UNT | HEALTH SCIENCE CENTER

GRADUATE SCHOOL OF BIOMEDICAL SCIENCES

Biochemistry & Cancer Biology
Student Handbook
2019-2020

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.

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Biochemistry & Cancer Biology Discipline

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Graduate Faculty: Basha, Basu, Borejdo, Cheng, Das, Dory, Fudala, I. Gryczynski, K. Gryczynski, Jones, Lacko, P. Mathew, S. Mathew, Mathis, Prokai, Ranjan, Raut, Su, Vishwanatha, Wu

The Biochemistry and Cancer Biology program is an interdisciplinary program that offers both MS and PhD degrees. The goal of this program is to provide students with 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. The program includes faculty members from several departments engaged in various aspects of biochemical, biophysical 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, cancer immunotherapy, stem cell biology, tumor invasion and metastasis, tumor microenvironment, cancer therapeutics, drug resistance, drug metabolism, adenovirus-mediated gene therapy, drug delivery, drug discovery, nanotechnology, molecular imaging of cancer, epigenetic effects on cancer risks, disorders of lipid metabolism in atherosclerosis, lipoprotein metabolism and biophysics of muscle contraction. The interdisciplinary research also includes investigation of the link between cancer with other disorders. The research projects employ state-of-the-art molecular, cellular and biochemical techniques that include genomics, proteomics, mass spectrometry, molecular cloning, gene targeting, FACS analysis, advanced fluorescence spectroscopy, optical imaging and advanced molecular technology.

Students may choose major professors from any department according to their research interests. In addition, students will be able to utilize the resources and expertise of faculty members with diverse backgrounds from several departments. During the first year, students will acquire sufficient background in biological sciences, including biochemistry, molecular biology, cell biology, pharmacology, microbiology and immunology. The students will have the opportunity to rotate in research laboratories in any department prior to selecting their thesis advisors. Students will take two discipline specific courses. They will be able to select additional elective courses from any department based on their needs and interests. MS students are expected to graduate in 2 years whereas PhD students usually require 5 years to complete their degree.

Biochemistry & Cancer Biology Graduate Faculty and Their Research

Faculty and Position

Riyaz M. Basha, Ph.D.
Associate Professor
Pediatrics & Women's Health
Category III

Research Interests

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 such candidates, such as c-Met (a receptor for hepatocyte growth factor), Survivin (an inhibitor of apoptosis protein) and Specificity protein 1 (Sp1) transcription factor for enhancing therapeutic efficacy in cancer. Investigational new drugs that have the ability to target these candidates are being screened for developing novel therapeutic strategies. Small molecules such as Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) have been widely tested in cancer therapy and prevention. NSAIDs' response is typically mediated via cyclooxygenase (COX)-dependent pathways. Recent data identified a NSAID, Tolfenamic Acid (TA), which acts through the COX-independent mechanisms and causes higher efficacy and minimum side-effects (toxicity) in pre-clinical models for some human cancers. TA targets Sp transcription factors that play critical role(s) in the growth and metastasis of cancers. Sp proteins also regulate the expression of Survivin and c-Met which are associated with resistance to chemo- and radiation therapies and impact the disease prognosis. The current research is focused on developing strategies to improve therapeutic efficacy in breast cancer, Ewing sarcoma, medulloblastoma, neuroblastoma, ovarian and pancreatic cancers using preclinical models and clinical specimens. The combination of investigational agents that targets specifically critical markers are being tested to enhance the efficacy of standard treatment options. In addition, cancer health disparities and the combination therapies using investigational agents to induce immune response to kill cancer cells is also being investigated. Experiments will be conducted for understanding the potential molecular pathways associated with the proposed combinations. His laboratory is actively working with the collaborators (physicians and translational researchers) with in DFW area and other institutions including NCI-designated comprehensive cancer centers These investigational findings are crucial towards developing novel strategies for treating human cancers.

Alakananda Basu, Ph.D.
Professor
Microbiology, Immunology & Genetics
Graduate advisor,
Biochemistry & Cancer Biology
Category III

Dr. Basu's research is in signal transduction, especially in the context of cancer chemotherapy. Since an ability of cancer cells to evade cell death contributes to cancer and resistance to chemotherapeutic drugs, a major research effort is to investigate how signal transduction pathways regulate cell survival and cell death. She has been studying how various signaling pathways, such as protein kinase C, Akt, mTOR/S6 kinase (S6K) and mitogen-activated protein kinases 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 cancer therapy. Another area of her research is to investigate the molecular mechanism(s) of drug resistance. The ultimate goal of her research is to identify novel targets for cancer therapy, exploit intracellular signaling systems to develop innovative strategies to treat cancer and identify potential biomarkers to predict patient response to cancer therapy.

