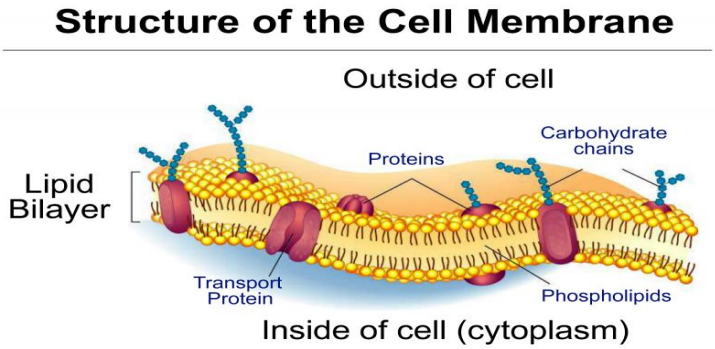
Week 3

Permeability of cell membrane

Like all other cellular membranes, the **plasma membrane** consists of both **lipids** and **proteins (fluid mosaic model)**. The fundamental structure of the membrane is the **phospholipid bilayer**, which forms a stable barrier between two aqueous compartments. In the case of the plasma membrane, these compartments are the inside and the outside of the cell. **Proteins embedded** within the phospholipid bilayer carry out the specific functions of the plasma membrane, including ***selective transport of molecules and cell-cell recognition.***

Lipids and **proteins** that are exposed to the outside of the cell may also have **oligosaccharides** (short chains of sugar molecules) attached to them, making them **glycolipids** and **glycoproteins**. The carbohydrate portion **recognizes and is recognized** by **specific binding substances on other cells or in the environment.**



Transport in Plant

Transport in plants occurs on three levels:

(a) the **uptake and loss of water** and solutes by individual cells
(b) short-distance transport of substances from **cell to cell** at the level of tissues or organs
(c) long-distance transport of **sap within xylem and phloem** at the level of the whole plant.

Modes of transports:

1. **Simple Diffusion or passive transport**

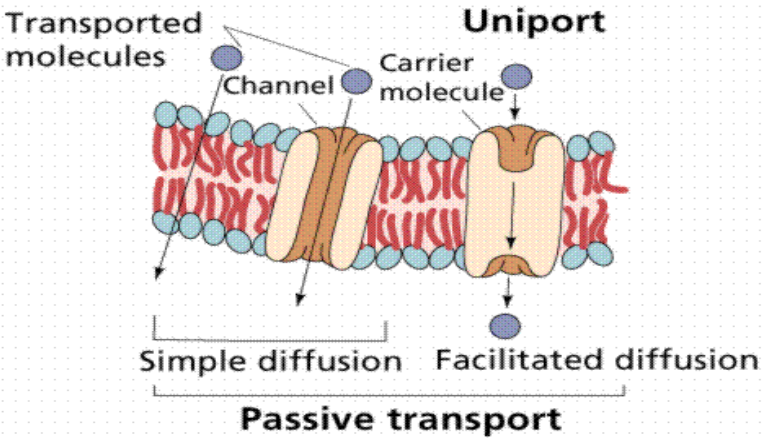
The simplest forms of transport across a membrane are passive. **Passive transport** does **not require the cell to expend any energy** and involves a substance diffusing down its **concentration gradient** across a membrane.

The cell membrane is **selectively permeable** because only **small molecules** can pass through and **larger** molecules such as **starch** or **proteins** cannot. Thus, over time, the net movement of molecules will be out of the **more concentrated** area and into the **less concentrated** one, until the concentrations become **equal**.

Carbon dioxide diffuses from the air into a leaf through the stomata, then into the photosynthesizing cells. This is because carbon dioxide is used up in **photosynthesis**, so the concentration in the **leaf** cells is **lower** than that in the **air** outside (due to concentration gradient).

