INDIANA UNIVERSITY

University Graduate School 2008-2009 Academic Bulletin

University Graduate School
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Biochemistry, Interdisciplinary

Biology, Chemistry, Medical Sciences, Optometry, Psychological and Brain Sciences

College of Arts and Sciences Bloomington

Director
Professor Carl Bauer*

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Departmental URL
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Graduate Faculty

(An asterisk [*] denotes membership in the University Graduate School faculty with the endorsement to direct doctoral dissertations.)

Carlos Miller Chair
Mark Estelle* (Biology)

Clyde Culbertson Professor of Biology
Yves Brun* (Biology)

Distinguished Professor, Class of '54
Carl Bauer* (Biology)

Lilly Chemistry Alumni Chair
Milos Novotny* (Chemistry)

Linda and Jack Gill Chairs in Biomolecular Sciences
Richard DiMarchi* (Chemistry), J. Michael Walker* (Psychology)

Robert and Marjorie Mann Chair
David Clemmer* (Chemistry)

Distinguished Professors
Carl Bauer* (Biology), Milos Novotny* (Chemistry), Peter Ortoleva* (Chemistry)

Professors
Joseph Bonanno* (Optometry), Jose Bonner* (Biology), Yves Brun* (Biology), Peter Cherbas* (Biology), David Clemmer* (Chemistry), Richard DiMarchi* (Chemistry), Mark Estelle* (Biology), Patricia Foster* (Biology), David Giedroc* (Chemistry), Kenneth Nephew* (Cellular and Integrative Physiology, Obstetrics and Gynecology, Medical Sciences), Elizabeth Raff* (Biology), James Reilly* (Chemistry), J. Michael Walker* (Psychological and Brain Sciences), Theodore Widlanski* (Chemistry), Malcolm Winkler* (Biology), Jeffrey Zaleski* (Chemistry)

Associate Professors
David Daleke* (Biochemistry, Molecular Science, Medical Sciences), Jim Drummond* (Biology), John Foley (Anatomy and Cell Biology, Medical Sciences), Clay Fuqua* (Biology), David Kehoe* (Biology), Joseph Near* (Pharmacology and Toxicology, Medical Sciences), Martha Oakley* (Chemistry), Claire Walczak* (Biochemistry and Molecular Biology, Medical Sciences), Faming Zhang* (Chemistry)

Assistant Professors
Lingling Chen* (Biology), Bogdan Dragnea* (Chemistry), Viola Ellison (Biology), Richard Hardy (Biology), Melanie Marketon* (Biology), Tuli Mukhopadhyay* (Biology), David Nelson* (Biology), Joseph Pomerening* (Biology), Anne Prieto* (Psychological and Brain Sciences), Sidney Shaw* (Biology), Thomas J. Tolbert* (Chemistry), Joel Ybe* (Biology)

Graduate Advisor
Associate Professor Martha Oakley*, Simon Hall 320C, (812) 855-4843

Degrees Offered

Master of Science and Doctor of Philosophy

Special Program Requirements

(See also general University Graduate School requirements.)

Admission Requirements
Undergraduate coursework must include two semesters of organic chemistry and one semester of biochemistry. Though not required, one semester of molecular biology and two semesters of biology are recommended. One semester of (bio) physical chemistry is strongly recommended. Deficiencies in required courses must be removed during the first year of graduate study. Students seeking admission should apply directly to the Interdisciplinary Biochemistry Graduate Program. Applications must include a complete entrance form, letters of recommendation, undergraduate transcripts, and scores on the Graduate Record Examination General Test. (While it is not required that applicants also submit scores on the Subject Test in Biochemistry, it is recommended that they do so.)

Master of Science Degree

Course Requirements
A minimum of 30 credit hours, of which 12 credit hours must be in biochemistry graduate coursework other than B880 and B600. Students are required to rotate (B580) in two laboratories in the fall semester and to participate in the biochemistry research club during their second year of the program. The graduate advisor must approve all coursework.

Thesis
Required.

Final Examination
Oral, covering thesis and major.

Doctor of Philosophy Degree

Course Requirements
A total of 90 credit hours, of which 23.5 are satisfied by the core courses (B501, B502, B503, B504, B580), Grant Writing (B680), Research Ethics (G601), and three semesters of B600. Six additional elective hours are required in either the major or minor field. Students may choose a major in one of the three tracks described below. In addition, students must complete a minor in a different track of biochemistry or in an outside program. The sequence of courses comprising the major must be approved by the student's advisory committee.

At the end of the first year, each student selects a research advisor and laboratory. Together with the advisor, the student also selects the other members of an advisory committee of three or four faculty members appropriate to the student's intended degree and one from the perspective minor field (see below). This advisory committee guides and monitors the student's subsequent independent work and guides the student's selection of advanced courses. The biochemistry graduate program requires that each student meet with the advisory committee at least once per year and that students present a research talk in the Biochemistry Research Club (BMB) during their second and subsequent years in the program.

Major Requirements:
Students may major in one of the following tracks:

1) Integrated Biochemistry
The course requirements for this major are the core courses (B501, B502, B503, B504, B580). The minor must be completed in an area outside biochemistry.

