

# Graduate School Core Service Curriculum

## **Organization of the Cell (GS-GS-501)**

This course covers the principles of cellular organization and communication. The emphasis will be on cellular compartmentation, communication within and among cells, and the maintenance of cellular structure. A description of membrane transport and ion channels will include molecular gradients, bioenergetics and energy transduction. Signaling within the cell will emphasize G-protein coupled signal transduction, calcium signaling and growth factors. Protein import and export will include the endoplasmic reticulum, nuclear, lysosomal and peroxisomal trafficking as well as vesicular transport and secretion. The structural maintenance of cellular morphology will discuss the cytoskeleton, myosin, intermediate filaments and junctional complexes.

Credits: 2

Term: 1

Counts for 30 hr. requirement: Y

Director: Dr. Steen Pedersen and Dr. Rick Sifers

## **Molecular Methods (GS-GS-502)**

Molecular Methods covers methods for studying and manipulating DNA, RNA, and proteins; these range from the most basic to state-of-the-art technologies available in the Baylor College of Medicine Advanced Technology Cores. Nucleic acid topics include DNA manipulation, cloning, preparation of libraries, sequencing, next generation sequencing, genomic profiling, RNA interference and CRISPR/Cas9. Protein topics include protein expression and purification, antibody generation and applications, flow cytometry, methods to detect/visualize protein-protein interactions, proteomics/mass spectrometry, and high throughput methods to study protein/protein and protein/DNA interactions.

Credits: 3

Term: 1

Counts for 30 hr. requirement: Y

Director: Dr. Nancy Weigel

**Genetics A (GS-GS-503)**

This course will discuss the general principles of genetics and its implication for inheritance and variation in living organisms. First, the concepts of the gene and mutation will be introduced and their link to phenotype will be discussed. This is followed by linkage, complementation and non-Mendelian inheritance. The use of genetics as a research tool is illustrated by the molecular basis of phenotype, the dissection of genetic pathways, and the use of genetic techniques in bacteria, yeast and Humans.

Credits: 2

Term: 1

Counts for 30 hr. requirement: Y

Director: Dr. Christophe Herman and Dr. Herman Dierick

**Genetics B (GS-GS-504)**

This course focuses on introducing genetic approaches offered by different model organisms for solving biological problems, understanding how these models can address problems related to human diseases, and learning technical terms and concepts unique to each system. Yeast genetics will be used to demonstrate how to order genes in a genetic pathway. Classical and modern genetic methods for studying gene function in *C. elegans* during development will be discussed, as will use of *Drosophila* genetics to study pattern formation, mutation isolation and mapping and mosaic analysis. Mouse genetics (gene knock-out, generating specific strains by crosses, and the use of transgenic approaches) and human genetics (linkage and pedigree analysis, gene mapping and analysis, and population biology and evolution) will be covered.

Credits: 2

Term: 2

Counts for 30 hr. requirement: Y

Director: Dr. Zheng Zhou

**Cell Division (GS-GS-505)**

This course examines the fundamental concepts in cell cycle regulation, DNA, telomeres and chromatin duplication, chromosomes segregation as well as cytokinesis. The course presents principals of cellular response to DNA damage, telomere dysfunction, perturbation in DNA replication and chromosome segregation. The molecular mechanisms of various DNA repair pathways including recombination and their regulation in cell cycle will be discussed. The relevance of cell cycle in growth regulation, development and cancer will be presented.

Credits: 2

Term: 2

Counts for 30 hr. requirement: Y

Director: Dr. Gregory Ira and Dr. Eric Chang

**Development (GS-GS-506)**

This course is an introduction to concepts of modern developmental biology, beginning by discussing simple principles, such as where the different parts of the body arise from, and how cells are able to become different from one another by using extracellular signals to influence gene expression. We will also discuss how a ball of cells receives information to set up the axes of the embryo – head and tail, and front and back, as well as similarities and differences of how this process is carried out in amphibians, birds, mammals and insects. The course will also address how these principles are applied in the differentiation of the nervous system and the limb.

Credits: 2

Term: 2

Counts for 30 hr. requirement: Y

Director: Dr. Andrew K. Groves

**Cancer (GS-GS-508)**

This is a short course on the biology of cancer. The course objective is to introduce students to basic mechanisms that lead to tumor initiation, progression, and metastasis. A history of oncogenes and tumor suppressor genes and their modern definitions are presented. Current concepts of cancer stem cells, tumor microenvironment, mouse models, and cancer therapeutics are discussed. Class includes lecture and group discussion of key recent papers in which students are expected to participate.

Credits: 1

Term: 2

Counts for 30 hr. requirement: Y

Director: Dr. Stephanie Pangas

**Gene Regulation (GS-GS-509)**

This course focuses on the mechanisms of regulated gene expression with a focus on eukaryotes. The course begins with RNA polymerase and transcriptional regulation through transcription factors, enhancers/repressors, co-transcriptional regulation, and the effects of chromatin structure and histone modification. The details of pre-mRNA processing are covered including the major and minor spliceosomes, polyadenylation, alternative splicing, and RNA editing. Mechanisms of regulation by noncoding RNAs including miRNAs, siRNAs, piRNAs and lncRNAs are also considered. Mechanisms of regulation of translation and protein degradation complete the discussion.

Credits: 3

Term: 3

Counts for 30 hr. requirement: Y

Director: Dr. Thomas Cooper

**Neuroscience (GS-GS-511)**

This is an introductory course covering fundamental aspects of modern neuroscience. The five lecture format begins with a brief discussion of neural development and the resulting organization of the mammalian nervous system, then progresses into the molecular and structural specializations that allow neurons to process and transmit information via electrical current. The course next explores how neurons contribute to higher brain functions such as learning and memory, and finally examines how neural dysfunction leads to common neurological disorders such as autism and Alzheimer's disease.

Credits: 1

Term: 3

Counts for 30 hr. requirement: Y

Director: Dr. Joanna Jankowsky

**Immunology (GS-GS-512)**

In the field of biology, the immune system is unique in that it crosses all organ boundaries and affects a vast number of processes critical for organismal function and survival. This short course introduces the basic cellular and molecular mechanisms of immunity. These include: the innate immune system (molecular "danger" patterns); the acquired immune system (B and T cell receptor gene rearrangement and their effector functions); the cross-talk between innate and acquired immunity; an overview of the principles of immune tolerance exemplified by mechanisms of transplant rejection and cancer immunity; and a discussion of autoimmune diseases and immunotherapies.

Credits: 1

Term: 3

Counts for 30 hr. requirement: Y

Director: Dr. Jonathan Levitt

**Ethics - Year 2 (GS-GS-515)**

Ethics-Year 2 is the second of 4 modules on responsible conduct of research. The course will discuss research misconduct, including College and federal policies and procedures. It will also review safe practices in the laboratory and the ethics of experiments with animals. This will be followed by small group discussion covering cases studies of scientific misconduct and animal research. A discussion will also be held for second-year students and their mentors on matching goals and expectations of the mentor and student, developing communication channels and using the thesis advisory committee as a resource.

Credits: 0.5

Term: 2

Counts for 30 hr. requirement: N

Director: Dr. Alison Bertuch

**Ethics - Year 3 (GS-GS-516)**

Ethics-Year 3 is the third of 4 modules on responsible conduct of research. The course will discuss writing and review of scientific manuscripts, how grant applications are reviewed including conflicts of interest in the peer-review, and financial conflicts of interest. Collaborative research arrangements, particularly with industry, will be considered along with intellectual property relative to publication and thesis submission. There will be a small group discussion covering case studies associated with these topics. A discussion will also be held for third-year students and their mentors on matching goals and expectations of the mentor and student, evaluating progress towards degree and alternative approaches for risky projects.

Credits: 0.5

Term: 3

Counts for 30 hr. requirement: N

Director: Dr. Alison Bertuch

**Ethics - Year 4 (GS-GS-517)**

Ethics-Year 4 is the fourth of 4 modules on responsible conduct of research. The course will discuss ethical considerations in research involving human subjects, including experiments with human derived materials and informed consent. A discussion on contemporary ethics issues and the scientist as a responsible member of society is included. This will be followed by a small group discussion covering case studies associated with these topics. A discussion will also be held for fourth-year students and their mentors on expectations of mentor and student, setting goals and timelines for graduation, career decisions and planning for the next step.

Credits: 0.5

Term: 3

Counts for 30 hr. requirement: N

Director: Dr. Alison Bertuch

**Macromolecules: Structure and Interactions (GS-GS-518)**

The objective of this course is to provide an overview of macromolecular structure and function including discussion pertaining to basic structural information on the various classes of macromolecules, and how such structures are determined and examined by NMR, X-ray crystallography and various optical methods. It includes an overview of how structural changes mediate information flow through pathways in relation to the basic binding, kinetic, and enzymatic properties of the macromolecules themselves.

Credits: 3

Term: 3

Counts for 30 hr. requirement: Y

Director: Dr. Steen Pedersen and Dr. B.V. Venkatar Prasad

**Introduction to Scientific Writing (GS-GS-519)**

This course will increase student awareness of effective scientific writing. Students will learn basic principles of scientific writing that they can put into practice immediately such as selecting high impact words, building effective sentences and paragraphs, and structuring individual sections of a scientific manuscript. The course, which centers on the concept of writing with clarity and brevity, includes exercises to build skills.

Credits: 1

Term: 4

Counts for 30 hr. requirement: N

Director: Dr. Susan Marriott

**Introduction to Biostatistics (GS-GS-521)**

The objective of this course is to provide an introduction to fundamental topics in applied biostatistics with an emphasis on basic science research. This class focuses on the practical application of statistical methods to study design and analysis.

Credits: 2

Term: 4

Counts for 30 hr requirement: Y

Director: Dr. Charles Minard

**Research Design (GS-GS-522)**

This course is designed to guide the student through the process of identifying a research problem, developing specific hypotheses and designing well-controlled experiments to test them. It will be taught in small groups of ~8 students/class. A faculty mentor helps formalize and organize the process, but students will develop their ideas through literature searches and discussion. The terms and discussion will center around the NIH format for grant applications (Specific Aims, Background and Significance, Experimental Design).

Credits: 3

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Michael Schmid

**Method and Logic in Molecular Biology (GS-GS-523)**

This course is intended to train students to read and critically interpret the primary literature. Students will learn what constitutes a well-designed experiment with proper controls. Small groups of students (8-10) will meet twice per week to discuss two assigned journal articles. The first meeting will be without faculty participation while the second meeting will be guided by one or two instructors per group. The first meeting will allow students the opportunity to independently address the scientific merit and design of the assigned readings and formulate their own opinions. During the second meeting, instructors will guide a discussion among students to bring out the salient features of the readings pertinent to the goals of the course.

