

**Ph.D. Program
Molecular Microbiology and Immunology (MMI)
Saint Louis University School of Medicine**

I. Overview

The Department of Molecular Microbiology and Immunology and Immunology (MMI) offers a graduate program in molecular microbiology and immunology leading to a Ph.D. degree. Our goal is to graduate exceptionally well-trained professionals who possess the necessary background and experience for a career in a research institution, academe or biotechnology. The Department reflects the strength and diversity of its faculty through a unifying focus of the study of host-pathogen interactions with areas of interest including: viral pathogenesis, immunology, molecular chaperones, gene regulation at the transcription and RNA processing levels and gene therapy. Molecular and cellular biology along with genetics and animal models form the intellectual and technical basis for the research.

Although each Ph.D. candidate will have a least one major mentor, the responsibility for the education of each Ph.D. student ultimately lies with faculty of the Department as a whole. Each graduate student participates with the Faculty in designing a program that meets the academic needs of the student. Each student receives a firm grounding in cellular and molecular biology, immunology, molecular genetics, and biochemistry.

All individuals interested in the MMI graduate program must enroll through the Core Graduate Program in Biomedical Sciences, a one year program where the student receives a strong foundation in Molecular and Cellular Biology and exposure to the diverse programs of scientific investigation carried out in the Saint Louis University's Health Sciences Center. As part of the first year Core Program, students undertake 3 or 4 six week rotations in laboratories among the basic science departments of the Health Sciences Center in order to select a mentor and department for study towards a Ph.D. degree.

II. Prerequisites

A Bachelor of Science or Masters degree is required and course work that includes: college physics, calculus, organic chemistry and the biological sciences.

III. Criteria for the Ph.D. Degree

A. Course Work (48 hrs)

1. First Year

1st Semester

BBS-G501 5 hrs Basic Biomedical Sciences I

BBS-G502 4 hrs Special Topics in Basic Biomedical Sciences

BBS-G592 1 hr Basic Biomedical Science Colloquium

BBS-G597 2 hrs Introduction to Basic Biomedical Research

2nd Semester

BBS-G503 5 hrs Basic Biomedical Sciences II

BBS-G504 4 hrs Special Topics in Basic Biomedical Sciences II

BBS-G597 2 hrs Introduction to Basic Biomedical Research

BBS-G592 1 hr Basic Biomedical Science Colloquium

BBS-G510 0 hrs Ethics for Research Scientists

2. Second Year

1st Semester

MB-G665 3 hrs Basic Immunobiology

xxxxx 2-4 hrs Electives**

MB-G691 1 hr MMI Journal Club

2nd Semester

MB-G635 3 hrs General Virology

xxxxx 2-4 hrs Electives**

MB-G691 1 hr MMI Journal Club

3. Third Year

1st Semester

MB-G624 2-3 hrs Advanced Topics in Immunology (encouraged but not mandatory)

MB-G691 1 hr MMI Journal Club

xxxxx 2-4 hrs Electives**

2nd Semester

MB-G650 3 hrs Oncogenic Viruses and HIV(encouraged but not mandatory)

MB-G691 1 hr MMI Journal Club

xxxxx 2-4 hr Electives**

4. Subsequent Years

MB-G691 1 hr MMI Journal Club

MB-G699 12 hrs Dissertation Research

**Electives: These can be any Advanced Topics courses offered by any Department. Electives may in fact be taken at any time in the student's graduate program - not necessarily in the second year; however, at least 48 hours of course work must be taken over the course of the Ph.D. In the second year, the graduate committee advises the student and his/her mentor to make a tentative plan for meeting the course requirements before the 4th year of graduate school (see course listing below).

B. Preliminary Degree Examination

The Preliminary Degree Examination is required to be taken prior to August of the second year. The examination is composed of both a written and oral component. The written component is termed the Preliminary Proposal, and it consists of a research proposal structured in the format of an NIH grant. The maximum page number including figures should be no more than 14 pages (minimum 11 point font, 0.5 in page margins). The topic of the proposal stems from the research interests of the mentor. The entire Departmental faculty reviews the proposal and examines the student on its content in an oral examination in order to test the student's comprehension and integration of knowledge not only in the area of the proposal but also in molecular biology, cell biology, virology, and immunology (especially topics covered in course work). This exam allows weaknesses and deficiencies in the student's training to be identified, which then can be corrected. A pass in this examination requires a majority vote of approval. Should the student fail, a second exam will be scheduled within three months. Completion of this examination is required to allow continuation into the third year.

