DEFINITION OF CELL

It is very difficult to give a correct definition of a cell. However, it is possible to give its general description. A cell is the fundamental, structural and functional unit of life. It may be defined as a mass of protoplast surrounded by a definite membrane—the plasma membrane. A plant cell has an extra envelope of the cell wall. A definition proposed by Loewy and siekewitz (1969) states that the cell is unit of biological activity bounded by a membrane which is selectively permeable to substances and independently capable of self-production.

SIZE AND SHAPE OF CELLS

Cells vary in size and shape. The units of their measurement are the **micron** (μ) or micrometer and angstrom (Å). 1 micron (μ) = 1/1000 m.m. and 1 angstrom Å = 0.001 μ.

The smallest cell known so far measures about 0.1 to 2.5 μ in diameter in Mycoplasmas. Bacterial cells measure about 0.2 to 5.0 μ in diameter, whereas longest cell has been reported to reach upto 55 cm in length among the bast fibre cells of *Boehmeria nivea*. (See Table 1.1). The shape of cells may be rounded, oval elliptical, spindle-shaped, block-shaped, polygonal, columnar, discoid, flat or plate-like. The typical size of a cell mostly depends on its genetic factors or on other internal and external factors viz., hormones, mechanical pressure and surface tension.

TABLE 1.1. Average measurements of some common cells, cell organelles and molecules.

Name of cell, organelle or molecule	Measurement
Ostrich egg	170 × 135 mm
Hen egg	60 × 45 mm
Human egg	100 μm
Amoeba	250—600 μm
Human Cheek cell	50 μm
Escherichia coli	5 μm long
Typhoid bacillus	2·4 × 0·5 micron
Influenza bacillus	0·5 × 0·2 micron
Nucleus	5 × 30 μm
Chloroplast	2 – 6 μm
Mitochondria	0·5 – 5 μm
Ribosomes	250 Å
Unit membrane	75 Å thick
Protein molecules	20 – 100 Å
Mycoplasma	1000 Å

INTERNAL ORGANIZATON OF CELL

A detailed study of the internal organisation of plant cell reveals that it has an outer boundary of cell wall lined by a cell membrane. The fluid substance filled within the cell membrane is cytoplasm in which are supended a variety of organelles, vesicles, inclusions and granules. The nucleus is the largest of the intracellular organelles. Usualy the nucleus bounded by double membranous nuclear envelope is present in almost all the living cells. However, a few organisms lack a definite nucleus bounded by

nuclear envelope. Thus, the living organisms are divided into two basic categories depending upon the presence or absence of nuclear envelope — (*i*) **the prokaryotes** and (*ii*) **the eukaryotes.** The organisms included under prokaryotes lack an organised nucleus with definite nuclear envelope whereas those included under eukaryotes possess definite nucleus.

(A) THE PROKARYOTIC CELL

The bacteria, cyanobacteria or blue-green algae and mycoplasmas belong to prokaryotes. A typical prokaryotic cell shows the following structure (Fig. 1.1) :

1. The cell possesses an outermost homologous colourless, thin or thick, lamellated and pigmented gelatinous sheath. In case of bacteria, this layer is called **slime** which may be in the form of **capsule** in some parasitic forms.

2. The **cell wall** is rigid and may be differentiated into 2-3 layers. The chief chemical substances present in the cell wall are-peptides, amino sugars, polysaccharides and teichoic acids. The innermost layer is chiefly composed of mucopeptides and muramic acid.

