# DEPARTMENT OF MOLECULAR MICROBIOLOGY AND IMMUNOLOGY

# **Mission Statement**

The Department of Molecular Microbiology and Immunology connects outstanding research programs to the academic mission of preparing students for professional careers in microbiology and immunology, medical and public health service fields, education, research, and industry. The Department of Molecular Microbiology and Immunology is committed to providing students with foundations to link their educational experience to basic and translational biomedical research activities built by department faculty with expertise in the areas of vaccine development, microbial pathogenesis, and molecular mechanisms that determine immune responses in health and disease.

The Department of Molecular Microbiology and Immunology offers a Master of Science (M.S.) degree in Biotechnology and a Doctor of Philosophy (Ph.D.) degree in Molecular Microbiology and Immunology. The Ph.D. in Molecular Microbiology and Immunology program of study is structured around a comprehensive core curriculum that includes MMI 5553 Principles of Immunology and MMI 5573 Principles of Microbiology and a "primer" core class MMI 5513 Genes, Microbes and Disease that intends to bridge areas of research at the molecular and cellular level with various research topics currently pursued by members of the Department. Core courses on MMI 7143 Principles of Scientific Writing and MMI 7113 Teaching in Life Sciences are structured to provide formal training in writing grants/research publications and effective tools for developing learning environments in life sciences, respectively. Supporting prescribed electives include specialized courses that focus on advanced topics in immunology, mycology, bacteriology, virology, and informatics, among others, designed to provide in-depth knowledge at the frontiers of the areas of research to be pursued by prospective students. The collective goal of core and elective courses in the curriculum is to provide both foundational and specialized knowledge in the areas of Molecular Microbiology and Immunology to guide doctoral students toward a field of study of their choice. Doctoral and Dissertation Research courses are intended to provide robust hands-on and mindson research-based training to generate significant findings advancing the student's field of study and resulting in peer-reviewed publications.

The mission of the Department of Molecular Microbiology and Immunology is to conduct outstanding research and provide exceptional educational experiences in a collegial environment. At the same time, we transform academic experiences from classroom to careers by merging scholarly activities with practical skills in fundamental and translational aspects of science in conjunction with a general and discipline-specific Professional Development Program intended to guide students into various career paths.

# **Core Values**

- Integrity in academic studies and research
- Respect
- · Responsibility and accountability
- Fostering a culture of community and communication

- M.S. in Biotechnology (p. 1)
- Ph.D. in Molecular Microbiology and Immunology (p. 2)

# Master of Science Degree in Biotechnology

The Master of Science degree in Biotechnology offers opportunities for rigorous, advanced study and research in biotechnology in order to prepare students for employment and research in this rapidly advancing and expanding field. A broad common base of knowledge for biotechnology is provided in the master's degree by a comprehensive core curriculum that includes key areas in biochemistry, cell and molecular biology, microbiology, and immunology. All students receive practical training by completing at least two laboratory courses. Additional coursework is selected from a list of approved lecture-based and laboratory courses and can include up to 9 hours of biomedical engineering lectures or 12 hours on aspects of management of biotechnology. The opportunity to gain research experience or develop further technical expertise is also possible through an internship in a biotechnology-based company or by producing a master's thesis.

# **Program Admission Requirements**

To be considered for degree-seeking status, applicants must submit, along with the application, two letters of recommendation and a Statement of Future Plans for a career in Biotechnology. International applicants are required to prove proficiency in the English language. In addition to satisfying the University-wide graduate admission requirements, applicants are expected to have completed an undergraduate major in the sciences with coursework comparable to the core required for the Bachelor of Science degree in Biology at UTSA. In particular, incoming students are required to have taken upperdivision undergraduate lecture and laboratory courses in cell biology and biochemistry, earning a grade of at least "B" in all of them; undergraduate coursework in microbiology and immunology is recommended. Students whose undergraduate preparation is deficient in one of these required areas but who meet the remaining standards for admission may be conditionally admitted and required to complete specific undergraduate course(s) as a condition of admission. In such cases, students should anticipate that additional time will be required to complete the degree. A minimum grade point average of 3.0 (on a 4.0 scale) is required for admission. Students who are denied admission to this M.S. program must reapply if interested in acceptance as a special graduate student.

# **Degree Requirements**

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Degree-seeking students are required to complete a minimum of 36 semester credit hours that must be approved by the student's Graduate Advisor and Comprehensive Examination Committee, as well as the Graduate Advisor of Record. Students are expected to meet with their assigned Graduate Advisor early in the first semester of study to prepare a course degree plan and organize a Committee as early as possible. Students must work closely with their Advisor and Committee to gain maximum benefit from this program.

