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422. (BIOL422) Genomics of Human Disease and Evolution. S. Tishkoff.Prerequisite(s): BIOL 221.

In this course we will discuss the identification and characterization of genetic diversity in the human genome, the genetic basis of normal variable traits, and the genetic basis of human disease. The study of the human genome increasingly impacts almost every aspect of our society, from medicine to law enforcement to how we view ourselves. The focus of this course will be to apply concepts and methods of genetics and genomics analysis (gene mapping, genome sequencing, epigenetics, gene expression) to better understand the genetic basis of both normal variable traits as well as disease for Mendelian (those traits influenced by a single gene) and complex (those traits influenced by multiple genes and environment) traits. We will discuss how to distinguish the evolutionary and demographic forces (i.e. mutation, migration, selection, population size) that influence genotypic and phenotypic variation within and among human populations. We will discuss how genomics and population genetics methodologies are being applied to study modern human origins, analysis of ancient DNA, ancestry, and population history.

We will also discuss the implications of these studies for personalized medicine. An ability to understand human genetic and genomics analyses will serve you well since in your lifetime you are almost certain to be faced with a major decision involving your heredity; and society will be forced to make major reforms in medicine, business, and law because of increasing genomics data. By the end of this class you should have a better understanding of the science behind the study of the human genome.

431. (BIOL431) Genome Sciences and Genomic Medicine. B. Gregory.Prerequisite(s): BIOL 221; BIOL 421 strongly recommended. Graduate students do not need permits or prerequisites as those will have been taken in undergraduate studies

This course will be a focused study of genomes, genomic techniques, and how these approaches are and will be used in diagnosing and treating human disease. Topics will include genome sequencing, analysis of sequences and microarrays, and new techniques including high-throughput sequencing and reverse genetic analysis with a focus on genome-wide mutant collections.

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.

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

This course investigates epigenetic phenomena: heritable alternate states of gene activity that do not result from alteration in nucleotide composition (mutations). Epigenetic mechanisms regulate genome accessibility and cell differentiation. They play a key role in normal development and in oncogenesis. For example both mammalian X-chromosome inactivation and nuclear transfer (cloning) are subject to epienetic regulation. Amongst the epigenetic mechanisms we will discuss in this course are chromatin organization, histone modification, DNA methylation and non-coding RNAs. The course is geared toward advanced undergraduate and beginning graduate students and is a combination of lectures, student presentations and researach presentations by guest speakers. Students will work with the current scientific literature.

SM 485. (BIOL485) The RNA World: A Functional and Computational Analysis. (B) B. Gregory.Prerequisite(s): BIOL 221 required. BIOL 421 strongly recommended. Graduate students will have satisfied prerequisites in their undergraduate studies

A focused study of genomic, biochemical, cellular, and molecular aspects of RNA. Topics of study will include RNA structure, RNA processing and turnover, splicing, ribozymes and riboswitches, RNA editing and modification, RNA interference, endogenous eukaryotic RNA silencing pathways, small RNA biology, computational methodologies for studying RNA biology, and RNA viruses. Lectures, student presentations, and discussions will be based on readings from the primary literature.

SM 486. (BIOL486) Chromosomes and the Cell Cycle. (B) Lampson, M..Prerequisite(s): The course section is limited to PhD students only.

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 a final paper in the form of a research proposal (50%) and on class participation (50%).

SM 493. (BIOL493) EPIGENETICS OF HUMAN HEA. (B)

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510. (IMUN510) Immunology. (B) G. Scott Worthen.Prerequisite(s): BIOM 600 or instructor permit. Priority given to students in the MVP & GTV programs of CAMB. Second priority to CAMB students in other programs. If slots remain, then Ph.D. students from other graduate groups by permit only. Ph.D. students only.

The purpose of this course is to provide 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 diseases, and its rolein immunopathological states such as autoimmunity and allergy. This is a required course for CAMB students in the Microbiology, Virology and Parasitology program and the Vaccine and Gene Therapy program, replacing IMMU 506 (Immune Mechanisms). It may also be used as an elective by CAMB students in other programs such as those from the Cancer Biology program and Cell Biology and Physiology program.

The course is divided into two parts. The first deals with innate and adaptive immune mechanisms, the structure, function, and molecular biology of antigen receptors and major histocompatibility complex molecules, and the development, activation, and differentiation of lymphocytes and other hematopoietic cells involved in immunity. The second part will cover the immune response in infection by bacteria, viruses, and parasites, and in pathological states such as cancer, allergy, and autoimmunity. The course is comprised of two 1.5-hour lectures per week.

