CANCER AND CELL BIOLOGY GRADUATE PROGRAM

Number of students in Program: 56
Number of faculty in Program: 130

Program Director:

David L. Nelson, Ph.D.
Professor
Molecular & Human Genetics

Program Executive Committee Members:

Andre Catic, M.D., Ph.D.
Assistant Professor
Huffington Center on Aging

Eric Chang, Ph.D.
Associate Professor
Lester & Sue Smith Breast Center

Suzanne Fuqua, Ph.D.
Professor
Lester & Sue Smith Breast Center

Daniel Lacorazza, Ph.D.
Associate Professor
Pathology

Weei-Chin Lin, M.D., Ph.D.
Professor
Medicine - Hematology & Oncology

Sean Hartig, Ph.D.
Assistant Professor
Medicine - Endocrinology

Susan Marriott, Ph.D.
Professor
Molecular Virology & Microbiology

Joel Neilson, Ph.D.
Assistant Professor
Molecular Physiology & Biophysics

Stephanie Pangas, Ph.D.
Associate Professor
Pathology

Fred A. Pereira, Ph.D.
Associate Professor
Huffington Center on Aging

JoAnne Richards, Ph.D.
Professor
Molecular & Cellular Biology

David Rowley, Ph.D.
Professor
Molecular & Cellular Biology

Fabio Stossi, Ph.D.
Assistant Professor
Molecular & Cellular Biology

Kimberley Tolias, Ph.D.
Associate Professor
Neuroscience

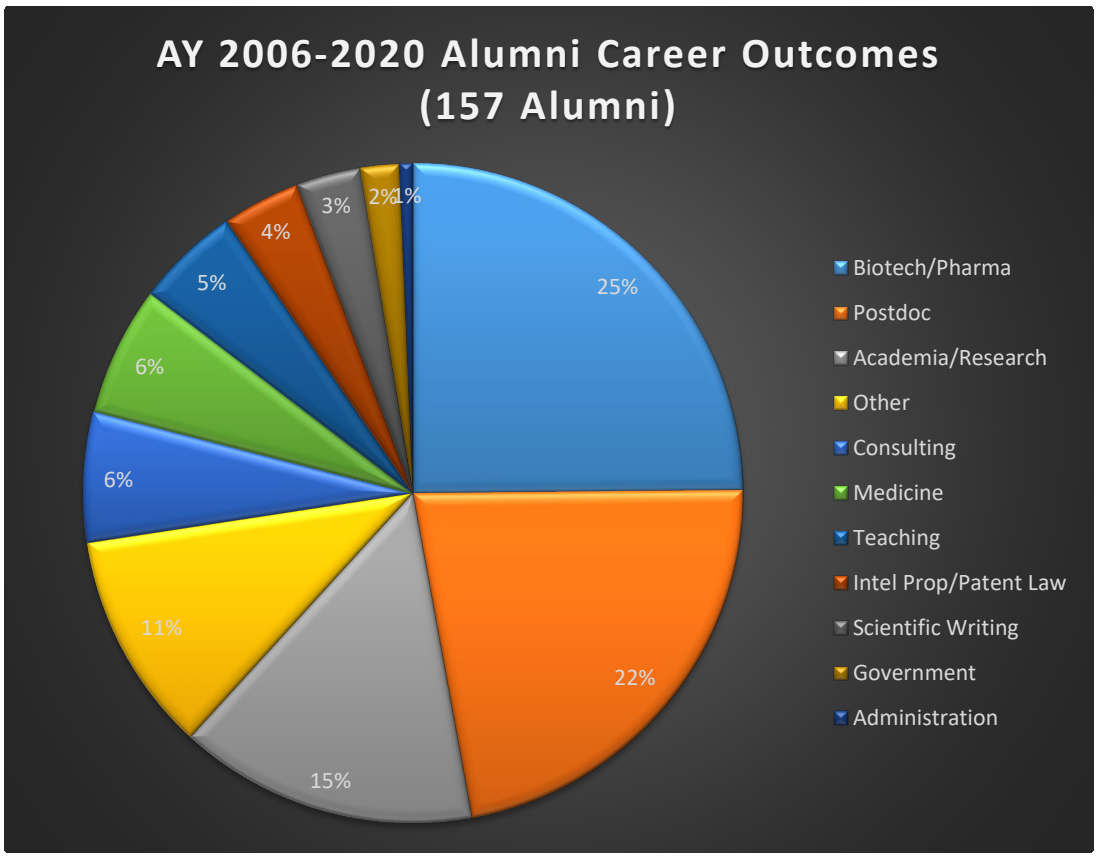
Jason Yustein, M.D., Ph.D.
Associate Professor
Pediatrics - Oncology

