# Spring 2022 Basic & Biomedical Sciences Course List - Duke SoM

**BIOCHEMISTRY:**
http://www.biochem.duke.edu

**BIOCHEM 301 Introductory Biochemistry I -** Introduction to Biochemistry I. Chemistry of the constituents of proteins, lipids, carbohydrates, and nucleic acids and their metabolic interrelationships. Prerequisite: two semesters of organic chemistry.

**BIOCHEM 302 Introductory Biochemistry II -** Introduction to Biochemistry II. This second semester of Biochemistry covers the synthesis, structure, and function of important biological molecules. Half of the course will cover carbon and nitrogen fixation and assimilation, and the synthesis of amino acids, nucleotides, DNA, RNA, and protein. The second half covers the structure, biosynthesis and function of important membrane lipids, membrane proteins and membrane-associated carbohydrates.

**BIOCHEM 536 Bioorganic Chemistry -** Basic enzymology, mechanisms of enzymatic reactions, cofactors, oxidoreductases, C1 chemistry, carbon-carbon bond formation, carboxylation/decarboxylation, heme, pyridoxal enzymes, thiamine enzymes. Prerequisite: Chemistry 331 or equivalent. *4 units/graded.*

**BIOCHEM 622 (SBB 622) Structure of Biological Macromolecules -** How to get the most out of experimental and computational 3D structure: a) 3D Molecular Literacy: Computer and physical molecular models of proteins and nucleic acids; worksheets and hands-on exploration. b) Data bases and the data itself: gaining familiarity with the PDB (Protein Data Bank) in general, the EDS (Electron Density Server), and the peculiarities, caveats, and reliabilities of different categories of molecular data. c) Computational methods for studying and depicting macromolecules: Model building in structural biology, Molprobity and all-atom contact analysis, and methodologies for multiple conformations, ensembles, and mobility. d) Student Projects: interactive 3D illustration of some scientific point about macromolecules, using kinemages or other molecular graphics programs often with short non-interactive introduction. Reports given at end of semester, progress shown periodically. Once a week in-class presentations, discussion, and hands-on work with physical and computer molecular models. Homework includes worksheets and individual student projects. *3 units/graded*

***First Half Semester:***

**BIOCHEM 667 Biochemical Genetics I: DNA and Genome Stability -** Chromatin and chromosome structure, replication, repair, genetic recombination, mutation and chromosome rearrangement. *2 units/graded*

***Second Half Semester:***

**BIOCHEM 631 (CMB, NEURO, PHARM 631) Membrane Biology: 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. *2 units/graded*

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**BIOCHEM 668 (CELLBIO, UPGEN 268) RNA Biology -** The major emphasis will be on reading and discussing primary research papers in depth. The course will explore new concepts in mechanisms of transcription, splicing, catalytic RNA, RNA modification, RNA editing, mRNA stability & translation. Each section of the course will consist of background lecture material and discussion of selected paradigm papers. Students will be asked to prepare presentations and discussions to demonstrate proficiency in the topics. *3 units/graded*

**BIOCHEM 695 Understanding NMR Spectroscopy –** Course aimed at graduate students who have some familiarity with high-resolution NMR who wish to deepen their understanding of how NMR experiments actually 'work'. Introduces quantum mechanical tools needed to understand pulse sequences, with emphasis on obtaining good understanding of how experiments actually work. Course also covers advanced biomolecular NMR experiments that enable structural and dynamic characterization of biomolecules. For roughly half of course, students will be expected to follow online lectures that accompany course textbook, with class meetings emphasizing concepts, group discussion, and problem solving. Instructor consent required. Instructor: Al-Hashimi Prerequisite: undergraduate physical chemistry, undergraduatae biochemistry and one year of calculus. This course will be offered every other spring, alternating with BIOCHEM 696. *4 units/graded*

**BIOCHEM 696 Macromolecular crystallography - (Not offered Spring 2022)** Theoretical and practical principles of macromolecular X-ray crystallography. Topics covered include crystal symmetry, space grouptheory and determination, diffraction theory, a practical understanding of crystallization, X-ray intensity data collection and data processing, phase determination, refinement and model validation. Consent required - contact course director for permission number. This course will be offered every other spring, alternating with BIOCHEM 695.

