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Department of Biomedical Engineering

Course Name: 23BMT201 Human Anatomy & Physiology

I Year : II Semester

Topic : UNIT 1- Cell membrane –Transport across membrane

Introduction

- Transport of substances across the cell membrane is necessary to maintain the normal functioning of the cells in our body.

Selectively Permeable

Cell Membranes act like gates allowing only certain substances in or out of the cell.

Transport across the cell membrane

- Lipid soluble substances, water & urea can easily pass through the lipid bilayer of the cell membrane
- The lipid bilayer of the cell membrane is impermeable to lipid insoluble substances such as ions & charged or polar molecules like glucose
- These substances pass through specialized protein channels, carrier proteins & active pump mechanisms
- Large macromolecules are transported through vesicles.

TYPES

- **Passive Transport**
  - Diffusion – Simple , Facilitated
  - Osmosis
- **Active Transport**
  - Primary
  - Secondary
- **Vesicular Transport**
  - Endocytosis
  - Exocytosis

PASSIVE TRANSPORT

Diffusion- Simple

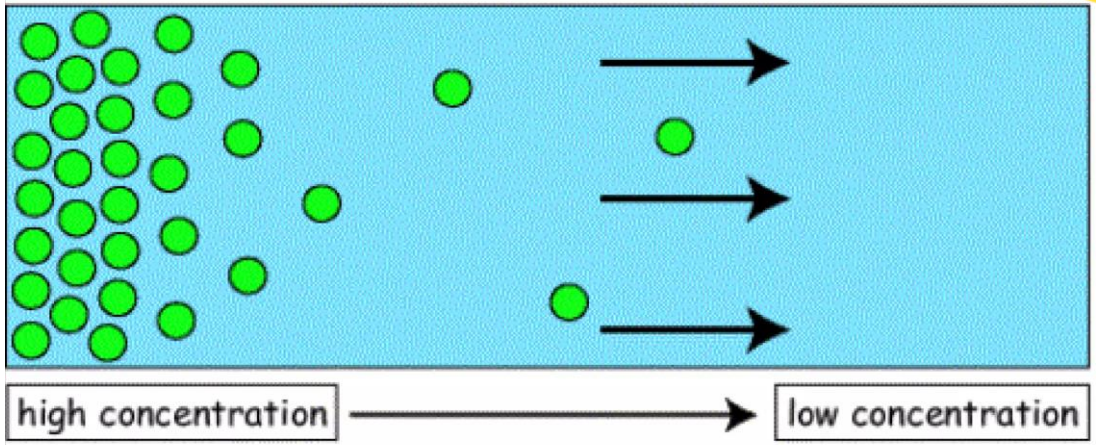
Facilitated

Osmosis

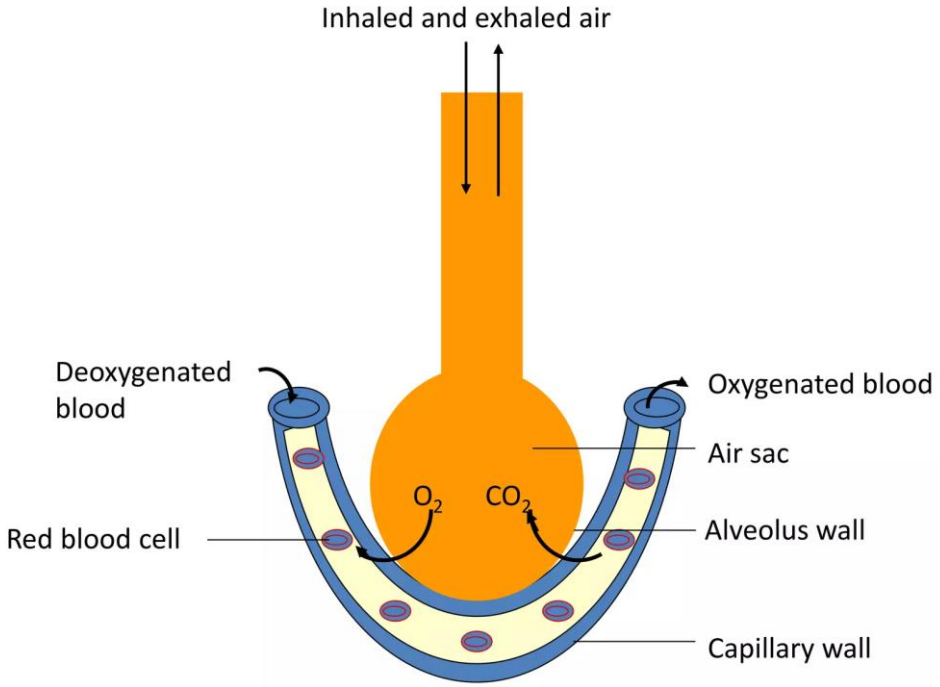
Diffusion-simple

- It is the movement of ions or molecules from a region of their high concentration to a region of their low concentration, without the expenditure of energy
- Movement is towards the concentration gradient until an equilibrium is achieved.