Zheng Zhou, Ph.D.
Professor
Biochemistry & Molecular Biology

Chenghang Zong, Ph.D.
Assistant Professor
Molecular & Human Genetics

JOB PLACEMENT/ADVANCED TRAINING

From the beginning, we encourage students to think deeply about their career choices. Wherever your ambition leads, you will receive the support you need to follow a path well worn by Program alumni who have built successful careers across diverse endeavors.



STIPEND, TUITION, FEES, HEALTH INSURANCE COVERAGE

Stipend: Academic Year 2022-2023 - $35,500 (Supported by CCB and GSBS in Y1 and by faculty mentor Y2 to graduation)

Tuition: Tuition is fully covered as a scholarship

Student Fees: Fees are paid by the student and subject to change.
The 2021-22 academic year student fees are as follows:
Year 1: $25 matriculation fee, $38 student services fee, and $150 Academic Success Center fee
Years 2 to graduation (per year): $20 Academic Success Center fee, $38 student services fee
Year 4: $204 graduation fee
Additional Fees: International students are assessed an annual Visa Fee each fall. F-1 Visa: $75. J-1 Visa: $100.

For more information visit https://www.bcm.edu/education/graduate-school-of-biomedical-sciences/admissions/stipends-benefits/fees-and-expenses .

Student Health Insurance
The CCB Graduate Program pays the cost of student-only health insurance coverage. Graduate students are responsible for the cost of their eligible family members' coverage. For more information on student health insurance, visit the Student Benefits webpage at https://www.bcm.edu/careers/benefits/student-benefits.

Years 2 to graduation: The faculty mentor pays the cost of student-only health insurance coverage. Graduate students are responsible for the cost of their eligible family members' coverage. For more information on student health insurance, visit the Student Benefits webpage at https://www.bcm.edu/careers/benefits/student-benefits.

Graduate Degree Plan
PhD in Cancer & Cell Biology

Students Starting Academic Year: 2021-2022

General Degree Requirements:

- Completion of at least 180 term hours
- At least 30 of those term hours must be in Didactic courses
- Completion of at least three terms of Research Rotation before appointing a major advisor
- Students must maintain satisfactory academic progress as detailed in the Student Handbook

Year One Requirements:

Term 1:	GS-GS-6600	Foundations A: Molecules to Systems	3 (Didactic) *(two-term course)*	
	GS-GS-6400	Foundations B: Biostatistics	2 (Didactic) *(two-term course)*	
	GS-GS-5111	Strategies for Success in Graduate School	1	
	GS-GS-5101	Responsible Conduct of Research 1	1	
	GS-CC-5100	Student Research Seminar	1	
	GS-CC-5030	Research Rotation ± Electives	4	Total to Date
		Total:	12 (5)	12 (5)
Term 2:	GS-GS-6600	Foundations A: Molecules to Systems	3 (Didactic) *(two-term course)*	
	GS-GS-6400	Foundations B: Biostatistics	2 (Didactic) *(two-term course)*	
	GS-CC-5101	Reading & Evaluating Scientific Literature	1	
	GS-CC-5100	Student Research Seminar	1	
	GS-CC-5030	Research Rotation ± Electives	5	Total to Date
		Total:	12 (5)	24 (10)
Term 3:	GS-GS-6202	Gene Regulation	2 (Didactic)	
	GS-CC-6208	Cellular Signaling	2 (Didactic)	
	GS-GS-5105	Scientific Writing	1	
	GS-CC-5100	Student Research Seminar	1	
	GS-CC-5030	Research Rotation ± Electives	6	Total to Date
		Total:	12 (4)	36 (14)
Term 4:	GS-CC-5301	NRSA Grant Writing & Project Development 1	3	
	GS-CC-6302	Molecular Carcinogenesis	3 (Didactic)	
	GS-CC-5100	Student Research Seminar	1	
	GS-CC	Research Hours ± Electives	5	Total to Date
		Total	12 (3)	48 (17)
Term 5:	GS-CC	Research Hours ± Electives	12	Total to Date:
		Total:	12	60 (17)

