CELL AND MOLECULAR BIOLOGY
(MD) {CAMB}

L/R 421. (BIOL421, BIOL528) Molecular Genetics. (A) Weinberg. Prerequisite(s): Intermediate level course in Genetics/Molecular Biology (equivalent to Biol 221).

A detailed analysis of gene structure and expression in both prokaryotic and eukaryotic organisms. Advances in DNA technology and genomics will be emphasized. The application of these advances to the molecular genetic analysis of development, cell function, and disease will be discussed.

480. (BIOL480) Advanced Cell Biology. (A) Wei Guo. Prerequisite(s): College level biochemistry and cell biology.

This course is designed for beginning graduate students and advanced undergraduate students with a particular enthusiasm for Cell Biology. CAMB/BIOL 480 does not attempt to cover all aspects of cell biology, and is therefore not appropriate for students seeking a lecture course that provides a comprehensive survey of the field. Rather, the primary objective of this course is to teach those students considering a career in the biomedical sciences how to read, discuss, and question research papers effectively. Intensive classroom discussions focus on the experimental methods used, results obtained, interpretation of these results in the context of cell structure and function, and implications for further studies. There is no assigned text; students learn to critically evaluate current literature by reading original papers on selected topics in modern cell biology. Accordingly, class participation/discussion is essential and the grade will be determined significantly by that. In addition, there will be two exams including answering short questions and an assay critiquing an original paper that is selected on a topic in Cell Biology.

SM 482. (BIOL482) Current Topics in Plant Molecular Biology. (M) Prerequisite(s): BIOL 205 or permission of instructor.

Lectures and student seminars on topics in plant molecular genetics, cell biology, physiology, development and other areas of current research in plants.

483. (BIOL483) Epigenetics. (B) Wagner. Prerequisite(s): BIOL 221.

This course will investigate epigenetic phenomena: heritable alternative states of gene activity that do not result from altered nucleotide sequence. Recent findings suggest an important role of these phenomena in normal development, as well as in oncogenesis. Many, but not all, epigenetic phenomena are based on the fact that in the organism DNA is organized into a higher order structure, the chromatin. We will therefore first discuss the implications of chromatin for gene activity. We will then investigate epigenetic phenomena such as DNA methylation, genomic imprinting, RNA interference, silencing, and co-suppression. This course is a combination of lecture and discussion using current scientific literature.

SM 486. (BIOL486) Chromosomes and the Cell Cycle. (B) Lampson, M. Prerequisite(s): The course is designed for advanced biology students who have taken BIOL 202 or equivalent. It is also open to graduate students.

Life depends on the propagation of genetic material from one generation to next through cycles of genome replication and cell division. The genome is copied by the parent, and one exact copy is inherited by each daughter cell. We will treat chromosomes as discrete entities, rather than collections of genes, that are replicated and divided with high fidelity to ensure that the genome remains stable over many generations. By reading selected primary literature covering several decades, we will build an understanding of the cell cycle by focusing on chromosomes and the associated molecular machinery. We will explore mechanisms that underlie replication and division, particularly control mechanism that maintain genome integrity and are critical to prevent disease. The goal of the course is to develop a picture of the cell cycle by examining some of the key experiments and insights that have led to our current understanding.

There is no textbook for the course. Readings from the primary literature will be assigned for each meeting and provided as pdf files. Presentations of these papers and class participation, including questions and critical evaluation, are an essential part of the course. Grading will be based on one in-class exam during the semester (30%), a final paper (30%), and class participation (40%, including paper presentations).

510. (IMUN510) Immunology for CAMB Students. (B) Y. Chen, G. Silvestri, J. Wherry. Prerequisite(s): BIOM 600 or instructor permit. Priority given to students in the MVP & GTV programs of CAMB. CAMB students only.

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.

