Ch. 6

# Cell Membrane

BIOL 222

## Overview: Plasma Membrane

- Plasma membrane
  - boundary that separates the living cell from its surroundings
- **Selective permeability**
  - Allowance of some substances to cross more easily than others

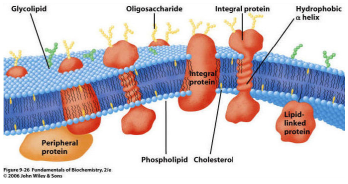


Figure 9-24 Fundamentals of Biochemistry, 2/e
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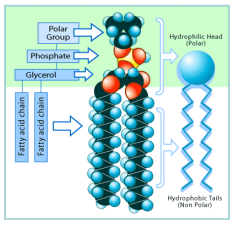
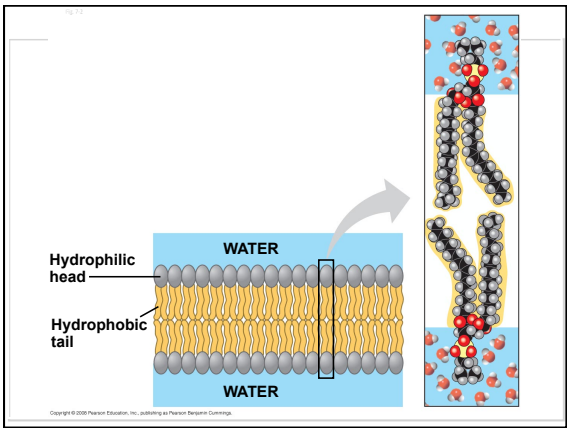
## Cell Membrane Model

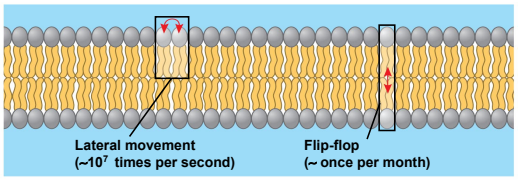
- **Fluid mosaic model**
  - Membrane is a fluid structure with a "mosaic" of various proteins embedded in it
  - Phospholipids
    - most abundant lipid in the plasma membrane
    - **amphipathic molecules**
      - contain hydrophobic and hydrophilic regions



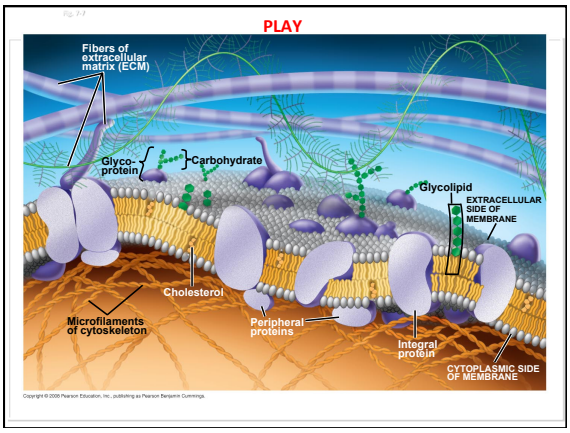



## The Fluidity of Membranes

- Phospholipids
  - Can move within the bilayer
  - Most of the lipids, and some proteins, drift laterally
    - Rarely does a molecule flip-flop transversely across the membrane

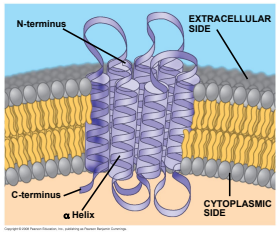




## Membrane Proteins

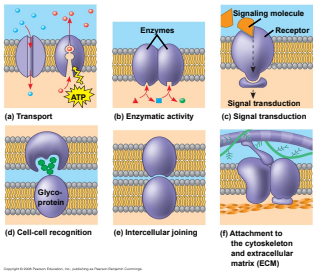
- **Peripheral proteins**
  - bound to the surface of the membrane
- **Integral proteins**
  - Penetrate the hydrophobic core
  - **transmembrane proteins**
    - Integral proteins that span the membrane
  - Hydrophobic regions of an integral protein
    - consist of one or more stretches of nonpolar amino acids
      - often coiled into alpha helices






## Membrane Proteins

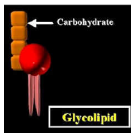
- Six major functions of membrane proteins:
  - Transport
  - Enzymatic activity
  - Signal transduction
  - Cell-cell recognition
  - Intercellular joining
  - Attachment to the cytoskeleton and extracellular matrix (ECM)

