# SUMMARY

# BIOLOGY

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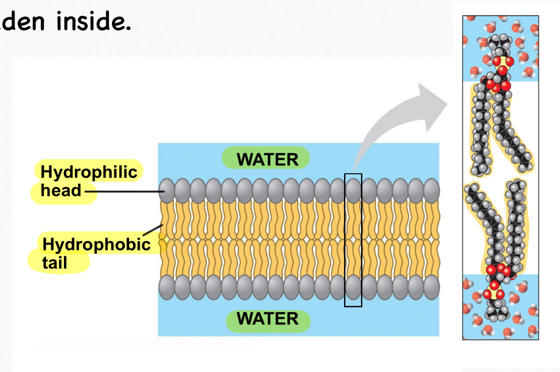
# Chapter 8: cell membranes

**Concept 8.1/Cellular membranes are fluid mosaics of lipids and proteins.**

- Components of cell membrane:

A.Lipids B.proteins C.carbohydrates.

- **Phospholipids** are the most abundant lipid in the plasma membrane.
- Phospholipids are **amphipathic molecules,** containing hydrophobic and hydrophilic regions.
- in a lipid bilayer; hydrophilic heads are exposed to water while hydrophobic tails are hidden inside.




- **fluid mosaic model :** the membrane is a mosaic of protein molecules bobbing in a fluid bilayer of phospholipids.

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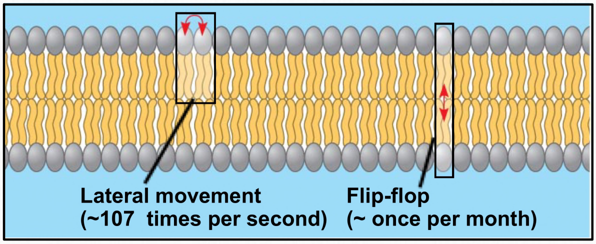
**💥The Fluidity of Membranes**

- A membrane is held together mainly by hydrophobic interactions, which are much weaker than covalent bonds.
- the fluidity of membranes is due to the rapid and continuous sideways movement of phospholipids within the lipid bilayer.
- Most of the lipids, and some proteins, move laterally and this type of movement is rapid (about 10^(7) times per second)

Rarely does a molecule flip-flop transversely across the membrane (once per month)



• Factors that affect membrane fluidity:

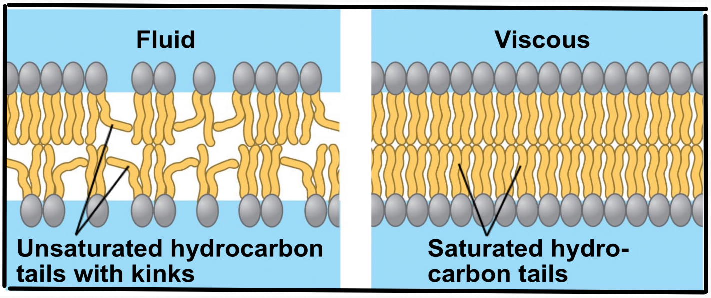
A. Content of saturated and unsaturated fatty acids.

B. Cholesterol

• As temperatures cool, membranes switch from a fluid state to a solid state.

• The temperature at which a membrane solidifies depends on the types of lipids.

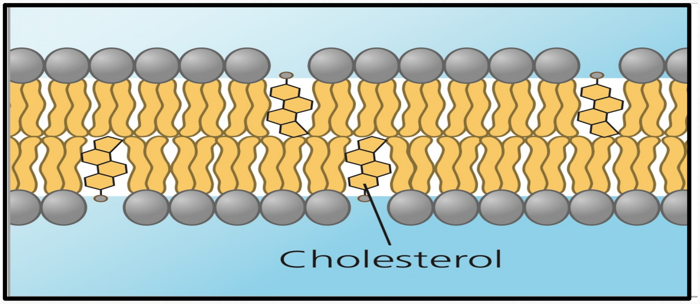
• Membranes rich in unsaturated fatty acids are more fluid than those rich in saturated fatty acids.




