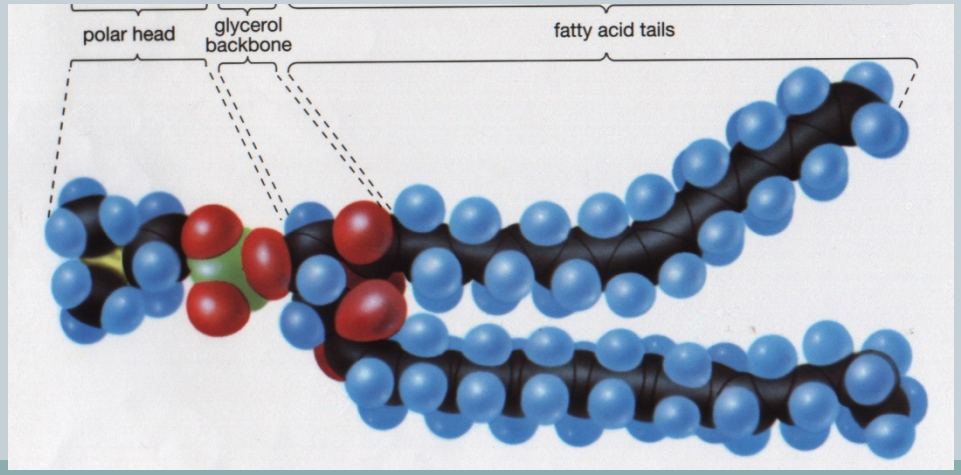
Transport Across Cell Membranes

CELL MEMBRANE STRUCTURE

- A phospholipid bilayer makes up the main part of the cell membrane
- Each phospholipid molecule contains a charged polar head (H_2O-loving) and non-polar, fat-soluble tails (H_2O fearing)
- This gives the cell membrane it's fluid-like nature

