Graduate School of Biomedical Sciences

Biochemistry & Cancer Biology Discipline Handbook 2021-2022

Regardless of the discipline, each GSBS student (MS or PhD) will receive the degree of Biomedical Sciences. The discipline is listed on the transcript as the Major.

The information provided in this document serves to supplement the requirements of the Graduate School of Biomedical Sciences detailed in the UNTHSC Catalog with requirements specific to the discipline of Biochemistry & Cancer Biology.

Table of Contents

Biochemistry & Cancer Biology Discipline

Rafal Fudala, Ph.D., Graduate Advisor
Office: CBH 313
Phone: 817-735-0102
Email: Rafal.Fudala@unthsc.edu
Discipline website**:** Biochemistry and Cancer Biology Discipline

Graduate Faculty: Basha, Basu, Bunnell, Chaudhary, Das, Fudala, Jones, P. Mathew, S. Mathew, Mathis, Prokai, Ranjan, Sankpal, Vishwanatha.

The Biochemistry and Cancer Biology discipline offers both Master of Science (MS) and Doctor of Philosophy (PhD) degrees. The discipline provides rigorous education and training in biomedical sciences with a specialty in Biochemistry and Cancer Biology. Students receive training through original research, formal classroom education, problem-based learning, seminars, and journal clubs.

Faculty members are engaged in various aspects of biochemical, biophysical, molecular, and cancer research. The specific research interests of faculty cover a wide range of topics, including signal transduction, posttranslational protein modification in health and disease, protein structure and function, protein-ligand and protein-protein interactions, metabolism, molecular carcinogenesis, tumor immunology, Natural Killer cell mediated immunotherapy of cancer, stem cell biology, tumor invasion and metastasis, tumor microenvironment, cancer therapeutics, drug resistance, drug metabolism, drug delivery, drug discovery, nanotechnology/imaging, epigenetic effects on cancer risks, cancer health disparities, alternative medicine therapies of cancer, disorders of lipid metabolism in atherosclerosis and lipoprotein metabolism. The interdisciplinary research also includes investigation of the link between cancer with other disorders, such as aging & Alzheimer's disease, HIV, and ocular diseases. Research projects employ state-of-the-art molecular, cellular, and biochemical techniques that include genomics, proteomics, mass spectrometry, protein crystallography, molecular cloning, gene targeting, FACS analysis, advanced fluorescence spectroscopy, optical imaging, and advanced molecular technology for the detection of genetic variation between normal and cancer cells.

Students may choose faculty advisors according to their research interests. During the first year, students will acquire sufficient background in biomedical sciences, including biochemistry, molecular biology, cell biology, pharmacology, physiology, and immunology. The students will have the opportunity to rotate in research laboratories prior to selecting their mentors. Students will take two discipline specific required courses as well as additional elective courses based on their needs and interests. MS students are expected to graduate in approximately two years, whereas PhD students usually require five years to complete the degree.

Biochemistry & Cancer Biology Graduate Faculty and Their Research

Graduate Faculty Membership Categories: Associate members of the Graduate Faculty are able to serve as members of thesis or dissertation advisory committees, as major professors (chairs) or co-chairs on thesis advisory committees, and as co-chair on dissertation advisory committees with a full member as chair. Full members of the Graduate Faculty are able to serve as members of thesis or dissertation advisory committees, and as major professors (chairs) or co-chairs on thesis or dissertation advisory committees.

