# Lecture 6

# Functions of cell membranes

- Cell membranes are selectively permeable membranes i.e allow passage of certain substances but not others

**1) Transport**

*Passive transport* :

a) Do not require energy

b) Cells do not perform work

c) Driving force is the concentration gradient.

**Types of passive transport**

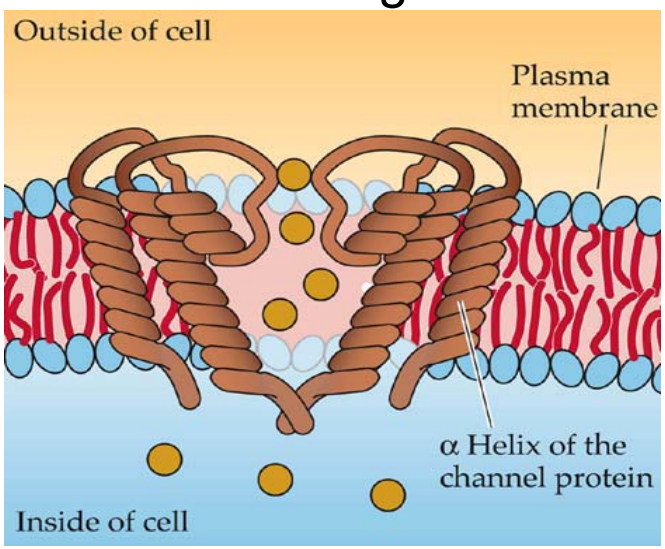
**)Simple diffusion :** movement of molecules from an area of higher concentration to an area of lower concentration untill equilibrium e.g diffusion of gases ($O_2$ and $CO_2$) in our lungs and RBCs.

**2)Facilitated diffusion** : a type of passive diffusion provides a channel for sugars and H2O. Binds its passenger, changes shape and release it to the other side.

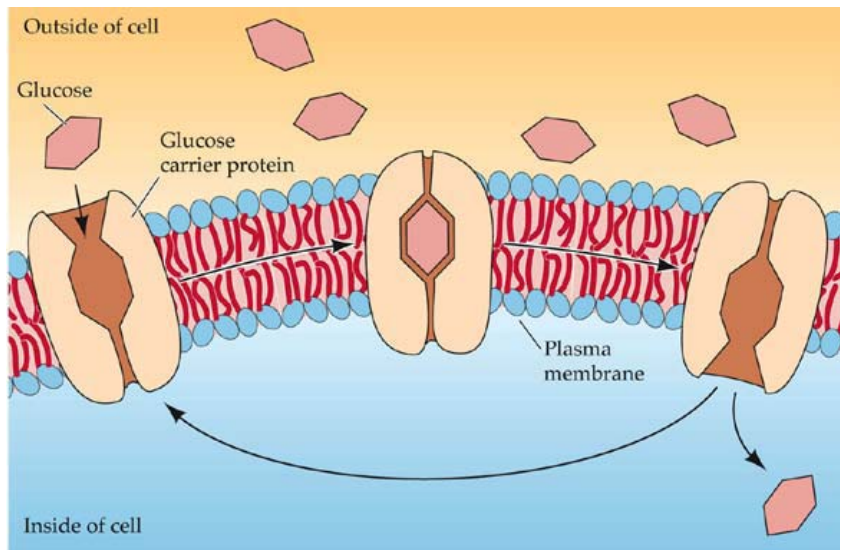
# Facilitated Diffusion

- Most molecules cannot move freely through the membrane, but can pass through membranes if a gradient exists, with the help of **membrane transport proteins**.
- No energy is involved, so it is still a passive process.
- Transport proteins are specific, and are limited in number in membranes.
- The rate of movement of materials is dependent on the availability of transport proteins as well as the concentration of the substance to be moved.
- **Amino acids**, **monosaccharides** and **ions** move through membranes via facilitated diffusion.
- it move through a hydrophilic **protein channel or pore** of the transport protein.
- **Ion channel proteins** are common in membranes.
- Much water movement through membranes also involves facilitated diffusion. There are special channel proteins, called **aquaporins** that facilitate the movement of water at a rate needed for cell activities.

