Cell: Structure and Functions

You have learnt by now that the bodies of all living organisms are made up of cells. Cells are capable of carrying out all the functions of a living organism such as movement, respiration, digestion and so on. Just as bricks are the building blocks of houses, cells are the **building blocks** of all living organisms. They are so minute that they can only be seen with the help of a microscope. Therefore, a cell is the **smallest basic unit of life.**

A **cell** can therefore be defined as the smallest **structural and functional unit of life.**

In this chapter you will study the structure and functions of various parts of a cell.

DISCOVERY OF THE CELL

An Englishman **Robert Hooke** discovered the cell in 1665. He observed thin slices of a cork under his crude microscope (Fig. 8.1). A cork is a part of the bark of a tree. Hooke observed that a slice of cork is made up of tiny honeycomb-like compartments, one on top of the other as shown in Fig. 8.2. He named these compartments as **cells**. It was much later that scientists discovered that all living things are made up of cells.

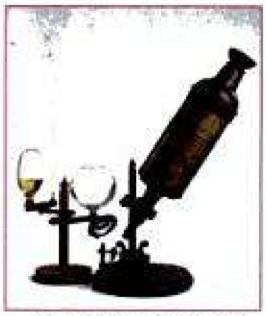

Fig 8.1 A replica of Hooke's microscope

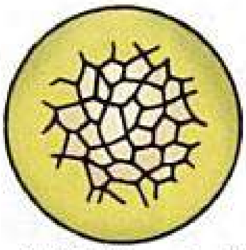

Fig 8.2 The cork cells as observed by Robert Hooke

Cells show a wide variation in terms of shape, size, functions and other features.

UNICELLULAR AND MULTICELLULAR ORGANISMS

Unicellular organisms are those which are made up of a single cell. In these organisms, all the functions like nutrition, respiration, excretion, growth and reproduction are carried out by the single cell.

Examples: *Amoeba*, *Paramecium*, yeast, bacteria (Fig. 8.3).

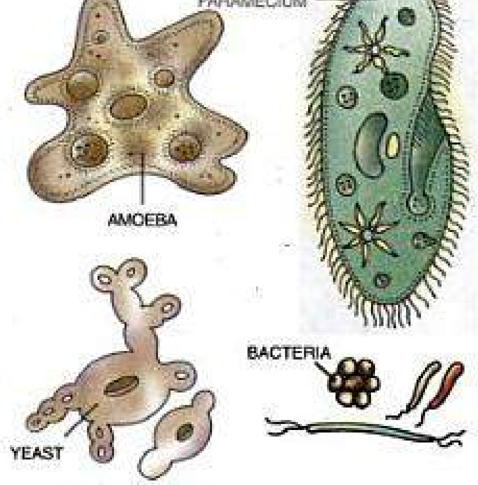

Fig 8.3 Some unicellular organisms

Multicellular organisms are those which are made up of a few to billions of cells. Most plants and animals consist of several million cells.

LEVELS OF ORGANISATION IN MULTICELLULAR ORGANISMS

The bodies of multicellular organisms are made up of different types of cells. A group of similar cells that performs a particular function is called a **tissue**. Many tissues combine to form an **organ** that carries out a particular function. Various organs with closely related functions combine to form an **organ system**. Several such organ systems get together to complete a living organism.

The various levels of organisation in a living body are summarised below (Fig. 8.4).

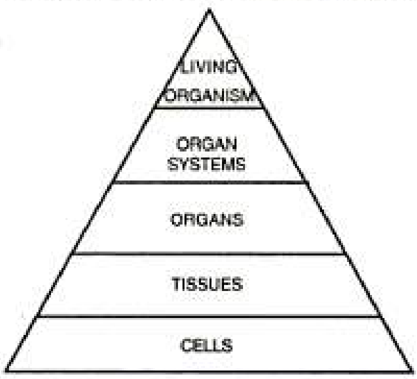

Fig 8.4 Levels of organisation in a multicellular organism

THE SHAPE OF THE CELL

The cells of animals and plants occur in a wide range of shapes. They may be oval, spherical, elliptical, cuboidal, columnar, discoid, polygonal or spindle-like. Generally, the shape of the cell is correlated to its function.