Faculty and Position	Research Interests
Riyaz Basha, Ph.D. Associate Professor & Vice Chair for Research, Pediatrics & Women's Health. Graduate Faculty Membership Category: Full Member	**Dr. Basha's** research is in the area of experimental therapeutics. The aberrant expression of certain molecular markers is associated with aggressive disease and poor prognosis in a variety of human malignancies. His lab is working on targeting c-Met (a receptor for hepatocyte growth factor), Specificity protein 1 (Sp1) transcription factor and survivin or baculoviral inhibitor of apoptosis repeat-containing 5 (BIRC5), an inhibitor of anti-apoptotic protein for enhancing therapeutic efficacy in cancer. These markers are associated with resistance to chemo- and radiation therapies and impact the disease progression and prognosis of cancer patients. We are testing certain investigational agents that have the ability to target these candidates focusing on developing strategies to improve therapeutic efficacy in breast cancer, Ewing sarcoma, Hepatocellular carcinoma, ovarian and pancreatic cancers using preclinical models and clinical specimens. We are also evaluating the combination of investigational agents and standard chemotherapeutic agents to enhance the therapeutic efficacy and reducing morbidity. In addition, cancer health disparities and the combination therapies using investigational agents to induce immune response to kill cancer cells is also being investigated. Dr. Basha's research projects designed to exploit the genomic biomarkers, genomic profiling/sequencing, and liquid biopsy for identifying precise therapeutic options. Dr. Basha is actively working with the collaborators (physicians and translational researchers) in DFW area including Cook Children's and JPS and other institutions including NCI-designated comprehensive cancer centers for developing less toxic and effective strategies for treating human cancers.
Alakananda Basu, Ph.D. Professor Microbiology, Immunology & Genetics Graduate Faculty Membership Category: Full Member	**Dr. Basu's** research is focused on signal transduction, especially in the context of cancer chemotherapy. She is also investigating how an alteration in the signal transduction pathways affect neurodevelopmental disorder. A major research effort is to investigate how various signaling pathways, such as protein kinase C, Akt and mTOR/S6 kinase (S6K) regulate apoptosis (a genetically programmed cell death), autophagy (a process by which a cell recycles its own components to survive under stressful or nutrient-derived conditions) and cellular senescence (loss of proliferative capacity of cells). Cellular,

molecular and biochemical approaches as well as state-of-the-art technologies, such as proteomics and genomics are used to determine how an intervention with a signaling pathway can be exploited for therapy. The ultimate goal of her research is to exploit intracellular signaling systems to develop innovative strategies to treat cancer and identify potential biomarkers to predict patient response to cancer therapy be exploited for cancer therapy.

Bruce Bunnell, Ph.D.
Chairman and Professor
Microbiology, Immunology & Genetics
Graduate Faculty Membership Category: Full Member

Dr. Bunnell's research program is focused on stem cells and tissue engineering. His group focuses on both the basic science and translational applications of adult stem cells. Dr. Bunnell investigates use of mesenchymal stem cells (MSCs) isolated from the bone marrow or adipose tissue. He is particularly interested in the interactions of MSC with the immune system and how the cells effectively inhibit robust inflammation in vivo. He is also working on the impact of biologic aging and obesity on the quality of the stem cell populations. His research group has determined that communication between ASCs from obese donors and breast cancer cells induces alterations in the cancer cells to make them more tumorigenic and metastatic. With regard to tissue engineering, Dr. Bunnell's group is collaborating on the development, testing and application of a microphysiologic model of the osteoarthritic human knee, which is composed of bone, cartilage, adipose tissue, immune cells and synovium. This in vitro physiologic model has applications in understanding disease processes and drug screening.

Pankaj Chaudhary, Ph.D.
Assistant Professor
Microbiology, Immunology & Genetics
Graduate Faculty Membership Category: Full Member

Dr. Chaudhary has a broad interest in cancer biology, but the majority of the work is directed towards basic and translational research of breast and prostate cancer. The research in Dr. Chaudhary[1]s laboratory focuses on various aspects of carcinogenesis, particularly the molecular mechanisms underlying breast and prostate tumor growth, angiogenesis and metastasis. A major focus of his work has been on the molecular basis of Annexin A2 function in promoting triple-negative breast cancer metastasis and angiogenesis. Dr. Chaudhary[1]s laboratory demonstrated that Annexin A2 derived from triple-negative breast cancer exosomes promotes angiogenesis and aggressive metastasis in triple-negative breast cancer. Increased expression of Annexin A2 is frequently observed in triple-negative breast cancer. Dr. Chaudhary[1]s findings demonstrated that Annexin A2 overexpression is associated with racial variation and is a potential prognostic candidate for triple-negative breast cancer in African-American women. In addition, Dr. Chaudhary established that Annexin A2 could potentially be used as an important therapeutic target in triple-negative breast cancer. Currently, Dr. Chaudhary[1]s laboratory is validating these findings and determine if Annexin A2 contributes to the disproportionate occurrence in triple-negative breast cancer and clinical outcome in African-American women.

