

# Cell Membrane



Cell Biology

Semester 1, Year 1

**Dr . Amira Osman**

Associate professor of Human histology & Cell Biology

**By the end of the lecture  
the student will be able to:**

## **Intended Learning Outcomes (ILOs)**

Recognize the molecular structure of the cell membrane

Recognize the different ways of transport across membranes

Discuss simple diffusion

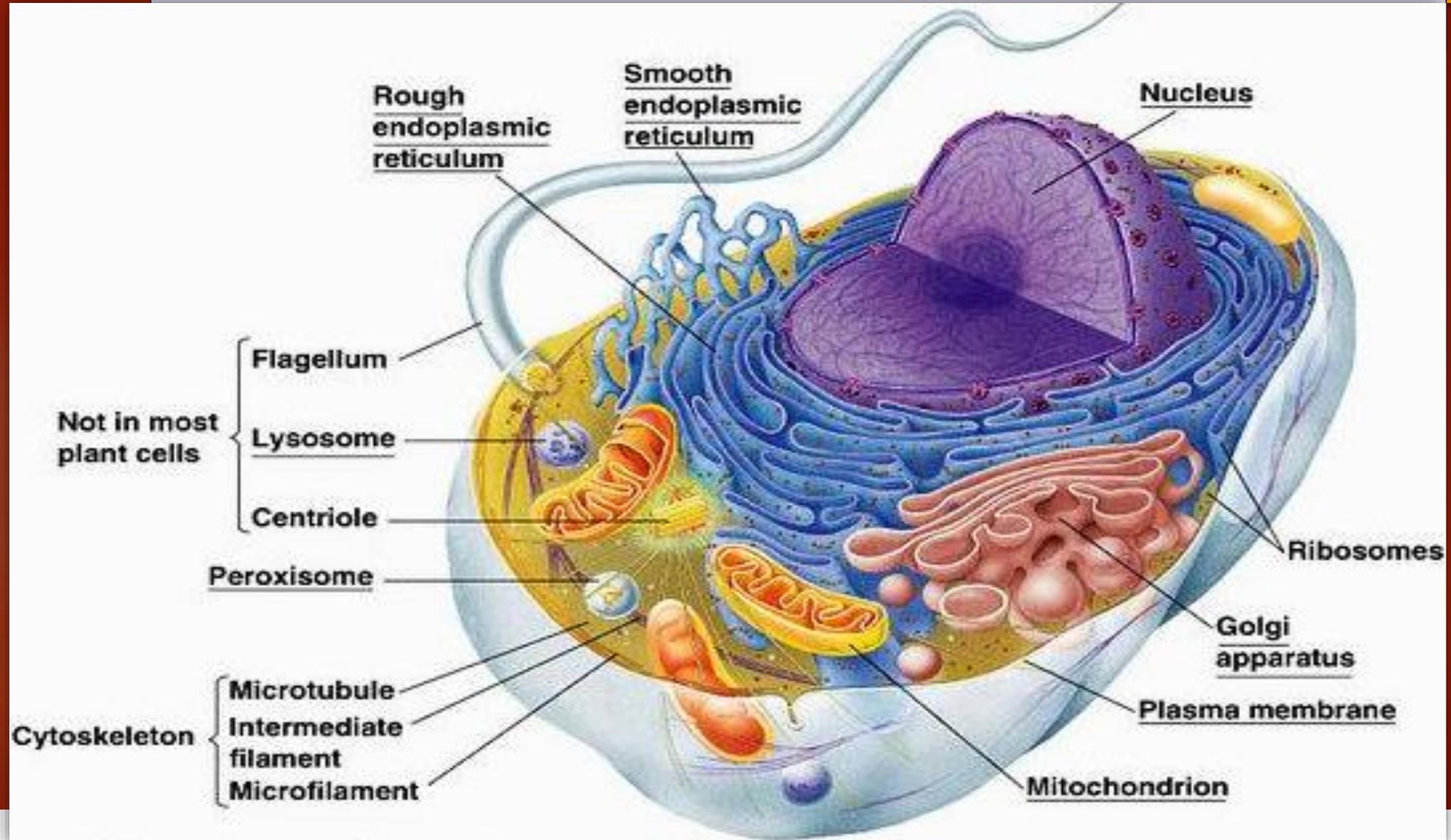
Discuss facilitated diffusion

Discuss osmosis

Recognize mechanisms of active transport

Recognize mechanisms of vesicular transport

# NUMBER OF CELLS ???



# THE CELL

**Structural & functional unit of the body**

**Cell Membrane**

**Cytoplasm**

**Nucleus**

**Organelles**

**Inclusions**

**Matrix**

<b>Cell Organelles</b>	<b>Cell Inclusions</b>
<b>Living components</b>	<b>Nonliving materials</b>
<b>Essential for the life of the cell</b>	<b>Usually not essential</b>
<b>Every organelle performs a special metabolic function</b>	<b>Do not carry out any specific metabolic function</b>
<b>They are permanent structures</b>	<b>May be permanent or temporary</b>

# Cytoplasmic matrix

**Water**

**70%**

**Inorganic  
ions**

**Na**

**K**

**Ca**

**Organic  
molecules**

**Carbohydrates**

**Lipids**

**Proteins**

**RNAs**

# Organelles

## Membranous

**Contain enzymes**

Mitochondria  
rER  
sER  
Golgi apparatus  
Lysosomes  
Peroxisomes

## Non-membranous

**Do not contain enzymes**

Ribosomes  
Centrioles  
Microfilament  
Microtubules  
Cilia  
Flagella

# CELL MEMBRANE

## Definition:

The **outer limiting** membrane which **surrounds** the cell and **regulates the passage** of materials into or out of the cell.

(plasma-membrane or plasmalemma)

## LM:

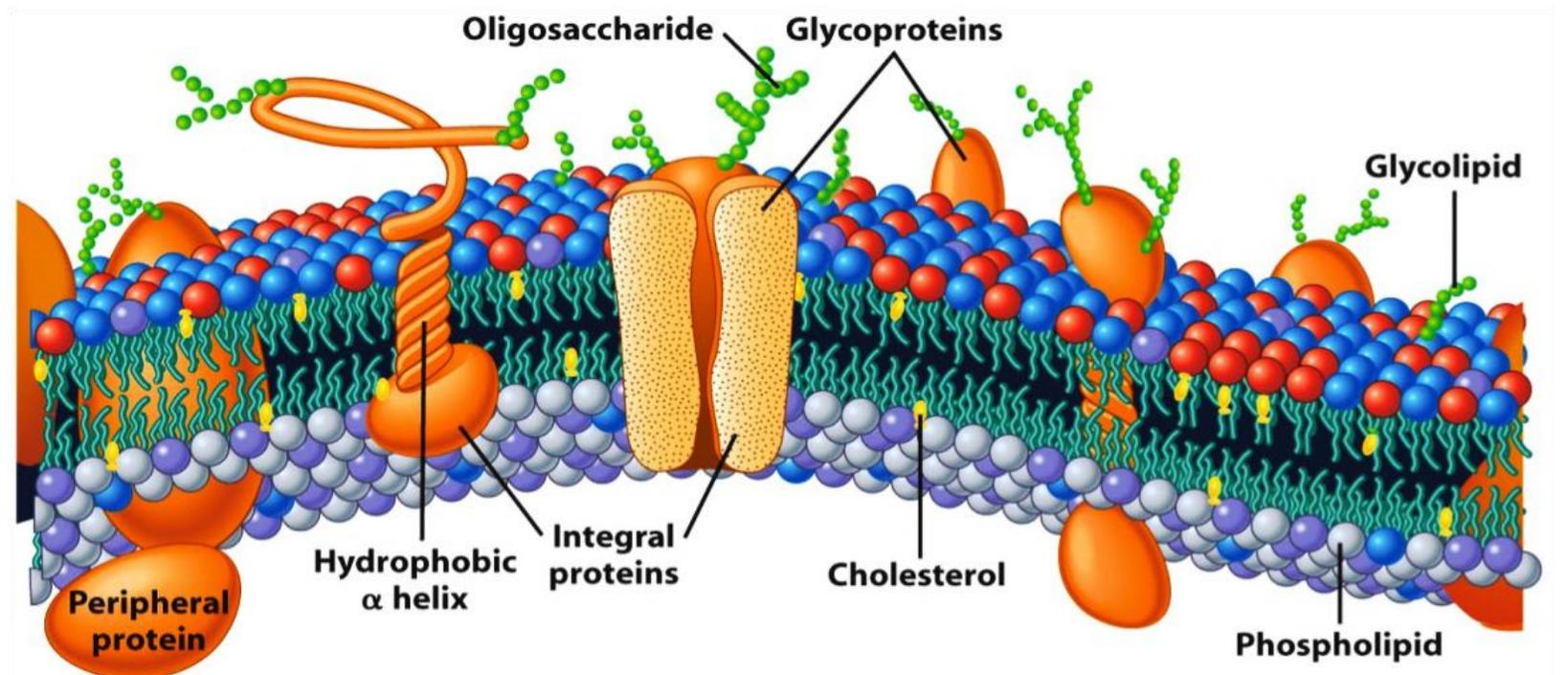
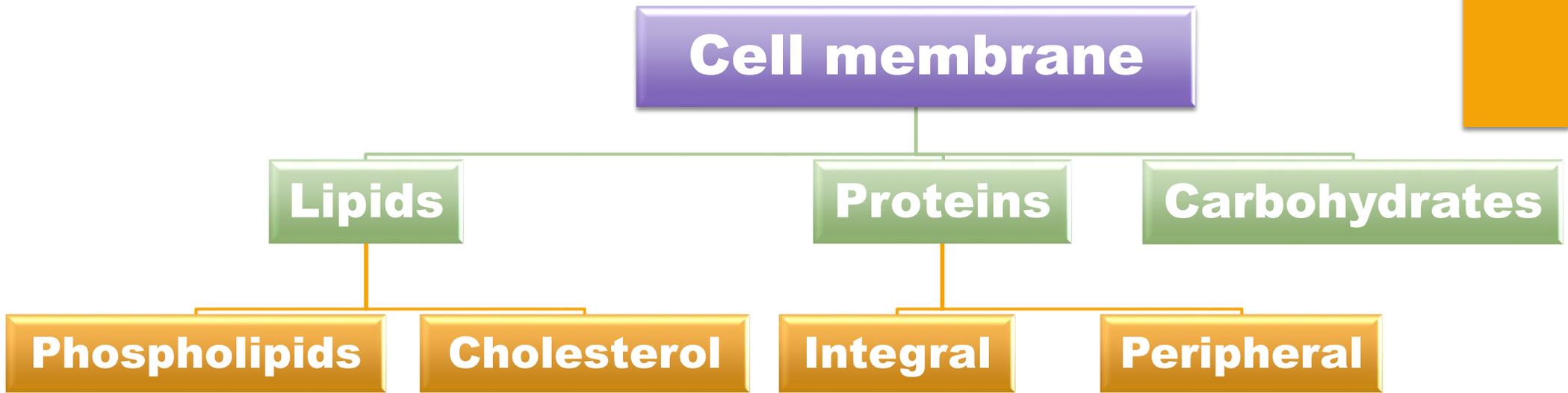
- **Very thin** to be resolved.
- Needs special stain e.g., **PAS** & silver

