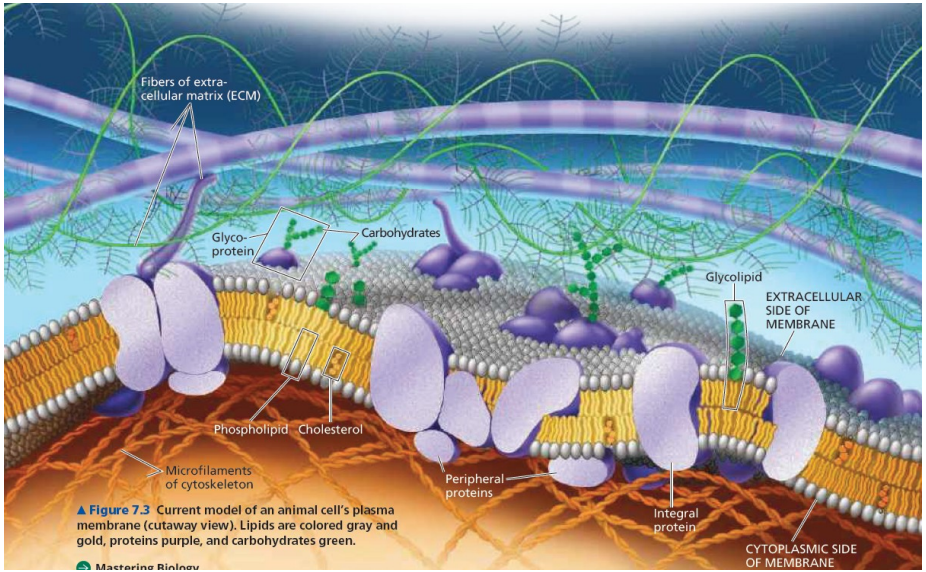
Chapter 7

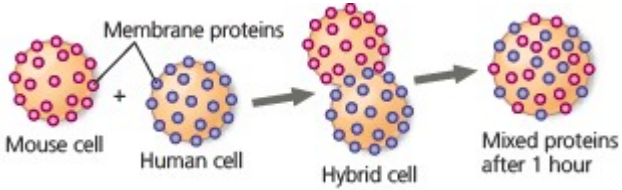
Membrane Structure and Function

Contents, figures, and tables of slides are based on and/or adapted from Campbell Biology, 12th ed., unless otherwise specified.

Membranes Are Fluid Mosaics

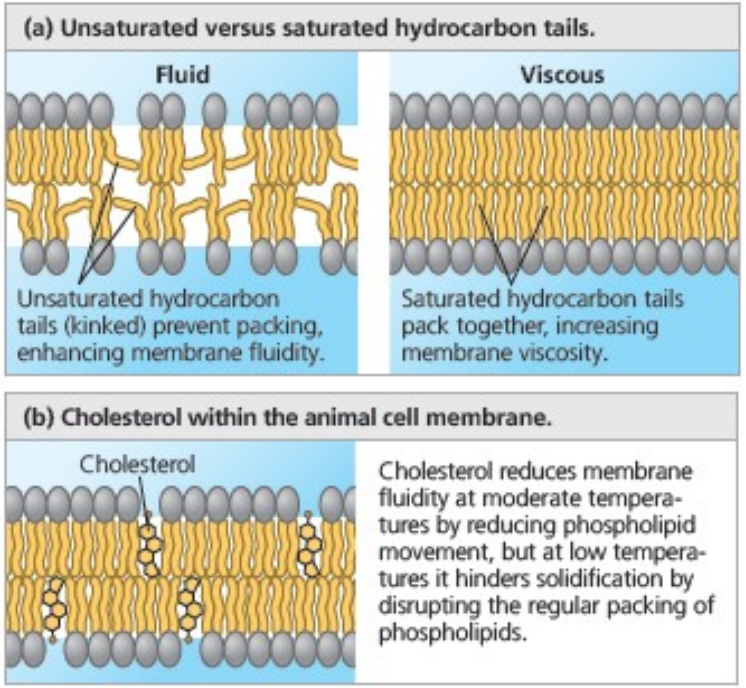
- Amphipathic phospholipids: hydrophilic heads, hydrophobic tails
- Fluid mosaic model: proteins float in a fluid lipid bilayer
- Membrane fluidity shown by cell-fusion (mouse–human) experiment
- Membrane models: sandwich model was replaced by the fluid mosaic model