- Some transport proteins have **channels with gates**. The gate opens to let the target molecule pass through when it receives an electrical or chemical signal. For example, neurotransmitter chemicals serve as signal molecules to open the gates for sodium to flow into the nerve cell.
- Facilitated diffusion also occurs with **carrier molecules**, substances to which the target molecule to be transported temporarily binds, resulting in a conformational change that moves the target substance through the membrane

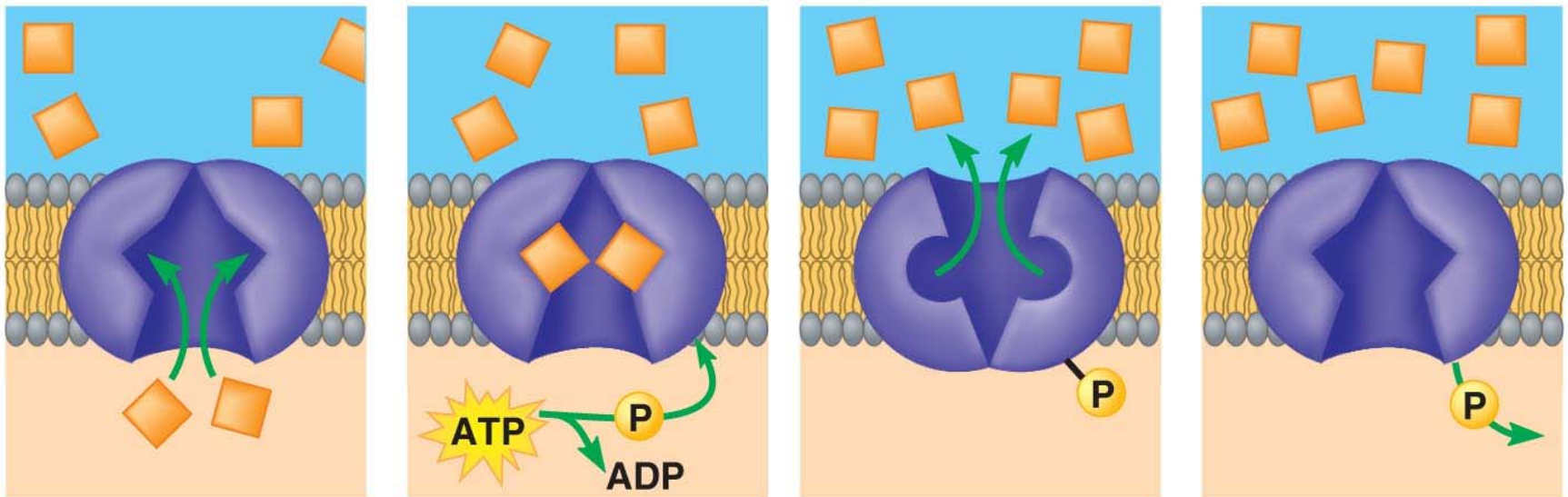



Potassium Ion Channel




Protein Glucose Carrier Proteins

# Active transport of a solute across a membrane




Solute binding

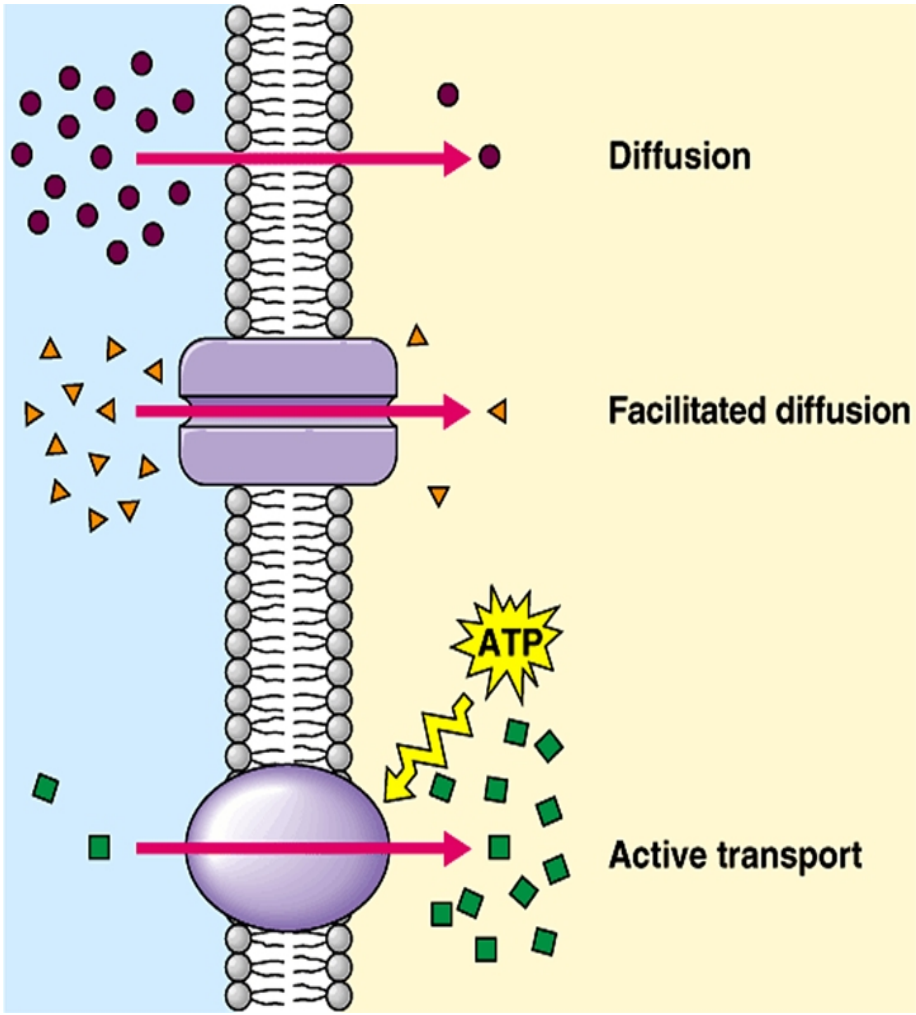
Phosphorylation

Transport

Protein reversion

# Moving Materials Through Membranes

- There are a number of ways to move materials through membranes:
  - **Simple diffusion**
  - **facilitated diffusion**
  - **active transport**
- **these ways** are used to move small quantities of substances.
- Simple and facilitated diffusion are means of passive transport.
- Active transport uses energy to move substances against a gradient.
- Larger volumes are moved by **exocytosis** or **endocytosis**.
  - Endocytosis and exocytosis, which involve extensive membrane rearrangements, are also energy consuming.




