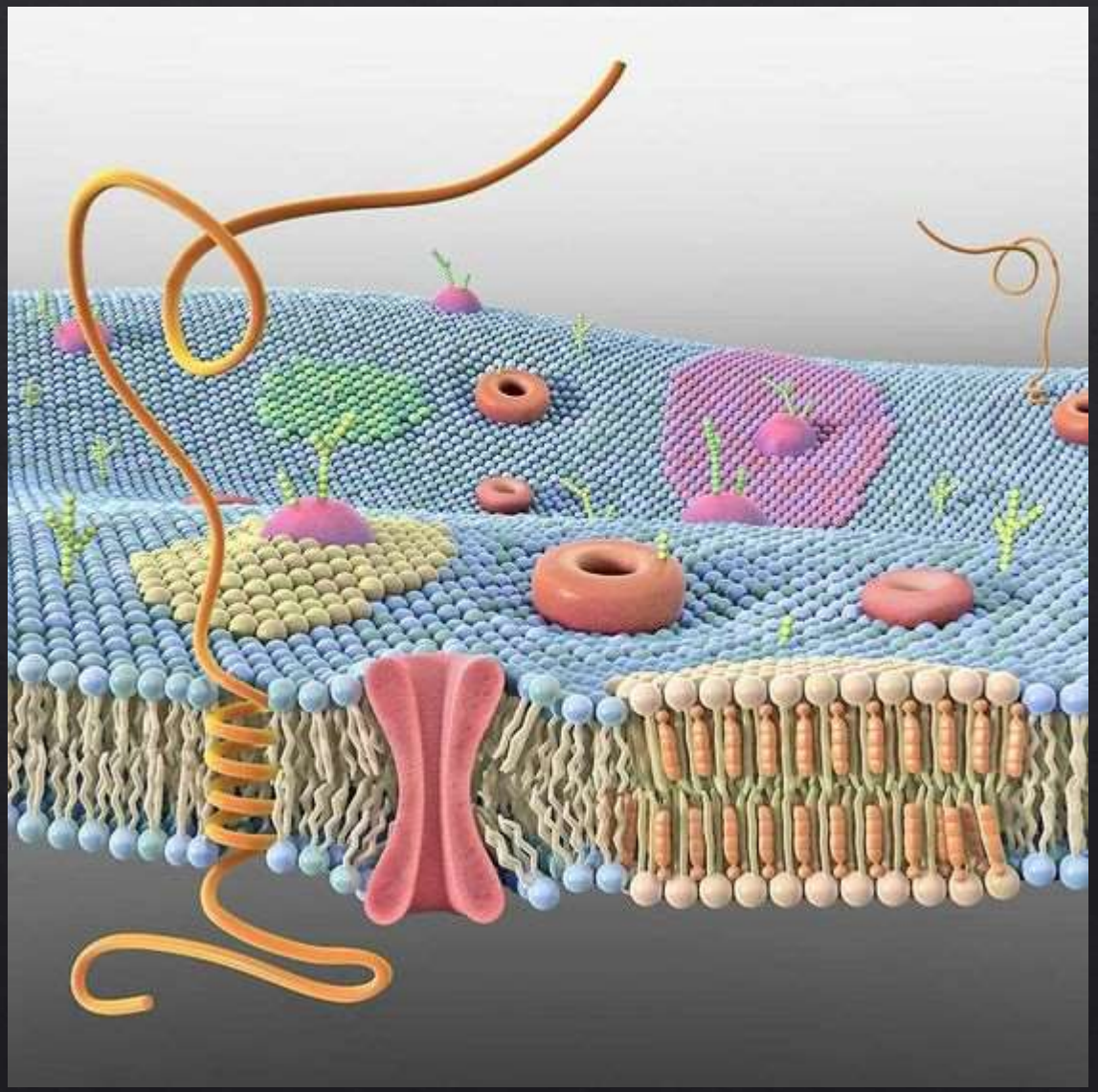
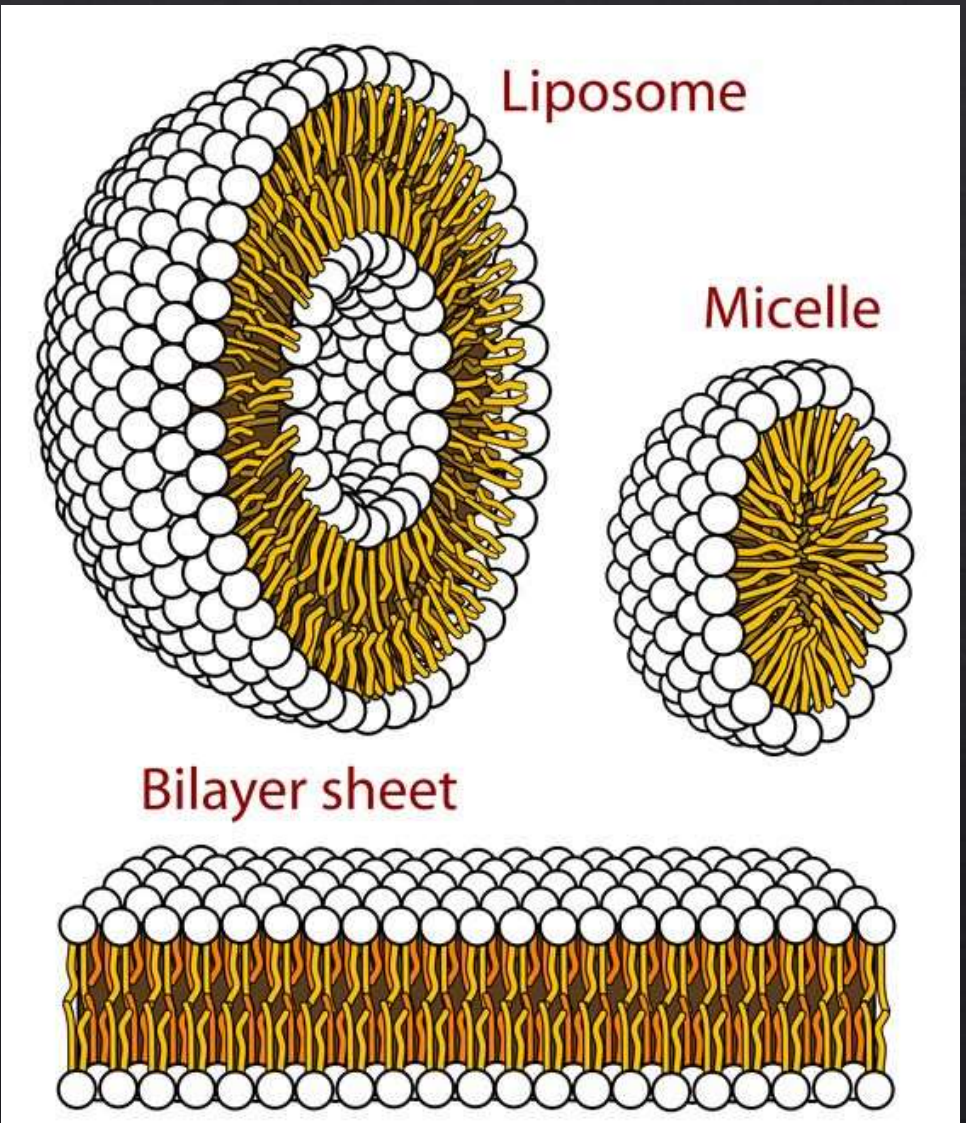
The cell membrane



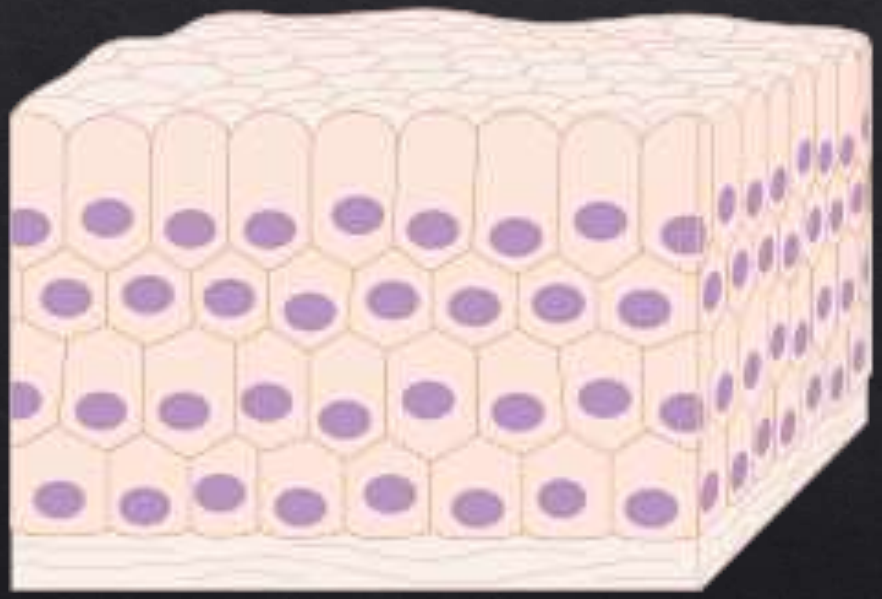
Lipids form the basic structure



- Three major structures are observed:
  - micelles
  - bilayers
  - liposomes
- Structures formed depend on:
  - type of lipid
  - concentration