Julian Borejdo, Ph.D.
Professor
Microbiology, Immunology & Genetics
Category III

The goal of Dr. Borejdo's research is to identify kinetic defects in heart muscle of patients suffering from Familial Cardiac Hypertrophy. He studies kinetics of the interaction at the level of a single molecule. This avoids averaging, which occurs when a large ensemble of molecules are studied by classical methods. He uses polarized fluorescence as a signal - fluorescence is the only signal with enough sensitivity to report behavior of single molecules. Dr Borejdo's lab studies autocorrelation of the polarized fluorescence rather than signal itself. This has the advantage that autofluorescence is greatly diminished.

Pankaj Chaudhary
Assistant Professor
Microbiology, Immunology & Genetics
Category II

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.

Hriday Das, Ph.D.
Professor
Pharmacology & Neuroscience
Category III

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 test the hypothesis that JNK and mTOR inhibitors prevent neuronal cell death by inhibiting PS1 transcription and PS1-mediated ERCa2+ leak channel activity. 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.

Ladislav Dory, Ph.D.
Professor
Physiology & Anatomy
Category III

Dr. Dory's research is primarily focused in the area of atherosclerosis, specifically reverse cholesterol transport and apolipoprotein E metabolism. He participated in the pioneering work of characterizing interstitial fluid lipoproteins, peripheral HDL formation and was the first to demonstrate, *in vivo*, the synthesis of apoE by peripheral (non-hepatic) tissues, as part of cholesterol efflux and HDL formation. He also pioneered work on the effects of hyperbaric oxygen on the development and regression of atherosclerosis in animal models and discovered a new allele for murine form of extracellular superoxide dismutase. His present work is aimed at elucidating the role of ecSOD in various diseases, including bacterial infection, asbestosis and irritable bowel disease and colon cancer.

Rafal Fudala, Ph.D.
Assistant Professor
Microbiology, Immunology & Genetics
Category II

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 correlatin 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 nanophotonics 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 paptide-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.

Ignacy Gryczynski, Ph.D.
Professor
Microbiology, Immunology & Genetics
Category III

Dr. Ignacy Gryczynski's research is focused on fluorescence spectroscopy and its applications in biochemistry and biology. Fluorescence spectroscopy and microscopy progressed recently towards nanotechnology. The technological advances in optics, computers, surface science and engineering made possible single molecule detection and overcame the diffraction limit. His laboratory is working on fluorescence enhancements near metallic surfaces and particles. The enhanced fluorescence is being applied to sensing devices and bioassays. He co-manages the time-resolved fluorescence laboratory, which carries basic spectroscopy research and is open to the needs of researchers from other departments.

Zygmunt "Karol" Gryczynski, Ph.D.
Professor
Microbiology, Immunology & Genetics
Category III

Dr. Zygmunt Gryczynski and his colleagues have established a Center for Commercialization of Fluorescence Technologies (CCFT) with support from Emerging Technology Funds (EFT) of Texas. His early work at the University of Maryland was focused on ultrafast time-resolved fluorescence spectroscopy, intrinsic fluorescence of hemoproteins as well as the thermodynamics of ligand binding and the allosteric mechanism of O_2 binding in hemoproteins. He has pioneered the use of multi-photon excitation and light quenching in time-resolved fluorescence spectroscopy. His focus has been on applications of fluorescence spectroscopy to study biological systems using time-resolved fluorescence, anisotropy, and FRET. He also pioneered novel fluorescence sensing methods for biomedical applications in tissue and blood. His interest includes modern optical imaging methods with focus on fluorescence microscopy. For the last six years his interests expanded to nanotechnology and applications of novel plasmonic effects induced by light in metallic nanostructures to fluorescence spectroscopy. He pioneered metal enhanced fluorescence and surface plasmons coupled emission phenomena for biomedical and diagnostics application. His current focus is to explore quantum-level interactions to study the dynamics of biophysical and biochemical processes at the molecular level.

Harlan Jones, Ph.D.
Associate Professor
Microbiology, Immunology & Genetics
Director, Center for Institutional Diversity
Category III

There is increasing evidence that psychological stress is an important risk factor in the initiation and progression of chronic disease (e.g. cancer, atherosclerosis, and chronic infectious disease). Dr. Jones' research interest include the investigation of how stress affects host immune mediation of chronic disease states with the intention of facilitating comprehensive therapeutic approaches against stress-induced disease pathogenesis.