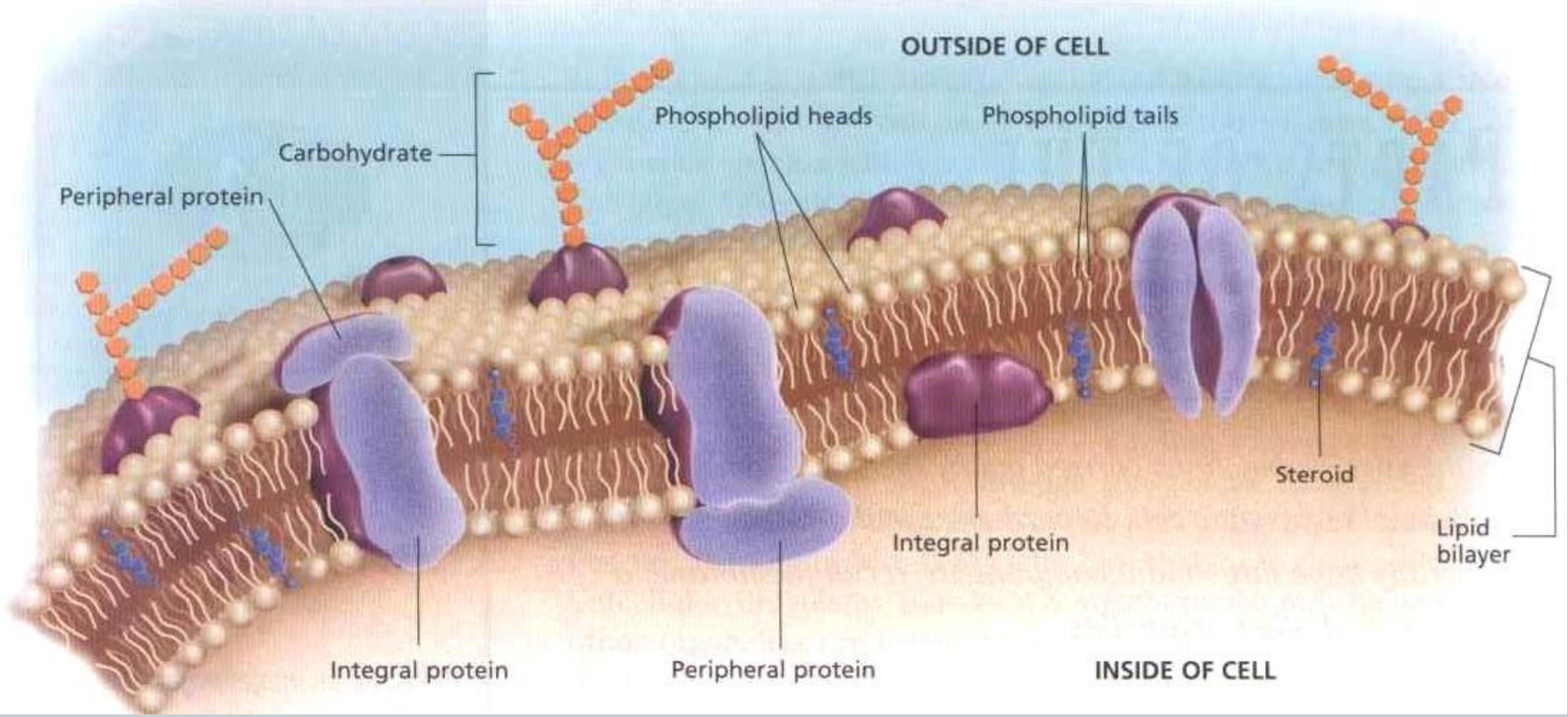


CELL MEMBRANE STRUCTURE

- Proteins form a 'mosaic' pattern (scattered) throughout the cell membrane
- Proteins are embedded in the cell membrane and on its surface
- Some are carrier proteins that bring H_2O, amino acids, ions, glucose… in/out of the cell (require ATP) eg. Sodium/potassium pump in nerve transmission
- Some proteins have channels/pores to allow passage of H2O, dissolved ions & small molecules

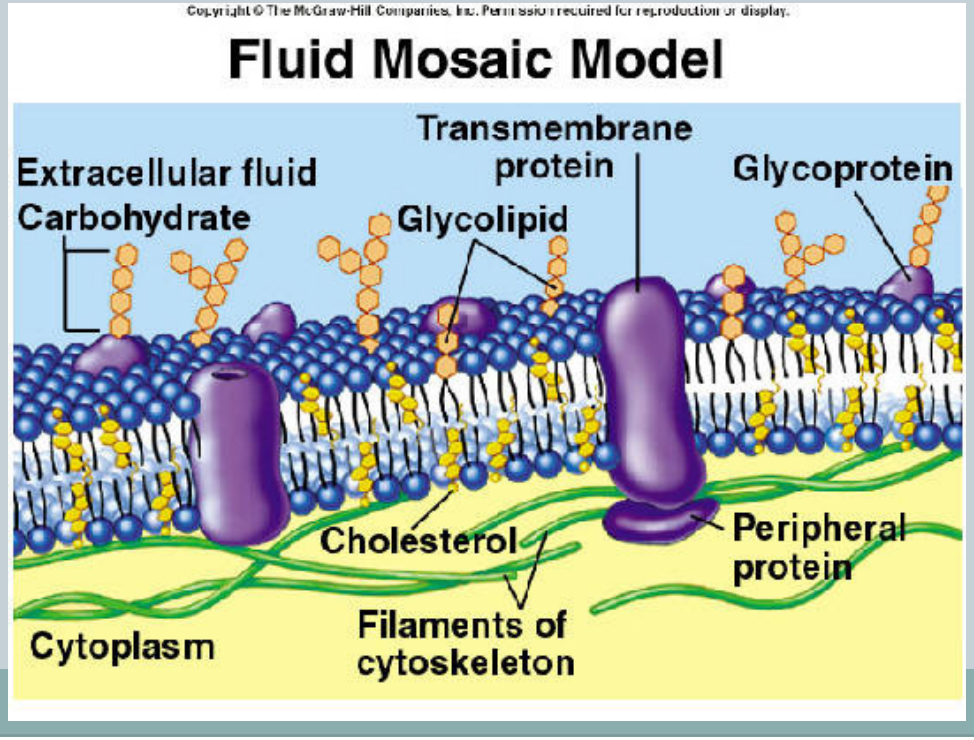
CELL MEMBRANE STRUCTURE

- Some proteins are receptors that a specific molecule can bind to (eg hormones)



FLUID-MOSAIC MODEL

- The fluid nature of the phospholipids coupled with the random scattering of proteins led to the development of the fluid-mosaic model of cell membrane structure.



