Biological Membranes and Transport

Course instructor: Jibril H. Yusuf PhD.

E-mail: jibril.habib@tiu.edu.iq

Course: **General Biology I** (MA 101)

Fall Semester (2025)

Week 4

Date 11-01-2026

Outline

- Introduction to Biological membranes
- Importance of Biological membranes
- Structure of the Cell Membrane
- Types of Membrane Transport

Objectives

❖By the end of this lecture, students should be able to:

1. Define biological membranes and explain their importance.

2. Describe the structure of the cell membrane using the fluid mosaic model.

3. Identify the major components of biological membranes.

4. Differentiate between types of membrane transport mechanisms.

❑ Introduction to Biological membranes?

➢Are **thin**, **flexible barriers** that **surround cells** and their **internal organelles**. It have the thickness of **5-8nm**.

➢They separate the **internal environment** of the cell from the **external environment** and **control the movement of substances** into and out of the cell.

- **Examples:** Plasma membrane, Nuclear membrane, Mitochondrial membrane and Endoplasmic reticulum membrane

❑ Importance of Biological membranes:

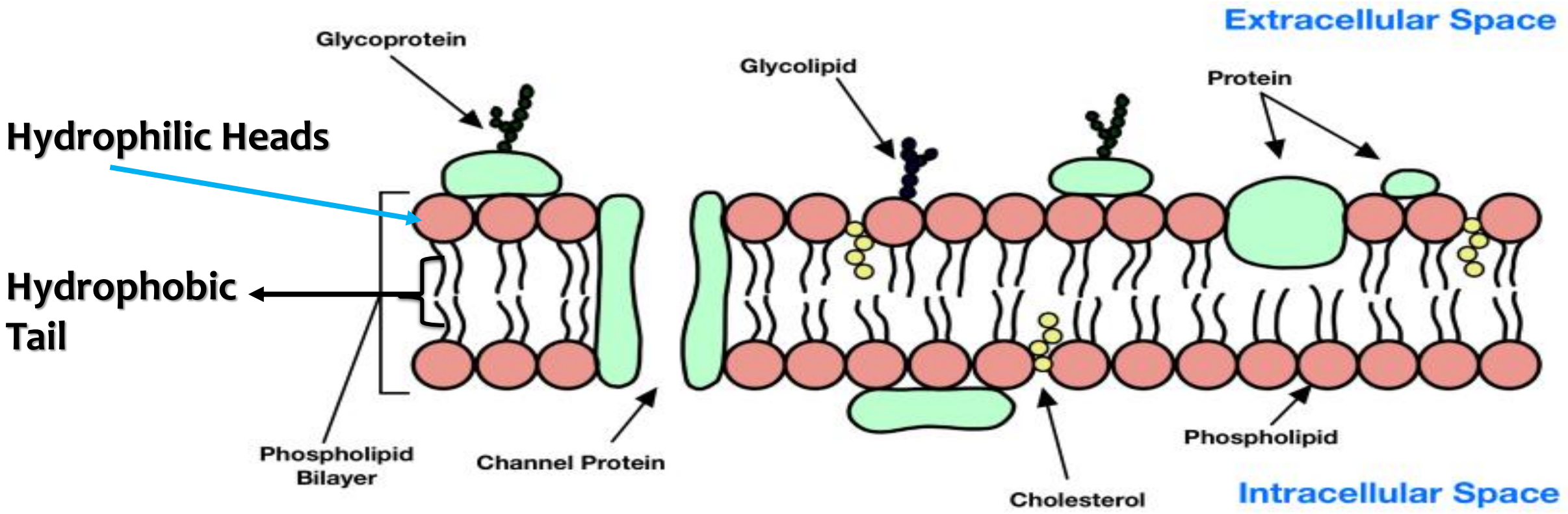
1) Protection of cellular contents.

2) Regulation of transport.

3) Cell communication and signaling.

4) Maintenance of homeostasis.

