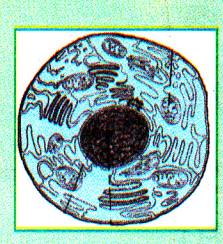
1 Cell – The Structural and Functional Unit of Life [For Revision Only]



All organisms, including ourselves, are made of microscopic cells. These cells perform activities which contribute to the overall tasks of an individual. It is also to note that every organism starts its life as a single cell. The same cell undergoes repeated divisions to give rise to a large mass of cells. Further, the cells get specialised for various tasks such as those of giving support, producing digestive enzymes and carrying out photosynthesis.

1.1 CELLS – A BASIC STUDY IN BIOLOGY

You have already read about cells in some detail in Class IX. However, it is necessary to refresh your knowledge for a proper understanding of several aspects of biology which specially constitute the Class X syllabus. Some of the main points about cells are as follows :

- All living beings are made up of cells.
- The cell is the structural and functional unit of the body.
- All living beings develop from a pre-existing cell.

1.2 CELLS – HOW NUMEROUS?

Larger an organism, greater the number of cells in its body.

Single-celled : Many small organisms are made up of just one single cell.

Examples : Bacteria, yeast and amoeba.

Few-celled : Some very small organisms are made up of just a few hundred or a few thousand cells.

Examples : Spirogyra, Volvox.

Multi-celled : Most plants and animals we see around are made up of millions and billions of cells.

Examples : Humans, mango.

1.3 CELLS — HOW SMALL?

Cells are very small and can be seen only with a microscope.

- **Smallest** cells are certain bacteria, red blood cells in the human body, etc.
- **Longest** cells are the nerve cells.
- **Largest** cells are the birds' eggs (actually the central yellow sphere). Ostrich egg, before development begins in it, is the largest single cell of the living world today. The white (albumen) of the egg and the egg-shell are extra parts added on the actual egg as it passes down the reproductive tract.

An average-sized adult human constitutes approximately:

- **1000 million million cells in the whole body.**
- **10,000 million nerve cells in the brain cortex.**
- **25 million million red blood cells.**
- **30 thousand million white blood cells.**

1.4 CELL SHAPES

Different shapes of cells are often related to the different functions they perform.

- Human red blood cells are **circular** and **biconcave**, for easy passage through blood capillaries and to transport oxygen.
- White blood cells are **amoeboid** (amoeba-like movement, with pseudopodia) that can squeeze out through capillary walls.
- Nerve cells are **long** to conduct "impulse" from distant parts of the body to the brain and vice-versa.
- Guard cells of stomatal pore in the leaves are **bean-shaped** to open and close it.

