Graduate 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
- Margaret Gardel, Physics
- Benjamin Glick
- Michael Glotzer
- Jean Greenberg
- David Kovar
- Stephen J. Kron
- Ilaria Rebay, Ben May Department for Cancer Research
- John Reinitz, Statistics
- Lucia Rothman-Denes
- Jonathan P. Staley
- Aaron Turkewitz

Associate Professors
- Sally Horne-Badovinac
- Jocelyn Malamy
- Ed Munro
- Michael Rust
- Alex Ruthenburg

Assistant Professors
- Robert Carrillo
- Ellie Heckscher
- Heng-Chi Lee
- David Pincus

Faculty not accepting students into their lab
Professors
- Robert Josephs
- Bernard Roizman, Microbiology

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

Emeritus Faculty
- Kwen Sheng Chiang
- Wolfgang Epstein
- Rochelle Easton Esposito
- Robert Haselkorn
- Anthony Mahowald
- Terence E. Martin
- Theodore L. Steck, Biochemistry & Molecular Biology
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 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 a teaching assistant 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](http://molbio.bsd.uchicago.edu).

**MOLECULAR GENETICS AND CELL BIOLOGY COURSES**

**MGCB 30400. Protein Fundamentals. 100 Units.**

The course covers the physical chemical phenomena that define protein structure and function. Topics include: three-dimensional structures of proteins; the principles of protein folding; molecular motion and molecular recognition; protein evolution, design and engineering; enzyme catalysis; regulation of protein function; proteomics and systems biology. Undergraduates are highly recommended to take BIOS 20200 (Introduction to Biochemistry) or equivalent before taking this course.

Instructor(s): E. Ozkan, J. Piccirilli, D. Arac Terms Offered: Autumn

Equivalent Course(s): HGEN 30400, BCMB 30400

**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): DVBI 31200, BCMB 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
Prerequisite(s): Molecular Biology I (MGCB 31200) or by special permission of an instructor
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.
Equivalent Course(s): DVBI 31400, BCMB 31400, HGEN 31400

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): HGEN 31600, DVBI 31600, BCMB 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
Prerequisite(s): For undergraduates: Three quarters of a Biological Sciences Fundamentals sequence.
Equivalent Course(s): BCMB 31700, 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): K. Moffat Terms Offered: Spring

MGCB 32300. Structure and Function of Membrane Proteins. 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): K. Moffat 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 32500. Quantitative Analysis of Biological Dynamics II. 100 Units.
This is a workshop style course in which students will work closely with instructors and TAs to implement
calculating/computational approaches to address specific research problems of interest to individual students.
The course is open to all students who have taken MGCB/DRSB 32000 or its equivalent, or who have otherwise
acquired a basic working knowledge of one or more programming languages (e.g. R, Matlab, Python). The
course will function as follows: prior to enrollment, each interested student will meet with the course instructors
to discuss an open scientific question they wish to address using mathematical/computational approaches. The
course will begin with a short presentation from each student describing the problem they propose to study,
followed by a discussion with the rest of the students and the course instructors about possible approaches.
The course instructors and TAs will then meet one-on-one with students over the course of the quarter to help
students implement the proposed strategies and adapt to challenges that emerge through this process. Students
will reconvene weekly as a group to report on their progress and discuss alternative approaches.
Instructor(s): E. Munro, M. Rust Terms Offered: Spring. Offered in alternating years beginning Spring 2020.
Prerequisite(s): MGCB 32000, DVBI 32000
Equivalent Course(s): DVBI 32550

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. Offered every other year in even years.
Prerequisite(s): For College students: Three quarters of a Biological Sciences Fundamentals sequence and 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: To be determined; may not offered in 2019-2020.
Prerequisite(s): Consent of instructor
Equivalent Course(s): ECEV 35400, STAT 35400, CAAM 35400

MGCB 35420. Stochastic Processes in Gene Regulation. 100 Units.
This didactic course covers the fundamentals of stochastic chemical processes as they arise in the study of gene
regulation. The central object of study is the Chemical Master Equation and its coarse-grainings at the Langevin/
Fokker-Planck, linear noise, and deterministic levels. We will consider both mathematical and computational
approaches in contexts where there are both single and multiple deterministic limits.
Instructor(s): J. Reinitz Terms Offered: To be determined; may not be offered in 2019-2020.
Prerequisite(s): Consent of instructor.
Equivalent Course(s): CAAM 35420, STAT 35420, ECEV 35420

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 including embryology, genetics, and molecular genetics.
Instructor(s): V. Prince, P. Kratsios. Terms Offered: Spring
Prerequisite(s): For Biological Sciences majors: Three quarters of a Biological Sciences Fundamentals sequence
including BIOS 20189 or BIOS 20190
Equivalent Course(s): DVBI 35600, ORGB 33600, BIOS 21356
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: Three quarters of a Biological Sciences Fundamentals sequence including BIOS 20187 or BIOS 20235.
Equivalent Course(s): ECEV 32900, BIOS 23299, DVBI 36100

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: Three quarters of a Biological Sciences Fundamentals sequence including BIOS 20189, BIOS 20190, or BIOS 20235. AND CONSENT OF INSTRUCTOR
Equivalent Course(s): BIOS 21237, DVBI 36400

MGCB 39200. Readings: MGCB. 100 Units.
Reading course in an area of developmental biology of special interest to the student. Must be prearranged with a faculty member and preapproved by the chair of the Curriculum Committee.

MGCB 39900. Tutorial: MGCB. 100 Units.

MGCB 47000. Thesis Research: MGCB. 300.00 Units.
Laboratory research for senior graduate students.

MGCB 47100. Non-Thesis Rsch: MGCB. 300.00 Units.
Laboratory research for first and second year graduate students.

MGCB 70000. Advanced Study: Molecular Genetics & Cell Biology. 300.00 Units.
Advanced Study: Molecular Genetics & Cell Biology