The course is divided, by topic, into three parts. The first deals with innate and adaptive immune mechanisms, the structure, function, and molecular biology of antigen receptors and major histocompatibility complex molecules; the development and differentiation of lymphocytes and other hematopoietic cells involved in immunity and mechanisms of lymphocyte circulation and memory. The second part will cover the immune response in infection by bacteria, viruses and parasites and how this impacts on vaccine design and active immunization strategies. The course concludes by focusing on the immune system's role in pathological states such as cancer, allergy, graft rejection and auto-immunity.

The formal part of the course is comprised of two 1.5 hour lectures per week. In addition each week there will be an informal 1.5-hour meeting, on Fridays, which will be used to introduce the students to specialized techniques used to measure immune responses or to discuss topical issues relating to the application of immunological knowledge in fighting disease with emphasis on the primary literature in the field. There will be two exams. The first will be taken after part I and the second after part II and III of the course.

511. Principles of Development. (B) M. Mullins D. Kessler. Prerequisite(s): Previous courses in molecular and cellular biology are recommended. Undergrad background in cell biology and molecular biology required. NON-BGS students require permission from course directors to register.

This graduate course, which will include lectures and readings from the literature, is designed to provide a foundation in the principles of developmental biology. Topics covered will include: fertilization and cleavage, pattern formation, gastrulation, germ layer formation, tissue specification, morphogenesis, tissue differentiation, organogenesis, stem cell biology, and developmental evolution. The use of modern molecular biology, genetics, and embryological manipulations will be discussed in the context of the analysis of developmental mechanisms.

512. Cancer Biology and Genetics. (B) John Lynch, Kate Nathanson. Prerequisite(s): BIOM600 or course director permission. Non-CAMB students must contact the course director prior to registration. Students are permitted to audit this class for non-credit with the permission of the course director.

The course objective is to introduce the students to important and current concepts in Cancer Biology and Cancer Genetics. The lectures are organized into 4 broad thematic groups: A) Cell-Autonomous Mechanisms (e.g., tumor suppressor and oncogene function, DNA repair pathways, senescence, apoptosis); B) Non Cell-Autonomous Mechanisms (e.g., tumor microenvironment, hypoxia, angiogenesis); C) Organ Systems (e.g., pancreatic cancer, hematopoetic malignancies); and D) Therapeutic Approaches (e.g. protein kinase inhibitors, immunotherapy, radiation therapy). The organizers, along with faculty from the School of Medicine, the Wistar Institute and CHOP, with expertise in the corresponding areas provide lectures for the course. The students are expected to present, and participate in discussions of one or more key recent papers at Journal Clubs that are held at the end of each thematic group. There will be mid-term and final exams of short essays relevant to the lectures.

SM 513. (GCB 513) Evolution in Cancer. (A) Dr. Carlo Maley and Dr. Lauren Merlo. Prerequisite(s): Permission of the instructor.Preference is given to students who have completed CAMB 512 and medical students.

Cancers evolve by mutation and natural selection. This is the basis for both why we get cancer and why it so hard to cure. We will survey the cancer literature through the lens of evolutionary and ecological theory and review how that theory does and does not apply to cancer biology. This seminar is restricted to graduate students.

This course is a graduate seminar course with both student and faculty presentations and discussions.

SM 518. Current Topics in Ion Channels. (C) Deutsch, C. Prerequisite(s): Basic knowledge of ion channels,Cell 600 or equivalent.

The course is a seminar format, specifically a journal club format, targeted to graduate students and MD/PhD students interested in ion channels. It meets for one hour, once a week for graduate students and once every other week for the entire group with formal presentation. On alternate weeks a faculty member meets with students to discuss and review the contents of each selected article for the subsequent week's presentation. This is an elective course meant to excite and intellectually enlighten students regarding the latest advances in ion channel research. It includes a wide range of ion channel topics from basic biophysics, structure, and physiology to cell biology and clinical applications. It is attended by faculty, students, and postdocs from the departments of Physiology, Pathology, Neuroscience, Pharmacology, Biochemistry & Biophysics, Psychiatry.

We require a written critique of each paper presented by other participants during the semester, submitted prior to the formal presentation of the paper. This critique will be graded by a faculty member, as will the student's participation in both the preparatory sessions and formal presentation sessions. In addition, the student will make one formal presentation, also graded by a faculty member. A final grade would be based on all three of these components.

