Biophysical Methods

An overview of the diversity of modern biophysical experimental techniques used in the study of biological systems at the cellular and molecular level. Topics covered will include methods that examine both structure and function of biological systems. Topics include light microscopy, fluorescence microscopy, image processing, confocal and multiphoton microscopy, phase contrast, electron microscopy, x-ray diffraction and protein structure determination, multidimensional NMR, spectroscopy, chromophores, calcium measurements, resonance energy transfer, membrane biophysics, electrophysiology, ion channels, action potentials, ligand-gated channels, fluctuation analysis, patch-clamp, molecular biology of ion channels, capacitance measurements, amperometry, optical traps, and molecular force measurements. The course is intended for students who seek an introduction to modern biophysical experimental methods. Due to the interdisciplinary nature of the course, students will have diverse backgrounds. A basic knowledge of and interest in physics and mathematics is expected but strong attempts are made to give an intuitive understanding of the mathematics and physics involved. Some knowledge of physical chemistry, molecular and cell biology, or neurobiology will be helpful. Depending on individual background most students will find certain aspects easy and other aspects demanding.

The course will meet M, W. at 2:45 in Room E-115 of Weill Cornell Medical College (Biochemistry Department) and Fridays at 2 PM in the same room. On Mondays and Wednesdays this course will be taught in a videoconference setting with about half the lectures originating at Cornell-Ithaca. On Fridays, there will be paper discussions and student projects.

Course Co-director: Fred Maxfield frmaxfie@med.cornell.edu

Lectures:

Date	Type	Instructor	Topic
9-Sep	**Lecture**	**FRM**	**Absorption, Fluorescence, light spectroscopy**
14-Sep	**Lecture**	**ML**	**Quantum mechanics of chromophores and vision, caged compounds**
16-Sep	**Lecture**	**ML**	**Wide field microscopy, fluorescence microscopy, Point spread function, contrast transfer function. Fourier transforms.**
21-Sep	**Lecture**	**ML**	**Deconvolution, Confocal microscope**
23-Sep	**Lecture**	**FRM**	**Fluorescent indicators – Ca imaging, ratio imaging etc.**
28-Sep	**Lecture**	**FRM**	**Fluorescence resonance energy transfer (FRET)**
30-Sep	**Lecture**	**WZ**	**multiphoton microscopy**
5-Oct	**Lecture**	**ML**	**Phase contrast and electron**

			microscopy
7-Oct	Lecture	Scott Blanchard	Total internal reflection microscopy (TIRF), Single Molecule Imaging
12-Oct			**FALL BREAK**
14-Oct	Lecture	Tim Ryan	PALM, STORM, high resolution methods
19-Oct	Lecture	Min Lu	CD and Analytical Ultracentrifugation
21-Oct	Lecture	Lois Pollack	X ray scattering and protein dynamics
26-Oct	Lecture	Hao Wu	Protein Crystallography
28-Oct	Lecture	Hao Wu	Protein Crystallography
2-Nov	Lecture	Harel Weinstein	Computational modeling and simulation
4-Nov	Lecture	Harel Weinstein	Computational modeling and simulation
9-Nov	**Lecture**	**David Eliezer**	**NMR Spectroscopy**
11-Nov	**Lecture**	**David Eliezer**	**NMR Protein Spectroscopy**
16-Nov	**Lecture**	**David Eliezer**	**ESR Spectroscopy**
18-Nov	Lecture	Yi Wang	MRI
23-Nov	Lecture	Olaf Andersen	Membrane Biophysics
25-Nov			**THANKSGIVING RECESS**
30-Nov		**ML**	**optical trapping, molecular forces**
2-Dec		**Kit Umbach**	**Atomic Force Microscopy**
7-Dec	Lecture	ML	Ion channels, voltage dependence, activation, tail currents, gating, Hodgkin-Huxley, action potentials, microelectrodes, voltage clamp
9-Dec	Lecture	ML	Noise, single channels, patch clamp

Friday classes:

11-Sep	Maxfield: Intro to Course
18-Sep	Maxfield Optical microscopy discussion/paper
25-Sep	Lee Cohen-Gould: Practical exercise in confocal microscopy
02-Oct	Mukherjee: Practical exercise in multiphoton microscopy
09-Oct	Blanchard: TIRF
16-Oct	Ryan/Maxfield: Optical microscopy discussion/paper
23-Oct	Min Lu/Hao Wu: Protein biophysics/X-Ray
30-Oct	Hao Wu/Jin Wu: X-Ray
06-Nov	Harel Weinstein: Computational modeling
13-Nov	David Eliezer/Clay Bracken: NMR
20-Nov	David Eliezer/Clay Bracken: NMR
27-Nov	Thanksgiving
04-Dec	Olaf Andersen: Electrophysiology