**1- Active Transport**

Active transport requires energy and uses a variety of transport mechanisms.

**Uniports** move one substance in one direction, **symports** move two substances in the same direction and **antiports** move two substances in opposite directions.

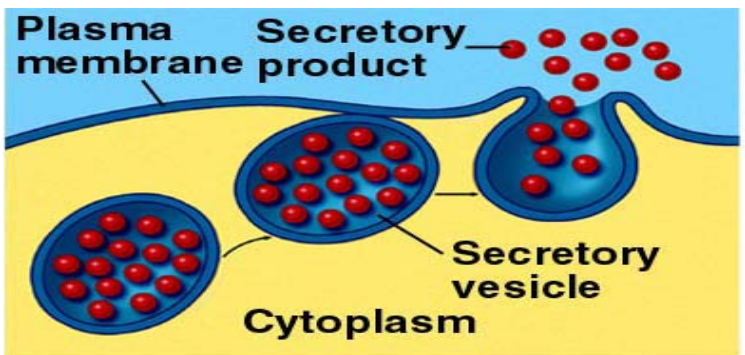
Symports and antiports are also known as coupled transporters

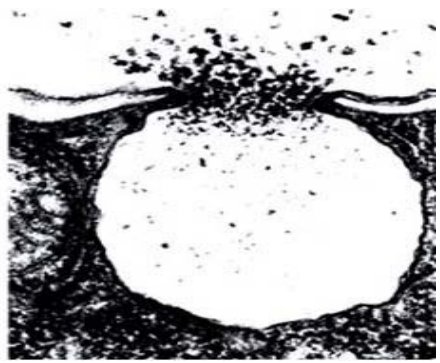
# Membrane Interactions with the Environment

- Larger substances, including macromolecules, require changes in membrane shape and/or the fusion of membranes to move into or out of cells. Such substances move into the cell by **endocytosis** and from the cell by **exocytosis.**

## 1- Exocytosis

- Materials can be exported from the cell by fusing vesicles with the plasma . membrane, a process called **exocytosis.**
- materials for export are packaged in a Golgi body and the vesicles formed travel along the cytoskeleton until they reach the plasma membrane.
- Once the vesicle membrane and plasma membrane fuse, the contents of the vesicle are freed from the cell for example : insulin,



## Endocytosis

- Substances that enter the cell using membrane modifications move by endocytosis**.**
- **There are three endocytosis processes:** phagocytosis, receptormediated endocytosis and pinocytosis.

