

**BIOCHEMISTRY:**

<http://www.biochem.duke.edu/>

***First Half Semester:***

**BIOCHEM 658 (SBB 658) Structural Biochemistry I** – [Structure of Macromolecules] Principles of modern structural biology. Protein-nucleic acid recognition, enzymatic reactions, viruses, immunoglobulins, signal transduction, and structure-based drug design described in terms of the atomic properties of biological macromolecules. Discussion of methods of structure determination with particular emphasis on macromolecular X-ray crystallography NMR methods, homology modeling, and bioinformatics. Students use molecular graphics tutorials and Internet databases to view and analyze structures. Prerequisites: organic chemistry and introductory biochemistry. *Minicourse, 1<sup>st</sup> half-semester. MWF 3:30-4:20 pm; Beese; ONLINE; 2 Units*

***Second Half Semester:***

**BIOCHEM 631 (CMB, NEUROBIO, PHARM) Contemporary Topics in Membrane Biology** – This course will highlight modern topics regarding biological membranes and membrane proteins that are important for human physiology and disease. Topics include structure and dynamics of biological membranes, structure and function of membrane proteins that play critical roles in cell signaling, diseases related to dysfunction of membrane and membrane proteins, and current efforts on drug discovery. Major techniques used in membrane research will also be covered. The format will be a combination of lectures and discussion of primary literature. Students will be evaluated based on their class participation and performance at the final presentations. Reserved for graduate students; open to undergraduate students by instructor permission. *Minicourse, 2<sup>nd</sup> half-semester. MWF 1:45-3:00 pm; Lee; ONLINE; 2 Units*

**BIOCHEM 659 (CELLBIO, IMMUNOL, SBB, UPGEN 659) Structural Biochemistry II** – [Molecular Biology I] Continuation of BIOCHEM 658. Structure/function analysis of proteins as enzymes, kinetics of binding, catalysis and allostery, protein folding, stability and design protein-protein interactions. Prerequisite: Biochemistry 658, organic chemistry, physical chemistry, and introductory biochemistry. This is an introductory course to learn how to use quantitative methods to understand biological structure and function. *Minicourse, 2<sup>nd</sup> half-semester. MWF 3:30-4:20 pm; Zhou; ONLINE; 2 Units*

**BIOCHEM 681 (SBB 681) Biophysical Methods** – This course provides an overview of nine prominent methods used in biochemistry, cell biology and structural biology. They are: optical spectroscopy, fluorescence, light microscopy, ligand binding, kinetics, mass spectrometry, magnetic resonance, electrophysiology and cryoelectron microscopy. The goal is to provide students with sufficient background knowledge to allow them to read and understand papers in the primary literature that employ one or more of these methods. Each method is taught by an instructor who employs the method in their own research. Grade is based on problem sets, quizzes and a final presentation to the class of a paper that uses a method of the student's choice. *TuTh, 10:15-11:30 am; Oas; HYBRID/147 Nanaline Duke Bldg; 3 Units*

**BIOLOGY**

<https://biology.duke.edu/courses/2020-fall>

**BIostatISTICS:**

<http://biostat.duke.edu>

**BIostat 701: Introduction to Statistical Theory and Methods I:** This course provides a formal introduction to the basic theory and methods of probability and statistics. It covers topics in probability theory with an emphasis on those needed in statistics, including probability and sample spaces, independence, conditional probability, random variables, parametric families of distributions, and sampling distributions. Core concepts are mastered through mathematical exploration and linkage with the applied concepts studied in BIostat 704. Prerequisite(s): 2 semesters of calculus or its equivalent (multivariate calculus preferred). Familiarity with linear algebras is helpful. Corequisite(s): BIostat 702, BIostat 703. Credits: 3 ONLINE

**BIostat 702: Applied Biostatistical Methods I:** This course provides an introduction to study design, descriptive

## Fall 20 Basic & Biomedical Sciences Courses

statistics, and analysis of statistical models with one or two predictor variables. Topics include principles of study design, basic study designs, descriptive statistics, sampling, contingency tables, one- and two-way analysis of variance, simple linear regression, and analysis of covariance. Both parametric and non-parametric techniques are explored. Core concepts are mastered through team-based case studies and analysis of authentic research problems encountered by program faculty and demonstrated in practicum experiences in concert with BIOSTAT 703. Computational exercises will use the R and SAS packages. Prerequisite(s): 2 semesters of calculus or its equivalent (multivariate calculus preferred). Familiarity with linear algebras is helpful. Corequisites(s): BIOSTAT 701, BIOSTAT 703, BIOSTAT 721. Credits: 3 ONLINE

**BIOSTAT 703: Introduction to the Practice of Biostatistics I:** This course provides an introduction to biology at a level suitable for practicing biostatisticians and directed practice in techniques of statistical collaboration and communication. With an emphasis on the connection between biomedical content and statistical approach, this course helps unify the statistical concepts and applications learned in BIOSTAT 701 and BIOSTAT 702. In addition to didactic sessions on biomedical issues, students are introduced to different areas of biostatistical practice at Duke University Medical Center. Biomedical topics are organized around the fundamental mechanisms of disease from both evolutionary and mechanistic perspectives, illustrated using examples from infectious disease, cancer and chronic /degenerative disease. In addition, students learn how to read and interpret research and clinical trial papers. Core concepts and skills are mastered through individual reading and class discussion of selected biomedical papers, team-based case studies and practical sessions introducing the art of collaborative statistics. Corequisite(s): BIOSTAT 701, BIOSTAT 702. Credits: 3 ONLINE

**BIOSTAT 703L: Introduction to the Practice of Biostatistics I Lab:** The lab will be an extension of the course. The lab will be run like a journal club. The lab will instruct students how to dissect a research article from a statistical and scientific perspective. The lab will also give students the opportunity to present on material covered in the co-requisite course and to practice the communication skills that are a core tenant of the program. Corequisite(s): BIOSTAT 703 or permission of the Director of Graduate Studies. Credits: 0 ONLINE

