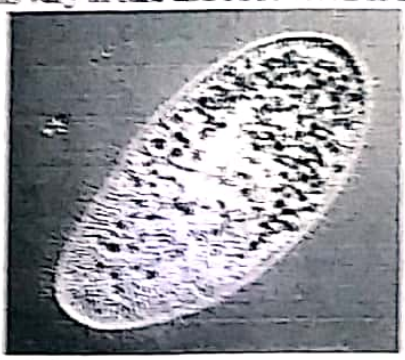
CELL – STRUCTURE AND FUNCTION

All organisms are composed of structural and functional units of life called "cells".
The body of some organisms like bacteria is made up of a single cell whereas the body of plants and animals are composed of many cells. Cells vary in size and structure. But the basic components of the cell are common.



THE CELL AND CELL THEORY

After the invention of microscope, Robert Hooke in 1665 observed a piece of cork under the microscope and found it to be made of "cells" (Latin cell = small room).
In 1672, Leeuwenhoek observed bacteria, sperms and red blood corpuscles, all of which were cells. In 1831, Robert Brown, an Englishman observed that all cells had a centrally positioned body which he termed the **nucleus**.

The cell theory

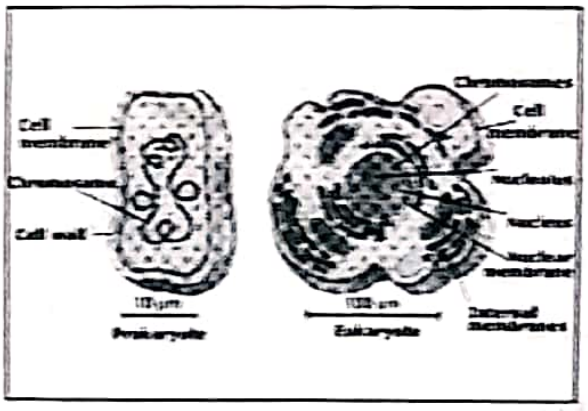
In 1838 M.J. Schleiden and Theodore Schwann formulated the "cell theory according to which:
all organisms are composed of cells.
cell is the structural and functional unit of life, and cells arise from pre-existing cells.

The Cell

A cell may be defined as a unit of **protoplasm** bound by a plasma or cell membrane and possessing a nucleus. Protoplasm is the life giving substance and includes the cytoplasm and the nucleus. The cytoplasm has in it **organelles** such as ribosomes, mitochondria, golgi bodies, plastids, lysosomes and endoplasmic reticulum. Plant cells have in their cytoplasm, large vacuoles containing non-living inclusions like crystals, and pigments. Every cell has three major components:
plasma membrane
cytoplasm
DNA

Types of cells

There are two types of cells. Organisms which do not possess a well formed nucleus are **prokaryotes** such as the bacteria. All others possess a well defined nucleus, covered by a nuclear membrane. They are **eukaryotes**.



Eukaryotic cell (eu = true, karyon = nucleus)	**Prokaryotic cell** (Pro = early/primitive)
1. Nucleus distinct, with well formed nuclear membrane.	1. Nucleus not distinct, it is in the form of a nuclear zone 'nucleoid'. Nuclear membrane absent.
2. Double-membraned cell organelles (Chloroplasts, mitochondria, nucleus) and single membraned (Golgi apparatus, lysosomes, vacuole, endoplasm reticulum) are present	2. Single-membraned cell bodies like mesosomes present. Endoplasmic reticulum, plastids, nitochondria microbodies like lysosomes, and Golgi body absent.
3. Ribosomes - 80 S	3. Ribosomes - 70 S
4. Distinct compartments in the cell i.e. the cytoplasm and the nucleus	4. No compartments.
5. Depending upon the species number of chromosomes per nucleus varies from two to many.	5. There is only one chromosome per cell.
6. Each chromosome is linear with its two ends free.	6. The chromosome is circular and remains attached to cell membrane at one point.
7. Each chromosome has one linear double-stranded DNA complexed with histones	7. The chromosome has single double-stranded circular DNA molecule and is not associated with histones.
8. Each chromosome has one centromere that divides a chromosome into two arms. However, if the centromere is terminal, the chromosome would have only one arm	8. The chromosome lacks a centromere.