C. Oral Examination

The Oral Examination will follow one year later (no later than August of the third year), and is composed of a written and oral component. The written component is called the Major Proposal, and is to be a maturation of the Preliminary Proposal (e.g. the Major Proposal will probably contain preliminary data developed by the student). The student will be required to submit their application to a funding agency in the format of that agency. It does not necessarily have to be submitted to the NIH, it could be to any appropriate agency. The grant application must be submitted within six months following the Oral Examination; however, the submission may occur after the Preliminary Degree Examination. Since some grants are targeted to students early in the program and other grants are targeted to mature students, the time when the grant is submitted is flexible and will depend on the circumstances of the student. The student's mentor and the examining committee for the Preliminary Degree Examination will make judgments about when and where the grant application should be submitted. The Major Proposal will be presented to a committee of the Graduate Faculty which includes as Chairman, the students' mentor, plus four other faculty members who may have appointments outside of the Department. The student is orally examined on the proposal and the area of research. At least four votes of approval are required for successful completion of this examination. If the student fails the examination, the examination committee plus the Dean of the Graduate School must approve a second attempt. A third attempt is rarely approved, and is considered by the Dean of the Graduate School only upon unanimous recommendation of the examining committee. This exam must be successfully completed by August of the 4th year.

D. Dissertation (12 hrs)

a. Dissertation Committee.

This committee includes as chairman the student's mentor and usually two members of the Graduate Faculty who served on Preliminary Degree Examination committee. An outline of the proposed dissertation must be submitted to, and gain approval from, the Dissertation Committee within 1 month of successful completion of the Oral Examination. Thereafter the Dissertation Committee will meet quarterly to review and critique the research progress.

Students are encouraged to interact with the members of their committee on an informal basis throughout the year.

In the event that a student finds it necessary to make a major change(s) in their proposed dissertation research, they are required to prepare a proposal outlining the changes and call a meeting of their Dissertation Committee at the time that the changes are made.

b. Application for the Ph.D. degree.

Within one month following successful completion of the Oral Examination, the student files with the Dean of the Graduate School candidacy papers including a formal outline setting forth the title and subject matter of the proposed dissertation. If the proposed research is to involve laboratory animals, the Animal Care Committee of the University must review and approve the research design. If the proposed research involves human subjects, the research design and any informed consent materials must be submitted to the Institutional Review Board for approval. The Ph.D. candidacy papers, research outline, recommendation of the Dissertation Committee, and any required research design approvals are submitted to the Graduate Dean who informs the student in writing of his/her advancement of Ph.D. Candidacy.

E. Annual Research Progress Report 1

All students are required to submit a progress report one week prior to their annual Spring research seminar (MB-G 692, Microbiology Research Club).

I. Goals

- a. Encourage students to periodically review their data from the perspective of integrating it into a publishable work.
- b. Alert students when specific weaknesses in their performance are detected, and provide support and assistance in rectifying them.
- c. Provide students with a clear and reliable yardstick by which to measure their progress toward completion of their dissertation research.
- d. Ensure that the dissertation is completed in a timely fashion.

2. Achievement of Goals

- a. Students will prepare a written progress report of no more than four double-spaced, typed pages (minimum 11 point font, 0.5 in. margins), including figures. This report should include:
 - i. A short paragraph reviewing the background of the project.
 - ii. A list of the original specific aims, posed as hypotheses being tested.
 - iii. A brief description of the work accomplished toward these aims in the previous year, as viewed from the perspective of integrating the data into a publishable report(s):
 - What are the most important data and what conclusions can be drawn from them?
 - How do these data fit the original hypothesis?
 - What additional experiments/controls are needed to make a publishable story?
 - A list of any minor changes or adjustments needed in the original specific aims with a brief justification.
 - A realistic timetable of work to be accomplished in the following year.

- b. The progress report is submitted to the members of the faculty and to each member of the student's Dissertation Committee at least one week prior to the scheduled seminar. (If one or more members of the Dissertation Committee come from outside of MMI, then the student should invite them to attend their scheduled seminar.)

- c. At the scheduled seminar, students present their data and discuss the details of the written report with the faculty.

- d. Each faculty member is expected to grade the student's performance in each of 11 areas, and provide the student with constructive suggestions for improvement.
 - i. Quality of the written report.
 - ii. Quality of the presentation.