**BIOSTAT 707: Statistical Methods for Learning and Discovery:** This course surveys a number of techniques for high dimensional data analysis useful for data mining, machine learning and genomic applications, among others. Topics include principal and independent component analysis, multidimensional scaling, tree-based classifiers, clustering techniques, support vector machines and networks, and techniques for model validation. Core concepts are mastered through the analysis and interpretation of several actual high dimensional genomics datasets. Prerequisite(s): BIOSTAT 701, 702, 704, 705, and 721 or 722 or their equivalents, or permission of the Director of Graduate Studies. Credits: 3 ONLINE

**BIOSTAT 710: Statistical Genetics and Genetic Epidemiology:** Topics from current and classical methods for assessing familiarity and heritability, linkage analysis of Mendelian and complex traits, family-based and population-based association studies, genetic heterogeneity, epistasis, and gene-environmental interactions. Computational methods and applications in current research areas. The course will include a simple overview of genetic data, terminology, and essential population genetic results. Topics will include sampling designs in human genetics, gene frequency estimation, segregation analysis, linkage analysis, tests of association, and detection of errors in genetic data. Prerequisite(s): BIOSTAT 701, 702, 704, 705, and 721 or 722 or their equivalents, or permission of the Director of Graduate Studies. Credits: 3 ONLINE

**BIOSTAT 713: Survival Analysis:** Introduction to concepts and techniques used in the analysis of time to event data, including censoring, hazard rates, estimation of survival curves, regression techniques, applications to clinical trials. Interval censoring, informative censoring, competing risks, multiple events and multiple endpoints, time dependent covariates; nonparametric and semi-parametric methods. Prerequisite(s): BIOSTAT 701, 702, 704, 705, and 721 or 722 or their equivalents, or permission of the Director of Graduate Studies. Credits: 3 ONLINE

## Fall 20 Basic & Biomedical Sciences Courses

**BIOSTAT 719: Generalized Linear Models:** The class introduces the concept of exponential family of distributions and link function, and their use in generalizing the standard linear regression to accommodate various outcome types. Theoretical framework will be presented but detailed practical analyses will be performed as well, including logistic regression and Poisson regression with extensions. Majority of the course will deal with the independent observations framework. However, there will be substantial discussion of longitudinal/clustered data where correlations within clusters are expected. To deal with such data the Generalized Estimating Equations and the Generalized Linear Mixed models will be introduced. An introduction to a Bayesian analysis approach will be presented, time permitting. Prerequisite(s): BIOSTAT 701, 702, 704, 705, and 721 or 722 or their equivalents, or permission of the Director of Graduate Studies. Credits: 3 ONLINE

**BIOSTAT 720: Master's Project:** Completed during a student's final year of study, the master's project is performed under the direction of a faculty mentor and is intended to demonstrate general mastery of biostatistical practice. Prerequisite(s): BIOSTAT 701 through BIOSTAT 706. Credits: 3 in Fall Semester and 3 in Spring Semester ONLINE

**BIOSTAT 721: Introduction to Statistical Programming I (R):** This class is an introduction to programming in R, targeted at statistics majors with minimal programming knowledge, which will give them the skills to grasp how statistical software works, tweak it to suit their needs, recombine existing pieces of code, and when needed create their own programs. Students will learn the core of ideas of programming (functions, objects, data structures, input and output, debugging, and logical design) through writing code to assist in numerical and graphical statistical analyses. Students will learn how to write maintainable code, and to test code for correctness. They will then learn how to set up stochastic simulations and how to work with and filter large data sets. Since code is also an important form of communication among scientists, students will learn how to comment and organize code to achieve reproducibility. Programming techniques and their application will be closely connected with the methods and examples presented in the co-requisite course. The primary programming package used in this course will be R. Prerequisite(s): None; familiarity with linear algebras is helpful. Corequisite(s): BIOSTAT 702. Credits: 3 HYBRID

**BIOSTAT 801: Biostatistics Career Preparation and Development I:** The purpose of this course is to give the student a holistic view of career choices and development and the tools they will need to succeed as professionals in the world of work. The fall semester will focus on resume development, creating a professional presence, networking techniques, what American employers expect in the workplace, creating and maintaining a professional digital presence and learning how to conduct and succeed at informational interviews. Practicums in this semester include an informational interviewing and networking practicum with invited guests. Students participate in a professional "etiquette dinner" and a "dress for success" module as well as an employer panel. Corequisite(s): BIOSTAT 701 through BIOSTAT 703. Credit: 1 ONLINE

**BIOSTAT 823: Statistical Program for Big Data:** This course describes the challenges faced by analysts with the increasing importance of large data sets, and the strategies that have been developed in response to these challenges. The core topics are how to manage data and how to make computation scalable. The data management module covers guidelines for working with open data, and the concepts and practical skills for working with in-memory, relational and NoSQL databases. The scalable computing module focuses on asynchronous, concurrent, parallel and distributed computing, as well as the construction of effective workflows following DevOps practices. Applications to the analysis of structured, semi-structured and unstructured data, especially from biomedical contexts, will be interleaved into the course. The course examples are primarily in Python and fluency in Python is assumed. Prerequisite(s): BIOSTAT 821 or permission of the Director of Graduate Studies. Credits: 3 ONLINE

**BIOSTAT 900. Current Problems in Biostatistics.** Advanced seminar on topics at the research frontiers in biostatistics. Readings of current biostatistical research and presentations by faculty and advanced students of current research in their area of specialization. Instructor: O'Brien. 1 unit. HYBRID

## Fall 20 Basic & Biomedical Sciences Courses

**BIOSTAT 906. Statistical Inference.** Introduce decision theory and optimality criteria, sufficiency, methods for point estimation, confidence interval and hypothesis testing methods and theory. Prerequisite: Biostatistics 704 or equivalent. Instructor consent required. Instructor: Xie. 3 units. ONLINE