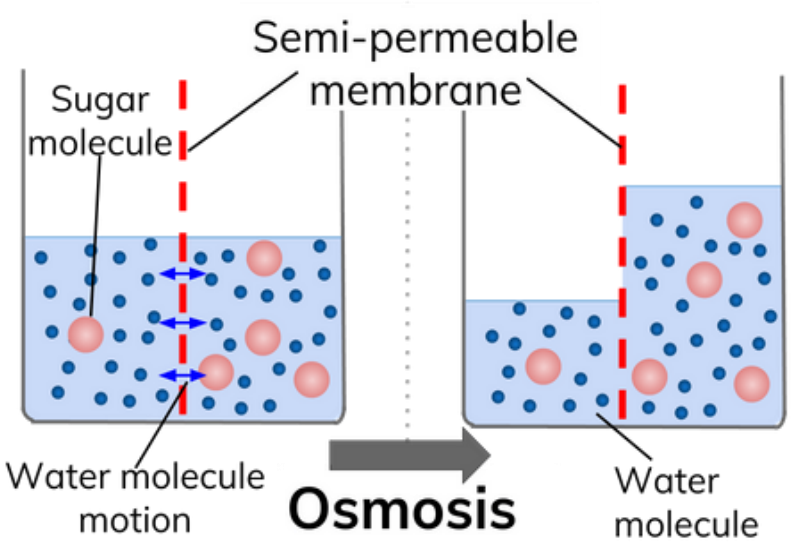
2. Facilitated transport

Facilitated transport is a type of passive transport. Unlike simple diffusion where materials pass through a membrane without the help of proteins, in facilitated transport, also called facilitated diffusion, materials diffuse across the plasma membrane with the help of **membrane proteins**. A **concentration gradient** exists that would allow these materials to diffuse into the cell without expending cellular energy. Such proteins allow **larger**, **polar** **molecules** such as **sugars** and **amino acids** to be taken up by cells. Extremely **specific** **recognition** by the **transport protein** enables material to be transported. For this reason, membranes may readily transport **one type** of molecule but be completely **impermeable to another** molecule, **even a closely related one**.



3. Osmosis

Osmosis is a **special case of diffusion**. Osmosis is the movement of water through a **selectively permeable membrane** from a region of **higher** water concentration to a region of **lower** water concentration. **Adding particles** to one side of a membrane can **establish** a **concentration gradient for water**. The **increase** in **particles** on one side results in a **decrease in water** for that area.

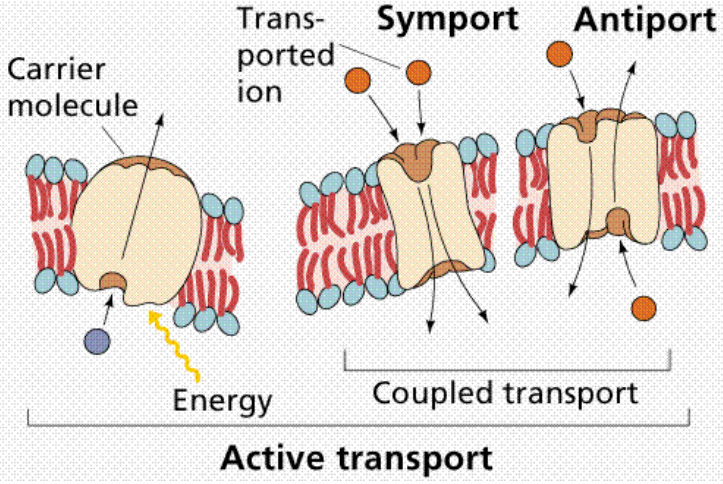


The significance of osmosis to plant

1. Osmosis helps in **absorption** of water by plants.
2. The **turgidity** of plant **organs** is dependent on water which is absorbed due to osmosis.
3. **Movement** of water from one cell to another is due to osmosis.
4. The **resistance** of plants to drought and frost is brought about by osmosis.
5. **Opening** and **closing** of stomata is brought about by osmosis.
6. **Expansion of cells** is dependent upon turgidity.

4. Active transport: moving against a gradient

Transport method that **moves particles** from an area of **low concentration** to an area of **high concentration** or **against a concentration gradient**. Active transport relies on **energy** from the **breakdown of ATP** to move substances across the membrane.