# CELL MEMBRANE

## EM:

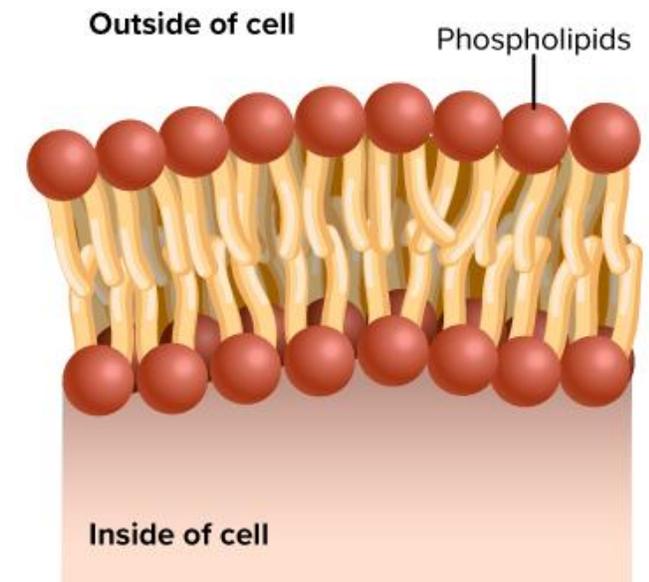
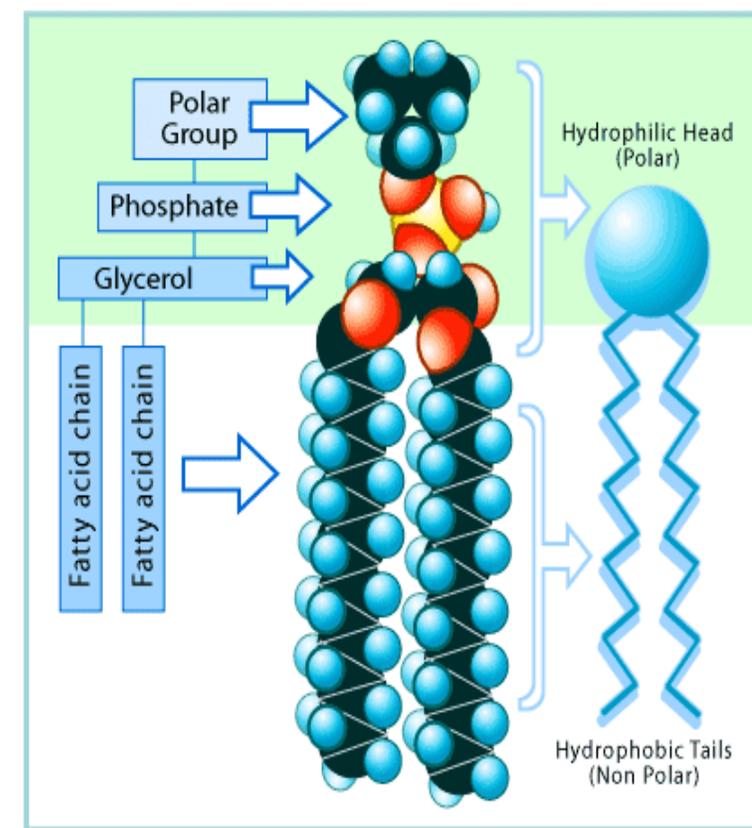
- 8–10 nm.
- **Trilamellar**; outer & inner dark (**electron dense**) layers and a middle light (**electron lucent**) one.
- This appearance is also called **unit** membrane.





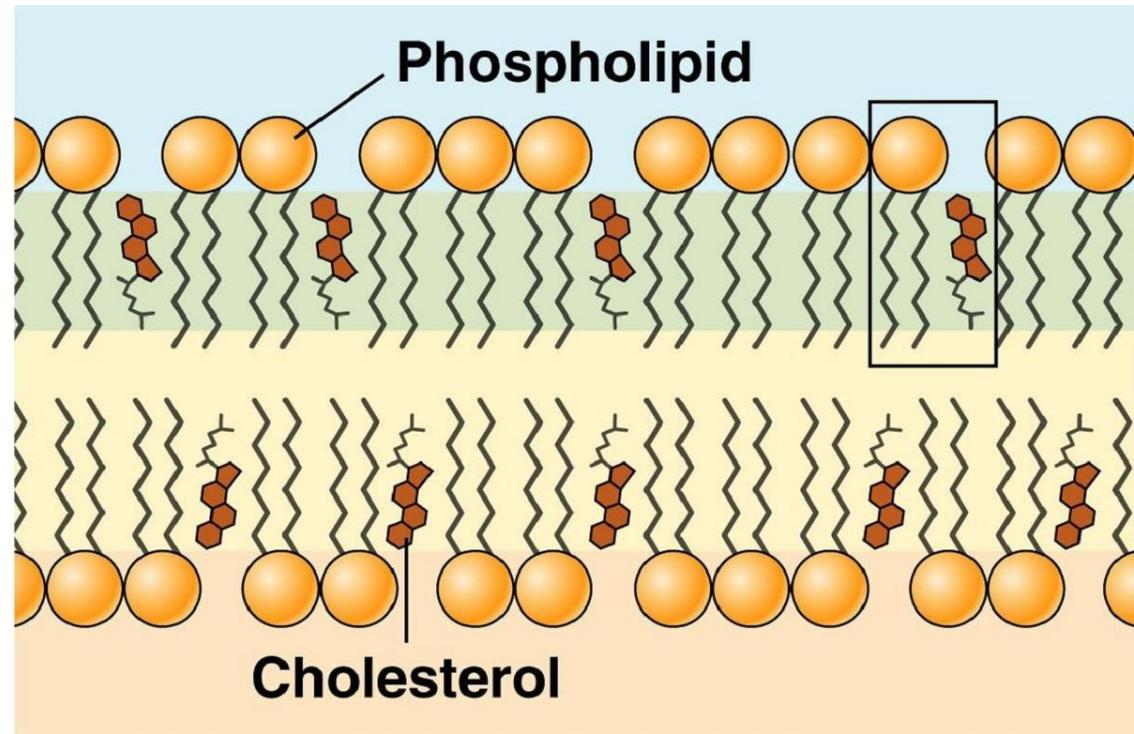
# Phospholipids bilayer:

- Each molecule consists of two long **non-polar hydrophobic** fatty acid chains (**tail**) and a **charged hydrophilic** phosphate part (**head**).
- Arranged into a double layer (**bilayer**) with their **tails** directed toward the **center** of the membrane (away from water) and their **heads** directed **outwards** (contacting the water).



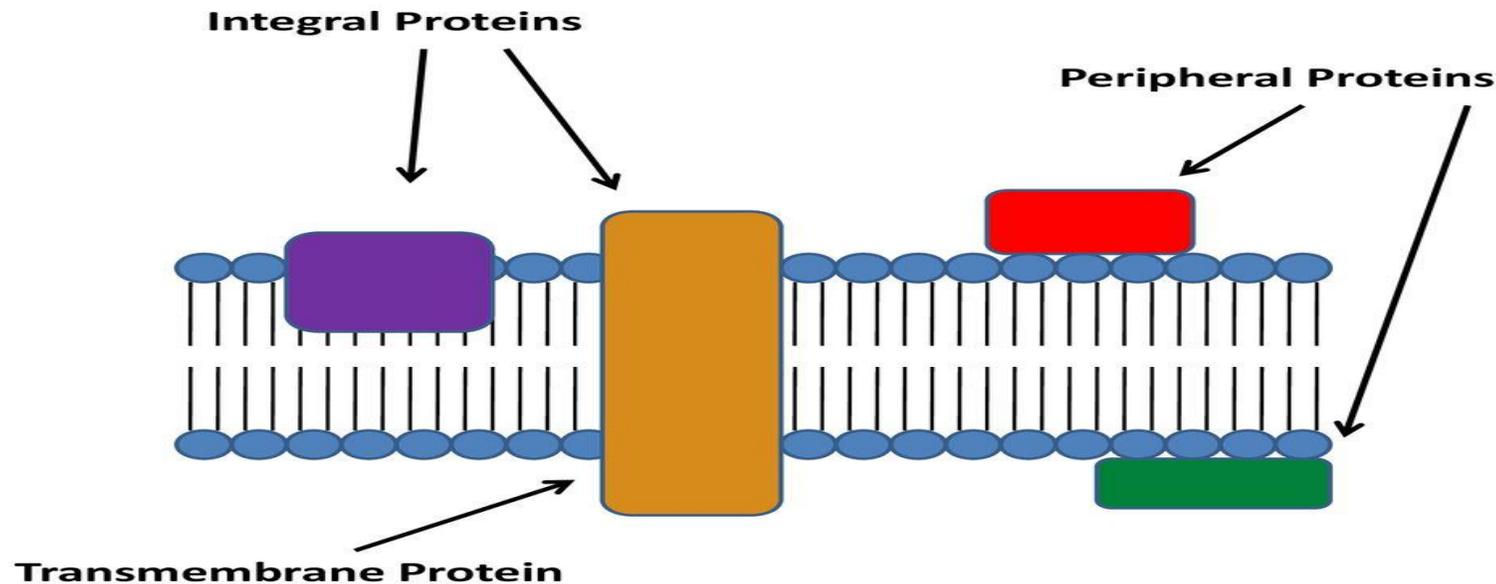
# Cholesterol.

Cholesterol molecules are present in **both leaflets** at varying densities among the closely-packed phospholipid fatty acids, **restricting their movements and modulating the fluidity** of all membrane components.