EXAMS: There will be two exams. The first will be taken after part I, and the second after part II of the course. Both will be open book, in-class exams. The exam will consist of essay or brief answer questions based on experimental design and/or data. Each exam is weighed equally in determining the final letter grades of students. The grades are based solely on the exams.

511. Principles of Development. (B) M. Mullins & P. Seale.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: the germ line and piRNA, signaling pathways in development, pattern formation and cell specification, gastrulation, tissue differentiation, morphogenesis, cell polarity, epigbenetics in development, organogenesis, stem cell biology, regeneration, and developmental evolution. The use of moleculart biology, biochemistry, genomics and genetics, cell biology, and embryological manipulations will be discussed in the context of the analysis of developmental mechanisms.

512. Cancer Biology and Genetics. (B) Todd Ridky and Yi Fan.Prerequisite(s): BIOM600 or course director permission. Non-CAMB students must contact the course director prior to registration. Students are not permitted to audit this course.

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.

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SM 518. Current Topics in Ion Channels. (C) Deutsch, C..Prerequisite(s): Basic knowledge of ion channels, BIOM 600 or equivalent. Corequisite(s): Prerequisite must be confirmed before student can register.

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. A final grade would be based on both of these components.

SM 522. (BIOL522) Human Evolutionary Genomics. (J) S. Tishkoff.Prerequisite(s): Permission of director.

Advanced seminar on current topics in human genomics and human evolution. Topics include the methods used for mapping and sequencing genomes; phylogenetic and population genetic analysis; and detecting variation in the human genome. This course is designed for graduate students but advanced undergraduates with a strong background in genetics are also welcome.

SM 526. (BIOL526) Experimental Principles in Cell and Molecular Biology. (B) K. Gallagher.Prerequisite(s): This course section is limited to BGS/PhD students only.

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

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

Genetic analysis involves use of induced mutations and natural variation to study biological processes. This course presents the logic and technology of this approach in four model organisms (Drosophila, C. elegans, mouse, Arabidopsis) and humans.

SM 530. The Cell Cycle, Genome Integrity and Cancer. (A) Brown, Eric and Busino, Luca.Prerequisite(s): Completion of BIOM 600, BIOM 555 and/or equivalent graduate level course work. Anyone without such course work must obtain instructor permission. Corequisite(s): Preferential registration of Cancer Biology and CAMB students up to the maximum of 12 students applies. Permission to register is required upon exceeding the 12 student limit.

This seminar course focuses on molecular and biochemical events that regulate cell cycle progression and genome maintenance, and explores how these processes influence cancer etiology and treatment. Specific topics will familiarize students with the key principles and recent developments within these areas. These topics include CDK-Cyclins and their inhibitors, regulation of G1-S and G2-M phase cell cycle transitions, DNA damage checkpoints and repair, the impactof telomere loss and chromatin regulation, and how each of these processes affects cancer etiology and treatment. In depth reading and evaluation of resesarch literature will be primarily used to accomplish these aims, as well as provide instruction on rigorious experimental design and data interpretation.

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532. (PHRM532) Human Physiology. (A) Tejvir Khurana.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 primarily designed for 2nd year BGS students; 1st year students in BGS or other programs will require the permission of the instructor. This course is not open to undergraduates. Corequisite(s): Students with out BIOM 600 require the instructors permission.

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, the reproductive systems, environmental and exercise physiology. As well as providing a basis of integrative physiology for students in fields such as physiology, 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. (NGG 534) Seminar on current genetic research: Modeling Human Disease in Diverse Genetic Systems. (B) T. Jongens.Prerequisite(s): CAMB 605 or CAMB 542 or permission of the instructor. Priority for enrollment will be given to CAMB graduate students. Class not open to Master or undergraduate 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.

SM 542. (PHRM542) Topics in Molecular Medicine. (A) Section 401: Johnson, Kholi Section 402: Atchison, Mason. Section 402: Open to combined degree and BGS students; capped at 12 students total; non-BGS students must receive permission from course instructors.

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. HIV Virology & Pathogenesis. (J) R. Collman and K. Bar.Prerequisite(s): Strong background in cell biology, immunology or virology fulfilled by 1st yr CAMB (previous BGS courses) or Module 1 of med school curriculum. Course is limited to graduate students. 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 development. Offered spring semester.

One 1.5 to 2 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 discussion 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.

