All organisms are composed of either one cell (**unicellular, e.g. bacteria**) or more cells (**multicellular, e.g. the adult human body**).

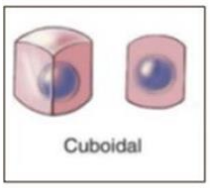
- Cells can be define as the basic structural and functional units of life.
- cells are classified into two groups : the **prokaryotes** and **eukaryotes.**
  - **Prokaryotic** is a unicellular microorganism that has no nuclear membrane, or any other membrane-bound organelles. E.g. bacteria.
  - **Eukaryotic** cell is a cell that contain a membrane-bound nucleus and other membrane bound compartments called organelles, which have specialized functions. E.g. animals, plants and fungi .

Cell size and shape

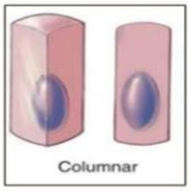
There are different size and shape of cells . Most cells though are much smaller and so we need a microscope to be able to examine them. **Light microscope** allows to see objects as small as 200 nm. In order to see the parts of cell that are smaller than this we need to use an **electron microscopes,**This type of microscope allows to observe objects that are only 0.2 nm.

There are different shapes of cells such as

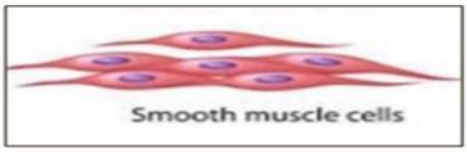
1. **Cube shape** e.g. Cuboidal cells.



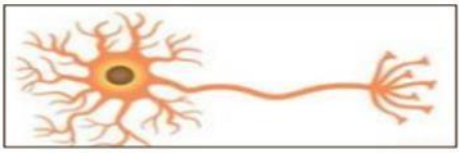
2. **Long column shape** e.g. Goblet cell.



3. **Spindle shape** e.g. Smooth muscle cells



4. **Cells have long projections** e.g. Nerve cells.



Protoplasm

The living part of the cell is called protoplasm. Protoplasm is composed of water, proteins, lipids, carbohydrates. Protoplasm consists of two distinct regions:

- Cytoplasm which lies outside the nucleus.
- Nucleoplasm which lies inside the nucleus.

Three main components of cells

1. **Plasma membrane:** is an outer membrane that separates the cell's interior from its surrounding environment.
2. **Cytoplasm:** It is the fluid present in the cell and surrounded by the cell membrane, which contains water, enzymes, salts.
3. **Nucleus:** is a large organelle that may or may not be centrally within the cytoplasm.

Plasma Membrane Functions

1) The plasma membrane isolates the interior of the cell from the external environment (Physical barrier).
2) It allows only certain molecules and ions to enter and exit the cytoplasm freely. Therefore, the plasma membrane is said to be selectively permeable .

3) Small lipid-soluble molecules, such as oxygen and carbon dioxide, can pass through the membrane easily.
4) The small size of water molecules allows them to freely cross the membrane by using protein channels called aquaporins.
5) Ions and large molecules cannot cross the membrane without more direct assistance.

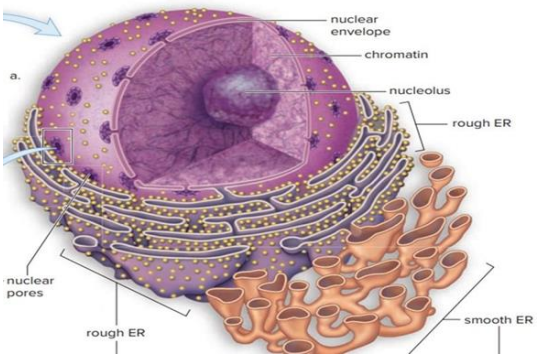
The Cytoplasm

The cytoplasm includes the contents of a cell between the plasma membrane and the nuclear envelope . It is contains organelles and cytoskeleton suspended in the gel-like called cytosol consists of 70 to 80 percent water. Many metabolic reactions, including protein synthesis, take place in the cytoplasm.

