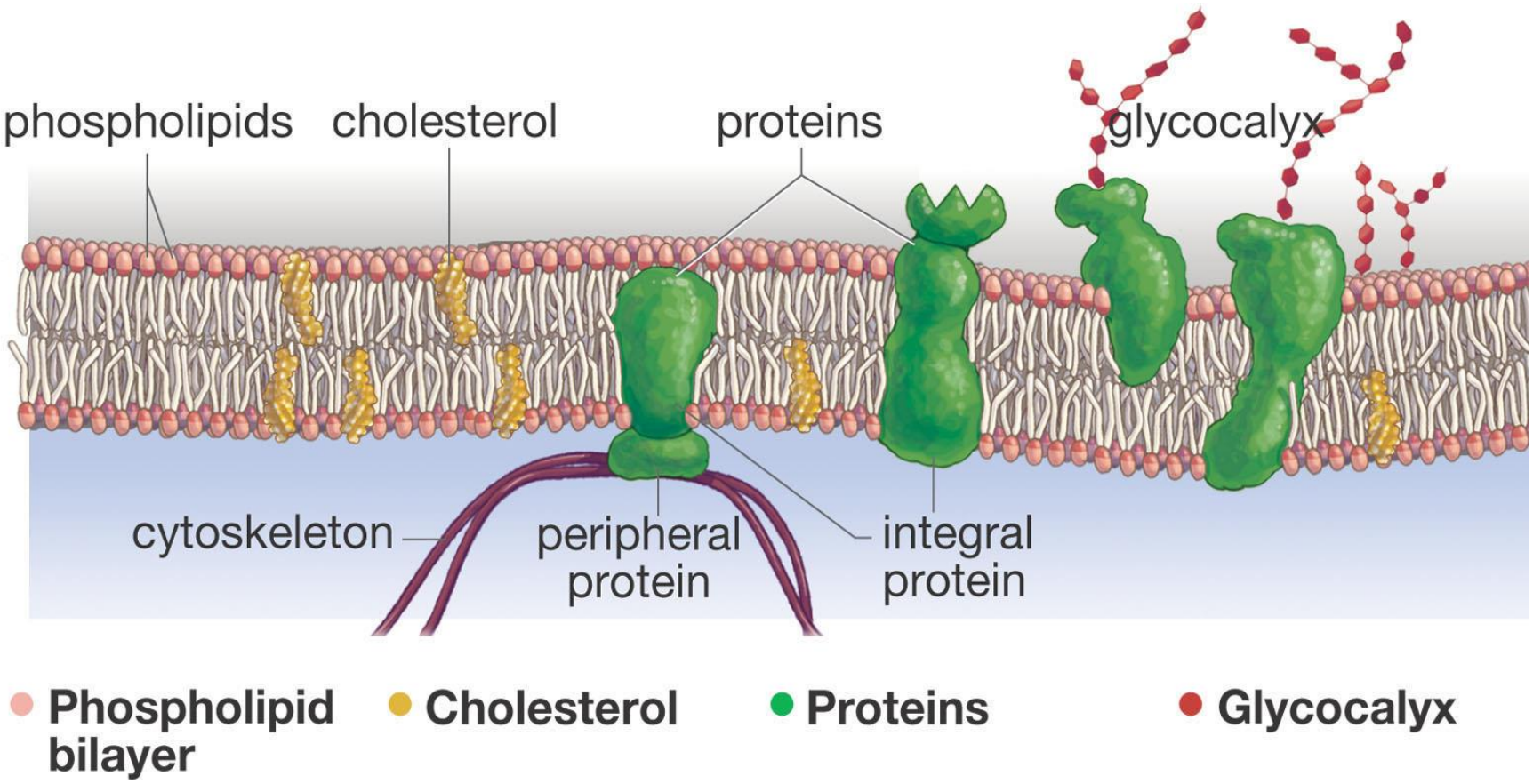
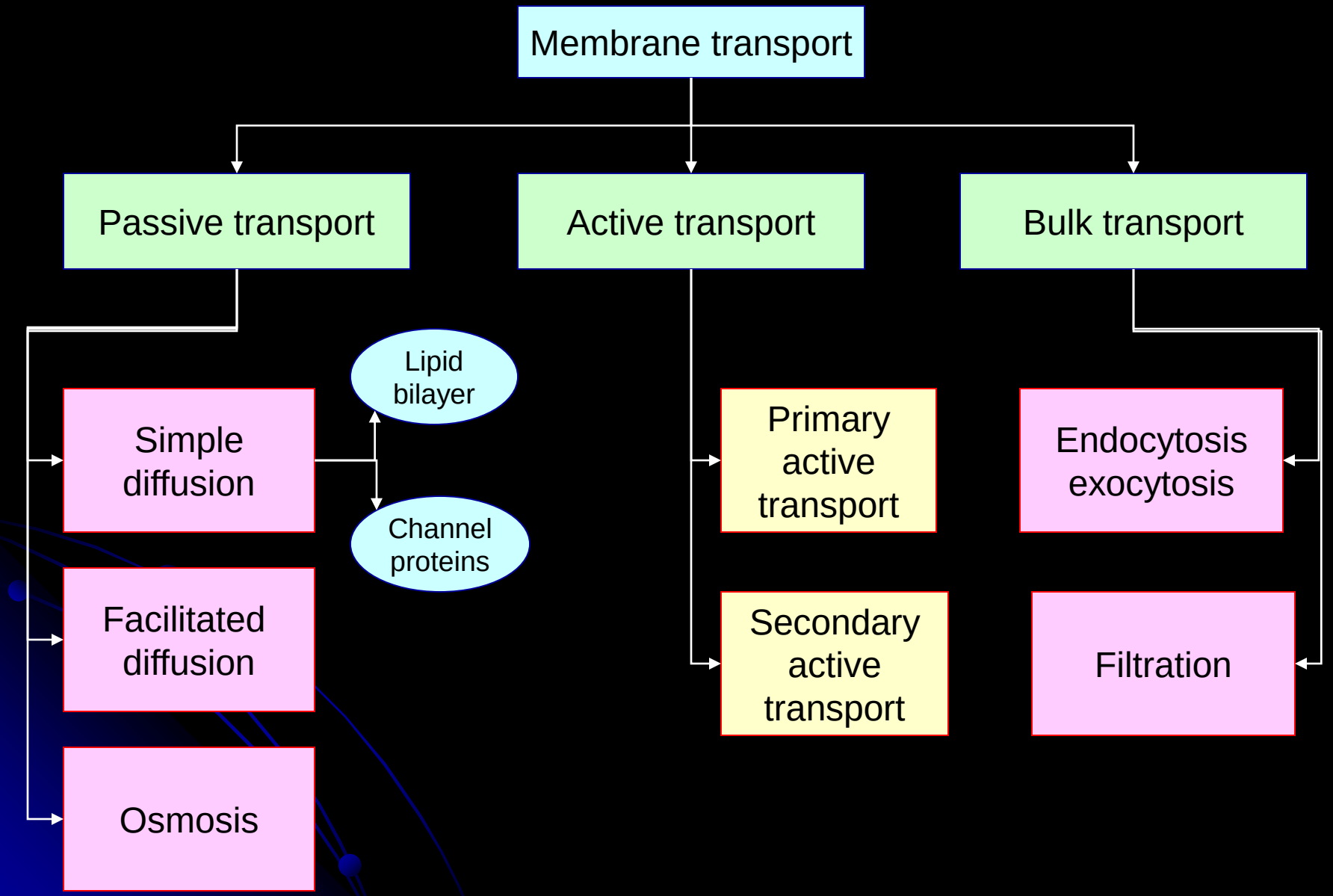
Membrane Transport
Passive Transport



