**Other Elective Options**

**Biomedical Graduate Studies**

**Biochemistry and Molecular Biophysics -** <http://www.med.upenn.edu/bmbgrad/academics.shtml>

**Cell & Molecular Biology**

Cancer Biology - <http://www.med.upenn.edu/camb/cb.shtml#Courses>

Cell Biology and Physiology - <http://www.med.upenn.edu/camb/UPENNCAMBCourses.shtml>

Developmental, Stem Cell and Regenerative Biology - <http://www.med.upenn.edu/camb/dsrb.shtml#requirements>

Gene Therapy and Vaccines - <http://www.med.upenn.edu/camb/gtv.shtml#courses>

Genetics and Gene Regulation - <http://www.med.upenn.edu/camb/ggracademics.shtml>

Microbiology, Virology, and Parasitology - <http://www.med.upenn.edu/camb/mvp.shtml#Courses>

**Biostatistics -** <http://www.med.upenn.edu/ggeb/BiostatCourseList.shtml>

**Epidemiology -** <http://www.med.upenn.edu/cceb/epi/edu/descriptions.shtml>

**Genomics and Computational Biology -** <http://www.med.upenn.edu/gcb/courses.shtml>

**Immunology** - <http://www.med.upenn.edu/immun/courses.shtml>

**Neuroscience -** <http://www.med.upenn.edu/ngg/Required_courses.shtml>

**Pharmacology** - <http://www.med.upenn.edu/ggps/user_docs/CourseDescriptions.pdf>

**Master of Bioethics**

<http://medicalethics.med.upenn.edu/education/master-of-bioethics-mbe/course-offerings>

**Bioengineering**

<http://www.be.seas.upenn.edu/current-students/masters/documents/BECourses.pdf>

**Master in Law**

<https://www.law.upenn.edu/admissions/master-in-law/curriculum.php>

**Masters in Health Policy Research**

<http://www.med.upenn.edu/mshp/courses.shtml>

**Master of Public Health**

<http://www.publichealth.med.upenn.edu/course_listing.shtml>

**Common BGS Electives**

**CAMB 510/ IMUN 510 Immunology for CAMB Students 1 c.u. (Spring semester)**

The purpose of this course is to give a thorough grounding in Immunology to Cell and Molecular Biology graduate students with an emphasis on the role of the immune system in combating infectious and neoplastic disease and its role in immunopathological states such as transplantation rejection, autoimmunity and allergy.  This will be a required course for CAMB students in the Microbiology, Virology and Parasitology program and the Vaccine and Gene Therapy program, replacing Immune Mechanisms 506.  It may also be used as an elective by other CAMB students such as Cancer Biology and Cell Biology and Physiology.

**CAMB 541/BIOL 540 Genetic Analysis 1 c.u. (Spring semester)**

This course describes the logic and practice of genetic analysis, i.e., the use of mutations for the analysis of gene function. The course is divided in two parts. The first part provides a general overview of the logic and methodology of genetic analysis. The second part introduces several widely used experimental systems—*Zea mays* (corn), *Arabidopsis thaliana*, *Drosophila melanogaster* (fruit fly), *Caenorhabditis elegans* (nematode), *Mus musculus* (mouse) -- and how genetic analysis has been used to study various processes in these organisms. Each case study highlights a different aspect of genetic analysis. The course ends by considering the special challenges of human genetics. The course is appropriate for graduate students and undergraduates and who have had an introductory course in genetics and molecular biology.

**CAMB 546 Seminar in HIV Medical Virology 1 c.u. (Spring semester)**

This course will introduce students to diverse basic principles that contribute to viral pathogenesis.  We will use HIV as a model to illustrate specific elements that relate to disease development, emphasizing a) pathogenesis, b) immunology, c) retroviral replication cycle, d) vaccine development.

**CAMB 550 Genetic Principles 1 c.u. (Spring semester)**

This is a required course of the Genetics and Gene Regulation Program and is designed to provide students with a comprehensive overview of genetic concepts and methodology.  The course is organized into three parts: I Fundamental genetic concepts; II Genetics of model organisms (with a focus on yeast, worms flies and mice); III Human genetics and disease.  Each week there will be two lectures and one associated discussion/problem-solving session.  Discussions emphasize practical aspects of generating and interpreting genetic data.

**CAMB 608 Regulation of Eukaryotic gene Transcription 1 c.u. (Fall semester)**

An advanced seminar course emphasizing the molecular biology and molecular genetics of transcription in eukaryotes. Based on current literature, the presentations and discussions familiarize the student with current technology and developing principles.

**CAMB 609 Vaccines and Immunotherapy 1 c.u. (Fall semester)**

Vaccination is perhaps the most successful medical intervention. The goal of this course is to expand on students' general understanding of the immune system and to focus this understanding towards the application of vaccination. Furthermore, the course will give the student a sense of how these principles are applied to vaccine and immune therapeutic development. The course covers basic science as well as the clinical, ethical, and political implications of modern vaccines.