The nucleus

The nucleus, a prominent structure in eukaryotic cells and is a large organelle that may or may not be centrally within the cytoplasm.

- It is enveloped in a double membrane , called nuclear envelop that has nuclear pores to control the passage of ions, molecules, and RNA between the nucleoplasm and the cytoplasm.
- It stores genetic information as DNA organized into linear structures called chromosomes (structures within the nucleus that are made up of DNA and proteins). This combination of DNA and proteins is called chromatin.



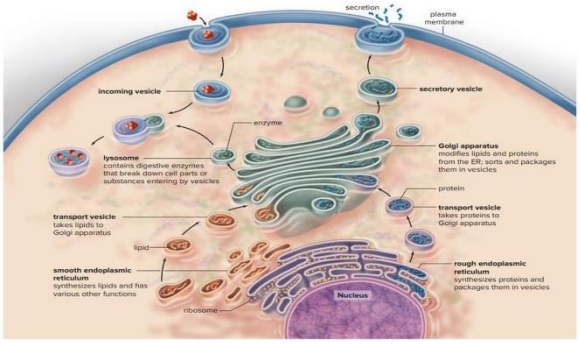
Ribosomes

Ribosomes are organelles composed of proteins and rRNA (nucleoproteins). Protein synthesis occurs at the ribosomes. Because protein synthesis is essential for all cells, ribosomes are found in practically every cell, although they are smaller in prokaryotic cells.

The endoplasmic reticulum

- ER is a major site for vital cellular activities, including biosynthesis of proteins and lipids.
- Numerous ribosomes attached to the membrane in some regions of ER allow two types of ER to be distinguished.
- RER's Is so named because the ribosomes attached to its cytoplasmic surface.
- RER is specialized for synthesize protein
- **The SER's functions include:**

1) Synthesis of carbohydrates, lipids (including phospholipids)and steroid hormones.
2) Detoxification of medications and poisons.
3) Storage of calcium ions.



Golgi complexes

Golgi complexes are located near the nucleus in most cells and it consists of many smooth membranous saccules, some vesicular, others flattened, but all containing enzymes and proteins being processed.

Lysosomes

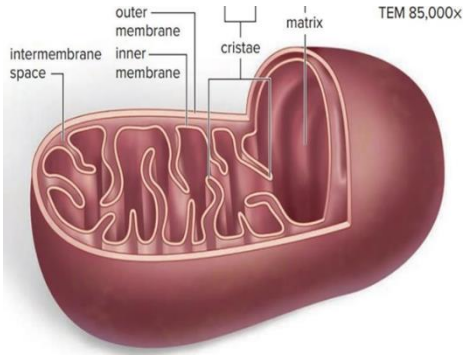
Lysosomes, membranous sacs produced by the Golgi complex, contain hydrolytic enzymes. Lysosomes are found in all cells of the body but are particularly numerous in white blood cells that engulf disease-causing microbes. When a lysosome fuses with such an endocytic vesicle, its contents are digested by lysosomal enzymes into simpler subunits, which then enter the cytoplasm. In a process called autodigestion, parts of a cell may be broken down by the lysosomes.

Mitochondria

Mitochondria (sing. = mitochondrion) are often called the powerhouses or energy factories of a cell because they are responsible for making adenosine triphosphate (ATP), the cell's main energy-carrying molecule.

Mitochondria are oval-shaped, double-membrane organelles,

- an outer membrane encloses the intermembrane space .
- an inner membrane with many folds (cristae) enclosing a gel-like matrix.

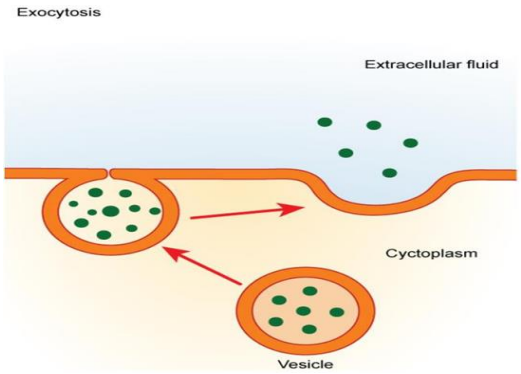


Mechanisms of transport across the plasma membrane

Bulk Transport (Vesicular transport)

Cells use bulk transport to move large molecules, such as polysaccharides or polypeptides, across the membrane. These processes use vesicles rather than channel or transport proteins this type of transport include Exocytosis and Endocytosis.

