CONCEPT: THE LIPID BILAYER

Types of Lipids

● Membrane lipids are composed of a combination of nonpolar tails and polar head groups

□ Many molecules of the lipid bilayer are **amphipathic**, meaning they have a *hydrophobic* portion and a *hydrophilic* portion

□ **Phospholipids** are the most common lipid found in membranes. They have a hydrophobic tail & hydrophilic head

- Composition of the head group determines their name: phosphatidylcholine, phosphatidylserine, etc…

□ **Sphingolipids** has a sphingosine (amino alcohol with long hydrocarbon tail) linked to a fatty acid

- Composition of attached group determines their name: sphingomyelin is attached to phosphorylcholine

- Sometimes sphingolipids are classified as phospholipids

□ **Glycolipids** are lipids attached to a sugar group

- *Gangliosides* have an oligosaccharide chain with a net negative charge

- *Cerebrosides* have a single uncharged sugar

- Glycolipids determine your blood type (A blood has N-acetylgalactosamine, B has galactose)

□ **Sterols** are steroids that have a hydroxyl group and short hydrocarbon chain. Very rigid.

- **Cholesterol** is the most common type in animal cells

EXAMPLE: Structure of common lipids

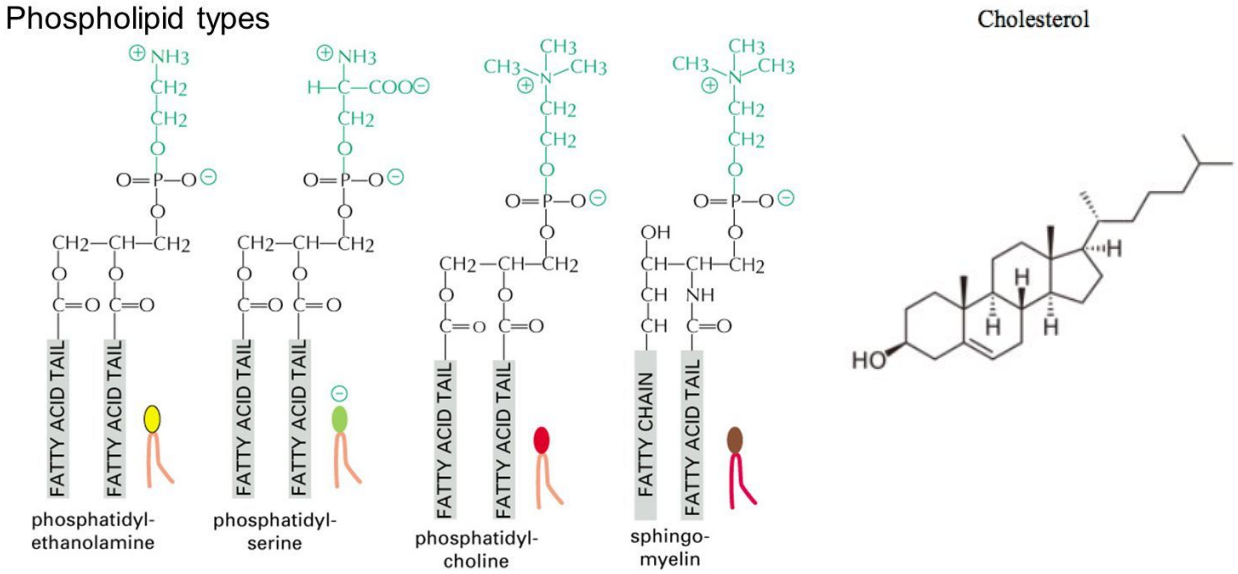


Figure 10–12. Molecular Biology of the Cell, 4th Edition.

Bilayer Formation and Fluidity

● Lipids form highly flexible *lipid bilayers* when suspended in water

□ A lipid bilayer is the most energetically favorable conformation of amphipathic lipids in water

- Lipid bilayers self-seal, meaning they spontaneously form, and reform when torn apart

- Form a boundary around a closed space

□ The **fluid-mosaic model** describes the nature membranes. The lipid bilayer is **fluid** (not stationary)

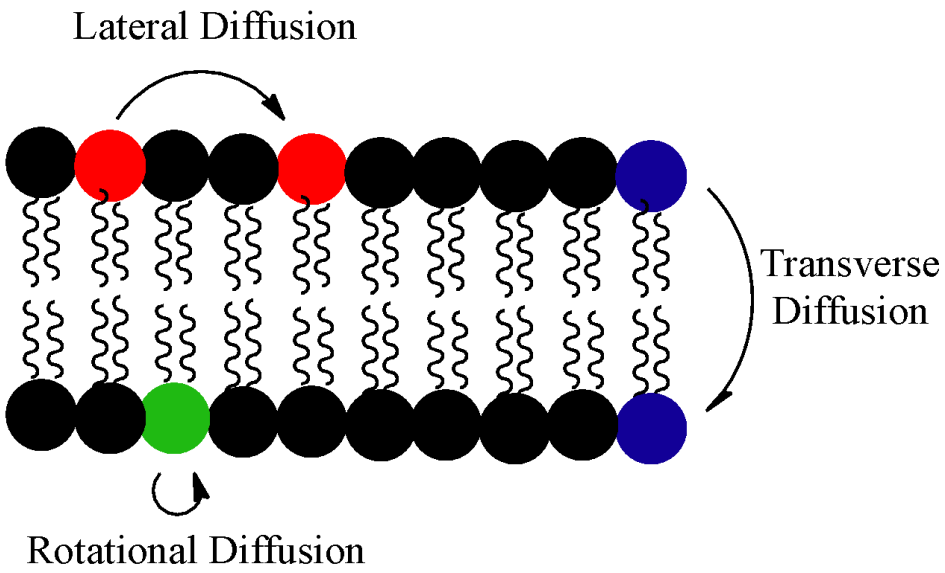
- **Lateral diffusion** is the movement of individual lipids within a single layer of the bilayer – occurs often

