





### DIFFUSION ACROSS MEMBRANE (LIVING SYSTEM)

- **Diffusion** is a main form of transport **within cells** and **across cell membranes** in the living systems.
- It is also the means of gaseous exchange for respiration and metabolism.
- It occurs in three ways:
  - **Simple Diffusion**
  - **Osmosis**
  - **Active Transport**

### SIMPLE DIFFUSION

- It is the random movement of substances along a concentration gradient without the expenditure of energy and any special membrane protein. So, it is also known as **passive transport**.

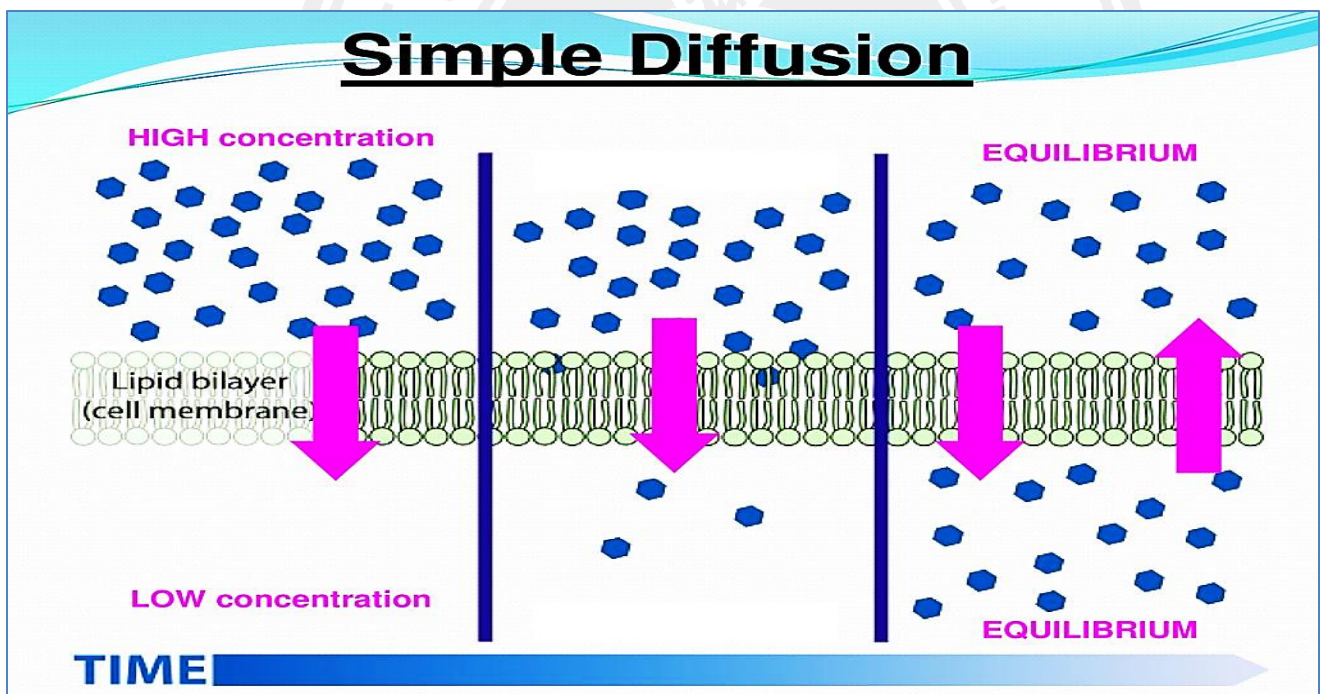


Fig: Simple Diffusion

- It is driven by the force of diffusion.
- **Small molecules** like  $H_2O$ ,  $O_2$ ,  $CO_2$  and **polar molecules (but small)** such as ethanol is transported by simple diffusion.



### FACTORS AFFECTING RATE OF DIFFUSION

- Concentration gradient across the membrane.
- Lipid solubility or hydrophobicity of that molecule.

### POLAR AND NON-POLAR SOLVENTS

- Polar solutes can dissociate into charged ions and dissolve in **polar solvents** like water, liquid ammonia etc.
- Non-polar solutes cannot dissociate into charged ions but can dissolve in **non-polar solvents** like benzene, ethylene, carbon tetrachloride etc.