Picture by LadyOfHats

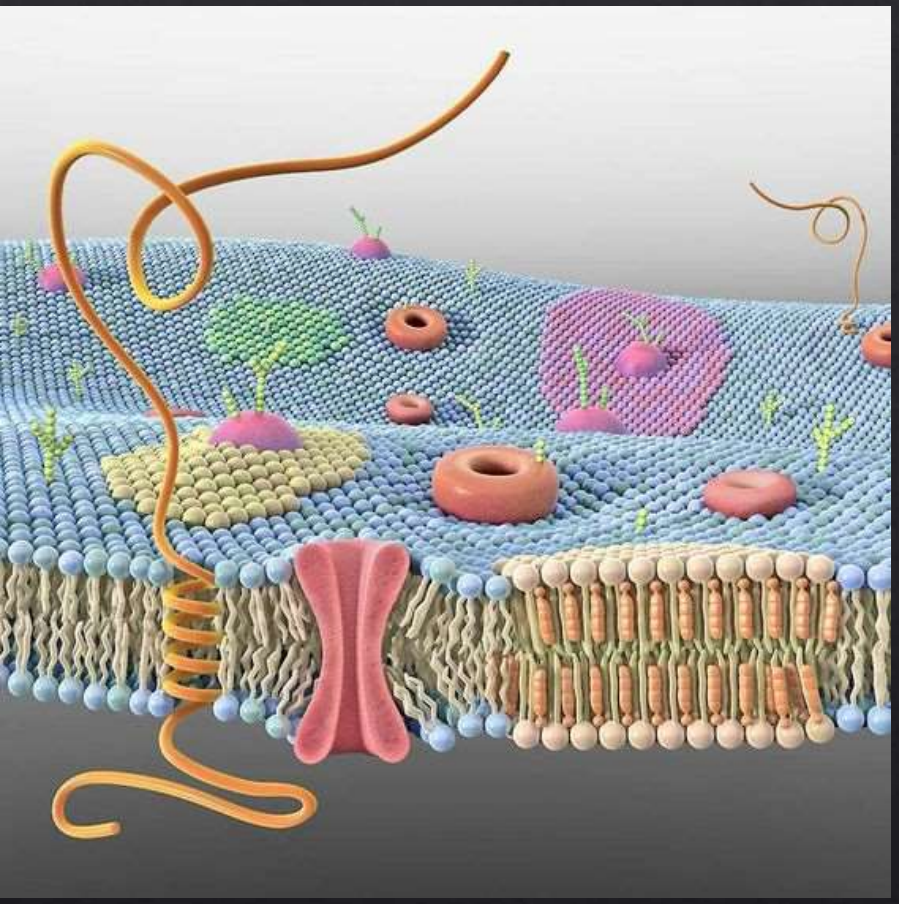
The cell membrane



Picture by Cancer Research UK

- Complex lipid-based structures that form pliable sheets
- Composed of a variety of lipids and proteins
- All cells have a cell membrane, which separates the cell from its surrounding
- Eukaryotic cells have various internal membranes that divide the internal space into compartments (i.e., organelles)

Cell membrane features



- Flexible, fluid structure
- Proteins span the lipid bilayer
- Asymmetric
  - Some lipids are found mostly "inside."
  - Some lipids are found mostly "outside."
  - Carbohydrate moieties are attached on the outer leaflet.
  - They can be electrically polarized.