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547. Fundamental Virology. (A) Matthew Weitzman.Prerequisite(s): Prior coursework in molecular or cellular biology. First Priority to MVP students, then CAMB students, then GCB students.

The course provides an introduction to virology aimed at graduate students in the biomedical sciences.

578. (BIOL488, NGG 578) 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.

548. Bacteriology. (A) Zhu, J; Bushman, R..Prerequisite(s): none. Priority given to MVP 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 molecular mechanisms in bacterial replication, then cover detailed studies of host-bacterial interactions. The course 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. (A) Hunter, C. & Lok, 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 fall 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. & Grant, S.. Open to all PhD students in BGS, priority given to CAMB and GCB students. Students outside of BGS or in non-PhD programs require permission from the 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 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.

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597. (NGG 597) Neural Development, Regeneration and Repair. (B) Greg J. Bashaw and Wenqin Luo.Prerequisite(s): Cell 600 or equivalent. Students who are not in one of the BGS graduate programs need instructor permission.

The goal of this course is to examine the principles underlying nervous system development. It is not a survey course. Rather, the course will focus on selected topics, for which we will discuss the genetic, molecular and cellular strategies employed to study these problems in different model organisms. Emphasis is on how to interpret and critically evaluate experimental data.

Fall 2016 Topics: Specification and generation of Neuronal Diversity; Axon and Dendrite Tiling and Self-Avoidance; Axon Guidance at the Midline; Synapse Formation; Wiring the Olfactory System, Axon Regeneration, Somatosensory System Development, Stem Cell Replacement Strategies for Neural Repair.

Textbooks: No specific textbooks are required. The following texts are useful resources. Developmental Biology by Scott Gilbert; Development of the Nervous System by Sanes, Reh, and Harris; and Molecular and Cellular Approaches to Neural Development edited by Cowan, Jessell, and Zipursky.

Format: Each class is 1.5 hours in length. During the first hour, an assigned paper will be discussed in detail. During the last 20-30 minutes, faculty will introduce methods, concepts, and background information pertinent to the paper that will be discussed at the following meeting.

SM 608. Regulation of Eukaryotic Gene Transcription. (A) Z. Zhou, S. Liebhaber, D. Epstein.Prerequisite(s): BIOM 555 or equivalent (exception=MD/PhD students). Students are expected to bring their laptops to class. This course is limited to 14 participants. All interested students need permits from course directors before registering.

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

598. Immunology for Cancer Biologists. (A) Sandra Ryeom.Prerequisite(s): CAMB Students only, priority given to Cancer Biology students.

Themes: The contribution of both adaptive and innate immune cells to tumor progression and metastasis; Mechanisms of immune-mediated edition of tumors; Barriers to tumor immunity that contribute to tumor escape.

Objective of course: To learn and analyze the major aspects of the inter-relationships between the immune system and tumors. By the end of the class students should be able to answer the question: why do current immunotherapeutic approaches for cancer fail in the majority of patients? Based on the topics covered in the course, students should be able to define research avenues that will increase the efficacy of immunotherapies for cancer.

During the course, we will: 1. Interpret how the processes of immune editing, equilibrium and escape influence the development of tumors. 2. Assess the divergent and convergent roles of myeloid and lymphoid cells in supporting tumor cell growth and metastasis. 3. Understand the nature of tumor antigens recognized by innate and adaptive immunity. 4. Learn how tumors co-opt immunosuppressive components of the immune system to prevent their destruction; how tumors influence their microenvironment. 5. Devise experimental approaches to ascertain the role of cellular and molecular components of the immune system in the progression and control of cancer.

Class format and student evaluation: The course will consist of didactic lectures and student-led discussions of papers. Students will analyze experimental restults from published articles and synmthesize the data into current paradigms about tumor immunology. Students will be graded on participation (75%) in discussions in class on a weekly basis and on one formal presentation during the course (25%).

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SM 601. Advanced Virology Seminar. (B) P. Bates. Non-CAMB students must obtain instructor approval.

This seminar course covers current topics and important concepts in virology. Students will read selected papers on various topics in virology. Each subject will be illustrated by ground-breaking classic papers and innovative recent articles. Students will present a seminar under the guidance of a faculty member. Grades will be based on the guidance of a faculty member. Grades will be based on the quality of the seminar(s) and participation in discussion.

SM 605. CAMB First Year Seminar. (A) John Seykora.Prerequisite(s): None. Preference to CAMB students is given. Students outside of CAMB may be accepted space permitting.

