Immunology and Microbial Pathogenesis, Ph.D.

Degrees Offered

• Doctor of Philosophy
• Joint Doctor of Medicine and Doctor of Philosophy

Nature of the Program

The Doctor of Philosophy degree in Immunology and Microbial Pathogenesis will prepare students from diverse backgrounds to serve as professionals that are knowledgeable about the immune system of humans and other mammals, how the immune system functions, and the consequences of its malfunction on the health of the host. Knowledge of the immune system will be fully integrated with an excellent understanding of the diversity of microorganisms that cause disease in humans and other mammals and mechanisms of disease pathogenesis. Students in the program will apply this knowledge to broad areas of research including the understanding of pathogen-host interactions and development of immunotherapies and vaccines. Graduates will possess the laboratory skills and knowledge needed to assess the functional status of the immune system and to assess the mechanism used by microbial agents to cause disease in mammals. Graduates will be qualified to pursue several professional career paths in private industry, state and federal government, and academic institutions.

The doctoral program in Immunology and Microbial Pathogenesis emphasizes extensive laboratory research in microbiology, immunology, microbial pathogenesis, and/or cell biology, i.e. the major purpose of graduate education in the program is research training. The basic philosophy of the program is that students acquire a strong foundation in the basic concepts of immunology and microbial pathogenesis and have flexibility in choosing advanced coursework in their specific areas of interest. Each student will complete an original, in-depth research investigation. Its learner-centered curriculum integrates both classroom and hands-on research experiences to produce students capable of designing and doing independent research and teaching.

Completion of the Ph.D. degree is realized when the student successfully presents the research results to faculty of the graduate dissertation committee and program/department. Typically, four to five years are required to realize this goal.

Faculty members and students explore diverse areas of inquiry related to the medical implications of microbes and the human body’s response to them.

Current Research Areas

IMMUNOLOGY

• Vaccines and immunotherapies against bacterial pathogens
• Autoimmune diseases and neuroimmunology
• Effects of stroke on the immune system
• Influence of sex chromosomes on immunity
• Biochemistry of inflammatory cytokines
• Immune response in bacterial and viral diseases
• Antibody function and use as therapeutics
• Regulation of signal transduction in immune responses
• Molecular aspects of cell signaling as it relates to cancer chemotherapy and cell growth
• Genomics studies of the immune system
• Effects of man-made pesticides and herbicides on the immune system
• Effects of heavy metals on the immune system

MICROBIOLOGY

• Physiology of pathogenic microbes
• Microbial genetics
• Mechanisms of bacterial pathogenesis
• Chemotaxis and motility
• Interactions between microbes and their hosts
• Vaccines and immunotherapies against bacterial pathogens
• Molecular mimicry and structure-function relationship of bacterial virulence factors
• Microbial biofilms
FACULTY
CHAIR
• John B. Barnett - Ph.D. (University of Louisville)

GRADUATE PROGRAM DIRECTOR
• Mariette Barbier - Ph.D. (Universitat de les Illes Balears)

PROFESSOR
• Laura F. Gibson - Ph.D. (West Virginia University)

ASSOCIATE PROFESSORS
• Tim Eubank - Ph.D. (The Ohio State University)
• Slawomir Lukomski - Ph.D. (University of Lodz, Poland)
• Karen Martin - Ph.D. (Duke University)
• Edmidio Pistilli - Ph.D. (West Virginia University)
• Cory Robinson - Ph.D. (Miami University of Ohio)

ASSISTANT PROFESSORS
• Kathy Brundage - Ph.D. (University of Pennsylvania)
• Jonathan Busada - Ph.D. (East Carolina University)
• F. Heath Damron - Ph.D. (Marshall University)
• Meenal Elliott - Ph.D. (University of Alabama)
• Jennifer Franko - Ph.D. (Case Western Reserve University)
• Michael Hu - Ph.D. (Peking University)
• Tracy Liu - Ph.D. (University of Toronto)
• Ivan Martinez - Ph.D. (University of Pittsburgh)
• Gordon Meares - Ph.D. (University of Alabama)
• Edwin Wan - Ph.D. (City University of Hong Kong)
• Valerie Watson - M.S. (West Virginia University)

