

GSBS Course Descriptions

Interpreting Course Numbers: The first digit indicates if the course counts toward the 30-credit hour requirements for all PhD students. Courses starting with 5 are non-didactic and do not count toward the 30-credit requirement. Courses starting with 6 are didactic and do count toward the 30-credit requirement. The second digit indicates the number of credits in the course. (A zero denotes a course which has a variable number of credits depending on student scheduling needs.) The last two digits are an internal identifier of the course.

GSBS Central Curriculum (GS-GS)

GS-GS-5010

MSTP Reading 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

Director: Dr. Sharon Plon

GS-GS-5101

Responsible Conduct of Research –

Year 1 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.

Term: 1

Director: Dr. Carolyn Smith

GS-GS-5102

Responsible Conduct of Research –

Year 2 Sessions will involve students in discussion during three lectures, as well as in one small group session where case studies will be reviewed. Students will be mentored on research misconduct, focusing on topics such as falsification, fabrication, and plagiarism. College and federal policies and procedures for handling misconduct allegations will be reviewed. A session with 2nd year students and their mentors will review expectations between mentor and student. Students will receive training on the ethics of biomedical studies with animals, covering topics such as when can animals be used ethically in research, the importance of avoiding unnecessary pain/suffering and euthanasia and animal use approval. The final session, which will be held in a small group discussion format with faculty facilitators, will focus on case studies involving scientific misconduct and experiments with animals.

Term: 2

Director: Dr. Carolyn Smith

GS-GS-5103

Responsible Conduct of Research –

Year 3 Sessions will involve students in discussion during four lectures, as well as in one small group session where case studies will be reviewed. Topics

covered during this module include authorship and peer review conflicts of interest and their management, and collaboration within academia and with industry. The mentorship lecture will be a meeting with 3rd year students and their mentors. The final large group session will be focused on rigor and reproducibility using interactive case studies, reviewing principles introduced in year 1. Finally, the session conducted in a small group discussion format with faculty facilitator will utilize case studies to highlight issues relevant to the review of grants and papers, conflicts of interest, and collaboration.

Term: 3

Director: Dr. Carolyn Smith

GS-GS-5104

Responsible Conduct of Research –

Year 4 Sessions will involve students in discussion during three lectures, as well as in one small group session where case studies will be reviewed. Topics covered during the lecture on research with human subjects will include defining what constitutes research with human subjects versus experiments with human material, confidentiality of medical data, and informed consent. The mentorship session on will be a meeting with 4th year students and their mentors. The lecture on the scientist as a responsible member of society will address contemporary ethical issues in biomedical research and the environmental and societal impacts of scientific research. Finally, the session conducted in a small group discussion format with faculty facilitator will utilize case studies to highlight issues relevant to research with human subjects and societal impact of research, focused on genetics/genomics, stem cells and neuroethics.

Term: 3

Director: Dr. Carolyn Smith

GS-GS-5105

Scientific Writing This course will increase student knowledge and skills in 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.

Term: 3

Director: Dr. Susan Marriott

GS-GS-5106

Intellectual Property 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.

Term: 4

Director: Dr. Patrick Turley

GS-GS-5107

Leadership Skills This course provides 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.

Term: 3

Director: Dr. Suzanne Fuqua

GS-GS-5108

Pharmacoepidemiology & Pharmacogenetics 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.

Term: 3 (every other year)

Director: Dr. Michael Scheurer

GS-GS-5110

Clinical Translational Research

Seminars Students attend four Bench-to-Bedside seminars and four additional one-hour translational research seminars, conferences or meetings that are relevant to clinical translational research or are of general educational value for the conduct of clinical translational research. The student is expected to submit a brief summary of the attended seminar or conference to the course directors.

Term: 5

Director: Dr. Sundararajah Thevananther

Prerequisite: Admission to CTR-CAQ program

GS-GS-5111

Strategies for Success in Graduate

School This course prepares incoming students to become scientific and professional leaders by developing skills for a successful graduate career early in their training. The objectives are to understand the expectations of a professional lab environment; take ownership over your training and graduate career; identify your scientific and personal working style and

motivations, discuss how to evaluate potential mentors and thesis labs, learn how to successfully manage the mentor-mentee relationship, discuss scientific and personal support services at BCM, and develop networking skills.

Term: 1

Director: Dr. Melanie Samuel

GS-GS-5112

Powerful Presentations This course develops scientific communication skills to effectively convey your ideas to both experts and nonexperts. Effective presentation is the basis for career advancement at all levels in science. Topics we will cover include the fundamentals of effective talk design, how to construct potent slides, how deliver information effectively, and in class presentations.

Term: 2

Director: Dr. Melanie Samuel

GS-GS-5113

Effective Project Design & Management

This course develops skills in designing and executing your thesis research. The course will discuss the scope of a thesis and what it means to make an original scientific contribution. Students will also be exposed to and practice using effective tools and approaches for managing and developing their thesis projects. Topics covered will include: how to design your own project, the challenges and opportunities of hypothesis driven and hypothesis independent research, and how to turn projects into papers through project management and time management.

Term: 4

Director: Dr. Buck Samuel

GS-GS-5114

Clinical Translational Research

Experience 1 Students accompany their clinical translational research (CTR) mentor in the clinical environment where they will learn about the care for individuals with diseases relevant to their translational thesis research and gain knowledge on how clinical translational research, and in the general field of medicine, is conducted. Students will then work with their CTR mentor to develop a clinical translational capstone project.