SM 526. (BIOL526) Experimental Principles in Cell and Molecular Biology. (A) Cashmore. Prerequisite(s): Permission of instructor.

The course aims to introduce principles of current experimental techniques used in modern biology.

SM 530. The cell cycle and cancer. (A) Diehl, Alan; McMahon, S; Assoian, R. Prerequisite(s): Prerequisite of CAMB 512 and/or BIOM 600 or equivalent graduate level advanced cell biology course. Anyone without BIOM600 or equivalent must obtain instructor permission.

This seminar course will focus on molecular and biochemical events that regulate cell cycle transitions and their relevance to human cancer. Topics will include control of the G1/S, G2/M transitions and S-phase initiation/progression. Participants will gain an understanding of the specific roles played by cyclins, cdks, and their inhibitors. The regulation of the cell cycle by tumor suppressor genes such as p16, Rb and p53, and by oncogenes such as cyclin D, cdc25A, MDM2, and c-myc, will also be explored. Where appropriate, the focus will be on understanding regulation of cell cycle control through transcriptional control of gene expression, protein-protein interactions, posttranslational modifications, (eg. phosphorylation), or regulation of protein stability, (eg. via ubiquitin-targeted degradation). Although achieving an improved understanding of mammalian cancer is a goal of the course, much of our knowledge of the cell cycle derives from work done in more genetically tractable organisms such as yeast, drosophila, and xenopus. Therefore a great deal of emphasis will be placed on studies performed in these model systems.

532. (PHRM532) Human Physiology. (A) Kevin Foskett. Prerequisite(s): Although not a formal prerequisite, a good foundation in cell biology at the level of BIOM/CAMB 600 (or an equivalent upper level undergraduate course) is strongly recommended. A general understanding of the chemistry and biochemistry of macromolecules, and of basic molecular biology will also be assumed. This course is not open to undergraduate students.

This course will present a survey of the physiology of most of the major organ systems. It will integrate knowledge of cellular and molecular mechanisms into an understanding of function at the tissue, organ, and organism levels. It will begin with a brief review of membrane physiology, followed by electrophysiology and signaling in nerve. Then, after a brief outline of neural control systems and their role in homeostasis, it will present motility and muscle, the cardiovascular system, respiration, the renal and gastrointestinal systems, and selected topics from the endocrine system. As well as providing a basis of integrative physiology for students in fields such as bioengineering and pharmacology,it should be of interest to students of cellular and molecular biology and genetic engineering who will need to appreciate the roles of specific systems and molecules at higher levels of organization.

SM 534. Seminar on current genetic research: Modeling Human Disease in Diverse Genetic Systems. (B) A. Gitler, T. Lamitina. Prerequisite(s): CAMB 605 or CAMB 542 or permission of the instructor. Class is not open to undergraduates and will give priority to CAMB graduate students.

An advanced seminar course emphasizing genetic research in model organisms and how it informs modern medicine. Each week a student will present background on a specific human disease. This is followed by an intense discussion by the entire class of ~2 recent papers in which model organisms have been used to address the disease mechanism and/or treatment. As a final assignment, students will have the opportunity to write, edit, and publish a "News & Views" style article in the journal "Disease Models and Mechanisms". Offered spring semester.

541. (BIOL540) Genetic Systems. (B) Poethig. Prerequisite(s): A college-level introductory course in genetics / molecular biology.

The genetics of different organisms (mouse, Drosophila, C.elegans, Arabidopsis, etc.) will be considered with the various techniques employed to study the action of genes in these organisms.

SM 542. (PHRM542) Topics in Molecular Medicine. (A) Section 401: Wells, Kahn. Section 402: Atchison.

TiMM is planned as a once-weekly seminar course whose goal is to introduce students to the ways in which biomedical research can provide new insights into clinical medicine and, conversely, how knowledge of clinical disease impacts scientific discovery. There are two sections for the course -- 401 and 402. Section 401 is for first year MD/PhD students only and section 402 is for VMD/PhD and PhD students.

