

2018 MOLECULAR BIOSCIENCES MINICOURSE DESCRIPTIONS

DAVID AXELROD: *CANCER GENES AND CELLS (16:695:621)*

Description: After successfully completing this course, students will have gained knowledge of cancer as the consequence of abnormal processes at the genetic, molecular, and cellular levels. They will have learned how some of that knowledge has been obtained and will appreciate what is not yet known. They will be able to critically evaluate published experimental cancer literature, to identify fruitful new avenues of research, and to propose new experiments to learn more about these processes. They will have had experience in communicating their ideas effectively in oral and written formats.

BEATRICE HAIMOVICH: *TOLL-LIKE RECEPTORS IN HEALTH AND DISEASE (16:695:622)*

Description: Toll-like receptors (TLRs) become activated in response to pathogen-derived and host-cell derived noxious insults. In this course we will examine mechanisms by which TLRs regulate inflammatory responses, and link these processes to host homeostasis as well as human diseases. After successfully completing this course students will have a working knowledge of topics that extend from TLRs to cell signaling, circadian clock, and the gut microbiome. The classes require active participation and will emphasize students-led critical evaluation and discussion of assigned current literature.

ANDY SINGSON: *GENETICS AND CELL BIOLOGY OF FERTILIZATION (16:695:623)*

Description: The union of sperm and egg is required for the propagation of all sexually reproducing species. The underlying molecular mechanisms of fertilization are also paradigms for other important cell cell interactions during development. After successfully completing this course, students will have gained a broad perspective of the field of fertilization that will include a historical point of view as well as an understanding of the current challenges in reproductive biology.

MIKE HAMPSEY & SAM GU: *EUKARYOTIC TRANSCRIPTION CYCLE (16:695:624)*

Description: The textbook description of transcription defines it a series of discrete processes, including initiation, elongation, RNA processing, termination, packaging of nascent mRNA and export through the nuclear pore complex. During the past decade more and more evidence has accumulate to indicate that these steps do not occur independently of each other. Indeed, very recent genetic evidence links transcription initiation with mRNA export. This course will define the stages of transcription and how they are linked to one another to control the amount of functional mRNA that exits the nucleus. The format of the course will be discussion of the “transcription cycle.” Each lecture will require reading of recent manuscripts, assigned prior to class. The class format will include didactic presentations and critical discussion of recent results from the literature. Unlike most undergraduate science classes, the lectures will be presented as questions; the ensuing discussion will lead to answers of these questions. Accordingly, students will be reminded of what is already known, but more importantly, address what is yet to be discovered and what experiments can be done to investigate these questions. The course format is not a journal club, but will be more didactic, albeit with students doing most of the discussion.

Grading: Students will be expected to attend all classes and participate in discussions. At the end of the course, students will be required to submit a written mini-review (5-7 pages, with

references) or a grant proposal to investigate a well-defined question(s) regarding the “transcription cycle.” The review or proposal will constitute 90% of your grade; participation in class discussion can adjust your grade by not more than a plus or minus unit.

HUAYE ZHANG: PEEKING INTO THE BRAIN (16:695:625)

Description: This minicourse will highlight recent in vivo imaging studies of cellular dynamics in the brain during physiological and pathological processes, as well as novel mechanisms underlying these processes. The latest advances in cutting edge imaging methods will also be discussed. After successful completion of this course, students will have a good understanding of the in vivo imaging approaches used to understand brain functioning. In addition, students will learn to present and critically evaluate scientific literature.

DAVID AXELROD: *CANCER AND CLINICAL ONCOLOGY* (16:695:626)

Description: After successfully completing this course, students will have gained knowledge of some of the properties of cancer cells and tissues that have a clinical impact. They will have learned how that knowledge has been obtained and translated to improve diagnosis, prognosis and therapy of cancer patients. They will also appreciate what has not yet been achieved. They will be able to critically evaluate published cancer literature, to identify fruitful new avenues of research, and to propose new experiments that could provide experimental results that could be translated into patient benefit. They will have had experience in communicating their ideas effectively in oral and written formats.

WENWEI HU AND ZHAOHUI FENG: *P53* (16:695:628)

Description: p53, which was discovered in 1979, is the most frequently mutated tumor suppressor gene in human cancer. In the past 30 years, the function of p53 has been the subject of intensive research, and new revelations about p53 function have not declined with age. p53 functions as a node in numerous signaling pathways to regulate many important biological activities. In addition to its pivotal role in tumor suppression, recent studies have shown that p53 is critically involved in many other physiological and pathological processes. Furthermore, it is clear that p53 is therapeutically important and many approaches are being taken to reconstitute its function in tumors. In this course, we will introduce some of our current understanding of p53 function by giving 2 lectures and using 6 examples from the current literature. Students that successfully complete this course will gain a rich knowledge of tumor suppressor p53 and its signaling pathway on cancer and other diseases. This knowledge and concepts will be also very useful for their future research on cancer research and molecular biology. In addition, students will learn the skills to critically evaluate the literature and scientifically present a paper.

MIKE HAMPSEY: *CANCER CELL METABOLISM* (16:695:629)

Description: A characteristic of all cancer cells, including well-oxygenated tumors, is the “Warburg Effect,” defined as the massive uptake of glucose and its metabolism by “aerobic glycolysis,” rather than by the more energy efficient process of respiration. The Warburg Effect is the basis of a definitive diagnostic of rapidly dividing cancer cells and their response to

chemotherapeutics: the PET scan, which detects the uptake of a radiolabeled, non-metabolizable glucose analog, ^{18}F -2-deoxyglucose. Despite having first been reported in 1923, the biochemical basis of the Warburg Effect remains largely unexplained. This course will focus on metabolic pathways that have gone awry in cancer cells. The format will include didactic presentations and critical discussion of recent results from the literature. Emphasis will be placed on what we don't know about cancer cell metabolism, in the context of established metabolic pathways. The resurgence of interest in the Warburg Effect, and the new research opportunities that this affords, will be a major theme.