Some cells like the white blood cells (leucocytes) in human blood and *Amoeba* change their shape very often. A nerve cell or a neuron is the longest cell in our body and is branched to carry messages. Muscle cells are spindle-shaped.

Shapes of various plant and animal cells are shown in Fig. 8.5.

THE SIZE OF THE CELL

The cells of animals and plants show a great variation in their sizes. Most cells are extremely small, so much so that they are invisible to the naked eye. You need a microscope to see them. However, a few cells are quite large and can be seen with the naked eye. For example, the largest living cell is the egg of an ostrich which is about 170 mm in diameter. Nerve cells have tails which may be as long as 3 m as in an elephant. The smallest cell known to man is the bacterial cell.

The size of a cell is measured in **micrometre or micron.** A micrometre is a unit for measuring very minute lengths. One micron is equal to one millionth of a metre. Micron is represented by the symbol **μm**.

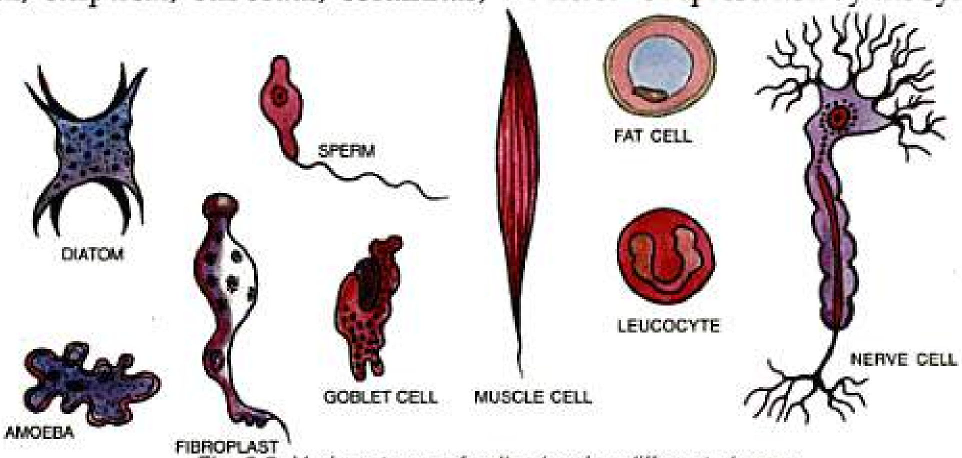

Fig. 8.5. Various types of cells showing different shapes

Angstrom and **Nanometre** are units used for measuring very small lengths. **Å** stands for angstrom and **nm** stands for nanometre.

$1\ \mu m = 10^{-6}\ m$

$1Å = 10^{-10}\ m$

$1\ nm = 10^{-9}\ m$

MICROSCOPE

A microscope is an instrument to view small objects by magnifying them. It enables us to see the different types of living cells and the structures they contain (Fig. 8.6).

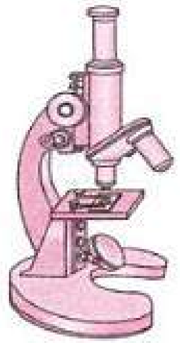

Fig. 8.6 A microscope

ACTIVITY 8.1

Study the various parts of a microscope in your biology laboratory in the presence of your science teacher. Make a sketch of it and label its various parts.

How to Make a Microscopic Slide

Most of the specimens are examined under the microscope by preparing a wet mount using water. The basic steps involved in preparing a wet mount are given below.

1. Clean the glass slide and place on a flat surface of the table.
2. Place a drop of water in the centre of the slide.
3. Place a thin piece of the specimen to be viewed on the water drop on the slide.
4. A drop of stain or dye may be added with a dropper on the slide. **Iodine, methylene blue** and **crystal violet stains** are commonly used.
5. Hold the cover slip over the object in such a manner that it touches the edge of the drop of water. Gently lower the cover slip so that it spreads out the water and no air bubble is trapped.
6. Dry the extra water that comes out of the cover slip with the help of a blotting paper.
7. Take care that the slide thus prepared is clean and dry.
8. Now place the slide under the microscope and examine the specimen.