TEACHING ASSOCIATE PROFESSOR
• Kelly Collins - Ph.D. (University of Cincinnati)

ADJUNCT PROFESSORS
• Don Beezhold - Ph.D. (University of Illinois Medical Center)
• John Noti - Ph.D. (Purdue University)
• David Weissman - M.D. (Northwestern University)

ADJUNCT ASSISTANT PROFESSORS
• Stacey Anderson - Ph.D. (West Virginia University)
• Candice Brown - PhD (Duke University)
• Alexandra Elliott - Ph.D. (West Virginia University)
• David Klinke - Ph.D. (Northwestern University)
• Yong Qian - Ph.D. (West Virginia University)
• Jenny Roberts - Ph.D. (West Virginia University)

LECTURER
• Michelle Witt - M.S. (Virginia Tech)

Doctor of Philosophy
MAJOR REQUIREMENTS - STANDARD TRACK

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMS 700</td>
<td>Scientific Integrity</td>
<td>1</td>
</tr>
<tr>
<td>BMS 701</td>
<td>Scientific Rigor and Ethics</td>
<td>1</td>
</tr>
<tr>
<td>Course Code</td>
<td>Course Title</td>
<td>Credits</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>BMS 702</td>
<td>Biomedical Lab Experience</td>
<td>2</td>
</tr>
<tr>
<td>BMS 706</td>
<td>Biomedical Research Methods</td>
<td>1</td>
</tr>
<tr>
<td>BMS 707</td>
<td>Experiential Learning for Biomedical Trainees</td>
<td>2</td>
</tr>
<tr>
<td>BMS 720</td>
<td>Scientific Writing</td>
<td>2</td>
</tr>
<tr>
<td>BMS 747</td>
<td>Foundations for Contemporary Biomedical Research I</td>
<td>4</td>
</tr>
<tr>
<td>BMS 777</td>
<td>Foundations for Contemporary Biomedical Research 2</td>
<td>4</td>
</tr>
</tbody>
</table>

Advanced MICB Courses - 2 from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MICB 781</td>
<td>Advanced Immunology</td>
<td>5-7</td>
</tr>
<tr>
<td>MICB 782</td>
<td>Advanced Microbiology</td>
<td></td>
</tr>
<tr>
<td>MICB 793</td>
<td>Special Topics (Vaccinology)</td>
<td></td>
</tr>
<tr>
<td>MICB 785</td>
<td>Immunology and Microbiology Journal Club (Minimum of 7; Every semester until graduation)</td>
<td>7</td>
</tr>
<tr>
<td>MICB 790</td>
<td>Teaching Practicum</td>
<td>2</td>
</tr>
<tr>
<td>MICB 796</td>
<td>Graduate Seminar (Minimum of 7; Every semester until graduation)</td>
<td>7</td>
</tr>
<tr>
<td>MICB 797</td>
<td>Research (1-15 per semester)</td>
<td>45</td>
</tr>
</tbody>
</table>

Qualifying Exam

Dissertation Proposal

Dissertation Defense

Total Hours: 83-85

MAJOR REQUIREMENTS - FAST TRACK

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMS 700</td>
<td>Scientific Integrity</td>
<td>1</td>
</tr>
<tr>
<td>BMS 701</td>
<td>Scientific Rigor and Ethics</td>
<td>1</td>
</tr>
<tr>
<td>BMS 707</td>
<td>Experiential Learning for Biomedical Trainees</td>
<td>2</td>
</tr>
<tr>
<td>BMS 720</td>
<td>Scientific Writing</td>
<td>2</td>
</tr>
</tbody>
</table>