• The steroid cholesterol has different effects on membrane fluidity at different temperatures.

• At warm temperatures (such as 37°C), cholesterol restrains movement of phospholipids (reduce fluidity)

• At cool temperatures, it maintains fluidity by preventing tight packing.




**Note:** The fluidity of the plasma membrane must be within a certain range in order to maintain its permeability and for the membrane proteins to be able to move to perform their function. If the membrane is highly fluid or solid, its function will be affected.

## 💥Membrane Proteins and Their Functions

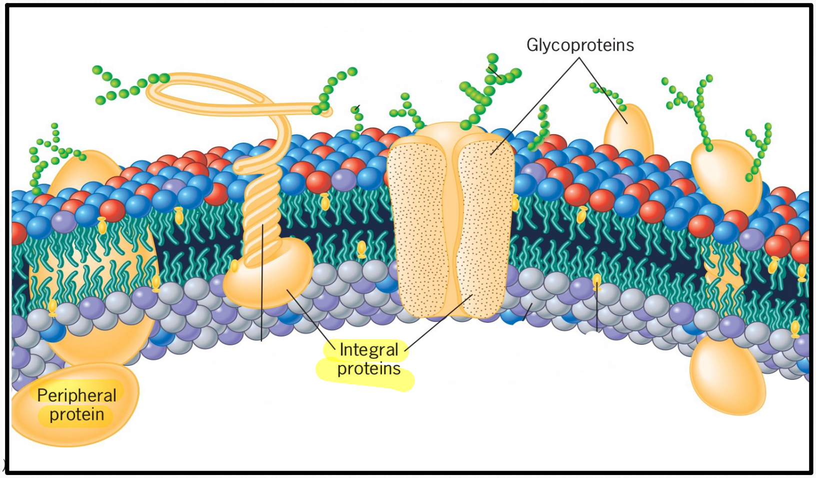
- A membrane is a collage of different proteins embedded in the fluid matrix of the lipid bilayer.
- Proteins determine most of the membrane's specific functions.
- major populations of membrane proteins:

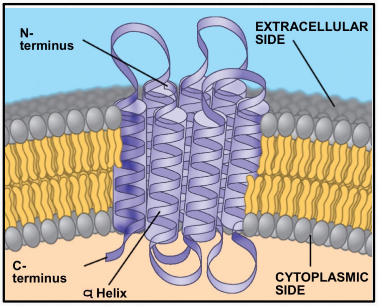
A.integral proteins. B.peripheral proteins

- Peripheral proteins are bound to the surface of the membrane.
- Integral proteins penetrate the hydrophobic core.

-Integral proteins that span the membrane are called transmembrane proteins.

-The hydrophobic regions of an integral protein consist of one or more stretches of nonpolar amino acids, often coiled into alpha helices




Integral protein

- Six major functions of membrane proteins:

-Transport

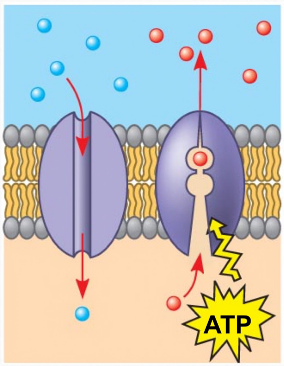
-Enzymatic activity

-Signal transduction

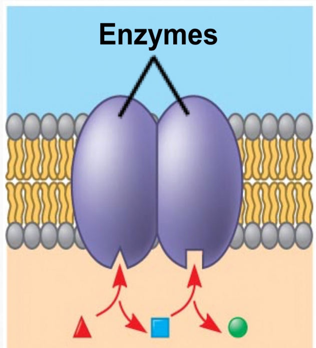
-Cell-cell recognition

-Intercellular joining

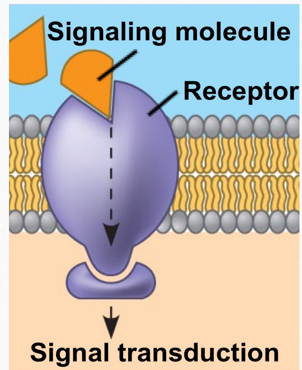
-Attachment to the cytoskeleton and extracellular matrix (ECM).