Credits: 3

Term: 2

Counts for 30 hr. requirement: Y

Director: Dr. Graeme Mardon

**Introduction to Intellectual Property (GS-GS-525)**

So you now have a great discovery or idea, how can you protect and market it? In this course we will learn about intellectual property law and technology transfer. We will cover different types of intellectual property, such as patents, trademarks, copyrights, etc., with an emphasis on genetic and biotechnology patents, both in the USA and internationally. We will also discuss copyrights: their nature, acquisition, and how to avoid infringing them, with an emphasis in instructional activity and educational settings.

Credits: 1

Term: 4

Counts for 30 hr. requirement: N

Director: Dr. Patrick Turley

**ABC-Applications to Biology of Computation (GS-GS-527)**

The course will offer a broad survey of different topics from a computational perspective: genomics, epigenomics, population genetics, transcriptomics, proteomics, structure-function, systems biology, networks, cellular imaging, phylogenomics, pattern discovery, drug design, medical informatics, the microbiome, the cancer genome and neurosystems. The objectives are to become familiar with basic computational challenges in these fields and with the current algorithmic solutions.

Credits: 2

Term: 2

Counts for 30 hr. requirement: Y

Director: Dr. Olivier Lichtarge

**Responsible Conduct of Research – Year 1 (GS-GS- 528)**

Sessions will involve students in discussion during lectures, as well as in small groups where case studies will be reviewed. Students will be mentored on this scientific process (accessing the scientific literature, thinking with the scientific method). Issues surrounding rigor, reproducibility, research material and its ownership will be presented, as will responsible authorship, plagiarism and copyright. Classes will also be devoted to the practical aspects of being a student scientist such as what to look for in laboratory rotations, selecting mentors, coping with stress and deadlines, what to do when experiments don't work, and how to go about career decision-making as well as professional aspects of being a scientist such as funding and advocacy.

Credits: 1

Term: 1

Counts for 30 hr. requirement: N

Director: Dr. Alison Bertuch

**MSTP Reading (GS-GS-548)**

MSTP Reading provides MSTP students early in their combined physician-scientist training with in-depth exposure to critical reading of the current biomedical literature in order to improve their ability to identify and design research strategies for solving current biomedical problems.

Credits: 1.5

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Sharon Plon



# Biochemistry and Molecular Biology

## **Thinking Like A Scientist (GS-BC 400)**

This is the first a series of 4 courses that aims to help first year graduate students begin to develop the critical thinking, speaking and writing skills that are necessary for their professional success in graduate school and beyond. In this course, students set short-term professional goals around courses and laboratory rotations and introduce the key concepts for a critical evaluation of the literature. Students will apply these concepts in faculty-facilitated discussions of three assigned papers from the scientific literature.

Credits: 1

Terms: 1

Counts for 30 hr. requirement: N

Director: Dr. Anna Sokac

## **Thinking Like a Scientist - Term 2 (GS-BC 407)**

The goal of this term is to develop critical reading skills for evaluating the scientific literature. For a set of assigned papers, the student will learn to identify the gap in knowledge and the hypothesis that was tested, and analyze the experimental outcomes in relation to the hypothesis. They will also develop reasonable future directions in the form of a new set of hypotheses generated by the results in the paper. Each week three students will present a journal-club presentation of an assigned paper. Two of the students will prepare a powerpoint presentation and the third student will serve as an “angel/devil” with the responsibility of defining the strengths and weaknesses of the paper. The other students will write a summary of the paper using the concepts defined by the framing funnel.

Credits: 2

Terms: 2

Counts for 30 hr. requirement: Y

Director: Dr. Anna Sokac and Dr. Ido Golding

## **Thinking Like a Scientist - Term 3 (GS-BC 408)**

The objective of this course is to build upon the analytical and presentations skills students developed through critical reading of the literature in Term 2. Students will continue to use the concept of the framing funnel to identify an existing gap in knowledge, and formulate a hypothesis/model that makes specific predictions that can be critically tested by experiments. Each student will prepare an abstract of a research proposal and present and defend the proposal in a short talk to other students and faculty.

Credits: 2

Terms: 3

Counts for 30 hr. requirement: Y

Director: Dr. Shelley Sazer

**Thinking Like a Scientist – Term 4 (GS-BC 409)**

The goal of Term 4 is to build upon the activities of Term 3 that culminated in writing a one-page proposal abstract. Students will do additional literature-based research in order to add both depth and breadth to each component of the one page abstract using the concept of the framing funnel with particular emphasis on the Background and Experiments sections. Each student will prepare a five page, written research proposal. The initial proposal will be discussed and revised in response to feedback from students and faculty. The student will then present and defend the proposal to other students and faculty.

Credits: 2

Terms: 4

Counts for 30 hr. requirement: Y

Director: Shelley Sazer

**Special Projects (GS-BC 435)**

Faculty mentored research for students that have selected their thesis advisor not been admitted to candidacy.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. B.V. Venkatar Prasad

**Special Topics (GS-BC 463)**

Scholarly study directed by a faculty member. Special topics allows a faculty member to develop individualized courses for students. Special topics cannot be used to satisfy the 30 hr. course requirement.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. B.V. Venkatar Prasad

**Seminar in Biochemistry (GS-BC-466)**

Student Seminar

Credits: 1

Term: 1, 2, 3, 4

Counts for 30 hr. requirement: N

Director: Dr. B.V. Venkatar Prasad

**Readings (GS-BC 548)**

Faculty directed literature projects that survey a specialized topic of interest.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. B.V. Venkatar Prasad

**Research Rotation (GS-BC 549)**

Faculty mentored research for students who have not yet selected a faculty advisor

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. B.V. Venkatar Prasad

**Dissertation (GS-BC 550)**

Thesis research directed by a faculty mentor and advisory committee. Open only to candidates for the Ph.D. or M.S. degree.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. B.V. Venkatar Prasad

# Clinical Scientist Training Program

## **Fundamentals of Clinical Investigation (GS-CT- 400)**

The objective of this course is to train students to interpret the results of other clinical investigators and to use the knowledge for providing state-of-the-art care for their patients. The course includes four modules reflecting specific areas relevant to a clinical researcher. These modules are: principles of clinical research; statistical methods in clinical research; clinical research - related issues.

Credits: 3

Term: 1

Counts for 30 hr. requirement: Y

Director: Dr. Ashok Balasubramanyam

## **CICS I: Grant Development for Clinical Investigators (GS-CT- 403)**

This course provides students with the skills to develop an important research question, formulate strong hypotheses and specific aims, and begin to draft the components of a career development grant proposal.

Credits: 2

Terms: 1

Counts for 30 hr. requirement: Y

Director: Dr. Ashok Balasubramanyam

## **CICS II: Clinical Trials for Clinical Investigators (GS-CT- 404)**

This course provides students with an understanding of the theory and practice of conducting scientifically rigorous clinical trials. Building on the work of the previous CICS I course and from knowledge gained from the Fundamentals in Clinical Investigation course, students will fully develop the hypothesis, specific aims, and experimental design of their projects.

Credits: 3

Terms: 2

Counts for 30 hr. requirement: Y

Director: Dr. Frederick Pereira

## **CICS III: Translational Research for Clinical Investigators (GS-CT- 405)**

This course provides students with an understanding of the theory and practice of conducting bench-to-bedside translational research. Building on the work of the previous term, students will continue the development of a K-type grant proposal, focusing on the career development plan and mentor's letters.

Credits: 3

Terms: 3

Counts for 30 hr. requirement: Y

Director: Dr. Jesus Vallejo

**CICS IV: Health Services Research for Clinical Investigators (GS-CT- 406)**

This course provides students with an understanding of the theory and practice of health services research. Building on the work of the previous term, students will continue the development of a K-type grant proposal.

Credits: 3

Terms: 4

Counts for 30 hr. requirement: Y

Director: Dr. Frederick Pereira

**CICS V: Evaluating a Completed Career Development Grant (GS-CT- 407)**

This course provides students with an appreciation of the NIH study section review process and a completed career development award.

Credits: 2

Terms: 5

Counts for 30 hr. requirement: Y

Director: Dr. Ashok Balasubramanyam

**Development and Commercialization of Biomedical Innovations (GS-CT- 408)**

This course provides a general overview of the steps required to move a biomedical innovation into the marketplace. The course begins with an overview of the ecosystem and a framework to assess opportunities for product development and commercialization. Other lectures take the students through the product development process, and provide insights into strategies for funding translational research projects through the “valley of death” gap that exists between basic research funding and commercial funding. Other topics include an introduction to intellectual property basics, and options for commercialization of biomedical assets, licensing and new ventures.

Credits: 1

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Ashok Balasubramanyam

**Responsible Conduct of Research for Clinical Investigators (GS-CT- 409)**

The RCRCI course is designed for the early career scientist/clinical or translational investigator, and will provide students with a fundamental competency and appreciation for the core topics within the ethical dimensions of biomedical research, as described below. During this one-week course, students will receive lectures from faculty with expertise in each of these core topics, to be followed by small group case study discussions illustrating ethics topics from the preceding lecture.

Credits: 1

Term: 1

Counts for 30 hr. requirement: N

Director: Dr. Maria Gramatges

**Special Projects (GS-CT- 435)**

Faculty mentored research for MS students or PhD students that have selected their thesis advisor but have not been admitted to candidacy.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Ashok Balasubramanyam

**Seminar in Clinical Sciences (GS-CT- 466)**

The purpose of this course is to provide a forum for students to improve their knowledge and skills in planning, preparing and effectively presenting their research to an inter-disciplinary audience.

Credits: 1

Term: 1, 2, 3, 4, 5 (not offered in AY16)

Counts for 30 hr. requirement: N

Director: Dr. Ashok Balasubramanyam

**Reading – CSTP (GS-CT- 548)**

Faculty directed literature reading projects that survey a specialized topic of interest to the student.

Credits: 1

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Ashok Balasubramanyam

**Research Rotation (GS-CT- 549)**

Faculty mentored research for students who have not yet selected a faculty advisor

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Ashok Balasubramanyam

**Dissertation (GS-CT- 550)**

Thesis research directed by a faculty mentor and thesis advisory committee. Open only to candidates for the PhD degree.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Ashok Balasubramanyam

# Developmental Biology

## **Classical Developmental Biology (GS-DB- 402)**

This course provides introductory information related to major questions in developmental biology. It also provides an introduction to classical experimental methods and examples are provided which highlight how developmental principles have been tested. These examples will allow the students to grasp how earlier investigations presaged present areas of inquiry for each organism. The course introduces the anatomy and histology of most organs and cells during development with a particular emphasis on *C. elegans*, *Drosophila*, mouse, chick, zebrafish, and *Xenopus*. The development of each organism is described in lectures and observed by the students in lab settings so that students can readily grasp the complex issues of modern developmental biology and begin to see how questions might be approached.