Term: 1-2, 3-5

Director: Dr. Ignatia Van den Veyver

Prerequisite: Admission to CTR-CAQ program

GS-GS-5115

Clinical Translational Research

Experience 2 Students will work with their clinical translational research (CTR) mentor in the clinical research environment on their clinical translational capstone project, that they developed in CTRE1.

Term: 1-2, 3-5

Director: Dr. Ignatia Van den Veyver

Prerequisite: 2 credits of GS-GS-5201

GS-GS-6101

Neuroscience This is an introductory course covering fundamental aspects of modern neuroscience. The lecture series begins with a discussion of neural development, evolution 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 autonomic functions that keep us alive and higher brain functions such as learning and memory. The course will close on an examination of how neural dysfunction leads to common neurological disorders such as developmental pathophysiology, autism, and Alzheimer's disease.

Term: 3

Director: Dr. Russell Ray

GS-GS-6102

Principles of Immunology 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 & immunotherapies.

Term: 4

Director: Dr. Jonathan Levitt

GS-GS-6111

Practical Skills in Translational Research Workshops 1

The course workshops are designed to provide active learning opportunities for the students who will gain practical skills using "hands-on scenarios" guided by the components needed to translate bench-research to the bedside research. In addition, they will learn how to develop research programs that will address clinical questions related to human health and disease.

Term: 1-2, 3-5

Director: Dr. Susan Hilsenbeck

Prerequisite: Admission to CTR-CAQ program

GS-GS-6202

Gene Regulation This course covers the mechanisms of regulated gene expression with a focus on eukaryotes beginning at the gene and chromatin, processing of pre-RNA and mRNA through protein turnover.

Term: 3

Director: Dr. Thomas Cooper

GS-GS-6203

Data Mining Data mining provides practical approaches and tools that allow biomedical researchers to analyze and understand their data and to craft new hypotheses. The course focuses 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 focus on applications of these methods through a visual programming platform that requires no training in programming. We 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.

Term: 3

Director: Dr. Gad Shauly

GS-GS-6205

Fundamentals of Epidemiology 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.

Term: 3

Director: Dr. Michael Scheurer

GS-GS-6206

Orientation to Clinical Translational

Research This course teaches introductory insight into the bioethical conduct and practical aspects of clinical research, including types and categories of clinical trials, different phases of translational research, and regulatory considerations of clinical and translational research. The course consists of interactive didactic lectures and homework assignments for all enrolled students. The objective is to provide a broad understanding of practical, regulatory and bioethical issues of clinical translational research and of the complex relationship between investigators, their designees, and research subjects.

Term: 1

Director: Dr. Melissa Suter

GS-GS-6400

Foundations B: Biostatistics This course will introduce biostatistical principles and technology most likely to be useful to laboratory scientists interested in basic and 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.

Terms: 1+2

Director: Dr. Susan Hilsenbeck

GS-GS-6600

Foundations A: Molecules to Systems

This course provides students with foundational and comprehensive knowledge in several critical areas of biology. Lectures are divided into nine modules that cover essential aspects of biology. Lectures will begin with a description of macromolecules, and then incrementally expand into more complex mechanisms, and finally into the presentation of systems. The diversified format includes a series of lectures, discussion sessions, and TA sessions in which "active learning" techniques and "backwards design" are implemented to promote both knowledge and skill development for learners.

Terms: 1+2

Director: Dr. Richard Sifers

Cancer & Cell Biology (GS-CC)

GS-CC-5000

Special Topics 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

GS-CC-5010

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

Credits: Variable
Term: 1, 2, 3, 4, 5

GS-CC-5030

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

Credits: Variable
Term: 1, 2, 3, 4, 5

GS-CC-5040

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

Credits: Variable
Term: 1, 2, 3, 4, 5

GS-CC-5050

Dissertation 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

GS-CC-5100

Student Research Seminar 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 on the quality of their presentation and research.

Term: 1, 2, 3, 4
Director: Dr. Joel Neilson

GS-CC-5101

Reading & Evaluating Scientific Literature

This course assists students in developing an understanding of scientific research and foster skills in reading and evaluating the scientific and medical literature. Discussion include the philosophies of scientific inquiry, the scientific methods/approaches, the factors and aspects that contribute to exemplary scientific publications.

Term: 2
Director: Dr. Frederick Pereira

GS-CC-5301

NRSA Grant Writing & Project Development 1

In this course, students learn to discuss the basic principles of grant proposal organization with an emphasis on the formulation of specific aims, how to develop a NRSA grant proposal using outlining, and how to present an elevator pitch and chalk talk of the proposal, while enhancing their collaboration and oral and written communication skills.

Term: 1
Director: Dr. Frederick Pereira

GS-CC-5302

NRSA Grant Writing & Development 2

In this course, students learn to refine scientific writing skills used in developing a NRSA grant proposal, the basic principles of oral presentations; and to orally defend a grant proposal. Students will get practical experience in scientific writing of a grant proposal and oral defense of the proposal.

Term: 2
Director: Dr. Frederick Pereira

GS-CC-6101

Cancer 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.

Term: 3
Director: Dr. Stephanie Pangas

GS-CC-6102

Biology of Aging 1 This course will familiarize students with the biology of aging, including mechanisms, models, clinical aspects, and the development of novel treatments, and the concepts of gerontology and geroscience

Term: 2
Director: Dr. Andre Catic

GS-CC-6201

Translational Cancer Biology 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.