**BIOSTAT 908. Independent Study (Rotations).** Faculty directed statistical methodology research. Instructor consent required. Instructor: O'Brien. 1 unit. ONLINE

**BIOSTAT 911. Advanced Inferential Techniques and Theory.** The theory for M- and Z- estimators and applications. Semiparametric models, geometry of efficient score functions and efficient influence functions, construction of semiparametric efficient estimators. Introduction to the bootstrap: consistency, inconsistency and remedy, correction for bias, and double bootstrap. U statistics and rank and permutation tests. Prerequisites: Statistical Sciences 711 and Biostatistics 906. Instructor: Li. 3 units. ONLINE

**BIOSTAT 914. Graphical Models for Biological Data.** Introduction to probabilistic graphical models and structured prediction, with applications in genetics and genomics. Hidden Markov Models, conditional random fields, stochastic grammars, Bayesian hierarchical models, neural networks, and approaches to integrative modeling. Algorithms for exact and approximate inference. Applications in DNA/RNA analysis, phylogenetics, sequence alignment, gene expression, allelic phasing and imputation, genome/epigenome annotation, and gene regulation. Department consent required. Instructor: Majoros. 3 units. C-L: Computational Biology and Bioinformatics 914. ONLINE

### BIOTRAIN:

**BIOTRAIN 720: Grant Writing for Biomedical Scientists.** Introduction to scientific grant writing for second- (or third-) year PhD students. This course contains lecture-based and active learning sessions. Content includes lectures combined with class discussions on grant agencies, format and structure of grant applications, concepts in peer review, best practices in articulating study design and data outcomes, rigor and reproducibility in a research plan, and crafting biological significance and training statements. Students write an NIH-style proposal and actively participate in topical study sections to receive oral and written critiques of their proposals and to provide constructive feedback of others' proposals. Open only to second- or third-year students in biomedical PhD programs. Instructor: Sullivan and staff. *MWF 8:45AM - 9:45AM*. ONLINE

### CELL AND MOLECULAR BIOLOGY:

<http://medschool.duke.edu/cmb>

#### **CMB 710 A-F - Cell & Molecular Biology Modules**

Modules in the CMB 710 series (A – F) are required for all CMB students. Modules are offered sequentially during the Fall semester. These are the core offerings of the Cell & Molecular Biology Program. Topics reflect the expertise of the corresponding faculty and emphasize either in-depth critical discussion of the primary literature or quantitative/mathematical approaches to addressing biological questions. Each module lasts for 2 weeks, with 3 meetings per week. Students entering through CMB are required to take 6 modules in fall semester of their first year with a minimum of 4 modules in the CMB 710 series. The other two may be from the UPGEN 778 series. A total of 12 modules are required for CMB, with a total of 8 from CMB710. To help you prepare for each module, the instructors have included a summary with any required reading that should be completed prior to the start of each module, and prerequisites.

Note: The Drop/Add deadline for Fall 2020, applies to **all modules**. CHECK for any prerequisites. *MWF 10:20 – 11:40 am*; Fox, Di Talia (Course Directors); Online Course; *1 Unit each*

**CMB 733.01 (NEUROBIO, PHARM) – Experimental Design and Biostatistics for Basic Biomedical Scientists – See PHARM 333.01**

## Fall 20 Basic & Biomedical Sciences Courses

**CMB 733.02 (NEUROBIO, PHARM) – Experimental Design and Biostatistics for Basic Biomedical Scientists** – See PHARM 333.02

**CMB 733.03 (NEUROBIO, PHARM) – Experimental Design and Biostatistics for Basic Biomedical Scientists Statistics** – See PHARM 333.03

**CMB 764 Cell and Molecular Biology Colloquium** – [Student Seminar] required of all CMB students. Each Monday at noon, presentations by upper-year students: one student talks about ongoing dissertation research and another introduces a research paper relevant to that week's seminar. Students attend the Thursday seminar and can have lunch with the speaker. Credit is based on attendance. *M 11:45-1:00 pm; Boyce; Online Course; 2 Units*

**CMB 797 Modern Techniques in Molecular Biology** - This course introduces the fundamental laboratory techniques used in basic research. It is divided into two sections. One section covers techniques used for protein purification, analysis, and the study of protein-protein interactions. The second covers nucleic acid based techniques, including a review of basic nucleic acid chemistry, enzymatic modification, qualitative and quantitative PCR, nucleic acid sequencing, cloning strategies, vectors, and measurement of transcript expression including microarray techniques. This course is built around a team-based learning model. Course reading material and recorded lectures are provided to students to review before class and class time is spent reinforcing the material through problem sets and group discussion. *8:45-9:45 am; Madan Kwatra; Online Course; 3 Units*

### **CELL BIOLOGY:**

<http://www.cellbio.duke.edu>

**CHEMISTRY: For a complete listing, please go to:** <http://www.chem.duke.edu/graduates/courses.php>

### **COMPUTATIONAL BIOLOGY & BIOINFORMATICS:**

<http://genome.duke.edu/education/CBB>

**CBB 510S Computational Biology & Bioinformatics Seminar**- Lectures, and seminars on selected topics of current interest in computational biology & bioinformatics. Required of all 1st and 2nd year CBB students. *Mon 12p-1p; Schmidler; Online; 1 Unit*

**CBB 520 Genome Tools and Technologies** - The course introduces the laboratory and computational methodologies for genetic and protein sequencing, mapping and expression measurement. Prerequisites: Students are expected to have some background course work in genetics, molecular biology, biochemistry, and a modern programming language. *TuTh 10:15-11:30 am; Dietrich; Online, 3 Units*