❖ Structure of the Cell Membrane (Plasma membrane):



❖ Structure of the Cell Membrane (Plasma membrane):

- Biological membranes consist of:

1. Phospholipid bilayer (selectively permeable).
2. Proteins (channels, carriers, pumps).
3. Carbohydrates (cell recognition, blood groups).
4. Cholesterol (membrane stability)

❖ Types of Membrane Transport:

- Membrane transport refers to the movement of substances across the biological (cell) membrane.

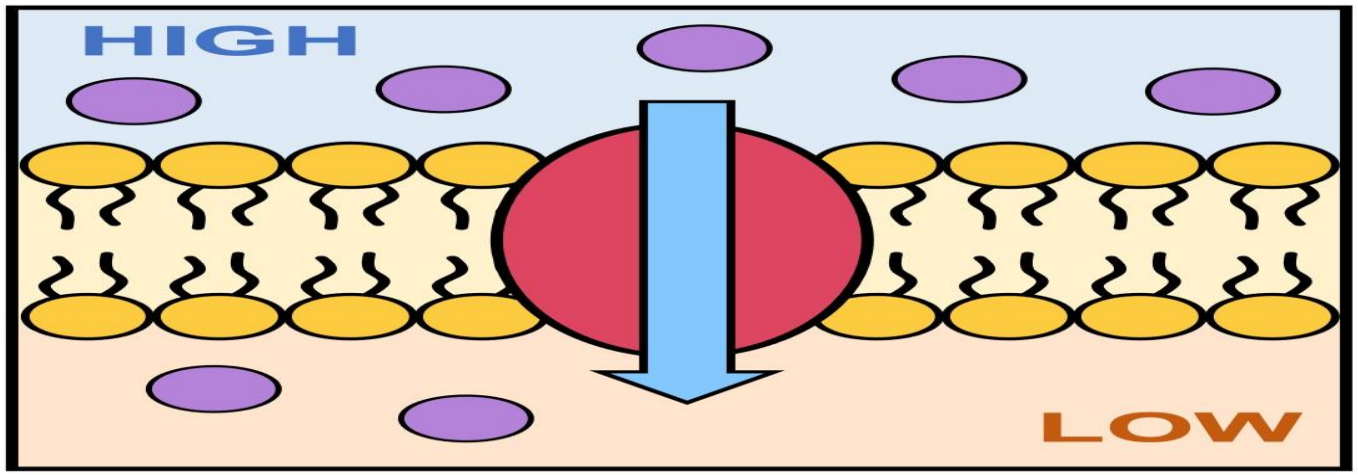
- Membrane transport is broadly classified into three main types:

1. Passive Transport (No energy required).
2. Active Transport (Energy required).
3. Vesicular (Bulk) Transport (Energy required).

❖ Passive Transport (No energy required):