Term: 2
Director: Dr. Jason Yustein

GS-CC-6202

Explorative Data Analysis 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

Term: 3
Director: Dr. Rainer Lanz

GS-CC-6203

Integrated Microscopy The course is composed of a set of lectures that cover basic and advanced forms of light and electron microscopy, and an accompanying set of practical labs where students receive hands-on training on all the available instruments. The main topics addressed in the class are: basic optics, light- and fluorescence-based microscopy (i.e., brightfield, DIC, phase contrast, deconvolution, confocal, live cell imaging), fluorescence-based molecular tools (i.e., FRET, FRAP, fluorescent proteins), transmission electron microscopy, super-resolution microscopy (i.e., SIM, STORM), and specialized automated high throughput microscopy and image analysis.

Term: 3
Director: Dr. Michael Mancini

GS-CC-6204

Regulation of Energy Homeostasis

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 interdisciplinary, including metabolic, biochemical, genetic and cellular aspects.

Term: 4
Director: Dr. Robb Moses

GS-CC-6205

Translational Breast Cancer Research

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.

Term: 2
Director: Dr. Suzanne A. W. Fuqua

GS-CC-6206

Cell Death in Development and Disease

This course will discuss the most updated molecular mechanisms of different forms of cell deaths (apoptosis, necrosis, and autophagy) identified in invertebrate model organisms and in mammals, and the functions and regulation of cell death in human diseases. It will also cover the history, methods, and logic of cell death studies in model organisms.

Term: 3
Director: Dr. Zheng Zhou

GS-CC-6207

Ethics & Regulatory Preparation for Research with Animal Models

This course combines lecture-discussion co-learning as well as hands-on sessions to instruct trainees on the regulatory and oversight requirements, guidelines for developing and reporting results, and sampling and delivery procedures employed when performing research involving animal models.

Term: 1
Director: Dr. John Seavitt

GS-CC-6208

Cellular Signaling 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 β , Notch, Hedgehog, WNT, Hippo and nuclear receptors. In addition, signaling pathways regulated by small molecules including calcium, phospholipids, cAMP, cGMP, and AMP are discussed.

Term: 3
Director: Dr. Brian York

GS-CC-6209

The Clock-Cancer Connection This course will cover the fundamental principles of the mammalian circadian clock, the mechanism driving chronic circadian disruption, and the role of circadian homeostasis in cancer prevention and treatment. Lecture topics will cover the historical background of the connections between circadian disruption and cancer, the importance of this topic, recent progress and unsolved problems, and the future promise in prevention and treatment.

Term 4
Director: Dr. Loning Fu

GS-CC-6210

Tumor, Technology, Therapy "Limitless replicative potential" is the key cancer hallmark that is widely recognized including by non-scientists. Furthermore, de-regulated replicative controls often create genomic instability, which accelerates the

evolution within cancer cells to reach a more aggressive state. This course will focus on the use of molecular biology and new advances in bioinformatics to define the mechanisms driving these events, and how basic science findings have guided the development of life-saving drugs.

Term 3
Director: Dr. Eric Chang

GS-CC-6301

Biology of Aging 2 This course provides students and post-docs with the up-to-date information and current understanding of the aging process and age-related human disorders. The course covers molecular aspects of aging research, models and theories of aging, and clinical perspectives of aging processes. This advanced graduate elective course is offered for trainees who will specialize in or have a strong background in the interrelated areas of development, aging and age-related diseases. Students comment that participation in discussions of each topic is a highlight of the course.

Term: 4
Director: Dr. Frederick Pereira

GS-CC-6302

Molecular Carcinogenesis 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.

Term: 4
Director: Dr. Yi Li

GS-CC-6303

Reproductive Biology 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.

Term: 4
Director: Dr. Stephanie Pangas

GS-CC-6401

Technologies for Cancer Drug Discovery & Development The course covers a variety of disciplines and topics important to cancer drug discovery and development. The course starts by covering pharmacology and basic cancer biology, then will transition to introductions of assay design, lead compound identification, medicinal chemistry and pharmaceuticals. Finally, preclinical animal models and clinical assessments are presented.

Terms: 3+4
Director: Dr. Jason Yustein

Chemical, Physical, & Structural Biology (GS-CP)

GS-CP-5000

Special Topics 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

GS-CP-5010

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

Credits: Variable
Term: 1, 2, 3, 4, 5

GS-CP-5030

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

Credits: Variable
Term: 1, 2, 3, 4, 5

GS-CP-5040

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

Credits: Variable
Term: 1, 2, 3, 4, 5

GS-CP-5050

Dissertation 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

GS-CP-5100

Student Research Seminar The Graduate Student Seminar Series gives students the opportunity to present their research formally to an audience of their peers. Students in years 2 through 5 will give different presentations designed to prepare them for different kinds of scientific speaking.

Term: 1, 2, 3, 4
Director: Dr. B.V. Venkatar Prasad

GS-CP-5101

Thinking Like a Scientist 1 This is the first in a series of 4 courses that aim to help first year graduate students develop the critical thinking, speaking and writing skills that are necessary for their professional success in graduate school and beyond. In this term, students set short-term professional goals around courses and laboratory rotations and gain strategies to improve their skills in technical writing and critical evaluation of the literature.

