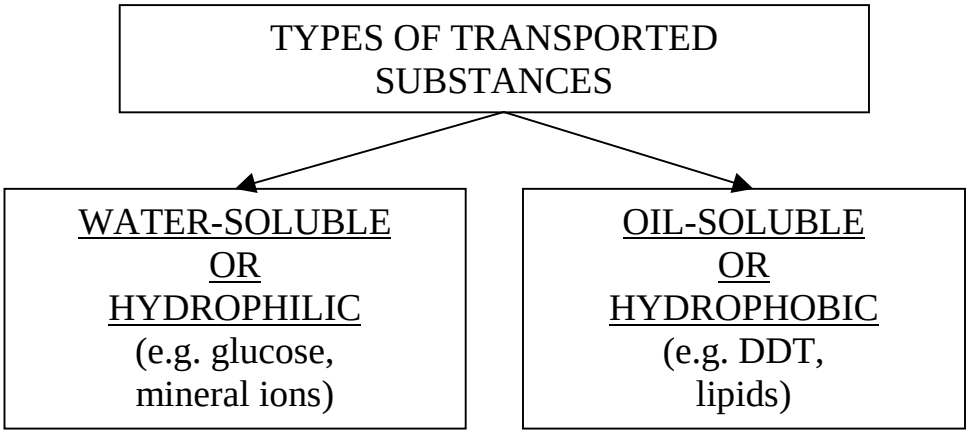
CYTOPLASM AND MEMBRANES



Cytoplasm

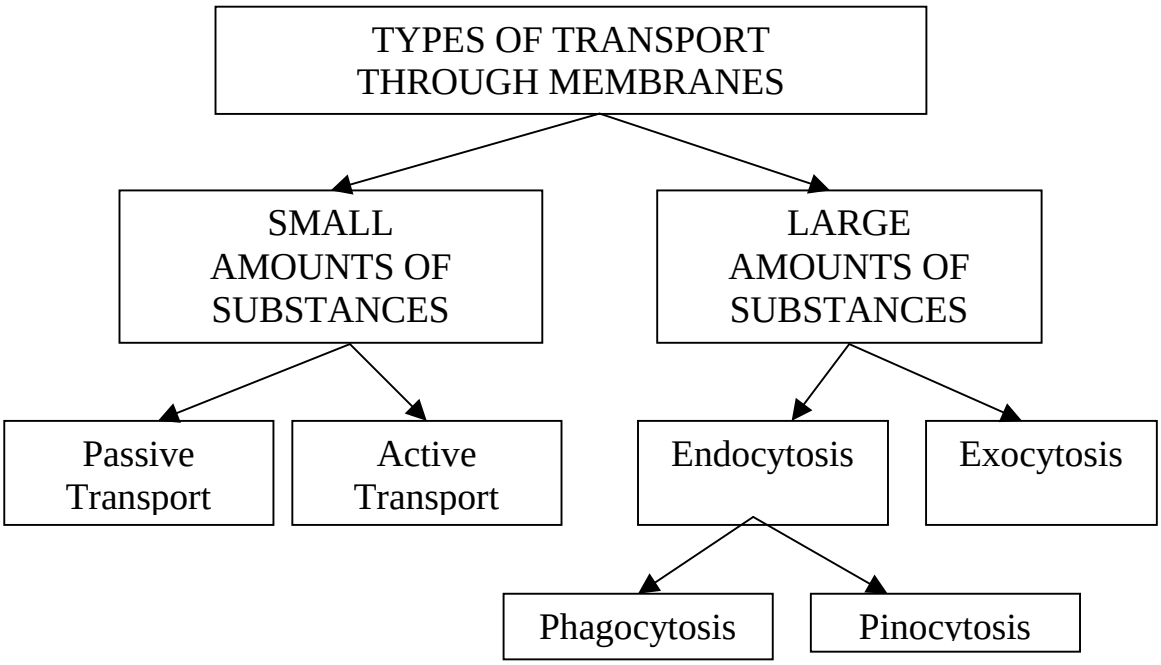
- The cytoplasm of plant cells is about 95% water, and of animal and bacterial cells is about 70% water.
- There are different concentrations of both water-soluble and oil-soluble substances in the cytoplasm that must pass into and out of the cell and organelle membranes.

Membranes

- Cell and organelle membranes have the same chemical composition, but the cell membrane is thicker.
- Fluid-Mosaic Model - Membranes are about 1/2 lipid and 1/2 protein, forming a 2-layered structure. This is called a bilayer of phospholipid molecules interspersed with many protein molecules. The phospholipid molecules have one end that is hydrophobic ('water-hating') and the other end that is hydrophilic ('water-loving'). Individual lipid molecules and some protein molecules are free to move within the layers.