GLYCOLIPIDS & GLYCOPROTEINS

- Glycolipids & Glycoproteins – are found on the outside of the cell membrane and serve as recognition sites allowing organisms to recognize foreign cells/molecules
- Glycolipids & Glycoproteins are not found on intracellular membranes (ie mitochondria, ER, golgi)
- Glycolipids are carbohydrate chains attached to a phospholipid head, glycoproteins are carbohydrate chains attached to a protein

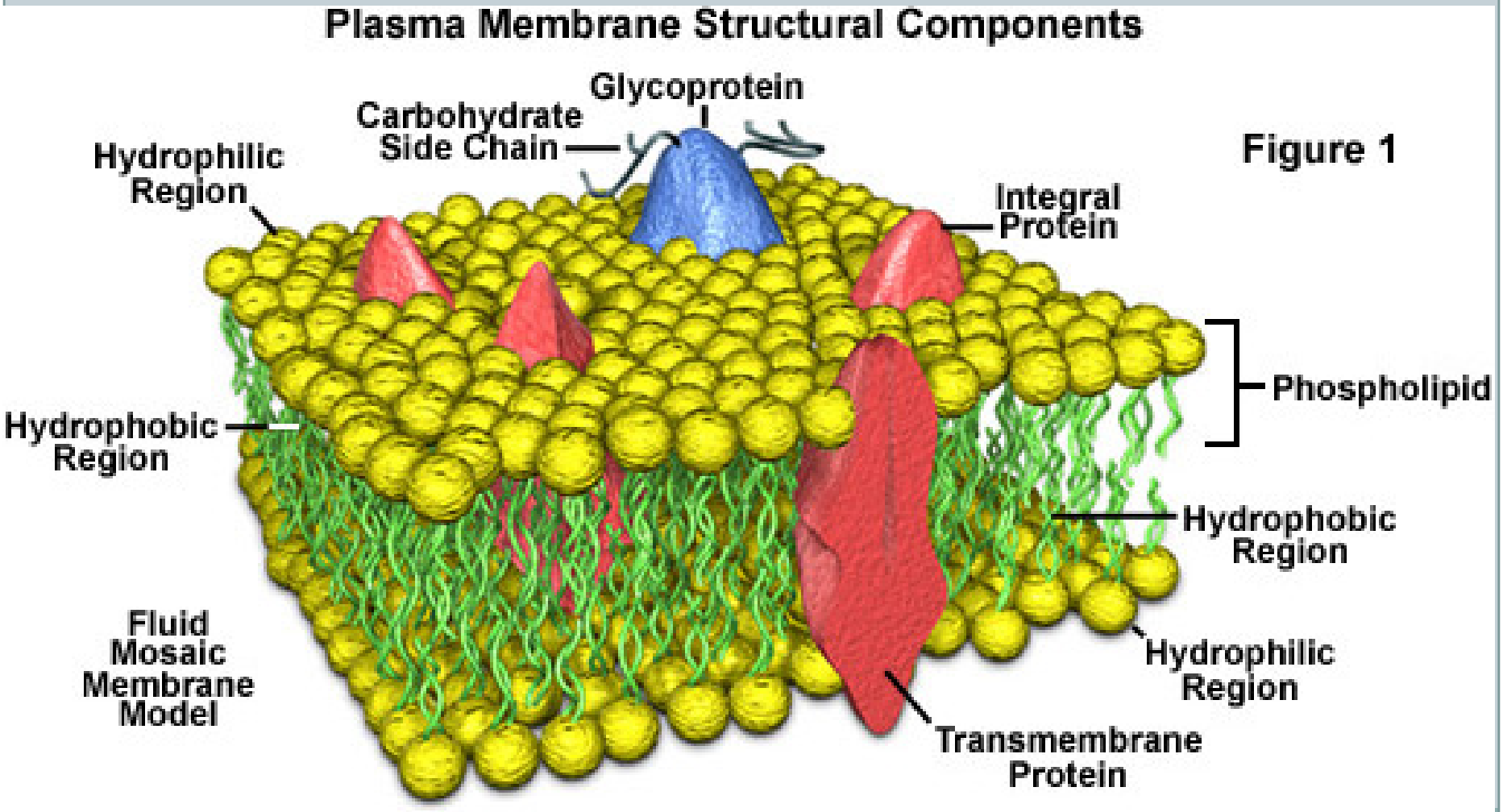
PROTEIN FUNCTION

- Allow/select certain molecules in/out of cell through channels (eg H_2O, O_2, CO_2, or ions)
- Carry molecules selectively in/out of the cell by carriers (eg Na^+, K^+, $C_6H_{12}O_6$, HCO_3^-, Ca^+)
- Catalyzes reactions on the surface of the cell (enzymatic proteins ie enzymes for ATP metabolism)
- Provide receptor sites (receptor proteins, eg for hormone binding)