SM 546. Seminar in Medical Virology: HIV Pathogenesis. (J) D. Weissman, R. Collman, L. Montaner. Prerequisite(s): Strong background in cell biology, immunology or virology fulfilled by: 1st yr CAMB (previous BGS courses); CD - Module 1 of med school curriculum; very strong UG background. Instructor permission required for non-CAMB graduate students.

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, and d) vaccine develpment. Offered spring semester.

One two-hour class weekly for the course of the semester. The first class will include two 45-minute introductory lectures given by the course instructors. Each week, a student will lead the class in the dissection and d iscussion of published papers on a specific topic. The format that we will follow will be a 20-minute introduction presented by the

student followed by the analysis of one to two articles, which will be presented by the student and discussed by the class.

547. Fundamental Virology. (B) F. Bushman. Prerequisite(s): Prior coursework in genetics and biochemistry. First priority to MVP students, then CAMB students, then GCB students.

The course provides a detailed introduction to animal virology aimed at graduate students in the biomedical sciences.

548. Bacteriology. (B) Zhu, J;. Prerequisite(s): Intro to Microbiology/Bacteriology. Priority given to graduate students.

The format of this course will be two lectures and one student presentation/paper discussion per section. The course will begin by introducing approaches to the analysis of host-pathogen interaction. It will cover the general concepts and recent advance of how bacterial pathogens prepare to infect the host, the successful strategies bacteria used to infect the host, and how they survive after the infection.

549. Parasites and Parasitism. (B) Farrell, J;. Permission needed from course director for non-CAMB students.

Parasites infect over one quarter of the world's population and parasitic diseases are a leading cause of death globally. "Parasites and Parasitism" is to be offered to first and second year MVP students over a seven-week block in the spring semester. The course will begin with an introduction to the major protozoan and helminth pathogens of humans, their geographic distribution and the diseases they cause. Subsequent lectures will emphasize a variety of topics from the current research literature using specific parasitic pathogens as examples. These will include how various protozoans enter cells and adapt to different intracellular habitats or how helminths utilize different strategies to survive within the GI tract. Malaria and schistosomiasis will serve as examples for how parasites cause disease while trypanosomes and leishmaniasis will be discussed as models for how parasites survive or evade immune elimination. Finally, several helminth and protozoan systems will be used to demonstrate the intimate association between parasite and vector that leads to efficient transmission. In addition to lectures, weekly discussion sessions will provide an opportunity for students to review papers or research specific topics and present their findings to their colleagues.

550. Genetic Principles. (B) Sundaram, M. Course open to BGS students only, priority given to CAMB and GCB students. Students outside of CAMB or GCB require permission from course director to register.
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. Offered spring semester.

578. (BIOL488, INSC578) Advanced Topics in Behavioral Genetics. (J) Abel/Bucan. Prerequisite(s): Permission of Instructor.

This course focuses on the use of genetic techniques to study the molecular and cellular bases of behavior. Particular emphasis will be given to the role of genetic approaches in understanding the biological processes underlying memory storage, circadian rhythms, and neurological and psychiatric disorders. Reverse genetic approaches utilizing gene knockout and transgenic technologies, as well as forward genetic approaches using mutagenesis and quantitative genetic techniques will be discussed.

597. (INSC597) Developmental Neuroscience. (A) Michael Granato, Jon Raper. Prerequisite(s): Background in introductory biology (molecular and cellular biology recommended.).

The developmental neuroscience course opens with a brief summary of classical experimental embryology and key developmental concepts. Topics covered in the course include: vertebrate and invertebrate pattern formation; neural cell determination; growth cone guidance; synapse formation and plasticity; programmed cell death; neural growth factors; special sense organ development. Each week includes two lectures and a small group discussion in which one or two important papers are analyzed in detail. Each student must write three short grant-style reports (approximately 2 pages each). No exams are given.