LEARNING OBJECTIVES

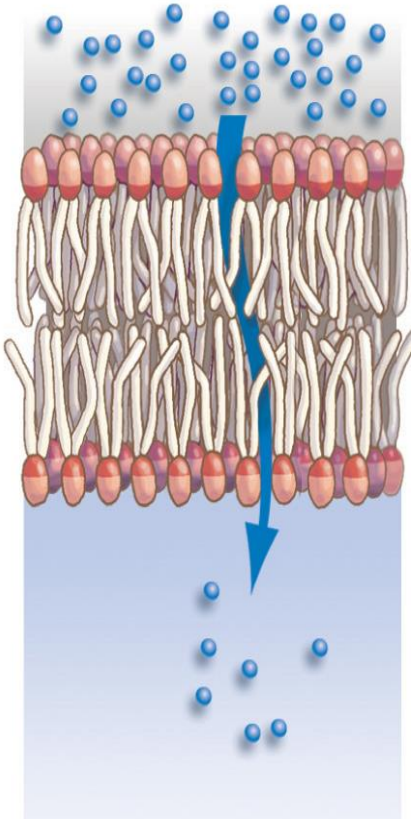
- At the end of the lecture ,students must be able to
- List the basic mechanism of transport
- Explain passive transport & its types
- Describe the factors affecting rate of diffusion.