Membrane Fluidity

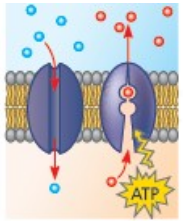
- Lipids and some proteins drift laterally; flip-flop is rare
- Unsaturated tails: kinks keep membrane fluid at lower temperature
- Cholesterol: restrains movement when warm, blocks packing when cool
- Cold-adapted organisms: more unsaturated lipids



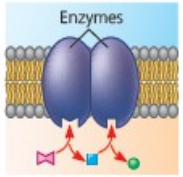
Membrane Proteins and Their Functions

- Integral proteins: span the bilayer (transmembrane α helices)
- Peripheral proteins: attached to the membrane surface
- Functions: transport, enzymatic activity, signal transduction, cell–cell recognition, intercellular joining, ECM attachment

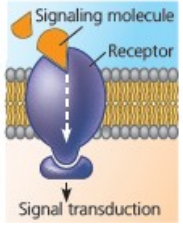
(a) Transport. *Left:* A protein that spans the membrane may provide a hydrophilic channel across the membrane that is selective for a particular solute (see Figures 6.32a and 7.15a). *Right:* Other transport proteins shuttle a substance from one side to the other by changing shape (see Figure 7.15b). Some of these proteins hydrolyze ATP as an energy source to actively pump substances across the membrane.



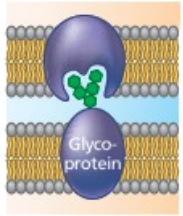
(b) Enzymatic activity. A protein built into the membrane may be an enzyme with its active site (where the reactant binds) exposed to substances in the adjacent solution. In some cases, several enzymes in a membrane are organized as a team that carries out sequential steps of a metabolic pathway.



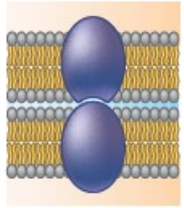
(c) Signal transduction. A membrane protein (receptor) may have a binding site with a specific shape that fits the shape of a chemical messenger, such as a hormone. The external messenger (signaling molecule) may cause the protein to change shape, allowing it to relay the message to the inside of the cell, usually by binding to a cytoplasmic protein (see Figures 6.32a and 11.6).



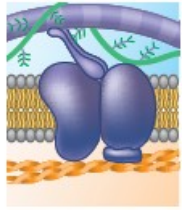
(d) Cell-cell recognition. Some glycoproteins serve as identification tags that are specifically recognized by membrane proteins of other cells. This type of cell-cell binding is usually short-lived compared with that shown in (e).



(e) Intercellular joining. Membrane proteins of adjacent cells may hook together in various kinds of junctions, such as gap junctions or tight junctions (see Figure 6.30). This type of binding is more long-lasting than that shown in (d).