### 1- Phagocytosis

- Phagocytosis occurs when membrane pseudopodia surround and engulf particulate objects, packaging them in a membrane-bounded vacuole.
- Phagocytosis is used for solid large objects, such as prey engulfed by *Amoeba, and bacteria by white blood* cells.

### 2- Pinocytosis (cell drinking)

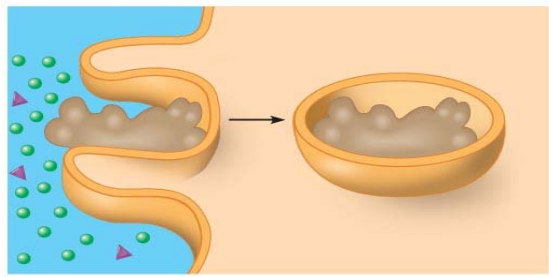
- In pinocytosis, the plasma membrane invaginates, substances "fall" in cavity, the membrane seals over and the molecules in the fluid will be moved into the cell enclosed vesicle.
- Once in the cytoplasm, the vesicle membrane degrade, the substances release into the cytoplasm.

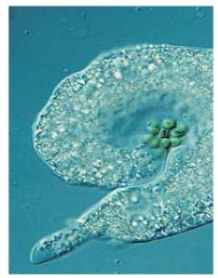
# Membrane Interactions with the Environment

- **Receptor mediated endocytosis**:
- Highly specific **receptor proteins** in the membrane attract the substance to be moved into the cell.
- The receptor proteins are attached to specific substances in the membrane creating a membrane depression in that area called a **coated pit**.
- The cytoplasmic side of the coated pit is coated with specific proteins, called **clathrins**.
- When sufficient target molecules have been attracted, the pocket will be pinched off forming a **clathrin-coated vesicle** in the cytoplasm.
- Molecules that bind to receptor sites are called **ligands**. (It's a general term that simply means something that attaches to a receptor.)
- Receptor-mediated endocytosis is an effective means of moving desired materials into cells. e.g absorption of cholesterol.

