2024-25

INTERDISCIPLINARY PROGRAM IN BIOMEDICAL SCIENCES

MCW GRADUATE SCHOOL

Program Description

The Interdisciplinary Program in Biomedical Sciences (IDP) is committed to providing a broad and integrated education in biomedical science. This education is designed to serve the students well as they move on to pursue specialized research projects. During the first year, students take a core curriculum designed to provide a foundation in biochemistry, cell biology, genetics, immunology, microbiology, pharmacology, physiology, signaling, laboratory techniques, and biostatistics. Students also take 4-6 credits of elective courses and manuscript and grant writing courses to help better prepare them for their chosen field of interest. Finally, two professional development courses provide students the opportunity to gain experience in various professional scientific skills.

Students also explore their individual research interests through four laboratory rotations that emphasize experimental design and integration into a research team. Students are encouraged to take advantage of the diversity of opportunities in the six participating departments. Once a student selects a dissertation advisor, they become affiliated with one of the following graduate programs: Biochemistry; Biophysics; Cell and Developmental Biology; Microbiology and Immunology; Pharmacology and Toxicology; or Physiology. In addition, students may also pursue a clinical focus if admitted into the Basic and Translational Science Program. Additional information about individual departmental programs is given elsewhere in this publication.

During their second year of studies, students take a course in writing an NIH-style fellowship and prepare and defend a proposal based on their own research that provides them with valuable experience in mastering a scientific problem, formulating a suitable hypothesis, and drafting a feasible and productive experimental scheme with which to test it. Successful completion of this qualifying exam is a major step towards being admitted to candidacy for a PhD degree in one of the participating departments. During their second semester and in subsequent years, students are also expected to successfully complete a number of advanced courses selected with the guidance of their dissertation mentor, dissertation committee, and the Graduate Program Director of their affiliated department. Upper-level students focus on the development of their research skills, performance of their doctoral research, and completion of their dissertation.

Once affiliated with a particular laboratory and department, students can expect attentive personal mentoring by their dissertation advisor. Throughout their graduate careers, students in the Interdisciplinary Program continue to meet as a group to share ideas, insights, and research accomplishments with each other and with the faculty.

This program prepares students for advanced study in one of the following PhD degree-granting programs: Biochemistry, Biophysics, Cell and Developmental Biology, Microbiology and Immunology, Pharmacology and Toxicology and Physiology.

Admission Requirements

In addition to the general Graduate School admission requirements, this program has additional specific requirements.

Successful applicants will show undergraduate achievement in science and mathematics courses and have prior research experience.

Fields of Study

Faculty participating in the Interdisciplinary Program in Biomedical Research have diverse research interests such as:

- Cancer Biology
- Cardiovascular Biology
- Cell Biology & Signaling
- Developmental Biology
- Drug Discovery
- Enzymology & Metabolism
- Free Radical Biology
- Gene Expressions and epigenetics
- Inflammation & Immunology
- Microbial Infection & Pathogenesis
- Microbiome
- Molecular Genetics
- Molecular Pharmacology & Toxicology
- Neuroscience (Cellular and Molecular)
- Physiological Sciences
- Stem Cell Biology & Regenerative Medicine
- Structural Biology
- Technology Development

Required Courses

16211,16212, 16213, 16214 Introduction to Biomedical Research I-IV. *1 credit each.*
These courses reflect student participation in laboratory research rotations, overall professionalism, timely completion of written reports, and attendance at required events.

16215 Foundations in Biomedical Sciences I. *3 credits.*
This new course will be a didactic based course that will provide the background for understanding the biochemical basis of life. Students will learn about thermodynamic principles that drive biochemical and enzymatic reactions, protein structure and protein dynamics and the thermodynamic principles that define these structures and their interactions with other biomolecules, the principles that define their functional activities and then an application of this knowledge to an understanding of metabolic pathways. Students will also learn how foundational biochemical principles apply to certain physiological settings in health and disease and how pharmacological intervention can modulate physiological responses. The format of the course involves lectures, in-class discussions, and review sessions which are designed to promote class participation.