### OSMOSIS

- It is a special case of diffusion of water across a semi-permeable membrane.
- The osmotic entry of water causes rise in the level of solution with higher concentration. The pressure developed is called osmotic pressure. In other words, it is the external pressure required to prevent net movement of water or solvent. It depends on the molar concentration of the solute.
- In the living systems, it is the primary means of transport of water through biological membranes.

## Tonicity Experiment – Thistle Tube

- ▶ Inside tube is hypertonic, outside tube is hypotonic
- ▶ Water moves from [high water] (hypotonic) to [low water] (hypertonic)

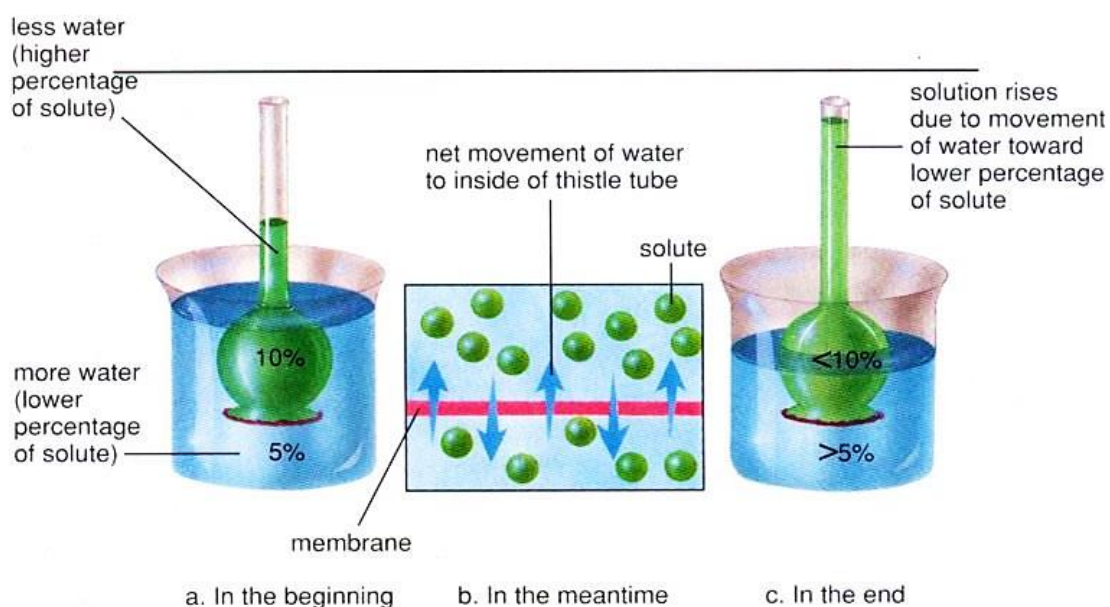
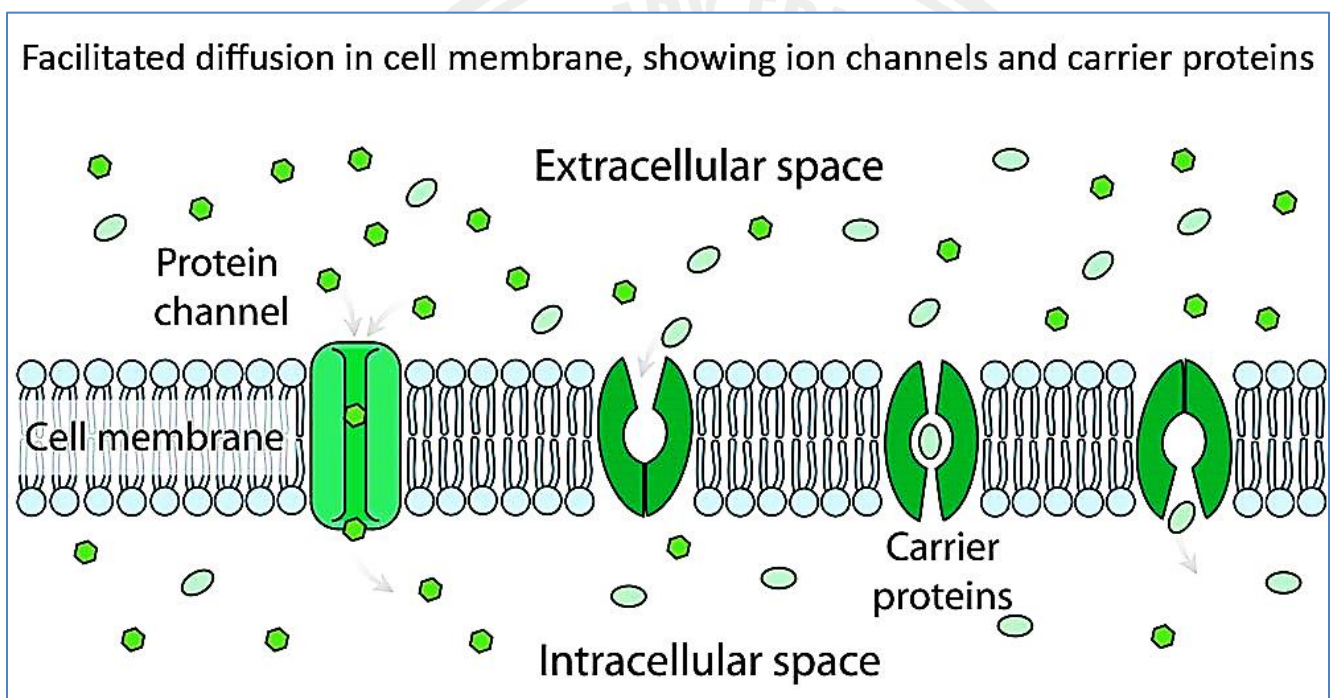