Membrane transport
Passive transport
Active transport
Bulk transport
Lipid bilayer
Simple diffusion
Channel proteins
Facilitated diffusion
Osmosis
Primary active transport
Secondary active transport
Endocytosis exocytosis
Filtration

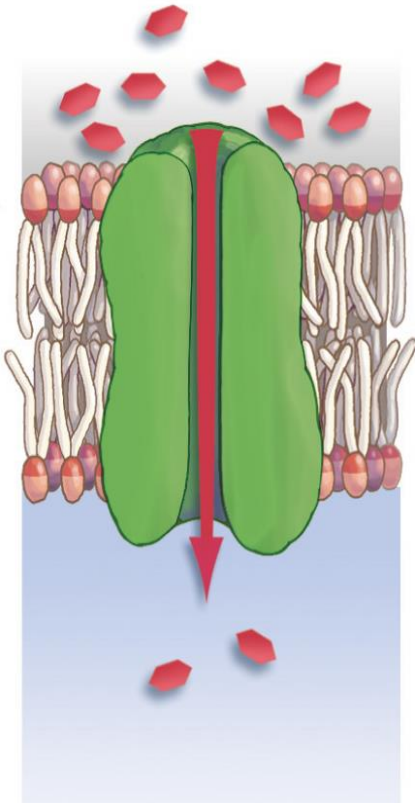
Passive Transport

1.Simple Diffusion

- Higher to lower concentration gradient
- Energy: ATP not required
- Occurs due to random kinetic movement of molecules
- *Net* diffusion stops when concentration on both sides equal