Diffusion



Solute transport is from the left to the
movement of the solutes is due to the c ation
gradient (dC/dx).

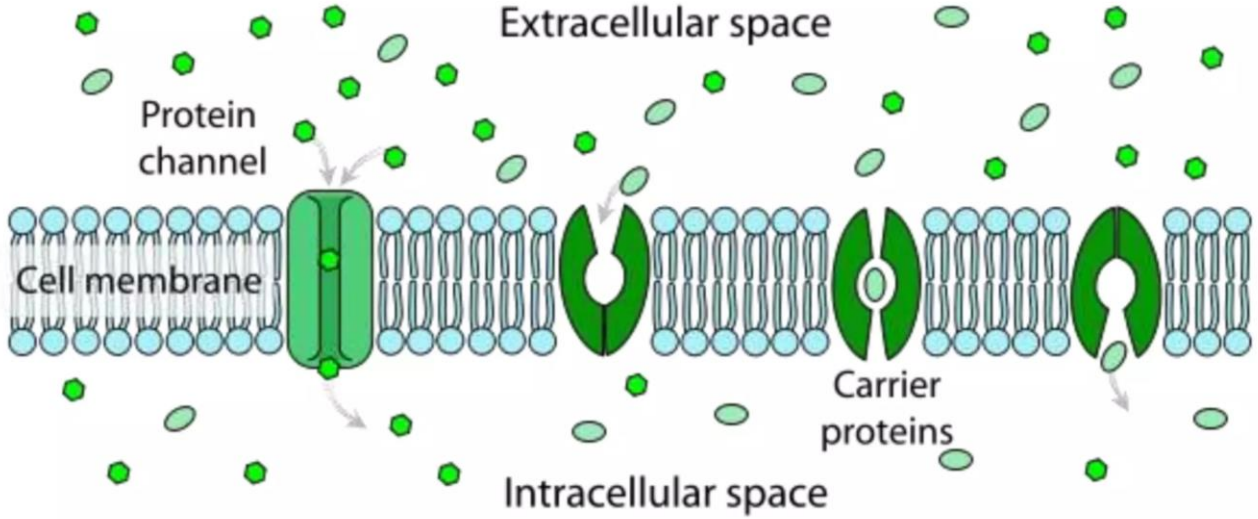


GASEOUS EXHANGE BY SIMPLE DIFFUSION IN THE ALVEOLUS

Facilitated diffusion

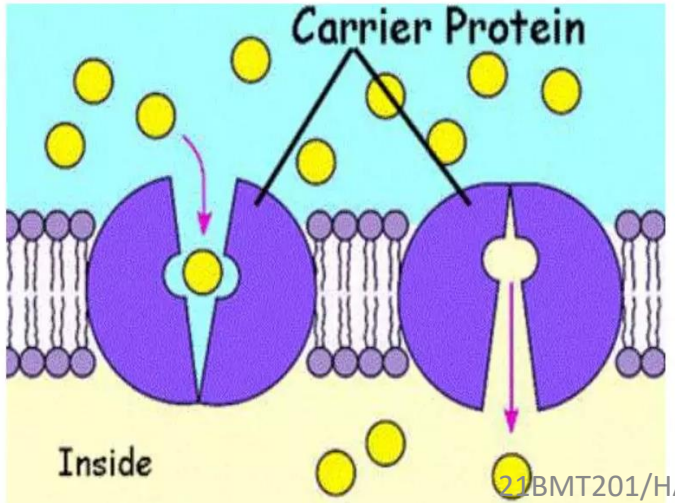
- Facilitated diffusion is the movement of specific molecules (or ions) across the plasma membrane, assisted by a carrier protein.
- The direction of movement is down the concentration gradient of the molecules concerned.
- No energy required.

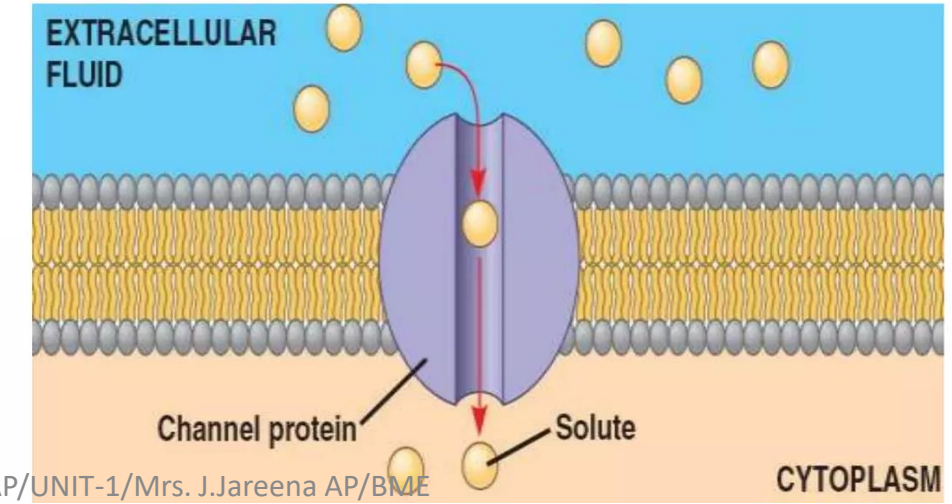
Facilitated diffusion



Difference between carrier proteins & channel proteins

- **Carrier proteins** bind to larger molecules, and change their shape so molecules can diffuse through.
- **Channel proteins** provide water filled pores for charged ions to pass through