Learning is achieved through group-based problem solving.
Term: 1

Director: Dr. Nicolas Young

GS-CP-6202

Thinking Like a Scientist 2 The goal of this term is to develop critical reading skills for evaluating the scientific literature. For a set of assigned papers, 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. Students will also develop reasonable future directions in the form of a new set of hypotheses that follow from the results of each paper. Each week one

student will present an assigned paper in the style of a journal-club. The other students will write a summary of the same paper, highlighting the logical flow of the paper.

Term: 2
Director: Dr. Timothy Palzkill
Prerequisite: GS-CP-5101

GS-CP-6203

Thinking Like a Scientist 3 The goal of this term is to build up on the analytical and presentation skills students develop 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 experimentally. Each student will write an abstract of a research proposal that will be discussed and revised in response from feedback from students and faculty.

Term: 3
Director: Dr. Ming Zhou
Prerequisite: GS-CP-6202

GS-CP-6204

Thinking Like a Scientist 4 The goal of this term is to build upon the activities of Term 3 that culminated in writing a proposal abstract based on a published paper. Students will do additional literature-based research to add both depth and breadth to each component of the abstract using the concept of the framing funnel, and develop one new specific aim building off of published results. By the end of the course, each student will have written a full research proposal, whose specific aims, outline and early

drafts will be presented to the class in written and oral form. They will receive feedback from students and faculty in the process of finalizing the proposal. Each student will also present a final presentation on the full proposal in a format similar to that of the qualifying examination.

Term: 4

Director: Dr. Zheng Zhou

Prerequisite: GS-CP-6203

GS-CP-6205

Chemical Biology 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.

Term: 5

Director: Dr. Jin Wang

GS-CP-6206

Drug Discovery: From Bench to Bedside

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.

Term: 5

Director: Dr. Yongcheng Song

GS-CP-6207

Electron Cryomicroscopy 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.

Term: 4 (every other year)

Director: Dr. Zhao Wang

GS-CP-6301

Advanced X-ray Crystallography X-ray crystallography is a powerful technique to determine atomic resolution structures from small, inorganic molecules to large, multi-subunit macromolecular assemblies. 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.

Term: 4 (every other year)

Director: Dr. Francis T.F. Tsai

GS-CP-6302

Chemical Concepts in Chemical Biology

Chemical biology is a relatively modern and highly interdisciplinary paradigm that centers on using small molecules to probe fundamental and disease-associated biological processes. This course will provide students with a firm foundation in synthetic, medicinal, biological, physical and analytical chemistry concepts for conducting chemical biology research. Upon successful completion of CCCB, the student will have an advanced knowledge of the chemical underpinnings of chemical biology research.

Term: 3

Director: Dr. Damian Young

GS-CP-6303

Macromolecules: Structure & Interactions

This course will provide fundamental information on macromolecular structures, techniques used in structure determination, principles of thermodynamics and kinetics, and how this information can be leveraged to design/develop lead compounds to modulate disease targets for clinical relevance with the help of novel cell-based screening techniques.

Term: 3

Director: Dr. B.V. Venkatar Prasad

GS-CP-6304

Molecular Biophysics 1 This is the first course in a two-term sequence. It presents in lecture format a survey of the major techniques of molecular biophysics, and the underlying physical principles and mathematics on which they are based.

Term: 1

Director: Dr. Theodore Wensel

GS-CP-6305

Molecular Biophysics 2 This is the second course in a two-term sequence. It presents in lecture format a survey of the major techniques of molecular biophysics, and the underlying physical principles and mathematics on which they are based.

Term: 2

Director: Dr. Theodore Wensel

Prerequisite: GS-GS-6401

GS-CP-6401

General Pharmacology 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.

Term: 4

Director: Dr. Pui-Kwong Chan

Clinical Scientist Training Program (GS-CT)

GS-CT-5010

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

Credits: Variable

Term: 1, 2, 3, 4, 5

GS-CT-5040

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

Credits: Variable

Term: 1, 2, 3, 4, 5

GS-CT-5050

Dissertation 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

GS-CT-5101

Responsible Conduct of Research for Clinical Investigators 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. 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.

Term: 1

Director: Dr. Maria Gramatges

GS-CT-6201

CICS 1: Grant Development for Clinical Investigators 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.

Terms: 1

Director: Dr. Ashok Balasubramanyam

GS-CT-6205

CICS 5: Evaluating a Completed Career Development Grant This course provides students with an appreciation of the NIH study

section review process and a completed career development award.

Terms: 5

Director: Dr. Frederick Pereira

Prerequisites: GS-CT-6201 and GS-CT-6304

GS-CT-6300

Fundamentals of Clinical Investigation

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 three modules reflecting specific areas relevant to a clinical researcher. These modules are: principles of clinical research; statistical methods in clinical research; special topics.

Term: 1

Director: Dr. Farrah Kheradmand

GS-CT-6302

CICS 2: Clinical Trials for Clinical Investigators

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.

Terms: 2

Director: Dr. Farrah Kheradmand

Prerequisites: GS-CT-6201 and GS-CT-6300

GS-CT-6303

CICS 3: Translational Research for Clinical Investigators

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.

Terms: 3

Director: Dr. Jesus Vallejo

Prerequisites: GS-CT-6201 and GS-CT-6302

GS-CT-6304

CICS 4: Health Services Research for Clinical Investigators

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.