Program of Study		
Code	Title	Credit Hours
A. Biotechnology lectures – core curriculum (10 credit hours):		
A1 Complete the following courses		
BIO 5001	Ethical Conduct in Research	
or NDRB 5001	Ethical Conduct in Research	

MMI 5013	Fundamentals of Biotechnology	
A2 Complete two of	the following courses:	
NDRB 5133	Principles of Cell Biology	
or BIO 5133	Principles of Cell Biology	
MMI 5553	Principles of Immunology	
MMI 5573	Principles of Microbiology	
B. 3 semester credit ho required:	urs in basic laboratory techniques are	3
MMI 5033	Biotechnology Laboratory I: Foundations and Techniques	
C. A minimum of 3 sem laboratory experience a	ester credit hours of additional organized are required from the following:	3
MMI 5133	Biotechnology Laboratory II: Advanced Applications	
or NDBB 5163	Recombinant Protein Biotechnology	

or NDRB 5163 Recombinant Protein Biotechnology Laboratory D. Applications of Biotechnology electives. Other 5000- to 7000-level 9-20

MI/BIO/CHE/NDRB courses that are not listed below can be taken as electives if approved by the Graduate Advisor of Record.

	MMI 5513	Genes, Microbes and Disease	
	MMI 5971	Directed Research	
	MMI 5972	Directed Research	
	MMI 5973	Directed Research	
	MMI 6323	Biostatistics	
	MMI 6513	Drug Development	
	MMI 6543	Vaccine Development	
	MMI 6643	Introduction to Bioinformatics	
	MMI 6923	Advanced Microbial Bioinformatics	
	MMI 6933	Data Analysis and Visualization for Biologists	
	MMI 6623	Internship in Biotechnology	
	MMI 6981	Master's Thesis	
	MMI 6982	Master's Thesis	
	MMI 6983	Master's Thesis	
	MMI 7041	Molecular Microbiology and Immunology Colloquium	
	BIO 5233	Medicinal Plants	
	BIO 5543	Pharmacology	
	BIO 5663	Applications of Recombinant DNA Technology	
	BIO 5783	Introduction to Good Manufacturing Practices and Good Laboratory Practices	
	CHE 6693	Medicinal Chemistry	
	NDRB 5123	Principles of Molecular Biology	
	NDRB 5813	Frontiers in Human Pluripotent Stem Cells	
E.	<b>Biomedical Engineerin</b>	g	0-9
	BME 6923	Tissue Engineering	
	BME 6933	Tissue-Biomaterials Interactions	
	BME 6943	Biomaterials and Cell Signaling	
F.	Management of Biotec	hnology:	0-12
	MOT 5163	Management of Technology	
	MOT 5173	Technology Transfer. The Theory and Practice of Knowledge Utilization	
	MOT 5223	Management of Professional Personnel	

MOT 5243	Essentials of Project Management	
MOT 5313	Emerging Technologies	
Total Credit Hours		36

# **Biotechnology Internship**

Subject to availability. The Internship in Biotechnology (MMI 6623) will require prior arrangement with biotechnology-based companies and approval of the Graduate Advisor of Record. May be repeated for credit, but no more than 9 hours will be approved and applied toward the program of study. Students may not take an internship if they select the Thesis Option.

# **Thesis Option**

Students electing the Thesis Option must complete 6 semester credit hours of MMI 5973 Directed Research, MMI 5972 Directed Research, or MMI 5971 Directed Research, and 6 semester credit hours of MMI 6983 Master's Thesis. Students must successfully defend their thesis research before their Graduate Committee prior to the submission of the thesis to the Dean of the Graduate School for approval. Specific rules must be adhered to concerning the composition of the Master's Thesis Committee. Only Graduate Faculty members from UTSA can chair the Committee. Fixed-term track faculty or faculty from another institution can serve as committee members when approved as Special Members of the Graduate Faculty.

# **Comprehensive Examination**

As specified by University regulations, degree candidates must pass a comprehensive examination administered by the student's Graduate Committee. Students who currently are not enrolled but intend to graduate must register for MMI 6801 Comprehensive Examination for the semester to apply for graduation. Certain rules must be adhered to concerning the composition of the Master's Comprehensive Examination Committee. Only <u>Graduate Faculty</u> members from UTSA can chair the Committee. Fixed-term track faculty from UTSA or from another institution can be a member of the committee when approved as Special Members of the Graduate Faculty. Students who do not meet the criteria (or necessary expectations) to pass the Comprehensive Examination can retake the comprehensive exam one additional time.

# Doctor of Philosophy Degree in Molecular Microbiology and Immunology

The Department of Molecular Microbiology and Immunology offers opportunities for advanced study and research leading to the Doctor of Philosophy degree.

