MEMBRANE STRUCTURE AND FUNCTION
Membrane structure

Lipid bilayer: hydrophobic fatty acid interior

Phosphate + hydrophilic group exterior
Membrane structure

Proteins incorporated into the bilayer
- Hydrophobic amino acid side chains
- Hydrophilic amino acid side chains
- Transmembrane alpha-helix
- Extracellular carbohydrates

“Fluid mosaic model”

Often, “islands” of protein complexes
Membrane Functions

1. Platform for biochemical reactions
Enzymes and other organelles (e.g. ribosomes, microtubules) attach to surface

(B) Organizing chemical reactions
Membrane Functions

2. Sensing
Receptors bind to "ligand" and transmit a signal across the membrane

(C) Information processing

Life 8e, Figure 5.18 (Part 3)
Membrane Functions

3. Cell recognition
Receptors on different cells bind them together
Membrane Functions

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Membrane Functions

4. Differential permeability
Channels and carriers transport substances across membranes

- Allows cells to adjust pH and salt concentrations
- Allows cells to keep functional chemicals inside
- Allows cells to take up food molecules and exclude toxins
- Allows cells to separate chemical reactions that otherwise would interfere with one another
Osmosis

Because the plasma membrane is differentially permeable, allowing water to cross more easily than solutes.
How do cells survive changes in osmotic concentration of their surroundings?

Plants, fungi, most protists and bacteria have cell walls
- Cell wall limits growth in hypotonic solution by exerting pressure on contents and thus protects membrane.
- In hypertonic solution, get plasmolysis (bad), but cells produce or take up solutes to balance outside solution

Animal cells and other cells without cell walls
- Animal cells stay in salt water, or keep their surroundings at high solute concentration
- Also, animal cells have “cytoskeleton” inside, which connects to inside of plasma membrane and keeps it from expanding; some protists have “pellicle”
**How molecules cross membranes**

1. **Dissolving in lipid layer**
   Small non-polar molecules (benzene, ethanol, O₂, CO₂)
   Works for artificial lipid bilayers (i.e., no proteins)

2. **Pores in lipid layer**
   Small polar molecules (H₂O, NH₃)
   Also works for lipid bilayers
   Postulate transient pores

3. **Channels, Carriers, Pumps**
   Specific materials transported
   Specific membranes
   Regulated in time and sometimes direction
   Proteins
Channels

Protein complex forming controlled hole for rapid flow
"Downhill" (along energy gradient)
“Gated” (opens, closes in response to stimulus)
Channels known for Na⁺, K⁺, Cl⁻, Ca²⁺, and others, including H₂O (aquaporins)!

(A) Side view

Outside of cell

Inside of cell

α-Helix of the channel protein
**Carriers**

Proteins that shuttle molecules across a membrane:

Operation:
- Carrier binds molecule—needs **specific, reversible binding site**.
- Carrier shifts to expose molecule to other side of membrane—needs flexibility.
- Carrier releases molecule.
- Empty carrier shifts to return binding site to original side of membrane.
**Why carriers are proteins:**

Binding sites must be specific, reversible

Proteins have multitude of possible shapes, some of which have crevasses that fit transported molecule

Exact complementarity of shape allows specificity: right molecule forms many Van der Waals bonds; wrong molecule will not fit, or will not form bonds

Variety of protein side chains provides variety of weak bonds (H-, electrostatic, hydrophobic, as well as Van der Waals); weak bonds give tight, but reversible bonds
Pumps

Proteins that use energy to move molecules across a membrane

Pumps known for H⁺, Ca²⁺, and Na⁺/K⁺, Mg²⁺, K⁺, K⁺/H⁺, P-lipid, heavy metals
Summary: How fungi take up and accumulate sugar (glucose) and K^+

1. Proton pump in plasma membrane pumps H^+ out of cell, forming gradient of [H^+] and electric charge.

2. Carrier binds glucose and proton outside, transports both to the inside.

3. Energy of H^+ and charge gradients used to power accumulation of glucose from low concentration solution.

Note: K^+ moves in along the electric (voltage) gradient
**Summary:** How animal cells take up and accumulate $K^+$ and glucose $^+$

$Na^+/K^+$ pump in plasma membrane replaces the $H^+$ pump and forms $Na^+$, $K^+$, and electrical gradients.