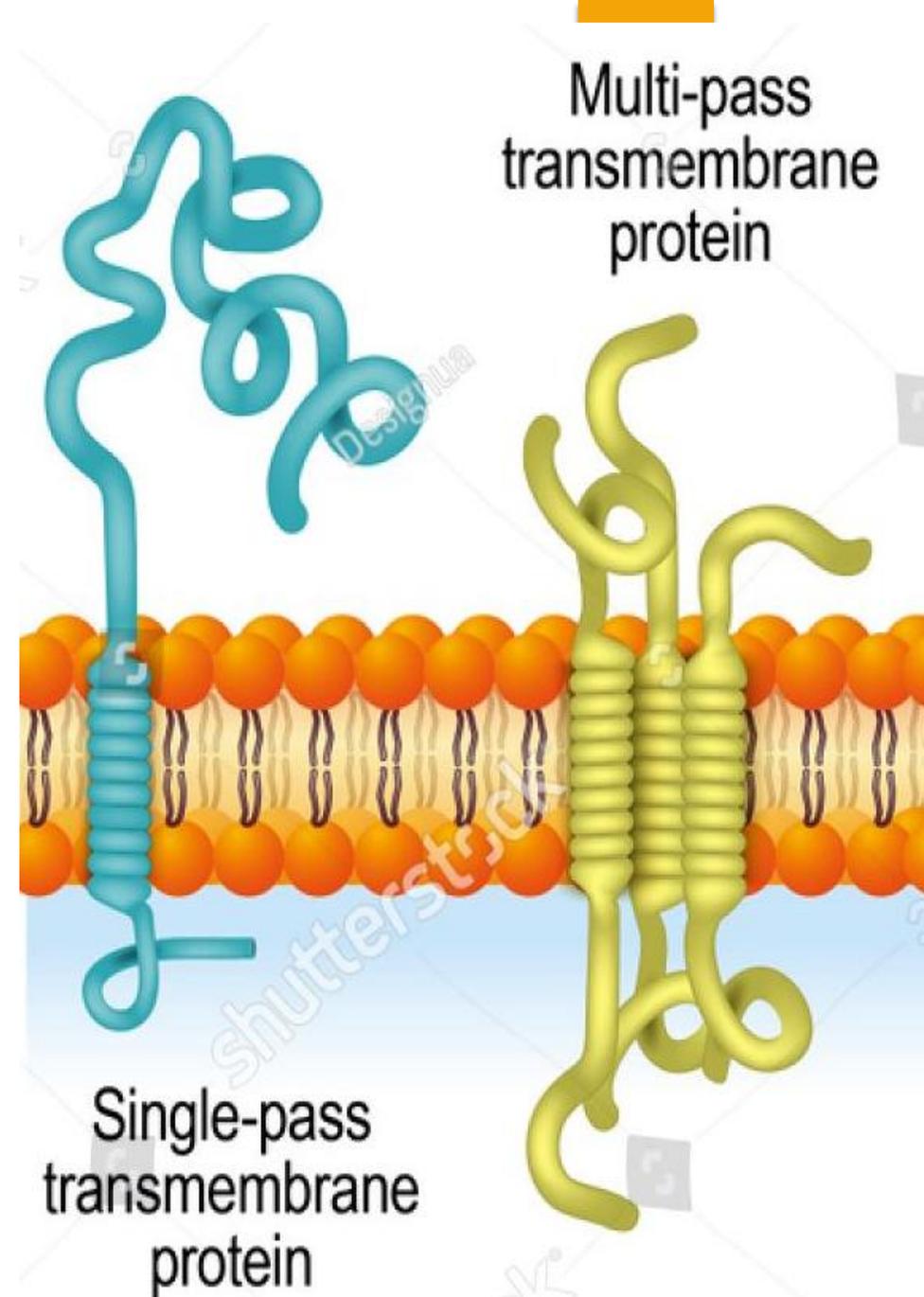
# Membrane proteins:

Integral proteins	Peripheral proteins
Incorporated within the lipid bilayer	Bound to one of the two membrane surfaces
Can be extracted only by using detergents	Can be extracted from cell membranes with salt solutions



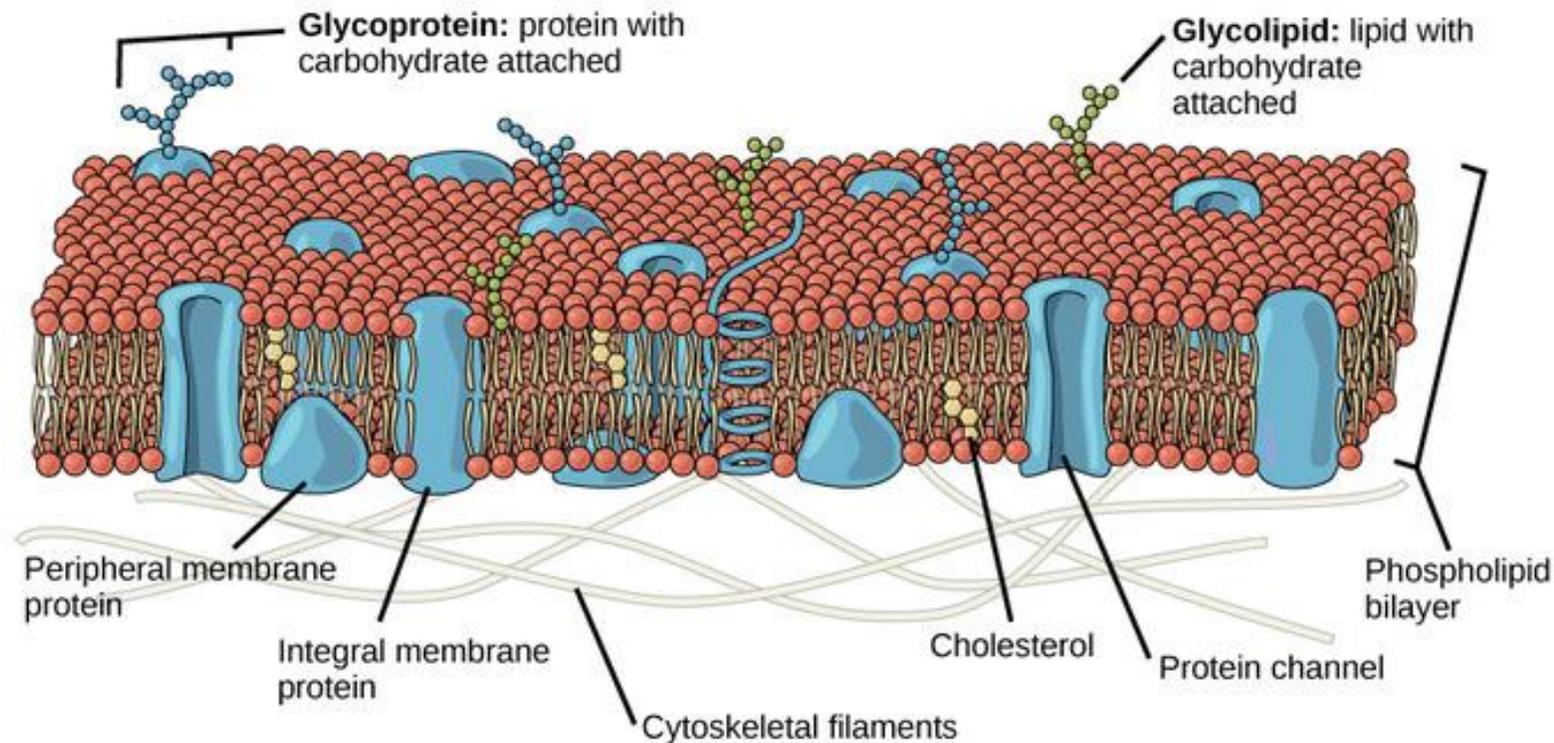
## Integral proteins:

- Proteins which span the entire cell membrane are called “**transmembrane proteins**”.
- Transmembrane proteins inserted once through the membrane are called “**single-pass transmembrane proteins**” while those that pass through several times are called “**multipass transmembrane proteins**”