**BIOCHEM 746S - Biochemistry Seminar -** required of all first-, second- and third-year biochemistry students. *1 unit/graded.*

**BIOLOGY:**
**https://biology.duke.edu/**

**BIOSTATISTICS:**

**http://biostat.duke.edu**

**BIOSTAT 704: Introduction to Statistical Theory and Methods II:**

This course provides formal introduction to the basic theory and methods of probability and statistics. It covers topics in statistical inference, including classical and Bayesian methods, and statistical models for discrete, continuous and categorical outcomes. Core concepts are mastered through mathematical exploration, simulations, and linkage with the applied concepts studied in BIOSTAT 705. Prerequisite(s): BIOSTAT 701 or its equivalent Corequisite(s): BIOSTAT 705, BIOSTAT 706 Credits: 3

**BIOSTAT 705: Applied Biostatistical Methods II:**

This course provides an introduction to general linear models and the concept of experimental designs. Topics include linear regression models, analysis of variance, mixed-effects models, generalized linear models (GLM) including binary, multinomial responses and log-linear models, basic models for survival analysis and regression models for censored survival data, and model

assessment, validation and prediction. Core concepts are mastered through statistical methods application and analysis of practical research problems encountered by program faculty and demonstrated in practicum experiences in concert with BIOSTAT 706. Computational examples and exercises will use the SAS and R packages. Prerequisite(s): BIOSTAT 702 or its equivalent Corequisite(s): BIOSTAT 704, BIOSTAT 706, BIOSTAT 722 Credits: 3

**BIOSTAT 706: Introduction to the Practice of Biostatistics II:**

This course revisits the topics covered in BIOSTAT 703 in the context of high-throughput, high-dimensional studies such as genomics and transcriptomics. The course will be based on reading of both the textbook and research papers. Students will learn the biology and technology underlying the generation of "big data", and the computational and statistical challenges associated with the analysis of such data sets. As with BIOSTAT 703, there will be strong emphasis on the development of communication skills via written and oral presentations. Prerequisite(s): BIOSTAT 703 Corequisite(s): BIOSTAT 704, BIOSTAT 705 Credits: 3

**BIOSTAT 708: Clinical Trial Design and Analysis:**

Topics include history/background and process for clinical trial, key concepts for good statistics practice (GSP)/good clinical practice (GCP), regulatory requirement for pharmaceutical/clinical development, basic considerations for clinical trials, designs for clinical trials, classification of clinical trials, power analysis for sample size calculation, statistical analysis for efficacy evaluation, statistical analysis for safety assessment, implementation of a clinical protocol, statistical analysis plan, data safety monitoring, adaptive design methods in clinical trials (general concepts, group sequential design, dose finding design, and phase I/II or phase II/III seamless design) and controversial issues in clinical trials. Prerequisite(s): BIOSTAT 701, 702, 704, 705, and 721 or 722 or their equivalents, or permission of the Director of Graduate Studies Credits: 3

**BIOSTAT 709: Observational Studies:**

Methods for causal inference, including confounding and selection bias in observational or quasiexperimental research designs, propensity score methodology, instrumental variables, and methods for non-compliance in randomized clinical trials. Prerequisite(s): BIOSTAT 701, 702, 704, 705, and 721 or 722 or their equivalents, or permission of the Director of Graduate Studies Credits: 3

**BIOSTAT 718: Analysis of Correlated and Longitudinal Data:**

Topics include linear and nonlinear mixed models; generalized estimating equations; subject specific versus population average interpretation; and hierarchical models. Prerequisite: Biostatistics 701, 702, 704 and 705 or permission of the Director of Graduate Studies. 3 units.

**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

**BIOSTAT 722: Introduction to Statistical Programming II (SAS):**

This class is an introduction to programming in SAS, 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 (data step, procedures, macros, ODS, 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 focus used in this course will be SAS. Prerequisite(s): None; familiarity with linear algebras is helpful Corequisite(s): BIOSTAT 705 Credits: 3

**BIOSTAT 732: Independent Study:**

Independent Study is a semester long course focused on mentored research in the practice of biostatistics. Students work with an assigned mentor. This course is only open to students by permission of the Director of Graduate Studies. Credits: 1, 2, or 3

**BIOSTAT 740: Continuation:**

Continuation is a semester-based, noncredit bearing enrollment status used when a student is continuing scholarly activities with the same mentor. This course is only open to students by permission of the Director of Graduate Studies. Credits: 0

**BIOSTAT 802: Biostatistics Career Preparation and Development II:**

The purpose of this course is to further develop the student's job seeking ability and the practical aspects of job/internship search or interviewing for a PHD program. The goal is to learn these skills once and use them for a lifetime. Modules that will be covered include: Communication skills both written and oral, interviewing with videotaped practice and review, negotiating techniques, potential career choices in the Biostatistics marketplace, and working on a team. This semester includes writing and interviewing practicum, and a panel of relevant industry speakers. Students will leave this course with the knowledge to manage their careers now and in the future. Prerequisite: BIOSTAT 801 Credit: 1

**BIOSTAT 821: Software Tools for Data Science:**

A data scientist needs to master several different tools to obtain, process, analyze, visualize and interpret large biomedical data sets such as electronic health records, medical images, and genomic sequences. It is also critical that the data scientist masters the best practices associated with using these tools, so that the results are robust and reproducible. The course covers foundational tools that will allow students to assemble a data science toolkit, including the Unix shell, text editors, regular expressions, relational and NoSQL databases, and the Python programming language for data munging, visualization and machine learning. Best practices that students will learn include the Findable, Accessible, Interoperable and Reusable (FAIR) practices for data stewardship, as well as reproducible analysis with literate programming, version control and containerization. Prerequisite: Permission of the Director of Graduate Studies Credits: 3