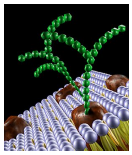





## Membrane Carbohydrates

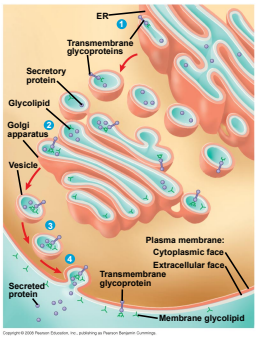
- Membrane carbohydrates
  - Used by cells to recognize each other
    - By binding recognition proteins to surface carbohydrates
  - **Glycolipids**
    - Carbohydrates covalently bonded to lipids
  - **Glycoproteins**
    - Carbohydrates bonded to proteins
  - vary among species, individuals, and even cell types in an individual



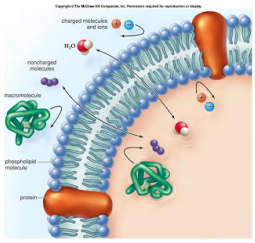
## Synthesis and Sidedness of Membranes

- Membranes have distinct inside and outside faces
  - Asymmetrical distribution
    - Proteins
    - Lipids
    - Associated carbohydrates
    - Determined when the membrane is built by the ER and Golgi apparatus
      - Components on the inside of ER or Golgi vesicle
        - end up on exterior of cell membrane



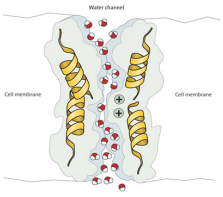

## The Permeability of the Lipid Bilayer

- Hydrophobic (nonpolar) molecules
  - Dissolve in the lipid bilayer and pass through the membrane rapidly
    - Such as hydrocarbons
      - But only very small ones
- Polar molecules
  - Do not cross the membrane easily
    - Repelled by inner hydrophobic region
    - Such as sugars



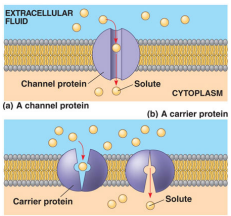

## Transport Proteins

- **Transport proteins**
  - Allow passage of hydrophilic substances across the membrane
  - **channel proteins**
    - hydrophilic channel that certain molecules or ions can use as a tunnel
    - **Aquaporins**
      - Facilitate the passage of water



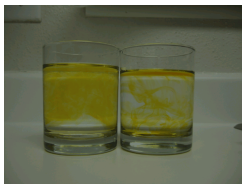
## Transport Proteins

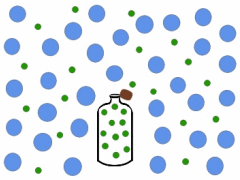
- **Carrier proteins**
  - Bind to molecules and change shape to shuttle them across the membrane
  - Specific for the substance it moves

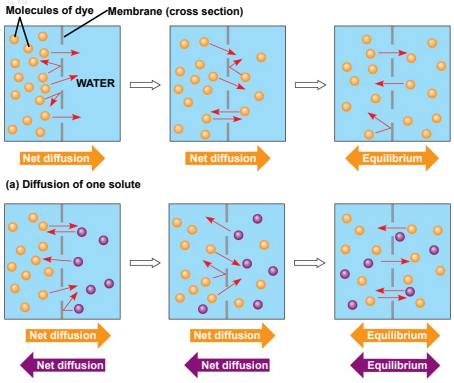



## Transport

- Diffusion
  - Tendency for molecules to spread out evenly into the available space
    - Due to Brownian movement
- Dynamic equilibrium
  - As many molecules cross one way as cross in the other direction

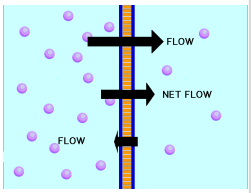






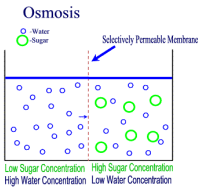
## Types of Transport: Passive – Simple Diffusion

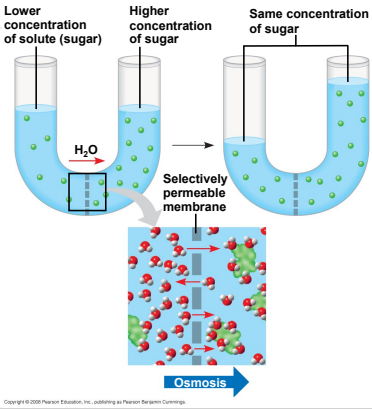
- **Passive transport**
  - No energy input required
- Simple Diffusion
  - Substances move (diffuse) down their **concentration gradient**
    - difference in concentration of a substance from one area to another