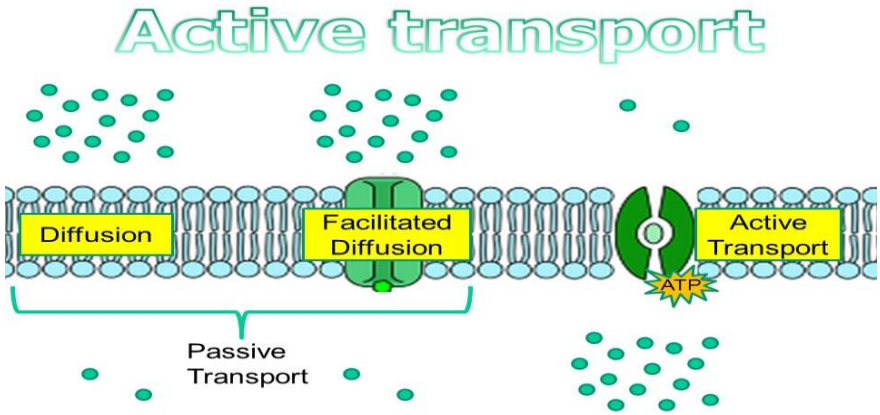


Active transport mechanism:

Active transport **mediated** by a **carrier**, the substance being transported is initially bound to a **specific site** on the carrier protein. This requirement for binding allows carriers to be **highly selective** for a particular **substrate to be transported**. Carriers therefore **specialize** in the transport of **specific organic metabolites**.

Binding causes a **conformational** change in the protein, which exposes the substance to the solution on the other side of the membrane. Transport is complete when the substance **dissociates** from the carrier's binding site.

Typically, carriers may transport **100 to 1000 ions** or molecules **per second**, which is about **106 times slower than passive transport**.



Types of active transport

1. **Primary active transport:**

directly uses a source of chemical energy (e.g., ATP) to move molecules across a membrane against their gradient. The membrane **proteins that carry out primary active transport** are called **pumps**. Most pumps transport **ions**, such as **H^+** or **Ca_2^+**. The **direction** of pumping is **intake outward**. Therefore **another mechanism** is needed to drive the active **uptake (inward)** of most mineral nutrients.

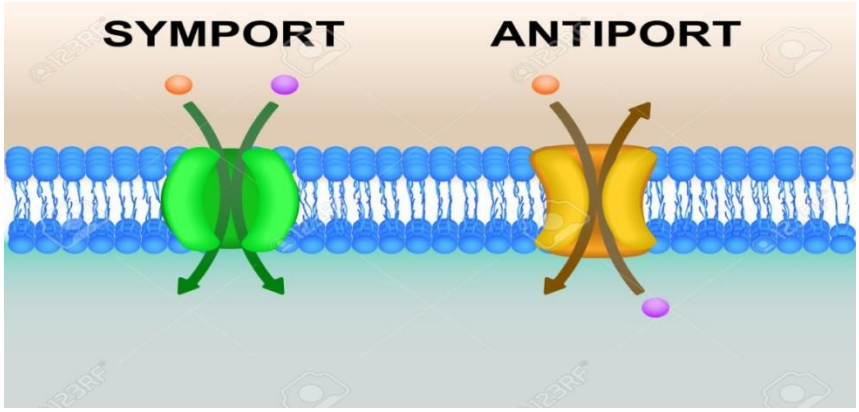
2. **Secondary active transport**

uses an electrochemical gradient – generated by primary active transport – as an energy source to move molecules against their gradient, and thus does not directly require a chemical source of energy such as ATP. Secondary transport may involve the binding of a **substrate (S)** and an ion (usually **H+**) to a carrier protein, and a **conformational change in that protein**.

There are two types of secondary transport:

1. **Symport**: the **protein** involved is called a **symporter**, because the two substances are moving in the same direction through the membrane.

2. **Antiport**: facilitated by a protein called an **antiporter**, refers to **coupled transport i**n which the downhill movement of protons drives the active (uphill) transport of a solute in the **opposite direction.**



3. Vesicle-mediated transport

Vesicles and vacuoles that fuse with the cell membrane may be utilized to release or transport chemicals out of the cell or to allow them to enter a cell. Exocytosis is the term applied when transport is out of the cell.