- iii. Suitability of timetable for the next year.
 - iv. Knowledge of the literature.
 - v. Ability to answer questions.
 - vi. Soundness of the conclusions drawn from the data.
 - vii. Treatment of alternative interpretations of the data.
 - viii. Ability to formulate research questions as hypotheses to be tested.
 - ix. Relevance of the data to the specific aims.
 - x. Ability to formulate research question as hypotheses to be tested.
 - xi. Research productivity/completion of specific aims.
- e. Each faculty and Dissertation Committee member is expected to submit a completed evaluation form for the student's records. A majority of the total ratings of the dissertation committee must be "B" or better to attain a passing grade for the semester of "Dissertation Research". Prior to the formation of a Dissertation Committee, the evaluation forms will be forwarded to the Graduate Program Directors who will synthesize a report. All evaluation forms and summary reports will be forwarded to the student and to the student's mentor.
- f. An "unsatisfactory" rating by the faculty, failure to submit an acceptable progress report on time, or failure to involve committee members when a major change in the dissertation research is made will automatically result in an unsatisfactory "Dissertation Research" grade for the semester and placement of the student on academic probation. The terms of the probation are:
- i. The Dissertation Committee will meet quarterly with student until probation is terminated. The student should provide a written report (4-5 pages double-spaced) addressing progress toward the goals outlined in the previous meeting.
 - ii. Probation is terminated if a student attains a satisfactory grade during the following two quarters.
 - iii. Three consecutive quarters of unsatisfactory research progress grades will be cause for dismissal from the program. Dismissal will occur if a majority of the faculty so vote.
- c. Expectations
- a. Skills in expository writing and oral presentation of data will be polished.
 - b. Critical thinking skills and the ability to formulate testable hypotheses will be reinforced.
 - c. Unsatisfactory performance will be identified for timely remedial action.
 - d. Students will acquire the ability to develop realistic research timetables.
 - e. Steady progress toward timely completion of dissertation research will be maintained.

F. The Ph.D. Dissertation

A dissertation is written and when approved by the Dissertation Committee, is followed by a public seminar.

G. The Ph.D. Degree

The Graduate Faculty consider that a Ph.D. will be granted when the student has achieved an appropriate breadth and depth of knowledge, and when he/she has demonstrated the ability in an independent manner to define a question, and to design and execute experiments whose unambiguous results answer the posed question. (We acknowledge that the student's research has been directed in large part by his/her mentor, and we anticipate that the ability to conduct fully independent research will require postdoctoral training). We will expect at least two or three publications in respectable peer-reviewed journals, some with the students as the first author. The student will be encouraged to write at least one manuscript under supervision of his/her mentor. Each student will be considered on a case-by-case basis.

IV. First Year Core Graduate Course Descriptions

BBS-G501: Basic Biomedical Sciences I (5) Prerequisites: Admission into the common first year biomedical sciences graduate program or permission of the Course Director. This intensive, multi-disciplinary lecture course is taught by faculty from all six biomedical research programs of the medical school. The lecture topics include macro-molecular structure, shape and information; DNA, RNA and protein synthesis; genetics and control of gene expression; membranes and intracellular organelles; and pathways and control of carbohydrate metabolism. BBS-G502 is co-requisite. (*Offered every Fall semester*).

BBS-G502: Special Topics in Basic Biomedical Sciences I (4) An intensive multi-disciplinary course designed for all biomedical graduate students. Course involves participation in small group exercises involving problem solving and critical analysis of the current scientific literature. The special topics are selected to coordinate with the lecture topics in the co-requisite course BBS-G501. (*Offered every Fall semester*).

BBS-G503: Basic Biomedical Sciences II (5) An intensive multi-disciplinary course designed for all biomedical graduate students. A continuation of BBS-G501, the course topics include bioenergetics; control nitrogen metabolism; the cytoskeleton, extracellular matrix, and cell junctions; cell signaling and drug action; cell cycle, cancer, and development; integrated biology and the immune system. BBS-G504 is co-requisite. (*Offered every Spring semester*).

BBS-G504: Special Topics in Basic Biomedical Sciences II (4) An intensive multi-disciplinary course designed for all biomedical students. Course involves participation in small group exercises involving problem solving and critical analysis of current scientific literature in selected special topics, as related to the lecture topics in the co-requisite

BBS-G503. (*Offered every Spring special*).

