BMEG 250: Cellular physiology & biophysics

This course expands understanding about cellular structure and investigates fundamental mechanisms of membrane transport, signal transduction, muscle mechanochemistry and neurotransmission. Structure and hierarchical organization up to the level of tissues are also studied using light and electron microscopy.

LEARNING OBJECTIVES

After the course, students will be able to:

- Understand cellular structure and intracellular organization of organelles
- Understand fundamentals of light and electron microscopy
- Operate light and electron microscopes for investigating cells and tissues
- Relate biophysical chemistry to cellular structure, as well as cellular interactions within tissues
- Understand biochemical properties of membrane lipids and investigate the structure of cellular membranes
- Understand membrane potentials and their impact on transport into and outside the cell
- Differentiate between the physiology of passive diffusion, facilitated diffusion, co-transport and counter-transport
- Relate membrane excitability to the physiology and function of ionotropic and metabotropic channels
- Understand the biology of gap junctions
- Understand the role of ion channels in pharmacobiology
- Understand signal transduction and how intracellular signaling cascades are initiated in response to extracellular stimuli
- Understand the chemistry and physiology of synaptic transmission
- Understand mechanochemistry and relate it to excitation and contraction of muscle tissue
- Understand and exploit molecular machines for cellular bioengineering

COURSE SCHEDULE

Lectures - 3 sessions of 1 hour each per week (36 total; 3 credits).
Labs - 1 session of 3 hours every three weeks (4 total; 1 credit)

Week	Description
1	Cellular structure and organelles, compartmentalization of cellular physiological functions
2	Investigating cell and tissue structure using light & electron microscopy
3	Biophysical chemistry of physiological solutions and metabolism, review of biological thermodynamics
4	Biochemical properties of membrane lipids, structure of cellular membranes, Singer-Nicholson fluid mosaic model
5	Membrane potentials, Gibbs-Donnan equilibrium potentials, Fickian diffusion
6	Facilitated transport across membranes, co-transport, counter-transport, ion pumps
7	Osmosis & regulation of cellular volume, regulation of intracellular pH

8 Membrane excitability, structure & mechanism of voltage-gated ion channels

9 Gap junctions, ligand-gated ion channels

10 Interaction of ion channels with cytoskeleton, targeting ion channels for drug development

11 Intracellular signaling cascades, cellular responses to external stimuli, neurochemistry, synaptic transmission

12 Smooth muscle excitability, mechanochemistry, contraction of muscles

13 Protein-protein interactions and molecular machines, application of molecular machines in bioengineering