Fig. Demonstration of Osmosis



### **FACILITATED DIFFUSION**

- Plasma membrane is **impermeable** to **large polar solutes** like glucose, amino acids and **charged solutes** like  $\text{Na}^+$ ,  $\text{Cl}^-$  ions etc.
- They are transported along a concentration gradient with the help of membrane protein such as **channel protein or carrier proteins**. This is called facilitated diffusion.
- Channel protein form **pores** while carrier protein transfers specifically. In both the cases energy is not required.

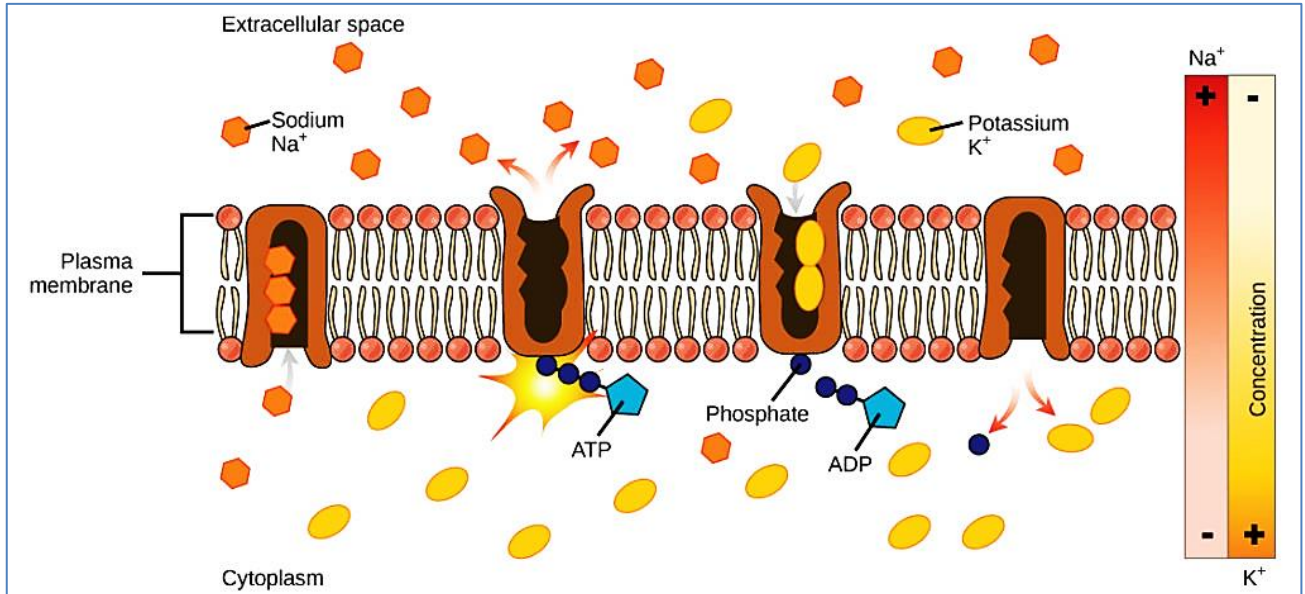