2) Cellular and Medical Biochemistry
The major consists of 12 credit hours chosen among the following courses:

Biochemistry:
B501 Integrated Biochemistry
B502 Analysis of the Biochemical Literature
B601 Nucleic Acids
B602 Advanced Protein Biosynthesis and Processing
B605 Structure and Function of Membranes
B680 Special Topics: Electron Microscopy
B680 Special Topics: Structural Bioinformatics
B680 Special Topics: Virology

Biology:
L585 Molecular Genetics
L586 Molecular Analysis of Cell Biology

Medical Sciences:
B801 Molecular and Cellular Biochemistry
B802 Metabolism and Signal Transduction

3) Chemical and Structural Biology
The major consists of 12 credit hours chosen among the following courses:

Biochemistry:
B503 Macromolecular Structure and Interactions
B504 Biomolecular Catalysis
B603 Advanced Macromolecular Structure and Interactions
B604 Structural Methods
B605 Structure and Function of Membranes
B680 Special Topics: Drug Design
B680 Special Topics: Electron Microscopy
B680 Special Topics: NMR
B680 Special Topics: Structural Bioinformatics

Biology:
L586 Molecular Analysis of Cell Biology

Chemistry:
C540 Organic Reactions Mechanisms
C612 Mass Spectrometry

Minor
The doctoral student in biochemistry may minor in any appropriate discipline or in a track in Biochemistry not chosen for the major. For an internal minor, the minor shall consist of 6 credit hours of the courses listed in each track above. The sequence of the courses comprising the minor must be approved by the student's advisory committee and the graduate advisor.

Grades
Every student must maintain a minimum GPA of 3.2 in order to remain in good standing. Courses to be counted toward the Ph.D. degree must be passed with a grade of B–(2.7) or better.

Qualifying Examinations
In the fifth semester, students meet with their examination committee to review past performance and to evaluate plans for completing the Ph.D. Includes written, oral, and research components. All full-time Ph.D. students must take the qualifying examination by the end of the fifth semester.

Satisfactory Progress toward a Degree
After passing the preliminary examination, for a student to remain in "good standing" requires that sufficient progress be made toward completing a thesis. If the research advisory committee judges progress to be unsatisfactory, probation may be recommended. At the end of the probationary period (usually a semester), probation will be lifted if the advisory committee judges the student's progress to be satisfactory. If the advisory committee judges the student's progress to remain unsatisfactory, then the student will be required to leave the program.

Final Examination
Oral, covering dissertation, major, and minor. The final requirement is a Ph.D. thesis, which must be defended in a public research seminar and in a meeting of the research advisory committee.

Other Provisions
All students enrolled in the Ph.D. program will be required to serve as associate instructors for at least one semester, regardless of their source of support; they must complete formal instruction in teaching methods in order to enhance their teaching skills. It is the conviction of the program that teaching experience is a vital aspect of graduate education, whether or not the student intends to pursue a teaching career after attainment of the desired degree.

Ph.D. Minor in Biochemistry
Students from other programs who wish to minor in biochemistry must complete at least 6 credit hours of graduate coursework in biochemistry, excluding B502, B580, and B600, with an average of B (3.0) or above. At least one of the courses must be B501, B503, or B504.

Courses

Biochemistry

B501 Integrated Biochemistry (4.5 cr.) P: Undergraduate biochemistry (equivalent to C483 or C484) or consent of instructor. Basic principles and methodologies of biochemistry; essentials of macromolecular biosynthesis; mechanism-based examination of biochemical aspects of cell biology; material is presented with an integrative approach designed to illustrate the interrelationship of biochemical processes.

B502 Analysis of Biochemical Literature (1.5 cr.) P: Concurrent enrollment in B501 or consent of instructor. Critical evaluation of the biochemical literature, using selected papers as examples; development of written and oral communication skills in the context of literature analysis.

B503 Macromolecular Structure and Interaction (3 cr.) P: B501 or undergraduate biochemistry (equivalent to C483 or C484), one semester of undergraduate organic chemistry (equivalent to C341), or consent of instructor. Undergraduate (bio)physical chemistry (equivalent to C481 or C361) is strongly recommended. Principles of inter-and intra-molecular interactions; structural stability of proteins and nucleic acids; thermodynamic and kinetic analysis of complex binding; experimental methods for analysis of macromolecular structure and binding.

B504 Biomolecular Catalysis (3 cr.) P: Undergraduate organic chemistry (equivalent to C342), undergraduate biochemistry (equivalent to C483 or C484), or consent of instructor. Theory and analysis of biochemical catalysis; enzyme kinetics; cofactors; regulation of enzymatic reactions.

B580 Introduction to Biochemical Research (3 cr.) P: Graduate standing. Objectives and techniques of biochemical research.

B600 Seminar in Biochemistry (1 cr.) P: B502 or consent of instructor. Advanced critical analysis of the current scientific literature and scientific presentations. Attendance and participation in the weekly biochemistry program seminar series is required.