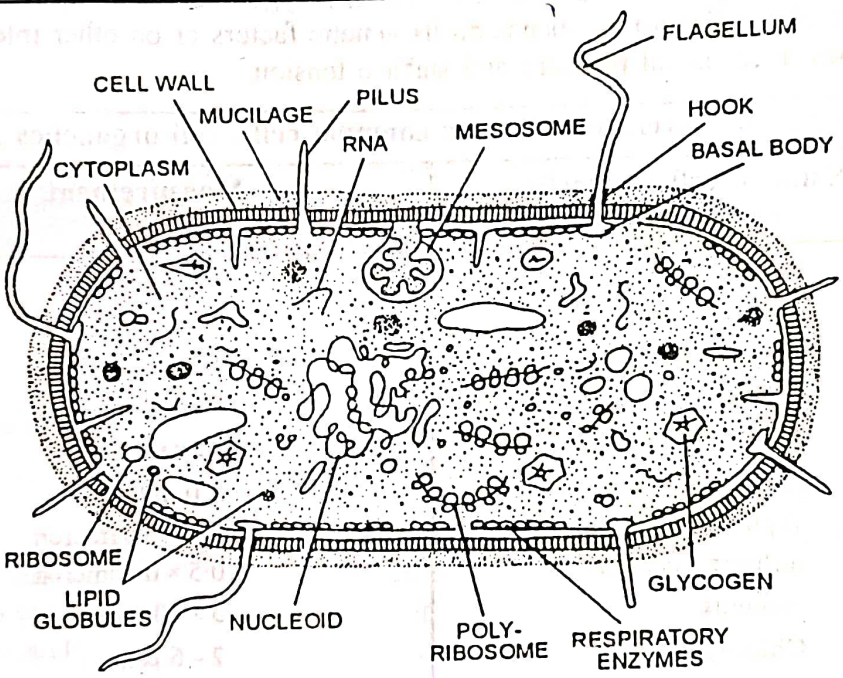


FIGURE 1.1.
A diagram showing structure of a typical bacterial cell.

3. The cell wall is followed by a thin plasma membrane composed of phospholipids, proteins and a small amount of polysaccharides. The plasma membrane possesses respiratory enzymes and performs cellular respiration. In case of some bacteria, the membrane gives rise infoldings called **mesosomes.**

4. The most characteristic feature of prokaryotic cell is the absence of well organised chloroplast, mitochondria and nucleus.

5. In case of blue-green algae the photosynthetic lamellae, called **thylakoids,** may occur regularly in the form of parallel stacks or dispersed irregularly in the peripheral part. In the photosynthetic bacteria there are vesicular infoldings of cell membrane, called **chromatophores,** which act as sites of photosynthesis.

6. The thylakoids are sac like structures composed of two unit membranes. The lamellae bear phycobilisome particles over their surfaces. The particles contain phycocyanin and phycoerythrin pigments in blue-green algae.

7. The true nucleus, with nuclear membrane, is absent in prokaryotes. The essential nuclear material, consisting of a single piece of naked DNA, is identified as **incipient nucleus** or **nucleoid.** The prokaryotic DNA is circular, ring-like, double stranded molecule with no free ends and measures about 1000 microns in length. The circular DNA is attached at a point to the plasma membrane.

Unlike eukaryotes, the prokaryotic DNA are not associated with basic proteins (or histones). However, recent findings indicate the presence of atleast two proteins which bind DNA. The prokaryotic nucleoid also contains a small amount of RNA.

8. The cytoplasm is filled with dense granules measuring about 10-25 nm in diameter. Most of these granules are ribosomes. In case of blue green algae, the cells contain large number of gas vacuoles and cyanophycean granules which are proteinaceous in nature.

(B) THE EUKARYOTIC CELL

A typical eukaryotic plant cell is composed of mainly two parts : (A) cell wall and (B) protoplast. The protoplast is further divided into protoplasm and ergastic substances. A diagrammatic representation of the typical plant cell is given in Figure. 1.2.

(*a*) CELL WALL

One of the major differences between animal cells and plant cells is the possession of true cell wall by the plants. The outer boundary of plant cells consists of non-living and metabolically inert structure,secreted by the living part of the cell, called the **cell wall.** It is a strong, porous, rather rigid but somewhat elastic wall. It gives a definite shape and provides protection to the protoplast.