**Fig. Facilitated Diffusion**

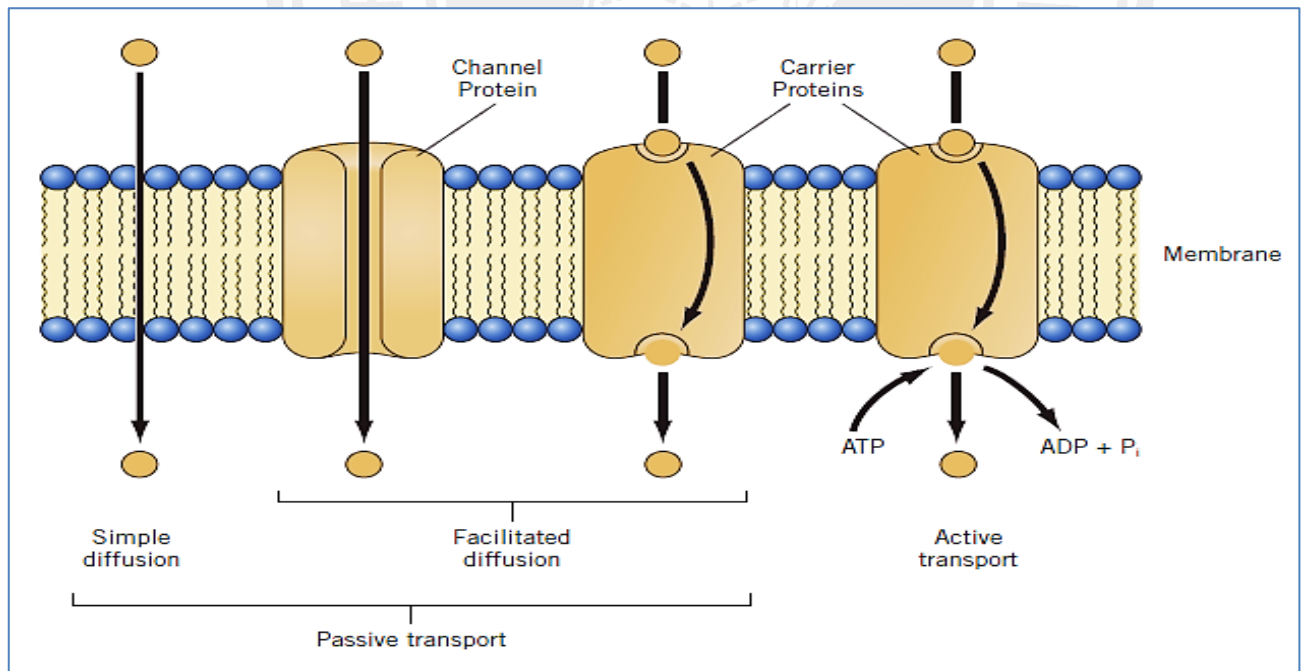
### **ACTIVE TRANSPORT**

- The movement of molecules across a membrane against the concentration gradient is called active transport. It occurs in an uphill manner that requires expenditure of energy from ATP.
- Na-K pump moves  $\text{K}^+$  ions into the cell and  $\text{Na}^+$  ions out of the cell.





**Fig. Active Transport**



**Fig. Various Means of Transport**



### **ROLE OF DIFFUSION IN METABOLISM**

- Diffusion is involved in different metabolic processes such as nutrition, exchange of gases, excretion.