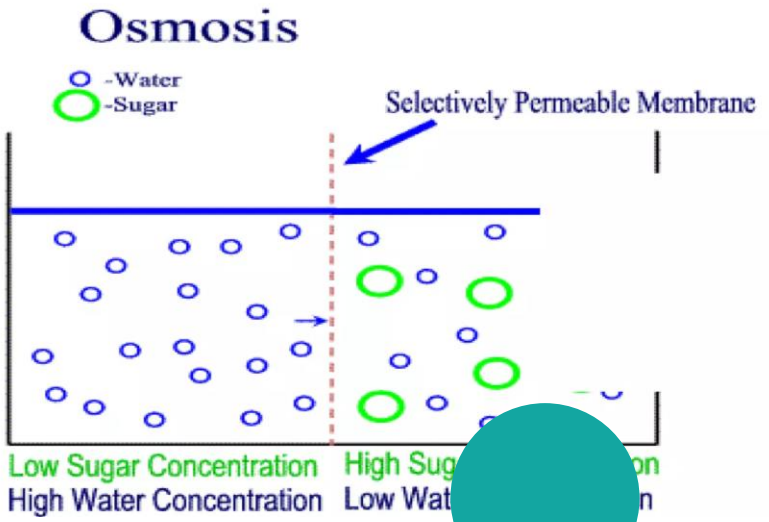




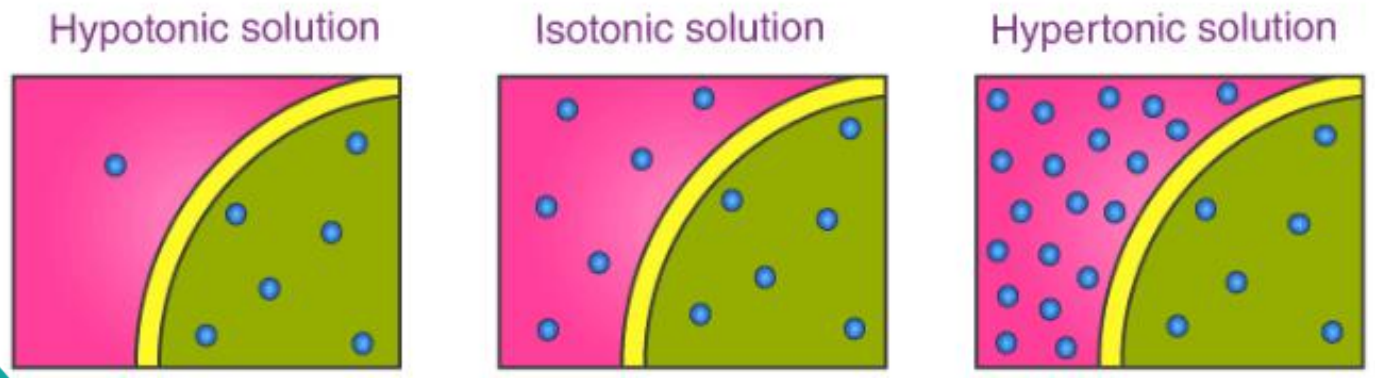
Osmosis

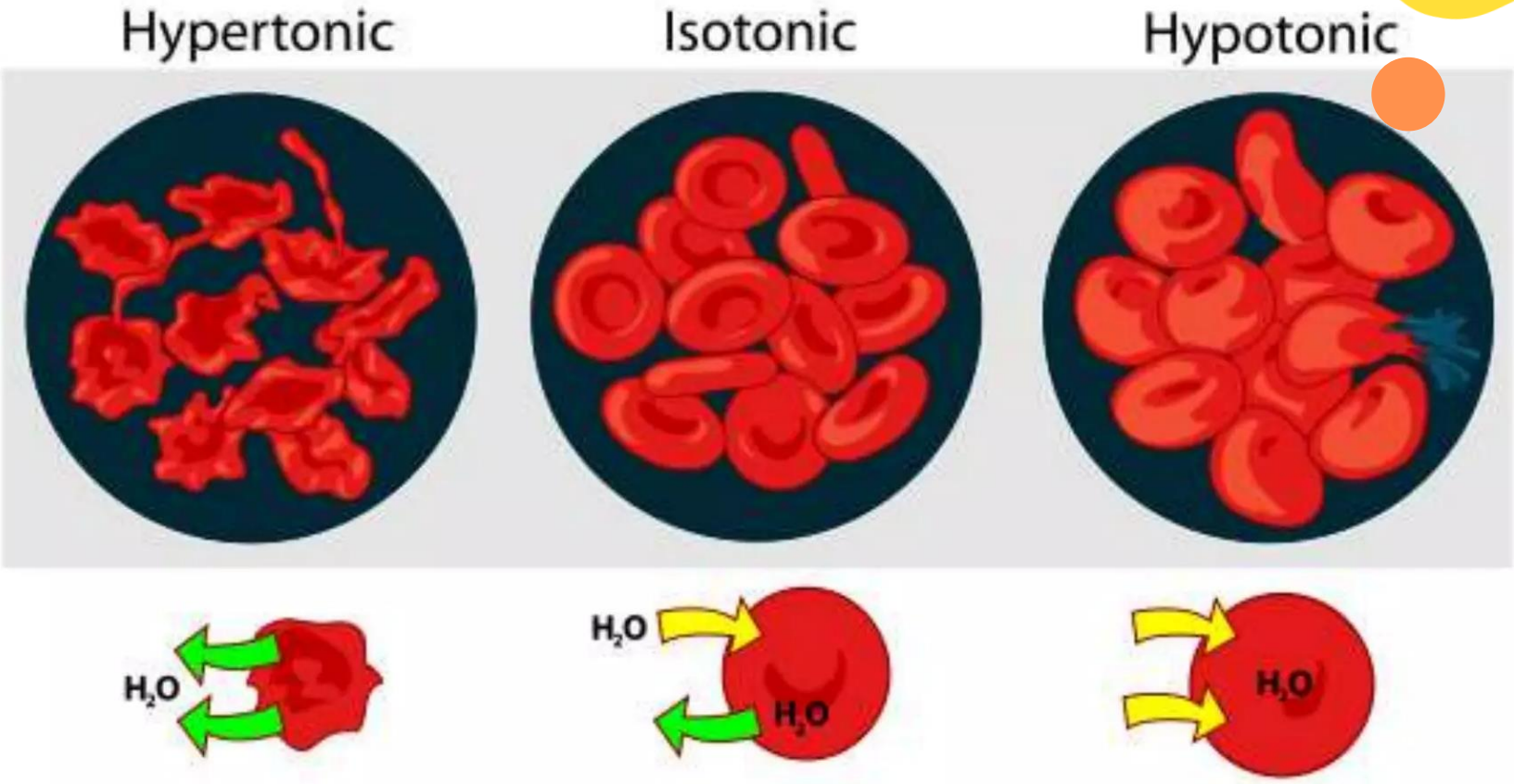
- *Osmosis is the movement of water molecules (solvent) through a selectively permeable membrane/ semipermeable membrane like the cell membrane.*
- Water diffuses across a membrane from an area of high concentration to an area of low concentration.

- Semi-permeable membrane is permeable to water, but not to the solute i.e.,sugar