PHOSPHOLIPIDS

- Allow for diffusion of lipid soluble molecules (O_2, CO_2, and alcohol)
- Allows for flexibility of the cell membrane
- Excludes water & ions
- Act as a boundary keeping organelles within the cell
- Create hydrophobic (water-fearing) and hydrophilic (water-loving) portions of the cell membrane

HYDROPHOBIC/HYDROPHILIC



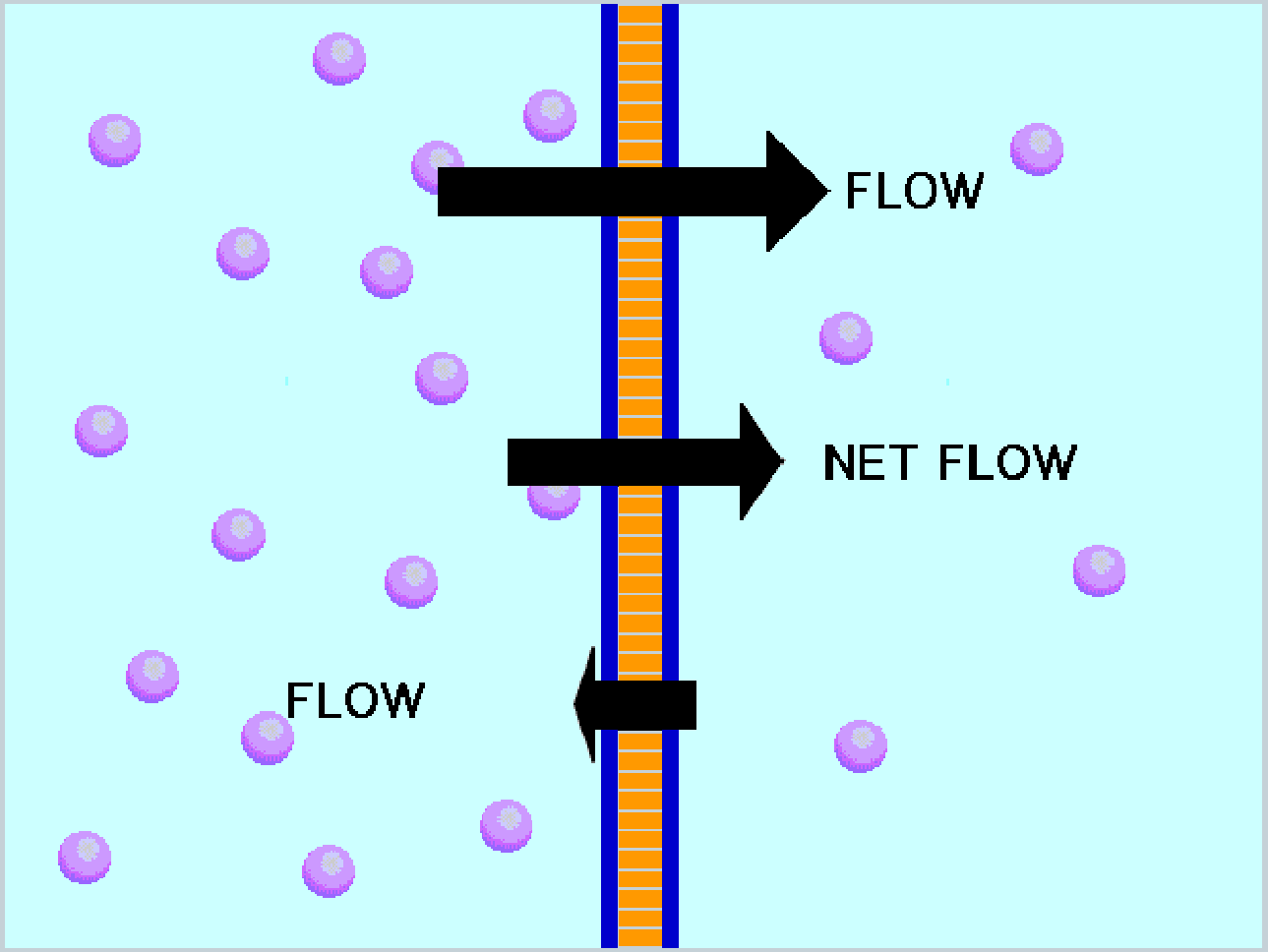
SELECTIVELY PERMEABLE MEMBRANE

- Selectively permeable has replaced the term semi-permeable when referring to cell membranes.
- Selectively permeable refers to the selective way that membranes and their proteins allow molecules in/out of the cell.

