BIOCHEMICAL AND BIOPHYSICAL METHODS, I & II

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

<u>Description</u>: 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.

<u>Learning Outcomes:</u> 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.

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

<u>Recommended reading</u>: 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.

<u>Method of evaluation</u>: 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.

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Part I: Structure			
Date	Торіс	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	

Preliminary schedule:

Oct 3	Methods: Biological mass spectrometry	Brian Chait
Oct 5	Methods: Visualizing challenging specimens with cryo-EM	Alex de Marco & Rich Hite
Oct 10	Methods: Multi-scale structural modeling	Andrej Sali
Oct 12	Case studies: Transcription	Liz Campbell & Seth Darst
Oct 17	Case studies: Probing transcription complex structures with chemical reporters	Bob Landick
Oct 19	Case studies: Chemical proteomics	Katya Vinogradova
Oct 24	Case studies: Ribosome biogenesis	Sebastian Klinge
Oct 26	Case studies: Nucleic acid structure	Anna Marie Pyle
Oct 31	Case studies: DNA replication	Mike O'Donnell
Nov 2	Methods: Cryo-electron tomography	Wei Dai
Nov 7	Case studies: Membrane proteins	Jue Chen & Rod MacKinnon
Nov 9	Case studies: Microbial pathogenesis	Gira Bhabha & Damien Ekiert
Nov 14 & 16	Student presentations	
Part II: Dynamics		
Jan 9, 2024	Methods: Overview of single-molecule techniques	Shixin Liu
Jan 11	Methods: Super-resolution microscopy	Melike Lakadamyali
Jan 16	Methods: Atomic force microscopy	Simon Scheuring
Jan 18	Methods: Magnetic tweezers	Terence Strick
Jan 23	No Lecture, Faculty Search Symposium I	
Jan 25	Methods: Molecular dynamics simulation and computational chemistry	JK Lyu & Bing Zhang
Jan 30	Methods: Genomic methods for studying chromatin structure and dynamics	Viviana Risca
Feb 1	Methods: Spectroscopy	Tom Sakmar
Feb 6	No lecture, Faculty Search Symposium II	
Feb 8	Methods: Protein chemistry	Tom Muir
Feb 13	Methods: Enzymology	Philip Cole
Feb 15	Methods: Computational prediction of protein structure and interactions	Mohammed AlQuraishi

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	