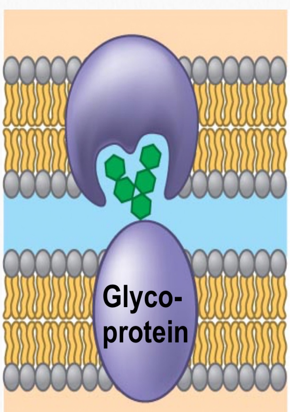

Transport



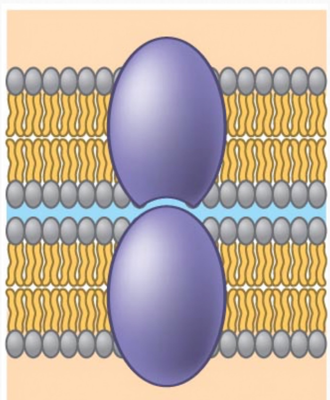

Enzymatic activity



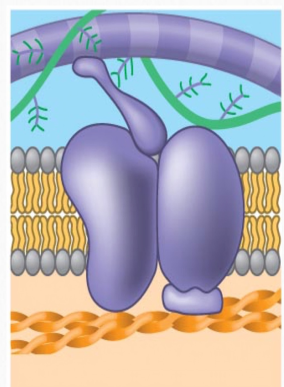

Signal transduction




Cell-cell recognition



Intercellular joining



Attachment to the ECM

**The Role of Membrane Carbohydrates in Cell-Cell Recognition**

- Cells recognize each other by binding to surface molecules, often **carbohydrates**, on the plasma membrane.
- Membrane carbohydrates may be covalently bonded to lipids (forming glycolipids) or more commonly to proteins (forming glycoproteins).
- Carbohydrates on the external side of the plasma membrane vary among species, individuals, and even cell types in an individual

**Synthesis and Sidedness of Membranes.**

- Membranes have distinct inside and outside faces
- The asymmetrical distribution of proteins, lipids, and associated carbohydrates in the plasma membrane is determined when the membrane is built by the ER and Golgi apparatus.

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**Concept 7.2: Membrane structure results in selective permeability.**

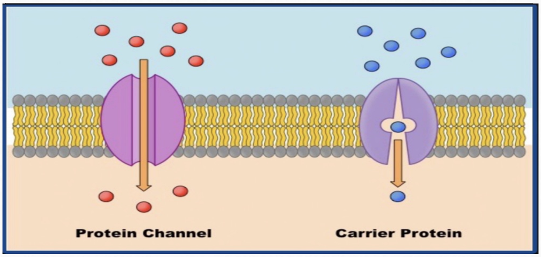
- cell must exchange materials with its surroundings, a process controlled by the plasma membrane.
- Plasma membranes are **selectively permeable**, regulating the cell's molecular traffic.
- Hydrophobic (nonpolar) molecules, such as hydrocarbons, can dissolve in the lipid bilayer and pass through the membrane rapidly.
- Polar molecules, such as ions and sugars do not cross the membrane easily.
- **Transport proteins** allow passage of hydrophilic substances across the membrane.
- two types of transport proteins:

1-**channel proteins**: have a hydrophilic channel that certain molecules or ions can use as a tunnel.

Example: Channel proteins called **aquaporins** facilitate the passage of water molecules through the membrane.