Credits: 2

Term: 1

Counts for 30 hr. requirement: Y

Directors: Dr. Mary Dickinson and Dr. Michael Lewis

## **Neural Development (GS-DB- 403)**

This advanced graduate course in developmental neurobiology provides students with a more detailed background of neural development that will serve as conceptual framework for future studies. It particularly focuses on molecular genetic studies that have helped us elucidate the mechanisms underlying the development of the nervous system. This course integrates knowledge about molecular patterning of the nervous system using a cross-species approach that also emphasizes evolutionary relationships. The role of genes and mechanisms that play a role in the selection of neuroblasts and neuronal differentiation, in the specification and function of glial cells, in growth cone guidance and synapse formation are covered in detail.

Credits: 3

Term: 4

Counts for 30 hr. requirement: Y

Directors: Dr. Benjamin Arenkiel and Dr. Roy Sillitoe

### **Molecular & Developmental Biology of Vision Research (GS-DB- 404)**

This course provides graduate students and postdoctoral fellows with broad exposure to the molecular genetics underlying normal and abnormal visual system development and function. This course offers an in-depth analysis of normal vertebrate and invertebrate development, genetic causes of disease, as well as the use of animal models for genetic analysis of normal and abnormal development and function.

Credits: 1

Terms: 4 (not offered in AY16)

Counts for 30 hr. requirement: Y

Director: Dr. Graeme Mardon

### **Evolutionary Conservation of Developmental Mechanisms (GS-DB- 422)**

This course focuses on the similarities and differences of developmental mechanisms between vertebrates and invertebrates. Invertebrates, such as *Drosophila* and *C. elegans*, have allowed scientists to isolate many genes that are required for proper development through genetic screens. Vertebrate homologs of many of these genes have been identified, and their role is being studied through a variety of approaches, including manipulations in chick and zebrafish as well as through mouse knockouts. The view of vertebrate and invertebrate developmental biologists on a series of topics like segmentation, Hox and Polycomb-group genes, limb development, and cell death is presented in this course. In addition, the lecturers discuss and compare the function of proteins required for specific developmental pathways in invertebrates whose homologs are involved in tumorigenesis in vertebrates. Additional topics include: evolution, evolutionary trees, and the evolution of developmental pathways, as well as how during evolution numerous molecular players are conserved and how they are deployed in various developmental processes in diverse organisms.

Credits: 2

Term: 3

Counts for 30 hr. requirement: Y

Director: Dr. Hugo Bellen

### **Topics in Development (GS-DB- 425)**

The purpose of this course is to introduce the students to some current topics in developmental biology, to improve the students' ability to read and interpret primary literature, and to improve the students' skills in presenting scientific data. A lecturer introduces a topic and then assigns two papers to two students to present in the next lecture. All students are expected to critically evaluate and interpret the assigned papers prior to attending class, and the selected students prepare a 45 min lecture on the assigned topic. Each student presents twice. Topics discussed include sex determination, epithelial morphogenesis and cancer, hematopoietic and cardiac development, stem cell therapy, skin cancer, nuclear hormone receptors, cell motility and invasive behavior (metastasis), and ectoderm-mesoderm interactions.

Credits: 3

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Mirjana Maletic-Savatic and Dr. Joshua Wythe



**Special Projects (GS-DB- 435)**

Faculty mentored research for students who have selected their thesis advisor but have not been admitted to candidacy.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Hugo Bellen

**Special Topics (GS-DB- 463)**

Scholarly study directed by a faculty member. Special topics allows a faculty member to develop individualized courses for students. Special topics cannot be used to satisfy the 30 hr. didactic course requirement.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Hugo Bellen

**Seminar in Developmental Biology (GS-DB- 466)**

The purpose of this course is to guide the students into learning how to approach scientific literature directly. Students are expected to read the primary literature and lead discussions in a group setting. Students in the Program in Developmental Biology participate in this seminar every term during their first four years at BCM.

Credits: 1

Term: 1, 2, 3, 4

Counts for 30 hr. requirement: N

Director: Dr. Hugo Bellen

**Readings (GS-DB- 548)**

Faculty directed literature projects that survey a specialized topic of interest to the student.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Hugo Bellen

**Research Rotation (GS-DB- 549)**

Faculty mentored research for students who have not yet selected a faculty advisor .

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Hugo Bellen

**Dissertation (GS-DB- 550)**

Thesis research directed by a faculty mentor and advisory committee. Open only to candidates for the Ph.D. or M.S. degrees.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Hugo Bellen

# Immunology

## **Logic and Presentation of Problem-Solving (GS-IM- 400)**

Understanding and presenting research in a logical manner is a critical skill for scientists. This course dissects of the logic of problem-solving science through using the rubrics of “OPTEMA” (Observations; Problematization; Testable ideas; Experimental design: Methods; and Analysis) and teaches both logical analysis and presentation through the One Figure Journal Club in which class participants including the instructor work through a single journal club article. In addition, the elements of scientific discourse, scientific statements with their associated citations, are approached using the evidential typology of Bruno Latour and a typology of citation –functions.

Credits: 1

Term: 1

Counts for 30 hr. requirement: N

Director: Dr. John Rodgers

## **Logic and Rhetoric of Writing Science (GS-IM- 401)**

Uses structure-functional analysis of scientific text to teach techniques of reading and writing science articles based on logic and rhetoric principles of *transdiscourse* (including summary, synopsis, paraphrase and, occasionally, quotation) and *metadiscourse* (including *hedges* and *boosts*).

Credits: 1

Term: 2

Counts for 30 hr. requirement: N

Director: Dr. John Rodgers

## **Logic and Rhetoric of Writing Proposals (GS-IM- 402)**

This course covers the logic of experimental design for general experimentation and grant proposals and the art of persuasion as it pertains to grant proposals. It will also cover the needs to students preparing for qualifying exams.

Credits: 1

Term: 4

Counts for 30 hr. requirement: N

Director: Dr. John Rodgers

### **Clinical Aspects of Immunology (GS-IM- 405)**

This course is designed for immunology students to learn more about the roles and importance of immunology in various human diseases and animal models, including cancer immunology, autoimmune diseases, infectious/tropical diseases, allergy and immunodeficiency. The goals of this course are to introduce students to these active research topics, to bridge basic immunology to clinical immunology, and motivate them for the selection of their own research topics related to important human diseases. This course will combine faculty lectures (50%), student presentations of scientific papers and student-designed future directions in the selected topics (50%).

Credits: 3

Term: 5

Counts for 30 hr. requirement: Y

Director: Dr. Richard Cook

### **Immunology (GS-IM- 423)**

This is a series of lectures stressing basic concepts in immunology. These include immunoanatomy and cytology, innate immunity, development of the immune system, immunoglobulin structure and genetics, antigen-antibody reactions, the major histocompatibility complex and antigen presentation, T cell receptors (genetics, structure, selection), T cell activation and effector functions, cell trafficking, phagocytic cell functions, immune responses to infections organisms and tumors, autoimmunity, allergies and immunodeficiency. The course includes weekly reviews led by senior graduate students that help to explore and clarify concepts.

Credits: 3

Term: 2

Counts for 30 hr. requirement: Y

Director: Dr. Jonathan Levitt

### **Regulation of Immune Responses (GS-IM- 425)**

This course is composed of mini-lectures by faculty (30%) and student presentations and discussions of articles (70%) from the current literature. Students receive written constructive comments from the instructors to help improve their presentation content and style. The focus of the articles, selected by the participating faculty, is on the cells, proteins and mechanisms that regulate cellular and humoral immune responses. Topics that are covered include pathways for antigen presentation by MHC molecules, thymic selection, T cell receptor structure/function, T cell co-stimulation, regulatory and memory T cells, dendritic cells, NK, CD4 and CD8 cell function, autophagy, toll-like receptors, cell-cell interaction molecules, and B cell activation and differentiation.

Credits: 3

Term: 3

Counts for 30 hr. requirement: Y

Director: Dr. Richard Cook

**Molecular Immunology (GS-IM- 428)**

This course consists of a series of faculty lectures (50%) and student-led discussions (50%) of major molecular mechanisms that control immune responses. Students receive written constructive comments from the instructors to help improve their presentation content and style. The course approaches the subject of immunology from the viewpoints of innate immunity, the immunological synapse, ion channels, central and peripheral tolerance, microRNA control of gene regulation in lymphocytes, lymphocyte activation and CTL killing. Each student develops a research proposal in an area covered in the course, guided by the companion course GS-IM 406.

Credits: 3

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Richard Cook

**Special Projects (GS-IM- 435)**

Faculty mentored research for students that have not been admitted to candidacy.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. John Rodgers

**Immunology Journal Club (GS-IM- 446)**

This course consists of weekly meetings, attended by students and faculty, for student presentations and discussions of high impact literature in immunology.

Credits: 1

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Min Chen

**Special Topics (GS-IM- 463)**

Scholarly study directed by a faculty member. Special topics allows a faculty member to develop individualized courses for students. Special topics cannot be used to satisfy the 30 hr course requirement.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. John Rodgers

**Readings (GS-IM- 548)**

Faculty-directed literature projects that survey a specialized topic of interest.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. John Rodgers

**Research Rotation (GS-IM- 549)**

Faculty-mentored research for students who have not yet selected a faculty advisor.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. John Rodgers

**Dissertation (GS-IM- 550)**

Thesis research directed by a faculty mentor and advisory committee. Open only to candidates for the Ph.D. or M.S. degree.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. John Rodgers

# Integrative Program in Molecular and Biomedical Sciences

## **IMBS Director's Course (GS-MB- 401)**

This course will prepare students to become leaders in interdisciplinary and integrative cell and molecular biomedical research by developing practical and intellectual skills very early in their training. The objectives are to: i) identify and evaluate the primary scientific literature and interpret the results; ii) evaluate and identify critical problems, identify significance and innovative approaches; iii), develop and justify the scientific rationale, testable hypotheses, design rigorous experimental approaches to test leading hypotheses using multiple and independent predictions; iv) develop specific aims and grant proposals; v) develop scientific writing skills; vi) write and orally defend a mock grant proposal; and vii) develop and give lucid presentations.

Credits: 1

Term: 1, 2, 3, 4

Counts for 30 hr. requirement: N

Director: Dr. Frederick Pereira

## **Biology of Aging & Age Related Diseases (GS-MB- 430)**

This course provides students and post-docs with the most up-to-date information on current understanding of the aging process and age-related human disorders. The course not only covers molecular aspects of aging research, including models and theories of aging, but also clinical perspectives of aging. This advanced (elective) graduate course is offered for students who wish to either specialize in or have a strong background in the interrelated areas of development, aging and age-related diseases. Students are strongly encouraged to actively participate by posing questions and contributing to discussions of each topic.