**CBB 574 Modeling and Engineering Gene Circuits** - This course discusses modeling and engineering gene circuits, such as prokaryotic gene expression, cell signaling dynamics, cell-cell communication, pattern formation, stochastic dynamics in cellular networks and its control by feedback or feedforward regulation, and cellular information processing. The theme is the application of modeling to explore "design principles" of cellular networks, and strategies to engineer such networks. Students need to define an appropriate modeling project. At the end of the course, they're required to write up their results and interpretation in a research-paper style report and give an oral presentation. Prerequisites: Biomedical Engineering 260L or consent of instructor. *WF. 1:45p-3:00p; Instructor You; Online 3 units.*

**New Course- CBB 914-Graphical Models for Biological Data** Introduction to probabilistic graphical models and structured prediction, with applications in genetics and genomics. Hidden Markov Models, transducers, conditional random fields, stochastic context-free grammars, Bayesian hierarchical models, and approaches to integrative modeling. Algorithms for exact and approximate inference. Applications in DNA/RNA analysis, phylogenetics, sequence alignment, allelic phasing and imputation, genome/epigenome annotation, and gene regulation. Prerequisite: probability and statistics (BIOSTAT 701 or STA 611 or equivalent), and some programming experience with python, R, or similar language. Instructor: Majoros *TuTh 11:45a-1:00p; Online*

**CBB 658 Biochem 658 Structural Biochemistry I-See BIOCHEM 658**

**CBB 659 Biochem 659 Structural Biochemistry II –See BIOCHEM 659**

### **COGNITIVE NEUROSCIENCE:**

751. Neuroscience Bootcamp. Neuroscience Bootcamp is a one week immersive lecture, discussion and laboratory course for graduate students in the Neurobiology Graduate Program and the Cognitive Neuroscience Admitting Program, and graduate students in allied programs at the discretion of the instructors. The Duke Neuroscience Bootcamp is designed to (1) provide a common knowledge base of neuroscience fundamentals; (2) demystify the tools of the discipline—providing hands-on experience with techniques that are commonly used to explore cellular/molecular, circuits and cognitive neuroscience; and (3) introduce new students to a wide variety of Duke faculty and helpful resources for ensuring a successful graduate career. Instructor: Glickfeld, Grandl, Egner. 2 units. C-L: Neurobiology 751; Online Only

### **DEVELOPMENTAL & STEM CELL BIOLOGY:**

<https://sites.duke.edu/dscb/>

**DSCB 700 Classic Papers in Development** - The goal of this Fall seminar course is to deepen understanding of the class findings and advances in the field of Development, Stem Cell, and Regenerative Biology and to provide a historical view of how these findings affect our approaches in the field today. The course will consist of both first and second year DSCB students and 20 faculty members who will select papers and facilitate group discussions. **MWF - 12-1:30 pm**; Silver; Online Only; 1 Unit

**DSCB 730 Hands on Development** Mini Course - This class is required for **first year DSCB students only**, will expose students to basic principles and techniques in development and stem cell biology. This year the class will be held virtually and students will meet with individual faculty to learn about different model systems. **MWF (8/17 - 8/28 afternoon only)**; Silver, 1 Unit

### **IMMUNOLOGY:**

<http://immunology.mc.duke.edu>

**IMMUNOL 544 Principles of Immunology** - This is a graduate level course that is open to both graduate students and advanced undergraduates. It is an introduction to the molecular and cellular basis of the immune response. Topics include anatomy of the lymphoid system, lymphocyte biology, antigen-antibody interactions, humoral and cellular effector mechanisms, and control of immune responses. The last third of the course focuses on special topics and application such as transplantation, autoimmunity, immunodeficiency, and tumor immunity. On selected days, the class is broken down into small discussion groups of approximately 15 students to discuss material introduced in the lectures or to work on problem sets. Graduate students in the Department of Immunology lead these sections. **MWF 1:45-2:35 pm**; Zhang; mode of instruction is online; 3 Units

**IMMUNOL 601 Immunology of Human Disease** - This advanced course will cover the immune aspect of various human diseases including autoimmune diseases, allergy, tumor, inflammation and infectious diseases. Required course for all students specializing in immunology. Prior course requirement: IMM544. **Tues 10:15-11:30 am**; He; mode of instruction is online; 1 Unit.

**IMMUNOL 701D Pillars of Immunology** – This course will cover discoveries of historical importance in the field of immunology through student presentations and discussions of classical papers. Intended for students seeking a PhD in Immunology. **F 10:15-11:30 am**; Tedder & Krangel; mode of instruction is online; 1 Unit

**IMMUNOL 735 Topics in Immunology** - Focus on current immunology research, emphasizing emerging research areas and new directions in established areas. Students present recent papers in selected subjects. Required course for all

## Fall 20 Basic & Biomedical Sciences Courses

students specializing in immunology. *Th 8:45-10 am; Chan & Ciofani; mode of instruction is online; Credit/no credit grading only; 1 Unit.*

**IMMUNOL 791A Research in Immunology** – This course is the first of two for first year students enrolled in the Immunology Graduate Program designed to introduce bench work in immunology and to expose students to a variety of techniques to increase their proficiency. One to two research rotations will be conducted in training faculty laboratories for periods of 6 weeks. Rotations should be approved by the DGS. The second course is IMMUNOL791B offered in the spring. Both courses must be taken in order for the four total credits and grades to post. 2 Units

### Second Half Semester:

**IMMUNOL 659 / BIOCHEM 659 Structural Biochemistry II** - See BIOCHEM 659

### INTEGRATED TOXICOLOGY AND ENVIRONMENTAL HEALTH (CERTIFICATE):

<http://sites.nicholas.duke.edu/envhealth/>

**ENVIRON 501 Environmental Toxicology** – Study of environmental contaminants from a broad perspective encompassing biochemical, ecological, and toxicological principles and methodologies. Discussion of sources, environmental transport and transformation phenomena, accumulation in biota and ecosystems. Impacts at various levels of organization, particularly biochemical and physiological effects. Prerequisites: organic chemistry and vertebrate physiology or consent of instructor.