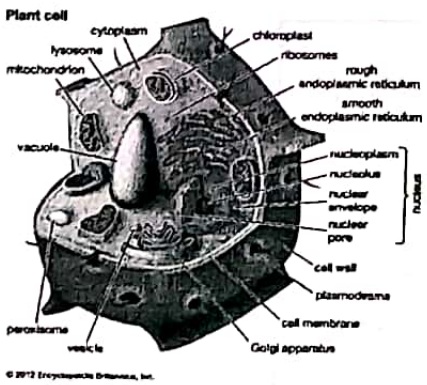
Differences between plant cell and animal cell

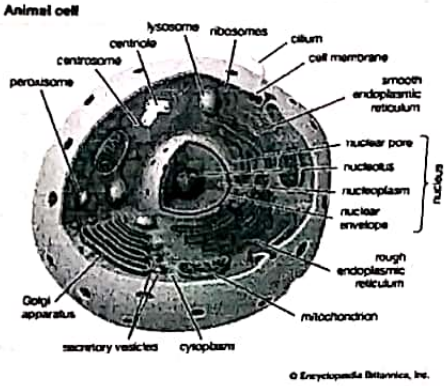
Plant cell

1. Cellulose cell wall present external to cell membrane.
2. Vacuoles are usually large.
3. Plastids present.
4. Golgi body present in the form of units known as dictyosomes.
5. Centriole absent.

Animal cell

1. No cell wall, outermost structure is cell membrane or plasma membrane
2. Generally vacuoles are absent and if present, are usually small..
3. Plastids absent.
4. Golgi body well developed having 2 cisternae
5. Centriole present





COMPONENTS OF THE CELL

The major components of the cell are (1) cell membrane, (2) cytoplasm, and (3) nucleus.

1. Cell membrane

Each cell has a limiting boundary, the cell membrane, plasma membrane or plasmalemma. It is a living membrane, outermost in animal cells but internal to cell wall in plant cells. It is flexible and can fold in or fold out. The plasma membrane is made of proteins and lipids. The **fluid mosaic model** proposed by Singer and Nicholson (1972) is widely accepted.

According to the fluid mosaic model,

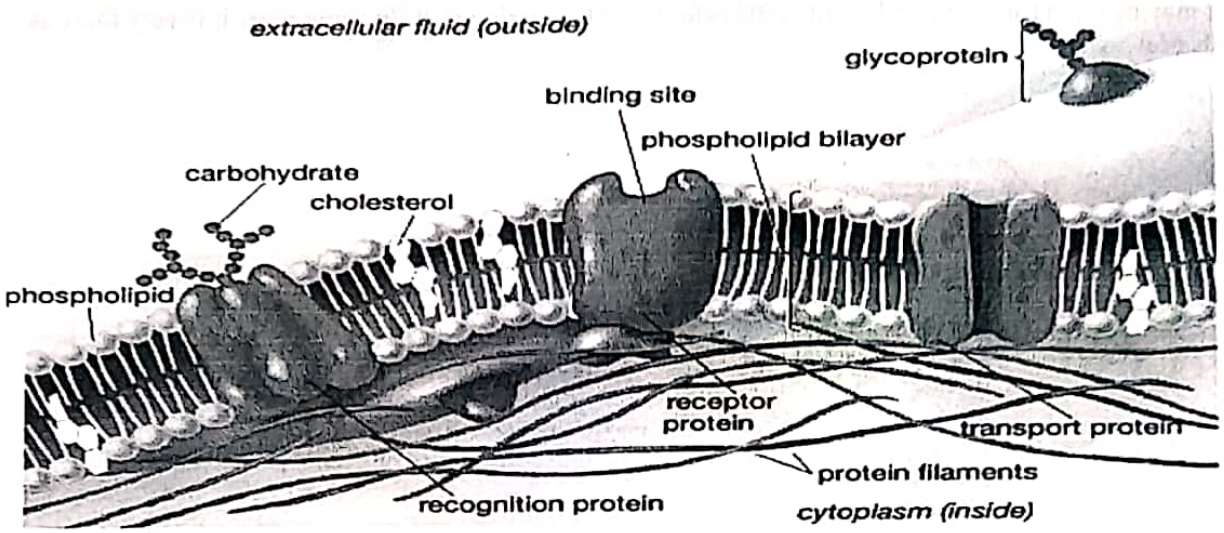
(i) The plasma membrane is composed of a lipid bilayer of phospholipid molecules into which a variety of globular proteins are embedded.