Membrane composition and asymmetry

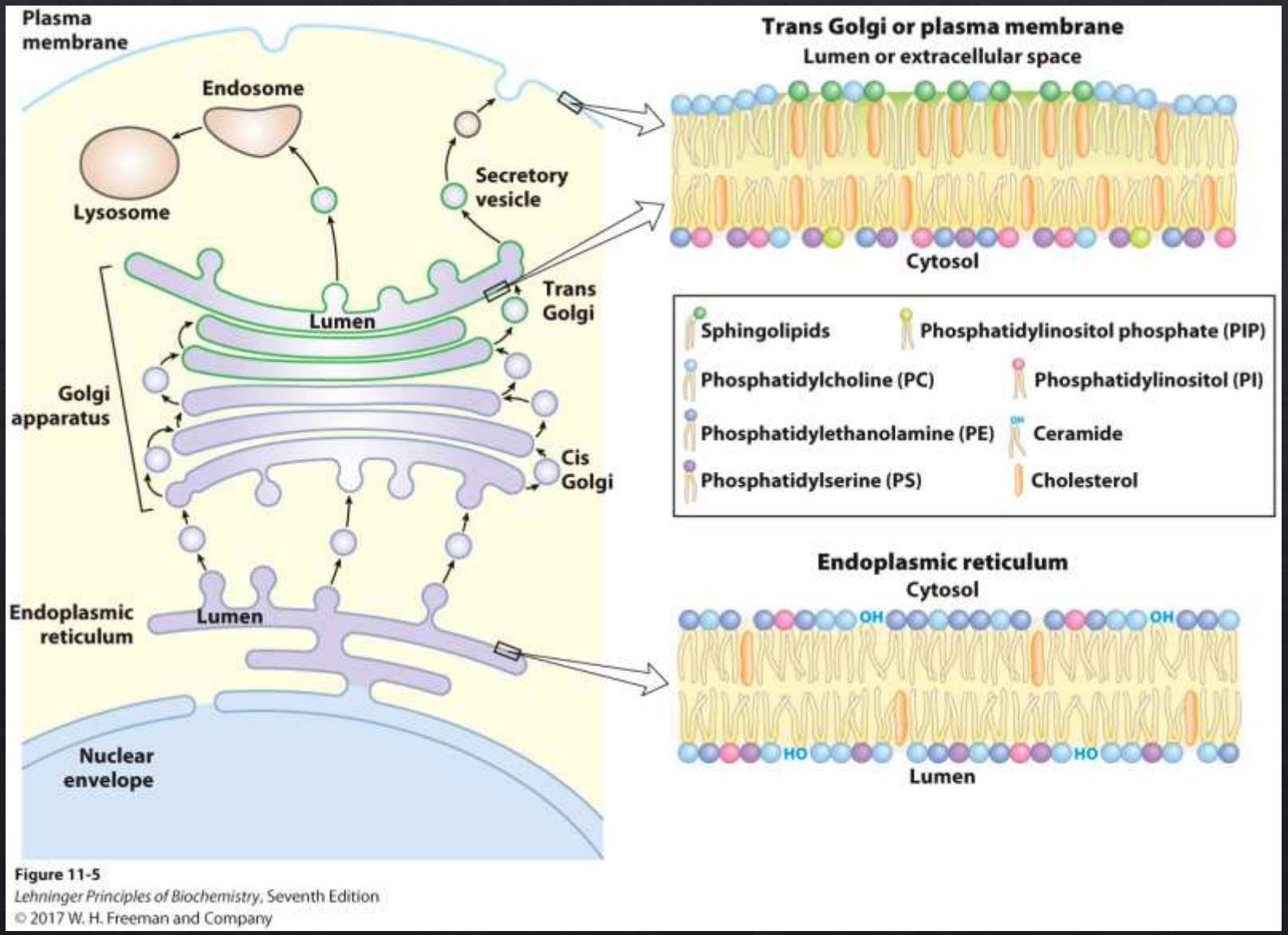


Figure 11-5
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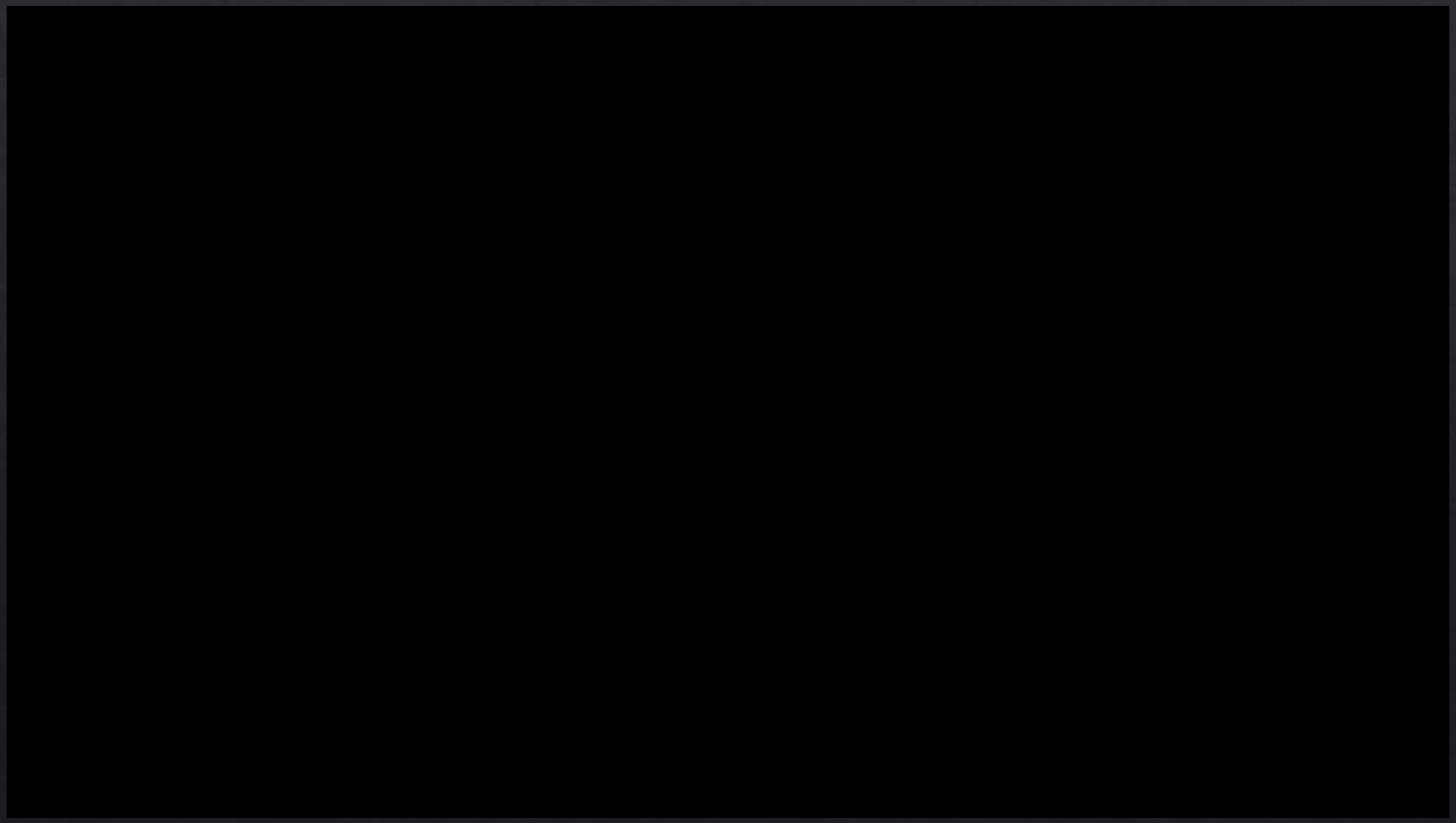
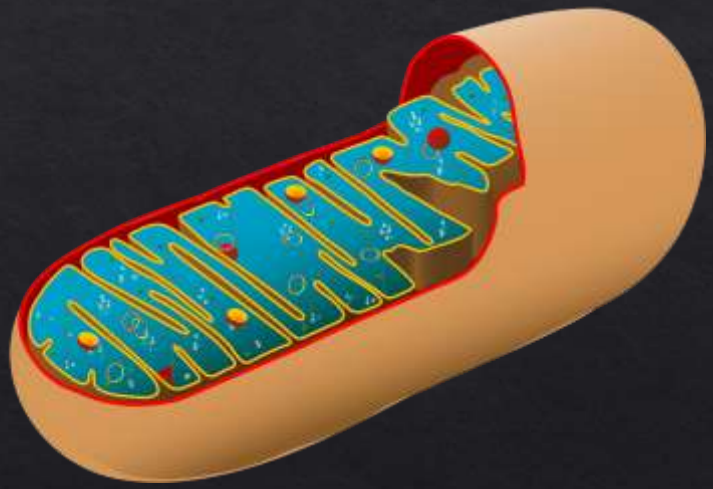
Membrane trafficking



The cell membrane

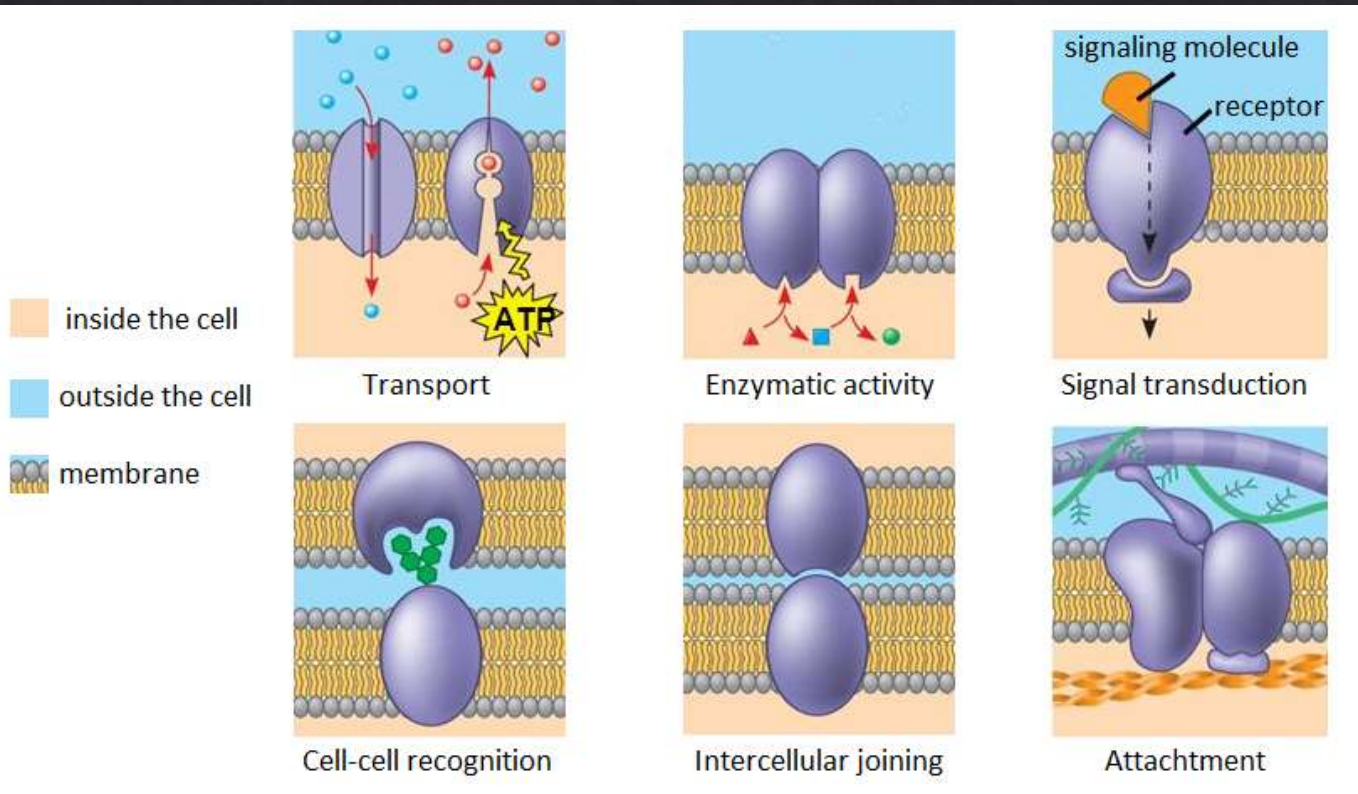
Lipid and protein composition and ratio change depending on cell/organelle function and life cycle