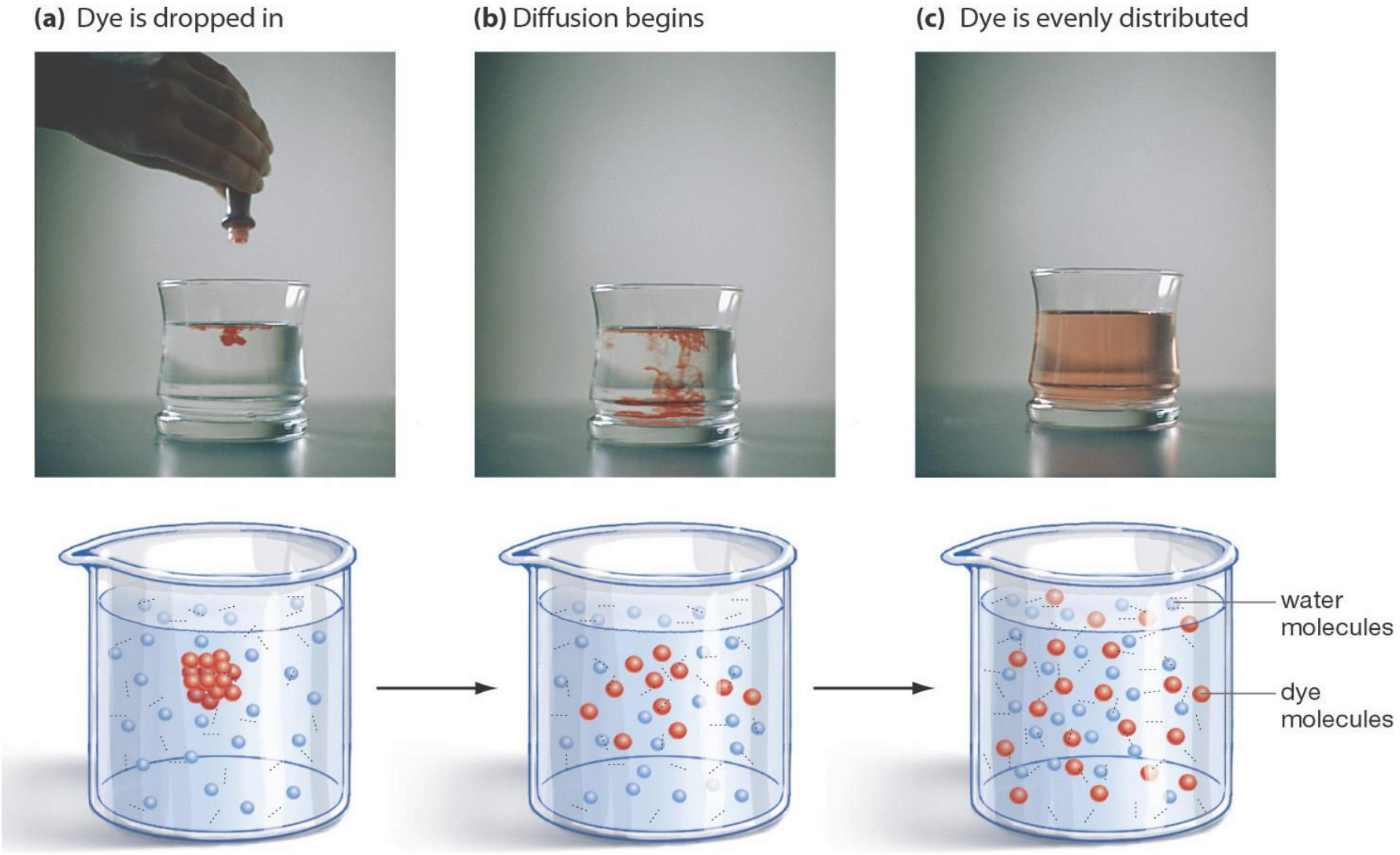


Lipid bilayer



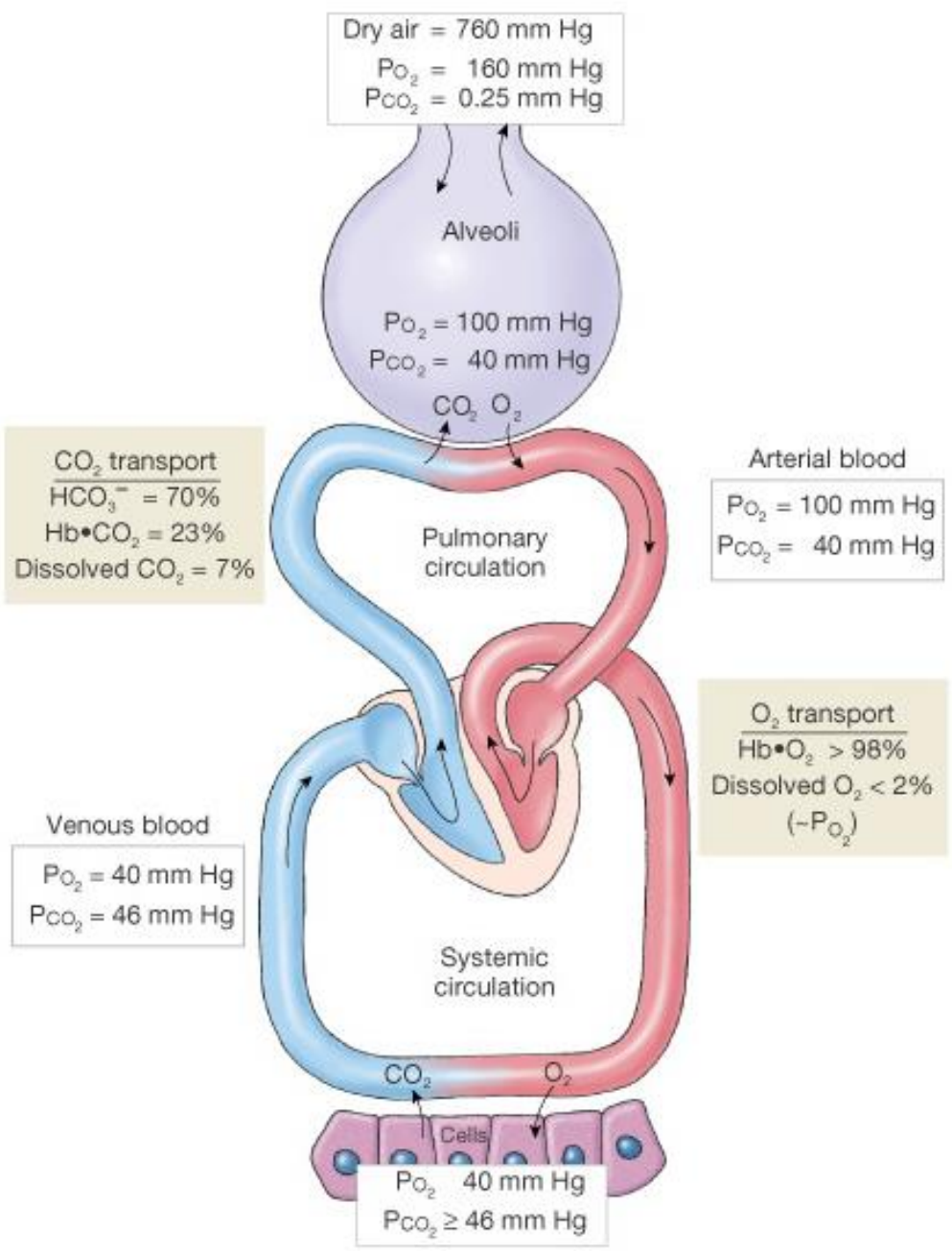
Channel proteins

Diffusion in Liquids



Diffusion of Gases

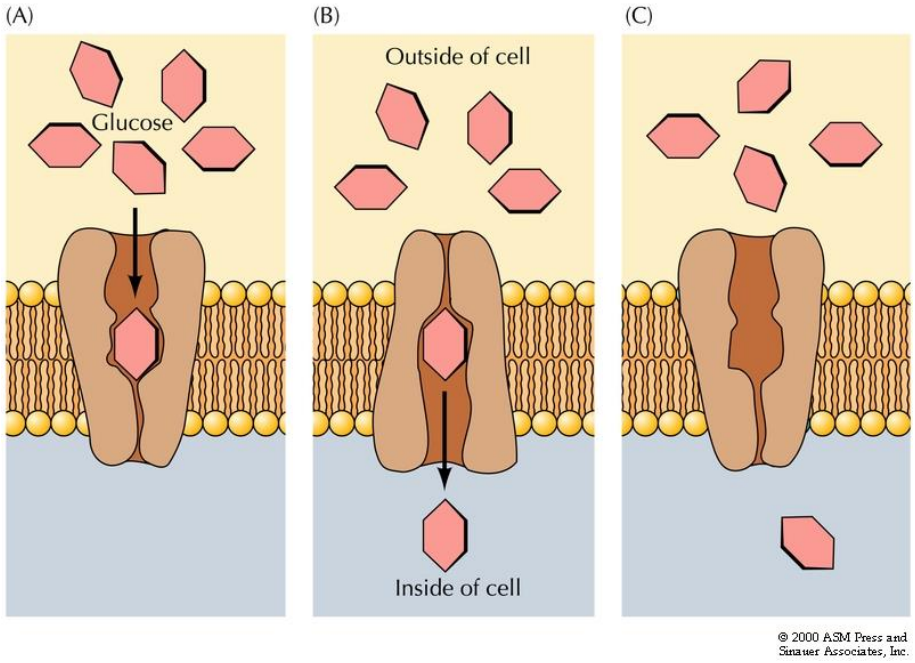
- Simple diffusion: from higher to lower concentration difference
- Oxygen
  - Lungs → Blood → Tissues
- Carbon dioxide
  - Tissues → Blood → Lungs



Passive Transport

2. Facilitated Diffusion