**BIOSTAT 824: Case Studies in Biomedical Data Science:**

This course will highlight how biomedical data science blends the field of biostatistics with the field of computer science through the introduction of 3 to 5 case studies. Students will be introduced to analytic programs typically encountered in biomedical data science and will implement the data science and statistical skills introduced in their previous course work. Prerequisite(s): BIOSTAT

707, 821, 822, and 823 or permission of the Director of Graduate Studies Credits: 3

**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. 1 unit.

**BIOSTAT 902: Missing Data Analysis: Theory and Application :**

Theory and application of missing data methodology, ad hoc methods, missing data mechanism, selection models, pattern mixture models, likelihood-based methods, multiple imputation, inverse probability weighting, sensitivity analysis. Prerequisites: Statistical Science 711, 721, and 732. Instructor consent required. 3 units.

**BIOSTAT 905: Linear Models and Inference:**

Introduction to linear models and linear inference from the coordinate-free viewpoint. Topics: identifiability and estimability, key properties of and results for finite-dimensional vector spaces, linear transformations, self-adjoint transformations, spectral theorem, properties and geometry of orthogonal projectors, Cochran's theorem, estimation and inference for normal models, distributional properties of quadratic forms, minimum variance linear unbiased estimation, Gauss-Markov theorem and estimation, calculus of differentials, analysis of variance and covariance. Prerequisite: Biostatistics 906. 3 units.

**BIOSTAT 908: Independent Study (Rotations):**

Faculty directed statistical methodology research. Instructor consent required. Instructor: O'Brien. 1 unit.

**BIOSTAT 910: Career Development and Prep:**

Student gains a holistic view of career choices and individual development plans including tools they will need to succeed as professionals in the world of work. The curriculum focuses on the unique challenges of PhD candidates and tools needed for successful careers in academia or in industry. May be repeated with consent of the advisor and the Director of Graduate Studies. 1 unit.

**BIOSTAT 913: Applied Empirical Processes:**

This course provides an introduction to the basic theory and application of empirical processes. Topics include: concepts of stochastic processes, Brownian motion and Brownian bridge process, stochastic integrals, weak convergence of sequences of random elements, convergence of empirical distribution functions, general Glivenko-Cantelli theorems and Donsker theorems, functional Delta method. An emphasis is put on applications in various biostatistical problems. Pre-requisites: Stat 711. 3 units.

## BIOTRAIN

**The Responsible Scientist I | BIOTRAIN 751**

This course, required for all 1st year PhD students in the School of Medicine, utilizes online lectures/modules, in-person lectures and small group discussions, and focuses on Responsible Conduct of Research (RCR) and Rigor & Reproducibility (R&R) topics for early-stage graduate students. Small group sessions centered on expanding the online/lecture material through discussion questions and case studies build community and encourage continual embedded dialogue about best practices in RCR and R&R. Small groups are led by training faculty representing each of the PhD training programs and departments, with teaching assistance from senior graduate students and postdoctoral fellows. Course Director: Erika Crosby, PhD.

# Spring 2022 Basic & Biomedical Sciences Course List - Duke SoM

**The Responsible Scientist II | BIOTRAIN 754**

This course, required for all 4th year students, utilizes online lectures/modules, in-person lectures, and small group discussions, and focuses on Responsible Conduct of Research (RCR) and Rigor & Reproducibility (R&R) topics for advanced graduate students. Small group sessions centered on expanding the online/lecture material through discussion questions and case studies build community and encourage continual embedded dialogue about best practices in RCR and R&R. Small groups are led by training faculty representing each of the PhD training programs and departments. Course Director: Erika Crosby, PhD.

## CELL & MOLECULAR BIOLOGY:

http://cmb.duke.edu/home.html

**CMB 631 (BIOCHEM 631, NEURO, 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. See BIOCHEM 631

**CMB 733-01, 733-02, 733-03 (BME, PHARM, NEUROBIO, MOLCAN 733-01, 733-02, 733-03) Experimental Design and Biostatistics for Basic Biomedical Scientists -** See PHARM 733-01, 733-02, 733-03

**CMB 764 Cell and Molecular Biology Colloquium [Student Seminar] -** Required of all CMB students. 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 (Cell Structure and Function) and can have lunch with the speaker. Mondays *11:45 am – 1:00 pm, Boyce; Online Course; 2 Units*

## CELL BIOLOGY:

http://note.cellbio.duke.edu/Graduate/Courses.html

**CBI/MCB 730 Stem Cell Biology** Lecture/discussion format designed for first-year graduate students to learn the fundamentals of stem cell biology and to gain familiarity with current research in the field. Prerequisites: undergraduate level cell biology, molecular biology and genetics. *3 units*