*Lectures ASYNCHRONOUS ONLINE; Discussions M 10:15-11:30 am GH 2102 and W 10:15-11:30 am ONLINE, or M 10:15-11:30 am ONLINE and W 10:15-11:30 am GH 2102; 3 units; Instructors: Di Giulio, Meyer*

**ENVIRON 540 Chemical Fate of Organic Compounds** – This course will review the basics of environmental organic chemistry with a focus on contaminant chemistry. During this course we will discuss quantitative processes used in predicting the fate and distribution of organic chemicals in the environment with regards to equilibrium/thermodynamics and some kinetic considerations. Topics will include equilibrium partitioning among air, water, sediments and biological tissues, including bioaccumulation and biomagnification. The processes influencing the transport and ultimate fate of organic contaminants in rivers and lakes will be discussed in addition to processes influencing global transport. Prerequisites: university-level general chemistry and organic chemistry within last four years.

*Lectures ASYNCHRONOUS ONLINE; Discussions M 3:30-4:45 pm or W 3:30-4:45 pm GH 1105 or ONLINE; 3 units; Instructor: Stapleton*

**ENVIRON 847S Seminar in Toxicology** – See PHARM 847S-01 (required class for certificate). A weekly research seminar throughout the year is required of participants in the Toxicology Program, but open to students in related fields as well. Students, faculty and invited national speakers present their latest research findings concerning neurotoxicology, molecular biology, teratology, environmental toxicology, public policy of environmental regulation and related fields. *F 12:00-1:15 pm GH 1112 or ONLINE; 1 Unit; Instructor: Meyer.*

**PHARM 533 Essentials of Pharmacology and Toxicology** - (required) See PHARM 533

**PHARM 554 Mammalian Toxicology** - See PHARM 554

### MEDICAL PHYSICS

<http://medicalphysics.duke.edu>

**MEDPHY 500 Radiation Physics** - A course covering the basics of ionizing and non-ionizing radiation, atomic and nuclear structure, basic nuclear and atomic physics, radioactive decay, interaction of radiation with matter, and radiation detection and dosimetry. *MW 10:05 am -11:20 am; Turkington; online/1032 Hock Plaza; 3 Units.*

## Fall 20 Basic & Biomedical Sciences Courses

**MEDPHY 505 Anatomy and Physiology for Medical Physicists** - A course focused on medical terminology, biochemistry pertaining to MP, basic Anatomy and physiology, elementary tumor and cancer biology, and overview of disease in general. Upon completion, the student should: (a) understand anatomic structures, their relationships, their cross-sectional and planar projections, and how they are modified by attenuation and artifacts in the final images; (b) understand the physiology underlying radionuclide images, (c) understand how (a) – (b) are modified by disease, (d) identify anatomical entities in medical images (different modalities), and (e).identify basic disease features in medical images (e.g., Pneumothorax in chest radiographs, microcalcifications in mammograms). *TU/TH 8:30 am – 9:45 am; Reiman; online only; 3 units*

**MEDPHY 530 Modern Medical Diagnostic Imaging System** - A course describing basics of imaging science, x-ray imaging modalities including basic principles, detectors, scattered radiation, planar imaging, CT, fluoroscopic imaging, nuclear medicine imaging, US and MRI, and computers in imaging. *TU/TH 12:00pm - 1:15pm; Solomon; online/1032 Hock Plaza; 3 Units.*

**MEDPHY 722 Advanced Photon Beam Radiation Therapy.** This course will cover the physics and clinical application of advanced external beam photon therapies with special emphasis on IMRT. Prerequisite: MP 220. *TU/TH 8:30 am - 9:45 am, Q. Wu.; online/1032 Hock Plaza, 3 Units*

**MEDPHY 725 Physics and Clinical Applications of Brachytherapy.** The course is designed to combine traditional lectures and clinical physics practicum on the topic of LDR (low dose rate) and HDR (high dose rate) brachytherapy. Prerequisite: Medical Physics 520. *MO/TH 3:30 pm - 4:30 pm; Craciunescu, Meltsner; online/clinics, 2 Units.*

**MEDPHY 726 Practicum on Monte Carlo method in Medical Physics** - This course focuses on the fundamentals of Monte-Carlo simulations and provides hands-on experience with clinical Monte-Carlo codes used in medical dosimetry. The course will introduce software such as MCNP, EGS, FLUKA, GEANT and Penelope and companion data analysis software ROOT, PAW and CERNLIB. Students will study at least one major code and will perform two or more projects based on a clinically relevant task. Prerequisites: Calculus, modern physics, and programming. Knowledge of C, C++, or Fortran would be a plus. *WE 1:45 pm –4:45 pm, Gunasingha, online only, 1-3 Units.*

**728. Clinical Practicum and Shadowing (RT).** The course gives hands on experience in practical aspects of medical physics as applied to radiation therapy. Special emphasis is given to the operation of various therapy units and dose measuring devices, techniques of measuring the characteristics of radiation beams, commissioning and quality assurance checks for radiation producing devices in the clinic. The course includes shadowing a clinician, technologist, or physicist, while performing their routine clinical tasks. *TH 5:15 pm - 8:15 pm, Zh. Wang, online/clinics, 3 Units.*

**MEDPHY 751-1 Medical Physics Basic Research Topics** - This seminar provides an overview of research projects conducted by medical physics faculty through a series of invited talks. The aim of the seminar is to help first year students identify their research interests and career/training orientation. *TU 1:45 pm – 3pm; Kapadia; online only, 1 Unit.*

**MEDPHY 751-3 Professional Development Skills for Medical Physicists** - This seminar provides important skills for students' professional development through a series of presentations on relevant topics that include public speaking, effective scientific and professional communication, interviewing skills, entrepreneurship, etc. Designed for second year Medical Physics students. *WE 8:30 am - 10:05 am; Wilson; online only, 1 Unit.*

