UPGEN 778A-F Schedule Fall Term 2019  
MWF 2-3:30p

UPGEN 778A-F consists of six mini-courses offered sequentially during the fall semester and together cover 24 topics. These courses are part of the core offerings of the University Program in Genetics and Genomics and allow maximum flexibility for a student-designed curriculum. Multiple topics are available during each mini-course and students choose one. The topics address everything from fundamentals of genetics to modern molecular genetic and genomic strategies for the analysis of a variety of biological systems.

***Please Note: Any changes made after the September 6 drop/add deadline will reflect a course withdrawal on a transcript.***

<table>
<thead>
<tr>
<th>Module A</th>
<th>Section 1</th>
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| Aug 26– Sept 6 | **Raluca Gordan**  
MGM Retreat Sept 6-Tentative | **Kris Wood**  
Tumor heterogeneity and evolution  
NanDuke 247 | **Simon Gregory**  
Genomic Technologies  
MSRB 3 1125 | **John Willis**  
Genomics of Adaptation  
Nan Duke 384 |
|         | Modeling protein-DNA interactions in vitro  
and in vivo  
GSRB I 4002 |                                                        |                                                        |                                  |
| Module B | Section 1              | Section 2               | Section 3               | Section 4                        |
| Sept 9– Sept 20 | **Dave McClay**  
Gene Networks During Development  
French 3319 | **Dave Sherwood**  
Basement membran-  
formation, functions, and human disease  
GSRB I 4002 | **Greg Crawford**  
"Epigenomic methodologies"  
MSRB 3 1125 | **Andy Alspaugh**  
"Genetics and Genomics of Infectious Disease"  
Nan Duke 384 |
|         |                                                        |                                                        |                                                        |                                  |
| Module C | Section 1              | Section 2               | Section 3               | Section 4                        |
| Sept 23–Oct 4 | **Jack Keene and Debby Silver**  
Mechanisms of RNA Regulation  
MSRB 3 1125 | **Danny Lew**  
The Logic of Genetics  
Nan Duke 384 | **Don Fox & Jessica Sawyer**  
"Critical skills in scientific presentation"  
GSRB I 4002 | **Craig Lowe**  
Genetics and Genomics of ancient, ancestral, and extinct species  
Nan Duke 247 |
|         | The Awesome Power of Yeast Genetics  
Nan Duke 384 |                                                        |                                                        |                                  |
| Module D | Section 1              | Section 2               | Section 3               | Section 4                        |
| Oct 9–Oct 21 | **Danny Lew**  
The Awesome Power of Yeast Genetics  
Nan Duke 384 | **Steve Haase**  
Biological Clocks  
MSRB 3 1125 | **Hiro Matsunami**  
Genetic Switches  
Nan Duke 247 | **James Alvarez**  
Animal Models of Cancer  
GSRB I 4002 |
|         |                                                        |                                                        |                                                        |                                  |
| Module E | Section 1              | Section 2               | Section 3               | Section 4                        |
| Oct 23–Nov 4 | **Blanche Capel**  
"Mouse Genetics and Genomics"  
Nan Duke 384 | **Robin Smith**  
Science Communication  
MSRB 3 1125 | **Ryan Baugh**  
C. elegans Genetics and Genomics  
French 3319 | **Philip Benfey**  
"Entrepreneurship in the life sciences"  
French 4219 |
|         |                                                        |                                                        |                                                        |                                  |
| Module F | Section 1              | Section 2               | Section 3               | Section 4                        |
| Nov 6–Nov 18 | **John Rawls, Lawrence David and Neil Surana**  
"Exploring the Microbiome"  
GSRB I 4002 | **Tim Reddy**  
"Computational Genomics"  
MSRB 3 1125 | **Amy Bejsovec**  
"Drosophila developmental genetics"  
French 3319 | **Nina Tsvetanova**  
The CRISPR/Cas system and genome editing  
Nan Duke 384 |
|         |                                                        |                                                        |                                                        |                                  |
Module Descriptions for Fall 2019:

Module A

Modeling Protein-DNA interactions In Vitro and In Vivo (Raluca Gordan)
In this module, the students will acquire Python programming skills through the use of computational models and methods for characterizing the DNA binding specificity of transcription factors. Topics will include: identification of DNA motifs from ChIP-seq data, alignment of DNA sequences, identification of transcription factor binding sites across the human genome, computing enrichment of DNA motifs in genomic data. (Basic coding skills are useful, but not required).

Tumor heterogeneity and evolution (Kris Wood)
Genomic instability is a hallmark of cancer. Over time, this instability gives rise to heterogeneous, subclonal mutation patterns within tumors that serve as a reservoir for evolution. In this module, we will discuss the mechanisms governing intratumoral genetic heterogeneity and its implications for tumor evolution during disease progression and therapy resistance.

Genomic Technologies (Simon Gregory)
In this module, students will learn about and discuss the practical and technical application of various state-of-the-art genomic tools. Class will include didactic lectures, paper reading, oral presentations in genomic technologies and online resources to uncover novel insights into biological processes and disease states.