Courtney Cross, Ph.D.
Assistant Professor
Microbiology, Immunology & Genetics
Graduate Faculty Membership Category: Associate Member

Dr. Cross's laboratory research in maternal-fetal medicine combined her interest in genetics, toxicology, and public health. The overarching goal of her research was to investigate the effect of genetics, toxicological exposure, and social determinants of health on the metabolic and antioxidant capacity of trophoblasts and placental tissue. Dr. Cross developed an in vitro pre-eclampsia model to investigate the effect of pathogenic reactive oxygen species concentration on antioxidant capacity, apoptosis, miRNA expression, and subsequent alternations in mRNA or protein levels, specifically ones involved in angiogenesis, proliferation, migration, invasion, cell cycle control and apoptosis. She was also a key investigator for two multi-center projects. The first project used next-generation sequencing and PHASE analysis to determine haplotypes of the efflux transporter P-glycoprotein (P-gp), encoded by the highly polymorphic ABCB1 (MDR1) gene. P-gp is strongly expressed in the placenta and protects the fetus from a variety of environmental toxins, pharmacologic agents, and illicit substances. This data, combined with information about mothers' epidemiologic data and social determinants of health, was analyzed to determine potential effects on P-gp expression or activity. The second multi-center project studied the safety and efficacy of bupropion for smoking cessation during pregnancy and the potential role of haplotypes in the phase II metabolism enzyme Cytochrome P450 2B6 (CYP2B6), which is the primary enzyme responsible for converting bupropion to its active form. Dr. Cross's educational research interests include non-cognitive factors that influence student success and faculty development in active learning.

Hriday Das, Ph.D.
Professor
Pharmacology & Neuroscience
Graduate Faculty Membership Category: Full Member

The long-term goal of **Dr. Das'** research is to develop cost-effective clinically useful drug therapies for the treatment of neurodegenerative diseases. Presenilin-1 (PS1) is a transmembrane protein which functions as ER Ca2+ leak channel and is the catalytic subunit of the PS1/γ-secretase complex. PS1/γ-secretase is involved in the proteolytic processing of type 1 membrane proteins including amyloid precursor protein (APP) and Notch-1 receptor. Mutations of the PS1 gene cause early-onset familial Alzheimer's disease by altering PS1/γ-secretase mediated processing of APP. Same pathogenic mutations of the PS1 gene also potentiate IP3R-mediated Ca2+ liberation from ER to cytoplasm. Transcriptional regulation of the PS1 gene appears to modulate both PS1/γ-secretase activity and ER Ca2+ leak channel. His laboratory has shown that PS1 expression can be regulated by the JNK signal transduction pathway involving tumor suppressor protein p53. One goal of this research is to understand how wild type p53 and cancer causing mutations of p53 differentially regulate the processing of APP and Notch1 as well as PS1-mediated ER Ca2+ leak channel. Another goal is to understand the mechanisms how HDAC, JNK and mTOR inhibitors prevent neuronal cell death in mouse model of Alzheimer's disease. He is also studying how regulation of PS1 may control cell

growth and proliferation via Erb4, a transmembrane receptor tyrosine kinase that regulates cell proliferation and differentiation.

Rafal Fudala, Ph.D.
Assistant Professor
Microbiology, Immunology & Genetics
Graduate Faculty Membership Category: Full Member

Dr. Fudala in his current ongoing studies is using fluorescence-based methods such as: laser confocal microscopy, fluorescence resonance energy transfer (FRET), fluorescence lifetime imaging microscopy (FLIM), fluorescence correlation spectroscopy (FCS) and cellular imaging as well as polarization-based techniques. Recently, Dr Fudala's interests have expanded to include fluorescence-based methods in biology and cellular imaging, as well as biological/biophysical applications of new nanophotonic processes and single molecule studies in the biomedical and diagnostic fields, especially for early cancer (malignant melanoma, bladder cancer) and cardiovascular diseases detection. Dr. Fudala's major current projects include: new peptide-based approach to improve specificity in cancer treatment, novel approaches to study viscoelectric properties of mucin in cellular microenvironments, and fluorescence-based detection of hyaluronidase and metalloproteinases. Currently, Dr. Fudala's interests also include developing high-density lipoproteins (rHDL) based nanoparticles to deliver drugs to cancer cells *via* HDL receptor SR-B1.

Jin Liu, Ph.D.
Assistant Professor
Pharmaceutical Sciences
Graduate Faculty Membership Category: Full Member

Dr. Liu is broadly interested in the development and application of computational methods to solve problems in pharmaceutical sciences. Her lab integrates pharmaceutical sciences with computer sciences, chemistry, biology, and physics to develop new biotechnologies, understand molecular mechanisms underlying diseases, and design new drugs. Specifically, Dr. Liu's lab is interested in protein allostery study, computer-aided drug design, CRISPR-Cas9 technology improvement, artificial intelligence (AI) for drug discovery, and big data analysis of health disparity diseases. Her lab extensively engages in dynamic collaborations with various experimental labs with a goal to bridge the interface of computational, experimental, and clinical research.