## Types of Transport: Passive - Osmosis

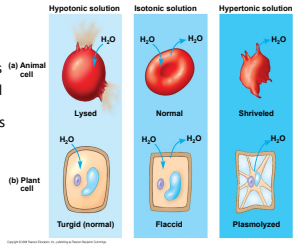
- **Osmosis**
  - diffusion of *water* across a selectively permeable membrane
    - from the region of lower ***solute*** concentration
      - to the region of higher ***solute*** concentration
    - Water will follow the solutes



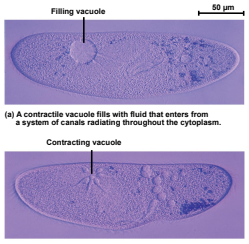
## Water Balance of Cells Without Walls

- **Tonicity**
  - ability of a solution to cause a cell to gain or lose water
- **Isotonic** solution
  - Solute concentration outside is the same as that inside the cell
  - No *net* water movement across the plasma membrane
- **Hypertonic** solution
  - Solution with higher solute concentration
- **Hypotonic** solution
  - Solution with lower solute concentration




## Water Balance of Cells Without Walls

- Hypertonic or hypotonic environments create osmotic problems for organisms
- **Osmoregulation**
  - Control of water balance
  - Necessary adaptation for life in such environments
- The protist *Paramecium*
  - Hypertonic to its pond water environment
  - Has a contractile vacuole that acts as a pump

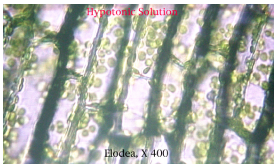


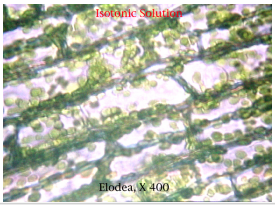

(a) A contractile vacuole fills with fluid that enters from a system of canals radiating throughout the cytoplasm.

(b) When full, the vacuole and canals contract, expelling fluid from the cell.

## Water Balance of Cells with Walls

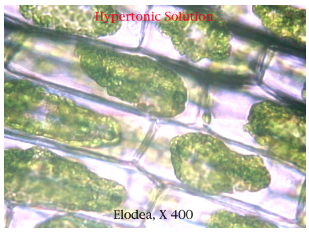
- Plant cell in a hypotonic solution
  - Swells until the wall opposes uptake
    - Cell is now **turgid** (firm)
  - If isotonic
    - No net movement of water into the cell
      - the cell becomes **flaccid** (limp)
      - Plant may wilt



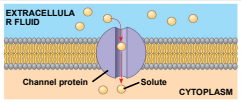
## Water Balance of Cells with Walls

- **Plasmolysis**
  - Hypertonic environment
    - Plant cells lose water
      - membrane pulls away from the wall
        - usually lethal

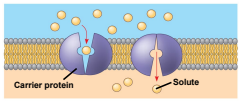



## Types of Transport: Passive - Facilitated Diffusion

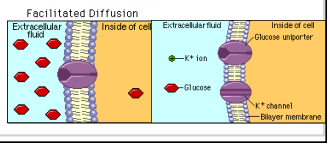
- **Facilitated diffusion**
  - transport proteins facilitate (enable) passive movement of molecules across the plasma membrane
- Channel proteins
  - corridors that allow a specific molecule or ion to cross the membrane
    - **Aquaporins** for facilitated diffusion of water
    - **Ion channels** that open or close in response to a stimulus (**gated channels**)




(a) A channel protein

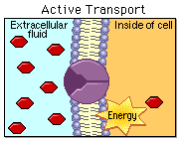


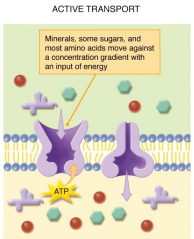

(b) A carrier protein




## Types of Transport: Active Transport

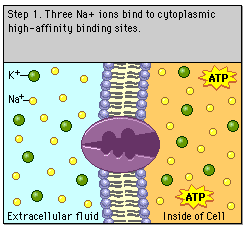
- **Active transport**
  - moves substances ***against*** their concentration gradient
  - **Requires energy**
    - in the form of ATP
  - Performed by specific proteins embedded in the membranes

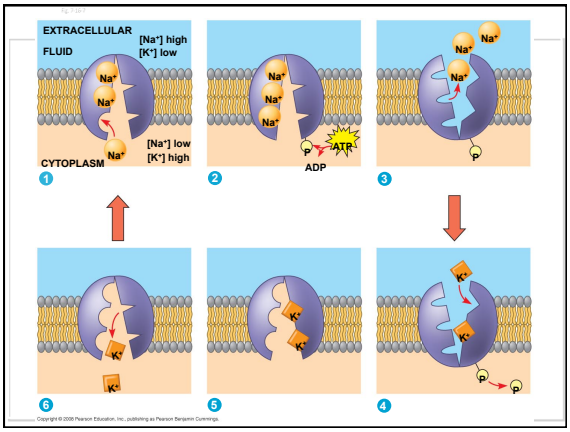


## Types of Transport: Active Transport

- Active transport
  - allows cells to maintain concentration gradients that differ from their surroundings
- **Sodium-potassium pump**