- Higher to lower concentration gradient
- No ATP required
- Occurs with the help of **carrier protein**



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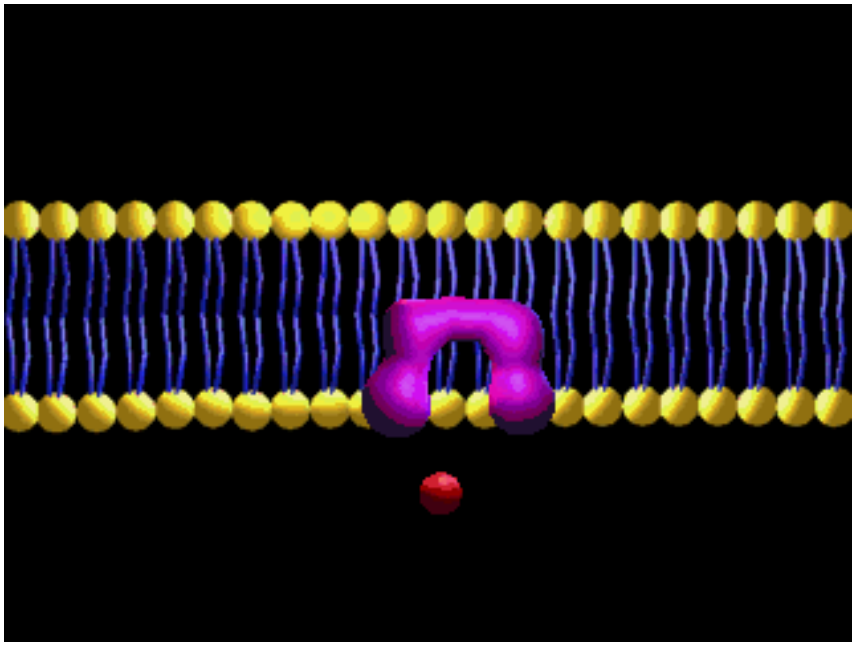
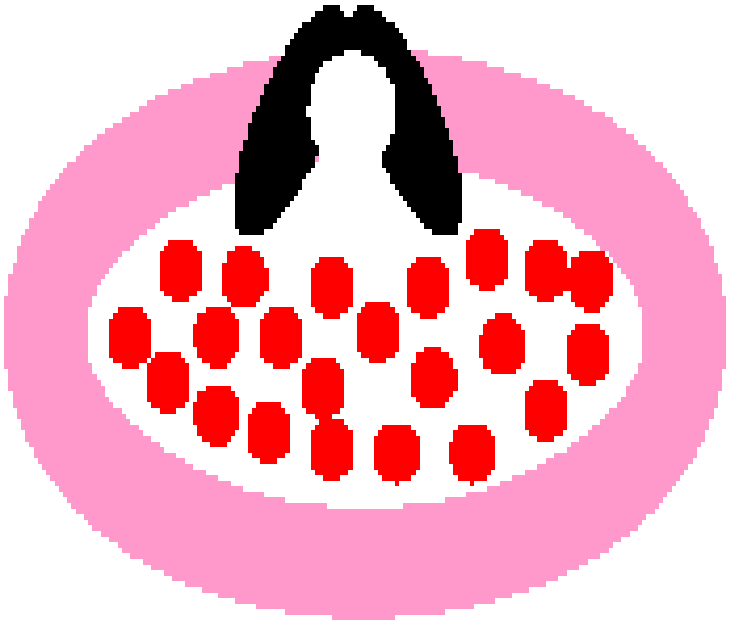
Facilitated Diffusion

- Some Carrier proteins do not extend through the membrane.
- They bond and drag molecules through the lipid bilayer and release them on the opposite side.