Topics are selected by course instructors and student participants. Course instructors vary yearly. The goal of this course is to provide students with an opportunity to analyze, present, and discuss significant research papers in the field of cell and molecular biology in small group settings. The sections are taught by faculty from the different programs within the Graduate Group. This is a required course for CAMB PhD students. Other BGS students are eligible, space permitting.

609. (IMUN609) Vaccines and Immunization Therapy. (A) David Weiner, Ph.D., Jean Boyer, Ph.D., Paul Offit, M.D..Prerequisite(s): Biology, biochemistry at the advanced college level, college level immunology is recommended. Not limited to CAMB students, however first options are to CAMB students

Vaccination is perhaps the most successful medical technological 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 and immune therapies for the 21 century. 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, regulatory, ethical, and political issues and implications of modern vaccines and world health.

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 and studies of vaccines is provided in the next section of the course along with lectures, which focus on the regulatory, safety, and ethical implications of vaccines in different world situations. The financial implications of specific vaccines on global health is one focus of the course.

The course is lecture style with many, many guest lecturers who are experts in their particular area of vaccine development. There are required readings to provide the student context and background for the diverse lectures topic. Students are graded on course participation, and a final project/exam. The project is to design in a PowerPoint report a vaccine strategy for a current disease or pathogen of importance that does not as yet have an effective vaccine or immune therapy. 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.

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SM 630. Topics in Human Genetics and Disease. (H) E. Shore, M. Devoto, S. Grant.Prerequisite(s): CAMB graduate students having taken CAMB550, or students in MD/PhD, veterinary,genetic counseling or nursing programs with equivalent courses. Must have directors permission to register.

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%).

610. Molecular Basis of Gene Therapy. (A) Michael Milone.Prerequisite(s): Background in biochemistry, cell biology and molecular biology. Any student notenrolled in a BGS graduate program who wishes to take this course must get permission in advance from Dr. Wilson. Students should send their undergraduate and graduate transcripts (including spring semester) along with their request to Dr. Wilson via email: wilsonjm@mail.med.upenn.edu and copy Robin Hartley: hartleyr@exchange.upenn.edu.This class is not accepting Non-BG S masters students.

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.

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

Protein misfolding and aggregation has been associated with over 40 human diseases, including Alzheimer's disease, Parkinsons disease, amytrophic lateral sclerosis, prion diseases, alpha (1)-antitrypsin deficiency, inclusion body myopathy, and systemic amyloidoses. 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, effects of protein aggregation on cell function, model systems to study protein aggregation and novel approaches to prevent protein aggregation.

Target audience is primarily 1st year CAMB, other BGS graduate students, or students interested in acquiring a cell biological perspective on the topic. MD/PhDs and Postdoc are welcome. MS and undergraduate students must obtain permission from course directors. Class size is limited to 14 students.

SM 620. Thematic Concepts in Developmental Biology. (A) DiNardo, S., Speck, N..Prerequisite(s): BIOM 600 (CELL 600); Gene Regulation; a developmental biology course (CAMB 511 or equivalent) is suggested not required. CAMB students have priority.

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", "Cell Biological Mechanisms in Development. Offered fall semester.

SM 691. Advanced Topics in Cell Biology & Physiology. (J) E. Grishchuk, M. Marks, C. Deutsch.Prerequisite(s): BIOM 600 or a similar survey course in cell biology. Permission needed for all non-CAMB students. Advanced undergrads must contact instructor to confirm qualifications.

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) Vesicular and viral trafficking, (3) Tissue mechanics, (4) Heart and muscle physiogy, (5) Cytoskeletal duynamics and cell division. 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.

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SM 632. (PHRM632) Targeting the cancer cell: from mecnanism to precision medicine. (B) X. Hua, J. Field, , A. Resnick, and W. Pear.Prerequisite(s): BIOM 600, Molecular and Cell Biology Courses. Priority given to PhD students. Class is limited to CAMB, PHARM, IMUN and other graduate students, including engineering. Masters will go on waiting list.

This course, "Targeting the cancer cell: from mecanism to precision medicine", will examine how various signal transduction mechanisms influence cell functions including replication, growth, transcription, translation and intracellular trafficking. We will also consider how non-cell autonomous mechanisms, such as the tumor microenvironment and the immune system influence cancer cell signali ng. We will consider how important signaling pathways, such as Ras, Raf, Notch , Wnt, TGF beta, and various kinases/phophatases become dysregulated in cancer, as well as delve into how the DNA damage response, immune system, and tumor microenvironment exert important influences on oncogenic signaling.