**CBI 830 Developmental Biology Colloquium** This course covers a broad range of problems in developmental biology based on prominent developmental biologists who are invited to speak at Duke University during that particular semester and participate in discussions with the class. *3 units*

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## COMPUTATIONAL BIOLOGY & BIOINFORMATICS:

http://www.genome.duke.edu/CBB/

**CBB 510S Computational Biology Seminar -** A weekly series of seminars on topics in computational biology presented by invited speakers and Duke faculty. *1 Unit*

**CBB 511 Journal Club/Student Seminar -** A weekly series of discussions led by students that focus on current topics in computational biology. Topics of discussion may come from recent or seminar publications in computational biology or from research interests currently being pursued by students. *1 Unit*

**CBB 540 (STA 613) Statistical Methods for Computational Biology -** Methods of statistical inference and stochastic modeling with application to functional genomics and computational molecular biology. Topics include: statistical theory underlying sequence analysis and database searching; Markov models; elements of Bayesian and likelihood inference;
multivariate high-dimensional regression models, applied linear regression analysis; discrete data models; multivariate data decomposition methods (PCA, clustering, multi-dimensional scaling); software tools for statistical computing. Prerequisites: multivariate calculus, linear algebra and Statistics 611. C-L: Statistics and Decision Sciences 613. *3 Units*

**CBB 561 (COMPSCI 561) Computational Sequence Biology** Introduction to algorithmic and computational issues in analysis of biological sequences: DNA, RNA, and protein. Emphasizes probabilistic approaches and machine learning methods, e.g. Hidden Markov models. Explores applications in genome sequence assembly, protein and DNA homology detection, gene and promoter finding, motif identification, models of regulatory regions, comparative genomics and phylogenetics, RNA structure prediction, post-transcriptional regulation. Prerequisites: basic knowledge algorithmic design (**COMPSCI 330**) or equivalent, probability and statistics (**STA 611**) or equivalent), molecular biology (**BIO 201L**) or equivalent. *3 units*

**CBB 574 (BME 574) 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 are 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. *3 Units*

**CBB 590 Special Topics in Computational Biology –** Topic: Computational Biology. C-L: COMPSCI 590. *3 Units.* Course Synopsis.

**CBB 634 Geometric Algorithms -** Models of computation and lower-bound techniques; storing and manipulating orthogonal objects; orthogonal and simplex range searching, convex hulls, planar point location, proximity problems, arrangements, linear programming and parametric search technique, probabilistic and incremental algorithms. Prerequisite: Computer Science 532 or equivalent. C-L: COMPSCI 634. *3 Units*

# Spring 2022 Basic & Biomedical Sciences Course List - Duke SoM

**INTEGRATED TOXICOLOGY AND ENVIRONMENTAL HEALTH (ITEHP; CERTIFICATE):**
https://sites.nicholas.duke.edu/envhealth/

**ENV 666 Aquatic Geochemistry -** *Cross-listed with CEE 666.* Geochemistry of the water-solid interface of soils and particles in environmental systems. Topics will cover the chemical composition of soils, geochemical speciation, mineral weathering and stability, sorption and ion exchange, soil redox processes, and chemical kinetics at environmental surfaces. Tentatively. *3 Units*

**ENV819 Mechanisms in Toxicology -** This is a graduate seminar, with lectures given and discussions led by the instructors, guest speakers, and course participants. ENV819 provides an in-depth examination of key molecular, biochemical and cellular mechanisms by which pollutants cause damage, as well as the mechanisms involved in organismal defenses against those insults. The content includes examinations of the basic biology underlying stress responses, as well as state of the art approaches for experimentally elucidating these phenomena. Specific topics are customized on a year-to-year basis to fit the interests of the students. *3 Units*

**ENV 848S Seminar in Toxicology -** *Cross-listed with PHARM 848S. Required course for certificate.* A weekly research seminar throughout the year is required of participants in the ITEHP, 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. *1 Unit*

**ENV 869 Environmental Law Clinic -** *Cross-listed with LAW 443. Meets course requirement for certificate.* Under Law faculty supervision, students work on interdisciplinary teams to solve nonprofit clients' legal and policy problems. Students gain hands-on, skill-based professional experience. Clinic follows Law School's academic calendar. Minimum 100 client work hours plus weekly seminar; mandatory, all-day intensive, typically 2nd Friday of semester; no dropping after 1st class. *4 Units*

**EOS 701S Orientation to Research Seminar -** *Meets course requirement for certificate.* Introduction to resources, skills, and practices for conducting research in earth and ocean sciences, with emphasis on written and oral communication. Consent of director of graduate studies required. *3 Units*

**IMMUNOLOGY:**
https://immunology.duke.edu

**IMMUNOL 736 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. *1 Unit*

**IMMUNOL 791B Research in Immunology** – This course is the second 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 10-12 weeks. Rotations should be approved by the DGS. The first course was IMMUNOL791A offered in the fall and is a prerequisite. Both courses must be taken in order for the four total credits and grades to post. *2 Units*