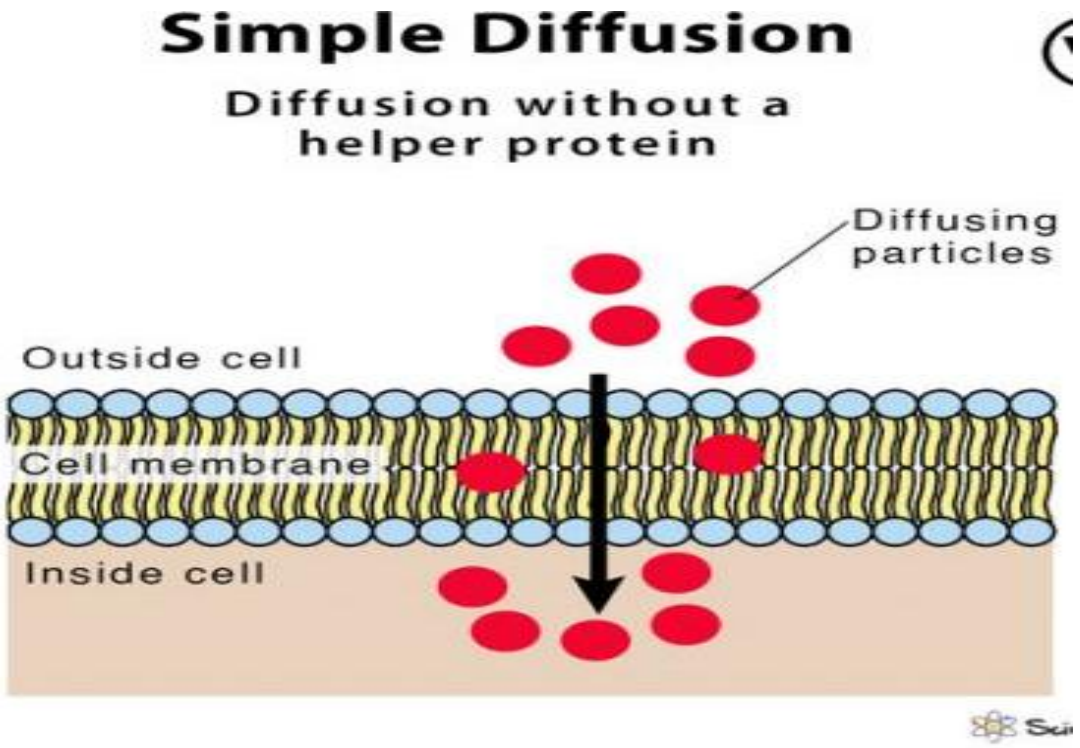
- Is the movement of substances across a biological membrane **without the use of cellular energy (ATP)**.

- Substances move **down their concentration gradient**, from an area of **higher concentration** to **lower concentration**, until **equilibrium is reached**.



❖ Main Types of Passive Transport:

1. Simple diffusion.
2. Facilitated Diffusion.
3. Osmosis.



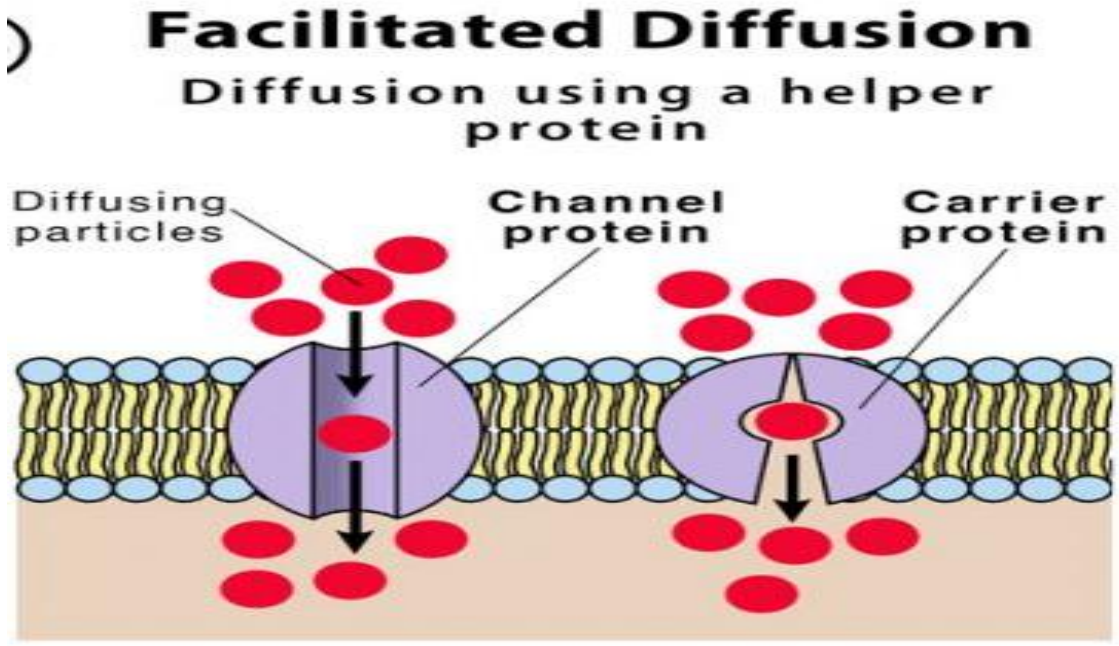
➢ Definition of Simple diffusion:

- Movement of small, nonpolar and lipid-soluble molecules directly through the phospholipid bilayer. Oxygen (O_2), Carbon dioxide (CO_2), Nitrogen (N_2), Steroid hormones, Fat-soluble vitamins.

➢Definition of Facilitated Diffusion:

- Movement of substances across the membrane through specific transport proteins, without energy use.

- Na^+, K^+, Glucose transporters, Amino acid transporters.



➢ Definition of Osmosis:

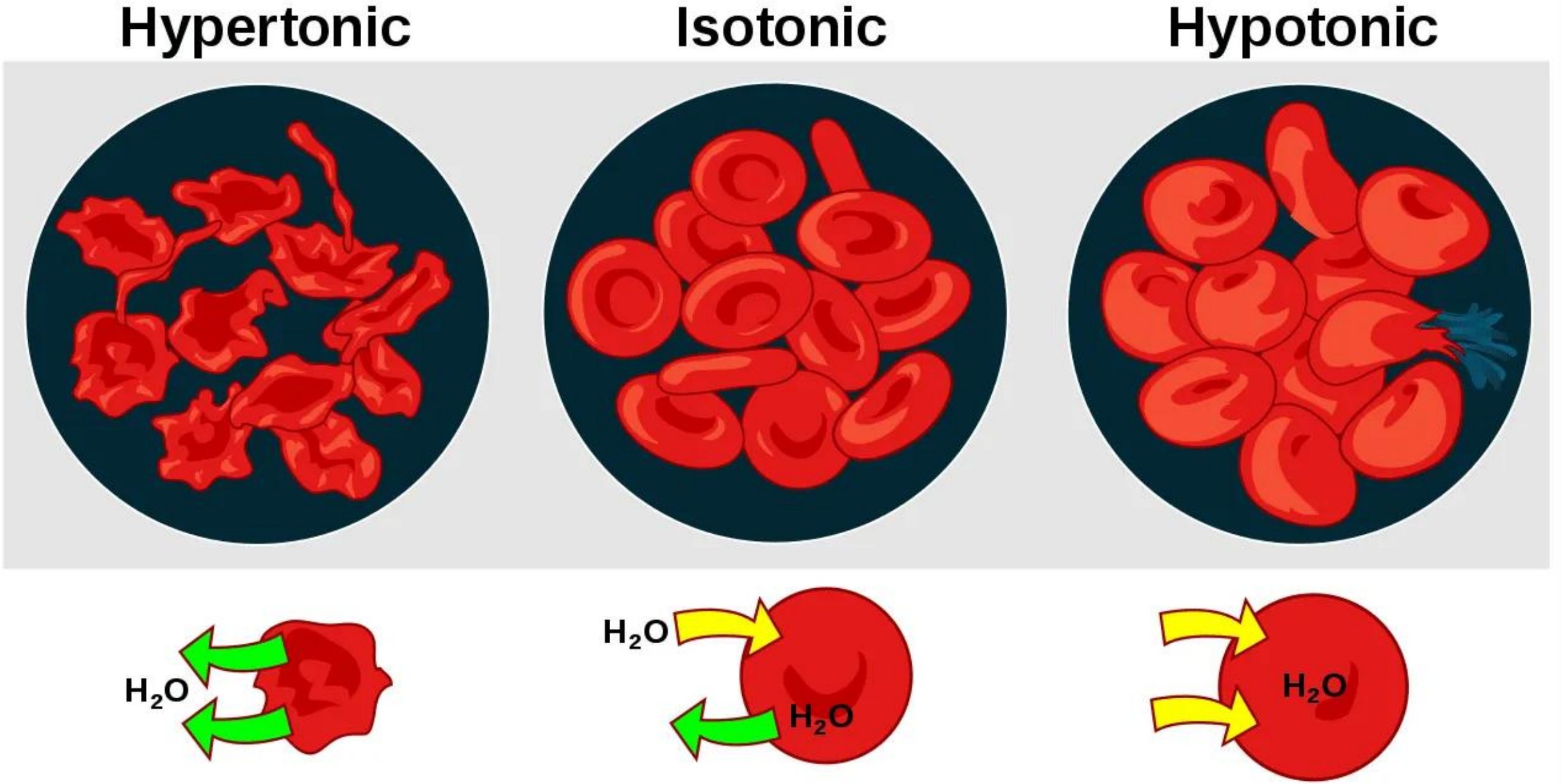
- Is the movement of water across a selectively permeable membrane from a region of **lower solute concentration** to **higher solute concentration**.