In the first half of the course, invited faculty members will pick 2 relatively recent papers from their field that highlight important areas. 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 relevant 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 ot the course is to provide students with a view of the cancer cell that integrates both cell autonomous and non-cell autonomous signals and to use this infomration to consider how to successfully treat cancer.

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) J. Riley.Prerequisite(s): Background in molecular biology, virology and immunology. BGS Students only. BGS Students only

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 assigned students, 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 participationin the discussions, which focus on critical evaluation of experimental design, data presentation and interpretation, is essential. Student evaluation will be based on attendance, in-class presentation (for 50% of the letter grade), and a take-home exam (for another 50% of the grade).

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SM 692. Advanced Topics in Cell Biology and Physiology II: Cell Signaling. (K) M. Lemmon, J. Baur.Prerequisite(s): BIOM 600 or a similar survey course in cell biology, or the permission of the instructor. We encourage participation by non-CAMB students.

Cells in complex organisms are required to adapt rapidly in a changing enviro nment. 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. Offered alternatelyin the spring sememster with CAMB 691.

695. Scientific Writing. (B) J. Katz, J. Lok.Prerequisite(s): BIOM 600, BIOM 555 and CAMB 605. Preference for enrollment in CAMB 695 is given to CAMB students with highest priority given to second-year students. Students from graduate groups other than CAMB may be enrolled if space permits.

This 7-week course is designed to introduce students to basic scientific writing skills and is ideal for second year graduate students preparing for qualifying examinations. 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 conveying the significance of your research, outlining the aims, and discussing the results for scientific papers and grant proposals. The course will also provide an overview of the structure and style of research grant proposals and scientific manuscripts. Classes are highly interactive, and the majority of class time will be spent discussing student scientific writing.

Evaluation: The goal of the course is to encourage active and open 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, participation, and timely submission of assignments-not on the quality of the writing itself.

SM 696. Contemporary Topics in Parasitology Research. (B) J. Lok, C. Lengner, and M. Povelones.Prerequisite(s): CAMB 549-001, Parasites and Parasitism.

This is a paper-based seminar course. Each week a student is assigned a recent seminal paper related to parasitology research. The papers are chosen by guest faculty. Students are required to provide concise but comprehensive background and present the paper in a journal club style format. A principal aim of the course is to develop the ability think outside of the box and to cultivate the skills necessary for developing the ability to critically appraise one's own research and that of others. The ability to present and review work will be tested.

SM 697. Biology of Stem Cells. (B) P. Gadue, C. Lengner.Prerequisite(s): BGS Core Courses. Graduate students only. NO undergraduates. Students other than CAMB will need permits. CAMB students receive priority seating.

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. Limited to 14 students.

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SM 698. Elective Tutorials in Cell Biology. (C) Lee, Robert (Fall semester) and Wei Tong (Spring semester).Prerequisite(s): Cell 600 or an alternative senior undergraduate, graduate, or professional school course in Cell Biology. Corequisite(s): Interested students must contact Dr. Burkhardt in advance with chosen topic and mentor in the Fall semester. Students interested in the spring semester must contact Dr. Tong in advance with chosen topic and mentor.

This tutorial course is designed to provide students with an in-depth knowledge of 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 another topic of interest.

SM 700. Topics in Microbiology. (B) S. Cherry.Prerequisite(s): Permission from instructor required. Student must have taken Immunology and 2 MVP pathogen classes.

This course is designed for second year students in the MVP program, and focuses on pathogen-host interactions. Students make a presentation designed for 30 minutes on a topic of their choice. The topic can be something that they are working on, or simply something that they are interested in. They are requested to provide sufficient background, discuss what is known and what is not known about the topic, and then frame two to three Specific Aims. The success of the course rests entirely upon the quality of the faculty and students involved. In past years, the class have been very interactive, with each of the 11 classes lasting about 1.5 hours. The discussions are deliberately wide-ranging, and review recent literature, techniques, and how to construct a grant. Generally, two faculty will be in attendance.

704. Stress Responses and Metabolism in Cancer. (B) C. Simon, K. Wellen, Z. Arany.Prerequisite (s): Must have taken first year CAMB courses. Permission to enroll is required from course directors, preference is given to second year CAMB students in the Cancer Biology Program.