**CAMB 630 Topics in Human Genetics and Disease 1 c.u. (Fall semester)**

Building on the foundations of the Human Genome and HapMap projects, as well as parallel efforts in model organisms, research in human genetics and genomics is progressing rapidly. Our understanding of basic concepts in genetics, and Mendelian and non-Mendelian human genetic disease is proceeding at an unprecedented pace. This course will provide students with an overview approaches to understanding current problems and techniques in human genetics. The format will be an advanced seminar course, with directed reading and students presentations.

**CAMB 632/PHRM 632 Cell Control by Signal Transduction Pathways 1 c.u. (Spring semester)**

This course, "Cell control by signal transduction pathways", will examine how various signal transduction mechanisms influence cell functions including replication, growth, transcription, translation and intracellular trafficking. The primary signal transduction pathways to be examined include those mediate by Notch, TGF- ß, TNF-a, Ras, and Rho.  We will also discuss intracellular signaling in response to DNA damage and explore in depth some of the key classes of enzymes involved in transmitting signals including kinases and phosphatases.

**CAMB 633 Advanced Seminar in Gene Therapy 1 c.u. (Spring semester odd-numbered years)**

This year's Advanced Seminar in Gene Therapy will cover controversial topics in the field.  It will meet on Wednesdays from 4:30 - 6:30.  The goal of this seminar is to provide graduate students with an understanding of the challenges, both experimentally and practical, that face the gene delivery field.  At least two sessions will deal with ethical issues.  With the exception of the first class meeting, each of the weekly, two-hour sessions will be devoted to a discussion of two recent papers.  All students are to have read the papers.  Evaluation will be based on attendance (required), active participation, and preparation of reviews of papers.  Students will be introduced to the process of manuscript review and will be asked to provide critical reviews for two manuscripts.

**CAMB 691 Advanced Topics in Cell Biology & Physiology 1 c.u. (Spring even-numbered years)**

This course, together with its companion CAMB 692, offers an advanced, in depth analysis of selected topics in cell biology and physiology.  CAMB 691 and 692 are complementary courses that focus on different aspects of cell biology; these courses are offered on an alternating basis in the spring semester.  The courses can be taken in either order, but require BIOM 600 or an equivalent background in basic cell biology.  CAMB 691 will focus on key issues at the forefront of research in the areas of (1) channels and transporters, (2) protein trafficking through cellular pathways, and (3) cytoskeletal dynamics and molecular motors.  The course format pairs faculty presentations with student-led discussion sessions highlighting important papers from the primary literature.  Students will be evaluated on their presentations, their participation in class discussions, and weekly problem sets.  Offered alternately in the spring semester with CAMB 692.

**CAMB 692 Advanced Topics in Cell Biology and Physiology II 1 c.u. (Spring odd-numbered years)**

Cells in complex organisms are required to adapt rapidly in a changing environment. Maintaining homeostasis while performing specialized functions requires that cells respond to extracellular signals as well as fluctuations in a host of intracellular metabolites. This course will cover selected topics and general principles related to signal transduction and the control of metabolic flux in living cells. The course format will include student-led discussion sessions both providing an overview of a topic as well as focusing on important papers from the primary literature. Students will be evaluated on their presentations and participation, as well as problem sets.

**CAMB 752/GCB 752 Genomics 1 c.u. (Spring semester)**

Recent advances in molecular biology, computer science, and engineering have opened up new possibilities for studying the biology of organisms. Biologists now have access to the complete set of cellular instructions encodedin the DNA of specific organisms, including dozens of bacterial species, the yeast Saccharomyces cerevisiae, the nematode C. elegans, and the fruit fly Drosophila melanogaster. The goals of the course are to 1) introduce the basic principles involved in mapping and sequencing genomes, 2) familiarize the students with new instrumentation, informatics tools, and laboratory automation technologies related to genomics; 3) teach the students how to access the information and biological materials that are being developed in genomics, and 4) examine how these new tools and resources are being applied to specific research.

**HCMG 899 Management and Economics of Pharmaceutical, Biotech and Medical Device Industries 1 c.u. (Spring semester)**

This course provides an overview of the management, economic and policy issues facing the pharmaceutical, biotechnology and medical device industries. The course perspective is global, with emphasis on the U.S. as the largest and most profitable market. Critical issues we will examine include: R&D intensive cost structure and rapid technological change; biotechnology and genomics startups and alliances with the pharma industry; a complex global marketplace in which prices are regulated in most countries and customers include governments and insurers, as well as physicians, pharmacists and consumers now reachable through DTC; intense and evolving M&A, including mergers, joint ventures, and complex alliances; government regulation of every business function: R&D, pricing, manufacturing and promotion; and global products and multinational firms. We use industry and Wharton experts from various disciplines to address these issues.