**IMMUNOL 800 Comprehensive Immunology** - An intensive course in the biology of the immune system and the structure and function of its major components. In sectioned lectures, we will have leading experts to discuss with you, in depth, the major challenges, major discoveries, as well as major

conflictions in listed areas of immunology. Specifically, we will focus on the evolution of our understandings: what was the original question, how it was approached and what is still missing to complete the picture. These lectures were largely split into three sections: T cell biology, B cell biology, and immune regulation. There will be three individual take-home exams and your final grade will be compiled with results from all three exams. This is a required course for students specializing in immunology. Consent of instructor required for registration. Prerequisite: IMMUNOL 544 or equivalent course. *3 Units*

**MEDICAL PHYSICS:**

http://medicalphysics.duke.edu

**MEDPHY 507 Radiation Biology -** An introduction to radiation biology. This course will cover the biological effects of radiation, including mechanisms of DNA damage, and normal tissue injury. The principle context is with relevance to radiation therapy. *1 Unit.*

**MEDPHY 510 Radiation Protection -** Course discusses the principles of radiation protection dealing with major forms of ionizing and non-ionizing radiation, the physics and chemistry of radiation biology, biological effects of ionizing and non-ionizing radiations (lasers, etc.) at cellular and tissue levels, radiation protection quantities and units, medical HP issues in clinical environments, radiation safety regulations, and basic problem solving in radiation safety. *3 Units*

**MEDPHY 520 Radiation Therapy Physics -** This introductory course has a clinical orientation, and reviews the rationale, basic science, methods, instrumentation techniques and applications of radiation therapy to the treatment of a wide range of human diseases. Major radiation modalities are covered including low and high energy photon therapy, electron and proton therapy, and low and high-dose rate brachytherapy. The clinical process of treatment, methods of calculating dose to patient, and the role of the medical physicist in radiation oncology clinic, are covered in detail. *3 Units*

**MEDPHY 714 Clinical Dosimetry Measurements -** This course covers advanced topics in clinical radiation dosimetry that is pertinent to both KV and MV energy range. Initially we will offer as 1 credit hour course in the spring of 2011, but plans to offer as 3-credit course in the future. Prerequisites: MP500, MP505. *1 Unit*

**MEDPHY 715 Advanced Topics in Radiation Detection and Dosimetry -** This series of lectures covers the topics in radiation detectors, measurements and signal processing. The basics of various types of radiation detectors used in nuclear, medical and health physics and their usage are discussed in detail. Prerequisites: MP500, MP505. *1 Unit*

**MEDPHY 723-01, 723-02 Advanced Radiation Therapy Topics and Procedures -** This course will cover advanced LDR and HDR brachytherapy, and other selected special procedures and special topics. Prerequisite: MP 520. *1 Unit each*\

**MEDPHY 726 Practicum on Monte Carlo Methods 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 is a plus. Instructor consent required. *1-3 Units*

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**MEDPHY 732 Advanced Topics of Ionizing-based Imaging Modalities -** This course covers advanced topics in ionizing-based imaging modalities such as X-ray and CT imaging, including linear system theory, image quality metrology, digital radiography and mammography. Instruction will consist of didactic lectures accompanied by hands-on laboratory exercises (practicum). *3 Units*

**MEDPHY 743 Basic Concepts of Internal Radiation Dosimetry -** This course covers the physical and anatomical/physiological foundations of internal radiation dosimetry. Topics covered include definition of dose, absorbed fractions, residence times and methods to determine them, and the MIRD methodology. Strategies to convert small animal radiopharmaceutical biodistribution data to humans will also be covered. Prerequisites: Medical Physics 500 and 505. Instructor consent required. *1 Unit*

**MEDPHY 745 Advanced Topics of Radionuclide Imaging and Therapeutic Applications -** This course covers advanced topics in radionuclide-based imaging modalities such as PET and SPECT, including image acquisition, image reconstruction, detector and detection theory, radionuclides, etc. and therapeutic applications of radionuclides. Instruction will consist of didactic lectures accompanied by hands-on laboratory exercises (practicum). *3 Units*

**MEDPHY 751-2 Academic Development Skills for Medical Physicists -** This seminar prepares students for academic and research work through a series of presentations on academic skills that include literature reading, scientific writing and presentation, maintaining scientific records, etc. *1 Unit*

**MEDPHY 751-4 Frontiers of Biomedical Science -** This seminar provides a series of presentations on cutting-edge / frontier research topics in the field of medical physics, focusing on the most state-of-the-art medical physics techniques and their clinical applications. Designed for second year Medical Physics students. *1 Unit*