Picture by LadyOfHats

Proteins functions

- Receptors: detecting signals from outside
- Channels, gates, pumps
- Enzymes



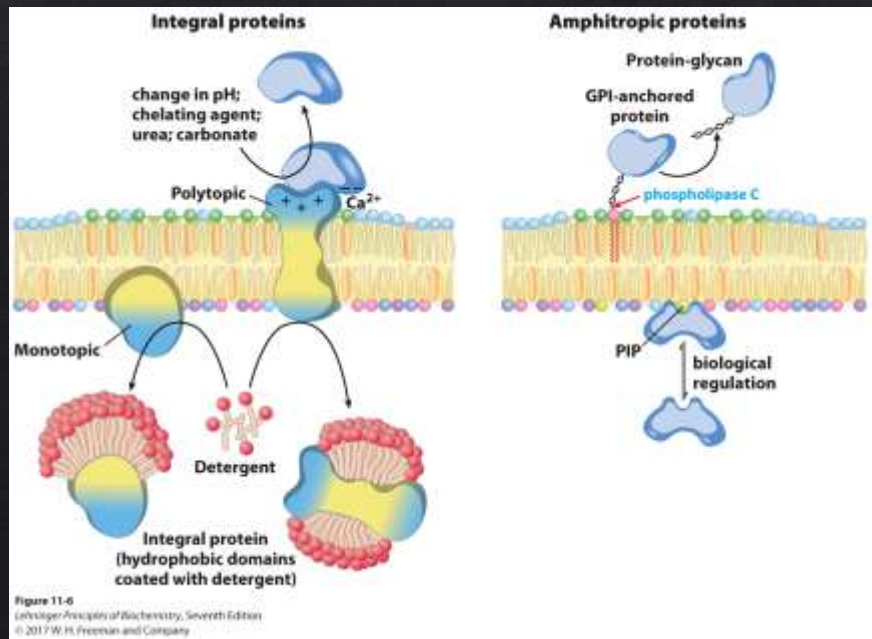
Picture adaped from Campbell et al. 9th edition from Socratic.org

Three types of membrane proteins

Peripheral membrane proteins can be dissociated from the membrane fairly easily during changes in ionic strength like pH changes.

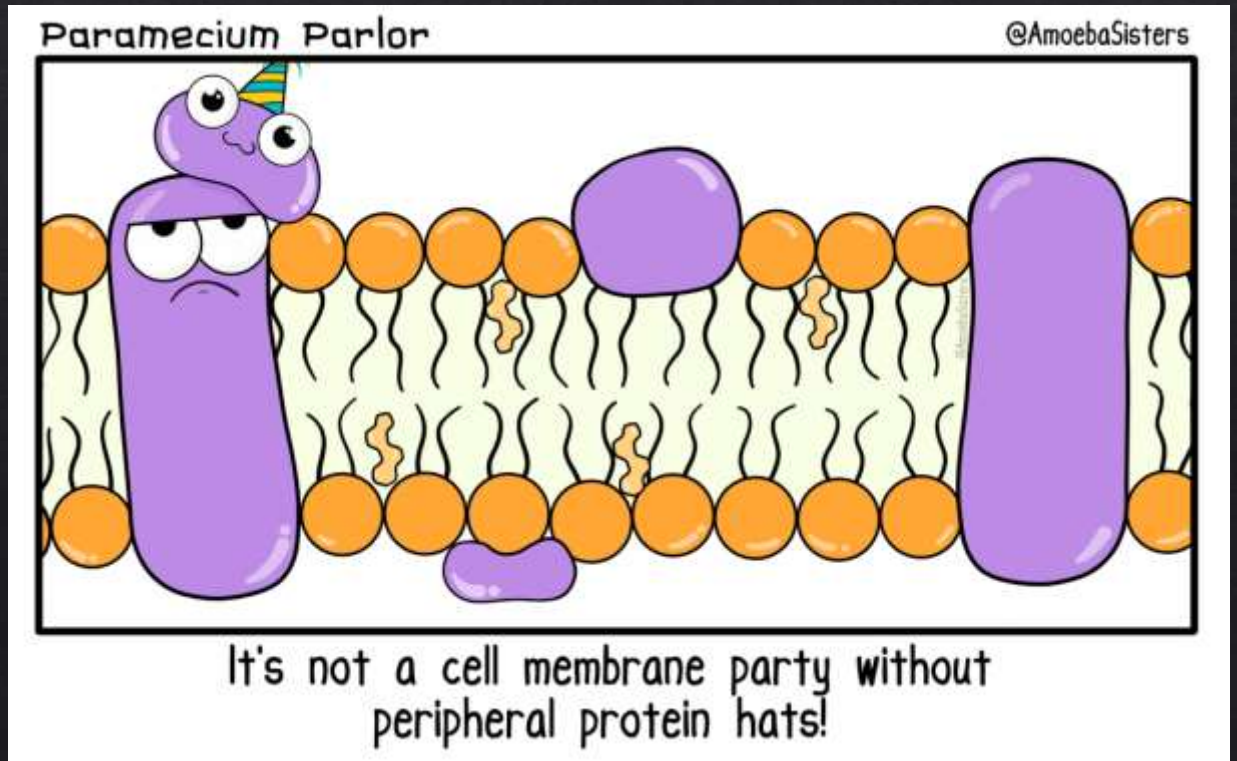
Integral membrane proteins can be removed from the membrane with the use of detergents, organic solvents or denaturants.

Amphitrophic proteins are linked to the membrane during specific regulatory events and can be reversibly removed.

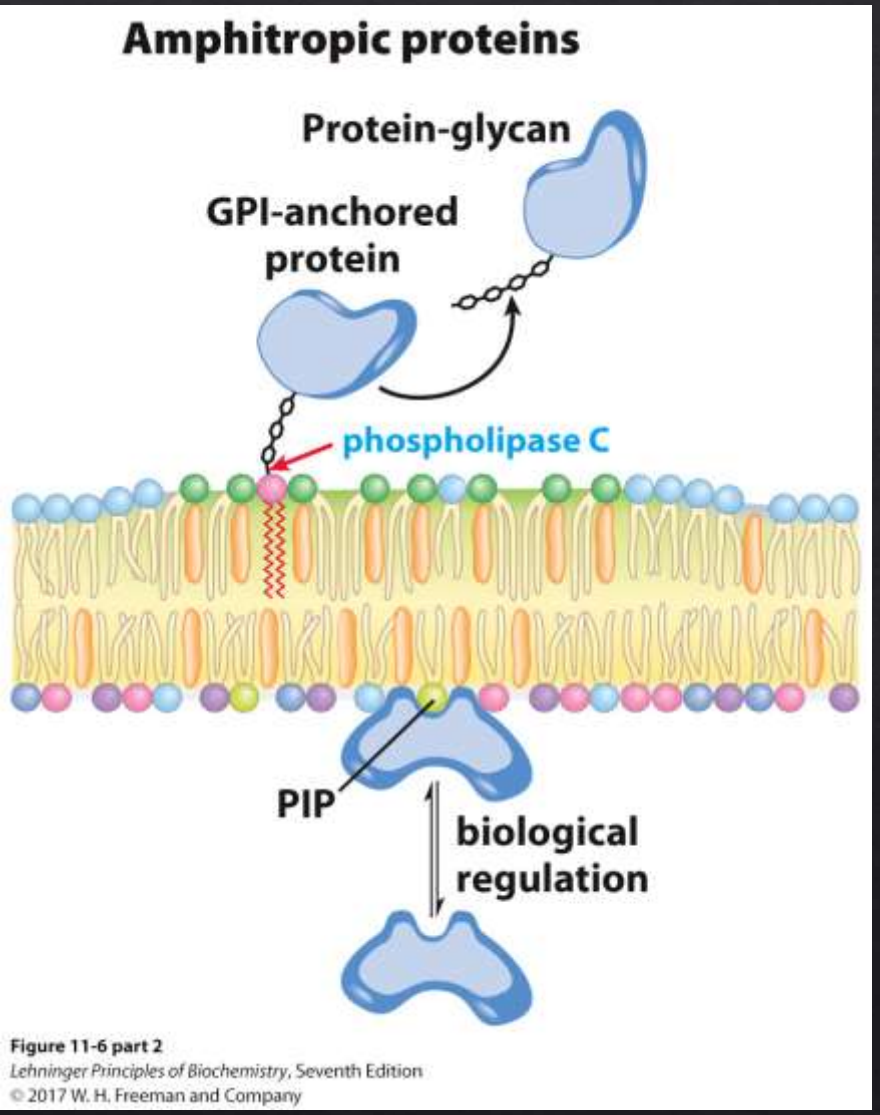


Peripheral proteins

Peripheral membrane proteins are associated with the membrane through electrostatic interactions and H-bonding with hydrophilic domains of integral proteins and/or membrane lipids



Amphitropic proteins



- Reversible association with the membrane
- Covalent interaction with lipids or carbohydrates attached to lipids
- Biological regulation results in attachment to, or cleavage from, lipids.