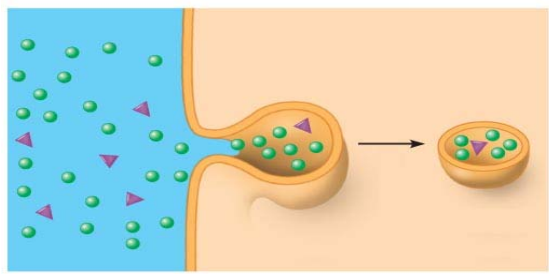
# Three kinds of endocytosis

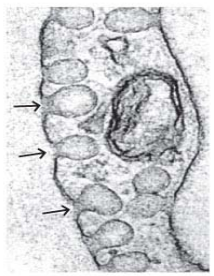
**Phagocytosis**



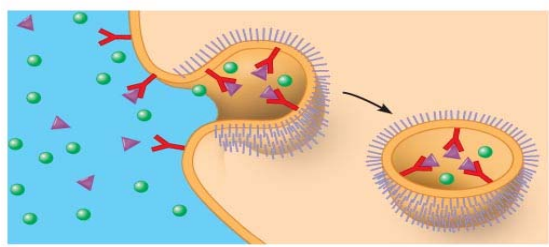


**Pinocytosis**



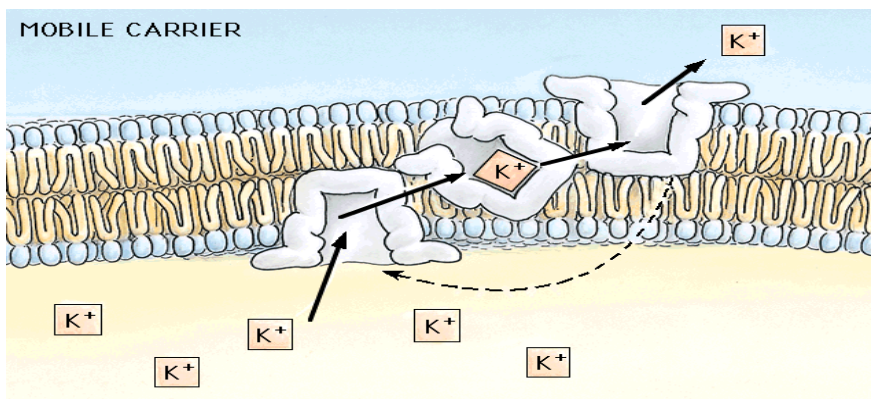


**Receptor-mediated endocytosis**



# Plasma membrane markers

- Special proteins or enzymes found in plasma membrane like:
- adenosine triphosphate transporting enzymes (Na+/K+ transporting ATPase , which found in all plasma membranes
- endoplasmic reticulum membrane contains glucose 6-phosphorylase
- inner mitochondrial membranes contains succinate dehydrogenase
- **Transport through membrane occurs via:**
- Rotation
- Crossing
- Conformation change
- Pore formation

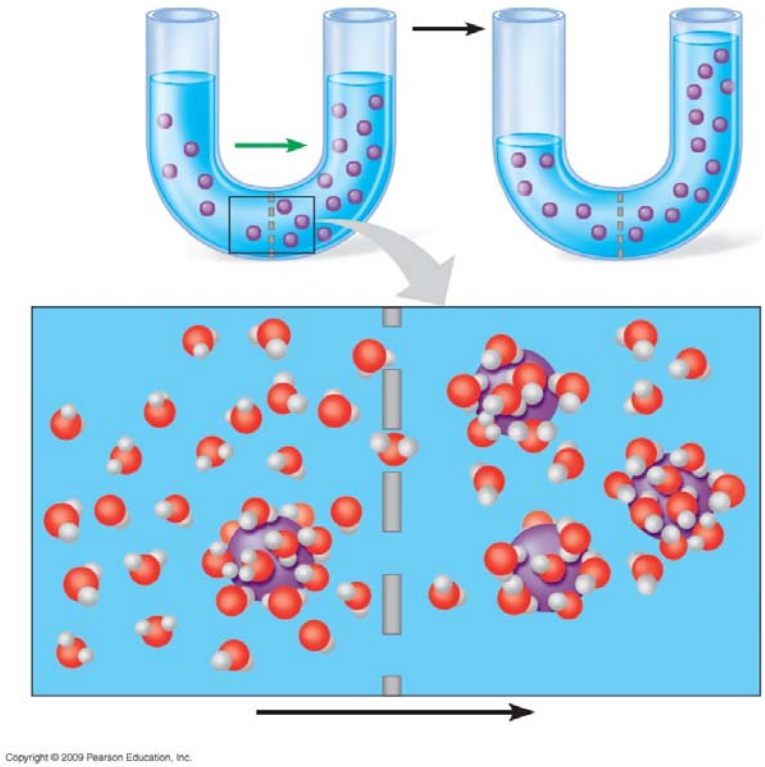


# Osmosis

- Osmosis is the diffusion of water across a membrane
- It is crucial for cells that water moves across their membrane.
- Water moves across membranes in response to solute concentration inside and outside of the cell by a process called **osmosis.**
- Osmosis will move water across a membrane down its concentration gradient until the concentration of solute is equal on both sides of the membrane

# Osmosis, the diffusion of water across a membrane

**Lower concentration of solute, Higher concentration of solute, Equal concentration of solute**



# Types of biological solution

- **Tonicity** is a term that describes the ability of a solution to cause a cell to gain or lose water
- Tonicity is dependent on the concentration of a non