➢ Types of Solutions in Osmosis:

i. Isotonic Solution: No net water movement

ii. Hypotonic Solution: Water enters the cell

iii. Hypertonic Solution: Water leaves the cell


Hypertonic
Isotonic
Hypotonic
H_2O
H_2O
H_2O
H_2O
H_2O

❖ Active Transport:

- Active transport is the movement of substances **against their concentration gradient**, requiring **energy (ATP)** and specific **transport proteins**.

➢ Types of Active Transport:

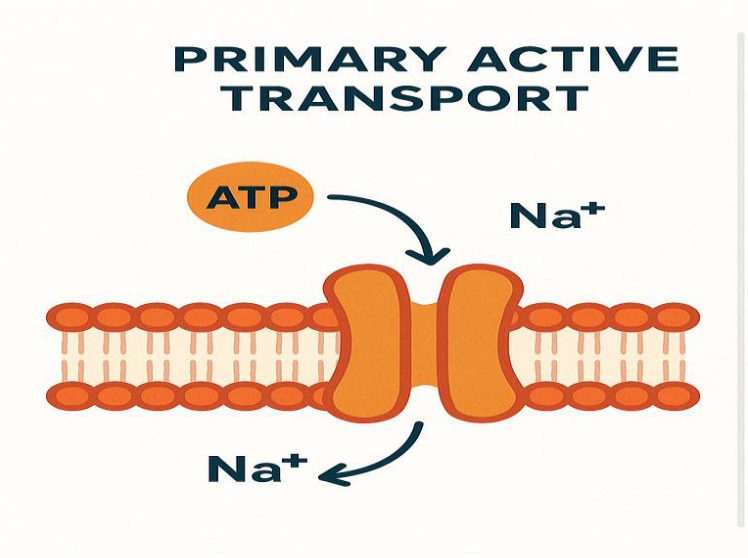
I. Primary Active Transport

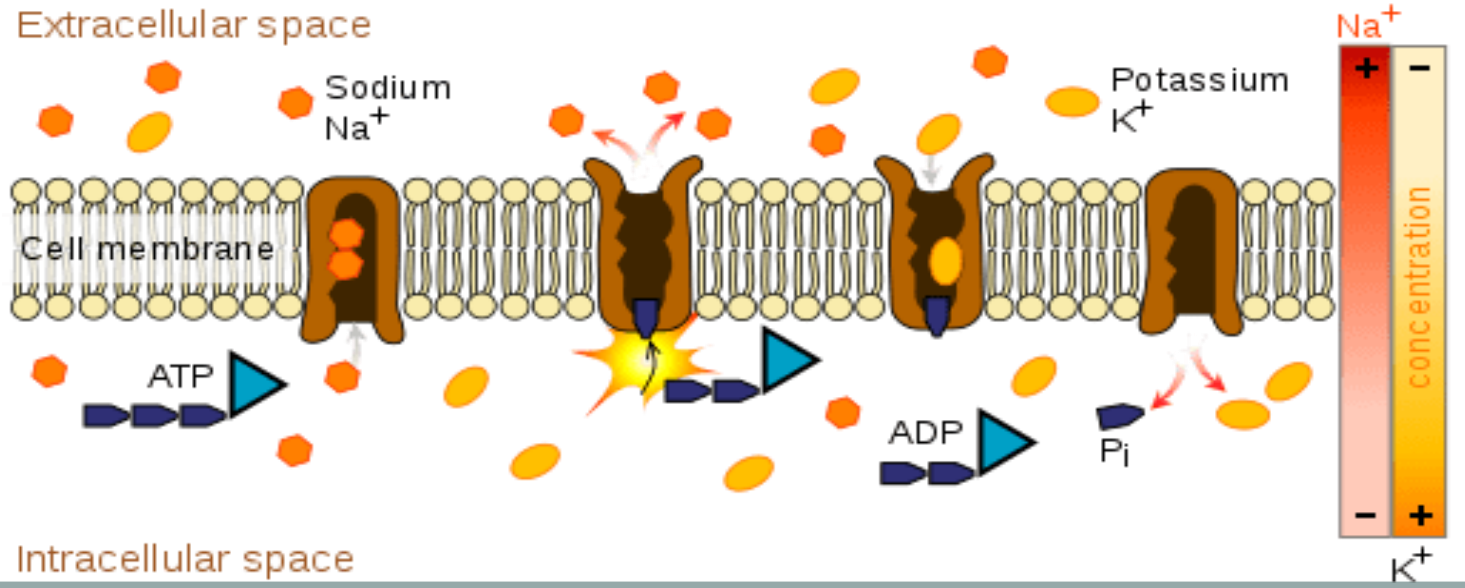
II. Secondary Active Transport

I. Primary Active Transport:

- Is a type of active transport in which energy is obtained directly from ATP hydrolysis to move substances against their gradient.