16216 Foundations in Biomedical Sciences II. *3 credits.*
This is an interdisciplinary course that provides students with a foundation in the areas of gene expression, and basic and contemporary cell biology. The material is primarily presented in

lecture format, but discussion sections and data interpretation discussions are also included. Students are expected to gain fundamental knowledge in the areas of gene regulation, translational and posttranslational control and cellular architecture.

16217 Foundations in Biomedical Sciences III. *3 credits.*
FBS III builds on the cell biology fundamentals introduced in the latter part of FBS I and II. This course starts with lectures on cell signaling and a discussion of a primary research article on the topic. The second part focuses on proteins specialized for ion flux and transport. Themes are exemplified by case studies on several diseases that affect either epithelial transport or excitable cells. The third part of the course focuses on DNA homeostasis, genetic principals, the basis of stem cells and cancer.

16218 Foundations in Biomedical Science IV. *3 credits.*
This course is designed to give students fundamental introductory concepts impacting the fields of Microbiology and Immunology, Neurobiology and Pharmacology in three modules. Topics were selected and integrated based on the essential concept that human biological responses and development are shaped by chemical cues. The impact on human biology from contact or colonization with microorganisms and the innate and adaptive immune responses to contact are discussed in the first module. Module 2 focuses on the physiological aspects of how signals are perceived and interpreted by the human nervous system. Module 3 communicates fundamental aspects of pharmacology, emphasizing the molecular and cellular levels of signaling and signal transduction. Each session is designed to incorporate current analytical methods, computational and statistical aspects of data analysis and clinical or practical impacts on human health and disease.

16242 Techniques in Molecular and Cellular Biology. *2 credits.*
The primary objective for this course is to provide information and conceptual knowledge of a number of the most common techniques required for biomedical research. The information presented in this course should facilitate comprehension of the scientific literature and introduce procedures that students will commonly use in their research projects. The lecture materials will present the theory behind each technique, the practical limitations of each technique and the questions that each technique addresses. Additional lectures will assist the student in using bioinformatics and biostatistics methods and in preparing results for publication.

16245 Statistics for Basic Sciences. *1 credit.*
This course is designed to provide graduate students working in the research laboratory or studying the experimental sciences with fundamental knowledge in biostatistics. It focuses on descriptive statistics, elements of probability theory, estimation, tests of hypotheses, methods of categorical data tabulation and analysis. After completion of the course, students should be able to develop an appropriate study plan to explore a biomedical research question and execute simple statistical analysis of the data collected in the study. Emphasis is placed on understanding concepts as well as learning to apply the covered statistical techniques. Students also learn how to read, interpret, and critically evaluate statistical concepts in the literature.

16290 Professional Development I. *1 credit.*
Emphasis in this course will be placed on oral and written communication, critical literature review, and responsible conduct in research. Students will learn good practices for peer review and perform interactive exercises to review each other's work.

16291 Professional Development II. *1 credit.*
Professional Development follows a multidisciplinary approach to promote individual career development in the biomedical sciences. The course includes lectures, discussion, sessions, seminars, and hands-on activities. Topics of particular emphasis are oral and written communication and rigor and ethics in scientific research.

16292 Writing a Scientific Paper. *1 credit.*
This course will present a step-by-step approach to putting together a scientific paper. Students will be divided into small groups, and these groups will stay together for the duration of the course. Each group will be given an identical set of data with which to compose a manuscript. Each week, a different aspect of paper writing will be discussed, and students will be given a take home assignment to write that particular component of the paper within the small groups. In the final week of the class, the finished papers will be peer reviewed by 2 other groups and a member of the faculty. The course will be graded on attendance, successful and timely completion of the assignments and evaluation of the final manuscript.