(ii) Each phospholipid molecule has two ends, an outer head hydrophilic i.e. water attracting, and the inner tail pointing centrally hydrophobic, i.e. water repelling.

(iii) The protein molecules are arranged in two different ways:

(a) Peripheral proteins or extrinsic proteins: these proteins are present on the outer and inner surfaces of lipid bilayer.

(b) Integral proteins or intrinsic proteins: These proteins penetrate the lipid bilayer partially or wholly.



Functions

(i) The plasma membrane encloses the cell contents.

(ii) It provides cell shape.

(iii) It allows transport of substances into and out of the cell.

Transport of small molecules (such as glucose, amino acids, water, mineral ions etc).

Small molecules can be transported across the plasma membrane by any one of the following three methods:

(i) **Diffusion** : molecules of substances move from their region of higher concentration to the regions of lower concentration. This does not require energy. Example : absorption of glucose in a cell.

(ii) **Osmosis:** movement of water molecules from the region of their higher concentration to the region of their lower concentration through a semipermeable membrane. There is no expenditure of energy in osmosis. This kind of movement is along concentration gradient.

(iii) **Active Transport:** When the direction of movement of a certain molecule is opposite to that of diffusion, it would require energy. This energy is provided by ATP

Transport of large molecules (bulk transport)

During bulk transport the membrane changes its form and shape. It occurs in two ways:

(i) endocytosis (taking the substance in)

(ii) exocytosis (passing the substance out)

Endocytosis is of two types :

Endocytosis and Phagocytosis

1. intake of solid particles
2. membrane folds out going round the particle, forming a cavity and thus engulfing the particle.

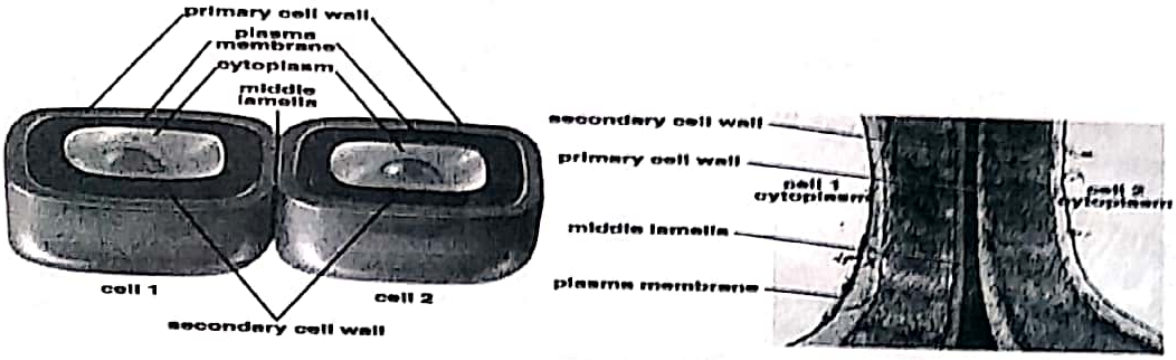
Cell membrane regulates movement of substance into and out of the cell. If the cell membrane fails to functio normally, the cell dies.

Cell wall

The outermost cell cover, present outside the plasma membrane is the **cell wall.**
Bacterial cell wall is made up of peptidoglycan

(a) Structure

– Outermost non-living layer present in all plant cells.
– Secreted by the cell itself.
– In most plants, it is chiefly made up of cellulose but may also contain other chemical substances such as pectin and lignin.
– The substance constituting the cell wall is not simply homogeneous but it consists of fine threads or fibres called microfibrils.
– It may be thin (1 micron) and transparent as in the cells of onion peel. In some cases it is very thick as in the cells of wood.