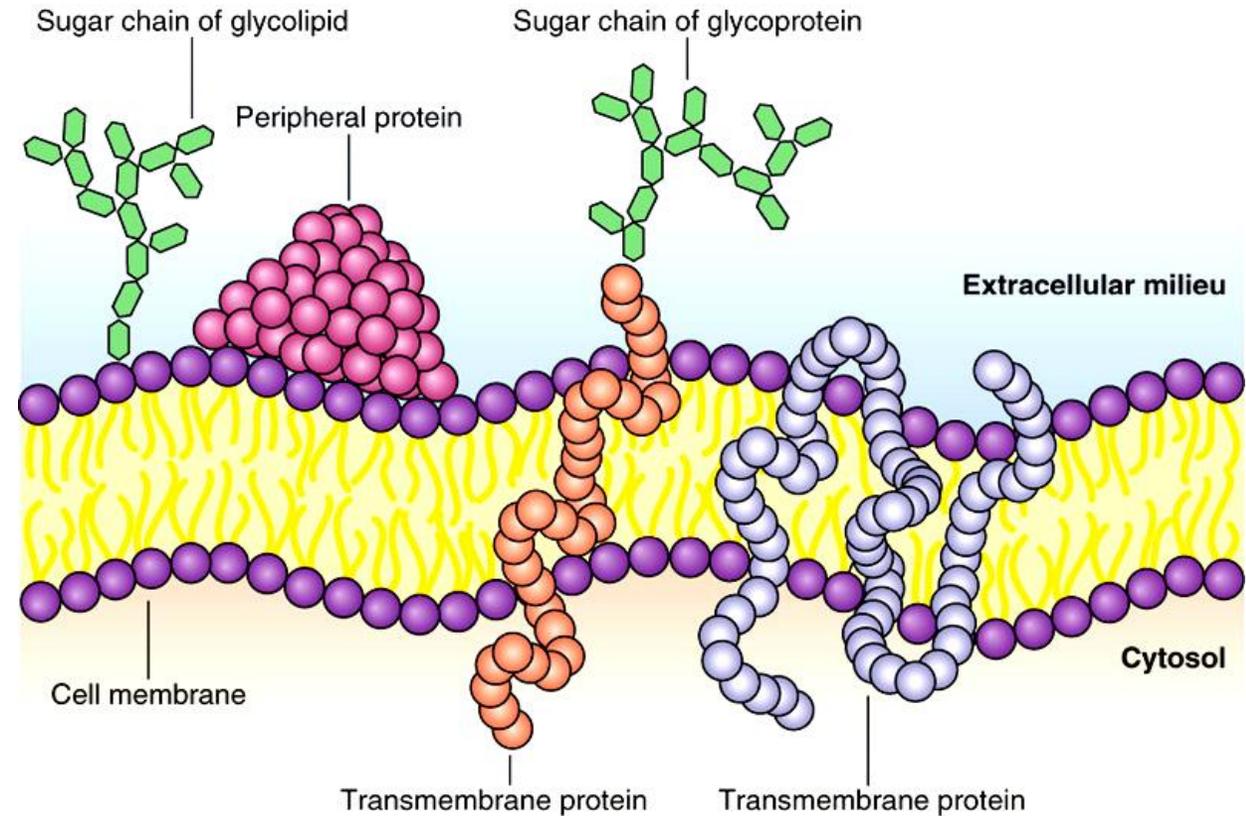
# Fluid mosaic model

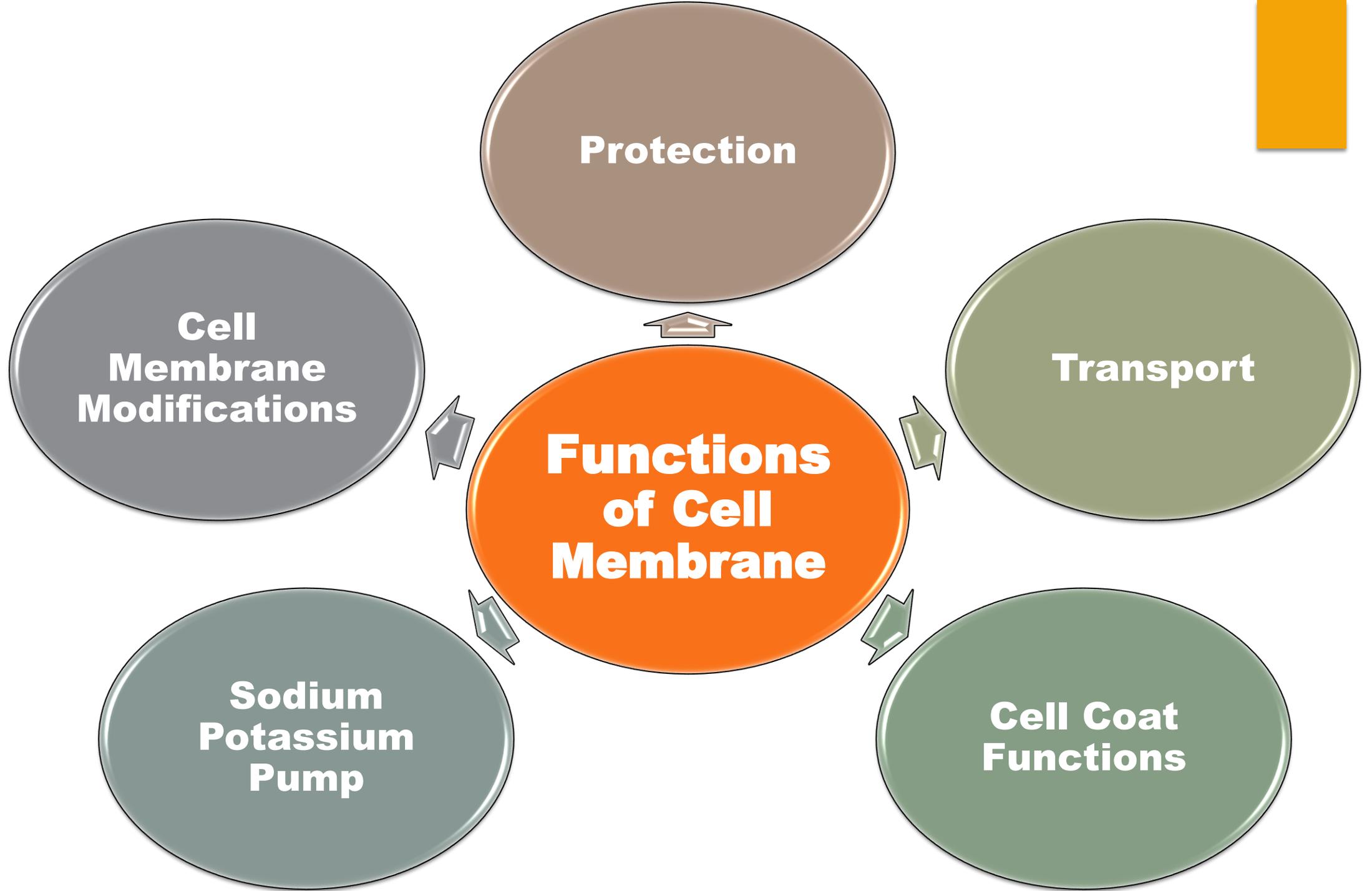
It is proposed recently that **lipids** are present in the **fluid** phase at body temperature, while **proteins** are **globular** in shape and are **floating** and **drifting** globules on the surface of lipid like floating iceberg in the sea



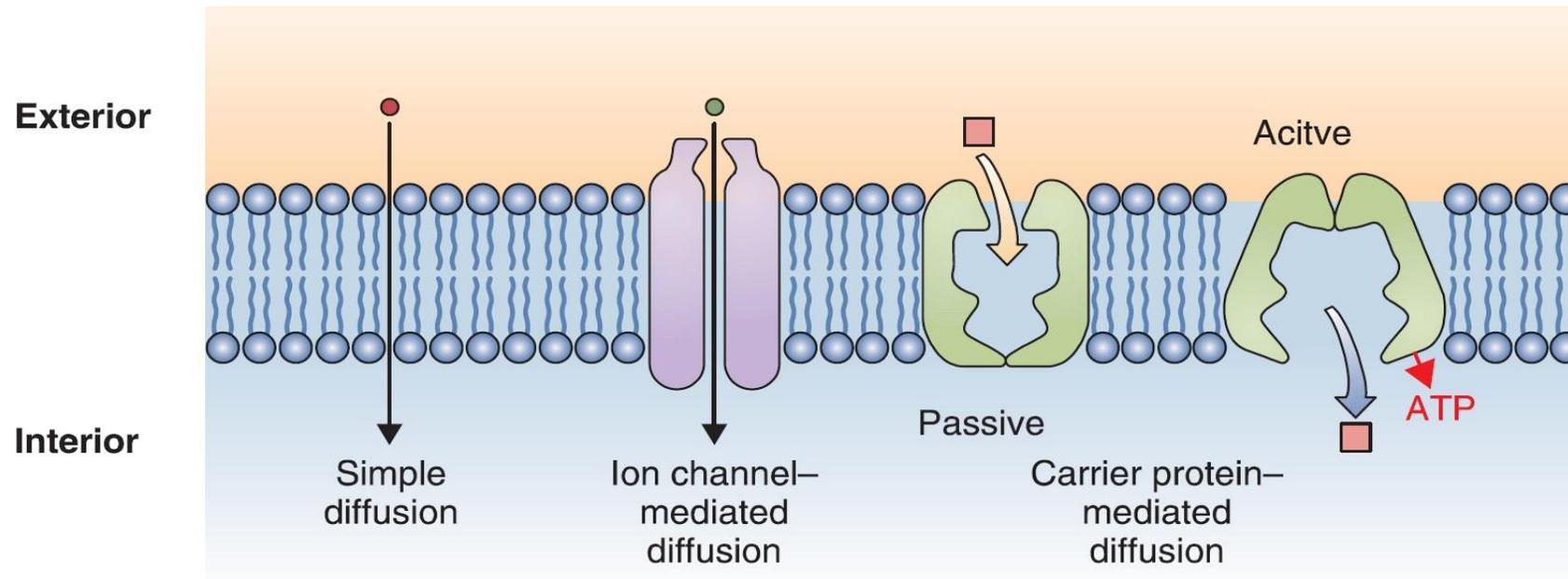
# Carbohydrates:

- Either attach to proteins to form “**glycoproteins**” or to lipids to form “**glycolipids**”
- Both are present only on **external surface** of cell membrane to form the cell coat (**glycocalyx**)

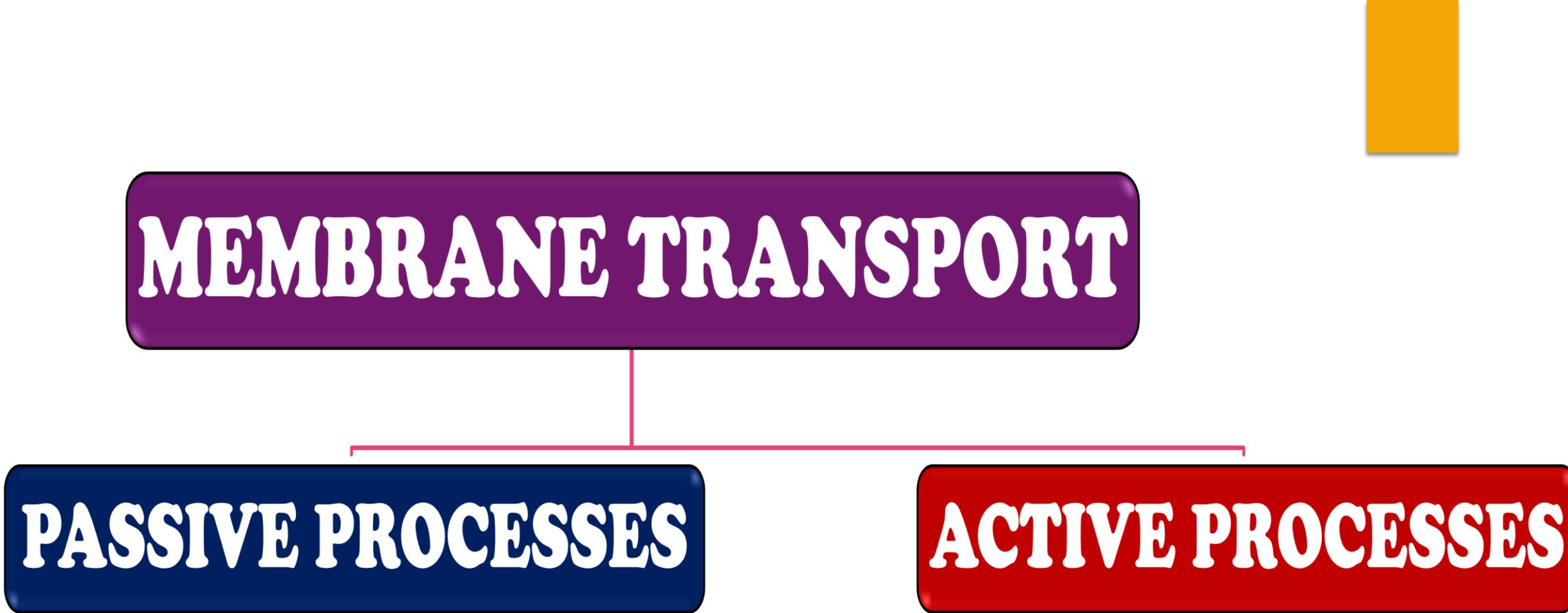




The plasma membrane is the site where materials are exchanged between the cell and its environment.



