Membrane Biology

Fall 2015

CBCH-3316

CRN 13534

Lecture: **M, W (3 pm-4.20 pm); LART 305**

Professor: **Sid Das**
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Office Hours: **T and R: 3-4 PM (or through prior appointments).**

Text Books:

Molecular Biology of the Cell by Alberts and others, 5th or 6th edition (2008, 2015)

Cell Membranes by Lukas K. Buehler (Garland Science, 2016)

Objective:

This course is aimed at students, who would like to learn the recent advances in membrane biology. We will discuss the experimental evidence, which leads us to understand the current models of the structure and function of biological membranes.

Strategies:

1. Rather than delivering boring lectures by this instructor, we will brainstorm topics, and discuss classic papers in membrane biology in addition to the text book.

2. Participants will be asked to describe their ideas of selected topics before class and compare that with other students.

3. The instructor will provide data and figures from primary literatures, and students will discuss the concept in an effort to gain an understanding of the topic.

4. The class will work on problems, presentations and writing short reports on the various aspects of Membrane Biology

Examination Procedure

There will be three class exams and a final exam. In addition, there will be classroom presentations and project report, which will be counted. Your grade will be distributed as follows:

Grades (100%) will be the average of two class exams, presentations, attendance (2%) and the final exam. The lowest class grade will be dropped.

Notes:

1) You are strongly encouraged to form groups consisting of 2-3 people-this will be helpful in discussing and presenting materials in the class.
2) Try not to miss any exam or class without proper notification.
3) Attendance is must and everyone needs to sign the attendance roster which carries 2% of your total grade.
4) You may not be allowed to take the test if you are absent for two weeks in a row prior to the test without informing the instructor.

Grading Policy

A = 90-100
B = 80-89
C = 70-79
D = 60-69
F = Below 60

Course Materials

The Role of Membranes in Cells and Organisms

(Ch-1, Cell Membranes by Lukas Buehler)

Membranes establish the outer limits of life
Lipids and proteins have different roles in the cell membranes
Membranes provide four basic cellular functions
Membranes are self-renewing structures
Membrane display a unique combination of mechanical and electrical properties
Membranes are linked to disease and serve as therapeutic targets
Fluid-mosaic model

The Molecular Organization of Cell Membranes

(Ch-2, Cell Membranes by Lukas Buehler)

The structure of Cell Membranes is described by the Fluid-Mosaic Model
Phospholipid bilayers from the structural foundation of cell membranes
The lipid bilayer serves as a scaffold for the attachment and integration of proteins
The width of phospholipid bilayers is universal and matches the size of small proteins
Cell membranes are complex modular structures
The bilayer configuration allows for an adjustable surface area without affecting width.
Fluidity is a defining characteristic of cell membranes
Membranes are two-dimensional liquids
Diffusion is an efficient method but not the only means of redistributing membrane components
Lipid and proteins organize into local domains
Membranes form closed structures called vesicles
Cell shape can be characterized by membrane curvature
Lipid packing influences membrane curvature
The fluid-mosaic model of cell membranes was built on thermodynamic principles
Bringing an old paradigm up to date.

Tools for Studying Membrane Components: detergents and Model systems

(Membrane Structural Biology by Mary Luckey)

Detergents
Model Membranes
Liposomes
Nanodiscs

Exam-1

Membrane Proteins

(Molecular Biology of the Cell by Alberts, Ch-10)

Membrane proteins can be associated with the lipid bilayer in various ways
Lipid anchors control the membrane localization of some signaling proteins
In most transmembrane proteins the polypeptide chain crosses the lipid bilayer in an α-helical conformation
Transmembrane alpha helices often interact with one another
Some β-barrels from large transmembrane channels
Many membrane proteins are glycosylated
Membrane proteins can be solubilized and purified in detergents
Bacteriorhodopsin is a light-driven proton pump that traverses the lipid bilayer as seven α helices
Many membrane proteins diffuse in the plane of the membrane
Cells can confine proteins and lipids to specific domains within a membrane
The cortical cytoskeleton gives membranes mechanical strength and restricts membrane protein diffusion

Exam: 2

Membrane transport

(Molecular Biology of the Cell by Alberts, Ch-11)

Principles of membrane transport
Classes of transport proteins
Active transport
Transporters and active membrane transport
Active transport can be driven by ion gradients
Transporters in the plasma membrane regulate cytosolic pH

Asymmetric distribution of transporters in epithelial cells
ATP-driven pump
Ca2+-pump is the best-understood P-type ATPase
The plasma membrane P-type Na+-K+ pump establishes the Na+-gradient across the plasma membrane
ABC transporters constitute the largest family of membrane transport proteins
Ion channels are ion-selective and fluctuate between open and closed states
The membrane potential in animal cells depends mainly on K+ leak channels and the K+ gradient across the plasma membrane
The resting potential decays only slowly when the N+-K+ pump is stopped
Aquaporins are permeable to water impermeable to ions
The function of a neuron depends on its elongated structure
Voltage-gated cation channels generate action potentials in electrically excitable cells
Patch-Clamp recording
Transmitter-gated cation channels
Transmitter-gated ion channels
Chemical synapses
Neuromuscular transmission

The Biological Diversity of Membrane Lipids

(Ch-4. Cell Membranes by Lukas Buehler)

A biologist's view of Lipid Diversity: Why so many lipids?
Lipid classes are rooted in common biosynthetic pathways
What qualifies a lipid as a membrane lipid?
Biologists think of membrane lipids as phospholipids, glycolipids and cholesterol.
The structure and stereochemistry of lipids with a glycerol core
Head-group composition determines phospholipid nomenclature
The aliphatic chains of membrane lipids are surprisingly diverse
Methyl-branched ether lipids are unique components of archaeal membranes.
Sphingolipids complement glycerol-based lipids in cell membranes
Complex systems require redundancy: a role for lipid heterogeneity
Saccharrolipids are part of outer membranes in bacterial cell walls
Sterols and hapanoids are polycyclic triterpines in eukaryotes and bacteria
An organism's lipid composition is a telltale of its taxonomic status

Exam-3

Presentations

For presentations you should form a group consisting of 2-3 people per group. The presentations will start from mid-October. I will discuss more regarding this in the class room.

EXAMINATION (FINAL)

Posted on August 20th, 2015