Grading: Student will be expected to attend all classes and participate in discussion. At the end of the course, students will be required to submit a written mini-review (5-7 pages, with references) or a grant proposal to investigate a well-defined question(s) regarding cancer cell metabolism. The review or proposal will constitute 90% of your grade; participation in class discussion can adjust your grade by not more than a plus or minus unit.

PAUL MANOWITZ: *MEDICAL MYSTERIES (16:695:630)*

Description: This mini-course will pose unique problems in genetics, metabolism, and/or biochemistry of human diseases in order to explore recent advances and the questions that these advances pose. We will focus on seven diseases that have different modes of inheritance. In each session, one student will present a 10-15 (maximum) minute general background of the disease and another student will present a paper that presents recent advances on an aspect of the disease. Each student will be asked to write a 3-5 page critique of the paper he/she presented in class on recent advances with emphasis on the questions that these advances pose.

MONICA ROTH: *MOLECULAR VIROLOGY: RETROVIRUSES & LENTIVIRUSES (16:695:631)*

Description: The course will focus on Retroviridae Family of viruses, RNA viruses that utilize reverse transcription in their life-cycle, with a particular emphasis on gammaretroviruses (MLV) and lentiviruses (HIV). Through an understanding of the viral life-cycle, approaches to inhibit them through antiviral therapies as well as exploit them for gene delivery vectors will be discussed. The course will include didactic lectures as well as reading current manuscripts on specific topics.

SAM GU AND MIGUEL ZARATIEGUI: *NON-CODING RNA-MEDIATED GENE REGULATION (16:695:632)*

Description: Non-coding RNAs are more than just rRNA, tRNAs, snRNAs, etc. Recent studies have identified many types of novel non-coding RNA molecules in human and model organisms, ranging from ~ 20 to thousands of nucleotides in size and performing a diverse set of molecular functions. Many of them regulate gene expression in a target-specific manner. In this course, we will discuss well established and novel RNA-mediated gene regulation mechanisms that involve small RNAs (e.g., microRNA, siRNA, piRNA, and tRNA fragments) or large RNAs (e.g., XIST RNA, cryptic transcripts, chromatin-scaffold RNA, and others). One fascinating aspect of non-coding RNAs is their connections with various transgenerational epigenetic phenomena, which will be discussed in this course as well. The format of the class will combine traditional lecture and discussion of one-two research articles in each class. Students are required to critically read the papers before each class and are expected to carry out most of the discussion.

KIRAN MADURA: *UBIQUITIN-PROTEASOME SYSTEM (16:695:634)*

Description: The ubiquitin/proteasome system (UPS) is one of most conserved mechanisms in eukaryotic evolution. The UPS is a proteolytic system that promotes the degradation of regulatory and damaged proteins, and the biochemical mechanism is very well understood. The Nobel Prize for these discoveries was awarded in 2004, just 20 years after the initial discovery of the pathway. Notwithstanding this award, various aspects of this mechanism remain poorly understood.

This mini-series of lectures will discuss i), the seminal studies that led to our understanding of the UPS, ii), topics that continue to be actively investigated and iii), its implication of protein turnover in human diseases.

This course will introduce you to novel experimental approaches, model systems, and a general appreciation for the intersection of the UPS in diverse biological systems.

Organization: Dr. Madura will present all the lectures. Relevant publications pertinent to each lecture will be provided, and students are expected to review these studies before each lecture. Attendance to all lectures is mandatory, and participation in discussion is expected. A final exam will be conducted during the last lecture period

JIM MILLONIG & EMANUEL DiCICCO-BLOOM: *NEURODEVELOPMENTAL DISORDERS (16:695:635)*

Description: The goal of this course is to teach the molecular, developmental and genetic bases of autism spectrum disorder and related Mendelian diseases (e.g., Fragile X, Rett, Tuberous Sclerosis and Timothy syndromes). Each week seminal papers will be discussed by Emanuel DiCicco-Bloom MD, a developmental neurobiologist and child neurologist, and Jim Millonig PhD, a molecular geneticist. Papers will be selected that have led to greater understanding of the underlying pathology and the development of new treatments. A variety of cutting edge techniques such as immortalized pluripotent stem cells (iPSCs) will be introduced and the positives and negatives of these approaches will be discussed. Each week one disease will be examined with Dr Millonig leading the molecular genetic aspects while Dr DiCicco-Bloom will focus on the developmental studies. By the end of this minicourse students should have a greater understanding of these diseases, how scientific advances have led to the development of new treatments and the challenges facing the generation of new therapies.

JERRY LANGER: *US AGAINST THE VIRUSES: IMMUNE DEFENSES AGAINST VIRUSES (16:695:636)*

Description: After an overview of the immune system and its mechanisms of viral defense, we'll focus on how interferons, in particular, are involved in a multi-pronged defense strategy. Reading and analyzing key papers since the discovery of interferon in 1957, we'll see how advancing methods have deepened our knowledge of the processes involved in early antiviral defense. Students will get an overview of the immune system, and will see how diverse in vitro and in vivo approaches have contributed to our current understanding.