# MEMBRANE TRANSPORT



**PASSIVE PROCESSES**

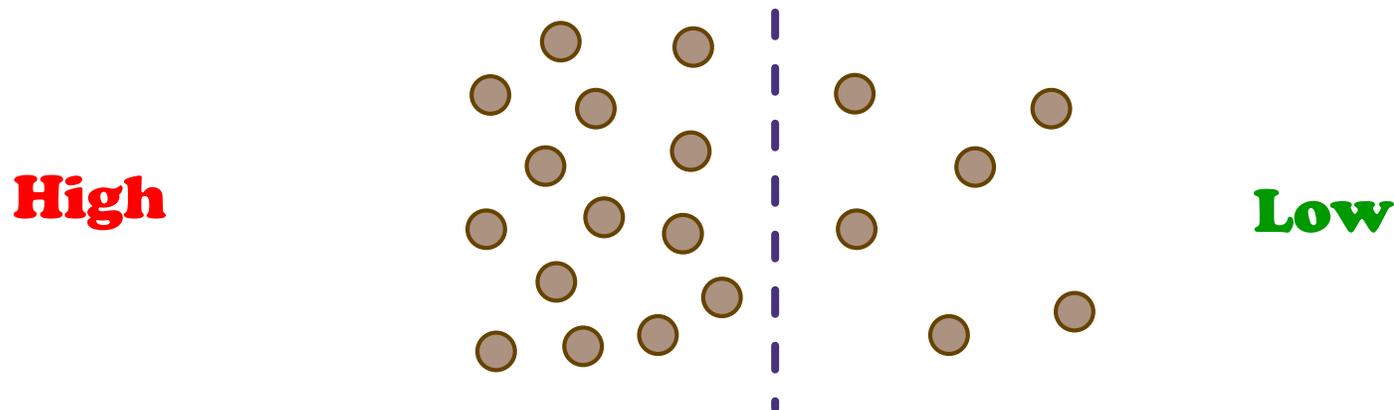
**ACTIVE PROCESSES**



# **PASSIVE PROCESSES**

# Passive Processes

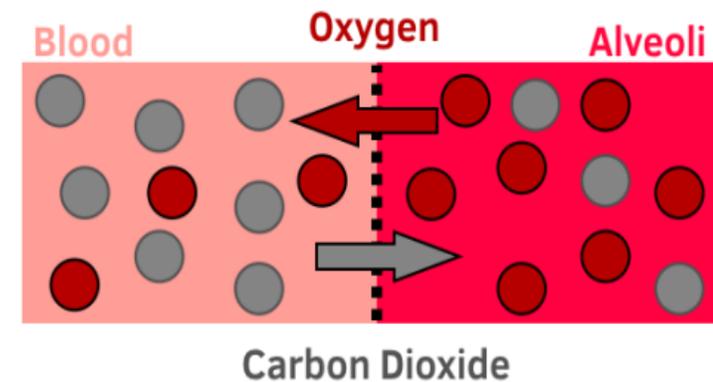
- ▶ Movement of substances **down a concentration gradient** due to the kinetic energy of the substance.
- ▶ **No** expenditure of cellular **energy** is required.
- ▶ Continues until **equilibrium** is reached (if unopposed).



# 1. Simple Diffusion

Definition: unassisted movement of **small, nonpolar** substances down their **concentration gradient** across a **selectively permeable** membrane.

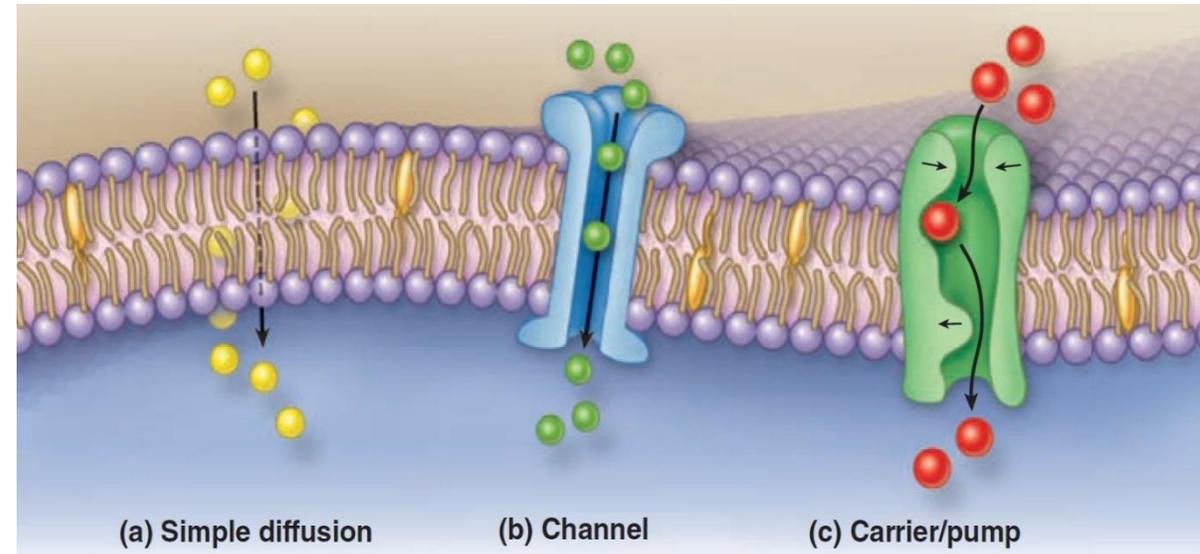
- ▶ The diffusion rate is **proportional to the concentration gradient** of the diffusing molecule.
- ▶ e.g., exchange of **O<sub>2</sub>** and **CO<sub>2</sub>** between blood and body tissues



## 2. Facilitated Diffusion

Definition: movement of **ions** and **small, polar** molecules down their **concentration gradient** **assisted** across a **selectively permeable** membrane by a **transport protein**.

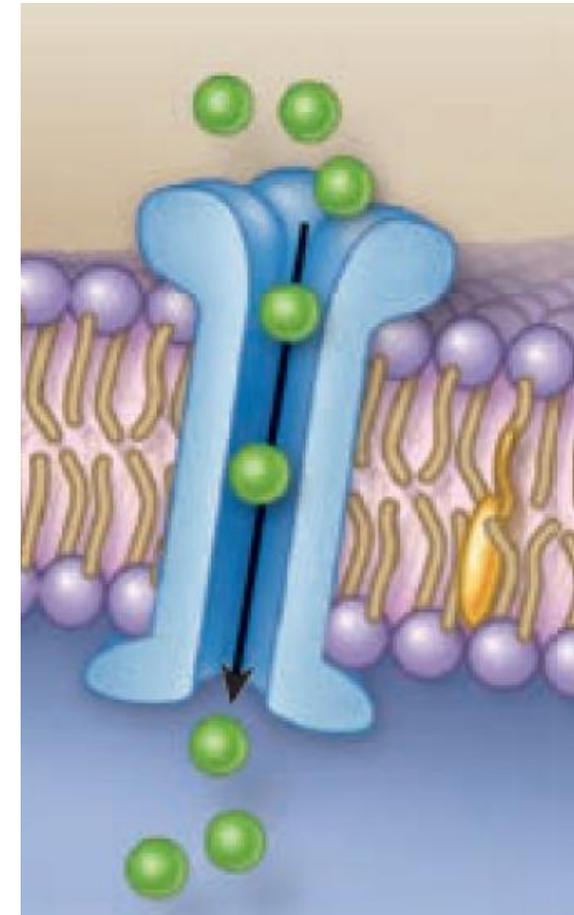
- ▶ This protein is either a **channel** or **carrier** protein.



# Channel-mediated diffusion

Definition: movement of **ion** down its **concentration gradient** through a **protein channel** made of **transmembrane proteins** that create **hydrophilic channels** through the plasma membrane.

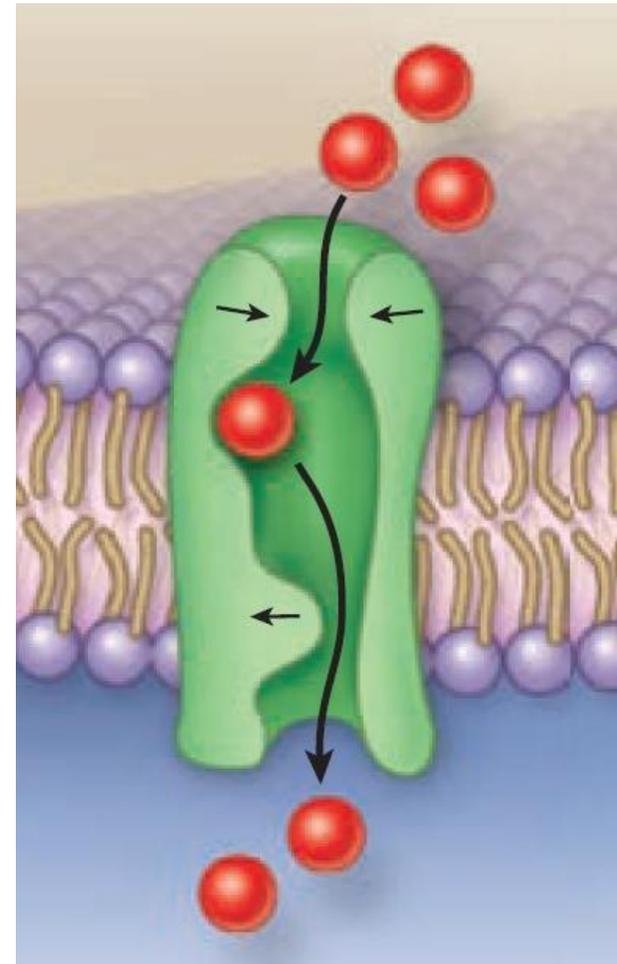
- ▶ Channels are **ion selective** and are regulated by cell needs.
- ▶ **Leak** (ungated) or **gated**.
- ▶ e.g., **Na<sup>+</sup>** channels.



# Carrier-mediated diffusion

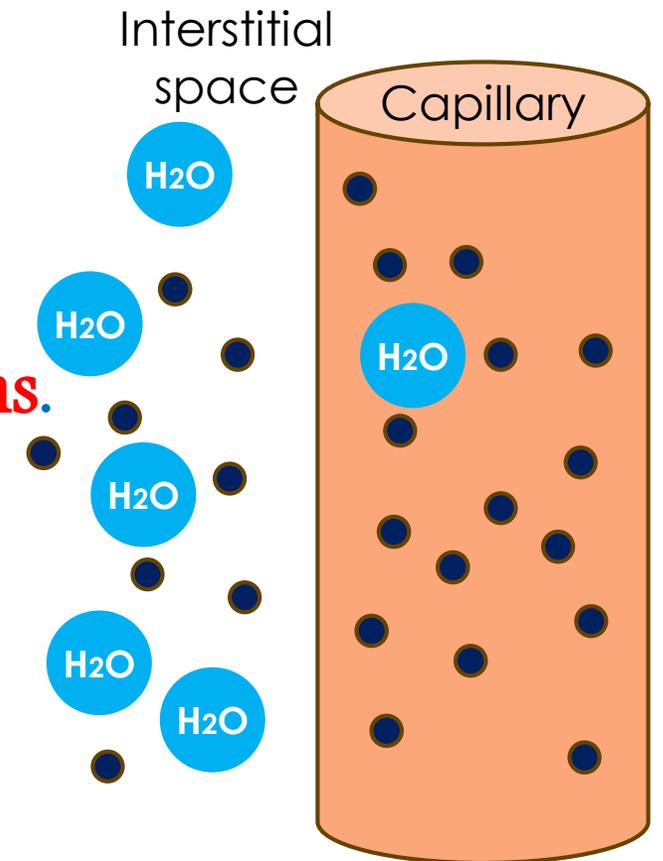
Definition: movement of **small, polar** molecule down its **concentration gradient** by a **carrier protein**.