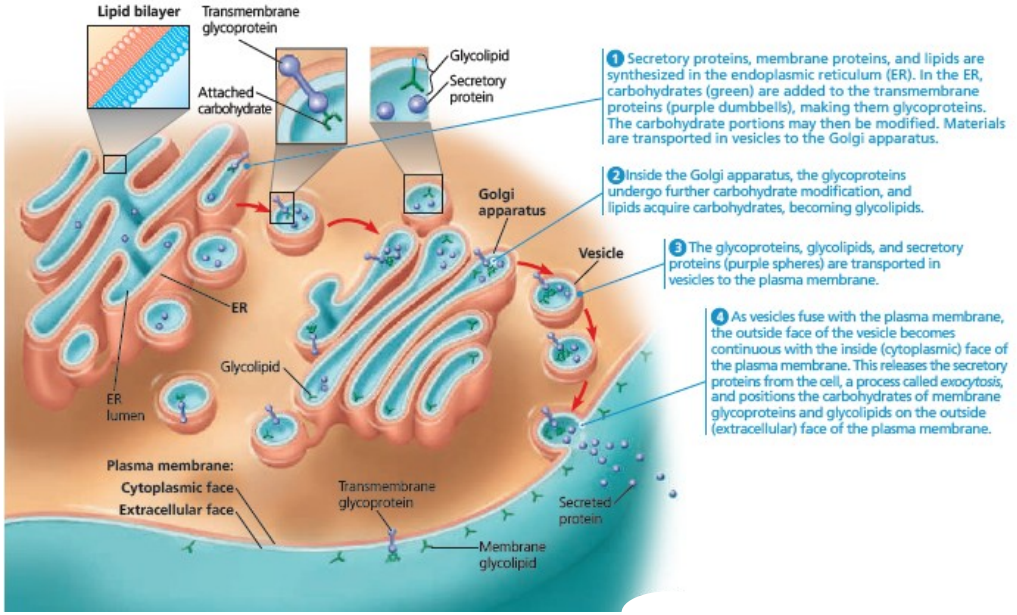


(f) Attachment to the cytoskeleton and extracellular matrix (ECM). Microfilaments or other elements of the cytoskeleton may be noncovalently bound to membrane proteins, a function that helps maintain cell shape and stabilizes the location of certain membrane proteins. Proteins that can bind to ECM molecules can coordinate extracellular and intracellular changes (see Figure 6.28).



Carbohydrates and Membrane Sidedness

- Glycolipids and glycoproteins on the outer face
- Carbohydrates mark cell identity (e.g., blood groups)
- Membranes have distinct inside and outside faces
- ER builds membrane; Golgi modifies it; vesicles deliver to plasma membrane



Selective Permeability

- Hydrophobic molecules (O_2, CO_2, hydrocarbons) cross easily
- Polar molecules and ions cross slowly; need transport proteins
- Transport proteins are specific for the substances they move
- Channel proteins and carrier proteins

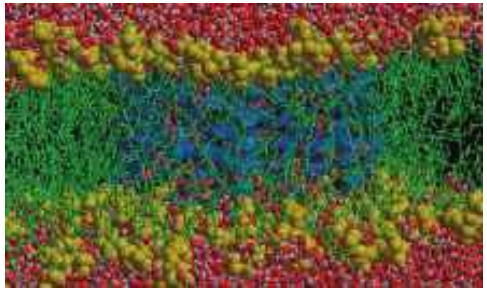
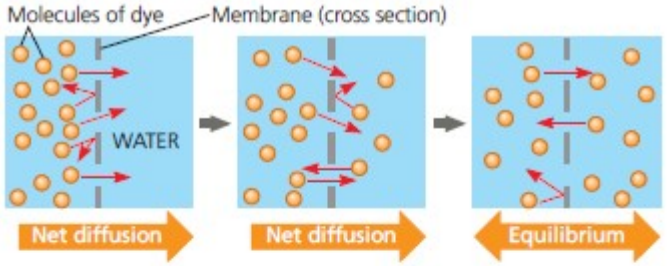


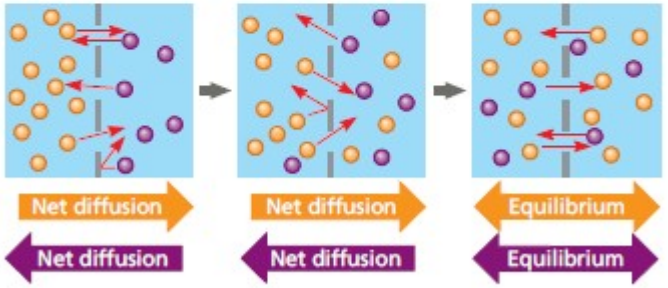
Fig. An aquaporin

Passive Transport: Diffusion

- Diffusion: net movement down a concentration gradient
- No energy input; entropy increases
- Each substance diffuses independently
- Passive transport: no ATP needed



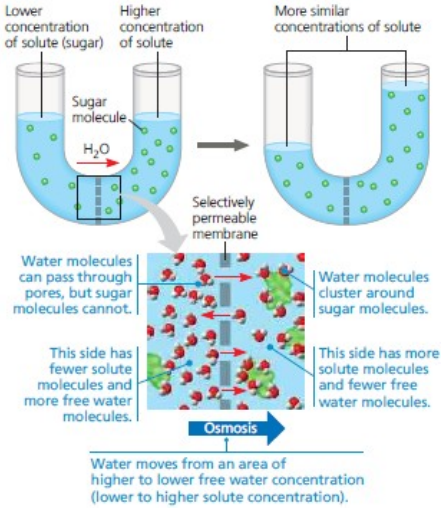
(a) Diffusion of one solute. Molecules of dye can pass through membrane pores. Random movement of dye molecules will cause some to pass through the pores; this happens more often on the side with more dye molecules. The dye diffuses from the more concentrated side to the less concentrated side (called diffusing down a concentration gradient). A dynamic equilibrium results: Solute molecules still cross, but at roughly equal rates in both directions.