Year Two Requirements:

Term 1:	GS-CC-5302	NRSA Grant Writing & Project Development 2	3	
	GS-GS-5113	Effective Project Design & Management	1	
	GS-CC-5100	Student Research Seminar	1	
	GS-CC	Research Hours ± Electives	7	Total to Date
		Total:	12	72 (17)

Student's Thesis Advisory Committee must be appointed by the end of Term 1 in the student's second year of enrollment.

Term 2:	GS-GS-5112	Powerful Presentations	1	
	GS-CC-5100	Student Research Seminar	1	
	GS-GS-5102	Responsible Conduct of Research 2	1	
	GS-CC	Research Hours ± Electives	6	Total to Date
		Total:	12	84 (17)
Term 3:	GS-CC-5100	Student Research Seminar	1	
	GS-CC	Research Hours ± Electives	11	Total to Date
		Total:	12	96 (17)
Term 4:	GS-CC-5100	Student Research Seminar	1	
	GS-CC	Research Hours ± Electives	11	Total to Date
		Total:	12	108 (17)
Term 5:	GS-CC	Research Hours ± Electives	12	Total to Date
			12	120 (17)

Thirteen additional didactic hours are required for a total of thirty (30)

Qualifying Exam Requirement:

- Must be taken by the end of the second year of enrollment.
- Student must complete all prerequisite activities defined by their program before taking the exam.

Course Requirements beyond Year Two:

Year 3, Term 3:	GS-GS-5103	Responsible Conduct of Research 3	1
Year 4, Term 3:	GS-GS-5104	Responsible Conduct of Research 4	1

Recurring requirements until Graduation:

Terms 1-4:	GS-CC-5100	Student Research Seminar	As required
Terms 1-5:	GS-CC-5050	Dissertation	As required*

**Students shall enroll in the number of credits of Dissertation needed to be enrolled full-time (12 credits) each term through Graduation.*

Research Course Work:

GS-CC-5010	Readings
GS-CC-5030	Research Rotation
GS-CC-5040	Special Projects
GS-CC-5050	Dissertation

Additional Cancer & Cell Biology courses*:

GS-CC-6101	Cancer	GS-CC-6207	Ethics & Regulatory Prep for Research with Animal Models
GS-CC-6103	Biology of Aging	GS-CC-6210	Tumor, Technology, Therapy
GS-CC-6201	Translational Cancer Biology	GS-CC-6303	Reproductive Biology
GS-CC-6202	Explorative Data Analysis	GS-CC-6304	Biology & Mechanisms of Age-Related Disease
GS-CC-6203	Integrated Microscopy	GS-CC-6401	Technologies for Cancer Drug Discovery & Development *(two-term course)*
GS-CC-6204	Regulation of Energy Homeostasis		
GS-CC-6205	Translational Breast Cancer Research		
GS-CC-6206	Cell Death in Development & Disease		

**Students may select electives from open course options in all graduate programs. Courses may be viewed in the AY21 Graduate School Bulletin*

CCB CURRICULUM

Key points:

- All required didactic coursework can be completed during the first year.
- There are a variety of Electives for each CCB Curriculum Category; there are numerous other GSBS courses to choose from.
- Students must ensure they have sufficient didactic credits each term–max 12 credits per term.
- The required 30 didactic credits should be completed in 1.5 years after matriculating to CCB program.
- The CCB Curriculum Chairs will advise students to select electives based on the student's interests.
- Students may have up to four research rotations (3 minimum) during the first year, before selecting a dissertation mentor. The first two rotations must be with CCB program faculty.

