2021 MOLECULAR BIOSCIENCES MINICOURSE DESCRIPTIONS

WENWEI HU AND ZHAOHUI FENG: TUMOR SUPPRESSOR P53 *(16:695:621:17031)*

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 1 lecture and using 7 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.

SUBHAJYOTI DE: *APPLICATION OF NEXT-GENERATION SEQUENCING TECHNIQUES (16:695:622: 17032)*

Description: Next generation sequencing (NGS) technologies allow us to sequence DNA and RNA quickly and cheaply than that was previously possible, revolutionizing the study of genomics and molecular biology, ultimately guiding clinical decision making in Precision Medicine. The mini-course will comprise of 6 instructed sessions and one hands-on tutorial session, and a mini-essay will be due in the last session. In an instructional session, first I will give an overview of the topic, guided by a classic review paper. Then, one (or two depending on the class strength) student(s) will present a research paper engaging the class in a scholarly group discussion. The students will learn about the emerging applications of the next generation sequencing technologies, best practice guidelines, key considerations during design of experiments, and interpretation of results.

Grading: Grading will be based on (i) participation in the discussion during the instructed sessions, and (ii) a mini proposal (~1000 words) due in the last class. The proposal will describe a possible NGS-based investigation the student might conduct in their area of research interest outlining Significance, Approach, and Expected Results and potential pitfalls in ~1000 words. Grading will be relative, and will be based on intuitive thinking in classroom setting (rather than domain knowledge).

MIKE HAMPSEY AND ALEX VALVEZAN: *CANCER CELL METABOLISM (16:695:623: 17033)*

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 <u>don't know</u> 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.

BEATRICE HAIMOVICH: ***TOLL-LIKE RECEPTORS IN HEALTH AND DISEASE (16:695:624:17034)***

Description: All toll-like receptors (TLRs) family members are activated by signals produced by invading microorganisms. However, several TLRs also activated by signals derived from damaged host tissues and/or bacteria that live in the gut. 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, host immunity, and immune cells interaction with the gut microbiome. The classes require active participation and will emphasize students-led critical evaluation and discussion of assigned current literature.

HONGHUA LI: ***APPROACHES TO GENE THERAPY (16:695:625:17035)***

Description: Gene therapy is a fast-growing field in biomedicine with major impact on treatment of many diseases that are not limited to genetic disorders. The proposed course covers the major concept (one hour), approaches (four hours) and clinical applications (two hours) with emphasis on approaches. The course completes with a brief summary and an essay exam (one hour).

Structure: A combination of reputable review articles and primary literature will be used as reference handout. Students are required to read the assigned handout for each class. One student will give a brief presentation to the class followed by comments of all other students. The amount of time for each student will be allocated based on the number of students. Instructor will give a summary of the class and provide important supplementary information that is not covered by the reference and class discussion to conclude the class.

Outcome: The class will expose students to the major aspects of the fast advancing field of gene therapy which will become one of the powerful tools in clinical practice and involves both basic research and clinical practice. Knowledge and training in gene therapy may let students gain advantage and become a great option in their career development. In addition, gene therapy can be used as a powerful tool in research and many other applications in biomedicine, for example, combatting deadly viruses including COVID-19.

Grading: Three aspects will be taken into consideration to determine the grades: 1. quality of presentation, 35%; (2). participation of class activities, 25% and (3) essay, 40%.

ANNIKA BARBER: ***BIOLOGICAL CLOCKS IN GENETICS, PHYSIOLOGY & BEHAVIOR (16:695:626: 17036)***

Description: Circadian rhythms are highly conserved across species, allowing organisms to synchronize internal processes and anticipate regular environmental changes. This mini-course will cover the cellular and molecular mechanisms by which organisms keep time. Understanding how circadian rhythms impact organismal physiology is critical to robust experimental design across many disciplines, as these rhythms affect numerous process from overt behaviors to cellular physiology. This course will cover fundamental properties of biological rhythms at the

molecular, cellular, organ and organism levels. Readings will introduce students to primary literature in the circadian field to gain an understanding of experimental methods in chronobiology from molecules to behaviors in diverse organisms.

PAUL MANOWITZ: ***MEDICAL MYSTERIES (16:695:627:17037)***

Description: This mini-course will pose unique problems in genetics, metabolism, and/or biochemistry of seven human diseases in order to explore recent advances in their causes and treatments. These diseases are severely debilitating and in some cases fatal. During each session, one or two students will discuss a scientific paper that presents recent advances on an aspect of the disease. The class will work as a team during the session to better understand these diseases. In addition, each student will be asked to write a 3-5 page critique of the paper he/she presented in class with emphasis on the questions that this paper poses.