Credits: 3

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Frederick Pereira

**Translational Cancer Biology (GS-MB- 431)**

This course integrates the basic science and translational aspects of research with clinical applications, thus enhancing student understanding of current research and clinical correlations in particular cancers. Each week will have a particular cancer focus and the meeting time will include a clinically focused lecture, a basic science focused lecture, and a journal club article presented by students. Students will attend a minimum of two tumor board sessions during the term, which include a patient case presentation followed by discussion detailing the background, treatment, outcomes, and research avenues of the patient's malignancy. These tumor boards can be attended at any time during the course.

Credits: 2

Term: 2

Counts for 30 hr. requirement: Y

Director: Dr. Jason Yustein

**Special Projects (GS-MB- 435)**

Faculty mentored research for students that have not been admitted to candidacy.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. David Nelson

**Special Topics (GS-MB- 463)**

Scholarly study directed by a faculty member. Special topics allow a faculty member to develop individualized courses for students. Special topics cannot be used to satisfy the 30 hr course requirement.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. David Nelson



**Seminar in Cell & Molecular Biology (GS-MB- 466)**

This is a Research in Progress Seminar Series for students enrolled in the Integrative Molecular and Biomedical Sciences Graduate Program (IMBS). The objective of the course is for students within the Graduate Program to have an opportunity to present their ongoing research to a diverse group of colleagues, and to receive feedback from these colleagues in regards to the quality of their presentation and work. The aggregate of the IMBS student body is divided into student six critique groups, two of which are assigned to each seminar on a rotating basis. Each member of the assigned critique group is required to complete one to two evaluation forms (Presentation Style or Scientific Rigor) and return it to the student present.

Credits: 1

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Joel Neilson

**Readings (GS-MB- 548)**

Faculty directed literature projects that survey a specialized topic of interest.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. David Nelson

**Research Rotation (GS-MB 549)**

Faculty mentored research for students who have not yet selected a faculty advisor

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. David Nelson

**Dissertation (GS-MB 550)**

Thesis research directed by a faculty mentor and advisory committee. Open only to candidates for the Ph.D. or M.S. degree

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. David Nelson

# Molecular and Cellular Biology

## **Explorative Data Analysis (GS-CB-400)**

Explorative Data Analysis will teach concepts of statistical learning and of data integration in database systems that together will enable students to explore and learn from large and complex datasets to generate new and unique biological insights. The approach to teaching will emphasize methods of statistical learning and their conceptual underpinnings rather than their mathematical properties, and will use a hands-on approach to progressive 'omics'-data integration and mining by using community-based resources for data analysis rather than on writing codes

Credits: 2

Term: 3

Counts for 30 hr. requirement: Y

Director: Dr. Rainer Lanz

## **Reproductive Biology (GS-CB- 406)**

Reproductive Biology covers mammalian reproductive processes at all levels of biological organization (anatomical, physiological, cellular, biochemical and molecular). The course is taught with a comparative approach analyzing findings in different animal model systems and clinical studies to ensure that clinical issues affecting reproductive success are presented, and to also demonstrate how basic science is moving toward understanding the causes and treating reproductive failure and diseases.

Credits: 3

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. JoAnne Richards and Dr. Stephanie Pangas

## **Cellular Signaling (GS-CB- 425)**

Cellular signaling covers major cellular signaling pathways, actions of intracellular kinases and nuclear receptors, and strategies for regulating cell signaling. The pathways covered include those regulated by GPCR, receptor tyrosine kinases, TGF $\beta$ , Notch, Hedgehog, WNT, Hippo and nuclear receptors. In addition, signaling pathways regulated by small molecules including calcium, phospholipids, cAMP, cGMP, and AMP are discussed.

Credits: 3

Term: 2

Counts for 30 hr. requirement: Y

Director: Dr. Nancy Weigel

**Integrated Microscopy (GS-CB- 426)**

This course is designed to give both a basic knowledge of the different types of light and electron microscopy approaches; and hands-on use of the instruments available in the Integrated Microscopy Core, training in immunofluorescence, RNA FISH and introduction to basic image analysis.

Credits:-2

Term: 3

Counts for 30 hr. requirement: Y

Director: Dr. Michael Mancini and Dr. Fabio Stossi

**Special Projects (GS-CB- 435)**

Faculty mentored research for students that have not been admitted to candidacy.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. JoAnne Richards

**Introduction to Molecular Carcinogenesis (GS-CB- 457)**

The course explores the fundamental concepts and experiments in tumor biology, cancer virology and oncogenes and growth control. This course provides a broad based introduction to students who have an interest in modern cancer research. Faculty from four departments (Cell Biology, Molecular Virology, Pharmacology and Biochemistry) serve as instructors.

Credits: 3

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Yi Li

**Cells, Tissues and Organs (GS-CB- 461)**

The Cells, Tissues and Organs course focuses on analysis of structure/function relationships in tissues and organs. This will include correlating tissue histology with organ physiology. Interactive lectures and discussions occur simultaneously with direct observation of human and some animal model tissues by the students through multi-head microscopes with a pathologist. Students participate in weekly essays and presentations.

Credits: 2

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. David Rowley

**Special Topics (GS-CB- 463)**

Scholarly study directed by a faculty member. Special topics allows a faculty member to develop individualized courses for students. Special topics cannot be used to satisfy the 30 hr course requirement.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Joanne Richards

**Introduction to Research and Research Proposals (GS-CB- 465)**

Introduction to Research & Research Proposals addresses topics relevant to the successful conduct of research including plagiarism and misconduct, and preparation of effective oral and poster presentations and research papers, as well as optimizing use of web-based resources. The second section of the course instructs students in how to prepare a competitive grant proposal with emphasis on developing research plans, design and analysis of experiments and enhancing significance and innovation with the goal of preparing students to take their qualifying examination.

Credits: 1

Term: 5

Counts for 30 hr. requirement: N

Director: Dr. John Lydon

**Seminar in Cell Biology (GS-CB- 466)**

Student Seminar

Credits: 1

Term: 1, 4

Counts for 30 hr. requirement: N

Director: Dr. Stephanie Pangas

**Regulation of Energy Homeostasis (GS-CB- 468)**

Regulation of Energy Homeostasis addresses the control of metabolism in health and disease, and how energy balance is signaled among organs. Emphasis will be placed on defining regulatory mechanisms and pathways, with particular attention to abnormalities occurring with disease. The approach will be inter-disciplinary, including metabolomic, biochemical, genetic and cellular aspects.

Credits: 2

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Robb Moses, Dr. David Moore

**Readings (GS-CB- 548)**

Faculty directed literature projects that survey a specialized topic of interest.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. JoAnne Richards

**Readings B (GS-CB- 548B)**

Faculty directed literature projects that survey a specialized topic of interest.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. JoAnne Richards

**Research Rotation (GS-CB- 549)**

Faculty mentored research for students who have not yet selected a faculty advisor.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. JoAnne Richards

**Dissertation (GS-CB- 550)**

Thesis research directed by a faculty mentor and advisory committee. Open only to candidates for the Ph.D. or M.S. degree.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. JoAnne Richards

# Molecular and Human Genetics

## **Introduction to Data Mining (GS-GE- 402)**

Data mining provides practical approaches and tools that allow biomedical researchers to analyze and understand their data and to craft new hypotheses. The course will focus on data mining essentials and will cover standard approaches to clustering, classification, regression and model selection, along with several domain-oriented techniques such as gene enrichment analysis. We will focus on applications of these methods through a visual programming platform that requires no training in programming. We will provide a basic introduction to the inner workings and mathematics, helping students to intuitively understand the data analysis algorithms without having to understand deep mathematical concepts.

Credits: 2

Term: 1

Counts for 30 hr. requirement: Y

Director: Dr. Gad Shaulsky

## **Gene and Cell Therapy (GS-GE- 403)**

This course covers various approaches to somatic and germ cell gene therapy, with emphasis on vector systems and other methods for gene delivery and targeting; model systems for specific applications of gene therapy; and the status of current therapeutic strategies for various inherited and acquired disorders.

Credits: 2

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Philip Ng

## **Human Genetics (GS-GE- 411)**

The goal of this course is help graduate students learn the fundamental principles of human genetics they will need to be effective contributors to the field of human genetics. By the end of the course, students will have an increased ability to comprehend the human genetics literature, conduct human genetics research, accurately interpret genetic data obtained from human subjects and communicate these findings to other researchers and the general public.

Credits: 3

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Daryl Scott

**Clinical Genetics (GS-GE- 419)**

The course is aimed at training graduate students in the applied aspects of clinical genetics. Students will learn how Human Geneticists address medical genetic problems in the clinic, interact with genetic fellows and learn how to design tests and experiments to address clinical problems.

Credits: 1

Term: 1

Counts for 30 hr. requirement: Y

Director: Dr. Daryl Scott

**Mammalian Genetics (GS-GE- 421)**

This course describes the contribution of mammalian cell culture and somatic cell genetics to the understanding of molecular mechanisms of gene expression. Topics covered include mammalian cell culture systems, properties of permanent and primary cell lines, isolation and selection of mutant cell lines, gene mapping, complementation analysis, cell hybrids, DNA mediated gene transfer, DNA and RNA viral vectors for gene transfer, gene transfer to the germline and somatic cells of animals.

Credits: 2

Term: 3

Counts for 30 hr. requirement: Y

Director: Dr. Hamed Jafar-Nejad

**Introduction to Medical Genetics (GS-GE- 425)**

This course will: provide students insight into the specialty of medical genetics and its place within the practice of medicine in the United States; offer students an opportunity to understand what it is like to be a medical geneticist and work in a diagnostic laboratory; and, inform students about educational and training requirements that lead to eligibility for board certification by the ABMG. The focus of the course will be on laboratory specialties, however, the specialties of Clinical Genetics and Genetic Counseling will also be discussed.

Credits: 3

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Marco Sardiello

**Special Projects (GS-GE- 435)**

Faculty mentored research for students that have not been admitted to candidacy.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Gad Shaulsky

**Bioinformatics and Genomic Analysis (GS-GE- 459)**

This course is intended to provide a background in the theory and application of standard computational methods for molecular biology research. The topics to be discussed include databases, sequence comparison, phylogeny, pattern inference and matching, RNA secondary structure, and protein structure. The course will also address computational issues for the Human Genome Program in the areas of large-scale DNA sequencing, chromosome mapping, and gene recognition. During the term, a seminar speaker, with expertise in an area relevant to the subject area of the course, is invited as a guest lecturer. Students are required to attend this seminar.

Credits: 3

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Kim Worley

**Special Topics (GS-GE- 463)**

Scholarly study directed by a faculty member. Special topics allows a faculty member to develop individualized courses for students. Special topics cannot be used to satisfy the 30 hr course requirement.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Gad Shaulsky

**Seminar in Molecular & Human Genetics (GS-GE- 466)**

This course is required of all first and second year students enrolled in the Molecular and Human Genetics Graduate Program. The course is conducted as a journal club to study current literature, to practice critical analysis of the literature and to refine presentation techniques. First year students present papers from the current literature, all students join in discussion of the paper presented.