GPI = glycosylated derivatives of phosphatidylinositol

Integral proteins

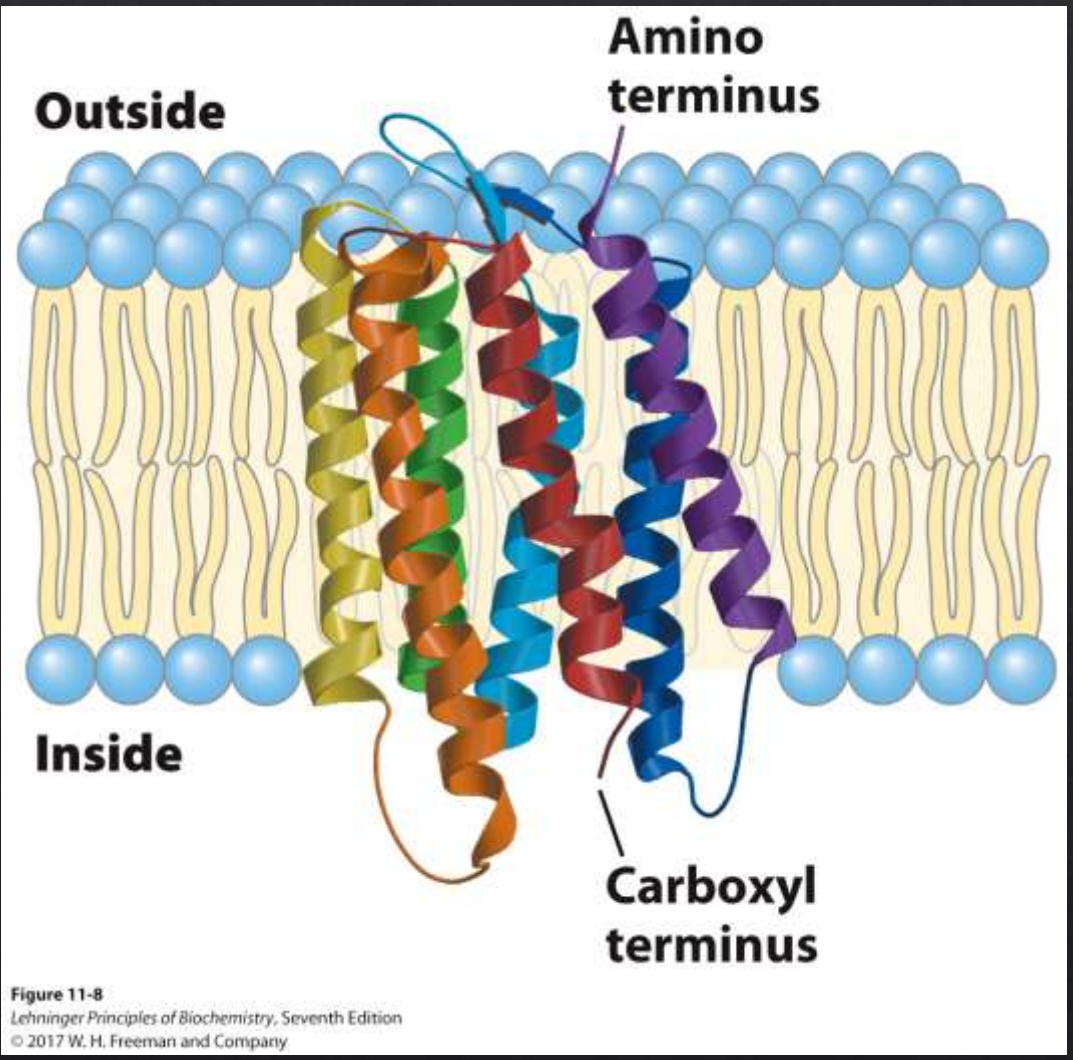
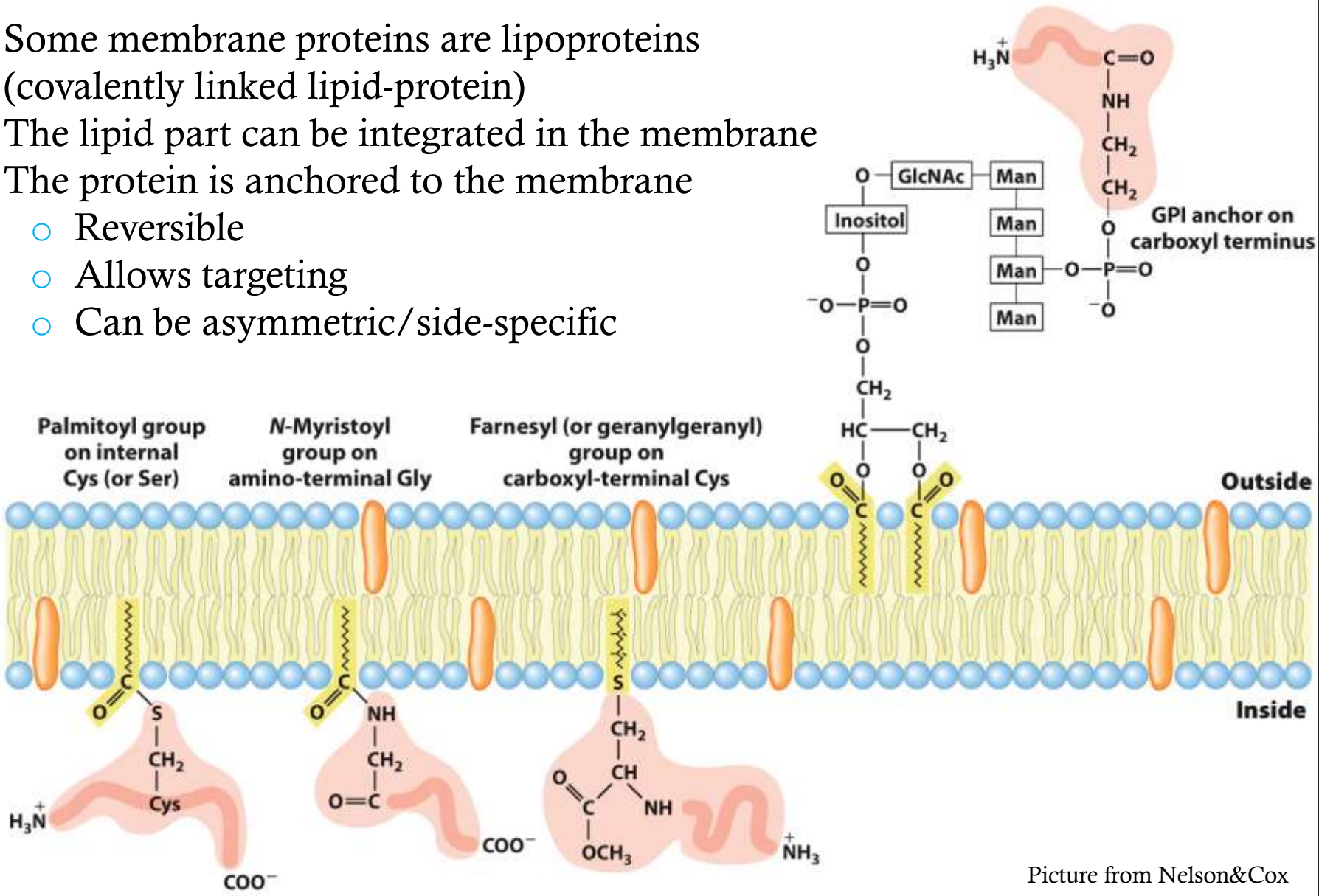


Figure 11-8
Lehninger Principles of Biochemistry, Seventh Edition

- Cross the membrane
- Are asymmetric
- Can be folded to keep nonpolar AA away from water
- Their structure can be predicted by their AA sequence
- Tightly associated with the membrane

Lipid-linked Membrane Proteins

- Some membrane proteins are lipoproteins (covalently linked lipid-protein)
- The lipid part can be integrated in the membrane
- The protein is anchored to the membrane
  - Reversible
  - Allows targeting
  - Can be asymmetric/side-specific



Picture from Nelson&Cox

Changes in membrane shape

- Can be induced by protein binding/removal
- Caveola implicated in a variety of cellular functions (e.g. receptor, trafficking, response to osmosis, etc.)
- Changes in curvature are fundamental for several biological processes