Refer to the Fluid Mosaic Model of the Cell Membrane diagram in your textbook.

- Membranes are differentially permeable because they allow some substances to pass through easily, and not others. Small uncharged molecules (e.g. oxygen and carbon dioxide) and water molecules can pass through easily. Lipid-soluble substances (e.g. alcohol) also pass through easily by dissolving into the phospholipid bilayer. Most water-soluble molecules (e.g. mineral ions, amino acids and simple sugars) can only pass through the channels made by the interspersed protein molecules, and require energy for transport.



TRANSPORT OF SMALLER QUANTITIES THROUGH MEMBRANES

SOLUTES, SOLVENTS AND SOLUTIONS

- Solution – a mixture where one substance dissolves in another (e.g. saltwater)
- Solute – the substance that dissolves (e.g. salt in saltwater)
- Solvent – the substance that does the dissolving (e.g. water in saltwater)

PASSIVE TRANSPORT

- Passive Transport uses no energy
- Substances move from high to low concentrations
- Diffusion is the movement of substances from high to low concentration. Oil-soluble substances pass through the lipid part of membranes easily by diffusion also.
- Osmosis is the diffusion of water. Water diffuses through the membranes by either slow diffusion through the lipid bilayer, or through protein channels.

ACTIVE TRANSPORT

- Active Transport requires energy from energy-rich ATP molecules.
- Substances move from low to high concentrations.
- Glucose is water-soluble, but requires some energy to be transported. First, proteins in the membrane 'pump' hydrogen ions (H^+) out of the cell. This requires the energy of ATP. Then the hydrogen ion (H^+) attaches to the glucose molecule to transport it into the cell through proteins in the membrane. Hormones such as adrenalin can attach to a membrane to increase the transport of glucose into a muscle cell.
- Mineral Ions (potassium K^+, sodium Na^+, calcium Ca^{2+}) are carried through the membrane either by ion-transporting proteins (a process that requires the energy of ATP), or by slow diffusion, since ions are water-soluble. Examples of ion

transport are calcium ions in muscle cells, and potassium and sodium ions in nerve cells.

- Exocytosis
  Exocytosis is the removal of large quantities of substances (e.g. milk from milk glands, venom from venom glands) out of a cell. The transport of large quantities occurs when vesicles containing the substances bind temporarily with the cell membrane.
- Endocytosis
  Endocytosis is the intake of large quantities of substances (e.g. infective bacteria, food for protozoans) into a cell. Endocytosis has 2 types:
  1. Phagocytosis (e.g. protozoans feeding, white blood cells engulfing invading bacteria)
  2. Pinocytosis (e.g. human egg taking in food such as oil in droplet form)

COMPARISON OF DIFFUSION,OSMOSIS AND ACTIVE TRANSPORT

DIFFUSION	OSMOSIS	ACTIVE TRANSPORT
Transport of gases or dissolved substances in solution from a region of high concentration to a region of low concentration	*Transport of water through a semi-permeable membrane from a solution of high concentration to a solution of low concentration*	*Transport of a substance from low to high concentration regions, using energy from the cell, through a living membrane*
1. Liquids and gases can diffuse over considerable distances	Water only transported over a short distance	Certain selected solutes, ions, glucose, sucrose, amino acid, etc., transported through short distances
2. Rapid in gases, but slow in solutions of substances	Slow process	Rapid process
3. Transport from high to low concentration	Transport of water from solution of high to low concentration	Transport of selected substances from region of low to high concentration
4. Occurs with or without a non-living permeable membrane	Either a living or non-living semi-permeable membrane needed	A living selective lipo-protein membrane is essential
5.No cell energy required	No cell energy required	Cell energy from ATP required

SURFACE AREA TO VOLUME RELATIONSHIP

- All organisms must exchange materials with their environment through membranes. Because their requirements are greater, large organisms must exchange more material than small organisms.
- As any object gets larger, its volume increases more rapidly than its surface area.

Side Length	Surface Area	Volume	S.A. to Volume Ratio
1 cm	6 cm^2	1cm^3	6
10 cm	600 cm^2	1000cm^3	0.6

- In the table, while the volume increases 1000 times, the surface area only increases 100 times.
- Very small organisms have the most effective materials exchange through membranes by having a round shape.
- One way that larger organisms overcome the problem is to change shape. For example, flatworms and algae are flattened in shape for greater surface area.