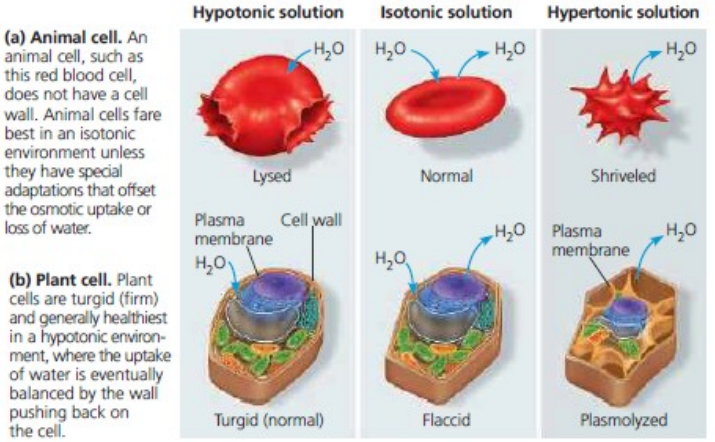


(b) Diffusion of two solutes. Solutions of two different dyes are separated by a membrane that is permeable to both. Each dye diffuses down its own concentration gradient. There will be a net diffusion of the purple dye toward the left, even though the *total* solute concentration was initially greater on the left side.

Osmosis and Water Balance

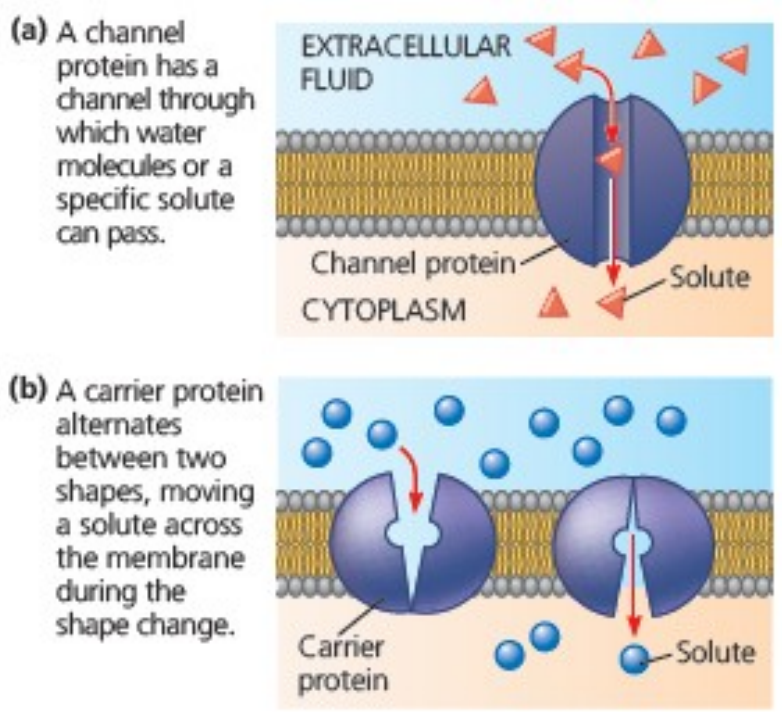
- Osmosis: water moves toward higher solute concentration
- Tonicity: isotonic, hypertonic, hypotonic
- Animal cells: lyse in hypotonic, shrivel in hypertonic
- Plant cells: turgid (healthy), flaccid, plasmolyzed
- Osmoregulation, contractile vacuoles in protists
- Water potential (Ψ) in plants: Ψ = Ψs + Ψp





