Program in Cell and Molecular Biology

Chair
- David Kovar

Faculty accepting students into their lab

Professors
- Douglas K. Bishop, Radiation & Cellular Oncology
- Edwin L. Ferguson
- Richard Fehon
- Benjamin Glick
- Michael Glotzer
- Jean Greenberg
- Stephen J. Kron
- Ilaria Rebay, Ben May Department for Cancer Research
- John Reinitz, Statistics
- Lucia Rothman-Denes
- Jonathan P. Staley
- Jerrold Turner, Pathology
- Aaron Turkewitz

Associate Professors
- Margaret Gardel, Physics
- Sally Horne-Badovinac
- David Kovar
- Jocelyn Malamy

Assistant Professors
- Ed Munro
- Michael Rust
- Alex Ruthenburg

Faculty not accepting students into their lab

Professors
- Robert Haselkorn
- Robert Josephs
- Bernard Roizman, Microbiology

Associate Professors
- Gayle K. Lamppa
- Laurens J. Mets
Emeritus Faculty

- Kwen Sheng Chiang
- Wolfgang Epstein
- Rochelle Easton Esposito
- Anthony Mahowald
- Terence E. Martin
- Theodore L. Steck, Biochemistry & Molecular Biology
- Ursula B. Storb
- Bernard S. Strauss
- Edwin W. Taylor

In the graduate program in cell and molecular biology, the Ph.D. degree places great emphasis on rigorous, didactic preparation in cell biology, molecular biology, and genetics, and focuses on choosing questions, defining experimental approaches, and interpreting data. Once qualified, advanced students choose from a wider range of opportunities for research in cell biology, molecular biology, genetics, developmental biology, plant biology, and microbiology. Of special interest is the design of interdisciplinary programs that emphasize the frontiers of biology.

**The Degree of Doctor of Philosophy**

The graduate program in cell and molecular biology offers a program of study leading to the Doctor of Philosophy in molecular genetics and cell biology. A Ph.D. candidate must fulfill certain formal coursework requirements, pass one preliminary and one qualifying examination, and present a satisfactory dissertation describing the results of original research.

The program expects knowledge of and proficiency in cell biology, molecular biology, and genetics. This requirement will normally be met by fulfilling the formal coursework described here, but detailed degree programs are flexible. Courses taken at other institutions, in other departments, or as part of the Pritzker School of Medicine curriculum may substitute for CMB courses with approval of the curriculum committee. To fulfill the requirements for a Ph.D., nine graded courses are required. In the program in cell and molecular biology, a student must take one course in each of three areas during the first year:

- Cell biology
- Molecular biology
- Genetics

In addition to these core courses, a second course in one of these areas is required to develop greater proficiency in a subdiscipline. The total of four required courses can be selected from among the following courses: MGCB 31200 Molecular Biology-I, MGCB 31300 Molecular Biology-II, MGCB 31400 Genetic Analysis of Model Organisms, MGCB 31500 Genetic Mechanisms, MGCB 31600 Cell Biology I, and MGCB 31700 Cell Biology II. Three additional graded electives must be taken, one of which may be a reading course. The electives can be selected according to the student’s interests and the availability of courses.
A student is also required to do three laboratory rotations before selecting an advisor and laboratory to pursue a Ph.D. dissertation. These rotations will be graded, and two will count towards the nine courses required for the Ph.D. All students are required to serve as teaching assistants for two quarters.

Students select a thesis advisor and begin laboratory research by the tenth month of the first year. To complete the Ph.D. degree, they must prepare, under the general direction of an appointed doctoral committee, a dissertation based upon their original research. Students are also required to submit, if not publish, at least one first author paper prior to their defense. A public seminar describing the results of the dissertation research must be presented and the dissertation must be successfully defended before the doctoral committee.

Admissions

For information about applying to our graduate program, please visit our website at http://molbio.bsd.uchicago.edu/index.php.

Molecular Genetics & Cell Biology Courses

MGCB 30400. Protein Fundamentals. 100 Units.
The course covers the physical-chemical phenomena that define protein structure and function. Topics include: the principles of protein folding, molecular motion and molecular recognition; protein evolution, design and engineering; enzyme catalysis; regulation of protein function and molecular machines; proteomics and systems biology. Workshop on X-ray Crystallography: The workshop is an addendum to Protein Fundamentals and is required for all BCMB students. This one week workshop will provide students with an intensive introduction to protein structure determination by x-ray crystallography. In addition to lectures, an extensive laboratory component will give students the opportunity to carry out protein crystallization, data collection (at Argonne), structure determination, refinement, model building and validation.
Instructor(s): R. Keenan, S. Koide, Kossiakoff Terms Offered: Autumn Equivalent Course(s): HGEN 30400,BCMB 30400