Genomics of Adaptation (John Willis)
Contemporary studies of how populations and species evolved adaptations to their ecological habitats. Focus on modern methods of genome mapping and sequence data and analysis in wild populations that can identify genetic changes that contributed to ecological adaptations. Emphasis on case studies of genomics of adaptation in plant and animal systems, including humans and our adaptations to environments that our ancestors encountered as they colonized diverse habitats throughout the world. Examples will also illustrate how speciation and hybridization can contribute to adaptive biodiversity

Module B

Gene Networks During Development (Dave McClay)
This module focuses on early cell diversification. Production of the many cell types of an organism occurs through signaling and networks of transcription factors that collectively increase the complexity and number of cell types in a developing organism. The goal of the module is to gain an understanding of these networks and to learn how knowledge of them can be attained.

Basement membranes-formation, functions, and human disease (Dave Sherwood)
Basement membranes are a thin, dense, sheet-like extracellular matrix that underlies all epithelia and surrounds most tissues. Basement membranes emerged at the dawn of animal multicellularity and are thought to have been essential for the formation of tissues. Although generally thought of as a static scaffolding that supports and segregates tissues, recent studies are revealing dynamic, diverse, and crucial roles for basement membranes in nearly every aspect of tissue function. The course explores these diverse roles (e.g. differentiation, polarity, tissue shaping, tissue connection) and the growing evidence of basement membrane dysfunction in numerous human diseases as well as its important role in aging.

“Epigenomic Methodologies” (Greg Crawford)
Many biological processes, such as tissue-specific gene expression, X inactivation, and development, are control by sequence-independent (epigenetic) mechanisms that are heritable yet reprogrammable. Aberrant changes in
chromatin structure that impact the function of genes or nuclear or developmental pathways can be the basis for many diseases. In this module, students will acquire a basic understanding of experimental chromatin-based techniques used to create functional maps of the genome. Topics will include identification and mapping of chromatin accessible sites, transcription factor binding sites, histone modifications, DNA methylation, long range chromatin looping, and tools to modify the epigenome to empirically test function.

“Genetics and genomics of infectious disease” (Andy Alspaugh)
Microorganisms undergo dramatic cellular changes in order to adapt to the harsh environment of the infected host. These adaptations often require coordination of metabolism, stress responses, and the expression of specific “virulence factors”. Investigators have used many experimental techniques to define factors that favor microbial survival in this setting. This module will explore the use of classical and molecular genetics techniques to study the pathogenesis of human infectious diseases. We will also discuss genome-wide evaluative tools in microbial pathogens. Most class-time will involve group discussion of specific articles related to the topic of each session. techniques in the context of the post-genomic era.

Module C

Mechanisms of RNA Regulation (Debby Silver & Jack Keene)
In this module, we will describe both specific and global regulatory processes and mechanisms that govern gene expression post-transcriptionally. As there are several steps between transcription and translation, it will be necessary to focus on particular examples that include pre-messenger RNA splicing, nuclear RNA processing, RNA subcellular localization, and RNA stability and translation. These processes are both coupled and coordinated in eukaryotic cells; moreover, they are interdependent and feed backward and forward to balance protein production in the face of environmental and cellular signals. In some cases, dynamic changes in RNA responses will be considered as well as how these processes maintain homeostasis and multicellularity in tissues and organs during development. We will highlight the importance of all of these processes by discussing how mutations in factors critical for splicing and RNA localization cause disease.

The Logics of Genetics (Danny Lew)
This module will focus on how to apply haploid/diploid genetics to solve a biological problem (we use signal transduction as an example). Yeast is used as the example system, and we discuss the design and implementation of genetic screens, complementation, linkage, and epistasis to order genes into pathways. The first week we will do problem sets covering classical genetics and the second week we will read papers covering molecular genetics and genomics approaches to understand the same pathway.

“Critical Skills in Scientific Presentations” (Don Fox & Jessica Sawyer)
Do you hope to obtain a job in science after graduate school? Are you terrified of public speaking? Are you tired of sitting through hard-to-follow seminars by your peers, but don’t know how to help them give clearer talks? If you answered yes to any of these questions, this module is for you. The goal of this module is to help you to effectively and confidently communicate your science to other scientists. Topics covered will include: designing better presentation slides and posters, developing a 2-minute “elevator speech” to give to your colleagues, and mastering the do’s and don’ts of a short scientific presentation. This module is meant to compliment the Solutions module on Science Communication (which focuses on communicating science to the public) by focusing on communicating science to your scientific peers. Each class is group discussion-based, and each student will have several speaking opportunities. This module is for 2nd yr and above students.

Genetics and Genomics of ancient, ancestral, and extinct species (Craig Lowe)
Studying the molecular changes that underlie ancestral traits has long been in the realm of science fiction. However, recent advances, both technological and theoretical, have allowed us to begin rigorously dissecting the molecular basis of ancient phenotypic changes. We will cover these recent advances as well as discuss future research in this area.
Module D

The Awesome Power of Yeast Genetics (Danny Lew)
This module will focus on using genetic interactions to identify and dissect new players in a pathway (we use cell polarity as an example). Along the way, we will discuss the generation and utility of various kinds of mutants, genetic suppression, synthetic lethality, and newer genomic methodologies including synthetic genetic arrays. Prerequisite: The Logic of Genetics.