The goals of the program are:

- To educate, mentor, and sponsor the next generation of scientists specialized in the study of mechanisms leading to diseases caused by microorganisms, host immune response to infectious and nonpathogenic microorganisms, and diseases arising from immune dysfunction.
- To advance multidisciplinary training and research portfolios within UTSA and other research entities in San Antonio.
- To meet the workforce needs of academic institutions and also of industries specialized in biotechnology, biodefense, and healthcare.
- To guide students toward a variety of career paths with general and discipline-specific Professional Development Plans.

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# **Student Learning Outcomes**

Upon completion of the Ph.D. in Molecular Microbiology and Immunology, students will be proficient in:

- Demonstrating knowledge and comprehension of the foundations of the immune systems in various hosts, microbial pathogenesis, host-pathogen interactions, microbial and host genomics, and biology of diseases of the immune system.
- Designing and executing experiments and applying the scientific method.
- Applying cutting-edge knowledge and experimental tools in microbiology and immunology to solve current health challenges.
- Effectively communicating molecular microbiology and immunology concepts, methods, and results from basic research in written and oral forms.

# **Admission Requirements**

Applicants must satisfy the University-wide graduate admission requirements described in the Graduate Catalog. In addition, they must satisfy one of the following MMI Ph.D. program-specific requirements.

- 1. Hold a Bachelor of Arts or a Bachelor of Science degree in STEM with a minimum grade point average of 3.0 in upper-division courses in Microbiology or Biosciences with course curriculum including, but not limited to, biology, genetics, microbiology, or immunology.
- 2. A master's degree in STEM, preferably in Biology, Microbiology and Immunology, Biotechnology, or related field.

Admission to the program is decided based on a holistic approach that includes the applicant's personal statement, course work, letters of reference, evidence of research experience, and one or more online or inperson interviews.

Complete applications must include:

- 1. Official transcripts.
- 2. Three letters of recommendation from persons familiar with the applicant's academic potential.
- 3. A statement of research/specialization interest and description of prior research experience.
- 4. Résumé/curriculum vita with a list of publications or scholarly products.
- 5. For International Applicants only: Test of English as a Foreign Language (TOEFL) iBT with minimum score of 100 is recommended.

# **Degree Requirements**

The degree requires 75 semester credit hours (SCH) for students entering with a Bachelor of Arts or a Bachelor of Science degree, or 66 SCH for students entering with a master's degree. The curriculum consists of core courses, courses in scientific writing and scientific teaching, elective courses, seminars, and dissertation research. Any grade lower than "B" in graduate courses or in leveling coursework at the undergraduate level will not count toward the Ph.D. degree.

Code	Title	Credit Hours
A. Core Curriculum (15 se	emester credit hours required)	15
MMI 5513	Genes, Microbes and Disease	
MMI 5553	Principles of Immunology	
MMI 5573	Principles of Microbiology	

	MMI 7113	Teaching in Life Sciences	
	MMI 7143	Principles of Scientific Writing	
B.	Electives (15 semester	r credit hours required)	15
	MMI 6323	Biostatistics	
	MMI 6643	Introduction to Bioinformatics	
	MMI 6743	Advanced Virology	
	MMI 6513	Drug Development	
	MMI 6543	Vaccine Development	
	MMI 6613	Introduction to Clinical Medicine and Pathology	
	MMI 6713	Advanced Clinical Medicine and Pathology	
	MMI 6803	Advanced Immunology	
	MMI 6883	Bacterial Pathogenesis	
	MMI 6733	Advanced Medical Mycology	
	MMI 6923	Advanced Microbial Bioinformatics	
	MMI 6933	Data Analysis and Visualization for Biologists	
	MMI 6973	Special Topics	

Students can alternatively take any 5000- to 7000-level course offered at UTSA with approval from the Molecular Microbiology and Immunology Doctoral Studies Committee.

C.	Colloquia (5 semester	credit hours required)	5
	MMI 7001	Professional and Leadership Development	
	MMI 7031	Graduate Student Seminar. Acquiring Presentation Skills	
	MMI 7041	Molecular Microbiology and Immunology Colloquium (Microbiology)	
	MMI 7041	Molecular Microbiology and Immunology Colloquium (Highlights in Immunology)	
	MMI 7041	Molecular Microbiology and Immunology Colloquium (Neuroimmunology)	
	MMI 7041	Molecular Microbiology and Immunology Colloquium (Vector-Borne diseases)	
	MMI 7041	Molecular Microbiology and Immunology Colloquium (Biofilms)	
	MMI 7041	Molecular Microbiology and Immunology Colloquium (Antifungal Drugs)	
	MMI 7051	Molecular Microbiology and Immunology Seminar	
D.	Doctoral Research (40	semester credit hours required)	40
	MMI 7571	Doctoral Rotation	
	or MMI 7572	Doctoral Rotation	
	MMI 7211	Doctoral Research	
	or MMI 7212	Doctoral Research	
	or MMI 7213	Doctoral Research	
	or MMI 7214	Doctoral Research	
	or MMI 7215	Doctoral Research	
	or MMI 7216	Doctoral Research	
	MMI 7311	Doctoral Dissertation	
	or MMI 7312	Doctoral Dissertation	
	or MMI 7313	Doctoral Dissertation	
	or MMI 7314	Doctoral Dissertation	
	or MMI 7315	Doctoral Dissertation	