MGCB 31000. Fundamentals of Molecular Biology. 100 Units.
This course covers the structure of genetic material, chromatin, replication, DNA repair and transcription, including its regulation, RNA processing, post-transcriptional regulation, and protein synthesis. Third- or fourth-year standing is required for undergraduates; any graduate student may enroll.
Instructor(s): J. Staley and Staff Terms Offered: Winter Prerequisite(s): For College students: Basic knowledge of genetics and biochemistry Equivalent Course(s): BCMB 31000, BIOS 21208
MGCB 31200. Molecular Biology-I. 100 Units.
Nucleic acid structure and DNA topology; methodology; nucleic-acid protein
interactions; mechanisms and regulation of transcription in eubacteria, and of
replication in eubacteria and eukaryotes; mechanisms of genome and plasmid
segregation in eubacteria.
Instructor(s): L. Rothman-Denes Terms Offered: Winter
Equivalent Course(s): BCMB 31200,DVBI 31200

MGCB 31300. Molecular Biology-II. 100 Units.
The content of this course covers the mechanisms and regulation of eukaryotic
gene expression at the transcriptional and post-transcriptional levels. Our goal is
to explore research frontiers and evolving methodologies. Rather than focusing
on the elemental aspects of a topic, the lectures and discussions highlight the most
significant recent developments, their implications and future directions.
Instructor(s): J. Staley, A. Ruthenburg Terms Offered: Spring
Equivalent Course(s): BCMB 31300,DVBI 31300

MGCB 31400. Genetic Analysis of Model Organisms. 100 Units.
Fundamental principles of genetics discussed in the context of current approaches
to mapping and functional characterization of genes. The relative strengths and
weaknesses of leading model organisms are emphasized via problem-solving and
critical reading of original literature.
Instructor(s): A. Palmer, D. Bishop, E. Ferguson, J. Malamy Terms Offered: Autumn
Equivalent Course(s): DVBI 31400,BCMB 31400,HGEN 31400

MGCB 31500. Genetic Mechanisms. 100 Units.
Advanced coverage of mechanisms involved in promoting genome stability
and genome evolution. A variety of experimental systems are explored from
bacteriophage to humans. Topics include the genetics and biochemistry of DNA
repair, homologous and site-specific recombination, transposition and genome
rearrangement. Two of three weekly meetings are lecture and the third student led
discussion of recent papers from the primary literature. The course emphasizes
experimental design and interpretation of primary data.
Instructor(s): D. Bishop
Equivalent Course(s): DVBI 31500

MGCB 31600. Cell Biology I. 100 Units.
Eukaryotic protein traffic and related topics, including molecular motors and
cytoskeletal dynamics, organelle architecture and biogenesis, protein translocation
and sorting, compartmentalization in the secretory pathway, endocytosis and
exocytosis, and mechanisms and regulation of membrane fusion.
Instructor(s): A. Turkewitz, B. Glick Terms Offered: Autumn
Equivalent Course(s): BCMB 31600,DVBI 31600
MGCB 31700. Cell Biology II. 100 Units.
This course covers the mechanisms with which cells execute fundamental behaviors. Topics include signal transduction, cell cycle progression, cell growth, cell death, cancer biology, cytoskeletal polymers and motors, cell motility, cytoskeletal diseases, and cell polarity. Each lecture will conclude with a dissection of primary literature with input from the students. Students will write and present a short research proposal, providing excellent preparation for preliminary exams.
Instructor(s): M. Glotzer, D. Kovar Terms Offered: Winter
Equivalent Course(s): DVBI 31700,BIOS 21238

MGCB 31900. Introduction to Research. 100 Units.
Lectures on current research by departmental faculty and other invited speakers. A required course for all first-year graduate students
Instructor(s): Staff Terms Offered: Autumn, Winter
Equivalent Course(s): BCMB 31900,DVBI 31900,GENE 31900,HGEN 31900

MGCB 32000. Quantitative Analysis of Biological Dynamics. 100 Units.
The basic focus of the course will be quantitative approaches to understanding organization and dynamics at the molecular, subcellular and cellular levels, and will rest on three pillars - modern imaging and image analysis, quantitative analysis and presentation of data, mathematical modeling and computer simulations.
Instructor(s): Edwin Munro; Michael Rust Terms Offered: Spring
Equivalent Course(s): DVBI 32000