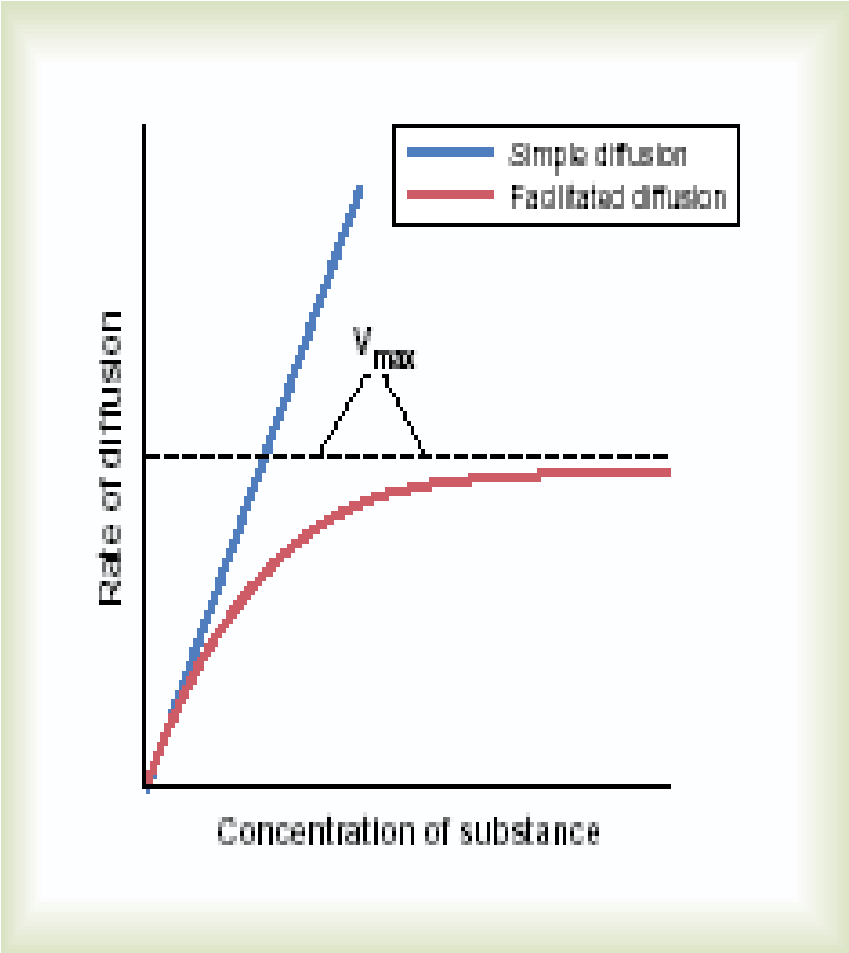
Facilitated Diffusion

- Other carrier proteins change shape to move materials across the cell membrane



Rate of Diffusion
Simple vs facilitated

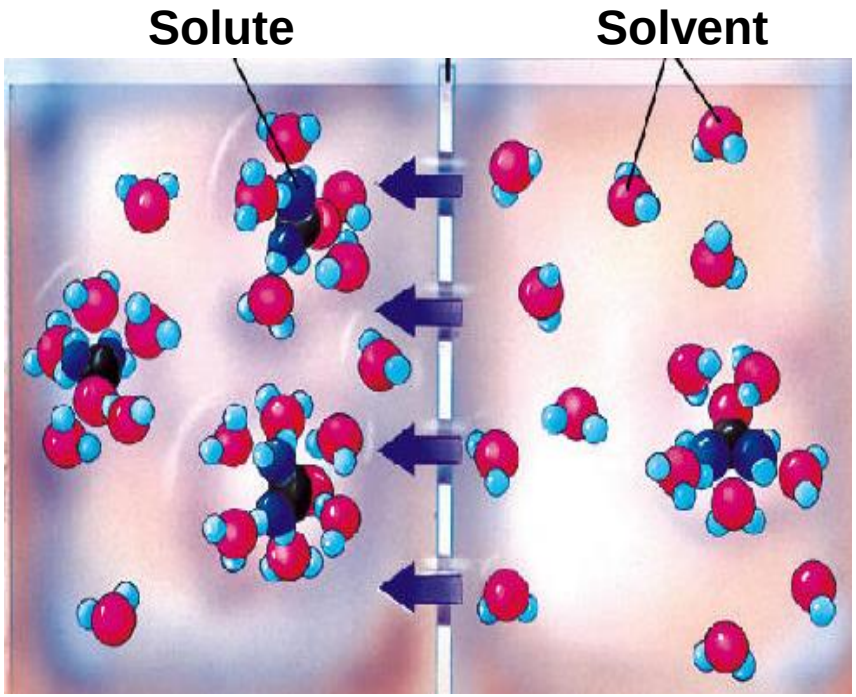
- V_{max} – Transport maximum
- **Straight line:** simple diffusion – rate of diffusion increases as you increase the concentration
- **Cruved line:** carrier mediated transport – rate of diffusion reaches a maximum when all carriers are saturated