Harlan Jones, Ph.D.
Associate Professor
Microbiology, Immunology & Genetics
Graduate Faculty Membership Category: Full Member

Dr. Jones conducts biomedical and health disparity research to identify mechanisms of disease pathogenesis involved in cancer, infectious, and inflammatory diseases that disproportionately affect underrepresented minority populations. His research program has identified novel mechanisms through which neuroendocrine factors mediate host cellular immune and respiratory inflammatory responses against pneumococcal disease, asthma, and lung cancer, elucidated potential roles through which microbial species directly respond to corticotropin releasing hormone and other hormones to escape host defenses. His most recent research, defining use of "bacterio-mimetic" components for immune-based targeted nanoparticle cancer therapeutics forms the basis of this application. Dr. Jones is a recipient of the UNTHSC Outstanding Graduate Faculty Award and National Role Model Award. He also serves as Director of the Center for Diversity and International Programs at UNTHSC.

Joseph Malaer, Ph.D.
Assistant Professor
Microbiology, Immunology & Genetics
Graduate Faculty Membership Category: Associate Member

Dr. Joseph Malaer's research interest is in cancer immunology, focusing on enhancing natural killer (NK) cell targeting of cancer stem cells. NK cells are a subset of lymphocytes that play an important role against cancerous cells, viruses, and bacteria. Cancer stem cells are thought to be a small population of cancer cells that have the ability to migrate, proliferate, and differentiate, and are responsible for metastasis and relapse. Dr. Malaer is also interested in expanding his research to include host-pathogen interactions. In addition to graduate education, Dr. Malaer is heavily involved in teaching for the undergraduate Biomedical Sciences program and serves as course director for the undergraduate Immunology, Applied Molecular and Cellular Biology, and Human Physiology courses.

Porunelloor Mathew, Ph.D.
Professor
Microbiology, Immunology & Genetics
Graduate Faculty Membership Category: Full Member

Dr. Porunelloor Mathew's research is in the area of Cancer Immunology, specifically the molecular mechanism by which Natural Killer (NK) cells recognize and eliminate cancer cells. NK cells are a subpopulation of lymphocytes that play an important role again tumor metastasis and various viral and bacterial infections. NK cell functions are controlled by a balance between positive and negative signals through various receptors. We have identified, cloned and characterized several receptors expressed on NK cells. One of the receptors, 2B4 (CD244), is a member of the immunoglobulin superfamily and is involved in killing cancer cells and virus-infected cells by NK cells. By generating 2B4 gene knockout mice, our group explored the in vivo role of 2B4 in the immune system. Defective signaling via 2B4 contributes to X-linked lymphoproliferative disease (XLP) in humans. Dr. Mathew also identified two other novel receptors called LLT1 and CS1 (CD319) that play a role in killing of cancer cells by NK cells. CS1 is overexpressed in multiple myeloma and a humanized monoclonal antibody against CS1 (Elotuzumab or Empliciti) has been approved as a breakthrough drug for the treatment of multiple myeloma. Dr. Mathew's research has opened new NK cell based targeted immunotherapy for cancer. We are also investigating the role of 2B4 and CS1 in autoimmune disease. Current research focuses on Cancer Stem Cells and the role of LLT1and PCNA in immune escape by breast cancer, prostate cancer, and pancreatic cancer.

Stephen Mathew, Ph.D.
Assistant Professor
Microbiology, Immunology & Genetics
Graduate Faculty Membership Category: Full Member

Dr. Stephen Mathew's research focuses on understanding the role of natural killer (NK) cell receptors in different disease models like cancer and lupus. Natural killer (NK) cells are cells of the immune system that form the first line of defense against cancer and infectious diseases. The research in his laboratory is focused towards unraveling the molecular basis of tumor cell recognition by NK cell and its multiple receptor ligand interactions. Specifically, in collaboration with pediatric oncologists and basic science researchers, the research team is investigating the role of immune receptors in acute lymphoblastic leukemia (ALL) in children. This will provide important insights into

the etiology of childhood leukemia as well as the development of new treatments that may improve the outcome of children with leukemia by modifying the function of immune cells in these patients. The other projects in the laboratory deal with deciphering the role of immune receptors 2B4, CS1 and LLT1 in prostate cancer, breast cancer, Ewing sarcoma, and lupus.