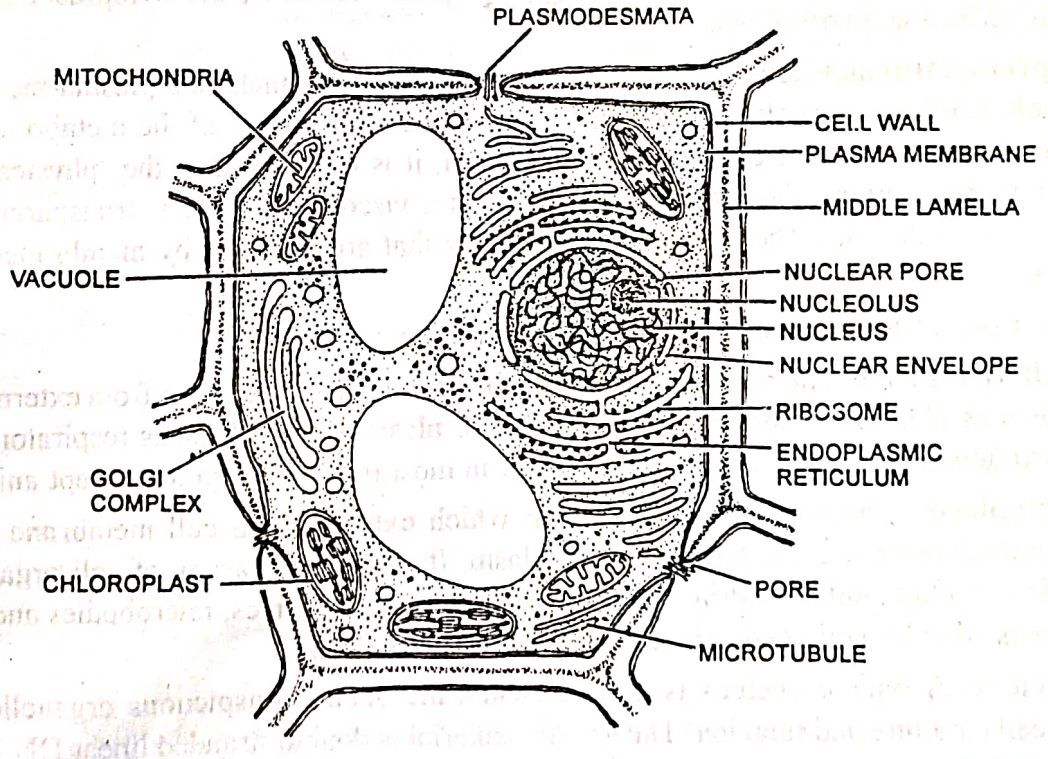
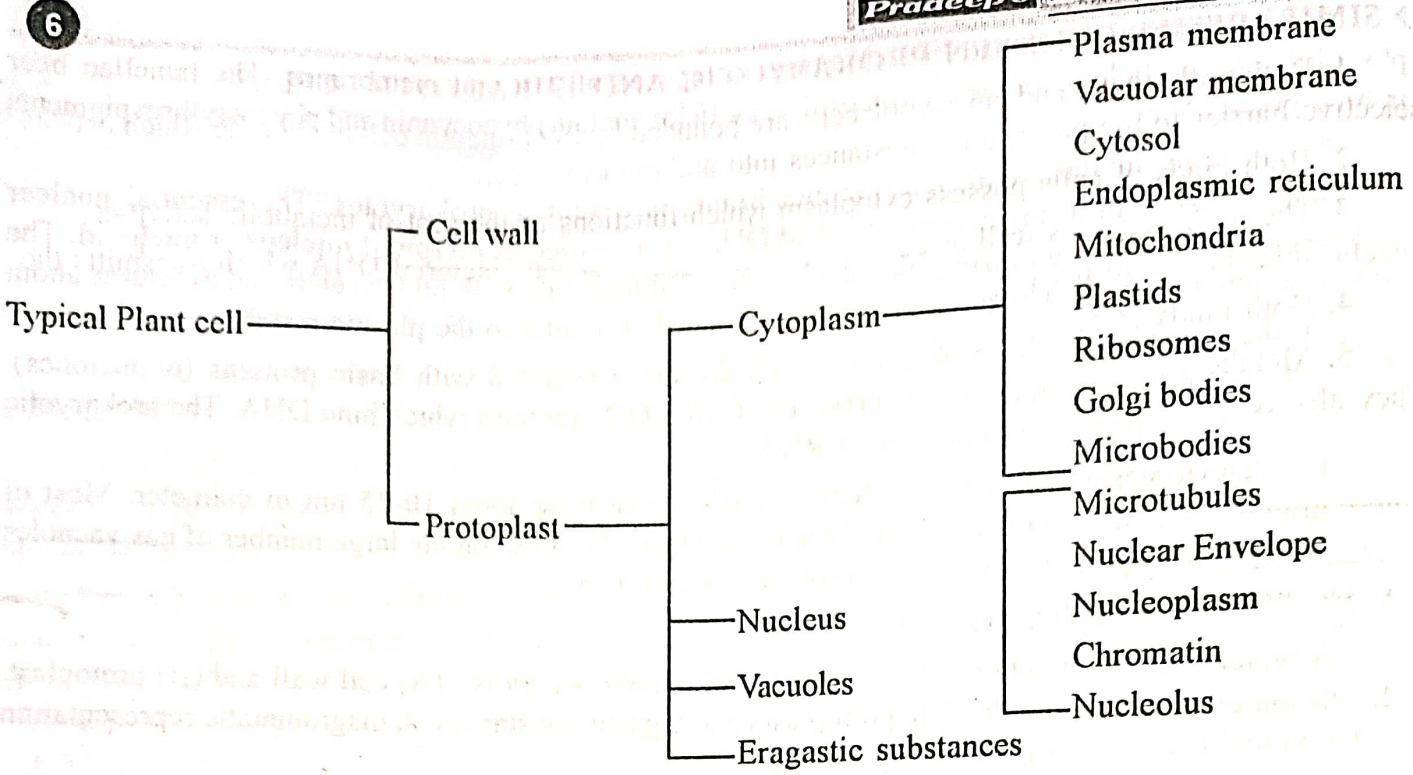