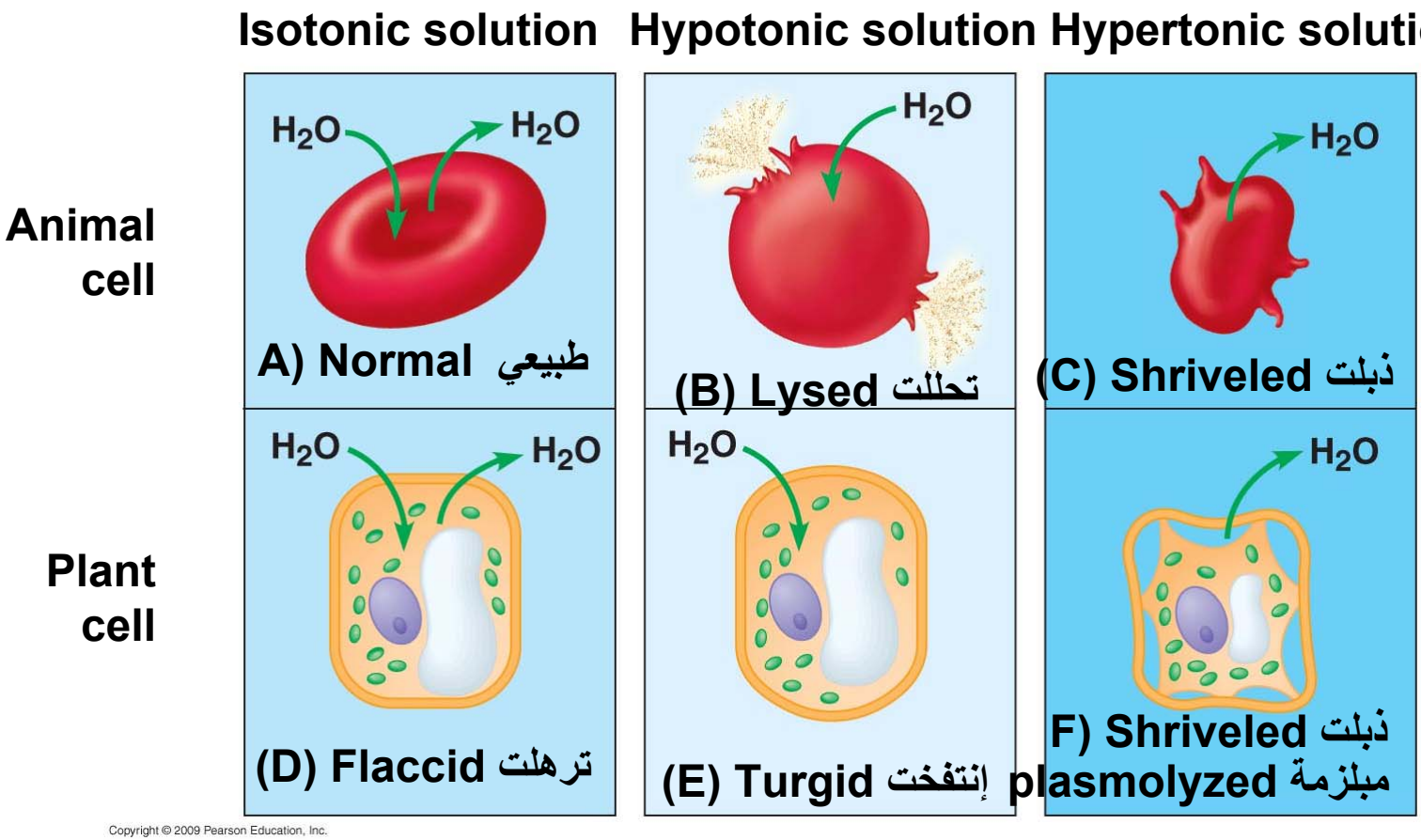
penetrating solute on both sides of a membrane.

**1- Isotonic solution:** indicates that the concentration of a solute of a cell and its isotonic environment are equal and the cell gains and loses water at the same rate.

**2- Hypertonic solution** indicates that the concentration of solute is higher than that inside a cell.

**3- Hypotonic** solution is a solution with a solute concentration lower than that of a cell.

# How animal and plant cells behave in different solutions



# Cell junctions

**A) Tight junctions or occludens :**

1) No spaces between membrane of adjacent cells.

2) Tightly pressed against each other to prevent leakage of fluid.