- When two compartments of different solute concentrations are separated by a semipermeable membrane, the compartment with higher solute concentration is called **hypertonic** relative to the compartment of lower solute concentration, which is described as **hypotonic**.
- When the internal solute concentration equals the external solute concentration, it is said to be **isotonic**

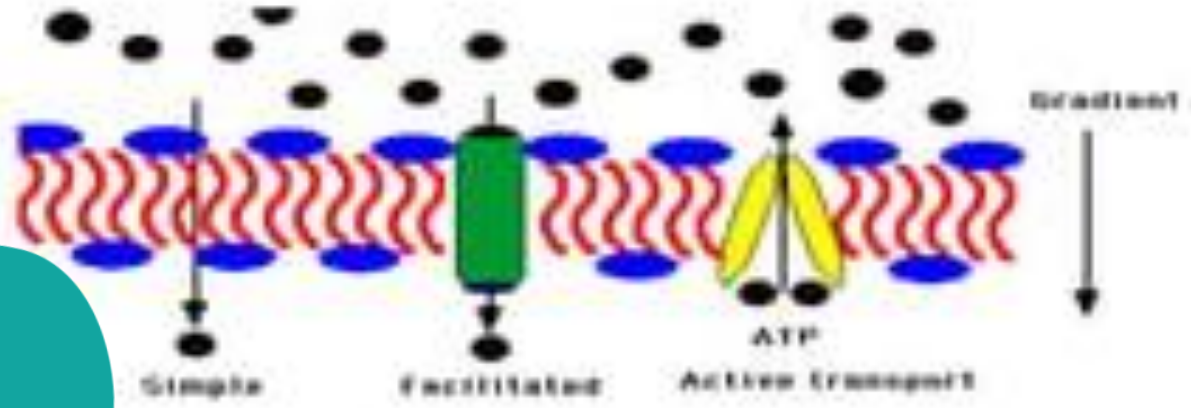




Interactive Red Blood Cell

Active Transport

- Molecules move **against** the concentration gradient (low to high)
- Energy must be provided
- Exhibit saturation kinetics