**Total Credit Hours** 

# **Advancement to Candidacy**

Advancement to candidacy requires a student to complete all the program requirements and to pass written and oral qualifying examinations following completion of core and a majority of elective courses. The written qualifying exam is administered in connection with the Principles of Immunology and Principles of Microbiology core courses. The oral qualifying exam is based on the dissertation research proposal and is administered by a five-member Oral Qualifying Exam Committee made up of tenured, tenure-track, or adjoint faculty. The qualifying exam is conducted as outlined in the Handbook of Academic Policies and Procedures for the Ph.D. Program in Molecular Microbiology and Immunology. Students are allowed two additional attempts to pass their oral qualifying examination. Results of the written and oral examinations must be reported to the Doctoral Studies Committee and the Dean of the Graduate School. Admission into the Doctoral program does not guarantee advancement to candidacy.

# Dissertation

Candidates must demonstrate their ability to conduct independent research by completing and defending an original dissertation. The research topic is determined by the student in consultation with their supervising professor and a Dissertation Committee. The Dissertation Committee is selected by the student and supervising professor and approved following guidelines of the UTSA Graduate School. The Dissertation Committee guides and critiques the candidate's research. The Committee is composed of four program faculty and one outside member. The Dissertation Committee must approve the completed dissertation.

# **Final Oral Examination**

Following an open presentation of the dissertation findings, the Dissertation Committee conducts a closed oral examination dealing primarily with the relation of the dissertation to the general field of specialty. Results of the oral examination must be reported to the Dean of the Graduate School. Awarding of the degree is based on the approval of the Dissertation Committee, which is approved by the relevant Doctoral Studies Committee, the Department Chair, and the Dean of the Graduate School. The Dean of the Graduate School certifies the completion of all University-wide requirements.

# Molecular Microbiology and Immunology (MMI) Courses

MMI 5013. Fundamentals of Biotechnology. (3-0) 3 Credit Hours. Prerequisite: MMI 3353 or equivalent. The course will provide students with the foundational principles and techniques used in the manipulation of biological systems for practical applications. Key concepts include genetic engineering, recombinant DNA technology, cell culture, bioinformatics, and bioprocessing. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10; LRS1 \$46.20; STSI \$21.60; LRC1 \$12.

# MMI 5033. Biotechnology Laboratory I: Foundations and Techniques. (0-9) 3 Credit Hours.

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Prerequisite: Good academic standing. This course provides students with hands-on experience in foundational biotechnology laboratory techniques, with a focus on novel approaches used in research and industry. Emphasizing integration approaches like flow cytometry and genomics, students will learn to operate advanced laboratory equipment, analyze data, and interpret results. Critical thinking exercises and case studies will guide students in designing experiments and troubleshooting protocols. Additionally, students will develop oral presentation skills through regular research presentations, enhancing their ability to communicate complex scientific concepts effectively. This course aims to prepare students for more advanced laboratory applications and the challenges of professional internships. This course has Differential Tuition. Course Fee: DL01 \$25; IUB2 \$10; L001 \$30.

# MMI 5133. Biotechnology Laboratory II: Advanced Applications. (0-9) 3 Credit Hours.

Prerequisite: MMI 5033. This course advances students' expertise in cutting-edge biotechnological applications. Students will engage in the use of selected advanced techniques focusing on real-world scenarios encountered in the biotechnology industry. Emphasis will be placed on data analysis, experimental design, and critical evaluation of current biotechnological research. Through collaborative projects, students will enhance their oral presentation skills by presenting findings to peers and industry professionals, simulating a professional work environment. The course also includes modules on career readiness, preparing students for successful transitions into internships and careers in the biotechnology sector. This course has Differential Tuition. Course Fee: L001 \$30; GS01 \$30; IUB2 \$10.

## MMI 5513. Genes, Microbes and Disease. (3-0) 3 Credit Hours.

Prerequisite: BCH 3303 or equivalent. Primer course that bridges molecular and cell biology, molecular structure and function of genes and nucleic acids, in the focused area of host-pathogen interactions. Genome projects, functional genomics, and the genetic control of development will also be covered. May be repeated for credit. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

#### MMI 5553. Principles of Immunology. (3-0) 3 Credit Hours.

Prerequisite: BCH 3303 or equivalent. A study of cellular and molecular interaction between cells and molecules of the immune system and principles of immune system function. Topics include immune system development, humoral and cell-mediated immunity, disease and treatments, immunization, immunodeficiency, and autoimmunity. May be repeated for credit. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