***e.g. cells of digestive tract ( intestinal cells).***

**B) Anchoring junctions or desmosomes**

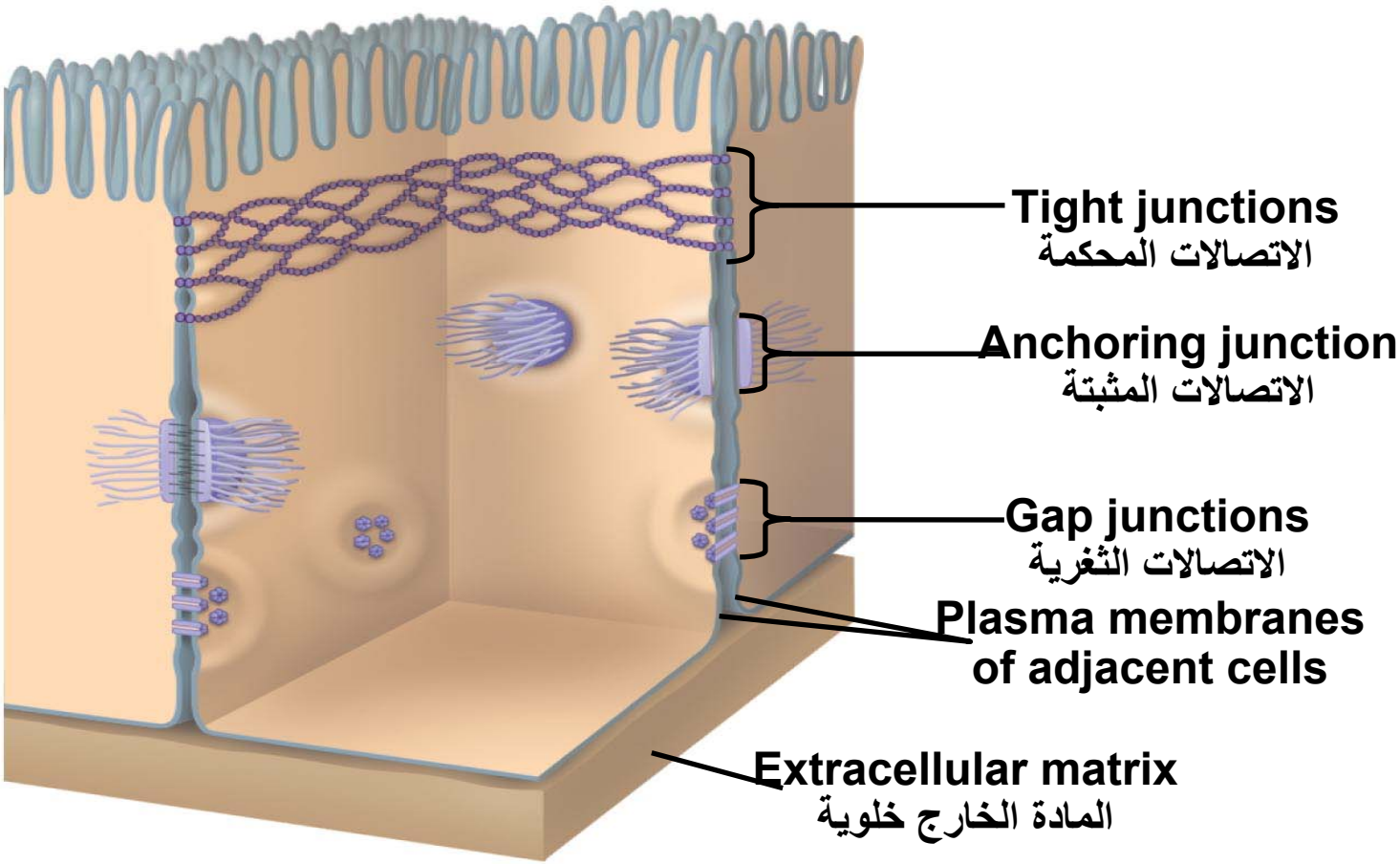
Each desmosome is made of regions of dense material on the cytoplasmic sites of the 2 plasma membranes, plus protein filaments in the narrow intercellular space between them. Desmosomes are anchored to intermediate filaments inside the cells. ***e.g. cells of epidermis of skin.***

**C) Gap junctions**

They are communicating junctions. They allow small molecules (ions) to flow through protein pores between cells

***e.g. heart muscle cells .*** In plant cells ***are called ''Plasmodesmata''***

# Three types of cell junctions in animal tissues



# Modification of cell membranes

1) Modification of cell membrane for protection and insulation

as ***myelin sheath*** which surrounds axon and is a modification of ***Schwann cells***.

2) The cell membrane of RBCs is ***highly selective*** to allow exchange of gases through it and is ***plastic*** to allow RBCs to be squeezed inside narrow capillaries.

3) **Photoreceptors** of retina which are sensory receptors detect and transmit light to the brain .

4**) Microvilli** : Projections of cell membranes, they increase surface areas of cells e.g. in cells of intestine.

