Program Description

The Graduate Program in Microbiology & Immunology (M&I) seeks to teach and train the next generation of research scientists in the molecular and cellular biology of bacterial pathogens, virus/host interactions, the innate and adaptive immune responses, animal and cellular model systems of infection and immunity, the microbiome, and the molecular mechanisms of gene expression, signal transduction, cell proliferation and cancer biology. It is the goal of the faculty and students to utilize classic and cutting-edge methodologies and technologies to conduct interdisciplinary research that will solve problems that are of significant biomedical importance.

Through participation in a variety of departmental activities, M&I graduate students receive a broad education and training base that encompasses various aspects of biomedical science including those centered in the fields of bacteriology, immunology, virology, molecular biology, microbe-host interactions, genetics/gene expression and cancer biology. Our students develop essential technical skills and/or capabilities that allow them to conduct independent research, and effectively communicate scientific accomplishments in both written and oral forms. In general, M&I faculty seek to promote accomplishment of these objectives by providing a stimulating work and learning environment in which scientific curiosity is encouraged, scientific questions of significance are investigated, rigorous experimental approaches to problems are designed and executed, data is critically interpreted, and sound and cogent concepts are developed. The M&I Graduate Program assesses accomplishment of these objectives through several mechanisms including didactic course requirements, required annual research in progress (RIP) scientific presentations, semi-annual meetings with dissertation committee members coupled with submission of committee report forms, and dissertation-specific qualifying and defense examinations. The ultimate goal of the M&I Graduate Program is to produce well-rounded scientists that possess the necessary maturity, experience, and knowledge base to become independent leaders in the biomedical sciences within academia, industry, government, or other health-related career venues. These goals are consistent with the mission of the MCW Graduate School and of the Medical College of Wisconsin as a whole.

Admission Requirements

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

Students enter the graduate program in the Department of Microbiology and Immunology through the Interdisciplinary Program in Biomedical Sciences (IDP), the Neuroscience Doctoral Program (NDP), the Medical Scientist Training Program (MSTP), or by direct entry into the department. Students who choose a mentor in the

Fields of Study

The following areas of research in the Department of Microbiology and Immunology offer excellent opportunities for graduate dissertation projects:

Molecular Biology of Bacterial Pathogenesis

- Characterization of the molecular properties of bacterial exotoxins, with the goals of defining their mode of action and how toxins modify host cell physiology
- Identification of host and bacterial proteins involved in attachment of Borrelia burgdorferi and Leptospira interrogans to human cells, and the consequences of these interactions(g)3 (a)3 (ns)-tio r p39<c[l)-4 (s)-2 (t)9 (c (peq)9( )TjEMC /LBody <MCID 10 >4C

chemokines and cytokines and their receptors
- Host Defense. Studies of MHC, antigen presentation, innate and adaptive immune responses to bacterial and viral infections, autoimmune diseases, and cancer
- Immune Metabolism and Molecular Immunology. Seahorse energy metabolism, metabolomic, proteomic, single cell sequencing, and ATAC sequencing analyses of immune system in health and disease

Molecular Mechanisms of Gene Expression
- Studies of the mechanisms and consequences of signal transduction: endothelin-mediated signaling through small GTPases, cycloxygenase-2, and the prevention of apoptosis.
- Study of two-component signal transduction networks in bacteria
- Studies of mosquito non-coding genetic variation in transcriptional enhancers and differential malaria susceptibility

Credits Required to Graduate
60 credits minimum

Program Credit Requirements
Students entering from the IDP and NDP, or who are direct admits into the department, are required to take 9 credits of advance coursework as a minimum. MSTP students are required to take 6 credits of advanced coursework at a minimum.

All students must also complete 16242 Techniques in Molecular and Cellular Biology, and 25300 Seminar for 2 semesters (1 semester if the student receives an "A" or "A- "). Furthermore, students entering from the IDP or NDP need to complete 16270 Integrated Microbiology and Immunology, 16292 Writing a Scientific Paper, and 16293 Writing an Individual Fellowship which are all from the IDP.

Required Courses
10222 Ethics and Integrity in Science. *1 credit.*
This course provides the basis for understanding the ethical issues related to basic scientific and medical research, including animal and human subject research, fraud, and misconduct, and governmental, institutional, and researcher responsibilities. Bioethics 10222 is offered during the spring and suuhe spr hu 332.4T5 (f)4m-1 (a)3 (f)4

ethical principles that apply in such situations, and the provide practical guidance on how these types of situations should be correctly handled. This course is offered as a discussion series. Students are expected to attend and participate in the discussion. Bioethics 10444 is offered during the spring terms only.

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 use bioinformatics and biostatistics methods and in preparing results for publication.

The course emphasizes the following core competencies: biomedical knowledge of

Dissertation. Continuation status is limited to three consecutive terms following the completion of Dissertation credits.

25299 Master's Thesis. *6-9 credits.*
Students in the Ph.D. degree program who cannot or elect not to complete that program may be allowed to transfer to the Master's program. This transfer must be approved by the student's advisor, the Program Director, the Chair, and the Graduate School. To transfer to the Master's Program, the student must be in good academic standing according to regulations established by the Graduate School.

Elective Courses

16217 Foundations in Biomedical Sciences III. *3 credits.*
Module III builds on the cell biology fundamentals introduced in the latter part of Modules I and II. This course starts with three lectures on cell signaling and a discussion of a primary research article on the topic. This forms the basis of Exam 1. 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. Exam 2 captures this material. The third and last part of the course focuses on DNA homeostasis, genetic principals, the basis of stem cells and cancer. Exam 3 closes out the Fall semester.