PASSIVE TRANSPORT: DIFFUSION/OSMOSIS

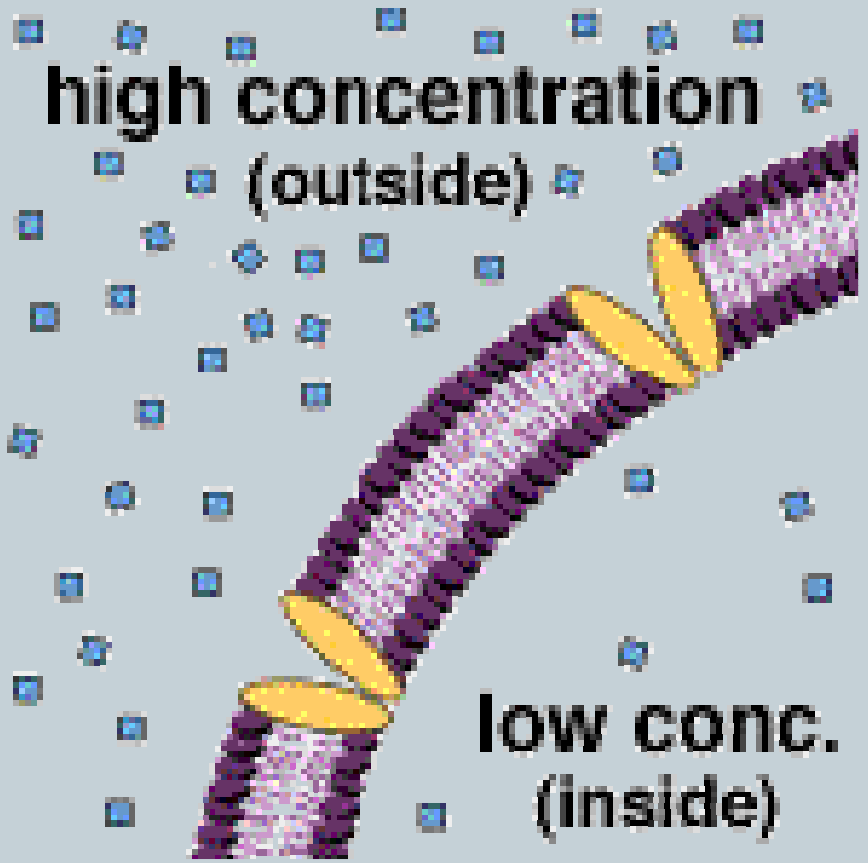
- Diffusion is the movement of particles from an area of high concentration to an area of low concentration
- Osmosis is the movement of water from an area of high concentration to an area of low concentration
- Any time a substance is moving from high concentration to low concentration we say that it is moving down the concentration gradient
- No energy (ATP) is required for these processes

PASSIVE TRANSPORT: DIFFUSION/OSMOSIS



PASSIVE/FACILITATED TRANSPORT

- Facilitated transport is still considered passive as no energy (ATP) is required for the process.
- Particles move from high concentration to low concentration.



FACTORS THAT AFFECT DIFFUSION RATES

- CONCENTRATION:
- Solutions consist of a solvent (often water) and a solute (particles dissolved in the solvent)
- A difference in solute concentrations on either side of a cell membrane creates a concentration gradient and diffusion will occur
- The larger the difference in solute concentrations the greater the rate of diffusion

FACTORS THAT AFFECT DIFFUSION RATES

- TEMPERATURE:
- An increase in temperature increases the kinetic energy of the particles in a solution (they move more quickly) and therefore increases the rate of diffusion

FACTORS THAT AFFECT DIFFUSION RATES

- IONIC/MOLECULAR SIZE:
- Smaller molecules will collide less frequently and therefore diffuse more quickly than larger molecules
- Large molecules (starches, proteins…) simply do not diffuse across cell membranes