The CCB Curriculum Categories: Foundational Knowledge, Cellular & Disease Mechanisms, Drug Discovery, Pre-Clinical Studies, Clinical Trials.

The **required didactic** courses are: Foundations A, Foundations B, Gene Regulation, Cellular Signaling, and Molecular Carcinogenesis.

In addition to these 17 (seventeen) didactic credits, CCB has program-specific **elective didactic** courses that focus on cancer and cell biology, e.g. Cancer, Reproductive Biology, Regulation of Energy Homeostasis; Cell Death & Autophagy, Explorative Data Analysis, Integrated Microscopy, and the Biology of Aging; Biology and Mechanism of Age-Related Disease, Tumor, Technology, Therapy; Translational Cancer Biology, Translational Breast Cancer Biology, Technologies for Cancer Drug Discovery & Development. There are other courses, see GSBS Bulletin.

The **required non-didactic** courses are: Responsible Conduct of Research (Y1-Y4), Student Research Seminar (all years), Strategies for Success in Graduate School (Y1), Reading and Evaluating Scientific Literature (Y1), Scientific Writing (Y1), Effective Project Design & Management (Y1), and Powerful Presentations (Y2), NRSA Grant Writing & Project Development 1 & 2 (Y2).

Non-didactic optional course: Readings (Y1)

Cancer and Cell Biology Graduate Program Planner

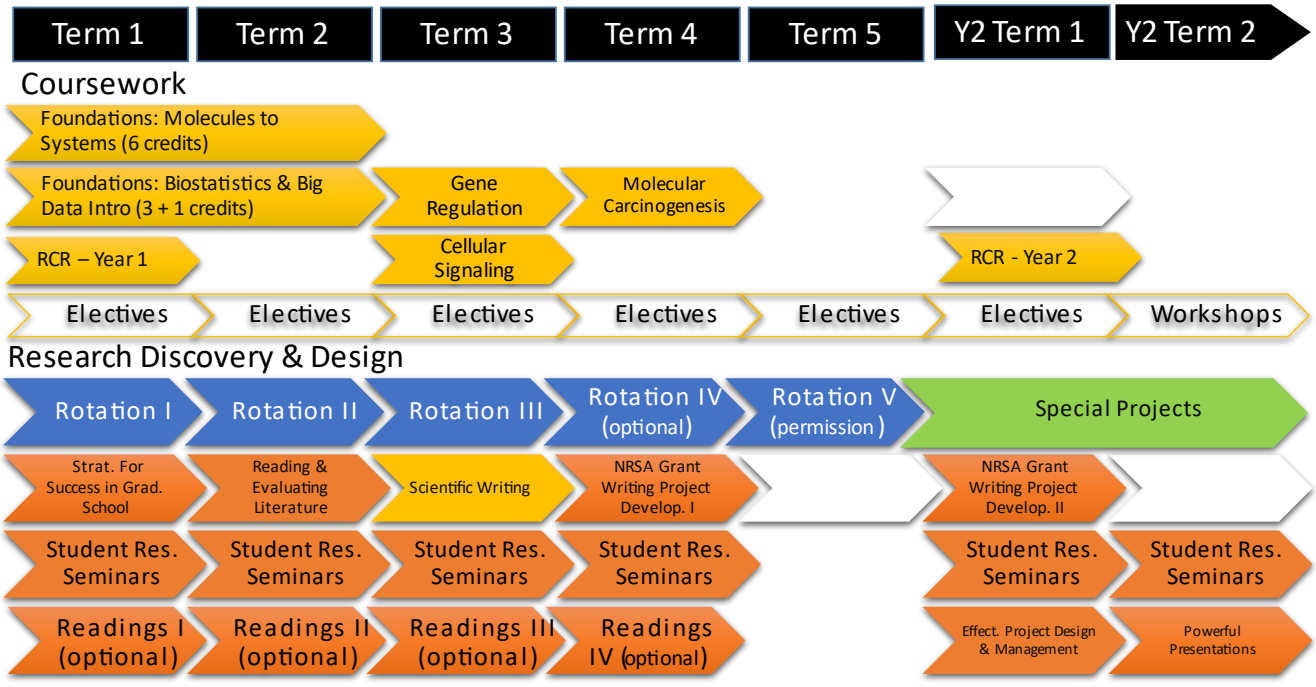
(12 credits/term; 30 didactic credit hours / Courses in ***italics* are non-didactic** / Minimum of **three research rotations** required)