Terms: 4

Director: Dr. Frederick Pereira

Prerequisites: GS-CT-6201 and GS-CT-6303

Development, Disease Models, & Therapeutics (GS-DD)

GS-DD-5000

Special Topics 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

GS-DD-5010

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

Credits: Variable

Term: 1, 2, 3, 4, 5

GS-DD-5030

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

Credits: Variable

Term: 1, 2, 3, 4, 5

GS-DD-5040

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

Credits: Variable

Term: 1, 2, 3, 4, 5

GS-DD-5050

Dissertation 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

GS-DD-5100

Student Research Seminar Students who have been admitted to candidacy will 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

Director: Dr. Sundararajah Thevananther

GS-DD-5101

Effectively Writing & Reviewing Proposals

This course will explain the requirements and expectations of the qualifying exam. The course is geared specially 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 or other fellowship applications from those students who qualify.

Term: 2

Director: Dr. Melanie Samuel

GS-DD-5110

DDMT Journal Club This course is required of all first and second year students enrolled in the Development, Disease Models & Therapeutics 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.

Terms: 3,4,5

Director: Dr. Daniel Gorelick

GS-DD-6201

Development The Development of a mature organism from a single cell is one of the most fascinating problems in biology. Understanding development can shed light on fundamental processes such as gene regulation and control of the cell cycle, and on translational problems such as the origins and progression of cancer and the possibility of tissue engineering and regeneration to treat human disease. This course is designed as an introduction to some of the concepts of modern developmental biology.

Term: 2

Director: Dr. Andrew Groves

GS-DD-6203

Animal Models of Human Disease 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.

Term: 5

Director: Dr. Christopher Ward

GS-DD-6205

Transmembrane Signaling 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.

Term: 4

Director: Dr. Christine Beeton

GS-DD-6206

Pathophysiology and Mechanisms of Human Disease

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.

Term: 4

Director: Dr. Daniel Lacorazza

GS-DD-6207

Advanced Topics in Muscle Physiology

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.

Term: 3

Director: Dr. George Rodney

GS-DD-6208

Evolutionary Conservation of Developmental Mechanisms

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.

Term: 3

Director: Dr. Andrew Groves

GS-DD-6209

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

Term: 3

Director: Dr. Robia Pautler

GS-DD-6210

Cardiovascular Diseases This course provides a general overview of the main common cardiovascular diseases and their causes. Topics covered include atherosclerosis, hypertension, congenital heart disease, ischemic heart disease, cerebral stroke, cardiac arrhythmias, and the effects of aging on the cardiovascular system. The course will be taught by a combination of clinicians, basic scientists, and physician scientists throughout the Texas Medical Center.

Term: 3

Director: Dr. Xander Wehrens

GS-DD-6211

Model Systems in Developmental Biology & Disease This course introduces the classical experimental methods and animal models used to address fundamental questions in developmental biology. Examples are provided which highlight specifically how developmental principles have been tested by choosing the best suited model system. These examples will allow the students to grasp how these earlier investigations directly inform their own future inquiry into the cellular and molecular mechanisms of development and disease.

Term: 1

Director: Dr. Ross Poché

GS-DD-6212

Topics in Cell Physiology 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.

Term: 1

Director: Dr. Ross Poché

GS-DD-6301

Human Physiology 1 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.

Term: 2

Director: Dr. Frank T. Horrigan

GS-DD-6302

Human Physiology 2 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.

Term: 3

Director: Dr. Frank T. Horrigan

GS-DD-6303

Neural Development 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.

Term: 4

Director: Dr. Benjamin Arenkiel

GS-DD-6403

Advanced Topics in Cardiac Pathophysiology & Disease 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.

Term: 4

Director: Dr. Xander Wehrens

GS-DD-6404

Advanced Topics in Vascular Pathophysiology & Disease This course explores cause and mechanism of cardiovascular disease. Specific topics include mechanistic discussion of atherosclerosis (lipids and lipoproteins, inflammation, oxidatively modified LDL), hypertension (epidemiology, mechanisms, and consequences), hemostasis (thrombosis and bleeding disorders), cerebral stroke, heart failure (systolic and diastolic dysfunction), cardiac arrhythmias, myocardial ischemia (healing and remodeling, cardiac fibrosis, myocarditis), laterality in heart disease and aging in the cardiovascular system. .

Term: 5

Director: Dr. Xander Wehrens

Genetics & Genomics (GS-GG)

GS-GG-5000

Special Topics 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

GS-GG-5010

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

Credits: Variable

Term: 1, 2, 3, 4, 5

GS-GG-5030

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

Credits: Variable

Term: 1, 2, 3, 4, 5

GS-GG-5040

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

Credits: Variable

Term: 1, 2, 3, 4, 5

GS-GG-5050

Dissertation 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

GS-GG-5100

Student Research Seminar Student Seminar.

Term: 1, 2, 3, 4

Director: Dr. Christophe Herman and Dr. Herman Dierick

GS-GG-5101

Clinical Genetics 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.

Term: 1

Director: Dr. Daryl Scott

GS-GG-5105

Genetics & Genomics Journal Club This course is required of all first and second year students enrolled in the graduate programs in Genetics & Genomics. 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.

Term: 3, 4, 5

Director: Dr. Hamed Jafar-Nejad

GS-GG-6102

Genetic Epidemiology and Population Genetics

This introductory level course in genetic epidemiology focuses on the design of studies to identify disease-gene associations. The lectures concentrate on the two most common study designs for genetic association studies: case-control studies and case-parent trios, and address disease-gene associations, gene-environment interactions, and maternal genetic effects. Students will learn about study design and data analysis through class lectures, independent readings, completion of problem sets and class discussions.