BBS-G510: Ethics for Research Scientists (0) Course covers a variety of topics relevant to the ethical aspects of conducting and reporting scientific investigations including general ethical principles, use of

animals and human subjects in research, authorship, mentorship, conflicts of interest, and scientific misconduct. (*Offered every Spring semester*).

BBS-G592: Basic Biomedical Science Colloquium (1) Students are introduced to the techniques of critical data analysis and formal scientific presentation through weekly colloquia. Faculty from the various biomedical science departments present in the fall semester, students present in the spring semester. Emphasis is placed on styles of presentation and techniques for effective communication. In the Spring semester, each student critically reviews and presents a topic from the current scientific literature at one of the weekly colloquia. All students are required to attend both the scientific presentation and a 10-15 minute discussion session that follows. (*Offered every Fall and Spring semester*).

BBS-G597: Introduction to Basic Biomedical Research (2) Each semester is divided into three five-week rotations in different research laboratories. Students are introduced to research problems currently under investigation and to advance techniques employed in those studies. The first rotation involves introductory activities distributed among the six graduate biomedical science programs of the medical school. (*Offered every Fall and Spring semester*).

Purpose of laboratory rotations:

1. To acquaint the student with the research of members of the Health Sciences Center.
2. To learn contemporary techniques and approaches in research.
3. To gain hands-on experience in scientific research.
4. To learn to carry out a research project, including: formulating questions, learning background pertaining to the questions, planning the experiments to address the questions, "debugging" failed experiments, and analyzing the results.

The mentor will:

1. Assist the student in formulating a research question, recommend pertinent background reading and suggest approaches to be taken in addressing the question.
2. Assist the student in learning the necessary experimental techniques to be used in the research outlined above.
3. Guide the student in learning to analyze and "debug" experimental results, without actually doing this work for the student.
4. Encourage discussion. Discuss the project, background reading, and other issues raised with the student as appropriate.
5. Discuss his/her research interests with the student.
6. Introduce the student to other projects and techniques in the lab.
7. Guide the student through further reading as applicable.

The student will:

1. As a trainee scientist, welcome the opportunity to participate in research, whether or not you intend to complete your dissertation research in the rotation lab. Welcome the opportunity to learn new techniques and new areas of research.
2. Complete the recommended background reading, and be ready to apply the

knowledge contained in that reading to the current research project. Expect to read independently for a lab rotation, as for any graduate course.

3. Invest hard work and critical thinking in your rotation project; these will be required for any degrees of success as a scientist. Take the rotation as seriously as other courses.
 - Demonstrate initiative in performing research. Ask questions. Carefully analyze your own experimental results. Be critical. Learn to adjust your experimental techniques or approaches if the planned experiment fails. Learn to plan your own experiments based on longer-range goals and current results.
 - Be prepared to work outside of normal working hours when necessary to finish an experiment. On the other hand, do not confuse "showing up" with doing research.
 - Respect the property of the lab.

The student is graded for each.

IV. Required Courses for the MMI Ph.D. Program

MB-G635: General Virology (3) A basic course in animal and human virology dealing with the structure, composition, replication, assay and identification of viruses that infect eukaryotic cells. Molecular aspects of pathogenesis: inflammatory, and immune responses including interferons and cytokines, acute versus persistent infections, slow virus disease, animal models, strategies for vaccine development, and concepts in antiviral therapy. (*Offered every other Spring Semester*)

MB-G665: Basic Immunobiology (3) A beginning graduate level course that presents fundamental concepts in both molecular and cellular immunology. Topics include innate immunity including complement and NK cells, antigen recognition structures; antigen processing and the major histocompatibility (MHC) locus; lymphocyte activation; cytokines; T and B cell development; cell-cell interaction in the immune response; and host immune responses in infection, allergy, and autoimmunity. Emphasis on experimental approaches and some review of current literature. (*Offered every Fall Semester*)

MB-G691: Microbiology Journal Club (1) Required of all graduate students, every Fall semester that they are in the program. Each student presents once per year.

MB-G692: Microbiology Research Club (1) Required of all graduate students, every Spring semester that they are in the program. Each student presents his/her current research once per year.

The Fall semester will be comprised exclusively of Journal Club presentations. All graduate students in their second year and beyond will be required to present one journal club. Journal Club will not extend into the Spring semester. The journal club schedule will be set at the end of August and each student will be expected to present on their date except for dire illness or family emergencies, but with the approval of the course master. Graduate students will be required to choose their papers one month in advance and discuss their choice with course master. Journal clubs for graduate students will be evaluated according to the attached form.