Biological Clocks (Steve Haase)
From sleep/wake cycles to flower opening to cell division, all organisms and cells display rhythmic behaviors. These behaviors are regulated by systems called biological oscillators. Specialized oscillators called circadian clocks, have the ability to keep time, so that events can be coordinated with diurnal cycles. In this module, we will examine the molecular mechanisms that comprise oscillators and clocks. We will discuss the common components of oscillating systems and the mechanisms that control the unique dynamics of the clocks and oscillators that regulate cell division and circadian rhythms. Quantitative models of these molecular oscillators will also be examined.

Genetic Switches (Hiro Matsunami)
Cells in our body are specialized; each cell expresses a specific set of genes. How do gene switches control expression in different cell types or even individual cells of the same cell type? This module will cover elements that regulate gene transcription including structure of genes, gene regulatory regions, epigenetic modifications and/or subnuclear localization of genes, all in concert guide the initiation of transcription of specific genes in eukaryotes. Various modes of gene expression controls will be discussed mainly based on careful readings of recent literatures.

Animal Models of Cancer (James Alvarez)
Animal models have provided important insights into the development, progression, and treatment of cancer. This module will cover the fundamentals of animal models of cancer, with a particular focus on mice. We will describe methodological approaches to generating mouse models of cancer and discuss the advantages and limitations of different approaches. We will then focus on specific areas across tumor types in which mouse models have provided critical mechanistic insights into tumor biology. Each class will involve a discussion of primary research articles from the literature.

Module E

Mouse Genetics & Genomics (Blanche Capel)
This module covers the history, nomenclature, basic tools, and emerging technologies of mouse genetics. Lectures cover the concept of inbred strains and their uses, experimental genetic approaches used to make and analyze models of human disease (including various forms of transgenesis and ES cell technology), quantitative trait loci, and emerging resources that facilitate the use of the mouse to study human variation, environmental impacts, and disease susceptibility.

“Science Communication” (Robin Smith)
In this six-part workshop, we’ll share some techniques that will help you communicate your work more effectively with a variety of audiences beyond your colleagues. We will have you practice telling your scientific story in several ways, from tweets and radio interviews to science cafes, blog posts and crowdfunding campaigns. Effective communication can help you get noticed by potential mentors and search committees, earn higher marks on your job and postdoc applications and advance your academic career. This module will include hands-on, active learning, so please bring writing materials or a laptop.
C. elegans Genetics and Genomics (Ryan Baugh)
This module covers basic tools and emerging technologies that make the nematode C. elegans a powerful genetic and genomic model system. Students will learn how genetic technique like genome editing, RNAi, and mutant screens can be used together with genomic approaches to study genes and pathways that control animal development and behavior. Epigenetic inheritance, aging, and natural variation will be covered as specific topics.

“Entrepreneurship in the life sciences” (Philip Benfey)
This module will cover various aspects of entrepreneurial activity in the life sciences. These include setting up, securing funding and working in a start-up company as well as protecting and licensing intellectual property. We will discuss how best to prepare for life in the start-up ecosystem. Students will be evaluated on class participation and will write an executive summary of a business plan for a start-up of their choice.

Module F

“Exploring the Microbiome” (John Rawls, Lawrence David and Neil Surana)
Recent advances in genomic technology have led to spectacular insights into the complexity and ubiquity of microbial communities (the microbiome) throughout our planet, including on and within the human body. The microbiome is now known to contribute significantly to human health and disease, regulate global biogeochemistry, and harbor much of our planet’s genetic diversity. Consisting of lectures and reading of primary literature, this module is designed to provide students with a foundational understanding of microbiome science. Enrolling students are expected to have a background in general microbiology. For more information, please contact John Rawls john.rawls@duke.edu

“Computational Genomics” (Tim Reddy)
My module covers the basics of analyzing data from high-throughput sequencing studies of gene regulation and genomic activity. The class provides students with hands-on experience analyzing data from published manuscripts where they reproduce figures from those papers. Upon completing my module, I expect that students have the ability to perform routine genomic analyses on their own, and will have the foundational skills needed to learn about more advanced analyses.

“Drosophila developmental genetics”(Amy Bejsovec)
During development, cells acquire positional information and deploy it to differentiate correctly. Genetic analysis in the fruitfly Drosophila melanogaster revolutionized our understanding of this process by identifying the key molecules that generate body pattern in all animals. Learn how these classic screens were conducted, how the molecules they identified act to promote patterning of the body, and how more recent techniques such as Gal4/UAS transgenic expression, FLP/FRT mosaic analysis, multicolor GFP tagging, and CRISPR/Cas9 gene editing have enhanced our ability to dissect developmental processes in the fly model system.

The CRISPR/Cas system and genome editing (Nina Tsvetanova)
Genome editing with CRISPR (overview of the system and its applications in genome editing and functional genomics through lecture, group-led presentations and discussion of relevant primary literature and a short written proposal).