Term: 4

Director: Dr. Philip Lupo

GS-GG-6103

Genetics and Genomics in Vision Research

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.

Terms: 4 (even year course)

Director: Dr. Graeme Mardon

GS-GG-6201

Model Systems Genetics

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.

Term: 2

Director: Dr. Christophe Herman

GS-GG-6202

Mammalian Genetics

This course describes the contribution of mammalian molecular genetics techniques to understanding the function of genes and the impact of genetic and epigenetic factors on human disease. The first half of the course focuses on historical aspects and advanced technologies used in mouse genetics. The second half of the course explores topics such as the human genome project, primate genetics, epigenetics, comparative sequence analysis and RNAi-based screens in the mammalian systems.

Term: 3

Director: Dr. Hamed Jafar-Nejad

GS-GG-6203

Gene and Cell Therapy

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.

Term: 4

Director: Dr. Philip Ng

GS-GG-6204

Method and Logic in Genetics & Genomics

This course is intended to train first year graduate students how to read and interpret the primary literature. In particular, we will teach students to discern what conclusions can be drawn from experimental data without over-interpretation. Students will learn what constitutes a well-designed experiment with proper controls. In addition, students will learn the fundamental experimental principles that pervade biological science, such as complementation, assigning function and specificity.

Term: 3

Director: Dr. Graeme Mardon

GS-GG-6205

Single Cell Methods & Analysis Single cell omics methodologies are intended to understand whole genome scale variations in individual cells.

This course focuses on the methods, the analysis and interpretation of these types of data as well as the strengths and limits of single cell approaches.

Term: 4

Director: Dr. Chuck Zong

GS-GG-6301

Bioinformatics and Genomic Analysis

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.

Term: 4

Director: Dr. Kim Worley

GS-GG-6302

Human Genetics

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.

Term: 4

Director: Dr. Daryl Scott

GS-GG-6304

Career Development in Medical Genetics

Diagnosis of genetic diseases is important for students to understand how to apply their scientific knowledge into the practice of medicine. By focusing on case studies of various types of human disease, this course focus on teaching students how to transfer the fundamental genetic knowledge and principles into the practices of human disease diagnosis.

Term: 4

Director: Dr. Chuck Zong

Immunology & Microbiology (GS-IY)

GS-IY-5000

Special Topics 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

GS-IY-5010

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

Credits: Variable

Term: 1, 2, 3, 4, 5

GS-IY-5030

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

Credits: Variable

Term: 1, 2, 3, 4, 5

GS-IY-5040

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

Credits: Variable

Term: 1, 2, 3, 4, 5

GS-IY-5050

Dissertation 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

GS-IY-5100

Student Research Seminar Graduate students will attend and present in a weekly research seminar series with presentations by Immunology & Microbiology Graduate students to discuss new developments and findings in their thesis research and develop networks. Students having passed their Qualification Exam will present their laboratory research once per year. Student evaluators will

provide student presenters with constructive feedback on their presentations.

Term: 2, 3, 4

Director: Dr. Jason Kimata

GS-IY-5105

Seminars in Immunology & Microbiology Research

Graduate students will attend the combined seminar series supported by Immunology/ Immunobiology/Molecular Virology and Microbiology. Presentations will be primarily scientists from other institutions along with BCM faculty and postdocs. Seminar topics or speaker suggested readings will be coordinated with the Literature Review in Immunology & Microbiology and Student Research in Immunology & Microbiology Seminar courses.

Term: 1, 2, 3, 4

Director: Dr. Jason Kimata

GS-IY-5110

Literature Review in Immunology & Microbiology

Immunology and Microbiology (I&M) graduate students will critically evaluate and present current research articles in areas of immunology, vaccine and immune therapy, microbiology, virology, parasitology and microbiome research. First and second year graduate students will give oral presentations (generally twice a year) of research articles to an audience comprised of fellow graduate students, postdocs, faculty and other scientists. Students will be paired with I&M faculty that will assist in choosing a journal article often related to the Seminars in Immunology and Microbiology faculty presentation(s) of the week that directly follows this course. Presenting students will be evaluated and receive feedback from fellow attendees, including students and faculty.

Term: 1, 2, 3, 4

Director: Dr. Anthony Maresso

GS-IY-6201

Cells, Tissues and Organs

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.

Term: 4

Director: Dr. David Rowley

GS-IY-6202

The Microbiome

This course will facilitate deeper understanding a host-associated community of microbes, termed the 'microbiome'. Through examination of a series of landmark and cutting edge papers, students will learn what constitutes a microbiome both in form and functions it provides to the host, plus the many molecular ways that it can influence health and progression of a wide range of diseases. Students will also learn about the key methodologies used to characterize and quantitatively analyze the microbiome in an

associated lab. Together, this class is intended to provide a robust foundation of knowledge and methodological know-how to be able to integrate microbiome studies into any research program.

Term: 3

Director: Dr. Buck Samuel

GS-IY-6203

Mechanism of Autoimmunity & Inflammation

In this course, students learn in depth about the immune mechanisms driving autoimmunity and inflammation, systemically, and in different organs. The course will be combination of lectures and discussions of the scientific literature.