- **Rotational diffusion** is the rotation of an individual lipid molecule (up to 500 revolutions a second)

- **Traverse diffusion** is the movement from one layer of the bilayer to the other and is extremely rare

□ **Liposomes** are synthetically made lipid spheres used to study membrane fluidity

EXAMPLE: Movement of lipids in the bilayer



Bilayer Composition and Asymmetry

● The composition of a membrane bilayer effects its fluidity and function

□ Fluidity of the lipid bilayer is controlled by the amount and composition of lipids

- Shorter hydrophobic chains = more fluid (Average is 18-20 carbons, but can be between 14-24)

- Saturated hydrophobic chains (no double bonds) are less fluid; Unsaturated chains are more fluid

- Double bonds form kinks in the tail, and therefore make packaging closely more difficult

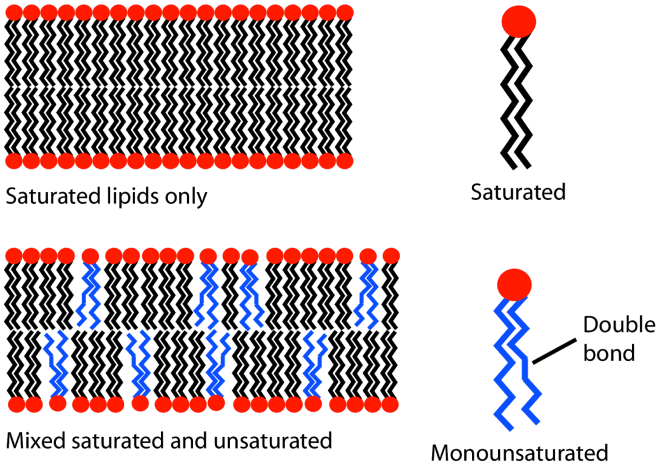
□ Cholesterol can modulate membrane fluidity

- It's short and rigid nature can fill spaces left by the kinks in unsaturated hydrocarbon chains

- Make membrane less fluid and less permeable

- Cholesterol makes up around 20% of the weight of lipid membranes in animal cells

EXAMPLE: Saturation of lipid hydrophobic chains affects fluidity



● Membrane lipids are not equally distributed on each side of the lipid bilayer

□ Every cellular membrane has two distinct faces: the *cytosolic* face and *extracellular* face (*luminal* face)

- The **cytosolic face** always faces the cytosol

- The **extracellular face (luminal face)** faces the extracellular space or the lumen of organelles

  - Double bonds form kinks in the tail, and therefore make packaging closely more difficult

□ **Flippases** remove specific phospholipids from one side of the bilayer and flip them to the other side

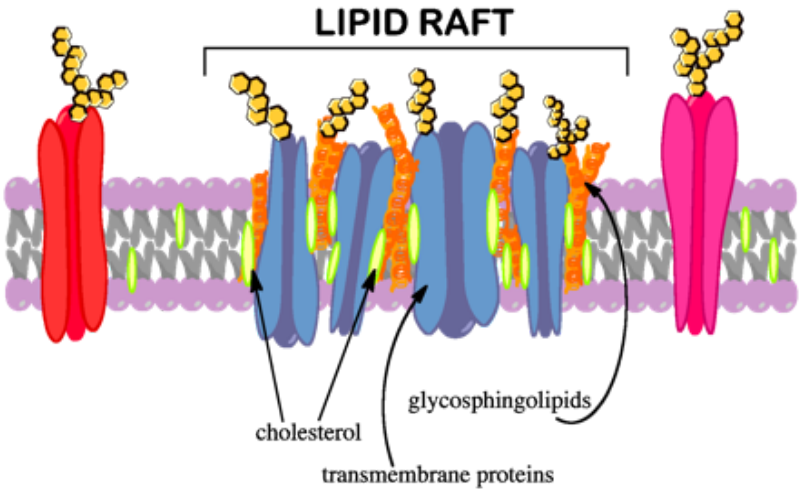
- Can be found in the ER or Golgi

□ **Phospholipases** are enzymes that cleave ester bonds between lipid molecules are only on cytosolic side

- Can effect composition of lipids on the cytosolic face side of the membrane

□ **Lipid rafts** are functional domains on the bilayer composed on particular lipids for a particular function

EXAMPLE: Asymmetrical arrangement of lipids and proteins in a bilayer form lipid raft domains

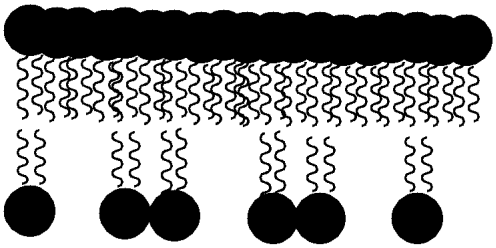


Lipid Assembly

- Lipids are synthesized in the Endoplasmic Reticulum
  - □ Lipids are synthesized on the cytosolic surface of the ER and forms only one monolayer
    - **Scramblases** are responsible for taking lipids from one monolayer and inserting them into the other
  - □ Newly formed membranes then pinch off the ER to form small vesicles
    - These vesicles fuse with other membranes
    - Some newly formed lipids will remain in the ER
  - □ **Lipid droplets** are vesicular structures made of excess lipids, responsible for storing them until use
    - Fat cells contain high amounts of lipid droplets

EXAMPLE: Lipid bilayer synthesis

1. Lipid synthesis occurs on only one side of the membrane



2. Scramblases move lipids to other bilayer