Credits: 1

Term: 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Andrew Groves and Dr. Hamed Jafar-Nejad



**Student Research Seminar (GS-GE- 468)**

A seminar series in which senior students (second year and up) will present their own research to an audience of students and faculty to develop their oral communication skills. The students will present their own work approximately once each year in a revolving schedule. Following each student's seminar, constructive advice from faculty and students will be provided about improving presentation skills and about producing effective presentation materials. The course is aimed to supply the students with the experience necessary to perform highly successful presentations outside of the college in national scientific meetings.

Credits: 1

Term: 1, 2, 3, 4

Counts for 30 hr. requirement: N

Director: Dr. Christophe Herman and Dr. Herman Dierick

**Readings (GS-GE- 548)**

Faculty directed literature projects that survey a specialized topic of interest.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Gad Shaulsky

**Research Rotation (GS-GE- 549)**

Faculty mentored research for students who have not yet selected a faculty advisor.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Gad Shaulsky

**Dissertation (GS-GE- 550)**

Thesis research directed by a faculty mentor and advisory committee. Open only to candidates for the Ph.D. or M.S. degree

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Gad Shaulsky

# Molecular Physiology & Biophysics and Cardiovascular Sciences

## Molecular Physiology & Biophysics

### **Advanced Topics in Muscle Physiology (GS-PY- 400)**

This course will focus on skeletal muscle and integrate current information on molecular structure of muscle, its function, signaling pathways controlling its development, growth and response to disease. The course consists of lectures by faculty, presentations by students of assigned papers with student participating and a final exam.

Credits: 2

Term: 3

Counts for 30 hr. requirement: Y

Director: Dr. George Rodney

### **Introduction to Animal MRI (GS-PY- 411)**

This course provides an introduction to the theory and application of small animal MRI which is currently not readily available through other courses.

Credits: 2

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Robia Pautler

### **Grant Writing Skills (GS-PY- 413)**

The goal of this course is to guide students to write a specific aims page on a specified theme while teaching them about grant structure, grant writing styles, and reinforcing scientific thinking in developing models, hypotheses, and experimental tests through question and answer sessions. The course interleaves lectures with group discussion. In the lectures, the students will be instructed in the overall layout of a grant, the purpose of the various grant sections, and the writing style for grants. Before each discussion, the students will be required to write a section of the specific aims page. In the discussion, the students will question each other's hypotheses, aims and approaches.

Credits: 1

Term: 2

Counts for 30 hr. requirement: N

Director: Dr. Steen Pedersen, Dr. Mary Dickinson

**Cell Physiology (GS-PY- 415)**

This course will introduce students to a variety of topics related to cellular physiology while also providing instruction as to how one critically evaluates primary research literature. The topics covered will include NeuroPhysiology, Metabolism and Physiology, Cancer Physiology, Cardiovascular Physiology, Muscle Physiology and Biophysics/Bioengineering. The lectures will be general overviews of the stated topics so that students of varying academic backgrounds may become familiar with systems they will encounter in subsequent physiology courses.

The course will consist of a 1-hour class that meets twice weekly. The first class will consist of a faculty lecture from an expert in each respective field. The second class will be in the format of a journal club Powerpoint presentation and include an open discussion and critical evaluation of literature pertaining to the previous faculty lecture. The presenting faculty member will choose a single paper to accompany their lecture.

Credits: 2

Term: 1

Counts for 30 hr. requirement: Y

Director: Dr. Ross Poché

**Human Physiology I (GS-PY- 430)**

This course will provide students with the basic knowledge of organ systems and integrative physiology in humans upon which the pathophysiology of human diseases can later be expanded. Lectures are intended to educate students about the current research being performed in each field and to elicit ideas about future research and human applications. Topics covered in this course, which is the first of two Human Physiology courses, include: cellular physiology, the nervous system, skeletal muscle, the cardiovascular system, and the respiratory system.

Credits: 3

Term: 2

Counts for 30 hr. requirement: Y

Director: Dr. Frank T. Horrigan

**Human Physiology II (GS-PY- 431)**

This course will provide students with the basic knowledge of organ systems and integrative physiology in humans upon which the pathophysiology of human diseases can later be expanded. Lectures are intended to educate students about the current research being performed in each field and to elicit ideas about future research and human applications. Topics covered in this course, which is the second of two Human Physiology courses include: the immune system, renal physiology, bone, the endocrine system, the reproductive system, the gastrointestinal system and liver.

Credits: 3

Term: 3

Counts for 30 hr. requirement: Y

Director: Dr. Frank T. Horrigan

**Special Projects (GS-PY- 435)**

Faculty mentored research for students that have not been admitted to candidacy.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Christine Beeton

**Special Topics (GS-PY- 463)**

Scholarly study directed by a faculty member. Special topics allows a faculty member to develop individualized courses for students. Special topics cannot be used to satisfy the 30 hour course requirement.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Christine Beeton

**Transmembrane Signaling (GS-PY- 465)**

This highly interactive upper level course is designed for students interested in understanding in-depth the important principles of trans-membrane signaling. In addition to introducing the roles of lipids, ion channels, kinases, and second messengers, selected examples of signal transduction pathways underlying muscle physiology and cell survival will be discussed in detail. One half of the course will be lectured by experts from related fields. Each lecture is paired with a group discussion of a relevant article.

Credits: 2

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Christine Beeton

**Seminar in Molecular Physiology & Biophysics (GS-PY- 466)**

Student Seminar

Credits: 1

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Irina Larina

**Reading (GS-PY- 548)**

Faculty directed literature projects that survey a specialized topic of interest.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Christine Beeton

**Research Rotation (GS-PY- 549)**

Faculty mentored research for students who have not yet selected a faculty advisor.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Christine Beeton

**Dissertation (GS-PY- 550)**

Thesis research directed by a faculty mentor and advisory committee. Open only to candidates for the Ph.D. or M.S. degree.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Christine Beeton

# Cardiovascular Sciences

## **Cardiovascular Physiology (GS-CS- 411)**

Topics covered include cardiac cycle, cardiac contractility, neural, and nonneural control of the circulation, biomedical instrumentation, and physical analytical methods. The various components of the cardiovascular system is integrated to define its basic control functions.

Credits: 4

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Sean Marrelli

## **Cardiovascular Disease and Pathology (GS-CS- 412)**

Topics covered include atherosclerosis, hypertension, myocardial ischemia and infarction, cardiac failure, and hypertrophy. Since this course emphasizes cardiovascular pathology, all components of the normal system are assessed within the disease process.

Credits: 3

Term: 5

Counts for 30 hr. requirement: Y

Director: Dr. Sean Marrelli

## **Special Projects (GS-CS- 435)**

Faculty mentored research for students that have not been admitted to candidacy.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Sean Marrelli

## **Special Topics (GS-CS-463)**

Scholarly study directed by a faculty member. Special Topics allows a faculty member to develop individualized courses for students. Special topics cannot be used to satisfy the 30 hr course requirement.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Sean Marrelli

**Seminar in Cardiovascular Sciences (GS-CS-466)**

Student Seminar

Credits: Variable

Term: 3, 4, 5 (not offered in AY16)

Counts for 30 hr. requirement: N

Director: Dr. Sean Marrelli

**Readings (GS-CS-548)**

Faculty directed literature projects that survey a specialized topic of interest.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Sean Marrelli

**Research Rotation (GS-CS-549)**

Faculty mentored research for students who have not yet selected a faculty advisor.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Sean Marrelli

**Dissertation (GS-CS- 550)**

Thesis research directed by a faculty mentor and advisory committee. Open only to candidates for the Ph.D. or M.S. degree.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Sean Marrelli

# Molecular Virology and Microbiology

## **General Virology (GS-MV- 401)**

This series of lectures and student paper presentations emphasize fundamental principles related to interactions of animal viruses with their host cells. General topics include chemical and physical properties of viruses, virus classification, cultivation and assay of viruses, viral replication and morphogenesis, vaccines and antivirals, viral pathogenesis, virus vectors, and viral oncogenesis. These topics are highlighted through detailed discussions of selected RNA and DNA virus families.

Credits: 4

Term: 2

Counts for 30 hr. requirement: Y

Director: Dr. Ronald T. Javier

## **Literature Review in Molecular Virology & Microbiology (GS-MV- 410)**

Literature Reports is a course in which all students in the Department of Molecular Virology and Microbiology must participate. At each meeting, two students each present a paper that they have picked alone, or with the help of their faculty mentor, to an audience of their fellow students and MVM faculty. (Every session has a different faculty mentor.) The goal of the class is to give the students a chance to gain experience presenting to critical audiences, to learn to critically assess data, respond to oral questions and prepare cogent presentations.

Credits: 1

Term: 1, 2, 3, 4

Counts for 30 hr. requirement: N

Director: Dr. Anthony Maresso

## **Genetics of Animal Viruses (GS-MV- 411)**

This series of lectures places emphasis on modern molecular genetic approaches to study animal viruses. Classical approaches are also covered when they provide useful accessory techniques to molecular methods. Lectures place emphasis on phenomena and reduce the emphasis on genetic peculiarities of the various viral taxonomic groups.

Credits: 3

Term: 4 (not offered in AY16)

Counts for 30 hr. requirement: Y

Director: Dr. Robert Franklin Ramig



**Concepts in Microbial Pathogenesis (GS-MV- 413)**

Microbial Pathogenesis will provide interested graduate students or postdoctoral fellows with knowledge of the basic and clinical aspects of mechanisms and consequences of microbial (bacterial and viral) pathogenesis. This course will provide students with the knowledge to understand how bacteria and viruses cause disease, insights into research approaches used to answer questions on microbial pathogenesis, and a forum for in depth discussion of data from selected papers and enhance their ability to critically analyze, discuss, and present data. \

Credits: 4

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Margaret Ellen Conner

**Bacterial Structure and Function (GS-MV- 417)**

The course covers the physiology of bacterial cells with an emphasis on current research topics. The first part of the course is devoted to discussion of the components of the bacterial cell wall and their roles in pathogenesis, cell motility, cell structure, nutrient transport, and protein secretion. The next section of the course includes lectures on the regulation of bacterial function, including transcription, translation, and specialized functions unique to bacteria. Finally, mechanisms by which bacteria adapt to their environment are discussed.

Credits: 3

Term: 2

Counts for 30 hr. requirement: Y

Director: Dr. Rob Britton

**Epidemiology of Viral Infections (GS-MV- 426)**

Principles of epidemiology as a basic science of preventive medicine are presented. These include: epidemiologic variables, measurements, retrospective and prospective studies, basic statistics, epidemiology of selected viral and bacterial infections of major public health significance, environmental epidemiology, cancer epidemiology associated with viral infections, seroepidemiology, and immunizations.