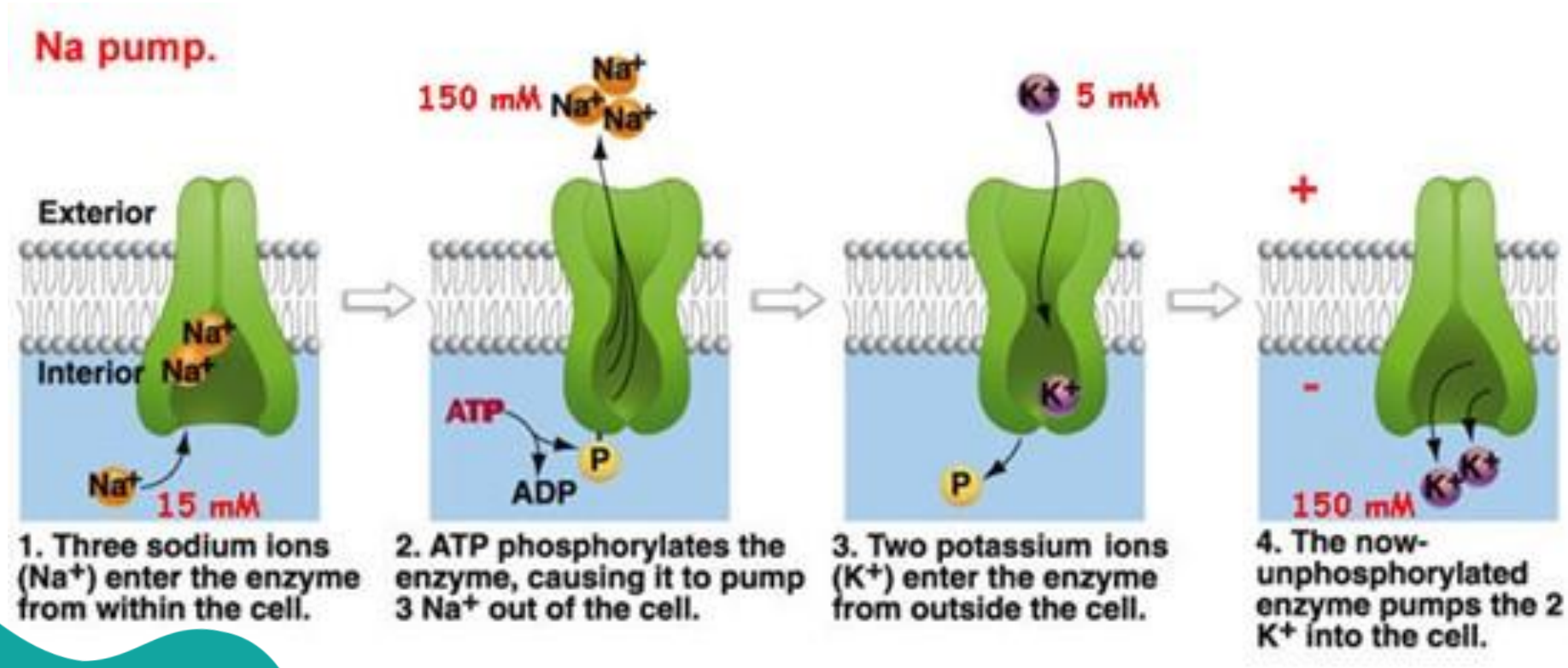


Active Transport

- Active transport is divided into two types according to the source of the energy used to cause the transport:

- 1. Primary active transport
- 2. Secondary active transport.

- **Primary Active Transport**
- Photon energy and redox energy are two sources of energy for primary active transport.
- Eg. Sodium Potassium pump



Secondary active transport

- Energy utilised in the transport of one substance helps in the movement of the other substance.

- Energy is derived secondarily, from energy that has been stored in the form of ionic concentration differences of secondary molecular or ionic substances between the two sides of a cell membrane, created originally by primary active transport.