ACTIVITY 8.2

Studying Cells of an Onion Peel under the Microscope

Take an onion and cut it into several pieces. Take a fleshy part of it. You will see a thin papery layer on the concave side. Hold this side towards you and break the piece. Tear off the thin peel. Place a small piece of this peel on a glass slide. Put a drop of water and cover it with a cover slip. Observe it under a microscope.

What do you see? You will observe small chamber-like cells. These are plant cells. Make a drawing of the structure (Fig. 8.7).

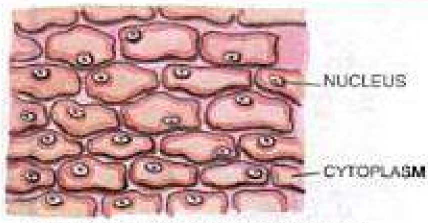

Fig. 8.7. Cells of an onion peel

ACTIVITY 8.3

Observing Cells of Human Cheek under the Microscope

Open your mouth and lightly scrape the inner part of your cheek with a finger or toothpick. Put the scrapings on a glass slide. Add a drop of water and cover it with a cover slip. Observe it under a microscope. Draw the structure of cheek cells which you see on the slide (Fig. 8.8). These are animal cells.

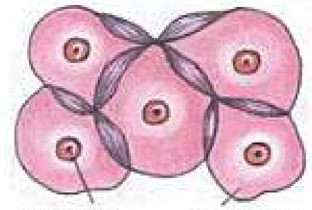

Fig. 8.8 Human cheek cells

STRUCTURE OF THE CELL

A typical cell consists of three parts :

1. Cell membrane or plasma membrane
2. Cytoplasm
3. Nucleus

The microscopic structure of a plant cell and that of an animal cell is shown in Fig. 8.9 and 8.10 respectively. Let us now study the structure and function of the cell in detail.

1. Cell Membrane

Cell membrane is also called the **plasma membrane.** In an animal cell, it is the outermost layer, whereas in a plant cell, it is protected by the cell wall. It is a living structure and controls the entry and exit of some substances in and out of the cell. It also protects the internal components of the cell. It gives shape and size to the cell.

In addition to the cell membrane, plant cells have an outer thick layer called **cell wall.** It is non-living and is mainly composed of **cellulose.** It is protective in function and mainly determines the shape of the cell. It is absent in animal cells.

2. Cytoplasm

It is a transparent, jelly-like living substance which fills the interior of an animal and plant cell. It is present between the cell membrane and the nucleus. It contains a number of minute living structures known as the **cell organelles** and many non-living substances known as **cell inclusions.**

3. Cell Organelles

These are active, living, permanent, extremely small structures present in the cytoplasm and are concerned with cell function. The various cell organelles present in a typical cell are:

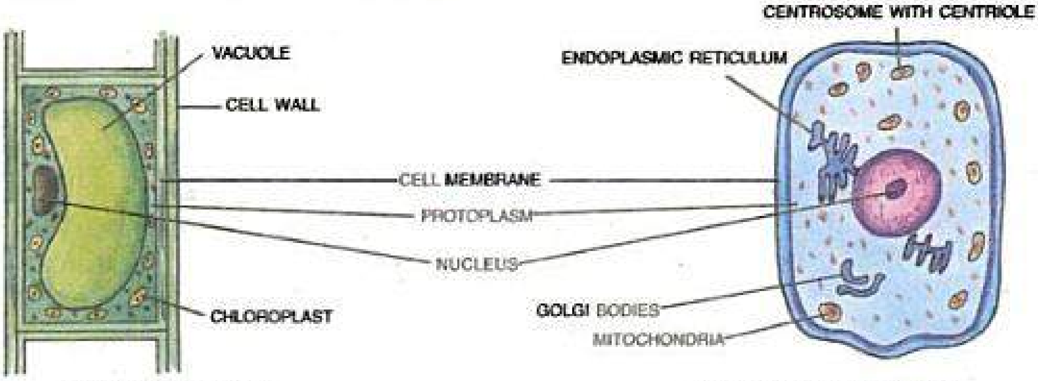

Fig. 8.9 A plant cell

Fig. 8.10 An animal cell

(i) Endoplasmic Reticulum

A system of membranes within the cytoplasm of plant and animal cells. It forms a link between the cell and nuclear membranes and is the site of protein synthesis. It helps in the transport of substances within the cell.