25230 Current Topics in Microbiology and Immunology. *2 credits.*

that addresses the interactions between bacterial toxins and mucosal cells. The goal of this course is to provide students an appreciation of how bacterial toxins that target mucosal cells function as virulence factors and are utilized as vaccines and for clinical therapies. The course format includes formal lectures and paper discussions.

25262 Tumor Immunology. *1 credit.*
Prerequisites: 16270 Integrated Microbiology and Immunology.
Tumor Immunology is an upper-level, 1-credit hour Microbiology/immunology course that will focus on the interactions of tumor cells with various components of the immune system. These interactions are complex, and immune-based strategies for treating cancer have had limited success in the clinic. This course will examine the following: (a) how the immune recognizes tumor cells as foreign, (b) immune strategies for targeting cancer, (c) barriers to achieving effective tumor immunity, (d) monitoring the immune response to cancer, and (e) use of animal models to study the interactions between tumor cells and the immune system. The goals of the course will be to gain an in-depth understanding of the complex interactions between tumor cells and the immune system, and to learn how animal models can be used to better understand these interactions. While the course will be heavily weighted towards the discussion of important papers in the field of Tumor Immunology, it will also involve didactic lectures. Students will be evaluated through attendance and participation (30% of final grade) and a final exam (70% of final grade). The course will meet twice a week for a total of 6 weeks.

25263 Signaling in the Immune System. *1 credit.*
Prerequisites: 16270 Integrated Microbiology and Immunology.
Signaling in the Immune System is an upper-level, 1-credit hour Microbiology course that focuses on how cell signaling processes shape and determine the activity of the immune system. Topics to be discussed include how cell signaling modulates cell development, antigen recognition, cell activation and migration. The course will consist of formal lectures by instructor and group discussions from scientific papers. Students will be evaluated by a single closed-

25266 Clinical Immunology. *1 credit.*
Prerequisites: 16270 Integrated Microbiology and Immunology.
Clinical Immunology is an upper-level, one-credit hour Microbiology course that will provide advanced information and conceptual knowledge regarding the human immune system in health and disease. Specific topics will include primary and secondary immunodeficiencies, autoimmune diseases (systemic autoimmune diseases and autoimmune diseases of the skin and gastrointestinal tract), atopic diseases, HLA and bone marrow transplantation. The course will comprise a combination of formal lectures by instructors, and group discussions of scientific papers from the recent literature.

25267 Bacterial Diversity and the Microbiome.

25269 Advanced Bacterial Physiology. *1 credit.*
Prerequisites: 16270 Integrated Microbiology and Immunology.
Advanced Bacterial Physiology is a 1 credit hour Microbiology course that focuses on fundamental and diverse aspects of bacterial physiology. Students will gain an understanding of the mechanism's bacteria use to execute, coordinate and control basic cellular processes such as macromolecular synthesis, nutrient utilization and metabolism, signal transduction, and stress responses. The course focuses on critical evaluation and discussion of papers from the primary literature. These discussions will be augmented by short didactic presentations of background material by the course director to place the paper's topic and findings in context.

25271 Membranes and Organelles. *1 credit.*
Prerequisites: 16216 Foundations in Biomedical Sciences II.
Membranes and Organelles is an upper-level, one-credit hour Cell Biology course that focuses on the topics of membrane protein trafficking and membrane biogenesis. Students will gain a detailed understanding of organelles and membrane protein trafficking and degradation, membrane vesicle fusion, secretion, and membrane biogenesis. The course will consist in part of readings of seminal papers describing the genetic screens for sec and vps mutants, as well as the Rothman in vitro vesicle fusion experiments. These experiments provide the first description of the proteins we know today to be involved in membrane protein fusion, secretion, and trafficking. After gaining grounding in the design and outcome of these historic screens, the class will focus on what is known today about the initial proteins identified in the original ground-breaking screens. The newer areas of membrane biology will follow similar format, examining the discovery of paradigm, and delving into what is known today. Students will be evaluated by participation in paper discussion (40%) and an in-class paper presentation (60%).

25273 Advanced Immunology. *1 credit.*
Prerequisites: 16270 Integrated Microbiology and Immunology.
Immunology is currently enjoying a golden age, and breakthroughs in immunology research have transformed our understanding of many areas of biomedical science. This rapidly evolving landscape is also giving rise to novel immune-based therapeutic approaches to prevent and cure many diseases such as autoimmunity, cancer, and infectious diseases. This is an advanced course to explore the experimental basis of immunology through lectures, readings from texts, and current immunological journals. Topics covered include the cellular basis of the immune response, antigens, antibodies, and molecular basis for generation of immunologic diversity, regulation of the immune response, innate and adaptive immunity, and diseases of the immune system.

covering a pathogen of their choice from the One Health perspective, including significance of the pathogen to human, animal, and economic health impacts at the bare minimum. The Aims should address a mechanism of infection and/or disease caused by the pathogen of their choice. Pathogens covered in detail in class may not be chosen by any student for the Aims page.

25289 Career Internships in the Biomedical Sciences. *0 credits.*
Career Internships in the Biomedical Sciences is a 0-credit training course that will provide students in the Graduate Program in Microbiology and Immunology with an opportunity to complete a semester-