

BIOCHEMICAL AND BIOPHYSICAL METHODS, I & II

Course organizers: Gregory M. Alushin, Seth A. Darst, Shixin Liu, and Michael P. Rout

Description: This course presents the fundamental principles of biochemistry and biophysics, with an emphasis on methodologies. In addition, case studies are discussed, examining how physical and chemical methods have been used to establish the molecular mechanisms of fundamental biological processes. The course is offered in two consecutive semesters. Part I introduces biological macromolecules and experimental tools for dissecting their three-dimensional structures and assembly principles. Part II covers methods aimed at delineating the conformational fluctuations, chemical turnovers, and kinetic trajectories of biological complexes at molecular, cellular, and evolutionary scales.

Learning Outcomes: Students will learn fundamental principles of biochemical and biophysical methods and how they have been used to advance scientific understanding of specific biological systems. Additionally, students will gain experience and skills in critical reading, grant writing, and oral presentation.

Class length and frequency: Two-hour session, biweekly (Tue & Thu 3-5PM)

Recommended reading: The Molecules of Life: Physical and Chemical Principles by John Kuriyan et al.; Molecular Biology of the Cell by Bruce Alberts et al.; Physical Biology of the Cell by Rob Phillips et al.

Method of evaluation: Semester I: A 5-minute oral presentation of a research proposal + 1-page written summary with Specific Aims; Semester II: A 3-page News&Views-style review of a chosen topic from a list curated by the course organizers.

Preliminary schedule:

Part I: Structure		
Date	Topic	Lecturer
Sept 12, 2023	Introduction to macromolecules: proteins; Methods: Isolating and tagging proteins	Greg Alushin & Mike Rout
Sept 14	Introduction to macromolecules: nucleic acids; Methods: X-ray crystallography	Shixin Liu & Seth Darst
Sept 19	no lecture (RU student retreat)	
Sept 21	Methods: Single-particle cryo-electron microscopy	Gabriel Lander
Sept 26	Methods: Nuclear magnetic resonance spectroscopy	David Eliezer
Sept 28	Methods: Atomic model building and visualization	Oli Clarke & Darst lab

Feb 20	Case studies: Evolution of protein folding and function	Rama Ranganathan
Feb 22	Case studies: Macromolecular condensates	Yuh Min Chook & Mike Rosen
Feb 27	Case studies: Gene evolution	Li Zhao
Feb 29	Case studies: Epigenetics and chromatin biology	Yael David
Mar 5	Case studies: Dynamics of ribosome translation	Ruben Gonzalez
Mar 7	Case studies: Evolutionary dynamics of the nuclear pore complex	Mike Rout
Mar 12	Case studies: Dynamic cellular processes	Tarun Kapoor
Mar 14	Case studies: Cytoskeletal filaments and cell mechanics	Greg Alushin
Mar 21	Proposal due	