FACTORS THAT AFFECT DIFFUSION RATES

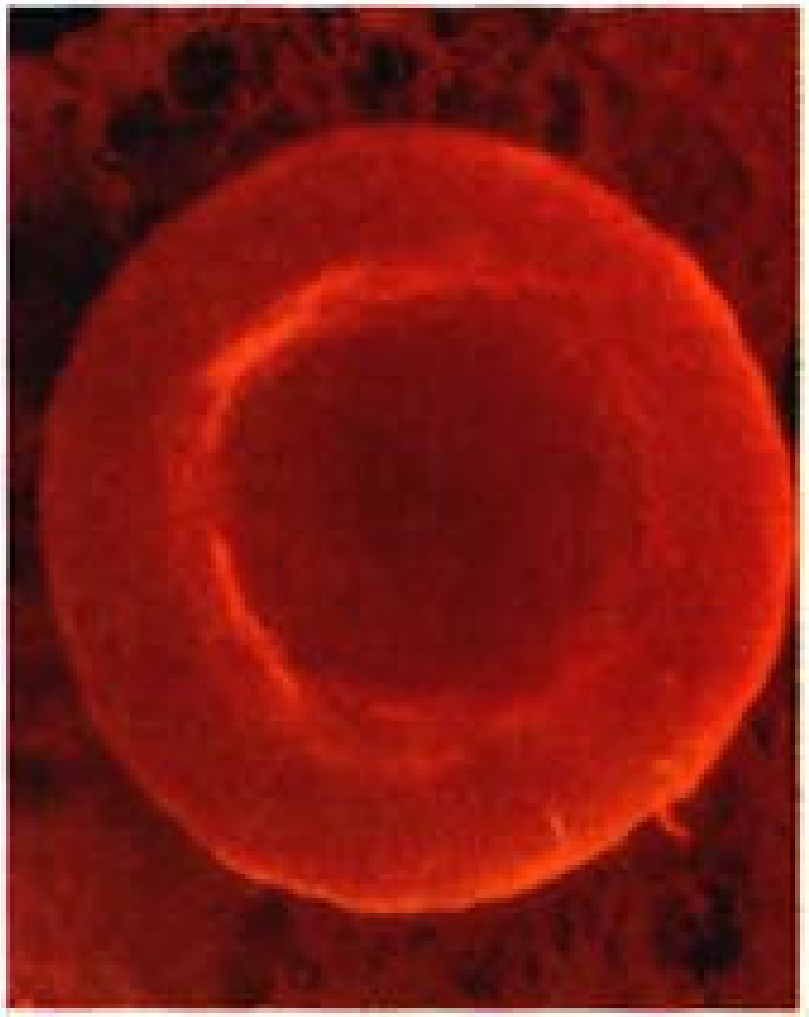
- SHAPE OF ION/MOLECULE
- Similar to size, the shape of a molecule may prevent it from diffusing rapidly
- Other molecules have a configuration (shape) that facilitates their diffusion

FACTORS THAT AFFECT DIFFUSION RATES

- VISCOSITY:
- Solutions with lower viscosity (fluid density) allow molecules to diffuse more quickly through them
- For example, particles will diffuse more quickly through water than they will through syrup
- MOVEMENT OF THE MEDIUM:
- Currents (in water, air, or cytoplasmic streaming) will aid in the process of diffusion

ISOTONIC

- **Isotonic Solutions:** contain the same concentration of solute as an other solution (e.g. the cell's cytoplasm). When a cell is placed in an isotonic solution, the water diffuses into and out of the cell at the same rate. The fluid that surrounds the body cells is isotonic.



HYPOTONIC

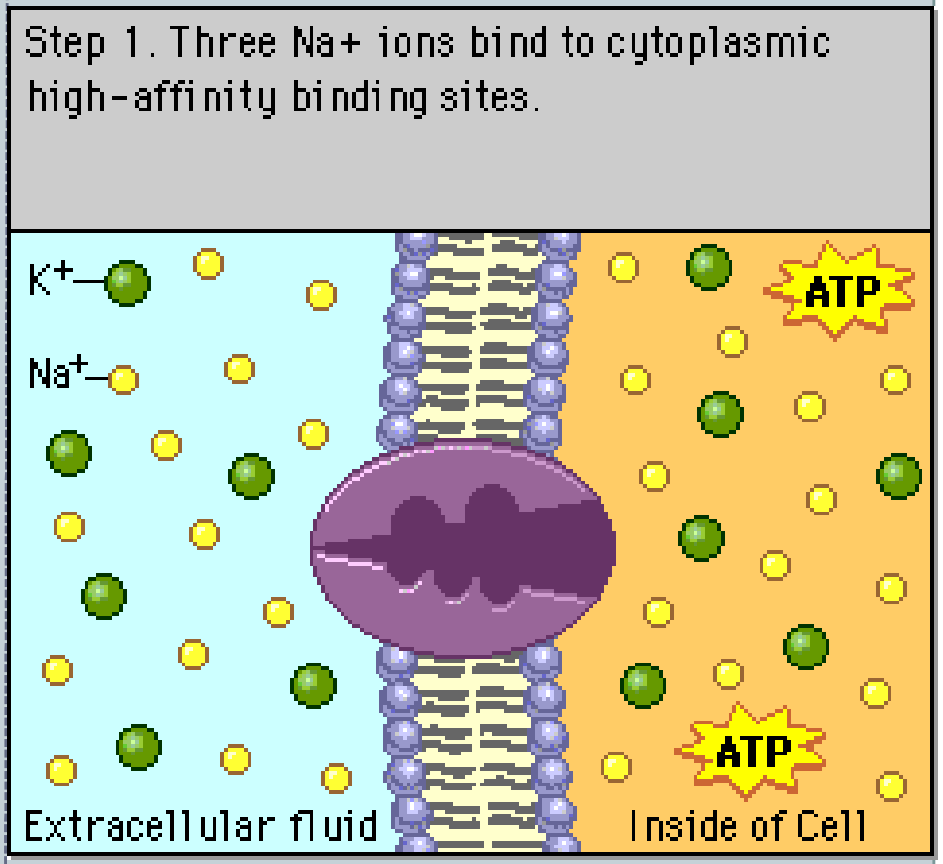
- **Hypotonic Solutions:** contain a low concentration of solute relative to another solution (e.g. the cell's cytoplasm). When a cell is placed in a hypotonic solution, the water diffuses into the cell, causing the cell to swell and possibly explode (lysis).