Michael Mathis, Ph.D.
Professor & Dean GSBS
Pharmacology & Neuroscience
Graduate Faculty Membership Category: Full Member

Cancer remains one of the major causes of mortality and morbidity in the world. Unfortunately, current therapies are limited by ineffective early detection and treatment; thus, new tools are needed. In my laboratory, we are working in translational research to develop oncolytic virotherapy vectors as gene delivery vehicles for cancer detection and therapy. Oncolytic virotherapy uses engineered replication-competent viruses to infect and kill malignant cells while sparing their normal counterparts. We are modifying capsid proteins on virus vectors for cancer retargeting, as well as developing novel combination approaches to induce anti-cancer immunity. In addition, we are working to develop novel nanoparticle platforms for cancer imaging and detection as well as delivery of anti-cancer cytotoxic agents.

Laszlo Prokai, Ph.D.
Professor
Pharmacology & Neuroscience,
Robert A. Welch Chair in Biochemistry
Graduate Faculty Membership Category: Full Member

Dr. Prokai is recognized nationally and internationally for his work on discovery, bio-organic and medicinal chemistry of central nervous system agents, as well as on neuropeptides, proteomics and mass spectrometry. His cancer research interests focus on (i) prevention of estrogen-related malignancies associated with hormone therapy by discovering and developing compounds with improved safety and selectivity compared to current estrogen products, and (ii) proteomic assessment of (a) the impact of oxidative stress in cancer and during chemotherapy, and (b) signaling events associated with cancer. Other interests include combinatorial and rational drug discovery, brain- and eye-targeted drug therapy, the role of oxidative stress and posttranslational protein modifications in health and disease, neurosteroids and metabolomics.

Amalendu Ranjan, Ph.D.
Assistant Professor
Microbiology, Immunology & Genetics
Graduate Faculty Membership Category: Full Member

Dr. Ranjan's primary research interest is in the area of nanomedicine and nanotherapeutics for cancer and other diseases. He is a biochemical/biomedical engineer trained in the fields of nanotechnology, drug delivery, modeling, optimization and scale up of nanoparticle formulation. He uses biodegradable and biocompatible polymeric or lipo-polymeric nanoparticles with the ability to tailor the release kinetics of drugs from these nanoparticles. He has the expertise in encapsulating various types of hydrophobic, hydrophilic and small molecule drugs in nanoparticles for cancer and other disease therapies.

His research also includes nanotechnology-based gene delivery. This platform has also been used for designing theranostic agents where in a dye can be encapsulated along with a drug and later tracked in vivo for imaging and evaluated for therapy. All such technologies may find use in imaging and therapy of cancer, infectious diseases, cardiovascular and neurodegenerative diseases. His research specialization includes optimization and scale-up of these nanotherapeutics/theranostics for making large batches for pre-clinical studies.

Umesh Sankpal, Ph.D.
Assistant Professor, Pediatrics and Women's Health/Microbiology Immunology & Genetics
Graduate Faculty Membership Category: Associate Member

Dr. Sankpal's research interests are in developing innovative approaches for cancer treatment and diagnosis. The strategy involves identifying novel anti-cancer compounds that target cancer specific genes and work synergistically with the standard treatments of chemotherapy and radiation. The proteins currently being targeted are the specificity protein family of transcription factors and anti-apoptotic protein Survivin. Various cell-based assays, animal models, and gene expression analysis is used to evaluate the underlying molecular mechanism of action. Another area of research being pursued is health disparity in breast cancer, which manifests in the form of significantly higher mortality rates for Black women compared to White women. The strategy involves studying the differences in breast tumor biology between these racial groups. The goal is to address the disparity in mortality rates between these two groups by identifying and developing these differentially expressed markers for diagnosis or as therapeutic targets..

Jamboor Vishwanatha, Ph.D.
Professor
Microbiology, Immunology & Genetics
Graduate Faculty Membership Category: Full Member

Dr. Vishwanatha's research is in cancer molecular biology and experimental therapeutics. His laboratory has established the role of Annexin A2 in ECM degradation and angiogenesis. They identified the function of a novel gene C17orf37 in cancer cell migration and invasion that resulted in a new nomenclature of the gene as MIEN1 (Migration and Invasion Enhancer 1). Their current studies have established Annexin A2 as a novel biomarker for triple negative breast cancer. In other projects, his laboratory has developed sustained release polymeric nanoparticles for targeted delivery of biologicals for cancer therapy. 2) Prostate cancer, molecular markers for progression of oral dysplasia, biological response modifiers, nanoparticle mediated gene delivery.

Requirements

The requirements below are in addition to the GSBS requirements listed in the GSBS Degree Programs chapter of the UNTHSC Catalog.