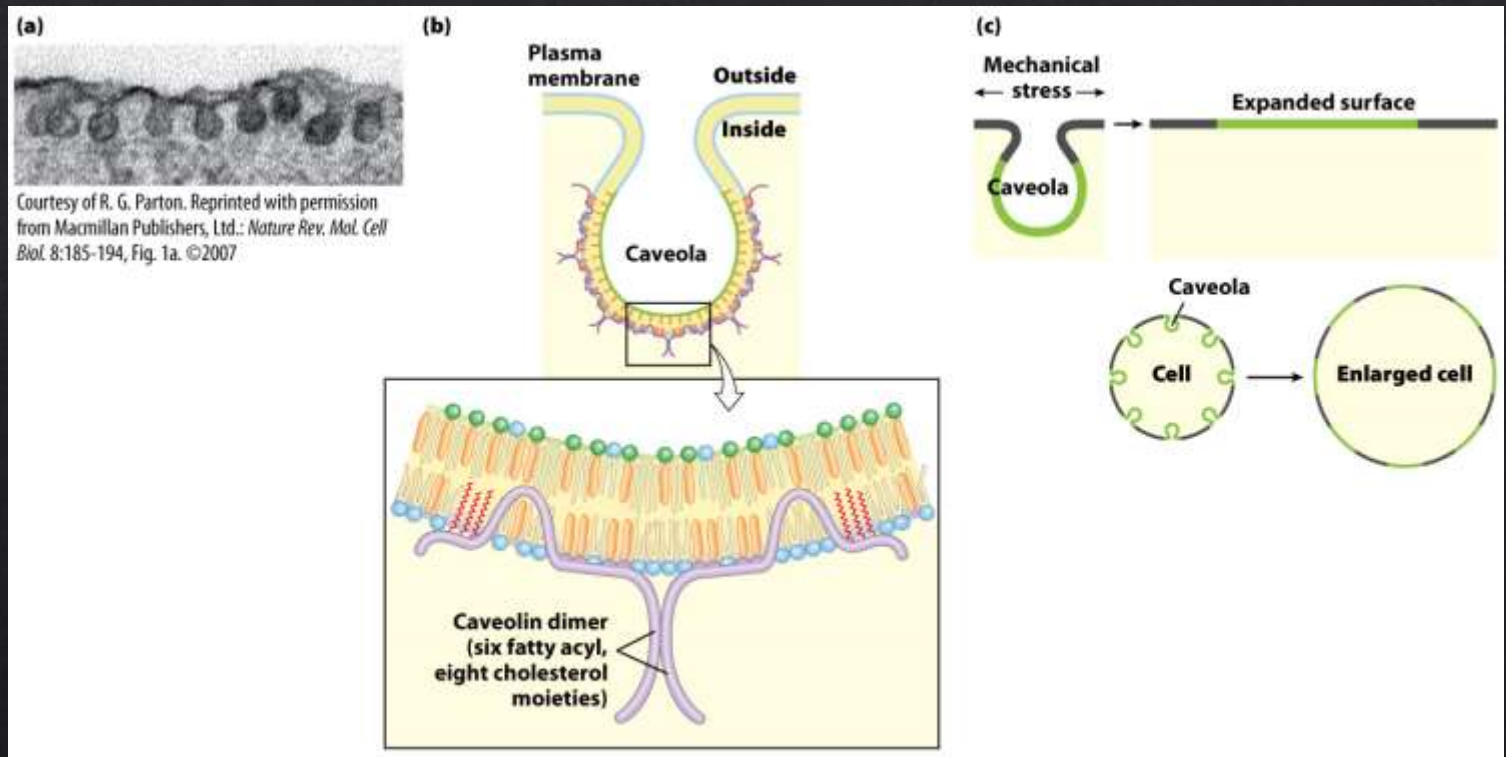


Figure 11-20
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Changes in membrane shape

- Exocytosis, endocytosis, cell division, fusion of egg and sperm cells, cell infection
- Can be mediated by single proteins or complexes of proteins
- Can be mediated by differences in charges, changes in concentration of the phospholipids (protein induced), protein-protein interaction

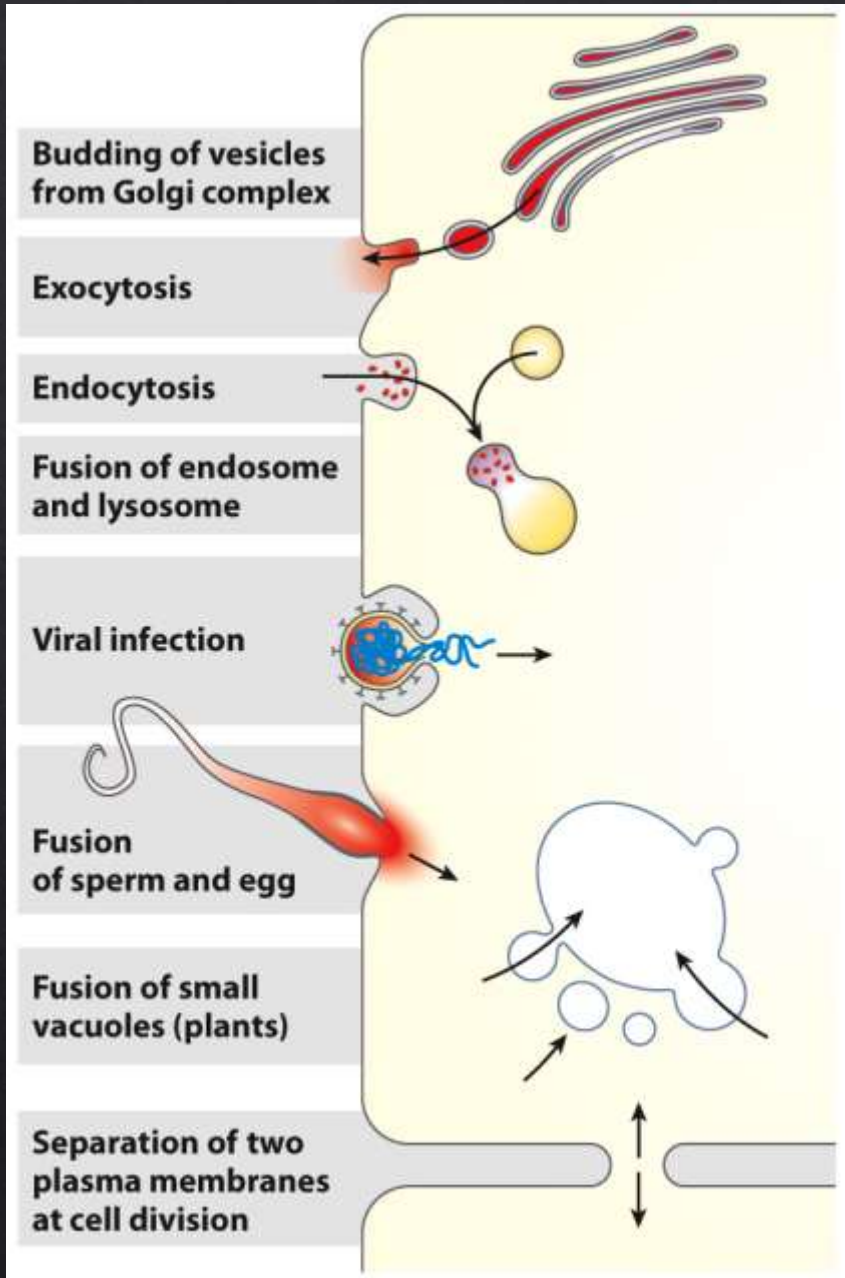


Figure 11-21
Lehninger Principles of Biochemistry, Seventh Edition

Membrane fusion

1. Recognition
2. Proximity and removal of interposed water
3. Local distruption of the membranes (hemifusion)
4. Fusion into a continous bilayer