### **DIFFUSION IN NUTRITION**

- The most important step in nutrition is absorption that occurs by diffusion mainly through the wall of small intestine (though certain items such as mustard, pepper, condiments and alcoholic drinks may be absorbed in the stomach).
- The digested carbohydrates and amino acids are absorbed by active transport. The transport of amino acids across the membrane require high concentration of  $\text{Na}^+$  in the intestinal lumen and it occurs by rapid and active process; fatty acids and glycerol are absorbed by pinocytosis (but short chain fatty acids are directly absorbed by simple diffusion) while water soluble vitamins are also absorbed by simple diffusion.
- The digested foods absorbed by the cells of small intestine enter into blood capillaries while fatty acids and glycerol enter lymphatic vessels. It is important to note that  $\text{Ca}^{2+}$  is absorbed by active transport against the concentration gradient.

### **DIFFUSION IN EXCRETION**

- It involves both passive diffusion and active transport. The elimination of waste products from the body is known as excretion and involves filtration of blood in the Bowman's capsule.
- Some of the useful substances like water, sodium chloride, glucose and amino acids are reabsorbed into the blood capillaries by active transport (while chloride moves out by passive diffusion).
- The re-absorption of water from the filtrate occurs by osmosis.

### **DIFFUSION IN GASEOUS EXCHANGE**

- Exchange of gases occurs during respiration. During respiration oxygen is taken up and  $\text{CO}_2$  is released out by diffusion across respiratory membrane. The transported gases are again exchanged between circulatory fluid and tissue.
- **DIFFUSION:** The tendency of molecules of solids, liquids and gases to get evenly distributed throughout the available spaces is called diffusion.



- **BROWNIAN MOVEMENT:** The perpetual motion of molecules due to the kinetic energy present in them is known as Brownian movement.
- **SIMPLE DIFFUSION:** The process whereby a substance passes through a membrane without the aid of an intermediary such as an integral membrane protein.
- **SEMI-PERMEABLE MEMBRANE:** A membrane which allows the passage of certain small molecules and prevents movement of larger molecules across it is called semi-permeable membrane.
- **OSMOSIS:** The spontaneous movement of water molecules across a semi-permeable membrane from its higher concentration to its lower concentration down a solvent concentration gradient.
- **OSMOTIC PRESSURE:** It is defined as the pressure required maintaining equilibrium, with no net movement of solvent.
- **ACTIVE TRANSPORT:** The movement of molecules across a membrane against the concentration gradient is called active transport.
- **FACILITATED DIFFUSION:** The transport of molecules across a plasma membrane which is facilitated by proteins that provide an alternate route or bypass is called facilitated diffusion.
- **DIGESTION:** The process during which complex food particles are broken down into smallest possible units so that they can be taken inside the cell is called digestion.

### **SUMMARY OF COMPARISON AMONGST DIFFUSION, OSMOSIS AND ACTIVE TRANSPORT**

<b>SIMPLE DIFFUSION</b>	<b>OSMOSIS</b>	<b>ACTIVE TRANSPORT</b>
➤ Diffusion is the movement of particles from a high to lower concentration.	➤ Osmosis is the diffusion of water across a membrane.	➤ Active transport moves particles from low to higher concentration.
➤ It is non selective.	➤ It is the passage of water (solvent).	➤ It is highly selective.
➤ It does not require any special membrane protein.	➤ It does not require any special membrane protein.	➤ It requires special membrane protein.
➤ It is a downhill process.	➤ It is a downhill process.	➤ It is an uphill process.
➤ A semi-permeable membrane may not be involved.	➤ A semi-permeable membrane is involved.	➤ A membrane is always involved
➤ It does not require expenditure of energy.	➤ It does not require expenditure of energy.	➤ It requires expenditure of energy.