**MEDPHY 734 Advanced Topics of Non-ionizing-based Imaging Modalities.** This course covers advanced topics in non-ionizing Imaging modalities such as Ultrasound and MR imaging, including speckle statistics, Doppler imaging, advanced MR pulse sequences, MR angiography, flow and diffusion etc. Instruction will consist of didactic lectures accompanied by hands-on laboratory exercises (practicum). *TU/TH 12 pm - 1:15 pm; Robertson; online only, 3 Units*

**MEDPHY 763 Advanced Radiation Biology in Medical Physics.** This course will teach students about cutting-edge topics in the field of radiobiology that have relevance to medical physicists. The teaching will be through the format of a



## Fall 20 Basic & Biomedical Sciences Courses

Journal Club. Journal Club Format. We will provide an outline for how to perform a manuscript review, prior to any student presentations. At the beginning of the semester, groups of students will select papers that they wish to present to the class. Each student assigned to a particular paper will prepare a written review and discuss their assessments with the class during one of the scheduled class dates. Class and group participation is required. Detailed report on selected subject. Students will select a topic from either the reviewed manuscripts or an approved subject of their own choosing (must contain both biology and physics components). The student will write a detailed report on this subject. We will provide a format for the report. Grading will be based upon quality of manuscript review presentations and the detailed final written report. *TU/TH 13:30 pm - 4:30 pm; Dewhirst, Palmer, Oldham; online only, 3 Units*

### **MOLECULAR CANCER BIOLOGY**

<https://pharmacology.duke.edu/training/graduate/molecular-cancer-bio>

**MOLCAN 780 (PHARM 780) Advances in Cancer Research** - [Student Seminar] A presentation and discussion course in which program faculty and graduate students review the recent progress in areas of cancer research being investigated at Duke University. Provides an important avenue for evaluation and feedback for graduate student research and is required each year for all students pursuing their Ph.D. degree in molecular cancer biology. *Th 3:20-4:30pm; Tsvetanova/Zhao; 2 Units (ONLINE)*

**MOLCAN 818 (PHARM 818) Molecular Mechanisms of Oncogenesis** - This course is a lecture presentation and discussion course on the molecular mechanisms underlying cancer development in which students complete periodic tests, present a paper, and work in a group to write and defend a grant proposal. The objective of the course is to provide an opportunity for in-depth discussions of molecular mechanisms underlying the development of human cancers. The course is intended for second-year students who have already taken the course of Cell Signaling. *TuTh 10:05-11:20 am; Wood/Yao; 3 Units (ONLINE)*

### **MOLECULAR GENETICS & MICROBIOLOGY**

<http://mgm.duke.edu>

**MGM 701 Foundations of MGM** – This core course is open to MGM first year students with exposure to research interests in the department. MGM faculty will provide an overview of their research along with important historical context. Credit grading only. *Tu (every other Tuesday) 4:00-5:30pm; Heaton; TBD; 1 unit (ONLINE)*

**MGM 720 Computational Tools in Next Generation Genomic Analysis** – This course is an intensive, one semester course in computer skills necessary to carry out analysis of next generation genomic data. The philosophy for this course is that we are training PhD students, and they should have a fairly in-depth understanding of how this analysis is carried out. This course offers that understanding. The course will involve only a small amount of lecture, and be primarily a hands-on laboratory with extensive discussion. Permission number from Instructor required for registration. Class size is limited to 6 students. *TuTh 1:25-2:40pm and lab of 3:05-4:20pm; Dietrich; 415 Jones, 3 units (HYBRID of ONLINE and IN-PERSON)*

**MGM 778 (CMB, UPGEN 778) - Genetic Approaches to the Solution of Biological Problems** – See UPGEN 778

**MGM790S - Topics in Molecular Genetics and Microbiology** - Required course for all graduate students receiving their degree through MGM through third year of PhD program. Instructor: Tobin and staff. 1 unit. *F (every other Friday) 4:00pm-5:30pm (ONLINE)*

**MGM 793 Research for Graduate Students** - Laboratory investigation for Graduate students. Various labs within the department of molecular genetics and microbiology. Credits to be arranged. Instructor consent is required. Instructor: Tobin. 2 units. *(HYBRID of ONLINE AND IN-PERSON)*

**NEUROBIOLOGY**

<http://www.neuro.duke.edu>

**NEUROBIO 719-01 Concepts in Neuroscience I:** Cellular and Molecular Neurobiology - The goal of this course is for you to gain in depth knowledge of cellular and molecular neurobiology and for you to learn to critically evaluate the associated primary scientific literature. This is a required core course for Neurobiology program graduate students. The course is also frequently taken by other graduate students with research interests in neuroscience including (but not limited to) those in Cognitive Neuroscience, Cell Biology, Developmental Biology, Pharmacology, Genetics, Biology, Psychology, and Biomedical Engineering.

The course is comprised of five, two-week long modules. Each module covers one core topic area (Neuronal Excitability, Synaptic Transmission, Cell Biology of the Neuron, Neuronal Development, and Neuronal Plasticity). Due to the Covid-19 restrictions, enrollment will not be granted to individual modules, but only for the complete course with limited enrollment. All modules are comprised of both didactic lectures and paper discussion sessions. The relative emphasis on different learning activities within each module is determined by the module directors and will vary.