The Spring semester will be comprised exclusively of research presentations which will be scheduled (as above) at the end of the Fall semester. Each laboratory must be represented in the presentations. All graduate students in the third year and beyond must give a research presentation. One week prior to their research presentation the student must circulate a research progress report to the faculty (see above, section E).

Directly following presentations by the graduate student, the Faculty and the student's mentor will discuss (in the absence of the student) the positive and negative attributes of the presentation and research report. A record of the discussions will be placed in the student's file and, where appropriate, copies forwarded to the members on the student's dissertation committee. Within a week of the presentation, the Mentor will provide the student with an evaluation of the seminar presentation and of the research report.

V. Advanced Topic Electives for MMI Students

MB-G624: Advanced Topics in Immunology (2-3) Prerequisites: MB-G665. A discussion of research publications focused on topics of current importance in molecular and cellular immunology. These may include recombination in the Ig and TCR loci; signal transduction coupled to antigen and cytokine receptors; molecular aspects of intracellular pathways in antigen processing; ligand-receptor interactions in cell-cell communications; cytokine networks and infection; role of T cell subsets in host defense mechanisms; and role of immune response and molecular mechanisms in pathogenesis of infectious disease. (*Offered every other year*).

MB-G650: Oncogenic Viruses and HIV (3) An advanced course dealing with the biological, biochemical, and physical properties of oncogenic DNA and RNA tumor viruses, their modes of interaction with cells, and the molecular events of host chromosomes. Lecture topics will include the role of viral and cellular oncogenes in cell transformation, tumorigenesis and normal growth control. The role of DNA tumor viruses and retroviruses, including human immunodeficiency virus (AIDS), as tools to investigate the mechanism of DNA replication, gene expression, and growth control in eukaryotic cells will be presented. (*Offered every Semester*).

MB-G675: Immunology Journal Club (2) An advanced topics literature survey. Students attend weekly presentations of current publications on topics in molecular and cellular immunology, vaccine development and gene therapy. Each student presents twice per semester (*Offered every semester*).

MB-G697: Research Topics (1-3) This is an advanced topics course taught by any one of the Faculty in the Department. Students meet with the instructor once a week to discuss and analyze a research topic. Material is taken from current research papers published in leading research journals. Topics for the course are selected by consensus of the students and Faculty members.

MB G-698: Special Topics in Biodefense (2) Research publications and seminars by experts in the field will be used to provide an introduction to biodefense related topics. Topics will include: the lifecycle of potential bioterrorist agents, detection of microbes in the environment, development of anti-microbials and vaccines, and public health reporting and infrastructure (*Offered every Fall semester*).

BCH-G623: Macromolecules: Structure, Function, and Interactions (4) Prerequisites: BBS-G501, -G502, -G503, and G504. Students are guided through a series of self-directed problem-solving exercises and laboratory demonstrations covering concepts and methodology in the analysis of enzyme

catalysis, protein-protein interactions, protein-nucleic acid interactions, and regulation of metabolism. Exercises include accessing and using primary sequence and 3-D structural data in experimental design and analysis (*Offered every Fall semester*).

BCH-G625: Preparation and Evaluation of Scientific Research Proposal Lectures dealing with organization and evaluation of research proposals. Presentations of published papers selected by students in an area outside their dissertation topic. Weekly progress reports lead up to submission of a research proposal. Proposals are critiqued by faculty and students and are revised in light written critiques. (*Offered every semester*).

BCH-G628: Introduction to Genomics and Bioinformatics Prerequisites: BBS-G501 and BBS-G502 or permission of instructor. This course introduces current practices in genomics and Bioinformatics. Lecture topics include finding information in sequence and structure databases, protein motif and family classification, comparative genomics, and large-scale gene expression data analysis. Computer based exercises are coordinated with lecture topics. (*Offered every Fall semester*).

RM I-597 Applied Biostatistics for Medical Sciences (3) This course teaches the basic methods of biostatistical analysis employed in epidemiological and experimental biomedical research. It employs didactic lectures on statistical theory and problem sets to be performed by the students. Taken Summer session.

VI. Other Course Offerings

MB-G531 Introduction to Research Techniques and Topics (1-3) Students within the first year of their studies in the Department can spend a minimum of six weeks doing a research project with one or more Faculty members. Projects are designed to acquaint the student with a specific line of research and to help them learn techniques and develop research skills.