A student who receives a single "C" in BMSC 6201, BMSC 6202, BMSC 6203, or BMSC 6204, but maintains an overall GPA of 3.0 or better after the first semester will be allowed to enter the Biochemistry & Cancer Biology Discipline and enroll for discipline specific required courses (MIMG 6208 and MIMG 6250). An "A" or a "B" in required for all discipline specific required courses. PhD students who fail to make a B in discipline specific required courses (MIMG 6208 and MIMG 6250) will be required to retake these courses and will have to delay their oral qualifying exams. MS students who fail to make a B in discipline specific required courses (MIMG 6208 and MIMG 6250) will be required to retake these courses.

I. REQUIRED COURSES

Advanced Biochemistry (MIMG 6208) – 2 SCH

Molecular and Cell Biology of Cancer (MIMG 6250) – 2 SCH

II. SEMINAR COURSES, JOURNAL CLUB COURSES, AND WIPS

Seminars in Microbiology, Immunology and Genetics (MIMG 5140) – 1 SCH

Signal Transduction Journal Club (MIMG 5210) – 2 SCH (Spring)

Journal Club in Nanomedicine (MIMG 6100) – 1 SCH (Spring)

All BCB students are required to register for a journal club course during every long semester beginning in the spring of year 1. Once MS students register for Thesis (BMSC 5395) or PhD students register for Doctoral Dissertation (BMSC 6395), they are no longer required to register for a journal club course. All MS and PhD students are required to present their research in Seminars in Microbiology, Immunology and Genetics, also known as "Works in Progress or WIPs," once per year beginning in their second year.

III. ELECTIVE (ADVANCED AND TECHNIQUE) COURSES:

- *Offered fall:*

Practical Fluorescence for Biomedical Science (MIMG 6210) – 2 SCH

Receptors and Second Messenger Signaling (MIMG 6435) – 2 SCH

Kinases and Phosphatases (MIMG 6436) – 2 SCH

Nanotechnology and Nanomedicine (MIMG 6208) -2 SCH

Advanced Molecular Biology: Techniques and Principles (MIMG 6206) - 2 SCH

Drug Discovery & Design (PHRM 6270) - 2 SCH

Histology (PHAN 5400) - 2 SCH

Grant Writing (BMSC 6102) – 1 SCH

- *Offered summer:*

Introduction to Flow Cytometry (MIMG 5150) - 1 SCH

Introduction to Bioinformatics (PHRM 5200) - 2 SCH

Methods in Molecular Biology (PHRM 6440) - 4 SCH

- *Offered spring:*

Bioimaging (MIMG 5201) - 3 SCH

Current Topics in Cancer Biology (MIMG 5160) 1 SCH

Medical Genetics (MIMG 6302) 2 SCH
Principles of Drug Discovery and Development (PSPT 6400) 4 SCH
Biomedical Mass Spectrometry (PHRM 6361) 1-2 SCH

SAMPLE DEGREE PLANS

I. **Master of Science (MS) Degree Plan** – The sample below does not imply that all requirements for graduation will be met with 30 SCH of course work. While it is possible to complete the requirements in this time frame, most research projects require additional semesters to complete. The typical time-to-degree for MS students is two years.

Dept	*Course Number*	*Title*	*SCH*	*Semester to be Completed*
BMSC	5150	Lab Rotations	2	Fall year 1
BMSC	6200	Intro to Experimental Design & Biostatistical Methods	2	Fall year 1
BMSC	6201	Fundamentals of Biomedical Science I	2	Fall year 1
BMSC	6202	Fundamentals of Biomedical Science II	2	Fall year 1
BMSC	6203	Fundamentals of Biomedical Science III	2	Fall year 1
BMSC	6204	Fundamentals of Biomedical Science IV	2	Fall year 1
		Subtotal	***12***	
Milestones to be completed by the end of fall semester, year 1: Selection of Major Professor, Change of Discipline.				
BMSC	5160	Biomedical Ethics	1	Spring year 1
BMSC	5315	Principles of Scientific Communication	2	Spring year 1
BMSC	5998	Individual Research for MS students	4	Spring year 1
MIMG	5140	Seminars in Micro, Immuno & Genetics	1	Spring year 1
MIMG	6208	Advanced Biochemistry	2	Spring year 1
MIMG	6250	Molecular and Cell Biology of Cancer	2	Spring year 1
		Subtotal	***12***	
Milestones to be completed: Designation of Advisory Committee, Degree Plan, Annual Progress Report.				
BMSC	5998	Individual Research for MS students	2-5	Summer year 1
BMSC	5108	Transferable Skills	1	Summer year 1
		Elective Courses	0-3	Summer year 1
		Subtotal	***6***	
BMSC	5998	Individual Research for MS students	3-5	Fall year 2
MIMG	5140	Seminars in Micro, Immuno & Genetics	1	Fall year 2
		Elective Courses	2-6	Fall year 2
		Journal Club Course	1	Fall year 2
		Subtotal	***12***	
Milestones to be completed: Research Proposal. The Research Proposal must be filed prior to enrollment in Thesis (BMSC 5395).				
BMSC	5395	Thesis	3-6	Spring year 2
BMSC	5998	Individual Research for MS students	3-6	Spring year 2
		Advanced Courses	0-3	Spring year 2
		Subtotal	***12***	
		Total for Degree (30 minimum)	***54***	