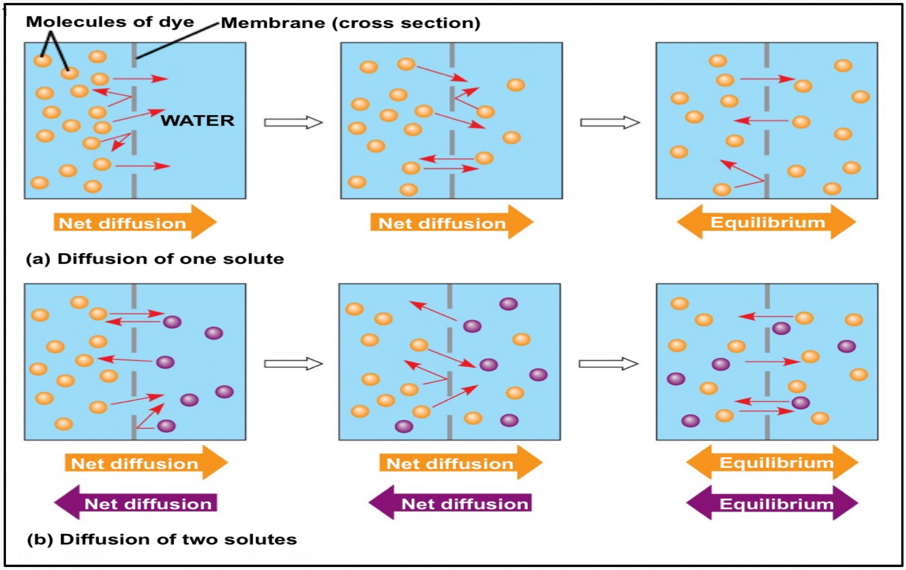
2-**carrier proteins:** bind to molecules and change shape to shuttle them across the membrane.

- a transport protein is specific for the substance it moves.



**Concept 7.3: Passive transport is diffusion of a substance across a membrane with no energy investment.**

- **Diffusion** is the tendency for molecules to spread out evenly into the available space



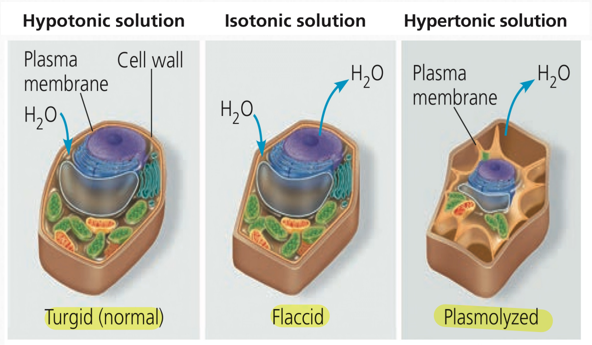

- Substances diffuse down their **concentration gradient**.
- **concentration gradient** is the difference in concentration of a substance from one area to another.
- No work must be done to move substances down the concentration gradient.
- The diffusion of a substance across a biological membrane is **passive transport** because it requires no energy from the cell to make it happen.

💥**Effects of Osmosis on Water Balance**

- Osmosis is the diffusion of water across a selectively permeable membrane
- Water diffuses across a membrane from the region of lower solute concentration to the region of higher solute concentration.

## 💥Water Balance of Cells with Walls

- Cell walls help maintain water balance
- A plant cell in a hypotonic solution swells until the wall opposes uptake; the cell is now turgid (firm) ,and this is the healthy state for most plant cells.
- If a plant cell and its surroundings are isotonic, there is no net movement of water into the cell; the cell becomes flaccid (limp), and the plant may wilt.
- In a hypertonic environment, plant cells lose water; eventually, the membrane pulls away from the wall, a usually lethal effect called plasmolysis.



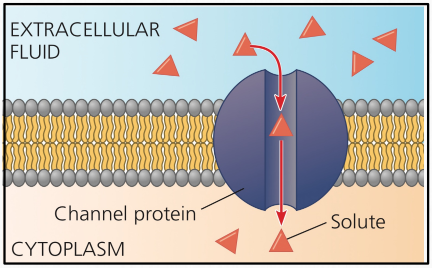

## 💥Facilitated Diffusion: Passive Transport Aided by Proteins

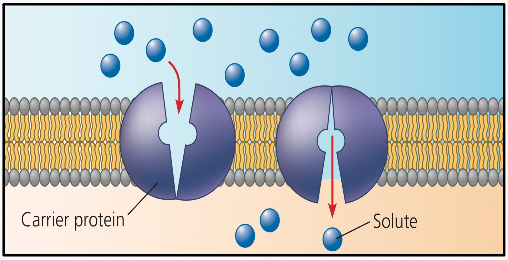
- In **facilitated diffusion**, transport proteins speed the passive movement of molecules across the plasma membrane.
- Channel proteins provide corridors that allow a specific molecule or ion to cross the membrane.
- Channel proteins include:

-Aquaporins, for facilitated diffusion of water

-Ion channels that open or close in response to a stimulus (gated channels)

- Carrier proteins undergo a subtle change in shape that translocates the solute-binding site across the membrane.

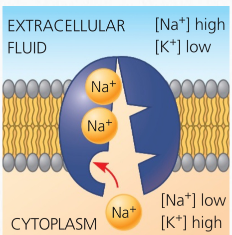


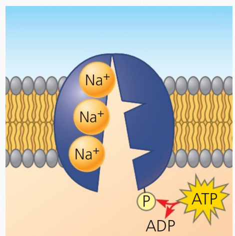
## Concept 7.4: Active transport uses energy to move solutes against their gradients

- Facilitated diffusion is still passive because the solute moves down its concentration gradient.
- Some transport proteins, however, can move solutes against their concentration gradients.
- **Active transport** moves substances **against** their concentration gradient.
- Active transport requires energy, usually in the form of ATP.
- Active transport is performed by specific proteins embedded in the membranes.
- Active transport allows cells to maintain concentration gradients that differ from their surroundings.

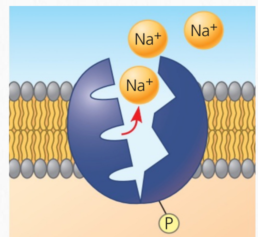
»The **sodium-potassium pump** is one type of active transport system.



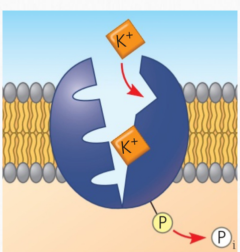

1-Cytoplasmic Na+ binds to the sodium-potassium pump



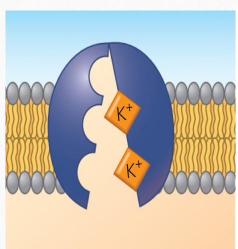

2-Na+ binding stimulates phosphorylation by ATP.



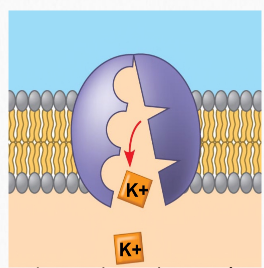

3-Phosphorylation causes the protein to change its shape. Na+ is expelled to the outside.




4-k+ binds on the extracellular side and triggers release of the phosphate group.

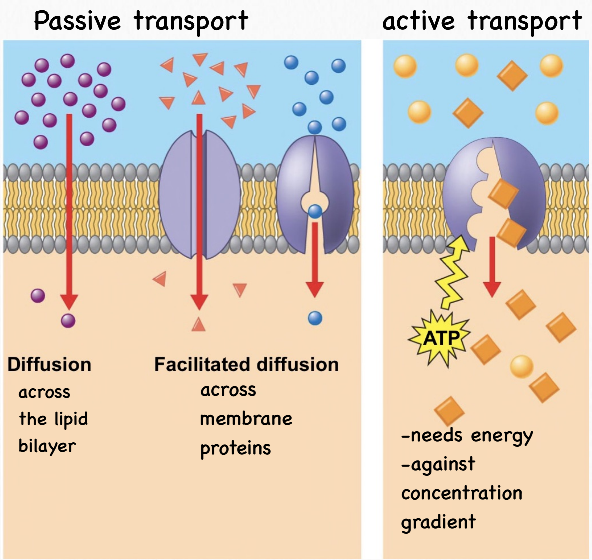



5-Loss of the phosphate restores the protein's original shape




6-K+ is released, and the cycle repeats.