16293 Writing an Individual Fellowship. *2 credits.*
This course provides a systematic approach towards writing a F31-like individual research fellowship. Topics include the organization of the NIH, how the NIH invites investigators to submit applications to support their doctoral studies, how PhD trainees and their mentors respond to these invitations, and how the NIH reviews a fellowship application. A weekly didactic session will be presented to the entire group of students who will have weekly individual writing assignments to complete and will have a weekly small group session to share their progress towards the completion of their writing assignments. Each student will identify a mentor-approved research topic that will be developed into a fellowship proposal, emphasizing the writing of a Summary, Specific Aims Page, and Research Plan that will form the basis of their qualifying examination written report and a fellowship grant.

Elective Courses

16265 Introduction to Organ Systems Physiology. *2 credits.*
Introduction to Organ Systems Physiology is a first-year elective course that focuses on the classic topics in physiology – the science of regulation and control systems – including the Physiology of Cells, Muscle, Cardiovascular, Pulmonary, Renal, GI, Endocrine, and Reproduction. It also introduces students to animal models in physiological research appropriate for the topic at hand.

16266 Bacterial Diversity and the Microbiome. *1 credit.*
This interdisciplinary course provides students with a solid foundation in the molecular and physiological basis of bacterial diversity with a particular focus on those organisms that comprise the gut microflora. The interaction between bacteria and viruses or phages is also highlighted. The course will be paper based with chalk-talk style discussion sessions designed to promote discussion of the literature.

16267 Protein Chemistry: Applications. *1 credit.*
Suitable for all students interested in developing critical thinking skills through literature examples of protein activity and its regulation. Students and instructors discuss literature that illustrates the in vitro reconstitutions, proteins structure/activity, and methods and logic of

experimental design including critical control experiments. In addition, discussions include methods learned in the first-year curriculum that might have been applied but were not. From these analyses, students hone their critical thinking and communication skills.

16268 Protein Chemistry: Principles. *1 credit.*
Suitable for all students interested in developing critical thinking skills through literature examples of protein activity and its regulation. In this course, students and instructors use the primary literature to learn and apply the practical formalisms in protein chemistry – including thermodynamics, kinetics, enzymology, and chemical biology – to the regulation of protein activity. Biology is governed by thermodynamic and kinetic principles, but these principles are often abstract to students. The purpose of this course is for students to develop utility in thermodynamic and kinetic principles and apply them to biological systems. The course emphasizes literature examples and expect students to learn these principles by working through problem sets provided by instructors. Students are able to differentiate when thermodynamics or kinetics likely govern a given biological system and have a framework by which to analyze new systems. In addition, discussions include methods learned in the first-year curriculum that might have been applied but were not.

16269 Basic Immunology. *1 credit.*
The purpose of this course is to introduce basic concepts in immunology through lectures, readings from texts and current journals. The course is geared toward students interested in contemporary concepts of cellular and molecular immunology. The course has been designed to integrate fundamental concepts in immunology with the goal of students being able to understand and critically evaluate the complex nature of immune interactions and immune dysfunction regardless of their specific research focus. The participating faculty are from diverse backgrounds with unique expertise. Students learn fundamental concepts in immunology with topics including innate and adaptive immunity, the cellular basis of the immune response, antigens presentation and antibodies, molecular basis for generating immunologic diversity, and regulation of immune responses. In the final block of the course, students integrate their knowledge of the immune system and apply it to disease.

16270 Integrated Microbiology and Immunology. *3 credits.*
The purpose of this course is to introduce basic and integrated concepts in immunology and cellular microbiology through lectures, readings from texts and current journals. The course is geared toward first year students matriculating into the Microbiology and Immunology (MI) Graduate Program as well as any student interested in contemporary concepts of cellular microbiology, immunology, and host-pathogen interactions. The course has been designed to integrate fundamental concepts in immunology and microbiology with the goal of students being able to understand and critically evaluate the complex nature of host-pathogen interactions and immune dysfunction regardless of their specific research focus. Students learn fundamental concepts in immunology and gain an appreciation of the basic properties of bacteria and virus structure, replication, and pathogenesis. In the final block of the course, students integrate their knowledge of pathogens and the immune system.