Passive Transport

3.Osmosis

- Special type of diffusion
- Movement of water molecules from higher to lower concentration
- No ATP required
- Across a semi-permeable membrane

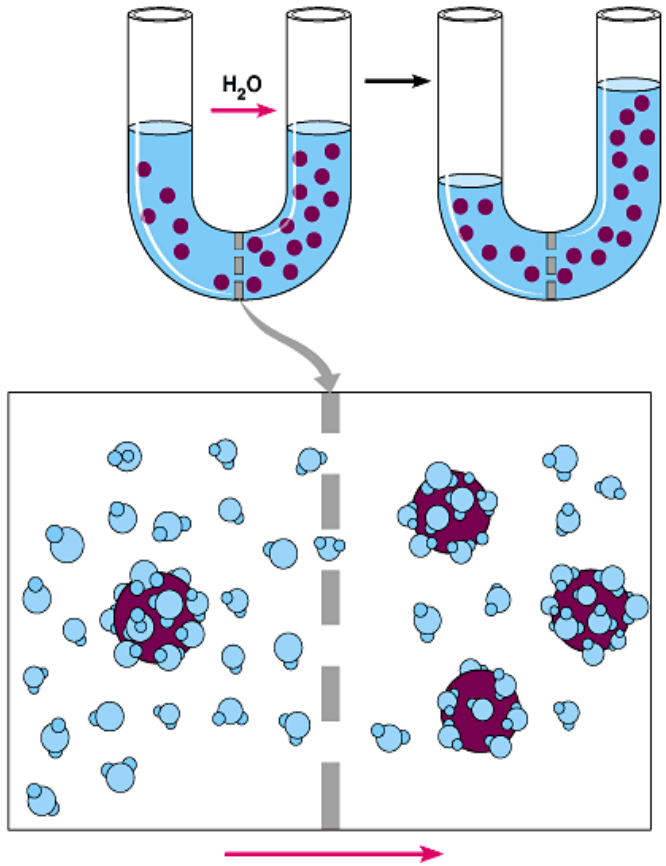


Osmosis

- Tonicity: related to number of solutes in a solution
- Isotonic solution
  - Same number of solutes as inside the cell
- Hypotonic solution
  - Solute concentration less than inside cell
- Hypertonic solution
  - Solute concentration more than inside cell

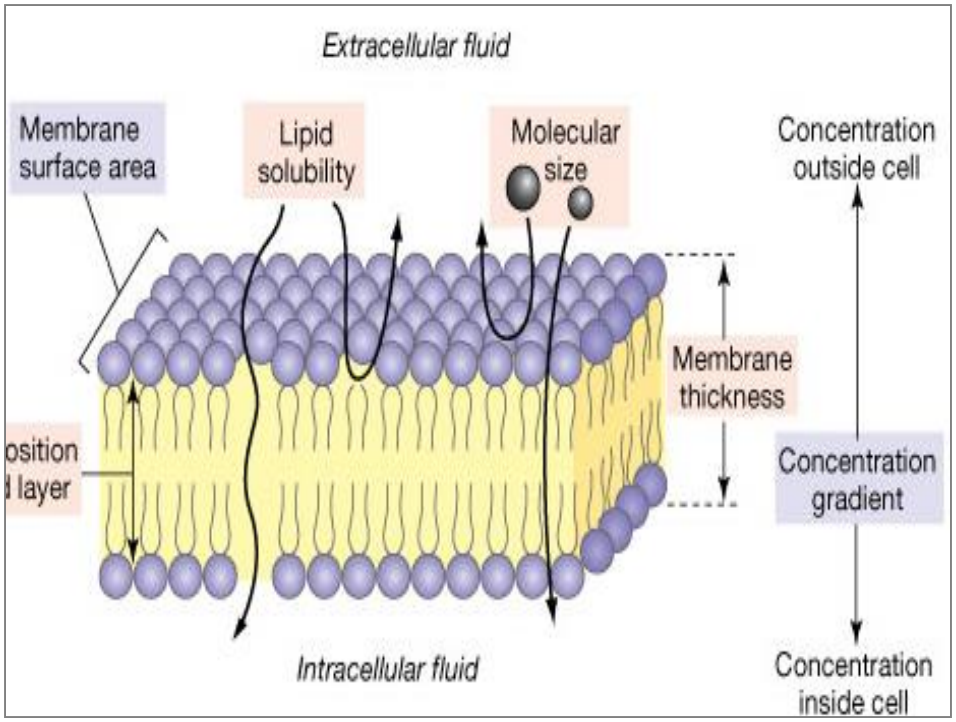
Osmosis

- Isotonic solutions
  - 5% glucose solution
  - 0.9% NaCl solution
- Water concentration – determined by solute concentration
- **Osmotic Pressure:** The pressure required to stop osmosis (‘prevent’ the net flow of water into a solution)