*Start date Aug 24 – Nov 16; MWF 10:15 am-11:30am; Grandl / West; Hybrid- Online/MSRB-01; 5 Units. (SFN Oct 24-28, No class Oct 26 and Oct 28) (Midterm Exam Oct 23)*

**NEUROBIO 719A Neuronal Excitability:** The electric excitability of neurons is mediated by ion channels. First, we will give an overview of the human ion channel set and discuss the basic structure and functions of ion channels. We will show how the function of ion channels is measured and analyzed. We will analyze the 3D crystal structures of a few ion channels in greater detail. In the second week we will begin with a review of the basic electrical properties of cell membranes, and then focus in-depth on what remains the archetypal study of neuronal excitability in the field: that of the axonal action potential by Alan Hodgkin and Andrew Huxley in a series of papers published in 1952. *Jorg Grandl.*

**NEUROBIO 719B Cell Biology of the Neuron:** This module will cover the fundamentals of basic cell biology as well as focusing on cellular specializations that are exaggerated in neurons. Topics include polarized protein trafficking, organelle motility, cytoskeleton organization, synaptic scaffolds, intracellular signaling cascades and cell-to-cell communication, including communication between neurons and non-neuronal cells. We will cover genetic methods for the study of molecular function in neurons and finally we will have a class project to discuss how neurotrophic factors promote cell survival and the molecular mechanisms of neuronal death. *Anne West.*

**NEUROBIO 719C Synaptic Transmission:** As the focal point of communication between neurons, the synapse is an essential adaptation of the nervous system that contains a wide variety of unique proteins and functional specializations. In this module, we will cover the structure and function of the synapse, from the dynamics of presynaptic vesicle release through the postsynaptic response to neurotransmitter, and the essential proteins and molecules that mediate these processes. Finally, we will discuss how these elements can be tailored to fit the needs of different circuits. *Kevin Franks/Court Hull.*

**NEUROBIO 719D Neural Plasticity:** Plasticity is one of the most unique features of the brain, mediating the ability of this organ to learn from its environment. In this module we will explore molecular and cellular mechanisms of experience-dependent neural plasticity. Emphasis will be given to synaptic plasticity, a major mechanism for learning and memory, but this module will also introduce the various forms of plasticity that lie under the “plasticity” umbrella. Upon completing this module students will be familiar with the major forms of synaptic plasticity and their molecular mechanisms, be able to identify experimental approaches to study synaptic plasticity, and learn of examples that illustrate how plasticity modifies circuit function and behavior. *Eva Naumann and Anne West.*

**NEUROBIO 719E Neural Development:** How the brain is wired during development is a fundamental question of neurobiology. In this module we will discuss the molecular mechanisms that sculpt brain patterning and axon guidance, we will discuss the regulation of neurogenesis, we will cover how the synapse is formed, and we will talk about how sensory information guides the development of the brain in early postnatal life. *Jeremy Kay.*

## Fall 20 Basic & Biomedical Sciences Courses

**NEUROBIO 726S.001 Neurobiology Journal Club (Seminar)** – First and second year neurobiology graduate students attend the weekly Neurobiology Invited Seminar Series. Once a month, students will meet to hold a student-run journal club to discuss the work of a speaker from an outside institution.

*Weekly Tu 12:00 pm – 1:15 pm; Monthly Fri 3:30pm-4:45pm West; Online; 1 Unit*

**NEUROBIO 733.01 (CMB, PHARM 733.01) Experimental Design and Biostatistics for Basic Biomedical Scientists** - See PHARM 733.01

**NEUROBIO 751 (NEUROSCI 751) Neuroscience Boot Camp** - Neuroscience Bootcamp is a week-long immersive lecture, discussion and laboratory course for graduate students in the Neurobiology Graduate Program and the Cognitive Neuroscience Admitting Program, and graduate students in allied programs at the discretion of the instructors. The Duke Neuroscience Bootcamp is designed to (1) provide a common knowledge base of neuroscience fundamentals; (2) demystify the tools of the discipline - providing hands-on experience with techniques that are commonly used to explore cellular/molecular, circuits and cognitive neuroscience. *Permission number from Instructor required for registration. August 17-21, MTWThF; varies but approx. 8:30am-4:45pm; J. Grandl; Online; 2 Units.*

**NEUROBIO 759S (PSY 759S, PHIL 753S) Principles in Cognitive Neuroscience I-** Introduction to the cognitive neuroscience of emotion, social cognition, executive function, development, and consciousness. Topics also include cognitive disorders, and computer modeling. Highlights current theories, methodological advances, and controversies. Students evaluate and synthesize findings across a variety of research techniques. Consent of instructor required. *T Th 12:00pm-1:15 pm; Cabeza; Online; 3 Units.*

**NEUROBIO 790 Student Seminar** – Preparation and presentation of seminars to students and faculty on topics of broad interest in neurobiology. Required of all first – and second-year students. *W 12:00 – 2:30 pm; Rebecca Yang/Jeremy Kay; Online; 1 unit*

**NEUROBIO 793 Research in Neurobiology (Independent Study)-** This course acquaints students with research in neuroscience and allows them to become proficient in a variety of techniques. It is an independent study in one of the laboratories of the training faculty. Students are expected to do three rotations in three semesters. *(Laboratory Rotations) (up to 12 Units)*

### **NEUROSCIENCE**

<http://www.dibs.duke.edu/education/graduate>

### **PATHOLOGY**

<https://pathology.duke.edu/education/phd-graduate-program/curriculum>

**PATHOL 725 Introduction to Systemic Histology** The purpose of this course is to teach students how to identify a variety of normal tissues and cell types in standard histologic sections. Structure/function relationships will be emphasized, using an organ system approach. The scheduled class time includes both lecture and laboratory using “virtual microscopy”, where scanned glass slides are viewed on the screen of your laptop/tablet computer. The course is open to graduate students and advanced undergraduates and is recommended for students whose research requires examination of tissue sections. *MWF 1:25-2:40 pm, Hale; ONLINE; 3 Units*

**PATHOL 735S Animal Models in Translational Research** The goal of this course is to give students a working knowledge of the use of animal models in research, types of models and how to choose for translational relevance. Topics include the regulations governing the use of animals in research, principles of in vivo experimental design, as well as best practices for data collection, interpretation and reporting during animal study conduct. Students will be exposed to the principle elements that impart variability and bias in the generation of animal study data, and will learn best practices