16271 Fundamentals of Neuroscience. *3.5 credits.*
Fundamentals of Neuroscience follows a multidisciplinary approach to current knowledge about the structural and functional properties of the nervous system. The mechanisms of the nervous system are described at the molecular, cellular, systems and complex brain function levels. The course includes in-class lectures, seminars from prominent scientists (video archives), and written assignments. The purpose of this course is to introduce 1st year graduate students to the structure and function of the human nervous system.

16272 Graduate Neuroanatomy. *0.5 credit.*
Graduate Neuroanatomy is a lab-based course intended to accompany MCW course Fundamentals of Neuroscience. The purpose of this course is to introduce 1st year PhD students to the anatomy of the human nervous system.

16273 Advanced Cell Biology. *3 credits.*
Advanced Cell Biology is an upper level, 3-credit hour cell biology elective course that focuses on a variety of advanced topics in contemporary Cell Biology. Students gain an in depth understanding of specific selected topics through the use of a variety of resources including webinars and podcasts, detailed in-class discussion of papers from the scientific literature and through preparation and presentation of a lecture on a cell biological topic directly relevant to the student's own research interests. Lectures by faculty are minimized.

16274 Metabolism. *1 credit.*
This course is mainly a didactic based course that comprehensively reviews subjects important to metabolism. The topics covered range from carbohydrate metabolism to oxidative phosphorylation to lipid and amino acid metabolism. There is a strong focus of these topics in health and disease, especially as they related to the cardiovascular system, cancer, diabetes, and immune system function. The depth of coverage within each topic is not necessarily comprehensive, but there may be a few aspects of each topic that are highlighted by focusing on landmark studies or recent developments from published articles. In addition, the discussions include methods learned in the first-year curriculum that might have been applied but were not.

16275 Understanding Cell Signaling through Therapeutic Drugs. *2 credits.*
This course presents advanced concepts in cellular signaling by analyzing the molecular mechanisms responsible for the therapeutic benefit, unanticipated toxicity, and limited effectiveness of particularly well-known drugs that target specific signal transduction pathways. The topics are designed to promote an enhanced understanding of the complexities of multiple signaling pathways, and a sophisticated appreciation of how these pathways are integrated to produce cellular responses. The course has a translational emphasis by focusing on the multiple molecular actions of current FDA-approved drugs, as well as discontinued drugs that were removed from the market due to unanticipated toxicity or limited effectiveness. The lectures provide an advanced analysis of the molecular responses that led to the success or failure of these drugs, encouraging students to develop sophisticated analytical skills that allow them to define how different signaling pathways are integrated. Lectures presented by instructors provide an in-depth overview of different signaling pathways, and manuscript discussions promote additional advanced analysis that creatively engages the students.

16276 Developmental and Stem Cell Biology. *3 credits.*
This course provides a detailed introduction to Developmental and Stem Cell Biology. The course uses an advanced graduate style format including lectures, in class paper discussions, and departmental seminars from experts in the field. Students prepare and present a lecture on a developmental and stem cell biology topic directly relevant to each student's own research interests. Students also provide feedback to their pers in the form of brief critiques of individual presentations.

16277 Cognitive Neuroscience. *1 credit.*
Cognitive neuroscience examines human brain information processing at the level of large-scale neurobiological systems. Some examples include information processing that underlies learning and retrieving concepts, comprehending, and producing language, directing, and maintaining attention, and recognizing sensory objects. Each session in this course begins with a 1-hour contextual lecture, followed by review and discussion of two relevant landmark papers, sometimes with opposing views. Emphasis is placed on understanding the processing models central to each domain, the extent to which these models are supported by empirical evidence from neuroimaging, and the relevance of the field to a variety of human brain disorders.

16278 Functional Genomics. *3 credits.*
This course will use a variety of didactic lecture, paper discussions, and hands on bioinformatics learning to provide students with fundamentals in genomics, transcriptomics, proteomics, genetic manipulation, epigenetics, protein modeling and molecular simulation. Theory, practical applications, and analysis methods will be taught.