Advanced MICB Courses - 2 from the following:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MICB 781</td>
<td>Advanced Immunology</td>
<td>5-7</td>
</tr>
<tr>
<td>MICB 782</td>
<td>Advanced Microbiology</td>
<td></td>
</tr>
<tr>
<td>MICB 793</td>
<td>Special Topics (Vaccinology)</td>
<td></td>
</tr>
<tr>
<td>MICB 785</td>
<td>Immunology and Microbiology Journal Club (Minimum of 7; Every semester until graduation)</td>
<td>7</td>
</tr>
<tr>
<td>MICB 790</td>
<td>Teaching Practicum</td>
<td>2</td>
</tr>
<tr>
<td>MICB 796</td>
<td>Graduate Seminar (Minimum of 7; Every semester until graduation)</td>
<td>7</td>
</tr>
<tr>
<td>MICB 797</td>
<td>Research (1-15 per semester)</td>
<td>45</td>
</tr>
</tbody>
</table>

Qualifying Exam

Dissertation Proposal

Dissertation Defense

Total Hours: 72-74

Seminars and Research Forum

Students are required to register for MICB 796 each semester of residence and are required to present at least one seminar during each school calendar year (Fall – Spring semesters).

Journal Club

Students are required to enroll in Journal Club each semester. The course involves the presentation and discussion of current research papers and will help acquaint students with the variety of methods used in scientific research.

Doctoral Research

Students will conduct research with a dissertation mentor during time in the program. Students register for research credits each semester, and their performance is graded by their dissertation mentor.

Qualifying and Dissertation Proposal/Ph.D. Candidacy

The written qualifying exam is given at the end of the first year of study. The dissertation proposal is completed in the third year of study. Admission to Ph.D. candidacy occurs following the successful defense of the dissertation proposal.
Dissertation Defense and First-Author Paper Requirement

Students are allowed to defend their dissertation when a minimum of one manuscript with the student as first author, based on dissertation research, is accepted in a peer-reviewed journal. The final examination for the Ph.D. degree consists of orally defending a written dissertation in a public seminar and then in private to the dissertation committee. Satisfactory performance in the oral defense will result in recommendation for granting of the Ph.D.

Suggested Plan of Study*

<table>
<thead>
<tr>
<th>First Year</th>
<th>Fall Hours</th>
<th>Spring Hours</th>
<th>Summer Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMS 700</td>
<td>1</td>
<td>1 BMS 701</td>
<td>1 MicB 797</td>
</tr>
<tr>
<td>BMS 706</td>
<td>1</td>
<td>1 MicB 785</td>
<td>1 Qualifying Examination</td>
</tr>
<tr>
<td>BMS 702</td>
<td>2</td>
<td>2 MicB 796</td>
<td>1</td>
</tr>
<tr>
<td>BMS 747</td>
<td>4</td>
<td>4 MicB 797</td>
<td></td>
</tr>
<tr>
<td>BMS 777</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second Year</th>
<th>Fall Hours</th>
<th>Spring Hours</th>
<th>Summer Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MicB 785</td>
<td>1</td>
<td>1 MicB 781</td>
<td>3 BMS 720</td>
</tr>
<tr>
<td>MicB 790</td>
<td>1</td>
<td>1 MicB 785</td>
<td>1 MicB 797</td>
</tr>
<tr>
<td>MicB 782 or 793</td>
<td>2 to 4 MicB 790</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>MicB 796</td>
<td>1</td>
<td>1 MicB 796</td>
<td></td>
</tr>
<tr>
<td>MicB 797</td>
<td>3</td>
<td>3 MicB 797</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8-10</td>
<td>9</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Third Year</th>
<th>Fall Hours</th>
<th>Spring Hours</th>
<th>Summer Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MicB 785</td>
<td>1</td>
<td>1 MicB 785</td>
<td>1 MicB 797</td>
</tr>
<tr>
<td>MicB 796</td>
<td>1</td>
<td>1 MicB 796</td>
<td>1 BMS 707</td>
</tr>
<tr>
<td>MicB 797</td>
<td>7</td>
<td>7 MicB 797</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>9</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fourth Year</th>
<th>Fall Hours</th>
<th>Spring Hours</th>
<th>Summer Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MicB 785</td>
<td>1</td>
<td>1 MicB 785</td>
<td>1 MicB 797</td>
</tr>
<tr>
<td>MicB 796</td>
<td>1</td>
<td>1 MicB 796</td>
<td></td>
</tr>
<tr>
<td>MicB 797</td>
<td>7</td>
<td>7 MicB 797</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>9</td>
<td>3</td>
</tr>
</tbody>
</table>