TERM 1 REQUIRED COURSES	**ELECTIVES**	
GS-GS-6600 Foundations A: Molec. To Sys. GS-GS-6400 Foundations B: Biostats. *GS-GS-5111 Straegies for Success in Grad. School* *GS-CC-5100 Student Research Seminar* *GS-GS-5101 Responsible Conduct in Research* *GS-CC-5030 Research Rotation (1-3h)* GS-GS-5302 CCB NRSA 2 Res.Design II (Y2) Electives (1-3h) *GS-GS-5113 Effective Project Design and Manag. (Y2)*	GS-DD-6202 Classical Developmental Biology GS-CC-6207 Ethics & Reg. Prep. Res.Animal Models GS-GS-6203 Data Mining *GS-CC-5010 Readings*	See GSBS Bulletin for more electives Y2 Disease Working Group areas/specialties workshops
TERM 2 REQUIRED COURSES	**ELECTIVES**	
GS-GS-6600 Foundations A: Molec. Sys. GS-GS-6400 Foundations B: Biostats. *GS-CC-5100 Student Research Seminar* *GS-CC-5030 Research Rotation (1-5h)* Electives (1-5h) *GS-GS-5112 Power Presentations (Y2)*	GS-DD-6201 Development GS-DD-6301 Human Physiology I GS-CC-6206 Cell Death/Autophagy GS-QC-6206 Appl. to Biol. of Computation GS-CC-6201 Translational Cancer Biology GS-CC-6205 Translational Breast Cancer Research	*GS-CC-5010 Readings* See GSBS Bulletin o for more electives
TERM 3 REQUIRED COURSES	**ELECTIVES**	
GS-GS-6202 Gene Regulation GS-GS-6208 Cellular Signaling *GS-GS-5105 Scientific Writing* *GS-CC-5100 Student Research Seminar* *GS-CC-5030 Research Rotation (1-5h)* Electives (1-5h)	GS-CC-6101 Cancer GS-GS-6101 Neuroscience GS-IY-6102 Principles of Immunology GS-IY-6301 Immunology GS-GE-6202 Mammalian Genetics GS-DD-6302 Human Physiology II GS-GE-6304 Method & Logic in Genet-Genomic GS-GS-6205 Fundamentals of Epidemiology GS-DD-6208 Evo. Conser. of Develop. Mech.	GS-CC-6202 Explorative Data Analysis GS-CC-6203 Integrated Microscopy GS-QC-6301 Pract. Intro. Program. for Scientists GS-GS-5108 Pharmacoepidemi. Pharmacogenetics GS-DD-6209 Animal MRI *GS-CC-5010 Readings* See GSBS Bulletin o for more electives
TERM 4 REQUIRED COURSES	**ELECTIVES**	
GS-CB-6302 Molecular Carcinogenesis GS-GS-5301 CCB NRSA 1 Res.Design. I (Y1) *GS-CC-5100 Student Research Seminar* *GS-CC-5030 Research Rotation (1-6h)* Electives (1-6h)	GS-GG-6302 Human Genetics GS-GG-6303 Medical Genetics GS-IY-6201 Cells Tissues and Organs GS-CC-6303 Reproductive Biology GS-CC-6204 Regulation of Energy Homeostasis GS-DD-6206 Pathophys. & Mech of Human Disease GS-NE-6204 Neurobiology of Disease GS-CC-6301 Biol. & Mech. of Aging-related Disease GS-GS-5107 Leadership Skills	GS-GE-6301 Bioinformatics Genomic Analyses GS-QC-6302 Computer-Aided Discovery Methods GS-CP-6207 Electron Cryomicroscopy GS-GE-6203 Gene and Cell Therapy GS-GG-6102 Genetic Epidemiology & Pop. Genetics *GS-CC-5010 Readings* See GSBS Bulletin o for more electives
TERM 5 REQUIRED COURSES	**ELECTIVES**	
GS-CC-5030 Research Rotation (1-11h) *Electives (1-11h)*	GS-CP-6205 Chemical Biology GS-PG-6206 Drug Discovery: Bench to Bedside GS -IY-6304 Clinical Aspects of Immunology GS-DD-6203 Animal Models of Human Disease GS-GS-6204 Ethics & Conduct of Clinic. Research	GS-CC-xxx Environment and Cancer *GS-CC-xxx Ident. of Druggable Cancer Targets* Disease Working Group areas/specialties / CTR-CAQ workshops See GSBS Bulletin for more electives