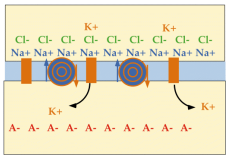


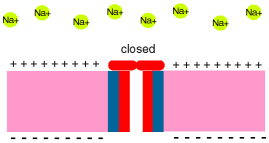




## Ion Pumps Maintain Membrane Potential

- **Membrane potential**
  - Voltage difference across a membrane
  - Voltage is created by differences in the distribution of positive and negative ions

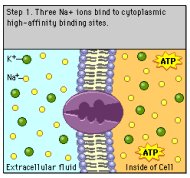
*MEMBRANE POTENTIAL*
*How does it get there?*
*CHANNELS & PUMPS!*

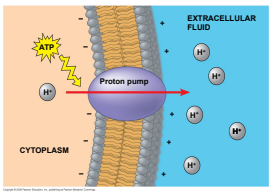


## Membrane Potential

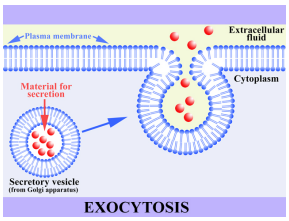
- **Electrogenic pump**
  - transport protein that generates voltage across a membrane
    - sodium-potassium pump
      - major electrogenic pump of *animal cells*
- **proton pump**
  - Main electrogenic pump
    - of *plants, fungi, and bacteria*

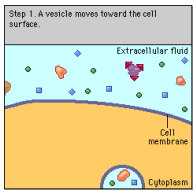



## Types of Transport: Active Transport - Exocytosis

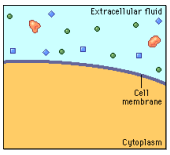
- **Exocytosis**
  - Transport vesicles migrate to the membrane, fuse with it, and release their contents
  - Used by secretory cells to export their products



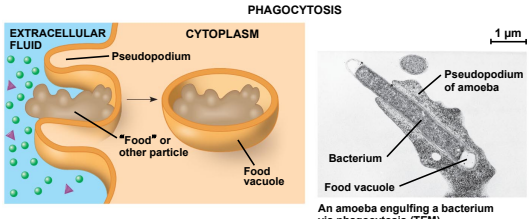




## Types of Transport: Active Transport - Endocytosis

- **Endocytosis**
  - cell takes in macromolecules
    - by forming vesicles from the plasma membrane
  - reversal of exocytosis, involving different proteins
- Three types of endocytosis:
  1. Phagocytosis ("cellular eating")
  2. Pinocytosis ("cellular drinking")
  3. Receptor-mediated endocytosis



## Active Transport: Endocytosis - Phagocytosis



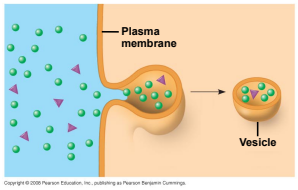




An amoeba engulfing a bacterium via phagocytosis (TEM)



## Active Transport: Endocytosis - Pinocytosis

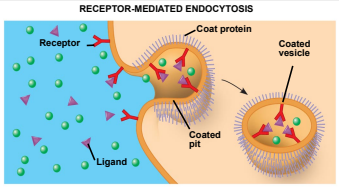


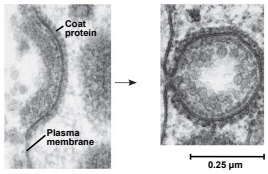


Pinocytosis vesicles forming (arrows) in a cell lining a small blood vessel (TEM)



## Active Transport: Receptor Mediated Endocytosis




A coated pit and a coated vesicle formed during receptor-mediated endocytosis (TEMs)

## You should now be able to:

1. Define the following terms: amphipathic molecules, aquaporins, diffusion
2. Explain how membrane fluidity is influenced by temperature and membrane composition
3. Distinguish between the following pairs or sets of terms: peripheral and integral membrane proteins; channel and carrier proteins; osmosis, facilitated diffusion, and active transport; hypertonic, hypotonic, and isotonic solutions
4. Explain how transport proteins facilitate diffusion
5. Explain how an electrogenic pump creates voltage across a membrane, and name two electrogenic pumps
6. Explain how large molecules/substances are transported across a cell membrane