Andras Lacko, Ph.D.
Professor
Physiology & Anatomy
Category III

Delivery of anti-cancer drugs to cancer cells and tumors, and currently working on a targeted drug delivery system utilizing reconstituted high-density lipoproteins. Dr. Lacko's lab developed a robust, targeted drug delivery system that has proven particularly effective against cancer cells and tumors. This delivery utilized biocompatible nanoparticles (rHDL) that are built from natural blood components that normally comprise high-density lipoproteins (the good cholesterol carrier). Paclitaxel is 5-20 times more effective than the free drug against cancer cells when delivered via the rHDL nanoparticles. Similarly, the rHDL nanoparticles enhanced the cytotoxicity of valrubicin (AD-32) against cancer cells while the encapsulation of the drug protected the non-malignant (normal) cells against toxic side effects. The selective delivery of anti-cancer agents to tumors was also demonstrated in a mouse model where the drug loaded rHDL nanoparticles were able to induce >80% tumor ablation, a five fold increase in apoptosis and three fold decrease in tumor angiogenesis. This work is now proceeding in three directions towards the translational developments of these findings to allow their utilization at the bedside.

Porunelloor Mathew, Ph.D.
Professor
Microbiology, Immunology & Genetics
Category III

Dr. 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 ben 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
Director & Graduate Advisor, Clinical Research Management
Category II

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
Category III

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
Category III

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
Category II

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.

Sangram Raut, Ph.D.
Research Assistant Professor
Physiology and Anatomy
Category I

Dr. Raut's background is in nanomedicine and fluorescence spectroscopy area. His research efforts are focused on formation and development of lipoprotein-based nanoparticles for delivery of anti-cancer drugs to solid tumors Ewing sarcoma, breast cancer, prostate cancer, and glioblastoma to name a few utilizing the scavenger receptor type B1 (SR-B1). This unique interaction between HDL nanoparticles and SR-B1 forms the basis of our hypothesis of tumor-selective drug delivery and reduced side effects from currently used chemotherapy drugs. His lab utilizes cell and tissue culture, patient tissue samples and xenograft/orthotopic animal models to evaluate the nano-drug delivery platform. Moreover, I am also intrigued by the cholesterol and lipid metabolism in various cancers and how the expression of HDL and LDL receptors and cholesterol uptake contributes to cancer progression and metastasis. He is also interested in utilizing fluorescence techniques to probe the cell membrane properties (such as fluidity or micro-viscosity) of cancer cells due to overexpressed SR-B1 receptors and enhanced cholesterol uptake as a consequence.

Dong Ming Su, Ph.D.
Professor
Microbiology, Immunology & Genetics
Category III

Dr. Su's research focuses on T cell immune system aging. Aged T cell system reduces immunosurveillance and promotes cancer development. Dr. Su's project on cancer biology is to determine how the age-related atrophied thymus plays a role for tumor cell resistance of immunotherapy, and mechanisms responsible for tumor dormancy and metastatic relapse. Although the survival rates of cancer patients have markedly improved with earlier detection and advancements in therapy, many cancer patients, particularly breast cancer, lymphoma, prostate cancer, and melanoma patients, still suffer from metastatic relapse after the primary cure. This recurrence is the major cause of cancer death, and it is partially attributed to the abnormal T cell immunity. Therefore, Dr. Su's project is to determine how the atrophied thymus generates an abnormal T cell immunity, including abnormal regulatory T cells, to resist immunotherapy and assist tumor relapse.

Jamboor Vishwanatha, Ph.D.
Professor
Microbiology, Immunology & Genetics Vice-president, Disparity & International Programs
Category III

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.

Hongli Wu, Ph.D.
Associate Professor
Pharmaceutical Sciences
Category III

The central theme of Dr. Wu's research is to understand the role of oxidative stress defense enzymes in age-related eye diseases. He also investigates natural product-derived antioxidants that may serve as leads for the development of new pharmaceutical products that may eventually cure age-related eye diseases.

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.

I. REQUIRED COURSES

Molecular and Cell Biology of Cancer (MIMG 6250) – 2 SCH: offered each spring

Receptors and Second Messenger Signaling (MIMG 6435) – 2 SCH: offered every other fall (Odd years)

Kinases and Phosphatases (MIMG 6436) – 2 SCH: offered every other fall (Odd years)

MS students should consult with the graduate advisor to decide which advanced courses they should take.

II. SEMINAR COURSES, JOURNAL CLUB COURSES, AND WIPS

Signal Transduction (MIMG 5210) – 2 SCH (Fall & Spring)

Seminar in Cell Motility (MIMG 5121) – 1 SCH (Fall & Spring)

Seminar in Current Topics (MIMG 5140) – 1 SCH (Fall & Spring)

All PhD students are required to register for Journal club courses each semester and MS students once a year. All MS and PhD students are required to present their research during Works in Progress Seminar (WIPS) once per year beginning in their second year.