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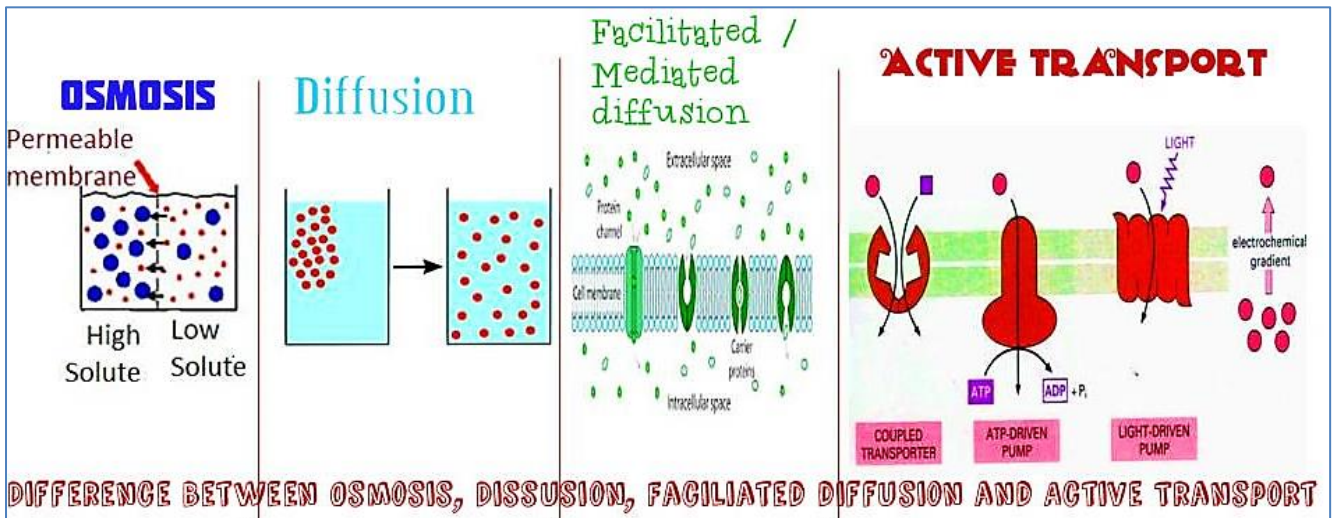
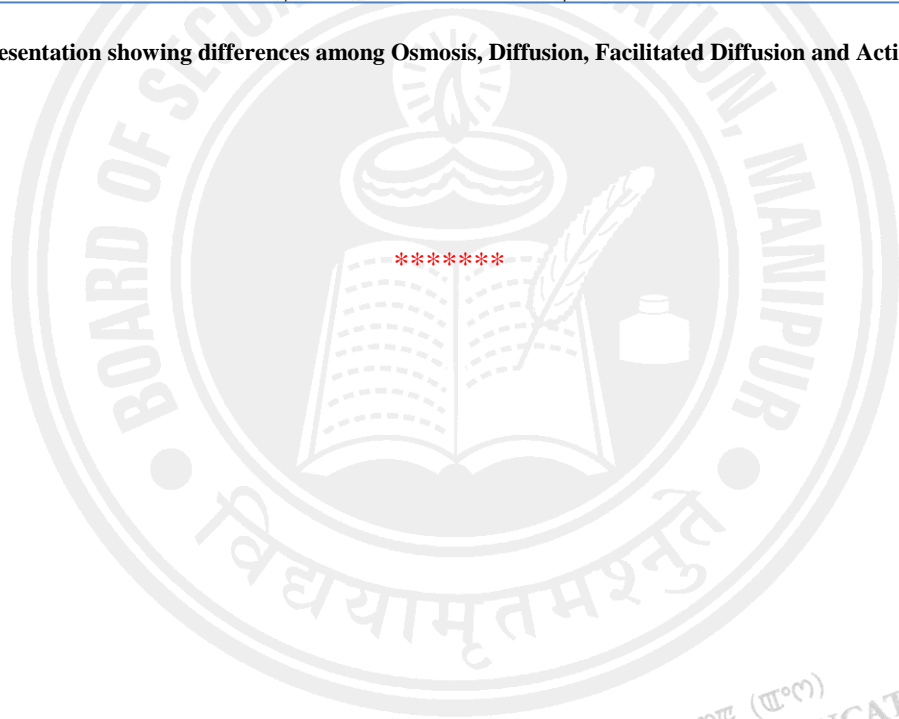


Fig. Diagrammatic representation showing differences among Osmosis, Diffusion, Facilitated Diffusion and Active Transport



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