## Fall 20 Basic & Biomedical Sciences Courses

for the conduct of high quality animal studies that lead to reproducible data. *MW 11:45am-1:00pm, Everitt/ Norton, ONLINE; 3 Units*

### PHARMACOLOGY

<https://pharmacology.duke.edu/training/graduate/pharmacology>

**PHARM 533 Essentials of Pharmacology & Toxicology** - Drug absorption, distribution, excretion and metabolism. Structure and activity relationships; drug and hormone receptors and target cell responses. Consent of instructor required. *Prerequisite: introductory biology; Chemistry 151L; Mathematics 31 and 32. Instructor: Slotkin and staff, MWF 3:30-4:45 pm; 147 Nan Duke; 4 Units (IN PERSON).* **NOTE: CMB Students in Pharmacology are currently required to take PHR 533 Essentials in Pharmacology & Toxicology. This is also a core course for the Environmental Health Certificate.**

**PHARM 733.01 (CMB, NEUROBIO, BME, MOLCAN 733.01) Experimental Design and Biostatistics for Basic Biomedical Scientists** - The use and importance of statistical methods in laboratory science, with an emphasis on the nuts and bolts of experimental design, hypothesis testing, and statistical inference. Central tendency and dispersion, Gaussian and non-Gaussian distributions, parametric and nonparametric tests, uni- and multivariate designs, ANOVA and regression procedures. Student presentations in addition to formal lectures. Consent of instructor required. *T 8:30-10:15 am; 147 Nan Duke; Slotkin (Runs concurrently with Section 733.02 & 733.03) 2 Units. (IN PERSON)*

**PHARM 733.02 (CMB, NEUROBIO, BME, MOLCAN 733.02) Experimental Design and Biostatistics for Basic Biomedical Scientists** - The use and importance of statistical methods in laboratory science, with an emphasis on the nuts and bolts of experimental design, hypothesis testing, and statistical inference. Central tendency and dispersion, Gaussian and non-Gaussian distributions, parametric and nonparametric tests, uni- and multivariate designs, ANOVA and regression procedures. Student presentations in addition to formal lectures. Consent of instructor required. *W 8:30-10:15 am; 147 Nan Duke; Slotkin (Runs concurrently with Section 733.02 & 733.03) 2 Units. (IN PERSON)*

**PHARM 733.03 (CMB, NEUROBIO, BME, MOLCAN 733.03) Experimental Design and Biostatistics for Basic Biomedical Scientists** - The use and importance of statistical methods in laboratory science, with an emphasis on the nuts and bolts of experimental design, hypothesis testing, and statistical inference. Central tendency and dispersion, Gaussian and non-Gaussian distributions, parametric and nonparametric tests, uni- and multivariate designs, ANOVA and regression procedures. Student presentations in addition to formal lectures. Consent of instructor required. *Th 8:30-10:15 am; 147 Nan Duke; Slotkin (Runs concurrently with Section 733.02 & 733.03) 2 Units. (IN PERSON)*

**PHARM 780 (MOLCAN 780) Advances in Cancer Research** – See MOLCAN 780

**PHARM 818 (MOLCAN 818) Molecular Mechanisms of Oncogenesis** - See MOLCAN 818

**PHARM 847S Seminar in Toxicology** – (ENVIRON 847S-01 - required class for certificate). A weekly research seminar throughout the year is required of participants in the Toxicology Program, but open to students in related fields as well. Students, faculty and invited national speakers present their latest research findings concerning neurotoxicology, molecular biology, teratology, environmental toxicology, public policy of environmental regulation and related fields. *F 12:00-1:15 pm; Meyer; GH 1112 or ONLINE; 1 Unit.*

### UNIVERSITY PROGRAM IN GENETICS AND GENOMICS

<http://upg.duke.edu>

**UPGEN 659 / BIOCHEM 659 Structural Biochemistry II - See BIOCHEM 659**

**UPGEN 658/ BIOHEM 658 Structural Biochemistry 1-See BIOCHEM 658**

## Fall 20 Basic & Biomedical Sciences Courses

**UPGEN 701 Advanced Topics in Genetics and Genomics** - This course is open only to first year UPGG graduate class. Weekly discussion of current literature in genetics (Fall semester) and genomics (Spring Semester). This course is meant to fill two objectives. The first objective is to ground each of the members of the UPGG first year class, regardless of their interest, in the two areas of focus of the program - namely, genetics and genomics. The second objective is to facilitate interactions among the diverse student body by bringing the class together once a week for discussion. *W 3:45p-5:00 Instructor Lowe; Online; 2 Units.*

**UPGEN 711 (BIOLOGY 701)** - Succeeding in Graduate School in the Biological Sciences- Weekly lecture and Q&A on choosing a thesis advisor, the grant proposal and scientific manuscript peer review processes, and other topics related to succeeding in graduate school. Also counts for RCR credit. Minicourse, 1st half-semester. *M 5:15p-6:15PM; Noor; Online; 0.5 Units*

**UPGEN 716 Genetics Student Research** - Presentations by genetics students on their current research. Required course for all graduate students specializing in genetics. Credit grading only. *Tues 4:30p-6:00 pm; Silva and Yan; Online; 1 Unit*

**UPGEN 750 Genetics Colloquium** - Lectures, and seminars on selected topics of current interest in genetics. Required of all students specializing in genetics. *Tu 12:30-1:30; Ashley-Koch; Online; 1 Unit*

**UPGEN 778A-F Genetic Approaches to the Solution of Biological Problems (MGM 778)** UPGEN 778A-F are 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. Each mini-course consists of six classes. *MWF 2:00-3:30 pm; Daniel Lew; Online; Full list of topics available at <https://upg.duke.edu/current-students/courses>; 1 Unit per module.*