- Example: Na^+/K^+ ATPase, Ca^{2+} ATPase, H^+ ATPase

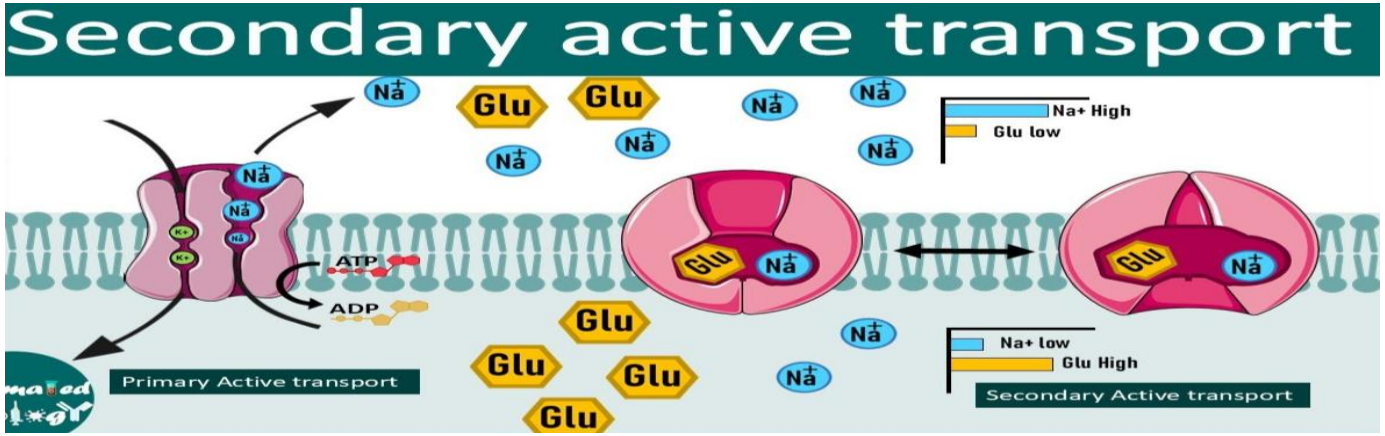


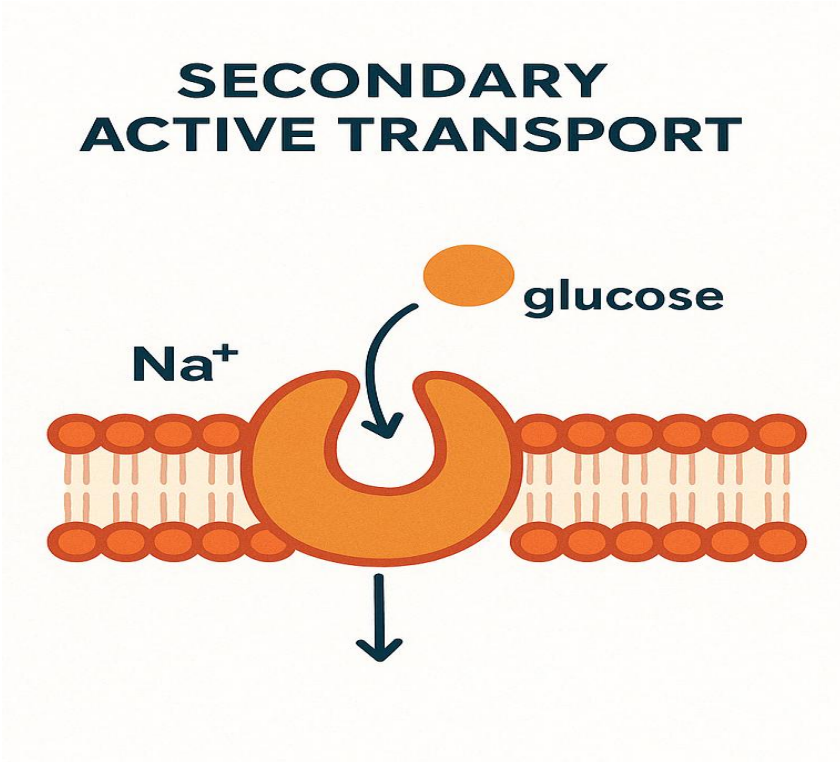


II. Secondary Active Transport:

- Is a type of active transport in which energy is obtained indirectly from ion gradients (created by primary active transport), not directly from ATP.

- Example: Na^+–glucose symporter





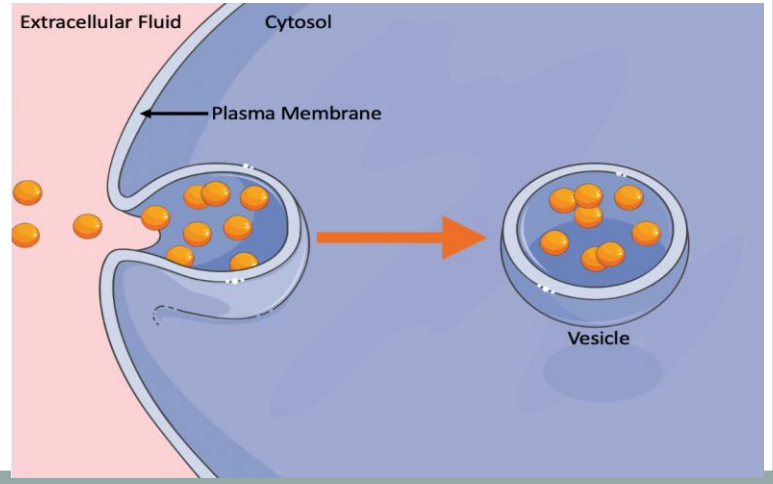
❖ Differences Between Primary and Secondary Active Transport:

Feature	Primary Active Transport	Secondary Active Transport
Energy source	Direct ATP hydrolysis	Ion gradient
ATP use	Direct	Indirect
Protein type	Pumps (ATPases)	Co-transporters
Example	Na^+/K^+ pump	Na^+–glucose symporter
Main role	Establish gradients	Use gradients

❖ Vesicular (Bulk) Transport:

- Vesicular transport, also called **bulk transport**, is the movement of **large particles**, **macromolecules**, and **large volumes of fluid** into or out of the cell using **membrane-bound vesicles**.