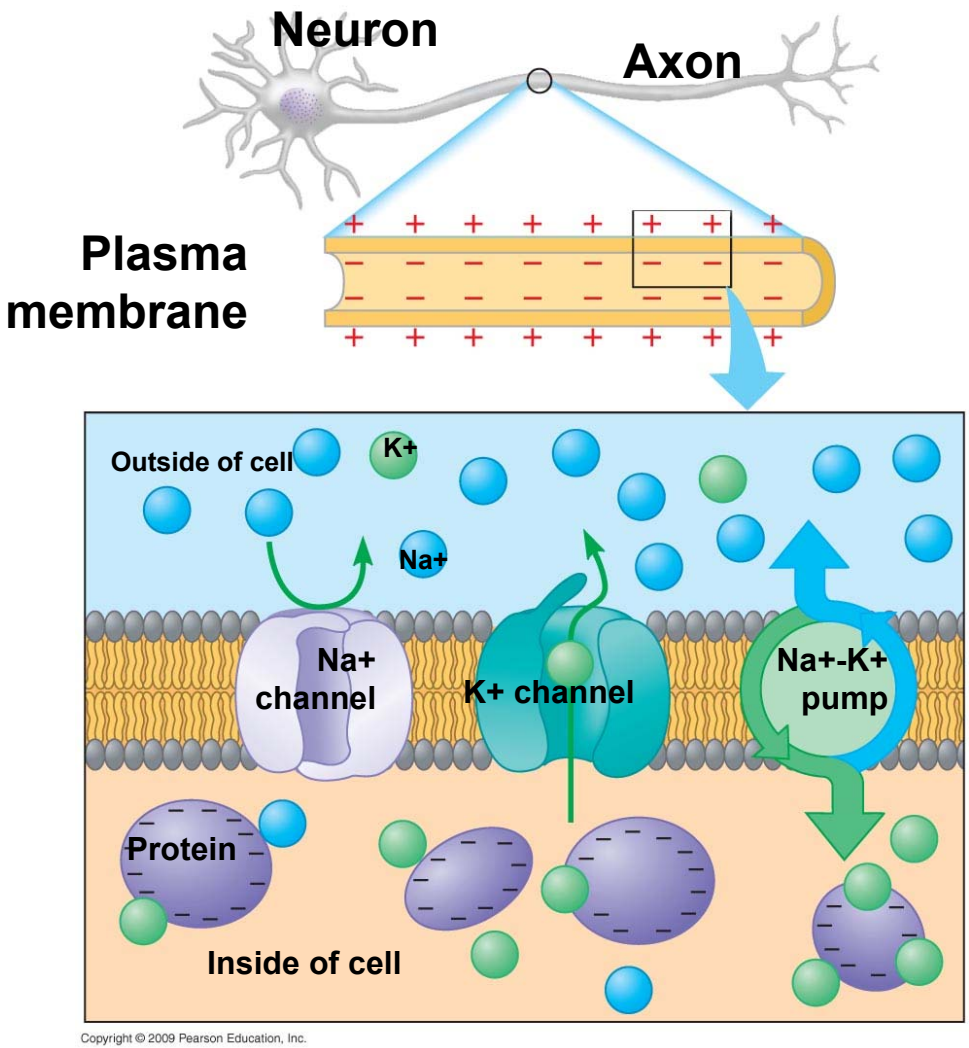
5) **Presence of basal and lateral infolding** of cell membranes as in cells of kidney tubules.

6) **Formation of pseudopodia** as in amoeba and WBCs.

# Na+/K+ pump

- Membranes proteins called sodium-potassium pumps **actively transport** Na+ out of the cell and K+ inside, helping keep the concentration of Na+ low in the cell and K+ high.
- The membrane potential can change from its resting value if the membrane's permeability to a particular ions changes.

# Na+/K+ pump


Neuron
Axon
Plasma membrane
Outside of cell
K+
Na+
Na+ channel
K+ channel
Na+-K+ pump
Protein
Inside of cell
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# Causes of resting membrane potential

- Na-K pump gates are working pumping 3Na+ ions out & allow 2K+ ions to pass inside.
- K ions diffuses out through passive K gates creating an electrochemical gradient. (+ve out & -ve in).
- A nerve signal begins as a change in the membrane potential :
- A **stimulus is any** factor that causes a nerve signal to be generated. e.g. light, sound. If a stimulus is strong enough, a neuron fires a nerve impulse or action potential