detail on mechanisms that viruses with different genome structures use to transcribe and replicate them. It will also include lectures on the ways that viruses take advantage of the host translation machinery and subvert antiviral defenses. Aspects of virus pathogenesis and epidemiology will be explored with emphasis in HIV pathogenesis, viral persistence, and the emergence of new viruses. The course will be aimed towards first year Ph.D. students in the Division of Graduate Medical Sciences. The classes will be taught by Microbiology Department faculty with expertise in virology. The content will include a combination of traditional lectures and discussion of primary research papers. Reading materials will include primary literature and suggested review articles, as well as handouts provided by the faculty. Students will be evaluated on their discussion of papers and in a final examination designed to test the students' critical thinking and analytical skills. Connor, Gummuluru, Oberhaus, Zamansky, Fearns. 2 cr, Spring sem.

GMS MI 702 Concepts in Bacterial Evolution and Genetics
This course is designed to provide a fundamental understanding of how bacteria evolve and the mechanisms they use to adapt to changing environments. Course is taught as a combination of traditional and interactive lectures as well as discussion of reading from the primary literature. The emphasis is on what we know and why. Topics to be covered include phenotypic ad phylogenetic classification of bacteria and their viruses, traditional and genomic approaches for analyzing gene expression, and mechanisms of gene transfer and regulation in bacteria. Fisher. 2 cr, Spring sem.

GMS MI 715 Immunological Basis of Disease
Journal article-based survey of mechanisms underlying diseases caused by abnormal immune system function. Emphasis will be on normal vs. pathological immune system processes towards reinforcing how basic immunological concepts have immediate clinical significance. Nikolajczyk. Var cr, Spring sem.

GMS MM 730 Biological Core Technologies
Prereq: GMS FC 701-703. The major goal of this course is to provide an overview of the principles and applications of modern techniques, which are regularly employed in academia and industry as tools for biomolecular and biomedical investigation. This course will focus on technologies which are available at BUSM. Specific technologies include microscopy, FACS, IHC, qPCR, genomic (next gen sequencing and microarrays), proteomics techniques, HTS, fluorescence molecular tomography, ultrasound and metabolic phenotyping techniques. Ravid, Gerstenfeld. 3 cr, Spring sem. Offered alternate years (2015)

GMS NU 756 Molecular, Biochemical and Physiologic Bases of Nutrition: Macronutrients
Prereq: at least one semester each of Biochemistry and Physiology and permission of the instructor. Regulation of lipid, carbohydrate, and protein digestion, absorption, transport, tissue and cellular metabolism. Integration of macronutrient metabolism in response to alteration in nutritional status (e.g. starvation, obesity) on a whole body and tissue-specific basis. Mechanism regulating macronutrient metabolism in response to stresses such as exercise and aging and disease. A discussion session will teach students to critically evaluate research papers, provide knowledge of seminal papers in the field, and introduce students to research approaches and state of the art methods (e.g. assessment of metabolic flux using stable isotopes, euglycemic clamps, metabolomics). Fried. 4 cr, Spring sem.

GMS OB 764 Basic Processes in Oral Biology
This course examines biological processes at the cellular and molecular levels. Provides a basis to understand the events that regulate inflammation; wound healing; bone formation and resorption; salivary proteins, the relevance to mineral homeostasis and anti-microbial activity; tooth development, eruption, and movement; and oral immune system and oral immunology protective and destructive aspects of oral tissues. Mochida. 2 cr, Spring sem. (follows the 2 cr, Fall sem. class; OB 763)

GMS PA 700 Basic and Experimental Pathology
Basic principles of pathology are presented through lectures (students attend the GMS PA 600 lectures), and computer-assisted instruction. Related research articles and basic histology are discussed in small group session that complement the lectures. Christensen, Flomenbaum, Blusztajn. 4 cr, Spring sem.