Factors affecting diffusion rate

- Concentration Gradient (ΔP)
- Surface Area (SA)
- Solubility (SOL)
- Thickness (T)
- Molecular weight (MW)

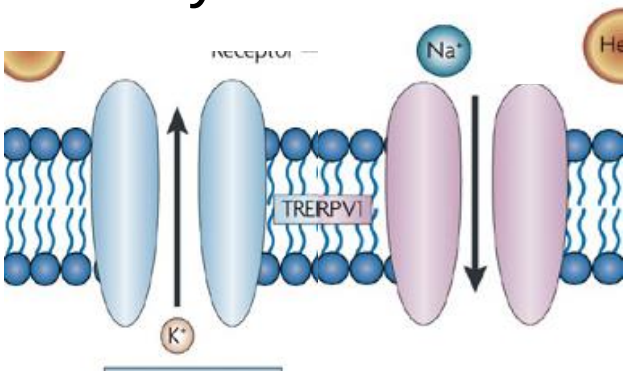


$$D \alpha \frac{\Delta P \times SA \times SOL}{T \times MW}$$

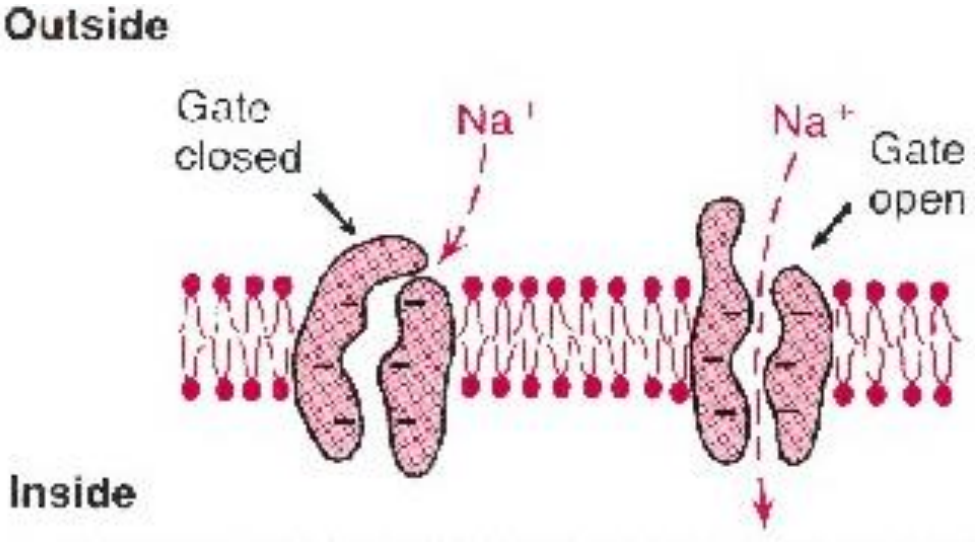
Diffusion through channel proteins

- **Non-gated** or leaky channels – remain open
- **Gated** channels – open or close by conformational change in membrane protein
  - Voltage gated
  - Ligand gated
  - Mechanical gated

Leaky channels



Gated channels



i. Voltage-gated channels

- Voltage-gated channels are the channels which open whenever there is a change in the electrical potential.
- For example, in the neuromuscular junction, when action potential reaches axon terminal, the calcium channels are opened and calcium ions diffuse into the interior of the axon terminal from ECF.

ii. Ligand-gated channels

- Ligand-gated channels are the type of channels which open in the presence of some hormonal substances. The hormonal substances are called ligands and the channels are called ligand-gated channels.
- Eg During the transmission of impulse through the neuromuscular junction, acetylcholine is released from the vesicles. The acetylcholine moves through the presynaptic membrane (membrane of the axon terminal) and reaches the synaptic cleft. Then, the acetylcholine molecules cause opening of sodium channels in the postsynaptic membrane and sodium ions diffuse into the neuromuscular junction from ECF.

iii. Mechanically gated channels

- Mechanically gated channels are the channels which are opened by some mechanical factors.
- Examples are, channels present in the pressure receptors (Pacinian corpuscles) and the receptor cells (hair cells) of organ of Corti and vestibular apparatus. When a Pacinian corpuscle is subjected to pressure, it is compressed resulting in deformation of its core fiber. This deformation causes opening of sodium channel and development of receptor potential.