599. Introductory Lab Rotation. (C)

SM 601. Advanced Microbiology Seminar. (A) Krummenacher, C. Lieberman, P. Weiss, S. Bergelson, J. Non-CAMB students must obtain instructor approval.

This seminar course covers current topics and important concepts in virology. Students will read papers from the literature on specific topics in virology, and then present a seminar with the guidance of a faculty member. Grades will be based on the quality of the seminar(s) and participation in class discussions.

SM 605. CAMB First Year Seminar. (A) Doug Epstein.

Topics and course instructors vary yearly. The seminar focuses on classic papers and the intellectual development of thought in cell and molecular biology. Multiple sections are taught by faculty from the different programs within the Graduate Group. Required course for CAMB PhD Students. Other BGS students eligible space-permitting.

SM 608. Regulation of Eukaryotic Gene Transcription. (A) T. Kadesch. Prerequisite(s): BIOM 555 (or equivalent) and permission of instructor. Exceptions for MD/PhD students. CAMB students will receive priority.

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

609. (IMUN609) Vaccines and Imunization Therapy. (A) David Weiner, Ph.D., Paul Offit, M.D., Dr. Jean Boyer.

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.

Initial lectures review immune mechanisms believed to be responsible for vaccine induced protection from disease. Subsequent lectures build on this background to explore the science of vaccines for diverse pathogens, including agents of bioterrorism as well as vaccines for cancer. An appreciation for the application of laboratory science to the clinical development of vaccines is provided in the next section of the course along with lectures, which focus on the ethical implications of vaccines in different situations. The financial implications of specific vaccines on the global community is one specific focus of the course.

The course is lecture style and has a required reading to provide the student background for the specific topic. Students are graded on course participation, a project and a final written exam. The project is to propose in a written report a vaccine strategy for a current pathogen of importance that does not as yet have an effective vaccine. Strategies used should build on the material presented in the class lectures. The course is intended for graduate students or medical students in various MS, Ph.D., or MD/Ph.D. programs on the campus as well as local scientists and professionals in the community. As a prerequisite students should have taken biology, biochemistry, or immunology courses at the advanced college level.

610. Molecular Basis of Gene Therapy. (A) Wilson. Prerequisite(s): Background in biochemistry, cell biology, and molecular biology. Any student not enrolled in a BGS graduate course who wishes to take this course must receive permission from Dr. Wilson (wilsonjm@mail.med.upenn.edu).

This is a team-taught, survey course that focuses on the basic science relevant to achieving efficient and effective gene transfer in animal models and humans for the treatment of disease. The course includes a unit devoted to a variety of vectors useful for gene transfer, with the remainder of the course devoted to the study of current gene therapy approaches using specific diseases as models. Prior background in biochemistry, cell biology, and molecular biology is essential. Aspects of organ system anatomy and physiology, virology, and immunology that are relevant to the course material are included in the course. Because of rapid movement in this field, specific topics vary somewhat from year to year. Offered every fall.

615. (BMB 518) Protein Conformation Diseases. (B) Yair Argon;Harry Ischiropoulos. Prerequisite(s): BIOM 600 or equivalent.

Protein misfolding and aggregation have been associated with a number of human diseases, ranging from Alzhemier's and Parkinson's Disease to Respiratory Distress Syndrome, alpha(1)-antitrypsin deficiency and Mad Cow Disease. This course will cover the common principles underlying such diverse diseases. The course will consist of lectures, directed readings, and student presentations and will cover seminal and current papers on the cell biology of conformational diseases. Examples of topics are cellular inclusion bodies, protein degradation pathways (proteosome vs. ER-associated degradation), effects of protein aggregation on cell function and mutations which lead to autosomal dominant diseases.

Target audience is primarily 1st year CAMB students or other students interested in acquiring a cell biological perspective on the topic. MD/PhDs and Postdods are welcome.

SM 618. Introduction to Viral Pathogenesis. (J) Neal Nathanson. Prerequisite(s): Introductory courses in virology (or microbiology) and in immunology are recommended. First priority to virology students - 2nd priority to CAMB students.