(ii) Plastids

Plastids are exclusively present in plant cells in large numbers, and are absent in animal cells. These are of three types, namely:

(a) Chloroplasts

These are green coloured plastids, containing the green pigment **chlorophyll.** They are present in the leaves and stems of most of the plants. They are regarded as the **kitchen of the plant cell** because they help in synthesis of food by photosynthesis.

(b) Leucoplasts

They are colourless plastids. They are mostly present in the roots and underground modified stems to store food.

(c) Chromoplasts

They are coloured plastids (red, yellow). These are present in abundance mainly in flowers and fruits (tomato, carrot).

(iii) Mitochondria

These are rod or oval shaped structures, bounded by two membranes and concerned with the release of energy from food during respiration. Hence, they are often referred to as the **power house** of the cell.

(iv) Ribosomes

These are granules attached to the endoplasmic reticulum or found freely in the cytoplasm. They help in the synthesis of proteins. They are found in both plant and animal cells.

(v) Golgi Bodies

These are small, hollow, plate-like or cup-shaped bodies found in animal cells. They synthesise, store and secrete enzymes and proteins. The golgi apparatus in plants is known as **dictyosome.**

(vi) Centrosome

It is a star-like structure found mostly in animal cells. It consists of **centrioles.** It helps in cell division.

(vii) Lysosomes

They are present in animal cells only. They contain enzymes for cellular digestion. If they burst, the cell may get damaged or destroyed. Hence, they are called the **suicidal bags** of the cell.

(viii) Vacuoles

These are fluid-filled spaces containing minerals dissolved in water. The solution that fills the vacuoles of plant cells is called **cell sap**.

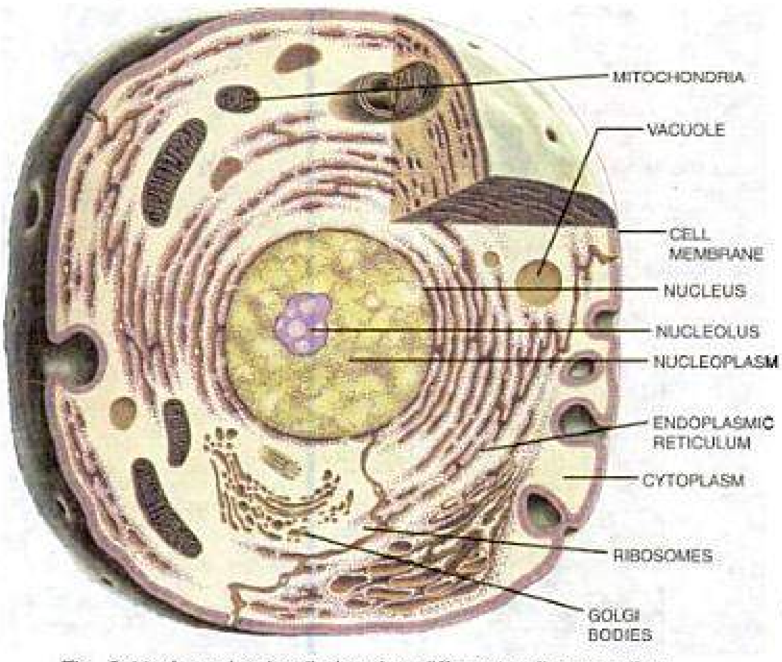

Fig. 8.11. An animal cell showing different cell organelles

Vacuoles are usually large and many in plant cells but small and few in animal cells.

4. Cell Inclusions

The non-living constituents of a cell are known as cell inclusions. These include water, minerals, salts, sugar, proteins, etc.

5. Nucleus

Nucleus is the most important part of a cell. It is usually spherical or oval in shape. It controls all the vital functions of the cell. It is made up of the **nuclear membrane, nucleoplasm, nucleolus** and **chromosomes** (Fig. 8.12).