III. ELECTIVE (ADVANCED AND TECHNIQUE) COURSES:

Offered every fall and spring:
Introduction to Confocal Microscopy (MIMG 5202)-1 SCH

Offered every fall:
Cellular and Molecular Fluorescence (MIMG 6220) – 2 SCH

Offered every 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 every spring:
Bioimaging (MIMG 5201) - 3 SCH

Offered in "even" fall semesters:
Drug Discovery & Design (PHRM 6270) - 2 SCH

Offered in "odd" fall semesters:
Advanced Molecular Biology: Techniques and Principles (MIMG 6202) - 2 SCH

Offered in "odd" spring semesters:
Advanced Biophysical and Biochemical Methods (MIMG 6360) - 3 SCH
Biomedical Mass Spectrometry (PHRM 6361) -1-2 SCH

SAMPLE DEGREE PLANS

I. **Master of Science 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	6203	Fundamentals of Biomedical Science IV	2	Fall year 1
		Subtotal	***12***	
Milestones to be completed: 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	2-6	Spring year 1
MIMG	6250	Molecular and Cell Biology of Cancer	2	Spring year 1
		Journal Club/Current Topics	1-2	Spring year 1
		Elective courses	0-2	Spring year 1
		Subtotal	***12***	
Milestones to be completed: Designation of Advisory Committee, Degree Plan. The Research Proposal must be filed prior to enrollment in Thesis (BMSC 5395).				
BMSC	5395	Thesis	3-6	Summer year 1
		Elective Courses	0-3	Summer year 1
		Subtotal	***6***	
		Total for Degree	***30***	

II. **Doctor of Philosophy 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: 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	2-5	Spring year 1
MIMG	6250	Molecular and Cell Biology of Cancer	2	Spring year 1
MIMG	5210	Signal Transduction Journal Club	2	Spring year 1
		Journal Club/Current topics	0-1	Spring year 1
		Elective courses	0-2	Spring year 1
		Subtotal	***12***	
Milestones to be completed: Designation of Advisory Committee, Degree Plan				
BMSC	6998	Individual Research	2-6	Summer year 1
		Elective Courses	0-4	Summer year 1
		Subtotal	***6***	
Milestone to be completed: Oral Qualifying Examination				
BMSC	6998	Individual Research	4-8	Fall year 2
		Journal Club/Seminar in current topics	1-3	Fall year 2
		*Advanced courses	0-4	
		Elective Courses	0-6	Fall year 2
		*Required to take MIMG6435 & MIMG6436 courses in odd years.		
		Subtotal	***12***	
BMSC	6998	Individual Research	2-8	Spring year 2
		Journal Club/Seminar in current topics	1-3	Spring year 2
		Elective Courses	0-6	Spring year 2
		Subtotal	***12***	

BMSC	6998	Individual Research	3-6	Summer year 2
2		Elective Courses	0-3	Summer year 2
		Subtotal	***6***	
Milestone to be completed: A Research Proposal must be on file prior to enrollment in Doctoral Dissertation (BMSC 6395)				
BMSC	6998	Individual Research	2-8	Fall year 3
		Journal Club/Seminar in current topics	1-3	Fall year 3
		Elective Courses	0-4	Fall year 3
		Subtotal	***9***	
BMSC	6998	Individual Research	3-6	Spring year 3
		Journal Club/Seminar in current topics	1-3	Spring year 3
		Elective Courses	0-3	Spring year 3
		Subtotal	***9***	
BMSC	6998	Individual Research	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	***93***	

Advancement to Candidacy

I. Master of Science

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

The research 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 and 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 6950). 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

Advancement to Doctoral Candidacy is a two-step process.

Step 1: Students will have to successfully complete their oral qualifying examination.

Step 2: Students will have to submit a research proposal.

A. Oral Qualifying Examination:

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. An examination committee will be formed by the graduate advisor. The exam will be open to any program faculty who is willing to serve in the exam committee. S/he will have to notify the graduate advisor prior to the exam so that the student, university member and the committee members are aware of the presence of additional faculty members. S/he may be required to submit questions for the exam and will have the right to vote. The major professor will not have voting rights.

ii. The topics of the examination will be based on the core courses and discipline-specific advanced courses.

iii. The length of the examination will be approximately 2 h. The student will be given the question set an hour prior to the oral examination. 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 12 questions. The students will have to select at least two questions from different categories.

iv. Upon completion of the examination, the faculty will vote on a pass/fail grade for the student. At least 75% favorable vote will be required for the student to successfully pass. The entire committee should approve for distinction. If a student does not pass, the faculty will inform the student of specific areas of weakness in writing.

v. 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 will be permitted to pursue a Master of Science degree.

vi. 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.

vii. 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 and 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 6950). Research proposal guidelines and the research proposal approval form are available on the GSBS Forms and Guidelines website.