The course will meet once weekly for student presentations and lectures. The goal of the course will be to give students a better understanding of the abrogation of normal cellular metabolism and stress signaling during cancer and how these interplay with each other to create/maintain a malignant state. Besides student presentations the course will include 4 lectures devoted to metabolomics methodologies.

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SM 701. Tumor Microenvironment. (A) E. Pure & C. Koumenis.Prerequisite(s): First year CAMB core courses must be completed. Course is for 2nd year graduate students and beyond. Corequisite(s): CB students get first priority followed by other CAMB students.

Course Content: This 15-week course is designed for second year (and up) graduate students interested in learning about the tumor microenvironment. The course will cover the cross-talk between the main players (tumor cells, stroma, vasculature and immune cells) of the local tumor microenvironment field as well as the systemic response/impact of primary tumors, disseminated tumor cells and metastases, and emphasize the connections between the basic biology of the tumor microenvironment to potential therapeutic intervention. The goals of this course are to enrich scientific culture, train for clear and concise oral presentations, improve grant-writing skills, and develop critical thinking , professional composure and discussion skills.

The course will be divided into 3 broad topic areas. At the beginning of each block, faculty members will present a 1 hour didactic lecture and overview of the topic followed by questions and discussions by students. Each week's session will be led by one or two students depending on the class size and inc lude a didactic primary research paper including specific technical background needed for the paper, presenting the data in the paper, leading discussion on the data and conclusions drawn from the paper. Required reading (including reviews and 1-2 primary papers) related to each week's class will be assigned for all participants in preparation for in class discussion focused on the contribution and impact of the presented paper to the field. Students will be guided in choosing the approproate depth of background and topic area and in giving formal presentations and constructive criticism of scientific data. Additionally each student will write a specific aim for a grant using data reviewed in one of his or her presentations as"preliminary data".

Evaluation: Students will be evaluated on their participation in class (40%), their presentations (40%) and their written assignment (Grant Specific Aim) (20%). Students will be given feedback immediately after their presentations and at the end of the second block on their in-class participation.

SM 702. (BMB 650) Current Biochemical Topics. (B) Black, B. & Shorter, J..Prerequisite(s): Course is limited to BGS graduate students and undergrads from the Vagelos Scholars Program.

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.

703. (BE 640) The ECM, adhesion receptor signaling, and translational biomechanics. (J) R. Mauck, R. Wells..Prerequisite(s): BIOM 600.

This course is geared towards first and second year graduate students in BGS/CAMB and SEAS/BE with an interest in the interface of extracellular matrix (ECM) cell biology and biomechanics. Students will learn about the ECM and adhesion receptors and their impact on the cytoskeleton and signaling, as well as fundamental concepts in biomechanics and engineered materials. We will discuss how these topics can inform the study of cell biology, physiology and disease. An additional objective of the course is to give students experience in leading critical discussions and writing manuscript reviews. Invited outside speakers will complement the strengths of the Penn faculty.

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SM 705. Advanced Topics in Bacterial-Host Interactions. (B) Igor Brodsky and Sunny Shin.Prerequisite(s): Strong background in cell biology, immunology and/or bacteriology fulfilled by 1st year CAMB (previous BGS) courses. Course is limited to 2nd - 3rd year graduate students or advanced undergraduates with course directors permission.

This course will delve into specific topics in general area of bacterial pathogenesis and bacteria-host interactions. We will be exploring key historical and current papers on topics related to bacterial invasion of and replication within host cells, bacterial interference with host cell signaling pathways, bacterial interactions with host mucosal tissues, and the role of bacterial colonization in shaping and instructing host immune responses. Each week, a student will lead the class in the discussion of published papers on a specific topic. The format of each class will be a 10-15 minute introduction of the key background and underlying questions to be presented by the student, followed by an in-depth anaylsis by all members of the class of one to two articles. Students will be graded based on their introductory presentation and active participation in the paper discussions.

SM 752. (GCB 752) Genomics. (B) S. Diskin.Prerequisite(s): GCB 531/534 Intro to Genomics or equivalent, or permission from instructor.

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 genomic sequence and set of cellular instructions encoded in the DNA of specific organisms, including homo sapiens, dozens of bacterial species, the yeast Saccharomyces cerevisiae, the nematode C. elegans, and the fruit fly Drosophila melanogaster.

The goals of the course include the following: 1) introduce the basic principles involved in sequencing genomes, 2) familiarize the students with new instrumentation, informative 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 basic and translational research. This will be accomplished through in depth discussion of classic and recent papers.

995. Dissertation.