II. **Doctor of Philosophy (Ph.D.) Degree Plan** - The sample below does not imply that all requirements for graduation will be met with 90 SCH of course work. While it is possible to complete the requirements in this time frame, most research projects require additional semesters to complete. The typical time-to-degree for PhD students is approximately five years.

Dept	***Course Number***	***Title***	***SCH***	***Semester to be Completed***
BMSC	5150	Lab Rotations	2	Fall year 1
BMSC	6200	Intro to Experimental Design & Biostatistical Methods	2	Fall year 1
BMSC	6201	Fundamentals of Biomedical Science I	2	Fall year 1
BMSC	6202	Fundamentals of Biomedical Science II	2	Fall year 1
BMSC	6203	Fundamentals of Biomedical Science III	2	Fall year 1
BMSC	6204	Fundamentals of Biomedical Science IV	2	Fall year 1
		Subtotal	***12***	
*Milestones to be completed by the end of **fall semester, year 1:** Selection of Major Professor, Change of Discipline*				
BMSC	5160	Biomedical Ethics	1	Spring year 1
BMSC	5315	Principles of Scientific Communication	2	Spring year 1
BMSC	6998	Individual Research for PhD students	3	Spring year 1
BMSC	5109	Diversity, Equity and Inclusion in Biomedical Sciences: Fundamental Concepts	1	Spring year 1
MIMG	5140	Seminars in Micro, Immuno & Genetics	1	Spring year 1
MIMG	6208	Advanced Biochemistry	2	Spring year 1
MIMG	6250	Molecular and Cell Biology of Cancer	2	Spring year 1
		Subtotal	***12***	
*Milestones to be completed by the end of **spring semester, year 1**: Designation of Advisory Committee, Degree Plan*				
BMSC	6998	Individual Research for PhD students	2-5	Summer year 1
BMSC	5108	Transferable Skills	1	Summer year 1
		Elective Courses	0-4	Summer year 1
		Subtotal	***6***	
*Milestone to be completed by the end of **summer semester, year 1**: Oral Qualifying Examination, Annual Progress Report.*				
BMSC	6998	Individual Research for PhD students	4-6	Fall year 2
MIMG	5140	Seminars in Micro, Immuno & Genetics	1	Fall year 2
		Journal Club Course	1	Fall year 2
		Elective Courses	2-6	Fall year 2
		Subtotal	***12***	
BMSC	6998	Individual Research for PhD students	1-5	Spring year 2
MIMG	5140	Seminars in Micro, Immuno & Genetics	1	Spring year 2

		Journal Club Course	1	Spring year 2
		Elective Courses	2-6	Spring year 2
		Subtotal	***12***	
BMSC	6101	Responsible Conduct of Research	1	Summer year 2
BMSC	6998	Individual Research for PhD students	3-6	Summer year 2
		Elective Courses	0-3	Summer year 2
		Subtotal	***6***	
*Milestone to be completed by the end of **summer semester, year 2**: Research Proposal; documentation of the completed proposal must be on file prior to enrollment in Doctoral Dissertation (BMSC 6395)*				
BMSC	6998	Individual Research for PhD students	2-8	Fall year 3
MIMG	5140	Seminars in Micro, Immuno & Genetics	1	Fall year 3
		Journal Club	1-2	Fall year 3
		Elective Courses	0-4	Fall year 3
		Subtotal	***9***	
BMSC	6998	Individual Research for PhD students	3-6	Spring year 3
MIMG	5140	Seminars in Micro, Immuno & Genetics	1	Spring year 3
		Journal Club	1-2	Spring year 3
		Elective Courses	0-3	Spring year 3
		Subtotal	***9***	
BMSC	6998	Individual Research for PhD students	3-6	Summer year 3
		Elective Courses	0-3	Summer year 3
		Subtotal	***6***	
BMSC	6395	Doctoral Dissertation	9	Fall year 4
		Subtotal	***9***	
		Total for Degree (90 minimum)	***93***	

Academic Procedures

For additional information regarding Academic Procedures, please refer to the Graduate School of Biomedical Sciences Catalog at: Academic Procedures (GSBS)

Advancement to Candidacy

I. Master of Science (MS)

Advancement to Master's Candidacy is achieved after successful completion of a research proposal.