**MEDPHY 765 Advanced Mathematical Methods for Medical Physicist -** This course will provide an introduction to boundary value problems and analytical partial differential equation techniques for wave-guide geometries found in medical applications (e.g., linear accelerators). ANSYS EM simulations will be performed to generate more accurate representation of linear accelerator waveguides and how (un)charged particles behave within the conductors. Hardware demonstrations will be provided time and resources permitting. Additionally, an introduction to complex variables and their application regarding the linac X-ray target and how they are related to different observed scattering phenomena (e.g., Compton scattering). Instructor consent required. *3 Units*

## MOLECULAR GENETICS & MICROBIOLOGY:

http://mgm.duke.edu/graduate/

**MGM 520 FC-Mediated AB Fundations -** Topics covered will include how the genetic and functional properties of the antibody Fc regions and their counterpart Fc-receptors can impact and be exploited to treat and prevent infections or cancer. The course will also cover design strategies to improve the Fc-mediated functions of monoclonal antibodies used for passive protection and treatment, as well as for vaccines to induce Fc-mediated antibody functions in active immuniczation strategies. The course is targeted for post-prelim students interested in state-of-the-art studies in immune respones to pathogens and malignancy. *1 unit*

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**MGM 522 (UPGEN 522) Critical Readings in Genetics and Genomics –** Classical and molecular genetic approaches to understanding eukaryotic cell function using unicellular organisms such as yeasts. Experimental approaches as well as illustrative studies of secretion, cell cycle, signal transduction, and cytoskeleton. Discussion of current literature and student presentations. *3 units; (crosslisted with UPGEN 522)*

**MGM 552 Virology -** Molecular biology of mammalian viruses, with emphasis on mechanisms of replication, virus-host interactions, viral pathogenicity, and the relationship of virus infection to neoplasia. *3 Units*

**MGM 582 Microbial Pathogenesis -** Modern molecular genetic approaches to understanding the pathogenic bacteria and fungi. Underlying mechanisms of pathogenesis and host- parasite relationships that contribute to the infectious disease process. *3 Units*

**MGM 732 (UPGEN 732) Human Genetics** – Topics include genetic mechanisms of disease (rare and common genetic risk variants, multi-factorial inheritance, epigenetics, cytogenetics), as well as disease-specific examples including neurogenetics, cancer genetics, pharmacogenetics, complex diseases and gene therapy. Lectures plus weekly discussion of assigned papers from the research literature. Prerequisites; University Program in Genetics 778 or equivalent, and graduate status or consent of instructor. *3 units graded credit; (cross listed with UPGEN 732)*

**MGM 790s Topics in Molecular Genetics & Microbiology -** This is a student seminar with two upper classmen students presenting each seminar. *1 Unit*

**MOLECULAR CANCER BIOLOGY:**
**http://pharmacology.mc.duke.edu/grad/mcb.html**

**MOLCAN 551 Biomedical Optical Spectroscopy and Tissue Optics (GE, IM)** - This course is designed to provide students with a working knowledge of the theoretical and experimental principles underlying the application of optical spectroscopy and tissue optics in biological and biomedical engineering. Topics covered in this course include: Absorption Spectroscopy; Scattering Spectroscopy; Fluorescence Spectroscopy; Tissue Optics; Monte Carlo Modeling; Diffusion Modeling; Spectroscopic System Design and Signal to Noise Analysis; and Molecular Imaging. This course also includes labs for each topic that is covered, journal article review on emerging technologies and a term project. Prerequisite: Physics 152L. *4 units.*

**MOLCAN 730 (CELLBIO) Stem Cell Course -** The course is designed for first-year graduate students to learn the fundamentals of stem cell biology and to gain familiarity with current research in the field. The course will be presented in a lecture and discussion format based on the primary literature. Topics include: stem cell concepts, methodologies for stem cell research, embryonic stem cells, adult stem cells, cloning and stem cell reprogramming and clinical applications of stem cell research. Prerequisites: undergraduate level cell biology, molecular biology, and genetics. *3 units.*

**MOLCAN 733-01, 733-02, 733-03 (BME, CMB, PHARM, NEUROBIO 733-01, 733-02, 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. Ethical issues in data handling

and presentation. Student presentations in addition to formal lectures. Intended for third-year graduate students. Instructor consent required. *2 units.*

**MOLCAN 780 (PHARM 780) Graduate Student Seminar –**
A presentation and discussion course in which program faculty and graduate students review recent progress in contemporary areas of Pharmacology and Cancer Biology. Provides an important avenue for evaluation and feedback for graduate student research and communication skills and is required for all students pursuing their PhD degree in Pharmacology and Molecular Cancer Biology. *2 units.*

**MOLCAN 819 Cancer as a Disease -** This course looks at cancer from the point of view of the patient, the doctor and the scientist. Faculty from around the medical center will discuss diagnosis, detection and prediction of cancer, the molecular basis of the disease, and new approaches to therapy. The object is to give students a deeper appreciation for the clinical aspects of cancer and how molecular biology can contribute to improved understanding and treatment of the disease. This course is mandatory for all MCBstudents, and would be suitable for second year students with a solid background in molecular biology. Permission is required to participate, class limit is 15. *2 Units*

