

## Cellular Biology

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- The Lipid Bilayer
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## Chapter 10: The Cell Membrane

1. The Lipid Bilayer
2. Membrane Proteins

### The Lipid Bilayer

#### Phosphoglycerides, Sphingolipids, and Sterols Are the Major Lipids in Cell Membranes

- **Plasma membrane:** the part of the cell that separates the exterior and the interior of a cell with a semipermeable lipid bilayer. The plasma membrane regulates import and export of materials for the cell and includes various proteins that interact with other cells.
- **Lipid bilayer:** the resulting structure of the spontaneous alignment of mostly amphiphilic phospholipids.
- **Amphiphilic:** a chemical compound possessing a polar **hydrophilic** component and a **hydrophobic**, or lipophilic (fat loving), non polar end.
- **Phospholipids:** the most abundant membrane lipid containing a polar head consisting of a phosphate group and two hydrophobic fatty acid tails made of hydrocarbons.
- **Phosphoglycerides:** the main compounds that make up the phospholipids in animal cells, consisting of have a three-carbon glycerol backbone. Different combinations of head groups and tails can yield different phosphoglycerides. The most notable are: phosphatidylethanolamine, phosphatidylserine, and phosphatidylcholine.
- *Sphingolipids:* similar to phosphoglycerides, but made up of sphingosine rather than glycerol.
- **Cholesterol:** a *sterol* containing a rigid ring structure and attached to a single polar hydroxyl group. Cholesterol sits in the middle of the bilayer and helps provide structure by reducing tail mobility.

#### The Lipid Bilayer Is a Two-dimensional Fluid

- **Liposomes**

#### Despite Their Fluidity, Lipid Bilayers Can Form Domains of Different Compositions

- **Lipid raft**

#### Lipid Droplets Are Surrounded by a Phospholipid Monolayer

- **Lipid droplets**

## The Asymmetry of the Lipid Bilayer Is Functionally Important

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## Glycolipids Are Found on the Surface of All Eukaryotic Plasma Membranes

- Glycolipids
- Gangliosides

### The Lipid Bilayer: Summary

Biological membranes consist of a continuous double layer of lipid molecules in which membrane proteins are embedded. This lipid bilayer is fluid, with individual lipid molecules able to diffuse rapidly within their own monolayer. The membrane lipid molecules are amphiphilic. When placed in water, they assemble spontaneously into bilayers, which form sealed compartments. Although cell membranes can contain hundreds of different lipid species, the plasma membrane in animal cells contains three major classes—phospholipids, cholesterol, and glycolipids. Because of their different backbone structure, phospholipids fall into two subclasses—phosphoglycerides and sphingolipids. The lipid compositions of the inner and outer monolayers are different, reflecting the different functions of the two faces of a cell membrane. Different mixtures of lipids are found in the membranes of cells of different types, as well as in the various membranes of a single eukaryotic cell. Inositol phospholipids are a minor class of phospholipids, which in the cytosolic leaflet of the plasma membrane lipid bilayer play an important part in cell signaling: in response to extracellular signals, specific lipid kinases phosphorylate the head groups of these lipids to form docking sites for cytosolic signaling proteins, whereas specific phospholipases cleave certain inositol phospholipids to generate small intracellular signaling molecules.

### Membrane Proteins

## Membrane Proteins Can Be Associated with the Lipid Bilayer in Various Ways

- Transmembrane protein
- Glycosylphosphatidylinositol (GPI) anchor
- Membrane-associated proteins

## Lipid Anchors Control the Membrane Localization of Some Signaling Proteins

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## In Most Transmembrane Proteins, the Polypeptide Chain Crosses the Lipid Bilayer in an $\alpha$ -Helical Conformation

- Single pass transmembrane proteins

- Multi-pass transmembrane proteins

## Transmembrane $\alpha$ Helices Often Interact with One Another

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## Some $\beta$ Barrels Form Large Channels

- Lumen

## Many Membrane Proteins Are Glycosylated

- Carbohydrate layer
- Lectins

## Membrane Proteins Can Be Solubilized and Purified in Detergents

- Detergents

## Bacteriorhodopsin Is a Light-driven Proton $H^+$ Pump That Traverses the Lipid Bilayer as Seven $\alpha$ Helices

- Bacteriorhodopsin

## Some $\beta$ Barrels Form Large ChannelsThe Cortical Cytoskeleton Gives Membranes Mechanical Strength and Restricts Membrane Protein Diffusion

- Spectrin
- Cortex

## Membrane-bending Proteins Deform Bilayers

- Membrane bending proteins