

Biochemistry and Molecular Medicine, Ph.D.

Degrees Offered

- Doctor of Philosophy
- Combined Degrees, Doctor of Medicine and Doctor of Philosophy

Nature of the Program

A major goal of the **Biochemistry and Molecular Medicine Program** is to foster ability for independent thought. To this end, our faculty cultivates an open, collegial relationship with one another and with our students. Close collaboration between scientists, the sharing of ideas, and open inquiry are critical components of our training plan.

The hallmarks of graduate training in biochemistry and molecular medicine are the emphasis placed on the use of the scientific literature in advanced coursework and on protecting time for laboratory research. In addition, students will have time for professional development through seminar presentation, attendance at national meetings, teaching opportunities, and seminar programs both within the department and throughout the Health Sciences Center.

This doctoral program focuses on the understanding of biology by exploring function of the molecular components of cells. The student's ability for independent thought is critical in preparation for a career as an independent scientist. During the second year, specialized courses in biochemistry are offered as students continue their research projects. During subsequent years, students emphasize independent dissertation research, and a few formal courses may be taken. 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. A fast-track option is available to West Virginia University undergraduate students who have excelled in undergraduate prerequisite courses relevant to biochemistry, and began their research in a Program member's laboratory during their junior year.

Faculty research in the program can provide the student with training in multiple basic sciences areas including:

- Epigenetic regulation of chromatin structure and gene expression
- RNA processing
- Cell survival mechanisms
- Regulation of metabolism
- Proteasome function
- Cell proliferation and cell cycle regulation
- Cell adhesion
- Kinases and phosphatases in signal transduction and in cancer cell metabolism
- Oxidant-induced cellular stress
- Structural biology and structure/function relationships of macromolecules such as RNA and/or proteins
- Molecular genetics of visual and auditory development
- G protein-mediated signaling by retinal photoreceptors
- Molecular basis of age-related blindness
- Development and application of new magnetic resonance approaches to biomedicine

These research areas provide fundamental knowledge toward the normal health-state and aim toward the amelioration of important diseases: atherosclerosis, blindness, cancer, deafness, diabetes, and metabolic disorders.

FACULTY

CHAIR

- Visvanathan Ramamurthy - Ph.D. (Wesleyan University)

GRADUATE PROGRAM DIRECTOR

- Aaron Robart - Ph.D (University of Calgary)

PROFESSORS

- Yehenev Agazie - Ph.D. (University of Saskatchewan)
- Steven Frisch - Ph.D. (University of California-Berkeley)

- Valery Khramtsov - Ph.D. (Institute of Chemical Kinetics and Combustion)
- Qiang Ma - Ph.D. (Rutgers University)
- Vazhaikurichi Rajendran - Ph.D. (University of Madras)
- Visvanathan Ramamurthy - Ph.D. (Wesleyan University)
- Mike Ruppert - M.D., Ph.D. (Johns Hopkins University)
- Michael Schaller - Ph.D. (McMaster University)
- David Smith - Ph.D. (University of South Florida)
- Maxim Sokolov - Ph.D. (Weizmann Institute of Science)
- Peter Stoilov - Ph.D. (Friedrich Alexander University)

ASSOCIATE PROFESSORS

- Jianhai Du - Ph.D. (Peking University)
- Michael Gunther - Ph.D. (Colorado State University)
- Saravanan Kolandaivelu - Ph.D. (All India Institute of Medical Sciences)
- Roberta Leonardi - Ph.D. (University of Southampton)
- Pete Mathers - Ph.D. (California Institute of Technology)
- Elena Pugacheva - Ph.D. (Russian Academy of Science)
- Aaron Robart - Ph.D. (University of Calgary)
- Andrew Shiemke - Ph.D. (Oregon Graduate Institute)
- Mark Tseytlin - Ph.D. (Russian Academy of Sciences)
- Scott Weed - Ph.D. (Yale University)

ASSISTANT PROFESSORS

- Kevin Courtney - Ph.D. (University of Ottawa)
- Wentao Deng - Ph.D. (University of Florida)
- Rong Liu - Ph.D. (Wayne State University)
- Michael Robichaux - Ph.D. (UT Southwestern)
- Bradley Webb - Ph.D. (Queen's University)

RESEARCH ASSISTANT PROFESSORS

- Alexey Ivanov - Ph.D. (Russian Academy of Sciences)
- Ezequiel Salido - M.D., Ph.D. (University of Buenos Aires)

TEACHING ASSISTANT PROFESSOR

- Marieta Gencheva - Ph.D. (Bulgarian Academy of Sciences)

SERVICE ASSISTANT PROFESSOR

- Neil Billington - Ph.D. (University of Leeds)