This course reviews the fundamentals of viral pathogenesis, and covers the following general areas: virus cell interactions, viral tropism and cellular receptors, sequential steps in viral infection; immune responses to viral

infections, virus-induced immunopathology, virus-induced immunosuppression; viral virulence; iral persistence, oncogenic viruses, host susceptibility to viral diseases, HIV and AIDS; viral vaccines.

SM 620. Thematic Concepts in Developmental Biology. (A) DiNardo, S. Prerequisite(s): BIOM 600 (CELL 600); Gene Regulation.

The goal of this seminar course is to foster discussion about general strategies used by cells and organisms to solve fundamental problems during development. This is not a survey course in Developmental Biology. Rather, we focus on an overarching theme for the semester (see below), enabling us to define the issues central to that theme, and explore attempts to uncover solutions using different model systems. Primary research papers are assigned for discussion, and all students are expected to contribute thoughtfully and energetically to the discussion each week. Prior years' topics have been: "Cell migration in Development", "Evolutionary Development", "Developmental links to Disease", "Cell Biology in Development", "Stem Cells", "Rulers, Clocks & Oscillators in Development". Offered fall semester.

SM 630. Topics in Human Genetics and Disease. (A) N. Spinner, T. Shaikh, , E. Shore, M. Devoto, S. Grant. Prerequisite(s): CAMB 550 or discuss with faculty.

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.

Every week, students are expected to participate in a 2-hour class session, and two students will present recent publications in human genetics and disease. After each session, instructors will meet with presenting students for 30 min. to provide individual feedback. Course directors will attend each class, and guest preceptor with relevant scientific expertise may also participate. Students will be assigned readings for the first half of the course, and then select their own papers for the second half of the course. Presentations will be prepared in consultation with course directors. Students must meet with instructors at least one to two weeks prior to the presentation date. In class, the student discussion leaders will i) present background information necessary to understand the assigned paper (10-15 min.), ii) lead discussion of the paper, focusing on critical evaluation of the methods and results, and iii) talk about the future directions for this research.

A short written assignment will be due by the end of the course. This written work will be in the form of a review piece or "news and views" format commonly seen in scientific journals. The topic of this review can be based on one of the two topics the student presents in class, or on a separate topic approved by the instructors. The review should be approximately 1,000 words or less (no more than 4 double-spaced pages).

Grading: Students will be evaluated based on class participation (25%), their first presentation (25%) and their second presentation (25%), and the written assignment (25%).

SM 631. (PHRM631) Cell Adhesion and the Cytoskeleton. (A) Dave Boettiger, Jeff Field. Prerequisite(s): BIOM600 or similar course in molecular cell biology. Limited to BGS, SAS, and Engineering graduate group students. Others by permit only.

This is a seminar course in the molecular mechanisms underlying the organization, dynamics and signaling through cell adhesion and the cytoskeleton. The course will cover the basic principles and biology of the molecules involved in cell-cell and cell-matrix adhesion and their interface with the cytoskeleton. This is an advanced seminar course. Students will present papers that will be selected to highlight classical and emerging methods including genetic screens, pharmacological studies, physical approaches, and genomic approaches. The issues addressed include regulation of cell adhesion, control of cell motility, and roles of adhesion and adhesion signaling in cancer and cardiovascular disease. Students will also present one paper of their own choosing. All presentations will be prepared in consultation with a faculty member with expertise in the specific area. The course requires a minimum of seven registered students to be offered.

632. (PHRM632) Cell Control by Signal Transduction Pathways. (B) X. Hua, J. Field. Prerequisite(s): BIOM 600, cell biology, or other course focusing on cell and molecular biology. Priority given to CAMB graduate students. Open to non-CAMB graduate students who have taken BIOM 600 or other related course. Not open to non-graduate students.

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-_, 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 sifnals including kinases and phosphatases.

In the first half of the course, invited faculty members will pick 2 relatively recent papers from their field that aren't necessarily definitive, but are interesting and could lead to new potential questions/areas for future investigation.