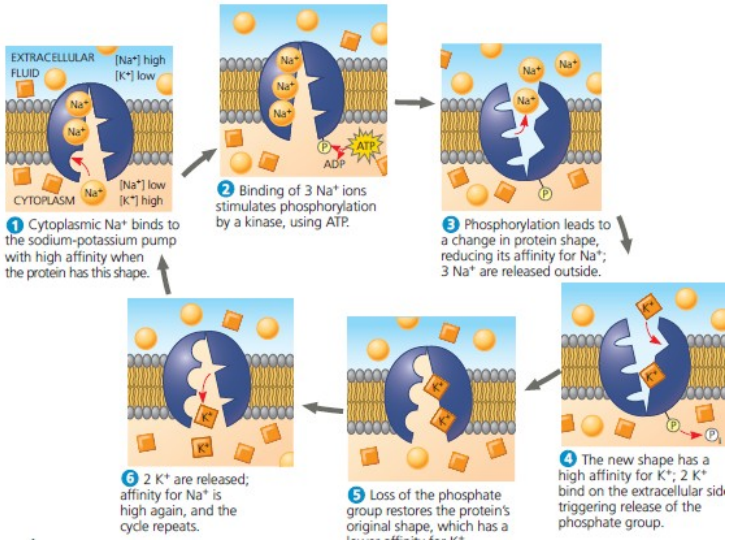
Facilitated Diffusion

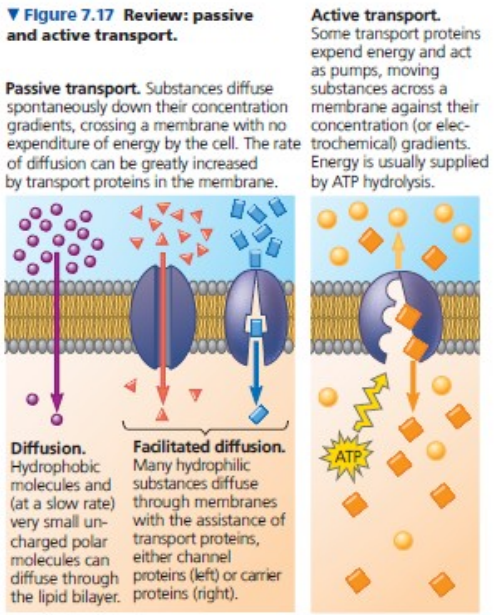
- Channel proteins: hydrophilic corridor (aquaporins, ion channels)
- Gated channels open/close with stimuli
- Carrier proteins: change shape, e.g., glucose transporter
- Passive: moves down gradient; saturable



Active Transport

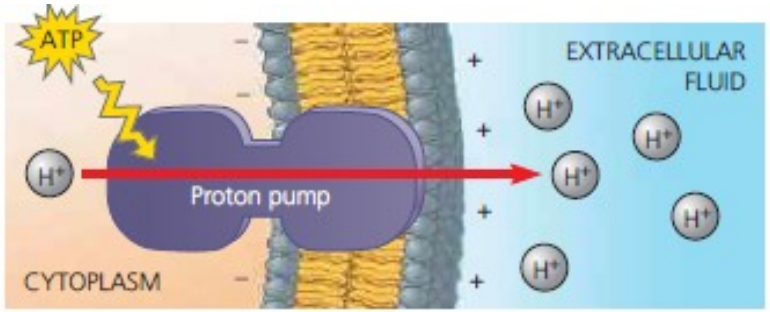
- Moves solutes against the gradient; requires energy (usually ATP)
- Sodium-potassium pump: 3 Na^+ out, 2 K^+ in
- Phosphorylation changes protein shape
- Maintains ion gradients

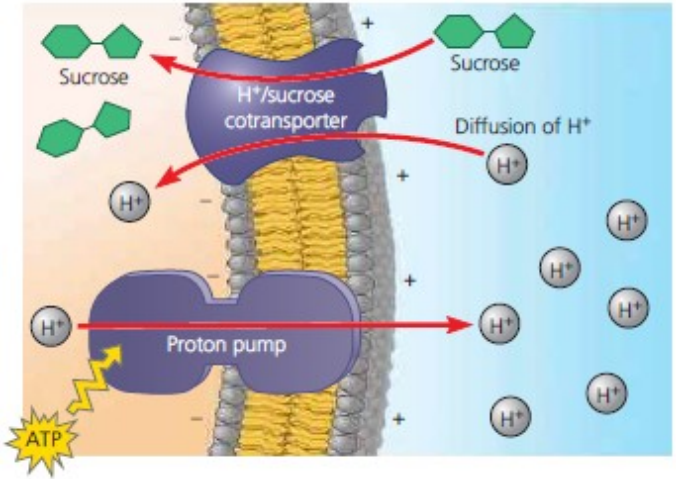




Membrane Potential and Cotransport

- Membrane potential: voltage across membrane, inside negative
- Electrochemical gradient: chemical + electrical forces
- Electrogenic pump: Na^+/K^+ pump (animals), proton pump (plants, bacteria)
- Cotransport: gradient of one solute drives another (sucrose–H^+)





Bulk Transport

- Exocytosis: vesicles fuse with plasma membrane, release contents
- Endocytosis: phagocytosis, pinocytosis, receptor-mediated endocytosis
- Ligands, coated pits and vesicles, LDL uptake
- Requires energy; membrane area recycled