Credits: 3

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Ervin Adam

**Special Projects (GS-MV- 435)**

Faculty mentored research for students that have not been admitted to candidacy.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Robert Franklin Ramig

**Special Topics (GS-MV- 463)**

Scholarly study directed by a faculty member. Special topics allows a faculty member to develop individualized courses for students. Special topics cannot be used to satisfy the 30 hr course requirement.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Robert Franklin Ramig

**Seminar in Molecular Virology (GS-MV- 466)**

Student Seminar

Credits: 1

Term: 2, 3, 4

Counts for 30 hr. requirement: N

Director: Dr. Robert Franklin Ramig

**Readings (GS-MV- 548)**

Faculty directed literature projects that survey a specialized topic of interest.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Robert Franklin Ramig

**Research Rotation (GS-MV- 549)**

Faculty mentored research for students who have not yet selected a faculty advisor

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Robert Franklin Ramig

**Dissertation (GS-MV- 550)**

Thesis research directed by a faculty mentor and advisory committee. Open only to candidates for the Ph.D. or M.S. degree.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Robert Franklin Ramig

# Neuroscience

## **Fundamentals of Human Neuroimaging (GS-NE- 400)**

Neuroimaging has rapidly become one of the most popular and powerful tools for neuroscience. This course surveys a variety of brain imaging modalities, describing what each measures and how the results are used for research. Neuroscience has classically relied on invasive electrode measurements, mostly in animals, to directly map electrical activity in the brain, and modern microelectrode arrays have expanded this method. Two other brain activity measurement schemes, electroencephalography (EEG) and magnetoencephalography (MEG), provide non-invasive measurements with excellent temporal resolution but limited spatial accuracy. Recently, magnetic resonance imaging (MRI) has become tremendously popular because it is non-invasive, involves no ionizing radiation, and offers substantial flexibility. In particular, MRI is used to measure brain structure in a variety of fashions, to measure white-matter connectivity using diffusion-weighted imaging (e.g., DTI), and to measure brain function (e.g., fMRI). Extensive techniques have been developed to localize and probe cortical activity in a variety of specialized areas. Optical imaging techniques have also contributed substantially to our understanding of brain function, mostly as an invasive technique in animal models. Positron-emission tomography (PET) provides additional specialized information about brain function. Students should have introductory physics and calculus capability at the freshman level.

Credits: 4

Terms: 1-2

Counts for 30 hr. requirement: Y

Director: Dr. David Ress

## **Neurobiology of Disease (GS-NE- 422)**

This course will cover important and scientifically tractable disorders of nervous system function. The course will expose the students to the incidence, clinical manifestations, pathophysiology and current scientific models of the causes and mechanisms of some of the most common disorders of brain and nervous system function and development throughout the lifespan.

Credits: 2

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Jeffrey Noebels

**Physiology of the Visual System (GS-NE- 424)**

This is an advanced level course on the physiology of the visual system. It covers the biochemistry, physiology and biophysics of phototransduction, synaptic transmission in the retina and functional architecture of the retina and central visual pathways. Additionally, principles of visual information processing in the eye and in the brain, mechanisms controlling eye movement and gaze stabilization are discussed.

Credits: 3

Terms: 4

Counts for 30 hr. requirement: Y

Director: Dr. Samuel Wu

**Analyses of Neuronal Function (GS-NE- 431)**

This course will cover all basic concepts linking neuronal function to behavior. The topics include how neurons communicate, connect into circuits, how plasticity modulates these circuits, and how sensory information is collected and encoded. Students will learn synaptic biochemistry and physiology, how neuronal circuits can be described and modeled computationally, how learning and memory can be linked to specific changes in neuronal circuit function and how different sensory stimuli are transduced into signals that the nervous system can use.

Credits: 3

Term: 2

Counts for 30 hr. requirement: Y

Director: Dr. Mauro Costa-Mattioli

**Special Projects (GS-NE-435)**

Faculty mentored research for students that have not been admitted to candidacy.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Matthew Rasband

**Genetics for Neuroscience (GS-NE- 441)**

This course is intended to teach neuroscience students how to tackle neurobiological problems using genetic strategies and tools. Students will be exposed to the basic concepts in genetics and will be taught the advantages and approaches used in invertebrate model organisms, *C. elegans* and *D. melanogaster*, focusing on different genetic, cell biological and neurobiological tools available in those organisms. The course will also focus on mouse genetics, highlighting the different techniques and approaches commonly used in the mouse, followed by genetic approaches in humans.

Credits: 3

Term: 3

Counts for 30 hr. requirement: Y

Director: Dr. Ben Deneen

**Preparing for Your Neuroscience Qualifying Exam (GS-NE- 447)**

This course will explain the requirements and expectations of the qualifying exam in Neuroscience. The course is geared specifically towards second year students who have successfully completed their first year coursework and several months' work in their chosen thesis lab. The course will cover the format of the written and oral exams, tips for structuring the aims and scope of the written proposal, and provide students with opportunity to develop and deliver their oral presentation for feedback from the group. The goal of the course is to help students begin thinking about their work independently and to present their research problem and experimental goals clearly. Ultimately, this course is intended to encourage independent NRSA applications from those students who qualify.

Credits: 1

Term: 2

Counts for 30 hr. requirement: N

Directors: Dr. Joanna Jankowsky and Dr. Kim Tolias

**Electrical Signaling in the Brain (GS-NE- 448)**

This course covers the basic concepts of electrical signaling from the proteins involved, biophysical principles and computational methods required to understand, measure and characterize electrical signaling in the brain. Students will learn about ion channel kinetic and steady state properties, circuit analysis of membrane potential, how to calculate changes in membrane potential produced by changes in channel gating, perform computational analyses of neuronal electrophysiology using the NEURON computer program, and learn about the application of these ideas to the study of neuronal function in vivo in awake behaving animals.

Credits: 3

Term: 1

Counts for 30 hr. requirement: Y

Director: Dr. Paul Pfaffinger

**Neuroscience Lab I (GS-NE- 449)**

Students will be introduced to basic approaches of molecular and cellular neuroscience including learning how to model biological systems and how to perform basic laboratory techniques. Primary focus will be on understanding how to break complex neuronal systems down to enable useful analyses as well as the importance of design and controls in different experimental approaches. Students will be exposed to a combination of problem solving, practical demonstrations, and discussions of pluses and minuses for different approaches.

Credit: 1

Term 1

Counts for 30 hr. requirement: N

Director: Dr. Paul Pfaffinger

**Neuroscience Lab II (GS-NE- 450)**

This course extends the practical laboratory demonstrations begun in GS-NE-449 with hands-on demonstrations in systems and computational neuroscience. Methods to be covered include classical and modern neuro-anatomical techniques, in vivo pharmac- and opto-genetics, model systems behavioral assays, fMRI, and computational modeling among others. One hour lecture and 3 hour laboratory demonstration per week.

Credits: 1

Term: 2

Counts for 30 hr. requirement: N

Director: Dr. Paul Pfaffinger

**Neural Systems I (GS-NE- 455)**

Neural Systems I course covers the mechanisms involved in processing sensory information by the brain. The course will cover the major sensory systems from organizational principles to the transformation of information. This course will cover the key topics in the processing of sensory information by the brain. The course will also introduce students to in depth analysis of important papers in systems neuroscience to better assist their development of critical reading skills. This course will prepare students for Neural Systems II which will cover how sensory inputs are transformed into motor actions by the brain. Following completion of this course student will understand the locations, functional organization, and functional significance of the main sensory processing streams in the central nervous system.

Credits: 3

Term: 3

Counts for 30 hr, requirement: Y

Director: Dr. Roy Sillitoe

**Neural Systems II (GS-NE- 456)**

Neural Systems II course covers the mechanisms involved in transforming sensory inputs into motor action and higher brain functions. The course will cover the spinal, cortical, limbic and cerebellar systems involved in motor planning and execution, behavioral control, and learning and memory. This course will cover the key topics in translation of sensory inputs into patterns of motor behavior as well as brain circuits involved in higher cognitive functions. The course will also introduce students to in depth analysis of important papers in systems neuroscience to better assist their development of critical reading skills. Following completion of this course student will understand the locations, functional organization, and functional significance of the main motor pathways as well as key findings linking brain function to complex cognitive behaviors.

Credits: 3

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Roy Sillitoe

Prerequisites: Neural Systems I (GS-NE-455).

**Theoretical Neuroscience: Networks and Learning (GS-NE- 457)**

This course provides an introduction to the mathematical theories of computation and learning by neural systems. These theories use concepts from dynamical systems (attractors, chaos) and concepts from statistics (information, uncertainty, inference) to relate the properties and functions of biological neural networks.

Credits: 4

Term: 3-4

Counts for 30 hr. requirement: Y

Director: Dr. Zachary Pitkow

**Introduction to Computation for Neuroscience (GS-NE- 458)**

Students will learn the basics of Python 3.x programming including the typical syntax and structure of macros and programs in the context of programming for neuroscience and creating of extensions to NEURON, EXCEL and CHIMERA. Students will learn to use this knowledge to break problems down to algorithms and then to code those algorithms using Python 3.x. In addition to working on problems specific to neuroscience, students will complete a tutorial on programming (<https://github.com/RunestoneInteractive/thinkcspy>). In order to ensure the course is relevant to our students, typically problems will involve solutions to standard tasks students face in the lab, such as setting up experiments, and the analysis and plotting of data for basic neuroscience experiments. In addition, these techniques will be useful in the modeling the function of neurons. The course will run as a set of 8 Tutorials lasting 3 hours each. These tutorials will be designed to help students solve basic problems in neuroscience research by certain of custom programs to meet their needs.

Credits: 1

Term: 1 (not offered in AY16)

Counts for 30 hour requirement: N

Director: Dr. Paul Pfaffinger

**Brain Cell Biology and Development (GS-NE- 459)**

This course covers the basic cellular organization and development of the nervous system. The first third of the course provides an overview and focal lectures on topics of particular importance to understanding cellular organization of neurons. The second third of the course covers cellular organization and function of glial cells. The final third of the course will cover the basics of neurodevelopment.

Credits: 2

Term: 2

Counts for 30 hr. requirement: Y

Director: Dr. Matthew Rasband

**Concepts of Learning and Memory (GS-NE- 462)**

This course is designed to introduce graduate students to the field of learning and memory. The course will introduce the student to classical and modern concepts of learning and memory across all levels at which learning and memory is studied, including behavioral, anatomical, cellular, molecular and genetic levels of analysis. The basic concepts of learning and memory will also be related to known disease of learning and memory.