Process regulated by biosignaling

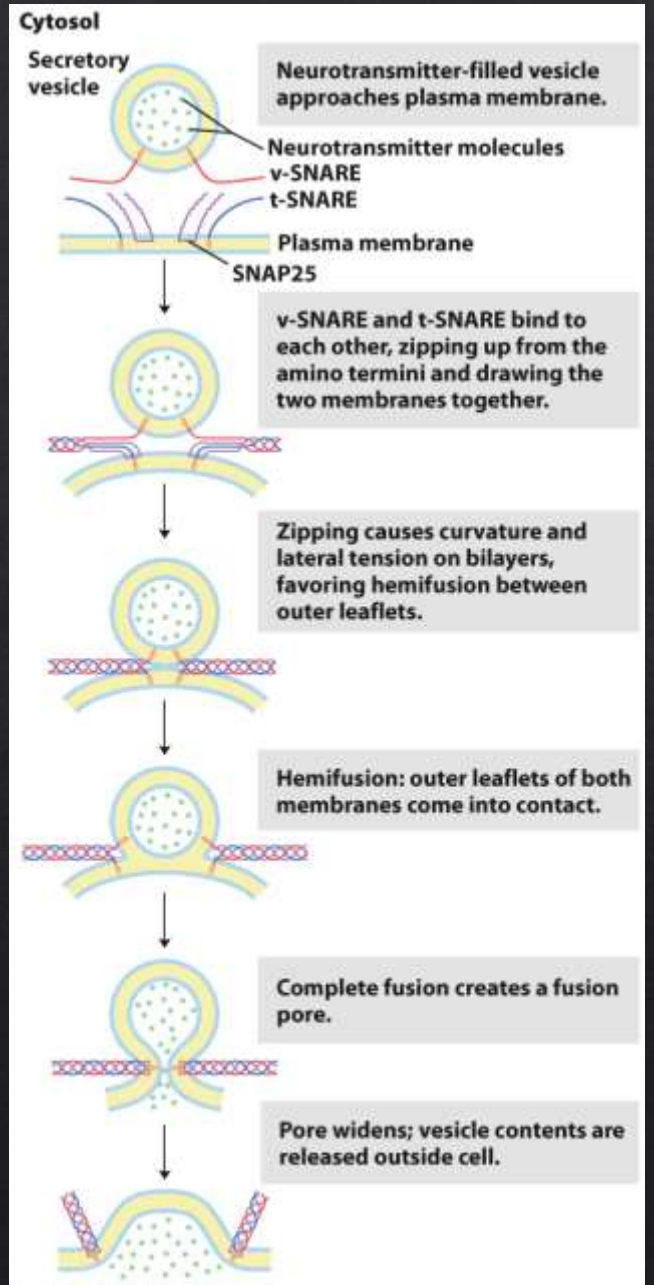


Figure 11-23

Lehninger Principles of Biochemistry, Seventh Edition

Picture from Nelson&Cox

Solute transport

- Ions
- Raw materials for biosinthesis or energy production
- Elimination of metabolic byproducts
- Can facilitate down the electrochimical or concentration gradient
- Can work against the gradient (requires energy)

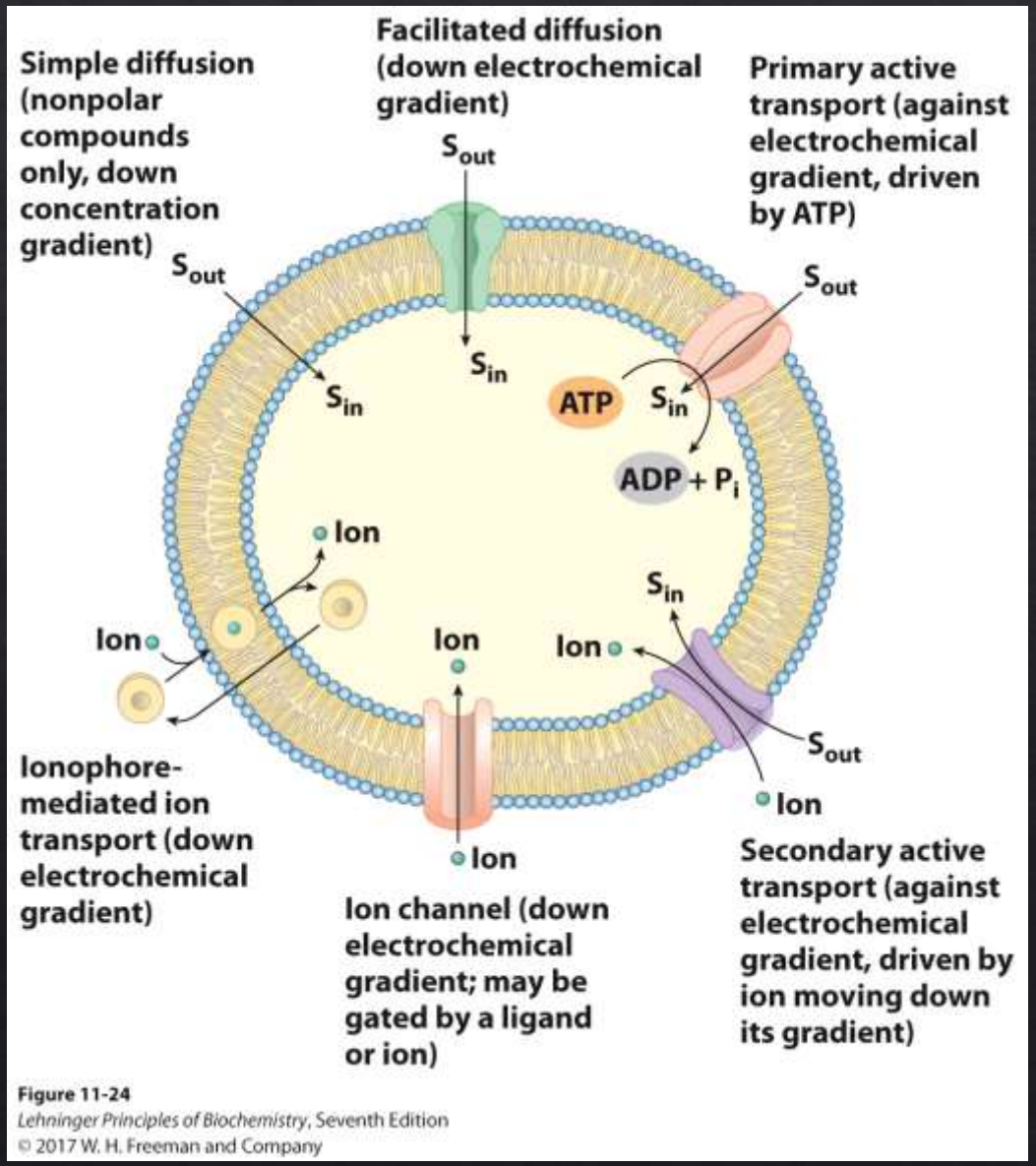
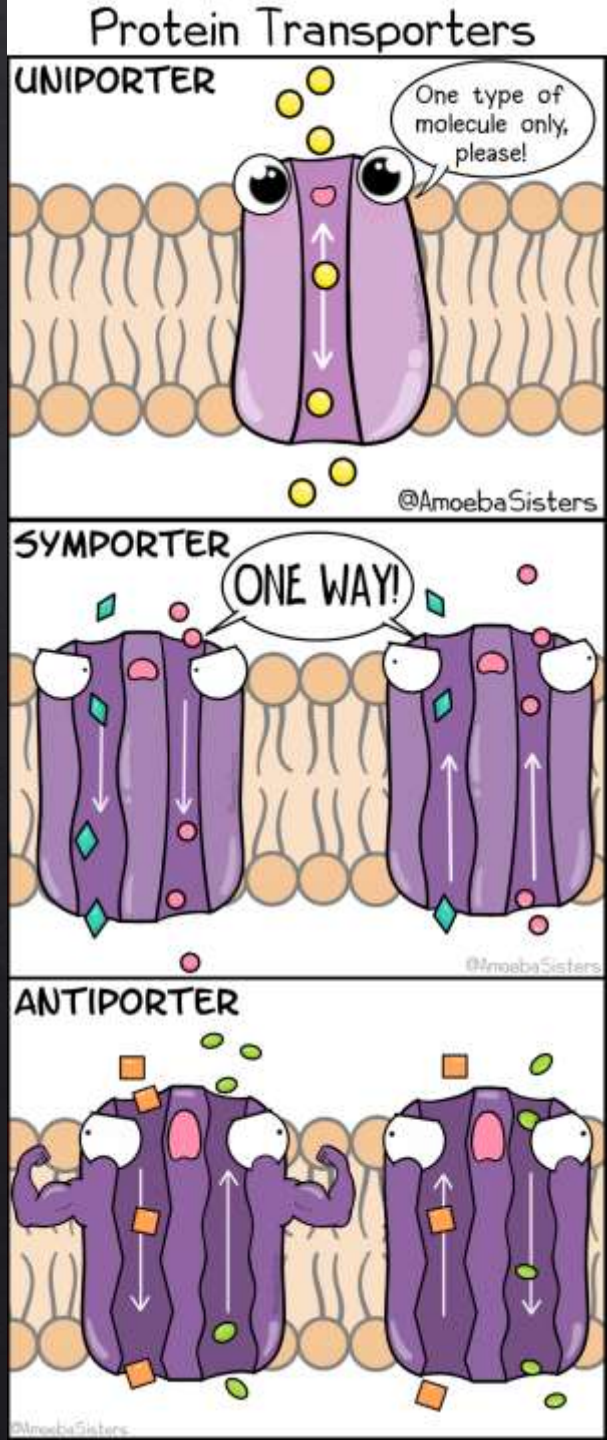