**NEUROBIOLOGY:**
http://neurobiology.mc.duke.edu/graduate/curriculum.html

**NEUROBIO 720 Concepts in Neuroscience II: Principles of Organization of Neuronal Systems**
The principles of organization of neurons into functional circuits will be examined through a series of 4 distinct modules, listed below. All four modules required for first-year neurobiology students. Instructor consent required. Prerequisite: Neurobiology 719. Consent of instructor required. ***4 credits (course will begin February 7)***

**NEUROBIO 720A - Sensory Processing: Representations and Computations:** A major function of the nervous system is to generate perceptions based on input from sensory organs. This module will explore how populations of neurons represent sensory information and perform computations on those signals. This question will be considered at a variety of levels of the visual and auditory pathways, and will span domains of inquiry from circuits to cognition.

**NEUROBIO 720B – Circuits and Computation:** Computational neuroscience seeks to describe brains and nervous systems as information processing units that have evolved to perform the complex computations needed to solve the difficult problem humans and animals face on a daily basis. In 1976, David Marr and Tomaso Poggio summarized the computational approach to neuroscience as consisting ofthree complimentary levels of analysis: the computational level, the algorithmic level, and the physical level. The computational level is concerned with identifying a specific problem that an animal is trying tosolve. The algorithmic level is concerned with generating an understanding of how the animal represents the problem and how the solution to that problem is generated. The physical level is concerned with the precise means by which neurons and neural circuits implement the solution in order to generate behavior. In this module, we will explore computational approach to neuroscience and introduce the information theoretic tools upon which it is based. Emphasis will be placed on models of neural encoding and decoding, signal detection theory, decision theory, and model neural circuits that perform evidence integration, object tracking, and binary choice.

**NEUROBIO 720C – Sensory-motor integration:** Much of our motor activity is directed by sensory

inputs. In this module, we will cover the basic principles of how the brain processes and transforms sensory inputs in the service of the planning and coordination of movements. We will consider the function of both cortical and subcortical areas in motor control. Topics will include the roles of the parietal and frontal cortices, movement coordination by the cerebellum, and the principles of motor skill learning. Examples will be drawn heavily from eye movements while drawing parallels to other motor effector systems. Course sessions will include some lecture material, but also will include class discussionof strategically-chosen historical and current papers.

**NEUROBIO 720D – Learning and Memory**: Our capacity to form memories and learn new behaviors is critical to survival, in part because these processes permit rapid adaptation and behavioral flexibility in the face of environmental change. In this module, we will examine memory and learning by considering processes ranging from classical conditioning to spatial navigation to the cultural transmission of behaviors such as speech. These complex phenomena will be viewed from cellular, circuit and systems perspectives.

**NEUROBIO 726S.001 Neurobiology Journal Club (Seminar) –** Once a month, first and second year neurobiology graduate students meet to hold a student-run journal club to discuss the work of an invited seminar speaker from an outside institution. On the following Tuesday, the students attend the seminar then have lunch with the speaker. *1 Unit*

**NEUROBIO 733-01, 733-02, 733-03 (BME, CMB, PHARM, MOLCAN 733-01, 733-02, 733-03) Experimental Design and Biostatistics for Basic Biomedical Scientists -** See PHARM 733-01, -02, -03

**NEUROBIO 735 Quantitative Neurobiology** - Through lectures and hands-on problem solving, this course will provide students with a working, practicable background in coding in Python, theoretical and computational neuroscience. The material will be oriented strongly towards the needs of working neurobiologists, and will require considerable independent work. *3 units.*

**NEUROBIO 762 Neurobiology of Disease**: This course is a month-long (January) series of 3 weekly two-hour sessions, each centered on a given disease of the nervous system. One or two students working with a designated faculty member are responsible for an introduction (20-25 minutes) followed by a discussion of key primary papers on the subject. Two or three articles provided in advance provide a framework for discussion. Diseases to be covered currently include: ALS, Alzheimer's, Epilepsy, bipolar disease, autism, addiction, Parkinson's disease, retinitis pigmentosa, and stroke. The idea is to describe thekey features of the disease, current insight into etiology and pathogenetic mechanisms of the disease, models available and the evidence (if any) establishing the validity of the models, therapies available and envisioned. The topic "Neuroengineering: Approach to Restorative Neurology" will also be addressed. Students are expected to have a background in fundamentals of neuroscience and cell and molecular biology. Permission of instructor required to register. *2 units*

**NEUROBIO 790S Student Seminar –** Preparation and presentation of seminars to students and faculty ontopics of broad interest in neurobiology. Required of all first – and second-year students.