- ▶ Carrier proteins are **highly selective**, often transporting only **one type** of molecule.
- ▶ **Some** carrier proteins require **energy** for active transport of molecules **against** their concentration gradient.
- ▶ e.g., **glucose** transport into cells by glucose carrier.



# 3. Osmosis

- ▶ Diffusion of **water** across a **selectively permeable** membrane.
- ▶ Direction is determined by **relative solute concentrations**.
- ▶ Continues until equilibrium is reached.
- ▶ e.g., solutes in **capillaries** “pulls” fluid from **interstitial space** back into blood.

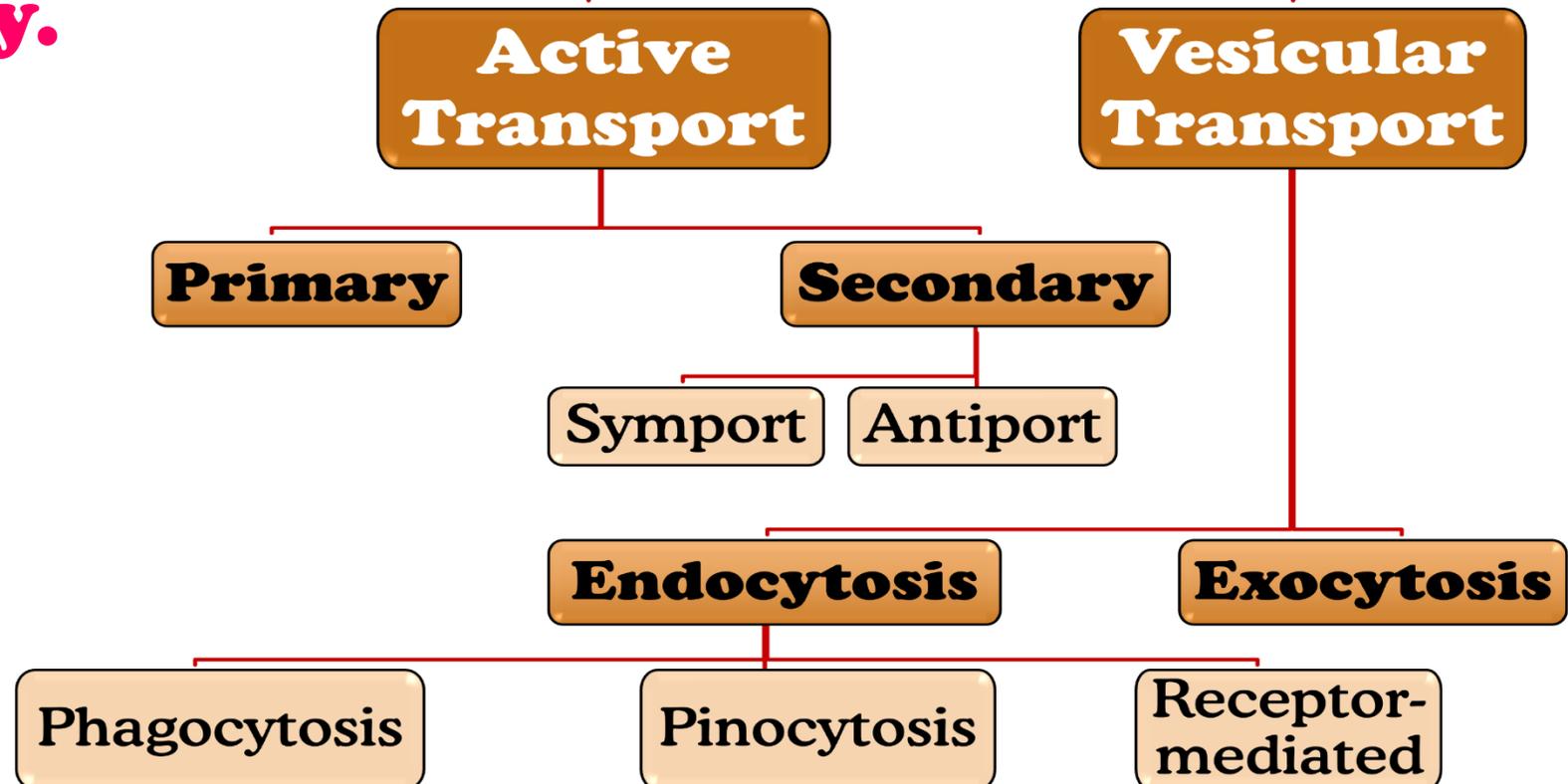




# **ACTIVE PROCESSES**

# Active Processes

**Movement of substances requires expenditure of cellular energy.**



# 1. Active Transport

Definition: transport of ions or small molecules across the membrane against a concentration gradient by transmembrane protein pumps.

Types:

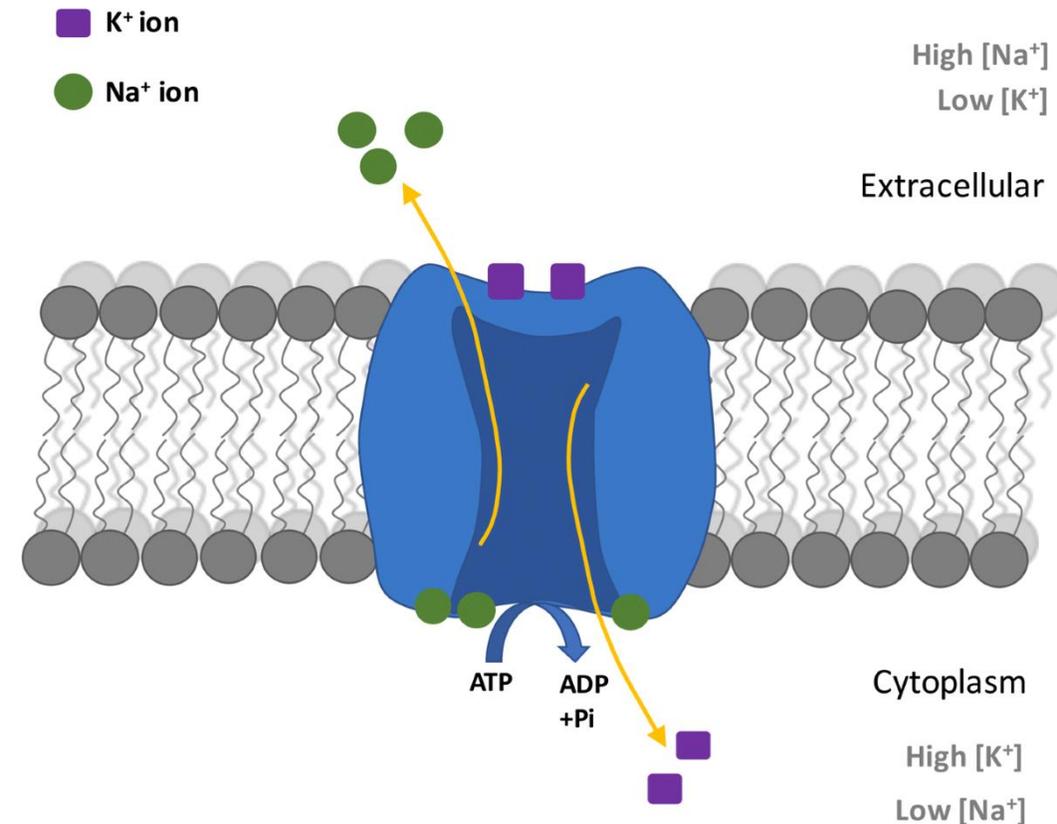
- Primary
- Secondary (symport & antiport)

# 1. Active Transport

## A. Primary:

- Movement of substance **up its concentration gradient** powered **directly by ATP**.

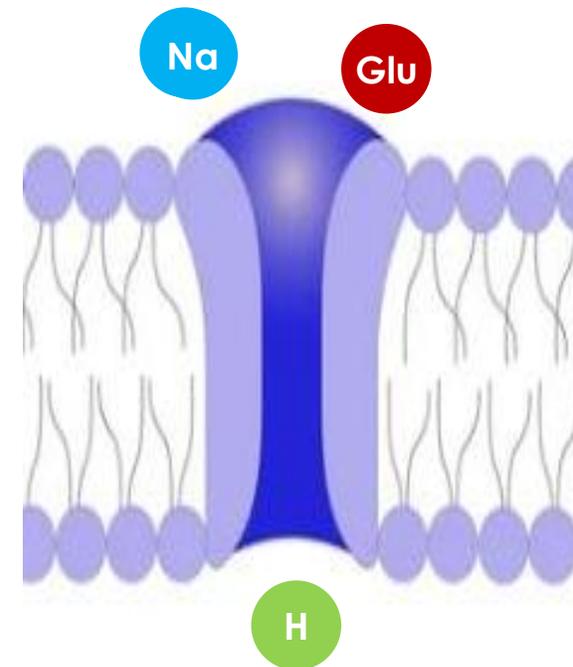
e.g., Na<sup>+</sup>/K<sup>+</sup> pump moves Na<sup>+</sup> out of the cell and K<sup>+</sup> into the cell



# 1. Active Transport

## B. Secondary:

- Movement of a substance up its concentration gradient **using** energy provided by the movement of a second substance (eg,  $\text{Na}^+$ ) down its concentration gradient.
  - i. Symport: in the same direction as  $\text{Na}^+$  (e.g.,  $\text{Na}^+$ /glucose transport)
  - ii. Antiport: in the opposite direction from  $\text{Na}^+$  (e.g.,  $\text{Na}^+$ / $\text{H}^+$  transport)



## 2. Vesicular Transport

Definition: a process that involves configurational changes in the plasma membrane at localized sites with subsequent formation of vesicles from the membrane or fusion of vesicles with the membrane.

### Types:

A. Exocytosis

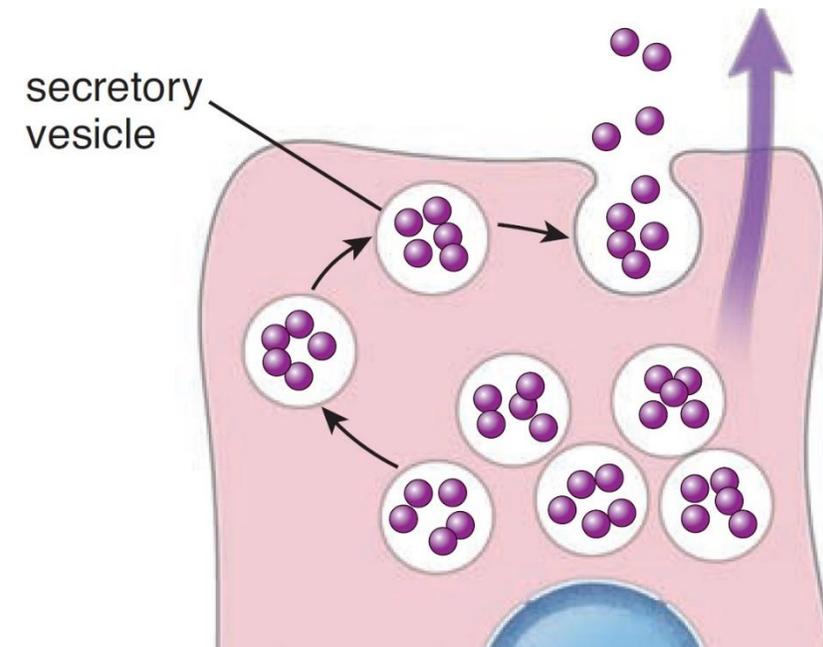
B. Endocytosis (phagocytosis, pinocytosis & receptor-mediated)

# A. Exocytosis

Definition: movement of large molecules out of the cell to the extracellular space by fusion of secretory vesicles with the plasma membrane.