- This process requires energy (ATP) and is essential for **nutrition**, **secretion**, **immune defense**, and **cell communication**.

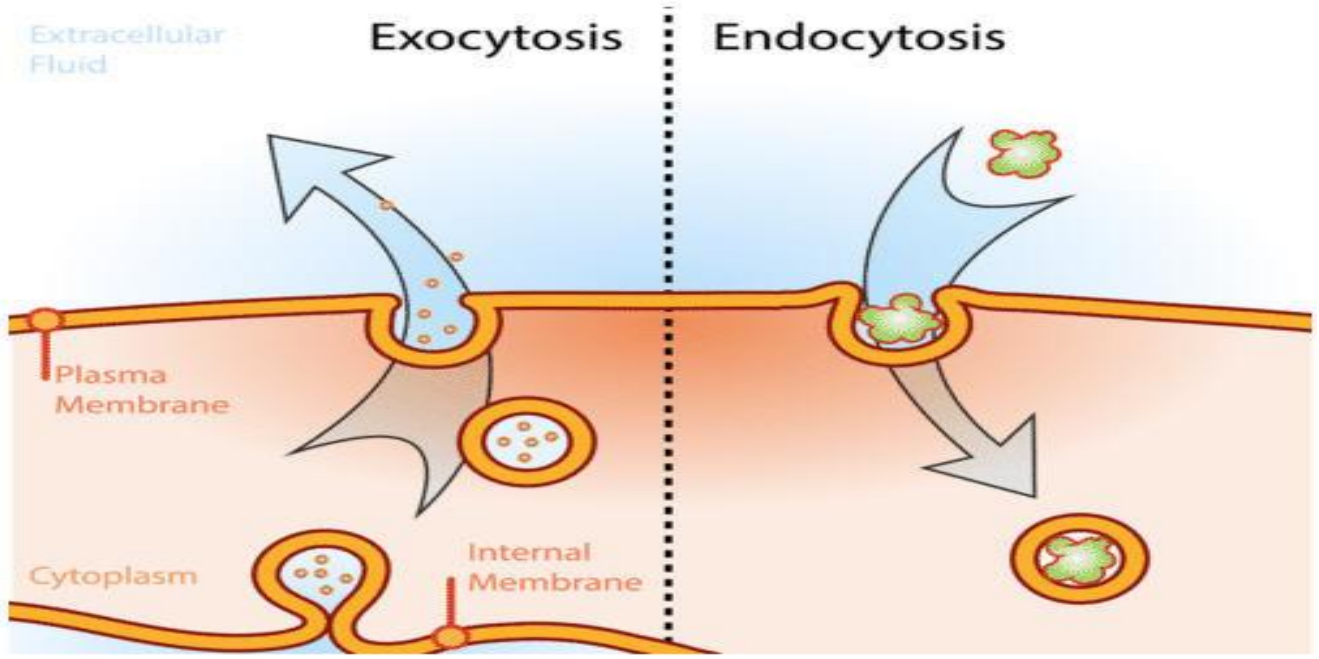


❖ Types of Vesicular Transport:

- Vesicular transport occurs in two main directions:

1. Endocytosis (Movement into the cell)

2. Exocytosis (Movement out of the cell)



References

1. Campbell, N.A. et al. (2020). Biology (12th ed.). Pearson Education.
2. Mader, S.S. (2022). Biology (14th ed.). McGraw-Hill Education.
3. Raven, P.H., Johnson, G.B. et al. (2021). Biology (12th ed.). McGraw-Hill
4. Principles of Biology

Thanks