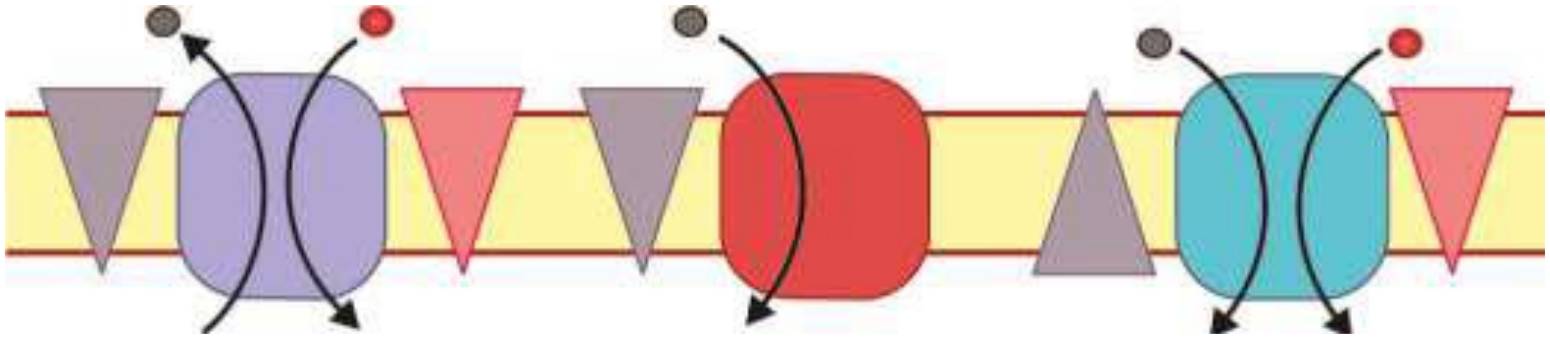
- It is also known as co-transport or coupled transport mechanism.
- **Antiport:** Carrier transporter transporting one substance for another.
- **Examples:** Na+ /Ca2+ exchanger is found in many cells and tissue in human body and helps in maintaining homeostasis.
- Influx of Na+ down its gradient into the cell and Ca2+ is efflux from the cell against its gradient.

Every 3 Na+ molecules(in) = Ca2+ (out)

- **Uniport:** Transport of a single substance by the carrier protein. ***Example:*** Transport of sodium or potassium ions through their respective channels.
- **Symport:** Unidirectional co-transport of two or moresubstance from one side of cell membrane to another.

Examples

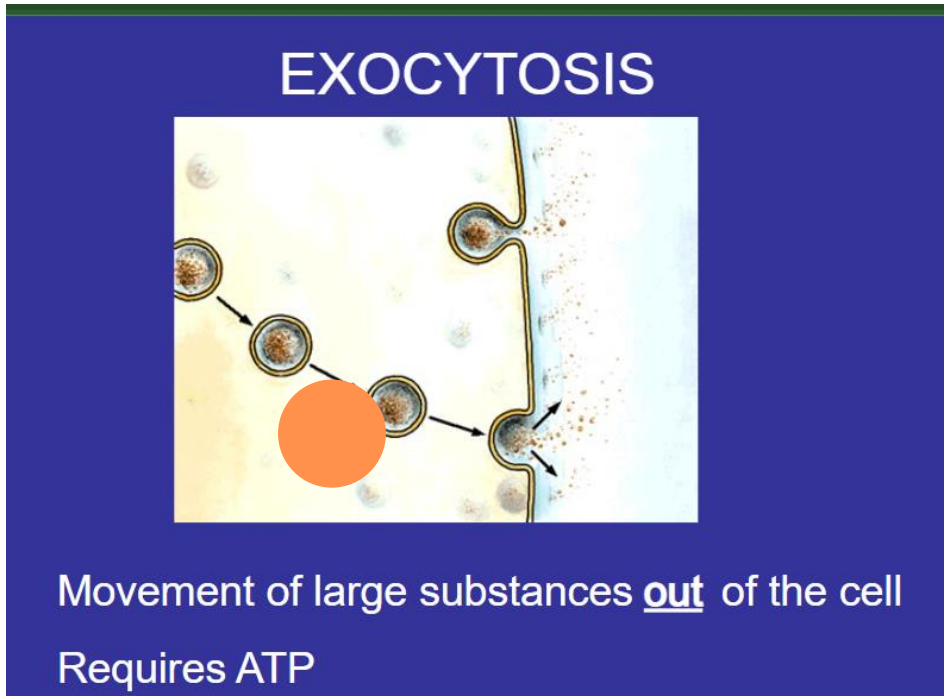
- Sodium glucose or sodium amino acid co-transport Na+/glucose co-transporter (SGLTl) is an electrogenic transporter favouring glucose, and galactose absorption in the small intestine and reabsorption of filtered glucose and galactose (SGLT2) in the proximal tubule of kidney nephrons.