Term: 1

Director: Dr. Christine Beeton

GS-IY-6301

Immunology This is a series of lectures stressing basic concepts in immunology. These include immunology 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 infectious organisms and tumors, autoimmunity, allergies and immunodeficiency. The course includes weekly reviews led by senior graduate students that help to explore and clarify concepts.

Term: 3

Director: Dr. Jonathan Levitt

GS-IY-6302

Grand Challenges and Methods in Immunology & Microbiology

This course will utilize primary literature to provide students an understanding of how important challenges in Immunology & Microbiology are addressed with a particular focus on rationale, thoughtful experimental design and rigorous methodologies are leveraged to answer the biggest questions in Immunology and Microbiology. The session topics will be organized around Grand Challenges in the fields of Immunology & Microbiology, such as Vaccines, Antimicrobial Resistance, Autoimmunity, HIV, Cancer Immunotherapy, and the like.

Term: 3

Director: Dr. Joseph Hyser

GS-IY-6303

Fundamentals of Effective Grant Writing

An ability to conceive significant and innovative research questions and to communicate them clearly is essential to achieve grant funding. This course is designed to introduce 1st or 2nd year graduate students to the fundamentals of successful grant writing including grant organization, strategy, and the review process using NIH as the model funding agency. Students will learn to strategically design at least two specific aims and to expand one of those aims into a fully developed research strategy section. During the course, students will present their aims and rationale several times with written and oral

feedback from peers and faculty. The course will culminate in an oral presentation with questioning by a select group of upper level graduate students, postdocs, and faculty. All students in the course will observe these oral presentations. This course is intended to develop skills in critical thinking, written presentation of complex scientific information, and oral presentation, as well as preparing students for their qualifying exam, and encouraging independent NRSA or other fellowship applications..

Term: 4

Director: Dr. Susan Marriot

GS-IY-6304

Clinical Aspects of Immunology

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%).

Term: 5

Director: Dr. Jonathan Levitt

GS-IY-6401

Concepts in Host Immune System-Microbiome Interactions

This course facilitates an integrated understanding of host immune system-microbe interactions, including how they are established, maintained in health, and altered in disease states. Students will develop a conceptual understanding of the primary components and functions that drive these interactions from both a host and microbial perspective and will apply this understanding to real-world problems using student-centered and team-based learning approaches..

Terms: 1+2

Director: Dr. Margaret Conner

GS-IY-6402

Concepts in Microbial Pathogenesis

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.

Term: 4

Director: Dr. Margaret Conner

Neuroscience (GS-NE)

GS-NE-5000

Special Topics 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

GS-NE-5010

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

Credits: Variable
Term: 1, 2, 3, 4, 5

GS-NE-5030

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

Credits: Variable
Term: 1, 2, 3, 4, 5

GS-NE-5040

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

Credits: Variable
Term: 1, 2, 3, 4, 5

GS-NE-5050

Dissertation 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

GS-NE-5100

Seminar Journal Club in Neuroscience

This course is required of all first and second year students enrolled in the Neuroscience Graduate Program. The course is conducted as a journal club to study the scientific literature, to practice critical analysis of the literature, and to develop and refine presentation skills. This course is coordinated with the Department of Neuroscience seminar series such that second-year students present papers from the laboratory of the upcoming seminar speaker. All students join in discussion of the paper and evaluation of the journal club presentation.

Terms: 2, 3, 4
Director: Dr. Javier Medina

GS-NE-5101

Preparing for Your Neuroscience Qualifying Exam

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.

Term: 2
Director: Dr. Joanna Jankowsky

GS-NE-5111

Neuroscience Lab 1 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 computational 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.

Term 1
Director: Dr. Paul Pfaffinger

GS-NE-5201

Advanced Functional MRI Laboratory

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).

Term: 4
Director: Meghan Robinson
Prerequisites: GS-NE-6400 and permission from Course Director

GS-NE-6101

Core Concepts in Computational Neuroscience

How do brains compute? This course covers the basic concepts underlying neuronal computation, from individual neurons up to networks of neurons in circuits. The focus will be on achieving a computational level understanding: how populations of neurons compute tasks critical for the organism's survival from sensory input. Students will also be exposed to key ideas from the field of Deep Machine Learning wherein artificial neural networks are employed to solve difficult real-world tasks.

Term: 4
Director: Dr. Ankit Patel
Prerequisites: GS-NE-6301. (GS-NE-6302 can be taken concurrently)

GS-NE-6112

Neuroscience Lab 2 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 pharmaco- and opto-genetics, model systems behavioral assays, fMRI, and computational modeling among others. One hour lecture and 3 hour laboratory demonstration per week.

Term: 2
Director: Dr. Russell Ray

GS-NE-6201

Analyses of Neuronal Function This course will cover the basic concepts of synaptic biology. The topics include the organization of the synapses, neurotransmitter release, neurotransmitter receptors,

synaptic plasticity in learning and memory, synaptic organization of microcircuits, and synaptic dysfunction in diseases. Students will learn synaptic biochemistry, cell biology, and physiology and how to study synapses.