CCB Curriculum Categories: Foundational Knowledge, Cellular & Disease Mechanisms, Drug Discovery, Pre-Clinical Studies, Clinical Trials.

Research Career Development Plan, details

Baylor College of Medicine



CCB-SPECIFIC, GSBS COURSES & SELECT ELECTIVES

(See student bulletin for additional courses)

The Biology of Aging course will familiarize students with the biology of aging, including mechanisms, models, clinical aspects, and the development of novel treatments, and the concepts of gerontobiology and geroscience.

The Biology and Mechanism of Age-Related Disease 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.

Cancer is an introductory 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.

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

The Ethics and Regulatory Preparation for Research with Animal Models 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.

The Explorative Data Analysis course teaches 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

The Foundations A: Molecules to Systems 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.

The Foundations B: Biostatistics 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.

The Gene Regulation 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.

The Integrated Microscopy 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.

The Molecular Carcinogenesis 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.

In the NRSA Grant Writing & Project Development 1 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.

In the NRSA Grant Writing & Development 2 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.

The Powerful Presentations course is to develop and scientific communication skills to effectively convey your ideas to both experts and non-experts. Effective presentation is the basis for career advancement at all levels in science. In this class, you will hone these skills through understanding how to develop and deliver longer format talks. Topics we will cover include: 1) the fundamentals of effective talk design; 2) how to construct potent slides; 3) how deliver information effectively; and 4) in class presentations. For feedback and presentations, each student will be matched with a faculty mentor in groups of eight to ten students.

The Reading and Evaluating the Scientific Literature course will assist students to develop an understanding of scientific research and foster skills in reading and evaluating the scientific and medical literature. We will discuss the philosophies of scientific inquiry, the scientific methods/approaches, the factors and aspects that contribute to exemplary as opposed to unsatisfying scientific publications. Students will be responsible for critically reading the assigned literature and participate in discussions to evaluate the selected literature as a group and individually.

The Regulation of Energy Homeostasis course 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.

The Reproductive Biology course 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.

The Scientific Writing 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.

The Strategies for Success in Graduate School course prepares incoming students to become scientific and professional leaders by developing skills for a successful gradate 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.

The objective of the Student Research Seminar 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.

The Technologies for Cancer Drug Discovery & Development 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 pharmaceutics. Finally, preclinical animal models and clinical assessments are presented.

The Translational Breast Cancer Research 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.

The Translational Cancer Biology 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.

The Tumor, Technology, Therapy course: “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.

USEFUL INFORMATION ON FELLOWSHIPS

Although your graduate stipend is guaranteed from matriculation to graduation, now is a good time to consider applying for an individual fellowship support to begin your graduate career. Having an individual fellowship is prestigious and further demonstrates your commitment to a career in biomedical sciences. As such, the Graduate School awards a one-time $3,000 Dean's award to graduate students who receive a fellowship from a nationally competitive funding source.

The NSF and DOD fellowships open to undergraduate seniors and graduate students who are early in their graduate career and pay for up to three years of stipend support. Applicants must be US citizens or permanent residents.

- NSF-Graduate Research Fellowship Program https://www.fastlane.nsf.gov/grfp/ (due in October of each year, open to US citizens and permanent residents)

- National Defense Science and Engineering Graduate Fellowship. Description: https://ndseg.org/ Application due in December of each year, open to US citizens only

There are many other fellowship opportunities once you have generated some data for your dissertation project. Consider exploring the NIH Career paths: https://researchtraining.nih.gov and the Fellowships Kiosk https://researchtraining.nih.gov/programs/fellowships