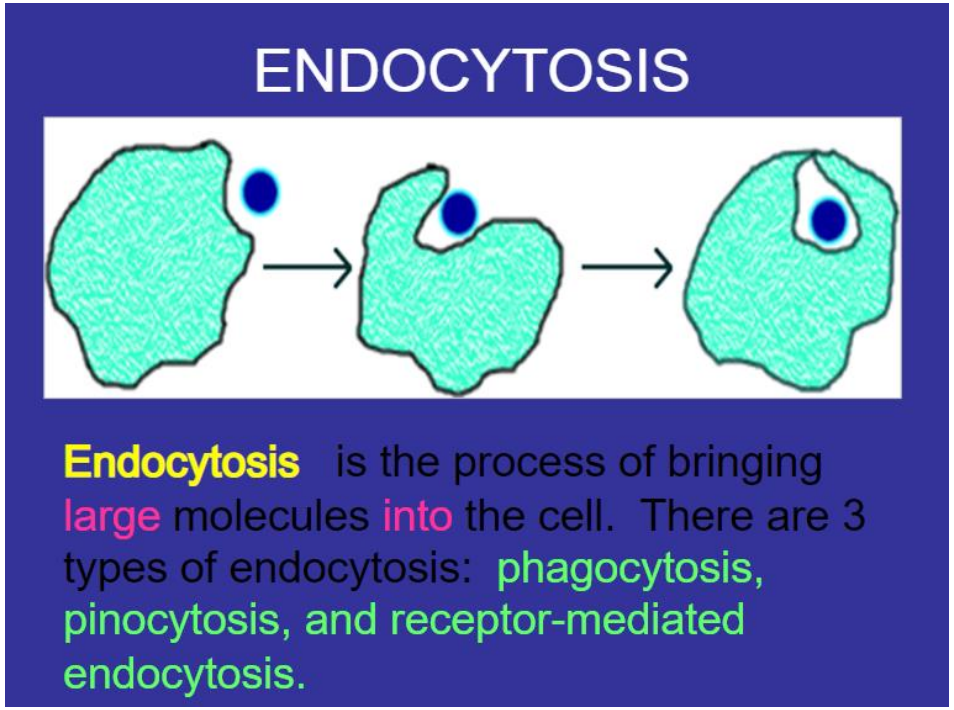


• Vesicular transport:

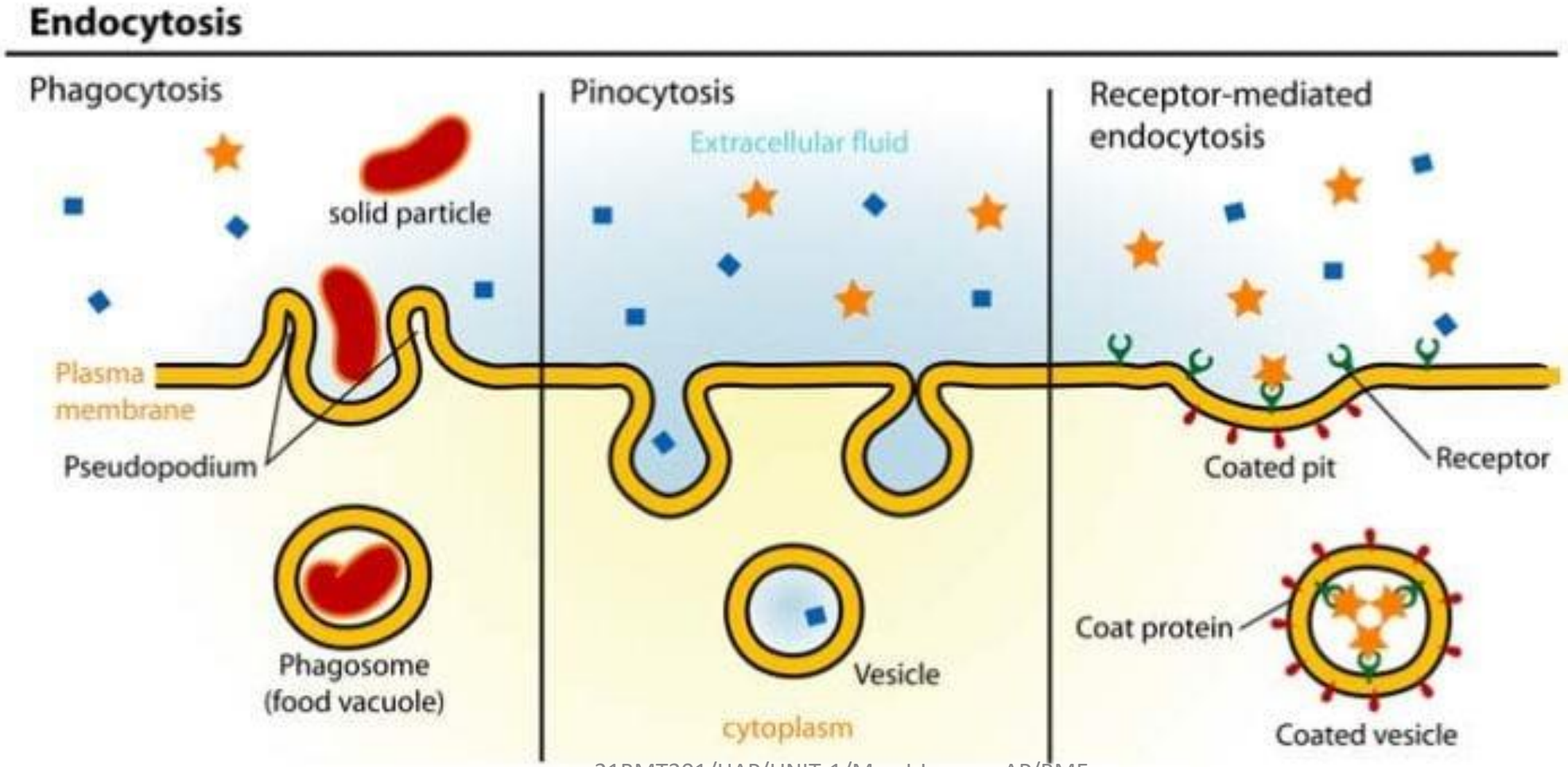
The materials move into or out of the cell by means of vesicles, also called bulk transport. The various mechanisms involved are:

- **Endocytosis**
- **Exocytosis**





- Phagocytes – Cell eating (engulf the invaders and digest it)
- Pinocytosis – moves liquid and smaller particles into the cell
- Receptor Medicated Endocytosis - The target molecules bind to receptor in cell membrane to move inside of the cell



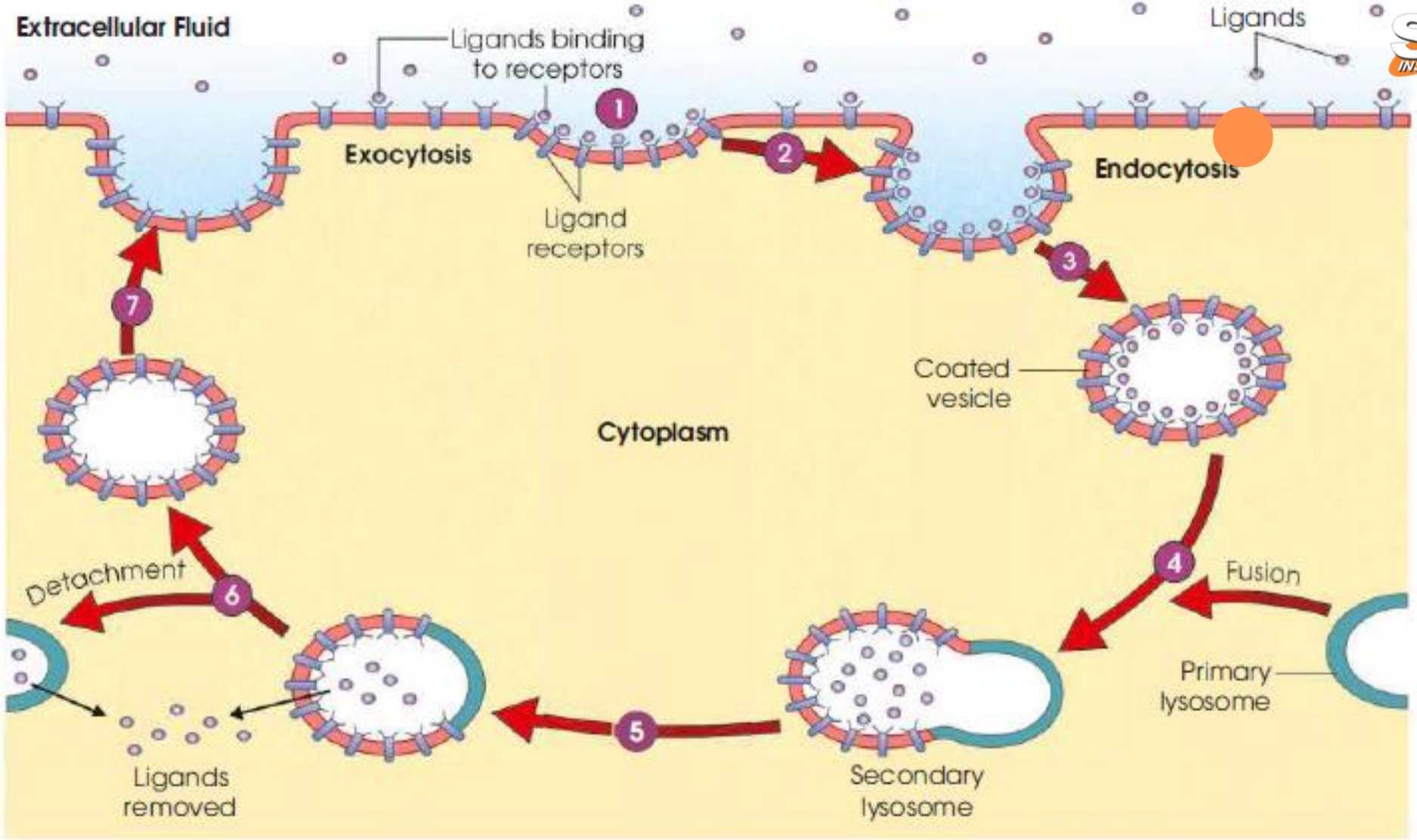


Fig. 3.11: Receptor-mediated endocytosis and exocytosis. 1. Ligand binding to receptors, 2. Area coated with ligands from pockets on membrane surface, 3. Pocket pinch to from endosomes, 4. Fusion of coated vesicles with lysosomes, 5. Removal of ligands, 6. Separation of lysosomal and endosomal membranes, 7. Fusing of endosome with cell membrane