### MMI 5573. Principles of Microbiology. (3-0) 3 Credit Hours.

Prerequisite: BCH 3303 and MMI 3713, or equivalents. A study of the cellular and molecular mechanisms by which bacterial, eukaryotic, parasitic and viral pathogens cause disease and the host immune responses against these pathogens. (Credit cannot be earned for both MMI 5573 and BIO 6573.) This course is available to Master and Doctoral students. May be repeated for credit. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

#### MMI 5971. Directed Research. (0-0) 1 Credit Hour.

The directed research course may involve either a laboratory or a theoretical problem. May be repeated for credit, but not more than 6 hours, regardless of discipline, in combination with MMI 5972 and MMI 5973 (Directed Research), and MMI 6951, MMI 6952, and MMI 6953 (Independent Study), will apply to the Master's degree. This course has Differential Tuition. Course Fee: GS01 \$30; IUB2 \$10.

### MMI 5972. Directed Research. (0-0) 2 Credit Hours.

The directed research course may involve either a laboratory or a theoretical problem. May be repeated for credit, but not more than 6 hours, regardless of discipline, in combination with MMI 5971 and MMI 5973 (Directed Research), and MMI 6951, MMI 6952, and MMI 6953 (Independent Study), will apply to the Master's degree. This course has Differential Tuition. Course Fees: GS01 \$60; IUB2 \$10.

#### MMI 5973. Directed Research. (0-0) 3 Credit Hours.

The directed research course may involve either a laboratory or a theoretical problem. May be repeated for credit, but not more than 6 hours, regardless of discipline, in combination with MMI 5971 and MMI 5972 (Directed Research), and MMI 6951, MMI 6952, and MMI 6953 (Independent Study), will apply to the Master's degree. This course has Differential Tuition. Course Fees: GS01 \$90; IUB2 \$10.

#### MMI 6323. Biostatistics. (3-0) 3 Credit Hours.

This course involves basic, intermediate, and advanced statistical vocabulary, concepts, and methods commonly used in the biomedical research. Concepts and appropriate selections of test/study design using power analyses and estimations of sample sizes; also for clinical trials. Analytical calibration curves, frequency distributions, descriptive statistics, measures of central tendency and dispersion/ error, probability, paired and unpaired, one-tailed and two-tailed t-tests, correlations, regression, one-way and two-way analysis of variance with repeated measures, parametric and nonparametric tests, post hoc tests for significance, reporting and interpretations of statistical results, validations of clinical tests for specificity, sensitivity, predictive values, likelihood ratios, and receiver operating characteristic curves. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

### MMI 6513. Drug Development. (3-0) 3 Credit Hours.

This course will provide students with an overview of the early drug discovery process, including target identification, validation, assay development, and high throughput screening up to pre-clinical trials. (Same as BIO 6513. Credit cannot be earned for both MMI 6513 and BIO 6513.) This course is available to Master and Doctoral students. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

#### MMI 6543. Vaccine Development. (3-0) 3 Credit Hours.

This course will provide students with an overview of issues about the roles of vaccines in the control of infectious diseases, vaccine development, clinical trials, and implementation of vaccine programs. (Same as BIO 6543. Credit cannot be earned for both MMI 6543 and BIO 6543.) This course is available to Master and Doctoral students. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

# MMI 6613. Introduction to Clinical Medicine and Pathology. (3-0) 3 Credit Hours.

Prerequisite: Graduate standing. Introduction to concepts of human disease, diagnosis, and underlying pathology. This course is available to Master and Doctoral students. Generally offered: Fall. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

#### MMI 6623. Internship in Biotechnology. (0-0) 3 Credit Hours.

Prerequisite: Enrollment in Master's in Biotechnology program and at least 18 credit hours including satisfactory completion of MMI 5013. An internship or a practicum in a Biotechnology company or approved research facility. Must have approval of Biotechnology Graduate Studies Committee. May be repeated for credit. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10; LRS1 \$46.20.

## MMI 6643. Introduction to Bioinformatics. (3-0) 3 Credit Hours.

The ability to sequence and analyze genomes has transformed biology. The genomic revolution has been made possible by the development of bioinformatics tools that combine computation with principles of molecular biology. In this course, students will learn how to use some of the major bioinformatics tools and will examine a few genomes to understand the vast amount of information present in them. This course is available to Master and Doctoral students. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

# MMI 6713. Advanced Clinical Medicine and Pathology. (3-0) 3 Credit Hours.

Prerequisite: MMI 6613. Advanced concepts of human disease, diagnosis, and underlying pathology. This course is available to Master and Doctoral students. Generally offered: Spring. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

#### MMI 6733. Advanced Medical Mycology. (3-0) 3 Credit Hours.

Prerequisite: MMI 3722 or equivalent. A comprehensive study of the etiological agents and host factors that lead to fungal disease in humans. This course is available to Master and Doctoral students. (Same as BIO 5733. Credit cannot be earned for both MMI 6733 and BIO 5733.) This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