Credits: 3

Term: 4

Counts for 30 hr requirement: Y

Directors: Dr. Mauro Costa-Mattioli and Dr. Daoyun Ji

**Special Topics (GS-NE- 463)**

Scholarly study directed by a faculty member. Special Topics allows a faculty member to develop individualized courses for students. Special topics cannot be used to satisfy the 30 hr course requirement.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Matthew Rasband

**Cellular Neurophysiology I (GS-NE- 464)**

This course provides a general background in cellular neurophysiology with an emphasis on an understanding of the properties of excitable nerve membranes and chemical synapses. The first part of the course covers the theory of ions in solutions, ion conduction through membranes, ion transport and distribution, nonlinear properties of neurons, nerve excitation and conduction, and stochastic properties of single ion channels. The second part of the course covers linear cable theory, multiple types of voltage-gated conductances, synaptic transmission including, quantal analysis; the role of calcium and transmitter release, various forms of synaptic plasticity.

Credits: 3

Term: 4 (not taught in AY16)

Counts for 30 hr. requirement: Y

Director: Dr. Samuel Miao-Sin Wu



### **Anatomy of the Nervous System (GS-NE- 471)**

The course will cover the basics concepts in neuroanatomy in a combined lecture and lab format. Lectures will cover a system or region of the brain and the lab components will involve the use of fixed brain tissue to perform dissections and identification of key landmarks. The course will end with a practicum final exam. The emphasis will be on the structural organization and functional systems of the nervous system.

Credits: 2

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Paul Pfaffinger

### **Advanced Functional Magnetic Resonance Imaging Laboratory (GS-NE- 472)**

This laboratory course will teach students to use blood-oxygen level dependent functional magnetic resonance imaging (BOLD fMRI) to explore human brain function. BOLD fMRI is the most popular method for examining the human brain, but poses unique technical, methodological, and data analysis obstacles. Students will learn how to overcome these obstacles by designing experiments and collecting fMRI data using the 3-tesla MRI scanners in BCM's Core for Advanced Magnetic Resonance Imaging (CAMRI).

Credits: 2

Term: 4

Counts for 30 hr. requirement: N

Director: Dr. Michael Beauchamp

Prerequisites: Fundamentals of Human Neuroimaging (GS-NE-400) and permission from Course Director

### **Theoretical Neuroscience: From Cells to Learning Systems (GS-NE- 473)**

We present the theoretical foundations of cellular and systems neuroscience from a distinctly quantitative point of view. We develop the mathematical and computational tools as they are needed to model, analyze, visualize and interpret a broad range of experimental data. The material covered includes the biophysical properties of single neurons, their visual sensory responses and how they relate to behavior. Additionally, we cover synaptic transmission and plasticity, as well as its relation to the mechanisms underlying learning and memory, and development of visual sensory neuron properties

Credits: 4

Terms: 1-2

Counts for 30 hr. requirement: Y

Director: Dr. Fabrizio Gabbiani

**Readings (GS-NE- 548)**

Faculty directed literature projects that survey a specialized topic of interest.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Matthew Rasband

**Research Rotation (GS-NE- 549)**

Faculty mentored research for students who have not yet selected a faculty advisor.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Matthew Rasband

**Dissertation (GS-NE- 550)**

Thesis research directed by a faculty mentor and advisory committee. Open only to candidates for the Ph.D. or M.S. degree.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Matthew Rasband

# Pharmacology

## **Drug Discovery: From Bench to Bedside (GS-PG-414)**

The objective of this course is to provide an overview of the making of a small-molecule drug. The topics include the identification of a drug target, bioassay development, structural biology, rational drug design and development, intellectual property protection as well as FDA regulations on new drug clinical trials.

Credits: 2

Term: 5

Counts for 30 hr. requirement: Y

Director: Dr. Yongcheng Song

## **General Pharmacology (GS-PG- 426)**

Basic pharmacological principles as they apply to basic research and to everyday life. The objectives of this course are to present the basic principles of pharmacology. Principles of pharmacodynamics, pharmacokinetics and major classes of therapeutic agents will be discussed.

Credits: 4

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Pui-Kwong Chan

## **Chemical Biology (GS-PG-427)**

Chemical Biology is a scientific discipline spanning the fields of chemistry, biology, and physics. It involves the application of chemical techniques, tools, and analyses, and often compounds produced through synthetic chemistry, to the study and manipulation of biological systems. The course teaches topics including an introduction to chemical biology, bio-orthogonal ligand reactions, small molecule inhibitors for protein-protein interactions and epigenetics, chemoproteomics, sensors for living cells, and state-of-the-art imaging techniques. The course content emphasizes applications of chemical tools in solving biological and biomedical problems.

Credits: 2

Term: 5

Counts for 30 hr. requirement: Y

Director: Dr. Jin Wang

## **Special Projects (GS-PG- 435)**

Faculty mentored research for students that have not been admitted to candidacy.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Choel Kim

**Special Topics (GS-PG- 463)**

Scholarly study directed by a faculty member. Special topics allows a faculty member to develop individualized courses for students. Special topics cannot be used to satisfy the 30 hr course requirement.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Choel Kim

**Seminar in Pharmacology (GS-PG-466)**

Student Seminar

Credits: 1

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Choel Kim

**Readings (GS-PG- 548)**

Faculty directed literature projects that survey a specialized topic of interest

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Choel Kim

**Research Rotation (GS-PG- 549)**

Faculty mentored research for students who have not yet selected a faculty advisor.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Choel Kim

**Dissertation (GS-PG- 550)**

Thesis research directed by a faculty mentor and advisory committee. Open only to candidates for the Ph.D. or M.S. degree.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Choel Kim

# Structural and Computational Biology and Molecular Biophysics

## **Computational Mathematics for Quantitative Biomedicine (GS-SB- 401)**

This course introduces essential computational, statistical and mathematical concepts to students who are interested in computational biology. It is intended that each of the concepts will be taught in the context of the real biological problems ranging from genomics bioinformatics, structural biophysics, computational neuroscience, systems biology, protein design, drug discovery, and medical bioinformatics

Credits: 8

Term: 1-2

Counts for 30 hr. requirement: Y

Director: Dr. Wah Chiu

## **Computational Molecular Biophysics and Structural Biology (GS-SB-402)**

This course is designed for students in computationally-oriented theoretical, biophysical, biomedical and bioengineering majors to introduce the principles and methods used for computer simulations and modeling of macromolecules of biological interest. Fundamental concepts in statistical mechanics, thermodynamics, and dynamics will be emphasized. Protein conformation/dynamics, empirical energy functions and molecular dynamics calculations, as well as other approaches will be described. Specific biological problems are discussed to illustrate the methodology. Classic examples such as the cooperative mechanisms of hemoglobin and more frontier topics such as the motional properties of molecular motors and ion channels as well as results derived from the current literature are covered. Other potential topics are protein folding/predictions, the nature of reaction rate enhancement in enzyme catalysis, physical chemistry properties of biologically relevant nano-materials, simulations of free energy changes in mutations, electrostatic properties of protein, molecular recognition, and the properties of binding sites. Particular emphasis is also given to the applications of molecular graphics. During the final reading period, each student carries out an original research project that makes use of the techniques and grading is based on the written and oral presentations of the results from the final projects.

Credits: 6

Term: 1

Counts for 30 hr. requirement: Y

Director: Dr. Jianpeng Ma

### **Advanced X-ray Crystallography (GS-SB- 403)**

X-ray crystallography is currently the most powerful technique to determine atomic resolution structures from small, inorganic molecules to large, multi-subunit macromolecular complexes. This course covers both theory and practical applications starting with crystallization, crystal systems, and data processing to finding a structure solution, model building, and structure refinement/validation. The course will prepare students with diverse scientific backgrounds to expand their research to protein crystallography as an analytical tool to probe the structure-function relationship of proteins and enzymes at the atomic level.

Credits: 3

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Francis T.F. Tsai

### **Computer-Aided Discovery Methods (GS-SB- 405)**

The objective of this course is to introduce students to the concepts, methods and tools relevant for computer-aided discovery using data collected using high-throughput technologies. The course will focus on the methods of integration of data, tools, and discovery processes and the methods of computational pattern discovery, hypothesis generation and testing. The students will master advanced applications of computing that enable new methods of discovery in a field of focus, which will initially be cancer biology. The course will not focus exclusively on technical, algorithmic or mathematical aspects nor will it focus on biology alone. Instead, the focus will be on genuine integration of the two fields.

Credits: 3

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Aleksandar Milosavljevic

### **Practical Introduction to Programming for Scientists (GS-SB- 406)**

In this course students will learn Python, one of the most widely used scripting languages in scientific computing. The course is primarily aimed at students with little or no programming background, but those with some programming experience in other languages wishing to learn Python are also welcome. The course covers basic programming concepts and data structures, and students will learn to write simple programs to improve their data processing productivity. We will also cover a number of open source scientific libraries available in Python (Biopython, SciPy, Matplotlib, etc.). Some basic familiarity with using a computer will be expected, and each student must have a laptop computer for use in class by the beginning of the term.

Credits: 3

Term: 3

Counts for 30 hr. requirement: Y

Director: Dr. Steven J. Ludtke

### **Current Topics in Computational Biomedicine (GS-SB- 407)**

This course introduces graduate students to the diversity of biological and clinical research problems that benefit from computational approaches. On alternating weeks the students will be exposed to speakers, or they will present a journal club. The speakers are drawn from across BCM, the TMC, Rice University and the greater Houston area and occasionally will include outside seminar speakers. During this one hour, a format of two short talks from two different speakers will discuss some of the most salient current problems studied in their laboratories, often with a significant emphasis on computational aspects. Style and content vary but, generally, the level is introductory and accessible to all members of the audience. Topics range from genomics to clinical text-mining and from bioengineering to public health, representing the rich diversity of computational biology research in the Gulf Coast area. The following week, the students will present two papers at journal club. One paper will be drawn from the immediate literature of the past 3 months, and the second paper will be drawn from any past time period, focusing on highly cited past influential papers across the field of computational biology. The papers will be selected by the participating Faculty, drawn from the SCBMB program, with input from the students if they so desire.

Credits: 1

Term: 1, 2, 3, 4

Counts for 30 hr. requirement: N

Director: Dr. Oliver Lichtarge and Dr. Richard Suckgang

### **Electron Cryomicroscopy for Molecules & Cells (GS-SB- 410)**

This course discusses in-depth theoretical and practical techniques in structural biophysics with a particular emphasis on electron imaging and crystallography. The topics include cryo-specimen preparative techniques, electron microscope optics, image contrast theory, specimen radiation damage, single particle image reconstruction, tomographic reconstruction, density based modeling, 3-D visualization, biological knowledge discovery from cryo-electron imaging.