B601 Advanced Nucleic Acid Biochemistry (1.5 cr.) P: B501 or consent of instructor. Mechanistic analysis of nucleic acid metabolism; specificity and role of DNA polymerases and repair pathways; DNA replication and recombination mechanisms; RNA structural motifs and physical properties; RNA synthesis and processing in gene expression; catalytic RNA molecules; applications of RNA molecules.

B602 Advanced Protein Biosynthesis and Processing (1.5 cr.) P: B501 or consent of instructor. Detailed analysis of protein synthesis, post-translational modification, and macromolecular assembly, including the role these modifications play in mature protein function, biosynthesis, structure, function, and analysis of complex oligosaccharides.

B603 Advanced Macromolecular Structure and Interactions (1.5 cr.) P: B503 or consent of instructor. Supplements and extends B503: emphasis on stability and folding mechanisms of proteins and nucleic acids and detailed thermodynamic analysis of binding interactions.

B604 Structural Methods (1.5 cr.) P: B503 or consent of instructor. Fundamental principles of circular dichroism, nuclear magnetic resonance, and X-ray crystallography in the study of protein and nucleic acid structures. Theoretical and practical aspects will be presented, with particular emphasis on application strategies.

B605 Structure and Function of Biological Membranes (1.5 cr.) P: B501, B503, or consent of instructor. Biochemistry and biophysics of lipids, membranes and membrane proteins; fundamentals of membrane transport; interfacial catalysis; transmembrane signal transduction.

B680 Special Topics in Biochemistry (1.5-3 cr.) P: Consent of instructor. Topics vary yearly and include the following: physicochemical techniques in the study of macromolecules; experimental methods in enzymology; organic chemistry of enzymatic reactions and enzyme models; conformational properties and macromolecules. Can be retaken for credit.

B880 Research: Biochemistry (cr. arr.)** This course is eligible for a deferred grade.

Cross-Listed Courses

Biology

L529 Bioinformatics in Molecular Biology and Genetics: Practical Applications (4 cr.) P: I501, I502, L519, or consent of instructor. Practical experience in a range of data analysis and software engineering methods applied to molecular biology data.

L585 Molecular Genetics (3 cr.) P: L364 and C483 or equivalent. The molecular basis of genetic interactions, with emphasis on microbial systems. The course covers the molecular mechanisms of mutation, suppression, recombination, complementation, etc., as well as mechanisms for gene transfer in bacteria and bacteriophage. The application of genetic analysis to a variety of molecular biological topics is emphasized.

L586 Molecular Analysis of Cell Biology (3 cr.) Critical analysis of recent advances in our understanding of molecular organization of cellular structures and of their mode of function. The primary interest of this course concerns the eukaryotic cell.

M525 Topics in Microbial Biochemistry and Physiology (3 cr.) P: Graduate standing and C483 or M350 or equivalent. The course will consider topics in physiology and biochemistry of eukaryotic and prokaryotic microorganisms. Subjects include membrane physiology and regulatory networks in metabolism and gene expression.

Chemistry

C615 Bioanalytical Chemistry (1.5-3 cr.) P: C511, C512. Survey of modern analytical techniques, including spectrochemical, electrochemical, and separation methods used in biochemical analysis and their applications. (May be given in alternate years).

C632 Structure, Function, and Spectroscopy of Metal Ions in Biological Systems (3 cr.) Introduction to the field of bioinorganic chemistry and spectroscopic methods for determining structure/function relationship of metal ions in biology. Emphasis on oxygen carriers, metal ion transport and storage, as well as oxidoreductases involved in oxygen, hydrogen, and nitrogen metabolism. A discussion of electron transfer proteins, photosystems, and the role of metals in medicine will also be included.

Medical Sciences

B801 Molecular and Cellular Biochemistry (3 cr.) P: Graduate standing and consent of instructor. Biochemistry for medical students, emphasizing structure-function relationships of cellular components, biosynthesis of nucleic acids and proteins, degradation of simple and complex cell constituents, and regulation of cell growth.

B802 Metabolism and Signal Transduction (3 cr.) P: Graduate standing and consent of instructor. Biochemistry for medical students, including signaling pathways, membrane biochemistry, and the metabolism of macromolecules in health and disease with emphasis on clinical applications.

Physics

P575 Introductory Biophysics (3 cr.) P: Two out of three from the following: (1) P221/P222 and P301 or equivalent, (2) C105/C106 or equivalent, and (3) L221 and L312 or equivalent; or consent of instructor. Overview of cellular components; basic structures of proteins, nucleotides, and biological membranes; solution physics of biological molecules, mechanics and motions of biopolymers; physical chemistry of binding affinity and kinetics; physics of transport and signal transduction; biophysical techniques such as microscopy and spectroscopy; mathematical modeling of biological systems.

Neural Sciences

N612 Ion Channels and Receptors (3 cr.) P: Graduate status and consent of instructor. Molecular, biophysical, and biochemical analysis of the major molecules responsible for neural excitability and synaptic transmission: receptor-coupled ion channels, voltage-dependent ion channels, G-protein coupled receptors, transporters, signal transduction pathways, synaptic vesicle-associated proteins, cytoskeletal proteins, classical and novel neurotransmitters and modulators.