MARC GARTENBERG & NANCY WALWORTH: ***YEAST GENETICS TO THE NOBEL PRIZE (16:695:628: 17038)***

DESCRIPTION: Genetic screens in model organisms have decoded how numerous cellular processes work. The simple genetics of unicellular organisms has permitted the study of conserved processes of more complex organisms in an informative and often elegant manner. Strikingly, several Nobel Prizes in the last fifteen years have gone to scientists who used yeast as a means to understand fundamental cellular behaviors. Students will gain a working knowledge of the power of genetic screens in defining cellular processes. Required reading will include primary literature and Nobel Lectures. Class sessions will include a short lecture given by one of the instructors followed by presentation of an assigned paper (likely done by pairs of students). For the final project/exam, students will be expected to identify a fundamental process for which they might design a genetic screen. They will present their ideas in groups before writing up their screen.

JERRY LANGER: ***EARLY IMMUNE DEFENSES AGAINST VIRUSES (16:695:630: 17040)***

DESCRIPTION: Why are a majority of viral infections - influenza, SARS-CoV-2, even poliovirus - mild or seemingly asymptomatic? What do we understand about this phenomenon? After an overview of the immune system and it's mechanisms of viral defense, we'll focus on innate immunity and early antiviral defenses. We'll also see how pathogenic viruses counteract our defenses. Participants will read and analyze historical and current research papers, including some on coronaviruses, and will see how advancing methods have deepened our knowledge of early antiviral defenses. We'll also read several examples of science reporting in general news sources to examine ways in which complex scientific/medical issues are/can be treated.

HUAYE ZHANG: ***PEEKING INTO THE BRAIN (16:695:631:17041)***

Description: This minicourse will highlight recent in vivo imaging studies of cellular dynamics i n 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.

Grading: Students are expected to attend all classes and actively participate in discussions. At the end of the course, students will write a paper (~1000 words) discussing future avenues of research in the field of in vivo brain imaging. The final paper will constitute 80% of the grade and participation in class will be 20% of the grade.

BEATRICE HAIMOVICH: *SARS-COV-2 AND HOW IT AFFECTS HUMANS (16:695:632:17042)*

Description: The emergence of SARS-Cov-2 and its devastating impact on human has led to an unparallel global surge in SARS-Cov-2-related research. Within few months, an ever-increasing number of studies has flooded the web, and this trend is on-going. In this mini course we will read and discuss current literature and, when relevant, earlier studies that explored human responses to viruses. Topics will include COVID-19 disease features; how the virus enters cells; host-immune responses; how the virus might infect and affect the nervous system; mechanisms by which the virus might trigger thrombosis; the generation of animal models and some preliminary data generated using these models. Students will be required to present assigned papers and participate in class discussion. Students will gain understanding of how the virus affects humans while gaining experience in reading, presenting, and evaluating primary literature.

YOUYI PENG, BILL WELSH, VLAD KHOLODOVYCH: *HOW TO DISCOVER YOUR OWN DRUG (16:695:634: 17043)*

Overview

Have you ever wondered how drugs get their start? In fact, many drugs stem their roots to the computer! Modern computational tools and techniques have now evolved to become a major driving force in the biopharmaceutical, biomedical, academic communities for projects ranging from drug and biomarker discovery, drug target identification and mechanistic studies, to prediction of biorelevant properties. No longer the exclusive domain of computational specialists, many in silico operations are accessible to biomedical scientists with little or no prior training.

User-friendly open-source and commercial "molecular modeling" software products enable non-experts to visualize and explore molecular systems large and small. The vast majority of these in silico exercises can be performed on laptops, while the remaining can be outsourced from the laptop to high-performance and "cloud" computing resources.

In this mini-course, we will learn about a few of these in silico tools & techniques commonly used for drug discovery. We will access them on your laptops by linking to the high-performance computing environments here at Rutgers-RBHS. Moreover, we will acquire hands-on skills in rational (i.e., in silico) drug design. Living up to its title, the mini-course will culminate with a unique opportunity for us - to develop our own drug for selected targets!

JIM MILLONIG & EMANUEL DICICCO-BLOOM: *NEURODEVELOPMENTAL DISORDERS (16:695:635: 17044)*

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.