**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)*

# Spring 2022 Basic & Biomedical Sciences Course List - Duke SoM

**NEUROBIO 881 Functional Magnetic Resonance Imaging -**
This course will cover the complete fMRI analysis pipeline, from the scanner to constructing brain maps. Students will be trained on basic principles of fMRI, artifact detection, preprocessing, and task-fMRI signal estimation. This course will also cover recent advancements in resting-state fMRI, connectivity/graph-theoretic/independent-component analyses, and machine learning. The course will consist of lectures, review of key research papers and integrated laboratory sessions. The laboratory sessions will include hands-on analysis of fMRI data sets. Students will gain experience both in the theoretical principles of fMRI analysis and in the practical aspects of implementing them. Instructor consent required. *3 units.*

## PATHOLOGY:

https://pathology.duke.edu/

**PATHOL 750 General Pathology -** Lectures deal with broad concepts of disease and underlying molecular mechanisms. Laboratory sessions familiarize the student with how to identify common diseaseprocesses in histologic sections. PTH 225 (histology) or an equivalent course is a prerequisite. *4 Units*

**PATHOL 785 Molecular Aspects of Disease -** This course is based upon the study of the background, investigative method and recent advances in understanding the molecular basis of selected diseases, with an in-depth focus on a small number of diseases where defects are known at genetic or molecular levels.*3 Units*

**PATHOL 786 Translational Aspects of Pathobiology -** Translational Research in Pathobiology is an integrated multidisciplinary course designed to provide students with the necessary tools to understand the principal components of the research processes involving patients or materials obtained from a human source. This course reflects the Department of Pathology's unique integration of traditional pathology research with experimental therapeutics in an environment that seeks to bridge the basic sciences and clinical medicine. *3 units*

**PATHOL 855S Graduate Seminar in Pathology -** Discussions outlining the scope of modern pathology. This will include reports of original research by graduate students, members of staff and visitors. *3 Units*

## PHARMACOLOGY:

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

**PHARM 730 Stem Cell Course -** The course is designed for first-year graduate students to learn the fundamentals of stem cell biology and to gain familiarity with current research in the field. The course will be presented in a lecture and discussion format based on the primary literature. Topics include: stem cell concepts, methodologies for stem cell research, embryonic stem cells, adult stem cells, cloning and stem cell reprogramming and clinical applications of stem cell research. Prerequisites: undergraduate level cell biology, molecular biology, and genetics. *3 Units*

**PHARM 733-01, 733-02, 733-03 (BME, CMB, NEUROBIO, MOLCAN 733-01,733-02, 733-03)**

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**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-Gaussiandistribution, parametric and non-parametric tests, uni- and multivariate, ANOVA and regression procedures are covered. Students will present their own data and literature examples in addition to lectures. Consent of Instructor required. *2 Units*

**PHARM 780 (MOLCAN 780) Graduate Student Seminar -** A presentation and discussion course in which program faculty and graduate students review recent progress in contemporary areas of Pharmacology and Cancer Biology. Provides an important avenue for evaluation and feedback for graduate student research and communication skills and is required for all students pursuing their Ph.D. degree in Pharmacology and Molecular Cancer Biology. *2 Units*

**PHARM 835 (I&E 835) Innovations in Drug Development** – Introduction to major issues in developing a drug to treat a disease in an interdisciplinary lecture-based and team-based learning environment. Translation of principles in biomedical sciences, biomedical engineering, and chemistry along with innovative approaches to develop a hypothetical drug for treating a disease of choice. Hypothetical development of model compounds, target analysis, and in vitro and in vivo models to test drug efficacy. *4 units.*

**PHARM 848S Seminar in Toxicology** – (ENV 848S - 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. *1 Unit.*

**UNIVERSITY PROGRAM IN GENETICS:**
http://upg.duke.edu/home.html

**UPGEN 522 (MGM 522) Critical Readings in Genetics and Genomics –** Classical and molecular genetic approaches to understanding eukaryotic cell function using unicellular organisms such as yeasts. Experimental approaches as well as illustrative studies of secretion, cell cycle, signal transduction, and cytoskeleton. Discussion of current literature and student presentations. *3 units*

**UPGEN 668 (BIOCHEM 668) Biochemical Genetics II -** Mechanisms of transcription, splicing, catalytic RNA, RNA editing, mRNA stability and translation .*3 Units.*

**UPGEN 716S Genetics Student Research -** This is a student seminar with two advanced students presenting each seminar. Refreshments are provided by first year students. *1 Unit*

**UPGEN 732 (MGM 732) Human Genetics –** Topics include genetic mechanisms of disease (rare and common genetic risk variants, multi-factorial inheritance, epigenetics, cytogenetics), as well as disease-specific examples including neurogenetics, cancer genetics, pharmacogenetics, complex diseases and gene therapy. Lectures plus weekly discussion of assigned papers from the research literature. Prerequisite: University Program in Genetics 778 (or any individual University Program in Genetics 778A-F module) or completion of the first-year Medical Scientist Training Program (MTSP) curriculum, or consent of instructor. *3 units*

**UPGEN 750S Genetics Colloquium -** Sponsored by the UPGG Program Seminar Series. *1 Unit*