Doctor of Philosophy

MAJOR REQUIREMENTS - STANDARD TRACK

Code	Title	Hours
A minimum GPA of 3.0 is required.		
BMS 700	Scientific Integrity	1
BMS 701	Scientific Rigor and Ethics	1
BMS 702	Biomedical Lab Experience	2
BMS 706	Biomedical Research Methods	1
BMS 707	Experiential Learning for Biomedical Trainees	2
BMM 715	Molecular Genetics	3
BMS 720	Scientific Writing	2
BMS 747	Foundations for Contemporary Biomedical Research I	4
BMS 777	Foundations for Contemporary Biomedical Research 2	4
Journal Club		7

BMM 785	Biochemistry and Molecular Medicine Journal Club	
Graduate Seminar		1
BMM 796	Graduate Seminar	
Research		52
BMM 797	Research	
Advanced Graduate Course - select one of the following:		4
BMM 750	Protein Chemistry/Enzymology	
BMM 751	Advanced Molecular Biology	
CCB 701	Biochemical and Oncogenic Signaling	
Advanced Graduate Course - select one of the following:		3-5
CCB 701	Biochemical and Oncogenic Signaling	
BMM 750	Protein Chemistry/Enzymology	
PSIO 750	Graduate Physiology and Pharmacology 1	
BMM 751	Advanced Molecular Biology	
MICB 784B	Special Problems in Microbiology	
Qualifying Exam		
Candidacy Exam		
Dissertation Defense		
Total Hours		87-89

MAJOR REQUIREMENTS - FAST TRACK

Code	Title	Hours
A minimum GPA of 3.0 is required.		
BMS 700	Scientific Integrity	1
BMS 701	Scientific Rigor and Ethics	1
BMS 707	Experiential Learning for Biomedical Trainees	2
BMM 715	Molecular Genetics	3
BMS 720	Scientific Writing	2
Journal Club		7
BMM 785	Biochemistry and Molecular Medicine Journal Club	
Graduate Seminar		1
BMM 796	Graduate Seminar	
Research		52
BMM 797	Research	
Advanced Graduate Course - select one of the following:		4
BMM 750	Protein Chemistry/Enzymology	
BMM 751	Advanced Molecular Biology	
CCB 701	Biochemical and Oncogenic Signaling	
Advanced Graduate Course - select one of the following:		3-5
CCB 701	Biochemical and Oncogenic Signaling	
BMM 750	Protein Chemistry/Enzymology	
PSIO 750	Graduate Physiology and Pharmacology 1	
BMM 751	Advanced Molecular Biology	
MICB 784B	Special Problems in Microbiology	
Qualifying Exam		
Candidacy Exam		
Dissertation Defense		
Total Hours		76-78

Seminars and Research Forum

Students will present three seminars during their graduate study. The first seminar is on a topic outside of the student's research area. The second seminar is the public presentation of the dissertation proposal, which is the background and proposed research for the dissertation project. The third seminar is the public presentation of the dissertation defense.

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 candidacy is completed in the second 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 PhD.

Suggested Plan of Study*

First Year

Fall	Hours	Spring	Hours	Summer	Hours
BMS 700		1 BMS 701		1 BIOC 797	3
BMS 706		1 BMM 715		3 Qualifying Exam	
BMS 702		2 BMM 785		1	
BMS 747		4 BIOC 797		4	
BMS 777		4			
		12		9	3

Second Year

Fall	Hours	Spring	Hours	Summer	Hours
BMM 785		1 BMM 785		1 BMS 720	2
BIOC 797		5 BIOC 797		4 BIOC 797	1
Advanced Course		3 Advanced Course		4 Candidacy Exam	
		9		9	3

Third Year

Fall	Hours	Spring	Hours	Summer	Hours
BMM 785		1 BMM 785		1 BIOC 797	1
BIOC 797		8 BIOC 796		1 BMS 707	2
		BIOC 797		7	
		9		9	3

Fourth Year

Fall	Hours	Spring	Hours	Summer	Hours
BMM 785		1 BMM 785		1 BIOC 797	3
BIOC 797		8 BIOC 797		8	
		9		9	3

Total credit hours: 87

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

BIOCHEMISTRY AND MOLECULAR MEDICINE

Students will:

- Identify and summarize the basic concepts of biochemistry and molecular medicine including: molecular genetics, protein structure and function, metabolism, cell biology and biophysics.
- Discuss, interpret and critique the research literature in biochemistry and molecular medicine.
- Demonstrate deep insight when discussing research in their specific field of study.
- Integrate broad, fundamental knowledge in the basic concepts of biochemistry and molecular medicine with detailed knowledge of the student's specific field of study.
- Identify the major questions and gaps in their specific field of study. When challenged, be able to identify significant gaps in our collective knowledge of biochemistry and molecular medicine.
- Acquire, develop and use standard biochemical laboratory techniques as well as those necessary to successfully perform state of the art experiments in the student's area of research.
- Design experimental protocols and conduct self-directed research that is well-controlled, rigorous and produces results with unequivocal interpretation.
- Conduct research to produce novel results that are presented at scientific meetings and published in peer-reviewed journals.
- Demonstrate oral, written and visual communication skills that result in clear and organized dissemination of material at a level appropriate for the audience.