FIGURE 1.2.
Diagrammatic representation of a typical plant cell reconstructed from the studies in electron microscopy.



(Cytoplasm + Nucleus = Protoplasm)

(*b*) PROTOPLAST

The actively metabolizing part that consists of living and non-living components surrounded by cell wall is commonly termed as the **protoplast.** It includes the plasma membrane and all that it encloses. The protoplast may be conveniently studied under the following four categories– (1) Cytoplasm, (2) Nucleus, (3) Vacuoles and (4) Ergastic substances. However, the cytoplasm and nucleus are collectively termed as **protoplasm.**

The **protoplasm** may be defined as the substance within and including plasma-membrane of a cell usually excluding large vacuoles and masses of secretions. Since most of the metabolic biological and physiological activities of life occur in the protoplasm, it is considered as the 'physical basis of life'. Under high magnifications, the protoplasm appears as a viscous, colourless, transparent material with various definite inclusions. The protoplasmic particles that are bounded by membranes are termed as **organelles.**

The various components of protoplast are as follows :

1. Cell Membrane. The cell membrane, which separates the cytoplasm from external environment is also known as plasma membrane, cytomembrane or plasmalemma. It lacks respiratory enzymes and remains surrounded by a non living, rigid cell wall in most of the eukaryotes except animal cells.