## Types:

- ❖ Constitutive secretion
- ❖ Regulated secretion



# A. Exocytosis

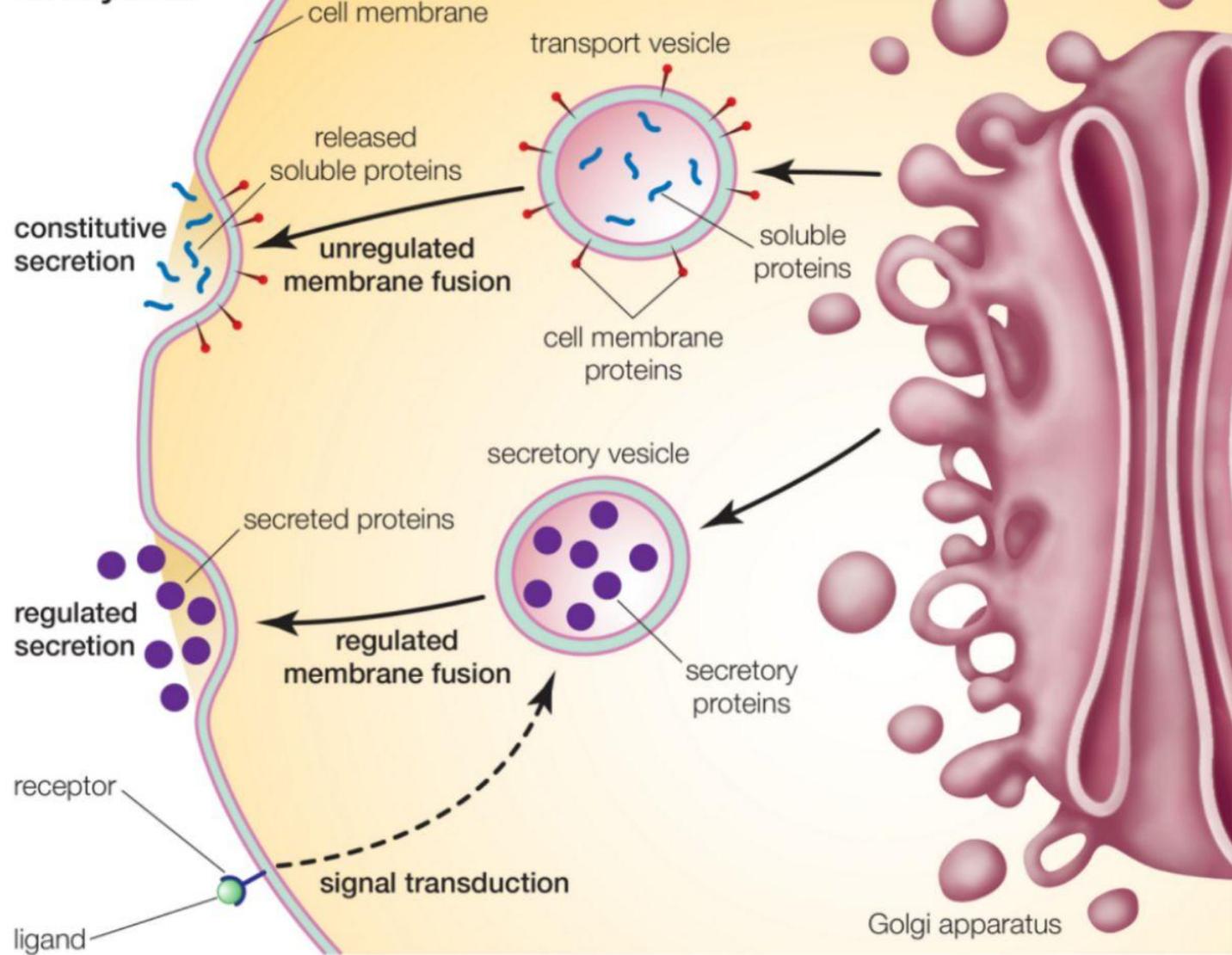
## ❖ Constitutive secretion:

- Proteins are secreted immediately after their synthesis → cells lack secretory granules.  
e.g., immunoglobulins in plasma cells and procollagen in fibroblasts

## ❖ Regulated secretion

- Cells concentrate secretory proteins and transiently store them in secretory vesicles within the cytoplasm.
- Secretion occurs in response to a regulatory signals coming to the cells.  
e.g., endocrine cells (hormones), exocrine cells (enzymes) and neurons (neurotransmitter).

# Exocytosis

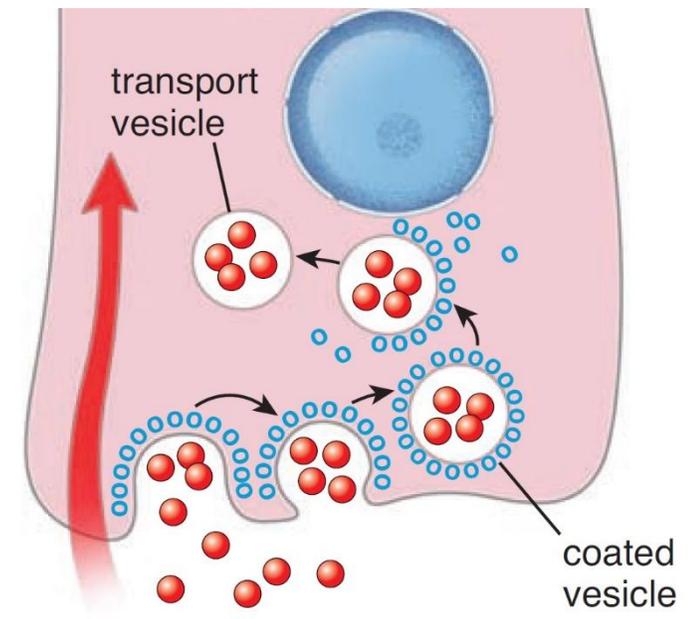


# B. Endocytosis

Definition: movement of macromolecules into the cells by being enclosed within folds of plasma membrane.

Types:

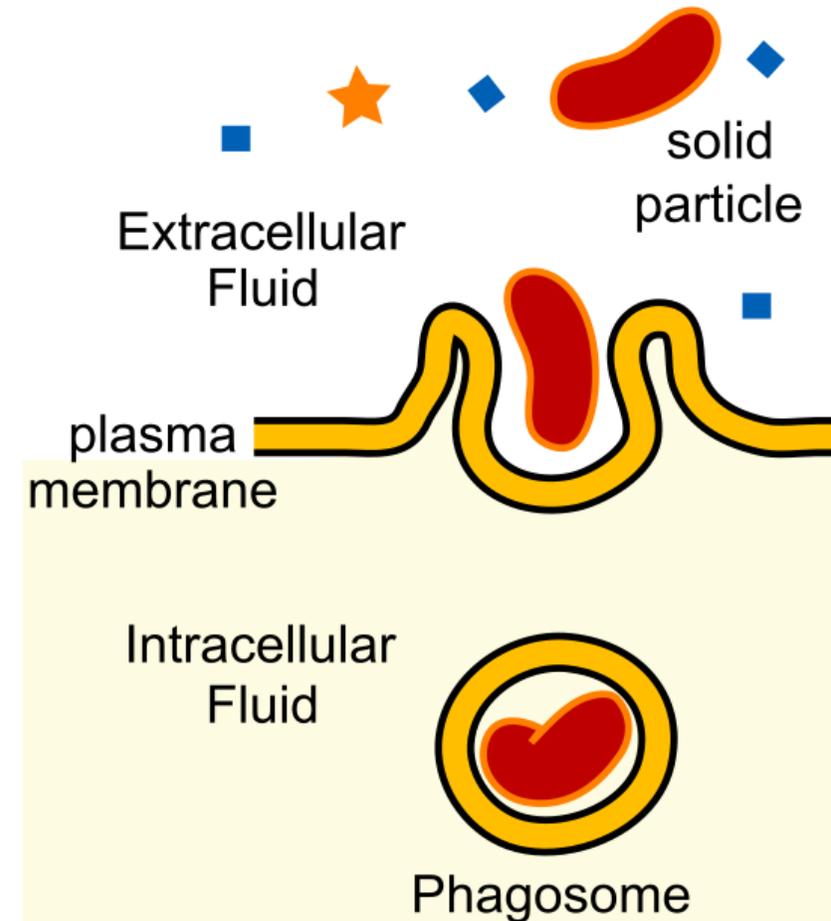
- ❖ Phagocytosis
- ❖ Pinocytosis
- ❖ Receptor-mediated endocytosis



# Phagocytosis (Cell eating)

- ▶ Ingestion of **large particulate** materials such as cell debris, bacteria, and other foreign materials.
- ▶ Plasma membrane sends out **pseudopodia** to engulf phagocytosed particles into large vesicles called **phagosomes**.
- ▶ It is **nonselective** process.

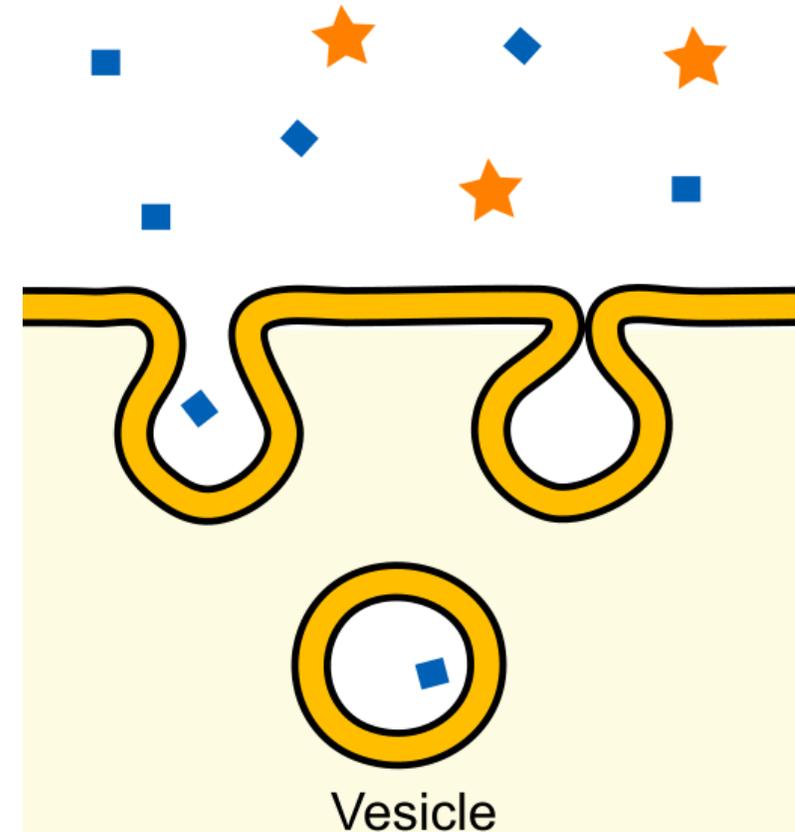
e.g., white blood cell engulfing a bacterium.