### MMI 6743. Advanced Virology. (3-0) 3 Credit Hours.

Prerequisite: Graduate standing. A study of the diversity of animal viruses with emphasis on the molecular details of genome replication, gene expression, and pathogenesis. (Same as BIO 5743. Credit cannot be earned for both MMI 5743 and BIO 5743.) This course is available to Master and Doctoral students. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

#### MMI 6801. Comprehensive Examination. (0-0) 1 Credit Hour.

Prerequisite: Approval of the program's Graduate Advisor of Record. Enrollment is required each term in which the Comprehensive Examination is taken if no other courses are being taken that term. For students who are not writing theses, this exam aims to assess their capabilities to synthesize and explain knowledge acquired in their field of study in both written and oral formats. The exam includes material from a variety of external sources as well as those covered in regular courses. The grade report for the course is either "CR" (satisfactory performance on the Comprehensive Examination) or "NC" (unsatisfactory performance on the Comprehensive Examination). This course has Differential Tuition. Course Fee: GS01 \$30; LRS1 \$15.40; STSI \$7.20.

#### MMI 6803. Advanced Immunology. (3-0) 3 Credit Hours.

Prerequisite: MMI 4743 or consent of instructor. Advanced applications of current molecular and cellular concepts of humoral and cell-mediated immunity, with emphasis on host-pathogen interactions, experimental design, and immunological technologies. This course is available to Master and Doctoral students. (Same as BIO 6803. Credit cannot be earned for both MMI 6803 and BIO 6803.) This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

#### MMI 6883. Bacterial Pathogenesis. (3-0) 3 Credit Hours.

Prerequisite: MMI 3713 and MMI 4743, or consent of instructor. This course will present a selection of topics in the field of bacterial pathogenesis. Lectures will cover regulation of virulence, colonization and host tissue damage, vaccines, antibiotics, and novel antimicrobials, evasion of the immune system, intracellular pathogens, pathogenic mechanisms of Gram-negative and Gram-positive bacteria, pathogenic mycobacteriology, and experimental tools in bacterial pathogenesis. (Same as BIO 6883. Credit cannot be earned for both MMI 6883 and BIO 6883.) This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

# MMI 6923. Advanced Microbial Bioinformatics. (3-0) 3 Credit Hours.

Prerequisite: BIO 2313 or equivalent; MMI 6643, enrollment in Molecular Microbiology and Immunology Ph.D. program required, or permission of the Molecular Microbiology and Immunology Department or instructor. With the advent of next generation sequencing (NGS), genomes and transcriptomes are being added at ever growing rates to the public sequence repositories, which poses challenges for comprehensive data analyses and mining. In this course, students will learn and apply bioinformatics tools and strategies - from the profiling of individual genomes to large-scale multi-isolate comparisons - to harvest the rich information content that can be found in big sequence data. This course focuses on microbial genomics/transcriptomics/evolution with focus on pathogens. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

# MMI 6933. Data Analysis and Visualization for Biologists. (3-0) 3 Credit Hours.

An introduction to modern techniques used by data scientists; including data organization, manipulation, analysis, visualization, and in silico experimentation. Students will be taught how to use an open-source data science platform (KNIME) to design a workflow specific to their research project. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

## MMI 6951. Independent Study. (0-0) 1 Credit Hour.

This course involves independent reading, research, discussion, and/ or writing under the direction of a faculty member. This course is for students needing specialized work not normally or not often available as part of the regular course offerings. May be repeated for credit, but not more than 6 hours, regardless of discipline, in combination with MMI 5971, MMI 5972, and MMI 5973 (Independent Study), will apply to the Master's degree. This course has Differential Tuition. Course Fee: GS01 \$30; IUB2 \$10.

## MMI 6952. Independent Study. (0-0) 2 Credit Hours.

This course involves independent reading, research, discussion, and/ or writing under the direction of a faculty member. This course is for students needing specialized work not normally or not often available as part of the regular course offerings. May be repeated for credit, but not more than 6 hours, regardless of discipline, in combination with MMI 5971, MMI 5972, and MMI 5973 (Independent Study), will apply to the Master's degree. This course has Differential Tuition. Course Fee: GS01 \$60; IUB2 \$10.