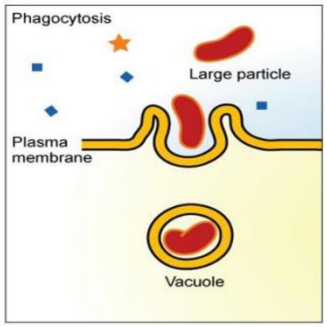
Exocytosis : There are many substances that must exit from a cell , the secretions or enzymes are packaged into vesicles and then moved towards the cell membrane where they are discharged , a vesicle fuses with the plasma membrane as secretion occurs. For example, the secretions produced by Golgi complex need to leave the cell.



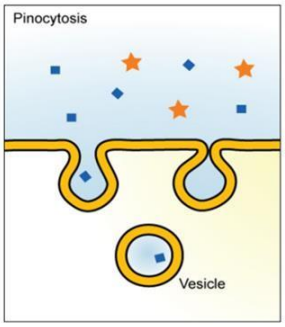
Endocytosis: The large molecules or other materials can enter the cell by this method. During endocytosis, a portion of the plasma membrane invaginates, or forms a pouch, to envelop a substance and fluid.

There are three major types of endocytosis:-

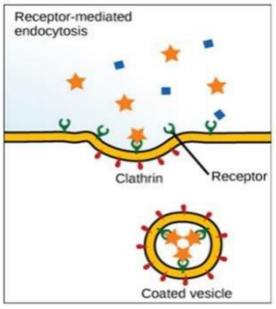
1. **Phagocytosis:** ("cell eating") is the ingestion of particles such as bacteria or dead cell remnants. Then the membrane pinches off to form an endocytic vesicle inside the cell. Some white blood cells such as macrophages and neutrophils are able to take up pathogens by endocytosis.



2. **Pinocytosis:** ("cell drinking") liquid can be packaged into a vacuole or vesicle which is then taken into the cell.



3. **Receptor-mediated endocytosis:** Type of endocytosis in which plasma membrane receptors first bind specific substances; receptor and bound substance then taken up by the cell.



Diffusion

- Diffusion is the random movement of molecules from an area of higher concentration to an area of lower concentration, until they are equally distributed.
- Diffusion is a passive way for molecules to enter or exit a cell. This type of transport does not require energy to move substances.

Active Transport

During active transport, a molecule is moving from an area of lower to an area of higher concentration.

Osmosis

Osmosis is a special case of diffusion and is the net movement of water across a selectively permeable membrane.

The direction by which water will diffuse is determined by the tonicity of the solutions inside and outside the cell.

- Tonicity is based on dissolved particles, called solutes, within a solution. The higher the concentration of solutes in a solution, the lower the concentration of water, and vice versa.

Typically water will diffuse from the area that has less solute (low tonicity, and therefore more water) to the area with more solute (high tonicity, and therefore less water). Tonicity describes the amount of solute in a solution. Three terms hypotonic, isotonic, and hypertonic are used to relate the concentration of solutes inside of a cell compared to the concentration of solutes in the fluid that contains the cells.

Hypotonic solution: the extracellular fluid has a lower concentration of solutes than the fluid inside the cell, and water enters the cell. Therefore, water passes into the cells by osmosis and causes them to swell up and eventually burst.

Isotonic solution: the extracellular fluid has the same concentration of solutes of the fluid inside the cell. They therefore cause neither shrinking nor swelling of cells and tissue.

Hypertonic solution: the extracellular fluid having a higher concentration of solutes than the fluid inside the cell the fluid contains less water than the cell does. Therefore, the water will leave the cell by osmosis and causes them to shrink.