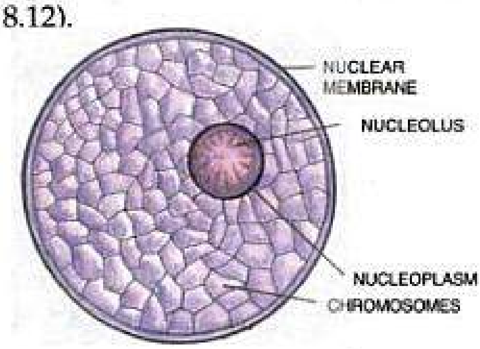

Fig. 8.12 Structure of nucleus

The **nuclear membrane** surrounds the nucleus and separates it from the cytoplasm. It is permeable and controls the passage of materials through and from the nucleus.

The **nucleoplasm** or **nuclear sap** makes up the body of the nucleus. It is denser than the cytoplasm.

The **nucleolus** is a spherical body in the nucleus. It is composed of the nucleoprotein **RNA** (ribonucleic acid). It is responsible for protein synthesis.

Nucleus also contains thread-like structures called **chromosomes**, which are composed of nucleoprotein **DNA** (deoxyribonucleic acid). The hereditary units of chromosomes are the **genes.** They are responsible for the transmission of characters from the parents to the offspring. It is on account of these genes that a child resembles its parents.

Those organisms which do not have well defined nucleus and nuclear membrane are called **prokaryotes**, for example bacteria, some blue green algae.

Those organisms which have well organised nucleus with the nuclear membrane are called **eukaryotes**, for example man, elephant, onion, cheek cells.

The summary of cellular structures and their functions is given in Table 8.1.

TABLE 8.1
Summary of Cellular Structures and Their Functions

S.No.	Name of the structure	Type of cell in which it is present	Function
1.	Cytoplasm	Animal and Plant	Metabolic functions of the cell.
2.	Nucleus	Animal and Plant	Regulates metabolic activities and transmits hereditary characters through generations.
3.	Cell membrane	Animal and Plant	Regulates movement of substances in and out of the cell.
4.	Cell wall	Plant	Gives shape and rigidity to the cell.
5.	Mitrochondria	Animal and Plant	Cell respiration and release of energy.
6.	Plastids	Plant	Storage of starch, site of some pigments, helps in photosynthesis.

7.	Golgi bodies	Animal and Plant	Formation of hormones, secretion, storage of proteins.
8.	Centrosome	Animal	Cell division.
9.	Lysosomes	Generally in Animal	Destroy damaged cells and unwanted cell products.
10.	Vacuoles	Animal and Plant	Store excess material.
11.	Endoplasmic reticulum	Animal and Plant	Contains enzymes, helps in protein synthesis.
12.	Ribosomes	Animal and Plant	Site of protein synthesis.

TABLE 8.2
Differences between a Plant Cell and an Animal Cell

S.No.	*Plant cell*	*Animal cell*
1.	A plant cell has a rigid, non-living cell wall.	There is no cell wall in an animal all.
2.	It contains plastids.	Plastids are absent.
3.	Centrosome is absent.	Centrosome is present near the nucleus.
4.	A plant cell has dictyosomes.	Animal cell has golgi bodies.
5.	Lysosomes are absent.	Lysosomes are present.
6.	It contains large and central vacuoles.	They are small and few in number.

EVALUATION

OBJECTIVE EVALUATION

A. Write True (T) or False (F) against the following statements in the given brackets.

1. Cells are invisible to naked human eye. ( )
2. Centrosomes play a major role in cell division. ( )
3. Animal cells have a cell wall but plant cells do not. ( )
4. Muscle cells are highly branched. ( )
5. White blood cells are irregular in shape. ( )

B. Fill in the blanks.

1. .... is the control centre of the cell.
2. Lysosomes are called the ....
3. .... is the structural and functional unit of life.
4. Several tissues combine to form ....
5. Size of the cell can be measured in .... and .... units.

C. Match the items in Column A with the items in Column B.

	Column A	Column B
1.	Building blocks	(a) Ribosome
2.	Kitchen of the cell	(b) Chloroplast
3.	Power house of the cell	(c) Lysosome
4.	Suicidal bag of the cell	(d) Mitochondria
5.	Protein synthesis	(e) Cells
		(f) Tissues