MGCB 32100. Senior Graduate Student Ethics. 100 Units.
This course explores specific ethical dilemmas that may arise in laboratory settings. The format of this course will provide opportunities for all students to voice their questions and opinions. Student groups of 4-5 will act as a review board during each session. Class time will center around the case, the conclusions of the review board, and the steps that should be taken to remedy the situation, if any. Faculty will guide and stimulate discussion in each case. Faculty will also provide any relevant University bylaws and/or NIH guidelines. Following the session, review board members will submit a formal 1-2 page justified decision in writing to the instructor. Successful completion of the course requires active participation in group presentations and general class discussions as well as joint submission of review board summaries.
Instructor(s): Jocelyn Malamy Terms Offered: Spring
MGCB 32300. **Structure and Function of Membrane Proteins. 100 Units.**
This course will be an in depth assessment of the structure and function of biological membranes. In addition to lectures, directed discussions of papers from the literature will be used. The main topics of the courses are: (1) Energetic and thermodynamic principles associated with membrane formation, stability and solute transport (2) membrane protein structure, (3) lipid-protein interactions, (4) bioenergetics and transmembrane transport mechanisms, and (5) specific examples of membrane protein systems and their function (channels, transporters, pumps, receptors). Emphasis will be placed on biophysical approaches in these areas. The primary literature will be the main source of reading.
Instructor(s): E. Perozo Terms Offered: Autumn
Equivalent Course(s): BCMB 32300

MGCB 34300. **Image Processing in Biology. 100 Units.**
Whether one is trying to read radio signals from faraway galaxies or to understand molecular structures, it is necessary to understand how to read, interpret, and process the data that contain the desired information. In this course, we learn how to process the information contained in images of molecules as seen in the electron microscope. We also deal with the principles involved in processing electron microscope images, including the underlying analytical methods and their computer implementation.
Instructor(s): R. Josephs Terms Offered: Spring
Prerequisite(s): For College students: One year of calculus
Equivalent Course(s): BIOS 21407

MGCB 35401. **Gene Regulation. 100 Units.**
This course covers the fundamental theory of gene expression in prokaryotes and eukaryotes through lectures and readings in the primary literature. Natural and synthetic genetic systems arising in the context of *E. coli* physiology and Drosophila development will be used to illustrate fundamental biological problems together with the computational and theoretical tools required for their solution. These tools include large-scale optimization, image processing, ordinary and partial differential equations, the chemical Langevin and Fokker-Planck equations, and the chemical master equation. A central theme of the class is the art of identifying biological problems which require theoretical analysis and choosing the correct mathematical framework with which to solve the problem.
Terms Offered: Spring
Prerequisite(s): Consent of instructor
Equivalent Course(s): ECEV 35400, STAT 35400
MGCB 35600. Vertebrate Development. 100 Units.
This advanced-level course combines lectures, student presentations, and discussion sessions. It covers major topics on the developmental biology of embryos (e.g. formation of the germ line, gastrulation, segmentation, nervous system development, limb patterning, organogenesis). We make extensive use of the primary literature and emphasize experimental approaches (e.g. classical embryology, genetics, molecular genetics).
Instructor(s): V. Prince, C. Ragsdale. Terms Offered: Spring
Prerequisite(s): For College students: Completion of the first three quarters of a Biological Sciences Fundamentals Sequence
Equivalent Course(s): BIOS 21356, DVBI 35600

MGCB 36100. Plant Development and Molecular Genetics. 100 Units.
Genetic approaches to central problems in plant development will be discussed. Emphasis will be placed on embryonic pattern formation, meristem structure and function, reproduction, and the role of hormones and environmental signals in development. Lectures will be drawn from the current literature; experimental approaches (genetic, cell biological, biochemical) used to discern developmental mechanisms will be emphasized. Graduate students will present a research proposal in oral and written form; undergraduate students will present and analyze data from the primary literature, and will be responsible for a final paper.
Instructor(s): J. Greenberg Terms Offered: Spring
Prerequisite(s): For undergraduates only: Completion of the general education requirement in the biological sciences
Equivalent Course(s): BIOS 23299, DVBI 36100, ECEV 32900

MGCB 36400. Developmental Mechanisms. 100 Units.
This course provides an overview of the fundamental questions of developmental biology, with particular emphasis on the genetic, molecular and cell biological experiments that have been employed to reach mechanistic answers to these questions. Topics covered will include formation of the primary body axes, the role of local signaling interactions in regulating cell fate and proliferation, the cellular basis of morphogenesis, and stem cells.
Instructor(s): E. Ferguson, R. Fehon Terms Offered: Winter
Prerequisite(s): For undergraduates only: BIOS 20189, BIPS 20190, or BIOS 20235 or equivalent.
Equivalent Course(s): BIOS 21237, DVBI 36400
MGCB 38100. Pedagogy for Scientists. 100 Units.
This course will enable graduate students in the molecular biosciences to develop their teaching skills through 1) the study and discussion of pedagogical theory; 2) class observation and critique; and 3) practical application of concepts through extensive teaching exercises. Teaching for different audiences and curricula will be emphasized. Undergraduate volunteers will supplement peer and instructor feedback. Classes will also be videotaped to allow for self-assessment.
Instructor(s): Jocelyn Malamy
Note(s): This course may not be taken to satisfy the requirement for elective courses, but must be taken as an extra course over and above the required nine courses. Course will be offered by petition from interested students.