Each paper will be assigned to a student, who will meet with the faculty mentor prior to the class to discuss the paper and their presentation. During the class, students will present each paper for approximately 45 minutes with time for discussion. Students will present the important background, break down the paper, look for strengths and weakness and come up with a plan of what the next set of experiments could or should be. In the second half of the course, students will independently pick a signal transduction paper for in-class presentation and will also write a short "News and Views" style article based on the paper they have chosen. The goal is that the course will lead students to think more about experimental design and interpretation rather than re-iteration of the biology they have learned as undergraduates.

SM 633. Advanced Seminar in Gene Therapy. (K) Dr. James M. Wilson. Prerequisite(s): Background in biochemistry, cell biology, molecular biology, and immunology.

This year's Advanced Seminar in Gene Therapy will cover controversial topics in the field. It will meet on Wednesdays from 4:30 - 6:30pm. 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.

Students who are not in CAMB need to request permission from the course director, Dr. James Wilson, via email: wilsonjm@mail.med.upenn.edu.

SM 637. Gene Therapy: Vectors, Immunology and Disease. (J) Chen, Albelda, Bushman, Paterson, Riley, Stedman, Weiner, Wilson, Wolfe, and Xiao. Prerequisite(s): Background in molecular biology, virology and immunology.

This seminar course is designed to provide students with a cohesive understanding of virology and immunology of gene therapy. Three major themes will be covered: vectors, vector immunology and gene therapy of genetic and acquired diseases. The topics to be covered are viewed as an extension of topics covered in CAMB 610 (Molecular Basis of Gene Therapy), although CAMB 610 is not an absolute prerequisite for this seminar. Each class will consist of a brief introduction by an instructor, reviewing background information related to the theme discussion. The topics are explored through discussions, led by faculty, of seminal research articles. Students are expected to have thoroughly reviewed the assigned articles and be able to present and discuss various aspects of the papers. Regular attendance and active participation in the discussions, which focus on critical evaluation of experimental design, data presentation and interpretation, is essential. Student evaluation will be based on attendance, preparation, and in-class participation.

SM 638. Advanced Seminar in Cell Death and Survival. (A) X. Yang, W. El-Deiry, B. Keith. Prerequisite(s): BIOM 600. Instructor permit needed for anyone who has not taken BIOM600.

The objective of this seminar course is to familiarize students with the pathways of cell death and cell survival in mammalian species as well as other organisms. The course has a strong emphasis on cancer and clinical applications of basic signaling. Specific areas that are covered include 1) the history of apoptosis research leading to the Nobel Prize in Medicine in 2002, 2) the structure, biochemical modifications and interactions that regulate death signaling in the cell intrinsic and extrinsic pathways, and 3) in vivo models that demonstrate physiological relevance. Additional emphasis is placed on understanding cell survival pathways including negative regulators of cell death and cross-talk with tumor suppressor and oncogene survival pathways.

An effort is made each semester to include emerging topics including autophagy, ER stress signaling pathways, and the impact of micro-RNAs, as well as the tumor microenvironment on cell survival and cancer. There is a strong interest in therapeutic applications and future directions that are always part of the discussions and later in the course become the main focus. Students are expected to read and to participate in the discussion of all assigned papers, and students are responsible for presenting the papers and leading discussions on a rotating basis. In addition students prepare a News & Views type of report on an additional topic of interest.

SM 650. DNA Damage Checkpoints and DNA Repair. (B) E. Brown, C. Bassing, and R. Greenberg. Prerequisite(s): Previous completion of CAMB 530 or equivalent introduction to cell cycle and DNA damage response regulation is recommended. Priority will be given to students in the Cell and Molecular Biology Graduate Group, followed by other Biomedical Graduate Studies graduate groups. If class fills, priority must be given to Cancer Biology Students.