Figure 11-24
Lehninger Principles of Biochemistry, Seventh Edition

Solute transport

- Protein transporters and ion channels lower the activation energy for transport of polar compounds and ions
- Protein transporters use specific weak noncovalent interactions with the substrate. Can be saturated. Have a gate at either side, never open at the same time
- Ion channels provide an aqueous path across the membrane. Cannot be saturated. Flow is regulated by concentration or by a gate open and closed through biological signal



Solute transport

- Passive transport the transported species moves down the gradient
- Active transport accumulates the solute above the equilibrium point. Essentian when key substrates are at low concentrations.
- Active transport requires energy
- Secondary active transport occurs when uphill transport is coupled to downhill flow of a solute originally pumped uphill by primary active transport.

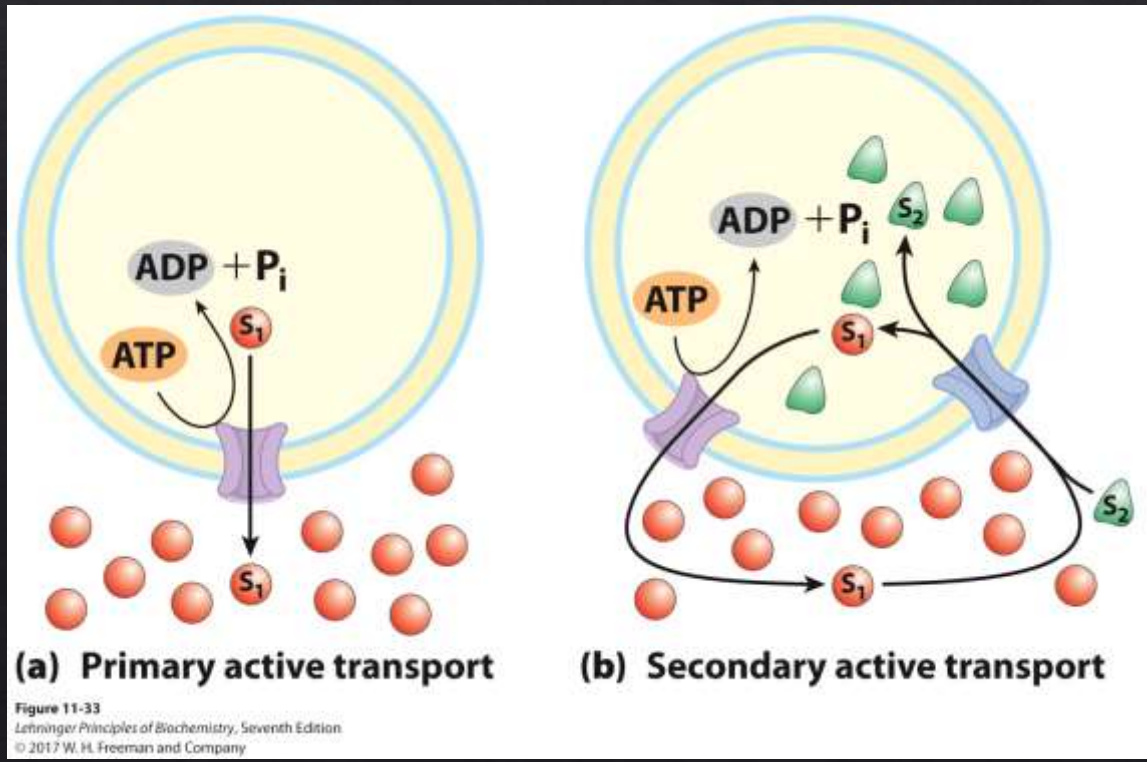


Figure 11-33
Lehninger Principles of Biochemistry, Seventh Edition

Picture from Nelson&Cox

Solute transport

- Active transporters called P-type ATPases are cation transporters that are reversibly phosphorylated by ATP
- Widespread in eukaryotes and bacteria
- Na+K+ ATPase of animal cells (antiporter) and H+ ATPase of plants and fungi set the transmembrane electrochemical potential.
- ATPases are fundamental for secondary active transport, electrical signaling in neurons, etc.

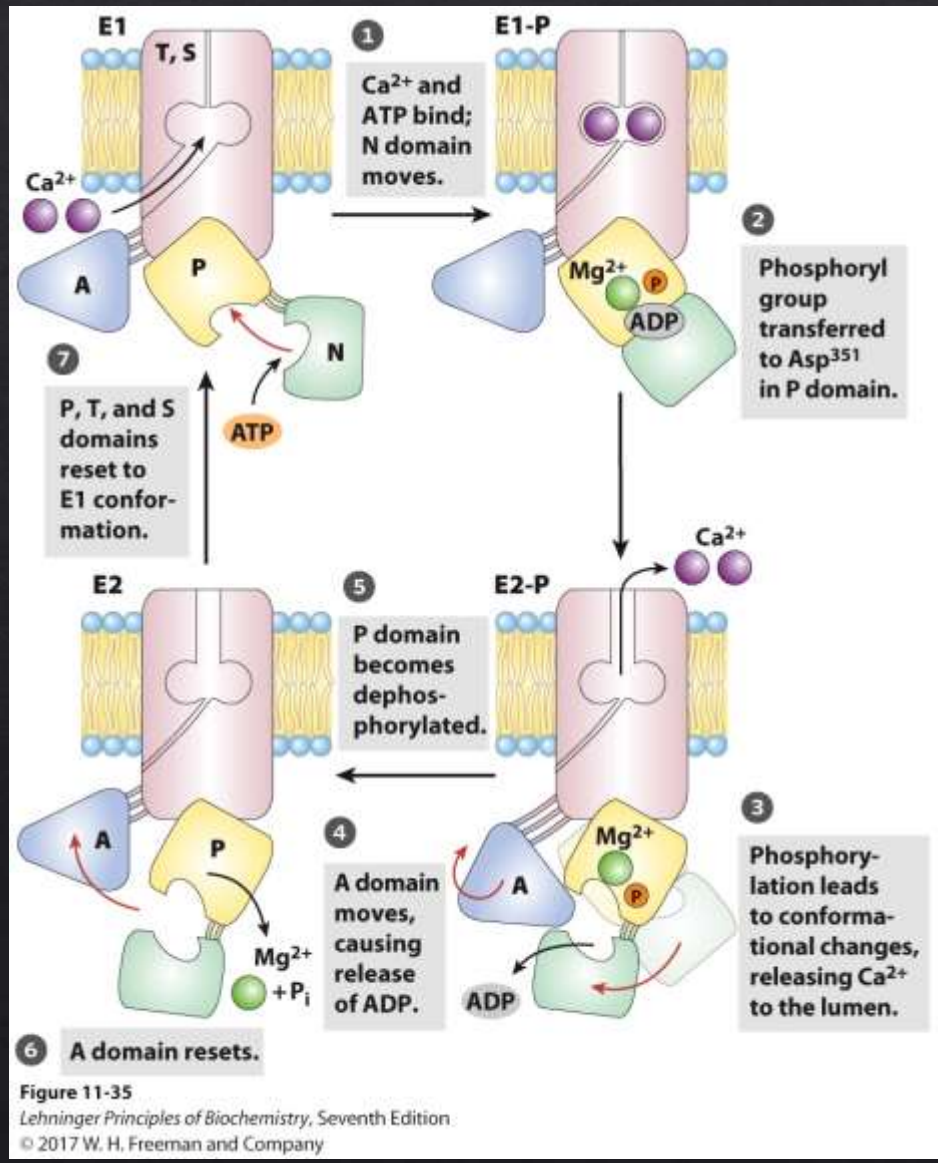


Figure 11-35
Lehninger Principles of Biochemistry, Seventh Edition

Solute transport

- Aquaporins form hydrophilic transmembrane channels for the passage of water
- Aquaporins are present in all organism, usually in multiple «versions» (11 in mammals)