## MMI 6953. Independent Study. (0-0) 3 Credit Hours.

This course involves independent reading, research, discussion, and/ or writing under the direction of a faculty member. This course is for students needing specialized work not normally or not often available as part of the regular course offerings. May be repeated for credit, but not more than 6 hours, regardless of discipline, in combination with MMI 5971, MMI 5972, and MMI 5973 (Independent Study), will apply to the Master's degree. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

## MMI 6973. Special Topics. (3-0) 3 Credit Hours.

Prerequisite: Consent of instructor. An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Topics courses may be repeated for credit if the topics vary. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

#### MMI 6981. Master's Thesis. (0-0) 1 Credit Hour.

Corequisites: Enrollment in MMI 6981, MMI 6982, or MMI 6983 is required each term in which the thesis is in progress. Thesis research and preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. This course has Differential Tuition. Course Fee: GS01 \$30; IUB2 \$10.

#### MMI 6982. Master's Thesis. (0-0) 2 Credit Hours.

Corequisites: Enrollment in MMI 6981, MMI 6982, or MMI 6983 is required each term in which the thesis is in progress. Thesis research and preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. This course has Differential Tuition. Course Fee: GS01 \$60; IUB2 \$10.

### MMI 6983. Master's Thesis. (0-0) 3 Credit Hours.

Corequisites: Enrollment in MMI 6981, MMI 6982, or MMI 6983 is required each term in which the thesis is in progress. Thesis research and preparation. May be repeated for credit, but not more than 6 hours will apply to the Master's degree. Credit will be awarded upon completion of the thesis. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

# MMI 7001. Professional and Leadership Development. (1-0) 1 Credit Hour.

This course focuses on building individual development plans and integration of professional and leadership skills. This course has Differential Tuition. Course Fee: GS01 \$30; IUB2 \$10.

# MMI 7031. Graduate Student Seminar: Acquiring Presentation Skills. (1-0) 1 Credit Hour.

This course includes oral presentations, discussions, critical evaluation of students' research in progress, or support preparation of manuscripts/ reviews by students to publish their data sets. The grade report for the course is either "CR" (satisfactory performance) or "NC" (unsatisfactory performance). May be repeated for credit. This course has Differential Tuition. Course Fee: GS01 \$30; IUB2 \$10.

# MMI 7041. Molecular Microbiology and Immunology Colloquium. (1-0) 1 Credit Hour.

Prerequisite: Graduate standing. This course includes oral presentations, discussions, critical evaluation of students' research in progress, or discussions of current journal articles or reviews of recent scientific advances. The grade report for the course is either "CR" (satisfactory performance) or "NC" (unsatisfactory performance). May be repeated for credit if topic varies. This course has Differential Tuition. Course Fee: GS01 \$30; IUB2 \$10.

## MMI 7051. Molecular Microbiology and Immunology Seminar. (1-0) 1 Credit Hour.

Prerequisite: Graduate standing. This course includes formal presentations of research by outside authorities in the biological sciences. The grade report for the course is either "CR" (satisfactory performance) or "NC" (unsatisfactory performance). May be repeated for credit. This course has Differential Tuition. Course Fee: GS01 \$30; IUB2 \$10.

## MMI 7113. Teaching in Life Sciences. (3-0) 3 Credit Hours.

Prerequisite: Admission to candidacy for the Doctoral degree. Required course for Molecular Microbiology and Immunology doctoral students. The student will be responsible for all aspects of leading a discussion section or laboratory course. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

# MMI 7143. Principles of Scientific Writing. (3-0) 3 Credit Hours.

Prerequisite: Admission to candidacy for the Molecular Microbiology and Immunology Doctoral degree. This course will provide an overview of scientific grant and manuscript preparation. The class will be directed toward producing a Ph.D. dissertation proposal and a predoctoral fellowship application. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

# MMI 7211. Doctoral Research. (0-0) 1 Credit Hour.

Prerequisite: Admission to Molecular Microbiology and Immunology Doctoral program. May be repeated for credit, but no more than 27 hours may be applied to the Doctoral degree. This course has Differential Tuition. Course Fees: GS01 \$30; IUB2 \$10.

## MMI 7212. Doctoral Research. (0-0) 2 Credit Hours.

Prerequisite: Admission to Molecular Microbiology and Immunology Doctoral program. May be repeated for credit, but no more than 27 hours may be applied to the Doctoral degree. This course has Differential Tuition. Course Fees: GS01 \$60; IUB2 \$10.

# MMI 7213. Doctoral Research. (0-0) 3 Credit Hours.

Prerequisite: Admission to Molecular Microbiology and Immunology Doctoral program. May be repeated for credit, but no more than 27 hours may be applied to the Doctoral degree. This course has Differential Tuition. Course Fees: GS01 \$90; IUB2 \$10.

### MMI 7214. Doctoral Research. (0-0) 4 Credit Hours.

Prerequisite: Admission to either the Molecular Microbiology and Immunology, Neuroscience, or Cell and Molecular Biology Doctoral program. May be repeated for credit, but no more than 27 hours may be applied to the Doctoral degree. This course has Differential Tuition. Course Fees: GS01 \$120; IUB2 \$10.