(b) Functions

– The cell wall protects the delicate inner parts of the cell.
– Being rigid, it gives shape to the cell.
– As it is rigid, it does not allow distension of the cell, thus leading to turgidity of the cell that is useful in many ways.
– It freely allows the passage of water and other chemicals into and out of the cells
– There are breaks in the primary wall of the adjacent cells through which cytoplasm of one cell remains connected with the other. These cytoplasmic strands which connect one cell to the other one are known as **plasmodesmata.**
– Walls of two adjacent cells are firmly joined by a cementing material called **middle lamella** made of calcium pectinate.

2. THE CYTOPLASM AND THE CELL ORGANELLES

The cytoplasm contains many cell organelles:
1. those that trap and release energy e.g. mitochondria and chloroplasts;
2. those that are secretory or involved in synthesis and transport e.g. Golgi, ribosomes and endoplasmic reticulum
3. the organelles for motility - cilia and flagella
4. the suicidal bags i.e. lysosomes
5. the nucleus which controls all activities of the cell, and carries the hereditary material

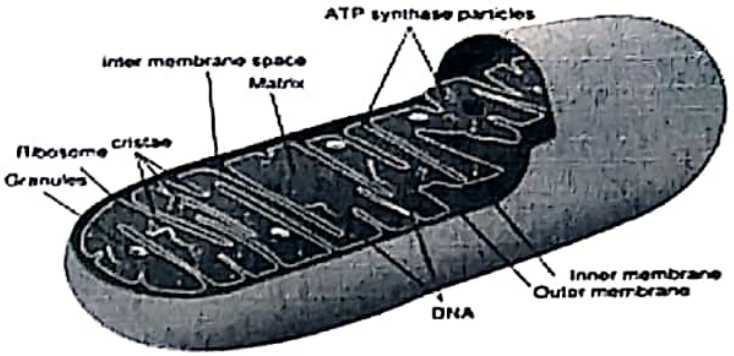
Mitochondria and chloroplast

Mitochondria (found in plant and animal cells) are the energy releasers and the chloroplasts (found only in green plant cells) are the energy trappers.

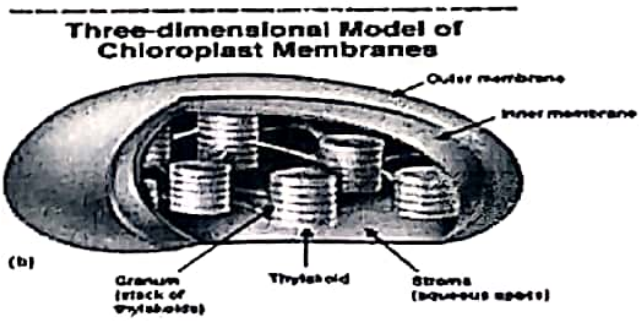
Mitochondria

Appear as tiny thread like structures under light microscope. Approximately 0.5 - 1.00 ∫m (micrometer)

Number usually a few hundred to a few thousand per cell.
Structure: The following parts.
– Wall made up of double membrane
– The inner membrane is folded inside to form projections called '*cristae*' which project into the inner compartment called the 'matrix'.
Function : Oxidises pyruvic acid to release energy which gets stored in the from of ATP for ready use. This process is also called **cellular respiration**. That is why mitochondria are called the 'power house' of a cell.



Plastids
Plastids are found only in a plant cell. These may be colourless or coloured. There are three types of plastids.
(i) Leucoplast - white or colourless
(ii) Chromoplast – blue, red, yellow etc.
(iii) Chloroplast – green
Chloroplast
Found in all green plant cells in the cytoplasm.
Number 1 to 1008
Shape: Usually disc-shaped or laminate as in most plants around you
Structure: the general plan of the structure of a single chloroplast has been shown.



Contains following parts :

Wall made up of double membrane i.e. outer membrane and inner membrane.
Sac-like structures called thylakoids placed one above the other constitute a granum.
Inside of the chloroplast is filled with a fluid medium called stroma.
Function: chloroplasts are the site of photosynthesis.