HYPERTONIC

- **Hypertonic Solutions:** contain a high concentration of solute relative to another solution (e.g. the cell's cytoplasm). When a cell is placed in a hypertonic solution, the water diffuses out of the cell, causing the cell to shrivel (crenation).

ACTIVE TRANSPORT

- Movement from low concentration to high concentration (against the concentration gradient)
- Requires energy (ATP)
- Example: sodium-potassium pump in neurons

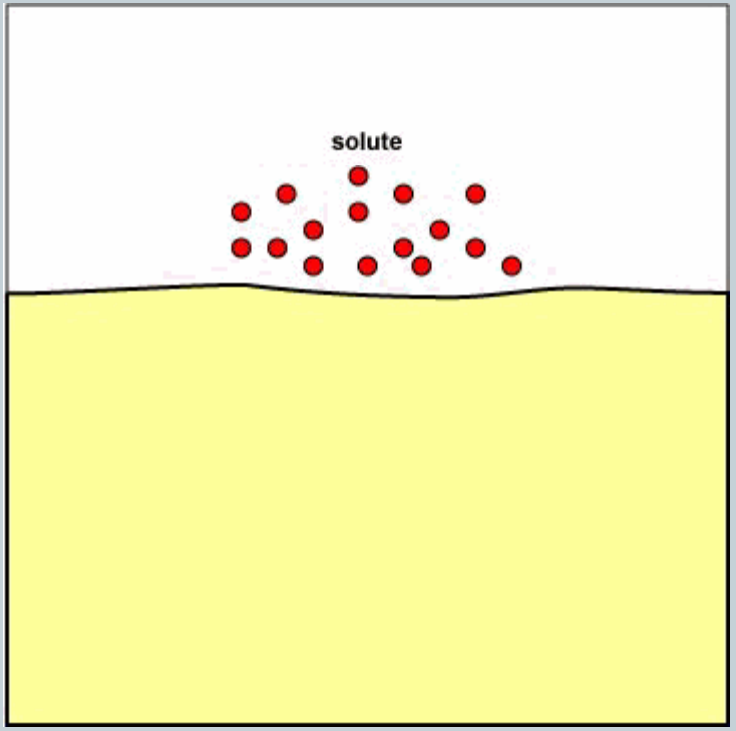


ENDOCYTOSIS

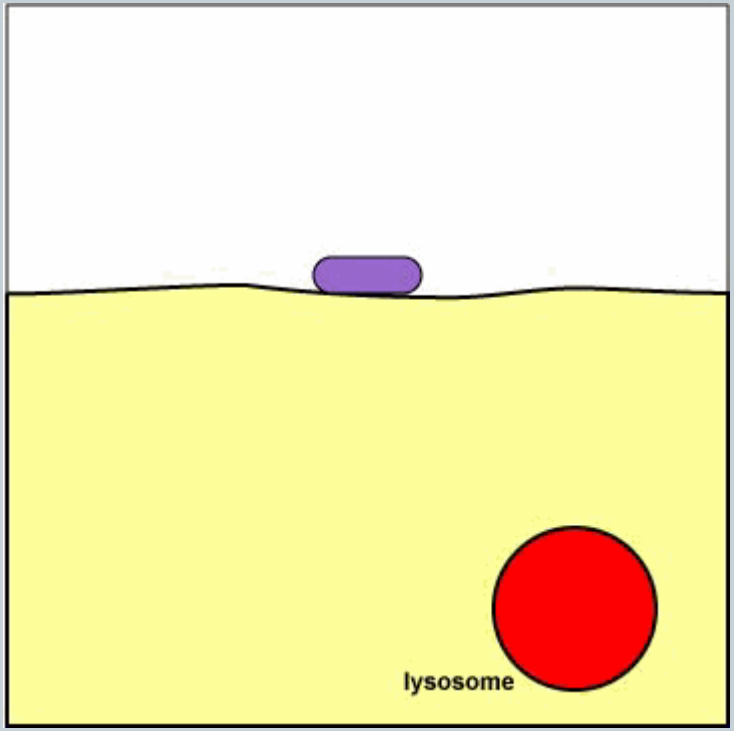
- 2 types – pinocytosis & phagocytosis
- Move objects too large to fit through the membrane