Credits: 2

Term: 4

Counts for 30 hr. requirement: N

Director: Dr. Wah Chiu

### **Structural Basis of Human Disease (GS-SB- 423)**

This course is designed for medical and graduate students to understand the potential use of structural information for solving disease problems and to be aware of the different structural and computational tools. Each one hour lecture will be jointly led by two instructors who will present the medical problems and the structural approaches towards solving them. Attendance is required for passing this course.

Credits: 1

Term: 4

Counts for 30 hr. requirement: N

Director: Dr. B.V. Venkatar Prasad

**Advanced Topics in Structural & Computational Biology (GS-SB- 430)**

This course is designed for the SCBMB students to read current literature in structural and computation biology, to critically review the papers and to present the topic in front of an audience. This is run similar to a journal club. Under the supervision of the two faculty members, each student will pick a topic area, research the necessary papers and make a 50 minute lecture presentation.

Credits: 1

Term: 1, 2, 4

Counts for 30 hr. requirement: N

Director: Dr. Wah Chiu

**Special Projects (GS-SB- 435)**

Faculty mentored research for students that have not been admitted to candidacy. Students are expected to consult with the faculty on the research topic to investigate; take part in laboratory research, read relevant literature, interact with laboratory personnel, attend regular research laboratory meetings, and report the research results to the faculty mentor regularly and at the end of the term.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Wah Chiu

**Special Topics (GS-SB- 463)**

Scholarly study directed by a faculty member. Special topics allow a faculty member to develop individualized courses for students. Special topics cannot be used to satisfy the 30 hr course requirement.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Wah Chiu

**Readings (GS-SB-548)**

Faculty directed literature projects that survey a specialized topic of interest in computational biology and biophysics. The student will pick a topic of interest and do a literature research after consulting with the faculty; hold regular meetings to discuss with the faculty on the chosen topics, and write up a summary report at the end of the term to provide a critical review on the state of the art knowledge of the chosen topics of study.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Wah Chiu



**Research Rotation (GS-SB- 549)**

Faculty mentored research for students who have not yet selected a faculty advisor.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Wah Chiu

**Dissertation (GS-SB-550)**

Thesis research directed by a faculty mentor and advisory committee. Open only to candidates for the Ph.D. or M.S. degree

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Wah Chiu

# Translational Biology and Molecular Medicine

## **Epidemiologic Approaches to Cancer Survivorship Research (GS-TB-400)**

The purpose of this course is to better understand the specific problems of cancer survivors and the need for multi-institutional team science in cancer survivorship research. This course will specifically emphasize epidemiologic approaches for determining risk factors, developing risk prediction models, and strategies for modifying risk (and outcomes) along the cancer control continuum to end-of-life care.

Credits: 1

Term: 3

Counts for 30 hr. requirement: Y

Director: Dr. Philip Lupo

## **Animal Models of Human Disease (GS-TB-401)**

This course is designed to expose students to methodologies employed in generating animal models for human diseases and in analyzing these models. The major emphasis is on mouse models, but other model organisms will be discussed as well.

Credits: 2

Term: 5

Counts for 30 hr. requirement: Y

Director: Dr. Cindy Buckmaster

## **Pathophysiology & Mechanisms of Human Disease (GS-TB-402)**

This course will provide students with an understanding of the basic mechanisms of human disease with a systems biology perspective. Molecular defects at different levels including the gene, RNA, protein, cell, tissue, and organ will be covered. The focus is on helping students develop critical thinking skills that will help them approach complex scientific problems.

Credits: 2

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Daniel Lacorazza

**Introduction to Biostatistics for Translational Researchers (GS-TB-403)**

This course will introduce biostatistical principles and technology most likely to be useful to laboratory scientists interested in translational research. Topics include ANOVA, linear regression, contingency table analysis, logistic regression, survival analysis, and nonparametric statistics. The course also introduces basic experimental design principles and designs for clinical trials. The R software environment will be introduced and used for statistical analysis of real-life problem sets.

Credits: 3

Term: 4

Counts for 30 hr. requirement: Y

Director: Dr. Susan G. Hilsenbeck

**Translational Breast Cancer Research (GS-TB-405)**

This course provides an introduction into current issues in translational breast cancer research. The course encompasses a series of lectures on problems in clinical breast cancer diagnosis and treatment, breast development, and evolution of breast cancer, and approaches to translational breast cancer research. The purpose of the course is to provide a broad understanding of clinical issues and problems in breast cancer, familiarize students with breast cancer from the clinician's standpoint, and with research areas of active development in the field.

Credits: 2

Term: 2

Counts for 30 hr. requirement: Y

Director: Dr. Suzanne A. W. Fuqua

**Introduction to Leadership Skills (GS-TB-407)**

The objective of the course is to provide students with knowledge regarding the importance of leadership skills in their training and future career development. While leadership skills are essential components in career development, it is appreciated that leadership skills can't be taught and imparted upon students in a short didactic lecture-based setting. Therefore, the objective of this course is to introduce students to the basic concepts of leadership skills.

Credits: 1

Term: 3

Counts for 30 hr. requirement: N

Director: Dr. Suzanne A. W. Fuqua

**Ethics, Conduct and Practical Aspects of Clinical Research (GS-TB-408)**

This course is designed to provide students practical insight into the bioethical conduct, practical aspects, including types and categories of clinical trials and the different phases of translational research, as well as regulatory considerations of clinical and translational research. The course encompasses a series of interactive didactic lectures, homework assignments, and observation of an IRB meeting. The purpose of the course is to provide a broad understanding of bioethical issues within the context of clinical research, as well as an understanding of the complex relationship between investigators, their designees, and research subjects.

Credits: 2

Term: 5

Counts for 30 hr. requirement: Y

Director: Dr. Melissa Suter

**Method and Logic in Translational Biology (GS-TB-409)**

This course is intended to illustrate to first year graduate and medical students skills important for the translational biology researcher, through evaluation of two medical cases and translational research related to the cases. Reading material will provide information students need to progress with their evaluation of translational research pertaining to the medical case, as well as provide a context for training in how to read and interpret primary literature. Emphasis will be placed on discerning elegant experimental approaches, what constitutes a well-designed experiment with proper controls and considerations for moving discoveries from pre-clinical to clinical testing.

Credits: 2

Term: 3

Counts for 30 hr. requirement: Y

Director: Dr. Marta Fiorotto

**Fundamentals of Epidemiology (GS-TB-410)**

This course introduces the basic principles and methods of epidemiology, with an emphasis on critical thinking, analytic skills, and application to clinical practice and research. Topics include outcome measures, methods of adjustment, surveillance, quantitative study designs, and sources of data. The course is designed for professionals intending to engage in, collaborate in, or interpret the results of epidemiological research as a substantial component of their career.

Credits: 2

Term: 2

Counts for 30 hr. requirement: Y

Director: Dr. Michael Scheurer

**Introduction to Pharmacoepidemiology and Pharmacogenetics (GS-TB- 411)**

The purpose of this course is to outline strategies to avoid serious systemic toxicities from chemotherapy and radiotherapy. This course will review the principles of pharmacogenetics and pharmacogenomics, pharmacodynamics and pharmacokinetics, and will outline the impact of genetic polymorphisms in drug metabolism and other pathways on the toxicity of anticancer agents and other therapies. The emphasis is on research concepts and applications and the interdisciplinary nature of the field.

Credits: 1

Term: 3 (even years)

Counts for 30 hr. requirement: N

Director: Dr. Michael Scheurer and Dr. Melanie Bernhardt

**Special Projects (GS-TB- 435)**

Faculty mentored research for students that have not been admitted to candidacy.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Ignatia B. Van den Veyver

**Special Projects Clinical (GS-TB- 436)**

Clinical faculty mentored research for students that have not been admitted to candidacy.

Credits: 3

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Ignatia B. Van den Veyver

**Special Topics (GS-TB- 463)**

Scholarly study directed by a faculty member. Special topics allow a faculty member to develop individualized courses for students. Special topics cannot be used to satisfy the 30 hr. course requirement.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Ignatia B. Van den Veyver

**TBMM: Bench to Bedside (GS-TB-466)**

This course is designed to provide a forum for an in-depth discussion of translational research. Each term will cover one subject or a specific aspect of a larger topic to allow for a more detailed review of the biomedical literature. The emphasis is on student participation and the role of the faculty member(s) at any given session is to facilitate the discussion. Students are expected to have reviewed assigned article(s) prior to each session and come prepared with comments, criticisms, questions or points of discussion. The faculty member will typically provide a brief overview of the topic at hand to provide some perspective on the subject, but will not direct the discussion. An outside speaker of national prominence engaged in translational research relevant to the topic will give a school-wide talk and meet with the TBMM students.

Credits: 1

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. William J. Craigen

**Seminar (GS-TB-467)**

Students who have been admitted to candidacy (years 3 and above) will be required to present a seminar yearly on the topic of their ongoing thesis research project with emphasis on the translational aspects of their research project. The purpose of this course is to provide a forum for students to improve their knowledge and skills in planning, preparing and effectively presenting their scientific research to an inter-disciplinary audience.

Credits: 1

Term: 2, 3, 4

Counts for 30 hr. requirement: N

Director: Dr. Sundararajah Thevananther

**Reading (GS-TB-548)**

Faculty directed literature projects that survey a specialized topic of interest.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Ignatia B. Van den Veyver

**Research Rotation (GS-TB-549)**

Faculty mentored research for students who have not yet selected a faculty advisor.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Ignatia B. Van den Veyver

**Dissertation (GS-TB-550)**

Thesis research directed by a faculty mentor and advisory committee. Open only to candidates for the Ph.D. or M.S. degree.

Credits: Variable

Term: 1, 2, 3, 4, 5

Counts for 30 hr. requirement: N

Director: Dr. Ignatia B. Van den Veyver

# Tropical Medicine

## **Diploma in Tropical Medicine Module 1 (GS-TM- 400)**

This module is a component of the four-module Diploma in Tropical Medicine program. This module will provide learners with knowledge and critical basic understanding of epidemiology, biostatistics, ethics, health economics and policy and other public health topics as they relate to global health. By the end of the module, learners are expected to elaborate the outline of a project to comprehensively address a major global health problem.

Credits: 6

Term: 3

Counts for 30 hr requirement: N

Director: Dr. Peter Jay Hotez

## **Seminar in Tropical Medicine - Global Health Policy (GS-TM 466)**

This course consists of a series of weekly lectures on a topic in tropical medicine. Lectures will convey different themes in tropical medicine from one year to the next, with the theme reflected in the latter portion of the course title. For example, course may focus on the theme of global health policy. In so doing, it will expose students to a variety of global health issues, in which both background information and contemporary policy debate will be presented.

Credits: 1

Term: 2, 3, 4, 5

Counts for 30 hr requirement: N

Director: Dr. Peter Jay Hotez