Total credit hours: 83-85

NOTE: The graduate curriculum is finalized with a plan of study once the mentor and laboratory have been selected in the first year. The plan of study is developed by the graduate committee in consultation with the student. The courses listed above include the required and elective coursework necessary for the student to finalize his/her plan of study. When the student enters the laboratory of his/her doctoral dissertation mentor repetitive enrollments in research, seminars, and colloquia are typical and will determine total hours necessary for degree completion.

*This is a suggested plan of study. Course sequences and length of time in program may vary depending on student and altered total credit hours.

Major Learning Outcomes

IMMUNOLOGY AND MICROBIAL PATHOGENESIS

Students will:

- Identify and summarize the basic concepts of microbiology, microbial pathogenesis, and immunology.
- Integrate detailed knowledge in microbiology, microbial pathogenesis, and immunology with the knowledge of student's area of research.
- Discuss, critique, and interpret primary research literature in microbiology, microbial pathogenesis, immunology, and in the student's area of research.
- Identify meaningful problems and questions for research in microbiology, microbial pathogenesis, and immunology.
• Acquire expertise and use laboratory techniques required to perform experiments in the student’s area of research.
• Design experimental protocols and conduct self-directed research that results in presentations at scientific meeting and publications.
• Demonstrate oral, written, and visual communication skills that result in clear and organized dissemination of material at a level appropriate for the audience.

COURSES

MICB 500. Medical Microbiology. 3 Hours.
Provides basic background in medical microbiology. Emphasis is on basic structure of all microorganism groups including bacteria, fungi, viruses, protozoa and helminths; epidemiology, immunology, and infectious disease.

MICB 522. Bioinformatics Resource for Epigenomic Data Analysis. 2 Hours.
The course introduces basic concepts in epigenomic data analysis for several commonly used genome-wide profiling techniques, such as RNA-Seq, ChiP-seq, and DNase-seq/ATAC-seq, and offers hand-on experience for a set of frequently used standalone GUI tools, online databases, and web servers.

MICB 581. Advanced Immunology. 3 Hours.
Students participate in a study of contemporary topics using primary literature selected from recent developments in the field of immunology.

MICB 582. Advanced Microbiology. 2 Hours.
Current methodologies and topics in microbial pathogenesis, pathophysiology of the disease, and host-pathogen interactions. Course involves active learning techniques, including critical assessment of primary research reports, designing and presenting lectures to faculty and peers, or interacting with invited outside seminar speakers.

MICB 583. Advanced Vaccinology. 3-4 Hours.
Students will explore vaccinology from theory, to models, to human uses.

MICB 590. Teaching Practicum. 1-3 Hours.
PR: Consent. Supervised practice in college teaching.

MICB 592. Directed Study. 1-6 Hours.
Directed study, reading, and/or research.

MICB 593. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.

MICB 691. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

MICB 697. Research. 1-9 Hours.
PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project, or a dissertation. (Grading may be S/U).

MICB 698. Thesis or Dissertation. 1-6 Hours.
PR: Consent. This is an optional course for programs that wish to provide formal supervision during the writing of student reports (698), or dissertations (798). Grading is normal.

MICB 699. Graduate Colloquium. 1-6 Hours.
PR: Consent. For graduate students not seeking coursework credit but who wish to meet residency requirements, use the University’s facilities, and participate in its academic and cultural programs. Note: Graduate students who are not actively involved in coursework or research are entitled, through enrollment in their department’s Graduate Colloquium to consult with graduate faculty, participate in both formal and informal academic activities sponsored by their program, and retain all of the rights and privileges of duly enrolled students. Grading is P/F; colloquium credit may not be counted against credit requirements for masters programs. Registration for one credit of 699/799 graduate colloquium satisfies the University requirement of registration in the semester in which graduation occurs.

