Syllabus

Membrane Biology

Fall 2023
CBCH-3316
CRN: 11271
Lecture
M, W (3 PM-4.20 PM)
Liberal Arts Building (LART), Room #106

Professor: Dr. Sid Das
Office: Biosciences Building 5.128 (747-6896)
E-mail: sdas@utep.edu.

Office Hours: M, W: 4.30-5. 15 PM (or by prior appointment)

Guidelines:

Traditional (Face-to-Face) lecture style will be followed. Side by side the Blackboard Ultra (UTEP) platform for online instruction will also be used.

Use of artificial intelligence

The use of generative AI tools such as Chat GPT is not permitted in this course.

Plagiarism detecting software

Some of your course work and take home assignments may submitted to the “Grammarly Plagiarism Checker’ to detect possible plagiarisms.

Scholastic Integrity

Maintaining the academic honesty is critical and any sort of dishonesty is considered a violation of the UTEP Handbook of Operating Procedures. Academic dishonesty includes cheating, plagiarism, and collusion. All suspected violations of academic integrity at UTEP must be reported to the Office of Student Conduct and Conflict Resolution (OSCCR) for possible disciplinary action. To learn more, please visit HOOP: Student Conduct and Discipline
Attendance and participation

Our class meetings are in-person at the Liberal Arts, Room 106, every Monday and Wednesday from 3:00 PM to 4.30 PM beginning August 28 through December 6. Please note that attendance for presentations is mandatory and will be monitored through a sign-in sheet or a BlackBoard poll sent by the speakers at any time. Inform the instructor beforehand if you face technical difficulties during the lecture or need additional assistance.

Textbooks:

Molecular Biology of the Cell by Alberts and others, 6th edition

(UTEP Bookstore).

Reference Books:

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

Will be provided by the instructor.

**Course description and 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:**

- Rather than delivering boring lectures by this instructor, we will brainstorm topics, and discuss classic topics in membrane biology in addition to the text and reference books.
- Participants will be asked to describe their ideas of selected topics before class and compare that with other students.
- The instructor will provide data and figures from primary literatures, and students will discuss the concept/idea of a particular topic.
- The class will work on problems, presentations and drafting short reports on the various aspects of Membrane Biology.
- It is expected that students will have a good understanding about the membrane model, plasma membrane biogenesis.

**Examination Procedure**

There will be quizzes, three exams and a final exam. Your grade will be distributed as follows:

Grades (100%) will be the average of three class exams, and the final exam. The lowest class exam grade (not the final) will be dropped.

**Notes:**

Try not to miss any exam without proper notification.

**Grading Policy**

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

<table>
<thead>
<tr>
<th>September 4</th>
<th>Labor Day</th>
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<tbody>
<tr>
<td>Labor Day</td>
<td>September 4</td>
</tr>
<tr>
<td>November 3</td>
<td>Fall Drop/Withdrawal Deadline</td>
</tr>
<tr>
<td>November 23-24</td>
<td>Thanksgiving Holidays</td>
</tr>
<tr>
<td>December 7</td>
<td>Last Days of Class</td>
</tr>
<tr>
<td>December 11</td>
<td>Final Exam 1-3.45 PM</td>
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</tbody>
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Course Materials

1. The Role of Membranes in Cells and Organism  
   (August 28-30, 2023)

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

2. The Molecular Organization of Cell Membranes  
   (Ch-2, Cell Membranes by Lukas Buehler)  
   September 6-13, 2023

   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

(Practice quiz)
3. Tools for Studying Membrane Components: Detergents and Model Systems
(Membrane Structural Biology by Mary Luckey)
September 18, 2023

| Detergents |
| Model Membranes |
| Liposomes |
| Nanodiscs |
Exam-1 (September 20, 2023)

4. Membrane Proteins
(Molecular Biology of the Cell by Alberts, Ch-10)
September 25-27, 2023

Membrane proteins can be associated with the lipid bilayer in numerous ways
Lipid anchors control the membrane localization of signaling proteins
In most transmembrane proteins the polypeptide chain crosses the lipid bilayer in an
$\alpha$-helical conformation
Transmembrane alpha helices often interact with one another
Some $\beta$-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 $\alpha$ 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

Practice Quiz
Exam-2: October 2, 2023

5. Membrane transport
(Molecular Biology of the Cell by Alberts, Ch-11) October 4-11, 2023

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 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

### 6. The cytoskeleton and membranes

*(Molecular Biology of the Cell by Alberts, Ch-16) October 16-23, 2023*

- The self-assembly and dynamic structure of cytoskeletal filaments
- How cells regulate their cytoskeletal filaments
- Molecular motors

**Intracellular Membrane Traffic**

*(Molecular Biology of the Cell by Alberts, Ch-13)*

- Molecular mechanisms in membrane transport and the maintenance of compartmental diversity
- Transport from the ER through the Golgi complex
- Transport from the ER through the Golgi complex

**Exam-3: October 25, 2023**

### 7. Vesicular Trafficking

*(Molecular Biology of the Cell by Alberts, Ch-13) October 30; November 1-6, 2023*

- The molecular mechanisms of membrane transport: compartmental diversity
- Transport from the ER to Golgi
  - COP-I, COP-II and clathrin-coated vesicles
  - Adaptor proteins and phosphoinositides
  - Rab proteins guide transport vesicles
  - **SNARE Proteins**
  - **Vesicular Tubular Clusters**
  - Oligosaccharide chains are processed in the Golgi Apparatus

**Presentations (November 08-December 06, 2023)**

For presentations you should form a group consisting of 3 people per group. The presentations will start from mid-October. The topic will be related to membrane structure, functions, receptors, signaling etc. I will discuss more regarding this in the classroom.

**Final Exams on December 11, 2023**

*(Posted on August 27, 2023)*