# Pinocytosis (Cell drinking)

- ▶ Nonspecific ingestion of fluid and small protein molecules via small vesicles.

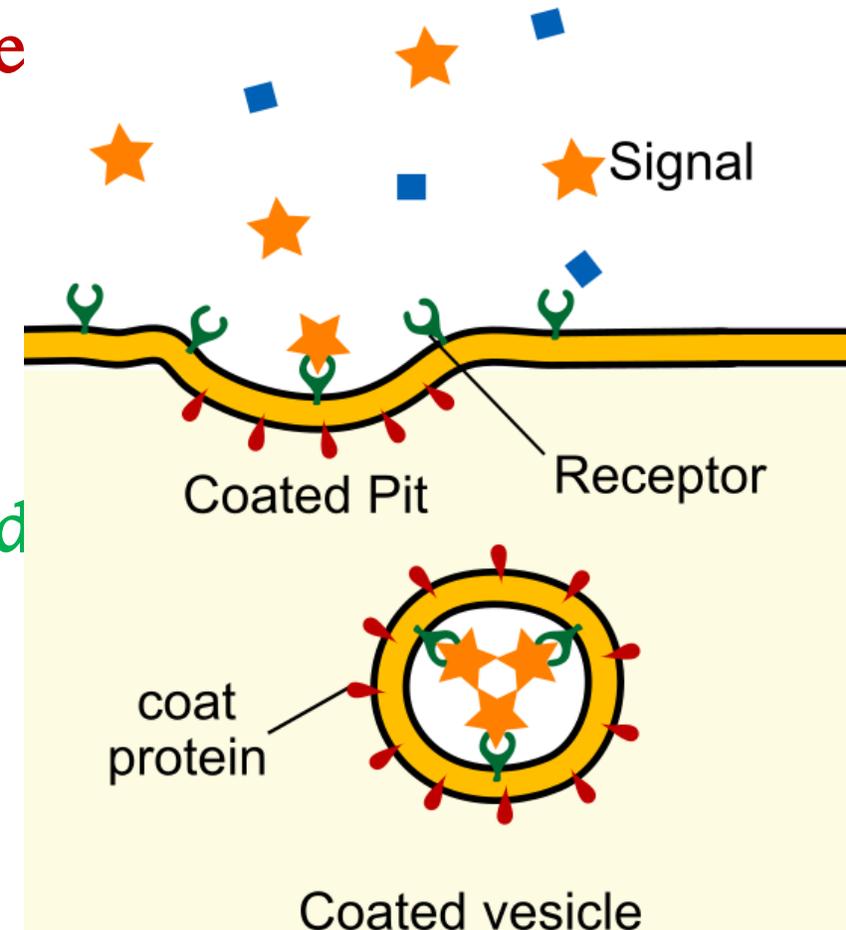
e.g., endothelium of blood vessels and in smooth muscle cells.



# Receptor-mediated endocytosis

- ▶ Plasma membrane receptors allow specific substance to enter the cell.
- ▶ Receptors recognize and bind to specific molecules that come in contact with the plasma membrane.
- ▶ The receptor and its bound substance then are pulled from the extracellular space into the cell forming a coated vesicle.

e.g., uptake of cholesterol into cells.



# MEMBRANE TRANSPORT

## PASSIVE PROCESSES

**Simple Diffusion**

**Facilitated Diffusion**

**Osmosis**

**Channel-mediated**

**Carrier-mediated**

**Leak channels**

**Gated channels**

## ACTIVE PROCESSES

**Active Transport**

**Vesicular Transport**

**Primary**

**Secondary**

**Symport**

**Antiport**

**Endocytosis**

**Exocytosis**

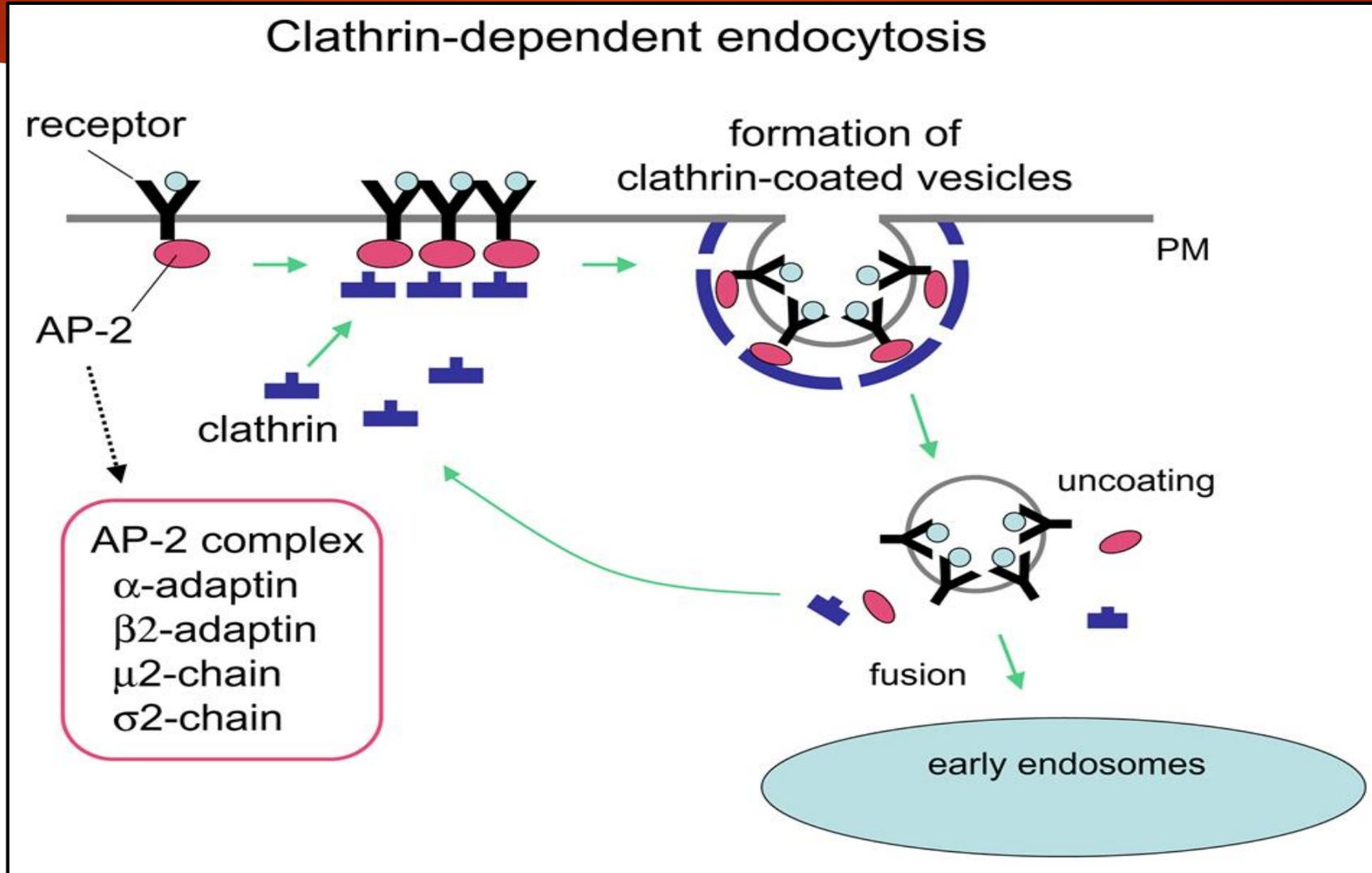
**Phagocytosis**

**Pinocytosis**

**Receptor-mediated**

# C) Receptor-mediated endocytosis:

**Definition:** It is a highly selective process requiring the presence of receptors and their ligands.



# Cell Coat Functions

```
graph LR; A[Cell Coat Functions] --- B[Cell Adhesion]; A --- C[Cell Recognition]; A --- D[Cell Immunity];
```

**Cell Adhesion**

**Cell Recognition**

**Cell Immunity**

# **Cell Membrane Modifications**

**Microvilli**

**Cilia & Flagella**

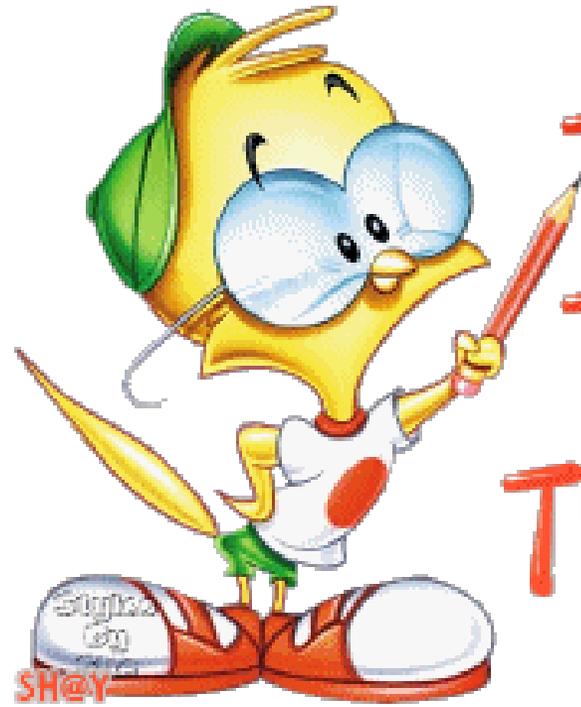
**Cell Junctions Formation**

**Cell Immunity**

# Specializations of cell membrane

- 1- Microvilli:** which are long finger-like projections on the surface of certain cells.
- 2- Cilia:** these are hair-like processes on the free surface of certain cells
- 3- Flagella:** they resemble cilia in general structure but are longer and present only in spermatozoa.
- 4- Cell junctions:** they connect adjacent cells together





Thank You  
Thank You  
Thank You!!!!