MICB 702. Microbiology. 5 Hours.
(For dental students only.) PR: Organic chemistry. Detailed study of pathogenic microorganisms. Emphasis on oral flora.

MICB 720. Cellular Immunobiology. 3 Hours.
This course will study contemporary topics in immunology from a research perspective. The primary focus of this course is to examine the impact of significant research discoveries on shaping current knowledge in immunology and disease. Students are expected to have prior understanding of basic immunology.

MICB 721. Bacterial Pathogenesis. 4 Hours.
Examines cellular and molecular-level strategies used by pathogens to survive and multiply in host systems, as well as modern approaches for studying these processes.

MICB 722. Bioinformatics Resource for Epigenomic Data Analysis. 2 Hours.
The course introduces basic concepts in epigenomic data analysis for several commonly used genome-wide profiling techniques, such as RNA-Seq, ChiP-seq, and DNase-seq/ATAC-seq, and offers hand-on experience for a set of frequently used standalone GUI tools, online databases, and web servers.
MICB 781. Advanced Immunology. 3 Hours.
Students participate in a study of contemporary topics using primary literature selected from recent developments in the field of immunology.

MICB 782. Advanced Microbiology. 2 Hours.
PR: (BMS 777 and MICB 721) or MICB 801. Current methodologies and topics in microbial pathogenesis, pathophysiology of the disease, and host-pathogen interactions. Course involves active learning techniques, including critical assessment of primary research reports, designing and presenting lectures to faculty and peers, or interacting with invited outside seminar speakers.

MICB 783. Advanced Vaccinology. 3-4 Hours.
Students will explore vaccinology from theory, to models, to human uses.

MICB 784A. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784B. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784C. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784D. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784E. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784F. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784G. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784H. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784I. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784J. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784K. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784L. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784M. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784N. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784O. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784P. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784Q. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784R. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784S. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784T. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784U. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784V. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.
MICB 784W. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784X. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784Y. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 784Z. Special Problems in Microbiology. 1-6 Hours.
PR: Consent.

MICB 785. Immunology and Microbiology Journal Club. 1-2 Hours.
A review of contemporary topics selected from developments in the field during the current year.

MICB 790. Teaching Practicum. 1-3 Hours.
PR: Consent. Supervised practice in college teaching of microbiology. Note: This course is intended to insure that graduate assistants are adequately prepared and supervised when they are given college teaching responsibility. It will also present a mechanism for students not on assistantships to gain teaching experience. (Grading will be P/F.)

MICB 791. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

MICB 792. Directed Study. 1-6 Hours.
Directed study, reading, and/or research.

MICB 793. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.

MICB 795. Immunology and Microbiology Journal Club. 1-2 Hours.
A review of contemporary topics selected from developments in the field during the current year.

MICB 796. Graduate Seminar. 1-3 Hours.
PR: Consent. Each graduate student will present at least one seminar to the assembled faculty and graduate student body of his or her program.

MICB 797. Research. 1-9 Hours.
PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project, or a dissertation. (Grading will be S/U.)

MICB 801. Immunity, Infection and Disease. 9 Hours.
An integrated approach to the study of infectious disease in humans, with focus on innate and acquired immunity, mechanisms of pathogenesis of infectious microorganisms, transmission, and treatment.

MICB 812. Immunity, Infection and Disease (MICRO) 1. 4 Hours.
The overall objective of this course is to understand the biology of diseases caused by microbial infection and the immune response that follows microbial infection in humans. The first section of the course will review the cells, tissues, and functions of the vertebrate immune system; the second section reviews the basic structure, physiology, and genetics of classes of infectious microorganisms.

MICB 820. Immunity, Infection and Disease (MICRO) 2. 4 Hours.
PR: Medical students must satisfactorily pass all first-year MD Degree courses to enroll in this course. The overall objective of this course is to understand the biology of diseases caused by microbial infection and the immune response that follows microbial infection in humans. The first section of the course will review the cells, tissues, and functions of the vertebrate immune system; the second section reviews the basic structure, physiology, and genetics of classes of infectious microorganisms.