- C.The sodium-potassium pump is results in a net negative charge inside the cell (3Na+ out side —2k+ inside the cell) —» net charge of +1 outside the cell membrane.




**How Ion Pumps Maintain Membrane Potential ?**

- **Membrane potential** is the voltage difference across a membrane.
- **Voltage** is created by differences in the distribution of positive and negative ions.
- Two combined forces, collectively called the **electrochemical gradient,** drive the diffusion of ions across a membrane:

- A chemical force (the ion's concentration gradient)

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-An electrical force (the effect of the membrane potential on the ion's movement)

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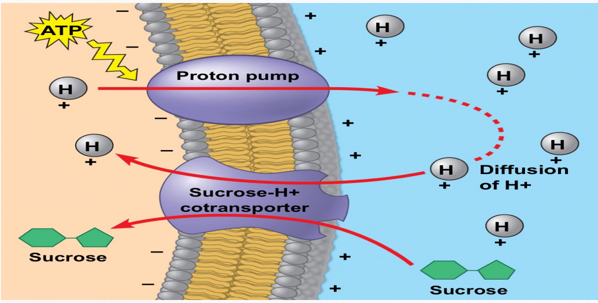
- An **electrogenic pump** is a transport protein that generates voltage across a membrane or contributes to the membrane potential.
- **The sodium-potassium pump is the major electrogenic pump of animal cells**
- The main electrogenic pump of plants, fungi, and bacteria is a **proton pump**.

**Cotransport: Coupled Transport by a Membrane Protein**

- Cotransport occurs when active transport of a solute indirectly drives transport of another solute.
- Plants commonly use the gradient of hydrogen ions generated by ATP-powered proton pumps to drive active transport of nutrients(sucrose) into the cell.

-an example of cotransport protein is H+ - sucrose cotransporter.




**Concept 7.5: Bulk transport across the plasma membrane occurs by exocytosis and endocytosis.**

- Small molecules and water enter or leave the cell through the lipid bilayer or by transport proteins.
- Large molecules, such as polysaccharides and proteins, cross the membrane in bulk via vesicles.
- Bulk transport requires energy.

» **Exocytosis**:

-In exocytosis, transport vesicles migrate to the membrane, fuse with it, and release their contents.

-Many secretory cells use exocytosis to export their products.

» **Endocytosis:**

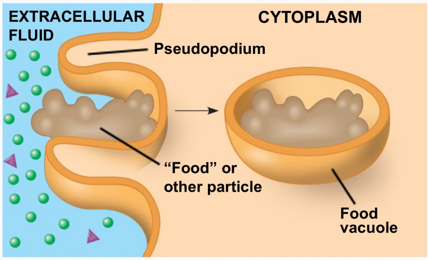
- In endocytosis, the cell takes in macromolecules by forming vesicles from the plasma membrane.
- Endocytosis is a reversal of exocytosis, involving different proteins.
- There are three types of endocytosis:

-Phagocytosis ("cellular eating")

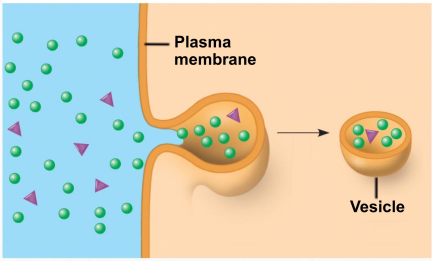
-Pinocytosis ("cellular drinking")

-Receptor-mediated endocytosis.

- In **phagocytosis** a cell engulfs a particle in a vacuole .
- The vacuole fuses with a lysosome to digest the particle.



• In pinocytosis, molecules are taken up when extracellular fluid is "gulped" into tiny vesicles.




• **receptor-mediated endocytosis:** is a specialised type of pinocytosis that enables the cell to get bulk quantities of specific substances, even though those substances may not be very concentrated in the extracellular fluid.
• specific substances bind to their protein receptors in the plasma membrane.
• The receptor proteins then cluster in coated pits, and each coated pit forms a vesicle containing the bound molecules.