2. Cytoplasm. The portion of protoplasm which extends from cell membrane to the nuclear envelope, excluding vacuole, is termed as cytoplasm. It contains a variety of cell organelles, such as endoplasmic reticulum, mitochondria, plastids, Golgi bodies, ribosomes, microbodies and microtubules. The ribosomes of eukaryotic cells are comparatively larger (80 s).

3. Nucleus. A typical nucleus is double membrane bound conspicuous organelle that controls eukanyotic cell structure and function. The genetic material is double stranded linear DNA that transmits genetic information from one generation to another. The DNA is associated with protein forming thread like organelles, the **chromosomes.** Each eukaryotic cell has two sets of chromosomes (diploid).

SIMILARITIES BETWEEN PROKARYOTIC AND EUKARYOTIC CELLS

1. Both prokaryotic and eukaryotic cells are bounded by lipoproteinic cell membrane which acts as selective barrier to the passage of substances into and out of the cell.

2. Both kinds of cells possess cytoplasm which functions as the seat of metabolic activities.

3. The prokaryotic as well as eukaryotic cells possess genetic meterial DNA which transmitts the genetic information to the offsprings.

4. Both kinds of cells possess ribosomes which help in protein synthesis.

5. Metabolic activities (anabolic and catabolic) occur in both prokaryotic and eukaryotic cells. They also respond to external stimuli and adapt to environment by the similar mechanism.

TABLE 1.2. Differences Between Prokaryotic Cells and Eukaryotic Cells

Prokaryotic Cells	Eukaryotic Cells
1. Cell wall, if present, is not made up of cellulose. Bacterial cell walls are made up of peptidogly can (= murein).	1. Plant cell walls are made up of cellulose.
2. The nucleus is absent, *i.e.*, there is no nuclear envelope, nucleoplasm and nucleolus. The nuclear material is diffused and, therefore, it is called nucleoid.	2. True nucleus is present. It consists of well organized nuclear envelope, nucleoplasm, chromosome and nucleolus.
3. There is single **circular** prochromosome which lies directly in the cytoplasm.	3. There are several **linear** kind of true chromosomes which are present inside the nucleus.
4. Nuclear material consists of naked DNA, *i.e.*, without histones or basic proteins. However, recent findings indicate the presence of atleast two proteins which bind DNA.	4. The chromosomes are made up of DNA and histones (= nucleoproteins).
5. Mitochondria, chloroplasts, endoplasmic reticulum and Golgi bodies are absent. The respiratory enzymes are located in cell membrane.	5. Mitochondria, endoplasmic reticulum and Golgi bodies are present. Chloroplasts are present in green cells of plants.
6. Ribosomes are small, 70 s type.	6. Ribosomes are large, 80s type.
7. During replication of prokaryotic nucleoid, the mitotic apparatus is not seen. Cell division is amitotic type.	7. Mitotic apparatus appears during nuclear division. The cell division is both mitotic and meiotic type.
8. Replication products of chromosomes between daughter cells are distributed with the help of cell membrane.	8. Cell membrane has no role in distribution of replication products.
9. Cell cycle is short and completes within 20 – 60 minutes.	9. Cell cycle is long and completes in 12 to 24 hours.
10. There is no streaming movements of cytoplasm.	10. Cytoplasm shows streaming movement.
11. Flagella, if present, are made up of a protein – **flagellin.** It is simple and about 20 nm. in diameter.	11. Flagella, if present, are made up of a protein – **tubulin.** Each flagellum has 9 + 2 pattern of microtubules. It is about 200 nm. in diameter.
12. Many prokaryotic cells possess pili and plasmids.	12. Plasmids and pili are absent.
13. Location of genes is continuous.	13. Location of genes is discontinuous, *i.e.*, split type.
14. Examples of prokaryotes are – Bacteria, Cyanobacteria, Mycoplasmas, Rickettsias, Spirochactes, etc.	14. Examples of eukaryotic cells are — Algae (except blue green algae), Fungi, Plants and Animals