## MMI 7215. Doctoral Research. (0-0) 5 Credit Hours.

Prerequisite: Admission to either the Molecular Microbiology and Immunology, Neuroscience, or Cell and Molecular Biology Doctoral program. May be repeated for credit, but no more than 27 hours may be applied to the Doctoral degree. This course has Differential Tuition. Course Fees: GS01 \$150; IUB2 \$10; STSF \$10.

## MMI 7216. Doctoral Research. (0-0) 6 Credit Hours.

Prerequisite: Admission to Molecular Microbiology and Immunology Doctoral program. May be repeated for credit, but no more than 27 hours may be applied to the Doctoral degree. This course has Differential Tuition. Course Fees: GS01 \$180; IUB2 \$10.

## MMI 7311. Doctoral Dissertation. (0-0) 1 Credit Hour.

Prerequisite: Admission to candidacy for the Molecular Microbiology and Immunology Doctoral degree and completion of at least 1-6 semester credit hours of MMI 7211, MMI 7212, MMI 7213, MMI 7214, MMI 7215, or MMI 7216. May be repeated for credit, but no more than 45 hours may be applied to the Doctoral degree. This course has Differential Tuition. Course Fee: GS01 \$30; IUB2 \$10.

# MMI 7312. Doctoral Dissertation. (0-0) 2 Credit Hours.

Prerequisite: Admission to candidacy for the Molecular Microbiology and Immunology Doctoral degree and completion of at least 1-6 semester credit hours of MMI 7211, MMI 7212, MMI 7213, MMI 7214, MMI 7215, or MMI 7216. May be repeated for credit, but no more than 45 hours may be applied to the Doctoral degree. This course has Differential Tuition. Course Fee: GS01 \$60; IUB2 \$10.

## MMI 7313. Doctoral Dissertation. (0-0) 3 Credit Hours.

Prerequisite: Admission to candidacy for the Molecular Microbiology and Immunology Doctoral degree and completion of at least 1-6 semester credit hours of MMI 7211, MMI 7212, MMI 7213, MMI 7214, MMI 7215, or MMI 7216. May be repeated for credit, but no more than 45 hours may be applied to the Doctoral degree. This course has Differential Tuition. Course Fee: GS01 \$90; IUB2 \$10.

### MMI 7314. Doctoral Dissertation. (0-0) 4 Credit Hours.

Prerequisite: Admission to candidacy for the Molecular Microbiology and Immunology Doctoral degree and completion of at least 1-6 semester credit hours of MMI 7211, MMI 7212, MMI 7213, MMI 7214, MMI 7215, or MMI 7216. May be repeated for credit, but no more than 45 hours may be applied to the Doctoral degree. This course has Differential Tuition. Course Fee: GS01 \$120; IUB2 \$10.

### MMI 7315. Doctoral Dissertation. (0-0) 5 Credit Hours.

Prerequisite: Admission to candidacy for the Molecular Microbiology and Immunology Doctoral degree and completion of at least 1-6 semester credit hours of MMI 7211, MMI 7212, MMI 7213, MMI 7214, MMI 7215, or MMI 7216. May be repeated for credit, but no more than 45 hours may be applied to the Doctoral degree. This course has Differential Tuition. Course Fee: GS01 \$150; IUB2 \$10.

# MMI 7316. Doctoral Dissertation. (0-0) 6 Credit Hours.

Prerequisite: Admission to candidacy for the Molecular Microbiology and Immunology Doctoral degree and completion of at least 1-6 semester credit hours of MMI 7211, MMI 7212, MMI 7213, MMI 7214, MMI 7215, or MMI 7216. May be repeated for credit, but no more than 45 hours may be applied to the Doctoral degree. This course has Differential Tuition. Course Fee: GS01 \$180; IUB2 \$10.

## MMI 7571. Doctoral Rotation. (0-3) 1 Credit Hour.

Prerequisite: Admission to the Molecular Microbiology and Immunology Ph.D. program. This course allows students to perform laboratorybased research under the direction of a Molecular Microbiology and Immunology faculty member. Students will receive mentoring and training in the areas of experimental design, experimentation, data acquisition, data analysis, and presentation (oral/written). May be repeated for credit, but no more than 6 hours may be applied to the Doctoral degree. This course has Differential Tuition. Course Fee: GS01 \$30; IUB2 \$10.

#### MMI 7572. Doctoral Rotation. (0-6) 2 Credit Hours.

Prerequisite: Admission to the Molecular Microbiology and Immunology Ph.D. program. This courses allows students to perform laboratorybased research under the direction of a Molecular Microbiology and Immunology faculty member. Students will receive mentoring and training in the areas of experimental design, experimentation, data acquisition, data analysis, and presentation (oral/written). May be repeated for credit, but no more than 6 hours may be applied to the Doctoral degree. This course has Differential Tuition. Course Fees: GS01 \$60; IUB2 \$10.