The research proposal should be based on the thesis project and include a summary of the project, problem/hypothesis, significance of the project, background, research design and methodology. The student must meet with the advisory committee and seek their guidance before preparing the research proposal. The research proposal should be provided to the advisory committee no later than 14 days prior to the defense. The formal presentation will be open to the general audience, while the defense of the research proposal will only be to the members of the student's advisory committee. The research proposal must be approved by the advisory committee and the dean prior to registration for thesis (BMSC 5395). Research proposal guidelines and the research proposal approval form are available on the GSBS Forms and Guidelines website.

Once a master's student has successfully advanced to candidacy, he/she may use "MS Candidate" as a title on any general business correspondence such as business cards, e-mail messages, etc.

II. Doctor of Philosophy (Ph.D.)

Advancement to Doctoral Candidacy is a two-step process. The first step of this process is successful completion of the Oral Qualifying Examination, a common milestone in most doctoral programs regardless of the field of study. The second step of this process is the preparation and defense of a research proposal. Below are details of the Biochemistry and Cancer Biology Discipline for advancing to candidacy.

A. Oral Qualifying Examination (OQE):

Purpose: This qualifying examination is to ensure that a doctoral student has sufficient mastery of fundamental principles of biomedical sciences to be successful as a Ph.D. candidate and independent researcher in the field of Biochemistry and Cancer Biology. Students are required to pass this examination before they can submit their research proposal.

Specifics:

i. The OQE should be completed after completion of prerequisite courses, before the end of the summer semester of the first year of study but no later than the second Fall semester.

ii. The discipline graduate advisor will form a committee of four to five graduate faculty, and s/he will serve as the chair of the OQE committee. The student will be provided with list of the committee members no later than 30 days prior to OQE. If the graduate advisor is the major professor, she/he will appoint another faculty member to serve as the chair of the committee. The major professor cannot participate in the OQE. A non-voting faculty member may be allowed to observe the procedures as a mechanism for training faculty to serve on future OQE committee.

iii. The topics of the examination will be based on the core courses and discipline-specific required advanced courses. The student will be provided with the list of topics under each category no later than 4 months prior the date of OQE.

iv. The student will be given the question set one hour prior to the oral examination. During this time, the student will not have access to any resources, such as books, internet or colleagues. The questions should be answerable in approximately 15 min so that the students can be tested in all of the defined areas. The students will be required to answer 6 out of minimum 12 questions divided onto 4 categories. The students will have to select at least one question from each category.

v. Upon completion of the examination, the faculty will vote on a pass/fail grade for the student. Majority favorable vote will be required for the student to successfully pass. If a student does not pass, the faculty will inform the student of specific areas requiring improvement in writing.

vi. If necessary, a student will be allowed to retake the oral qualifying examination once, but this must be completed before the end of the following semester. Failure on the second attempt will result in dismissal from the doctoral program, although the student may be permitted to pursue a Master of Science degree.

vii. An evaluation document has been developed by the graduate school in order to provide students feedback on their oral qualifying exam and to ensure that the students have demonstrated the appropriate knowledge required for advancement to candidacy. The appropriate forms may be obtained from the GSBS Forms and Guidelines website.

B. Research Proposal

All students are required to submit a research proposal no later than the end of the second year. The proposal should be based on the dissertation project and include a summary of the project, problem/hypothesis, significance of the project, background, research design and methodology. The student must meet with the advisory committee and seek their guidance before preparing the research proposal. The research proposal should be provided to the advisory committee no later than 14 days prior to the defense. The formal presentation will be open to the general audience, while the defense of the research proposal will only be to the members of the student's advisory committee. The research proposal must be approved by the advisory committee and the dean prior to registration for doctoral dissertation (BMSC 6395). Research proposal guidelines and the research proposal approval form are available on the GSBS Forms and Guidelines website.

Once a doctoral student has successfully advanced to candidacy, he/she may use "PhD Candidate" or "Doctoral Candidate" as a title on any general business correspondence such as business cards, e-mail messages, etc. In addition, the minimum number of credit hours required for full-time enrollment drops from 12 SCH to 9 SCH in long semesters.