- Pinocytosis = cell drinking (small objects)
- Phagocytosis = cell eating (larger objects)
- Both processes require ATP

ENDOCYTOSIS

PINOCYTOSIS

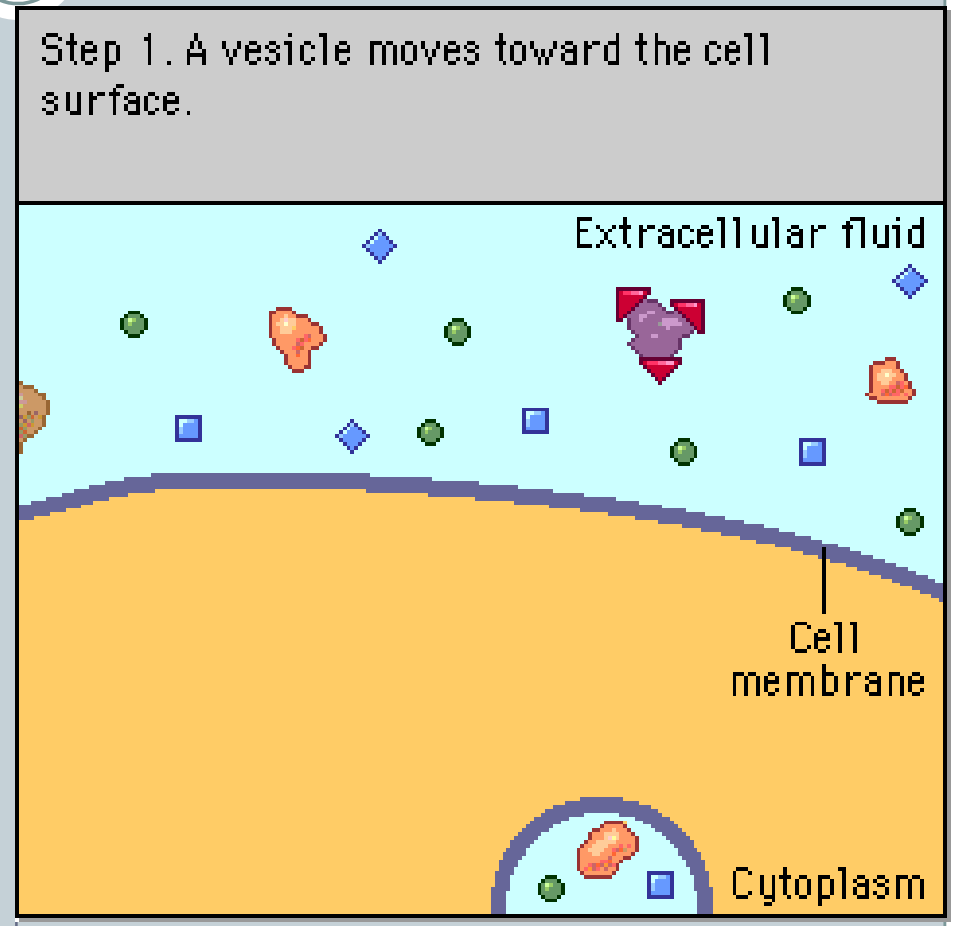


PHAGOCYTOSIS



EXOCYTOSIS

- This is the opposite process to endocytosis
- Vesicles produced by the golgi body move toward the cell membrane, fuse with the membrane and release their contents to the outside of the cell



LIMITS TO CELL SIZE

- Cell size is limited by their surface area to volume ratio
- As cells grow bigger their surface area to volume ratio gets smaller
- Once cells reach a certain size they must divide or they will die