DNA damage checkpoint and repair genes are important suppressors of cancer and aging. These processes function as part of a complex interconnected network of DNA recognition and processing, checkpoint signaling cascades and DNA repair. Because these processes preserve genome integrity, how they cooperate with one another is directly related to their ability to suppress cancer and aging. To study this emerging research area, students in CAMB 650 critically evaluate key research findings published in the last five years. In addition to providing an advanced understanding of DNA damage checkpoints, DNA repair and the connections of these processes with cancer and aging, this course is

designed to allow students to gain experience in critiquing scientific literature both independently and through group discussion.

Take home questionnaire assignments and participation in class discussions willmake up 50% and 30% of each student's final grade, respectively. In the final two weeks of the course, each student will study and propose a future research topic in field of DNA damage responses, cancer and aging. Students will be expected to pose a question and propose how the question will be experimentally answered. In the final week of the course, each student will turn in a one page summary of this proposal and will present their proposal to fellow students for discussion and critique. The one page proposal, presentation and critique will comprise 20% each student's final grade.

SM 691. Advanced Topics in Cell Biology & Physiology. (J) Holzbaur. Prerequisite(s): BIOM 600 or a similar survey course in cell biology. Permission needed for all non-CAMB students. Permission needed for all non-CAMB students.

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.

SM 692. Advanced Topics in Cell Biology and Physiology II. (K) Morris Birnbaum. Prerequisite(s): BIOM 600 or a similar survey course in cell biology, or the permission of the instructor. Permission needed for non-CAMB students. Priority given to CAMB graduate students.

An in-depth consideration of key topics in cell biology and physiology. This course will focus on three major aspects: (1)signal transduction; (2)cell cycle and apoptosis; and (3)cell division. The course format will include both faculty lectures and student-led discussion sessions focusing on important papers from the primary literature. Students will be evaluated on their presentations and participation, as well as problem sets. Offered alternately in the spring semester with CAMB 691.

695. Scientific Writing. (B) E. Golemis, M. Betts, J. Lok, J. Katz, H. Nelson, J. E. Russell. Prerequisite(s): BIOM 600, BIOM 555 and CAMB 605. Course open only to second year CAMB graduate students. If space permits, will open up to non-CAMB BGS graduate group students.

This 6-week course is designed for second year graduate students preparing for qualifying examinations. This course first introduces students to basic scientific writing skills. Participants will review the general principles of clear, persuasive writing, and will apply these principles to writing for a scientific audience. Particular emphasis will be placed on the structure, style, and contents of scientific papers and grant proposals. Each week students will complete a brief written exercise; the majority of class time will be spent in discussing student writing.

Evaluation: The goal of the course is to encourage active interaction among students. Ideal endpoints include improved self-editing, and development of effective strategies for offering and receiving editorial recommendations among peers. Grading will be predominantly based on class attendance and participation, not on the quality of the writing itself.

696. Parasitology Research. (B) D. Artis, D. Greenbaum.

SM 697. Biology of Stem Cells. (B) G. Cotsarelis, W. Pear. Prerequisite(s): BGS Core Courses. Non-BGS students will be admitted only with permission of the course directors.

The goal of this course is to introduce graduate students to the field of stem cell biology through lectures and reviews of important contributions from the literature. Topics include stem cell niche biology, epigenetics and reprogramming, tissue specific stem cells such as hematopoietic and epithelial stem cells, tissue regeneration, tissue engineering, and ethical and legal issues of stem cell and regeneration biology. The future potential and challenges in stem cell and regeneration biology will be discussed. Important aspects of stem cell identification and characterization utilizing multiple model systems will also be a focus. Offered Spring Semester.

698. Elective Tutorials in Cell Biology. (A) Burkhardt, Janis. Prerequisite(s): Cell 600 or an alternative senior undergraduate, graduate, or professional school course in Cell Biology.

This tutorial course is designed to provide students with an in-depth knowledgeof a specific topic in cell biology through directed readings with a faculty member. The tutorial can be used to enable students to become more deeply acquainted with the literature related to their thesis projects or to expand on a topic that the student found interesting in one of their basic courses.

SM 752. (GCB 752) Genomics. (B) Riethman, Cheung.

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.

995. Dissertation