Term: 2
Director: Dr. Mingshan Xue

GS-NE-6202

Anatomy of the Nervous System The course will cover the basic concepts in neuroanatomy in a combined lecture, demonstration, and hands-on lab format. The emphasis will be on the structural organization of the nervous system. A large part of the course will consist of lectures that cover a structure or region of the brain augmented by simultaneous hands-on dissection of fixed sheep brain tissue, histological photographs, and representative MRIs. The students will be divided into small teams and will dissect a sheep brain along with the instructor. It is expected that the teams will interact with the instructors as the lecture/demonstration progresses. Additional lectures and demonstrations will be used to compare and contrast mammalian brains with other species' brains commonly used in neuroscience research.

Term: 2
Director: Dr. Brett Foster

GS-NE-6203

Genetics for Neuroscience 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.

Term: 3
Director: Dr. Ronald Parchem

GS-NE-6204

Neurobiology of Disease 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. This is an advanced course assuming basic knowledge of neuroscience. Completion of an introductory course is required. Students outside the Neuroscience Graduate Program must receive permission from course director to register, as registration is limited to 20 students.

Term: 4
Director: Dr. Jeffrey Noebels

GS-NE-6301

Neural Systems 1 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 2 which will cover how sensory inputs are transformed into motor actions by the brain. Following completion of this course students will understand the locations, functional organization, and functional significance of the main sensory processing streams in the central nervous system.
Term: 3
Director: Dr. Jeffrey Yau

GS-NE-6302

Neural Systems 2 Neural Systems 2 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.
Term: 4
Director: Dr. Roy Sillitoe
Prerequisites: GS-NE-6301

GS-NE-6303

Electrical Signaling in the Brain This course covers the basics concepts of electrical signaling from the chemical and physical principles involved, to the biological components involved in generating, modulating and transmitting electrical signals in the brain. Students will learn about the foundations of electrical signaling, how ion channel function and regulation actively regulate membrane potential, how to analyze membrane potential using circuitry methods, and how to understand how electrical signals propagate across long distances.

Finally this course will explore some of the new methods to measure and manipulate electrical signaling in awake behaving animals.
Term: 1
Director: Dr. Paul Pfaffinger

GS-NE-6304

Brain Cell Biology & Development This course covers the basic molecular and cellular organization of the Nervous system. The first 2/3 of the course provides an overview and focal lectures on topics of particular importance to understanding molecular and cellular organization of neurons. The last third of the course covers aspects of neural development that integrates principles learned in the first 2/3 of the course.
Term: 1
Director: Dr. Matthew Rasband

GS-NE-6305

Concepts of Learning & Memory 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 diseases of learning and memory.
Term: 4
Director: Dr. Mauro Costa-Mattioli

GS-NE-6306

Cellular Neurophysiology 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.
Term: 4
Director: Dr. Samuel Wu

GS-NE-6307

Physiology of the Visual System 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.
Terms: 4
Director: Dr. Samuel Wu

GS-NE-6401

Fundamentals of Human Neuroimaging 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.
Terms: 1-2
Director: Dr. David Ress

Quantitative and Computational Biosciences (GS-QC)

GS-QC-5000

Special Topics 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

GS-QC-5010

Readings Faculty directed literature projects that survey a specialized topic of interest.
Credits: Variable
Term: 1, 2, 3, 4, 5

GS-QC-5030

Research Rotation Faculty mentored research

for students who have not yet selected a faculty advisor.
Credits: Variable
Term: 1, 2, 3, 4, 5

GS-QC-5040

Special Projects Faculty mentored research for students that have selected their thesis advisor but not been admitted to candidacy.
Credits: Variable
Term: 1, 2, 3, 4, 5

GS-QC-5050

Dissertation 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

GS-QC-5100

Student Research Seminar QCB graduate students will attend the course weekly where upper level student who have passed their qualifying exam will present their research. These research presentations will be presented to an audience of 1st year students and a faculty member to help develop their oral communication and research presentation skills. Following each student's presentation, constructive advice from faculty and students will be provided in a survey about improving oral and presentation skills and about producing effective presentation materials.
Term: 4
Director: Dr. Aleksandar Milosavljevic

GS-QC-5105

Seminar in Quantitative Biosciences 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. .

Term: 1, 2, 3, 4

Director: Dr. Oliver Lichtarge and Dr. Richard Suggang

GS-QC-5110

Advanced Topics in QCB QCB 1st year graduate students will attend the course weekly where QCB faculty will present their research. Each presentation will be 15 minutes, plus 5 minutes for discussion, and cover an advanced topic on recent development from the faculty's lab. Following each presentation, the students will discuss with the faculty any potential rotation projects in the lab. The course is aimed to supply the students with the topics for their rotations and research projects.

Term: 1, 2

Director: Dr. Aleksandar Milosavljevic

GS-QC-5301

QCB Research Design 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).

Term: 4

Director: Dr. BVVenkatar Prasad, Dr. Nicolas Young

GS-QC-6201**Applications to Biology of Computation**

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.

Term: 3

Director: Dr. Olivier Lichtarge

GS-QC-6301**Practical Introduction to Programming for Scientists**

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.

Term: 1

Director: Dr. Steven J. Ludtke

GS-QC-6302

Computer-Aided Discovery Methods 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.

Term: 4

Director: Dr. Aleksandar Milosavljevic

GS-QC-6401**Quantitative & Computational Methods for Biosciences 1**

This is the first in a two-course series that 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

Terms: 2

Director: Dr. Zhandong Liu

GS-QC-6402**Quantitative & Computational Methods for Biosciences 2**

This is the second in a two-course series that 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

Terms: 3

Director: Dr. Zhandong Liu

Legacy Program Courses

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. Jason Karch