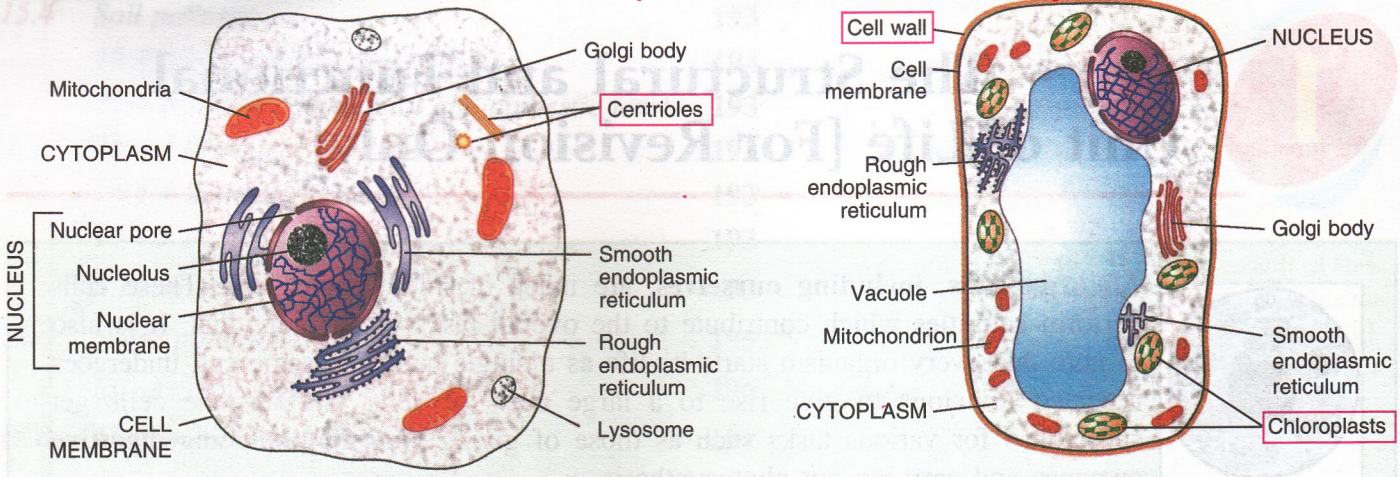


Fig. 1.1 : A generalised animal cell and a generalised plant cell. (Note the parts common to both cells and the parts which are found exclusively in an animal cell or in a plant cell)

1.5 GROSS STRUCTURE OF CELL – THE THREE ESSENTIAL PARTS

1. **Cell membrane** (or **plasma membrane**) encircles the cell.
   - It is a living membrane having fine pores.
   - It is *semi-permeable* (also called selectively permeable or differentially permeable) meaning that it allows only certain substances to pass through while preventing others.

     In the plant cell (Fig. 1.1 B), an additional outermost non-living layer called the **cell wall**, surrounds the cell membrane.
   - The cell wall is mostly made up of **cellulose**.
   - It gives **shape** and **rigidity** to the cell.
   - It is **freely permeable** (allowing substances in solution to enter and leave the cell without hindrance).
2. **Cytoplasm** is the part of the cell inside the cell membrane and outside the nucleus.
   - It is a semiliquid substance.
   - Many chemical reactions catalyzed by enzymes occur in it.
   - It contains several **organelles**, each concerned with some specific function.
   - The part of the cytoplasm other than the organelles (mitochondria, etc.) is called **cytosol,** which constitutes mainly the liquid medium.
3. **Nucleus** is a large somewhat spherical body lying nearly in the centre of the cytoplasm.
   - It is surrounded by a double layered nuclear membrane with nuclear pores (Fig. 1.2).

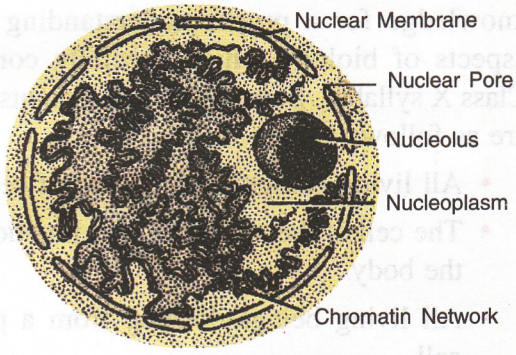


Fig. 1.2 : Structure of nucleus

   - The ground substance of the nucleus is a semi-solid substance (**nucleoplasm**) containing one or more round-shaped **nucleoli** (*sing.* nucleolus).
   - The nucleoplasm contains a network of dark-coloured fibres called **chromatin fibres**. These chromatin fibres condense into short thick **chromosomes** (Fig. 1.3) during cell division.

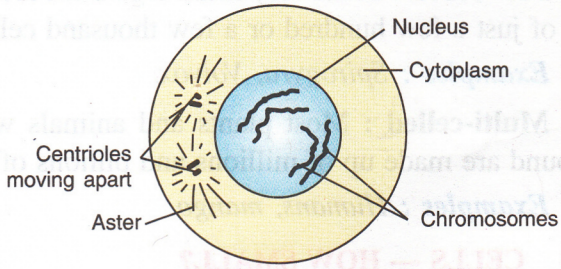


Fig. 1.3 : An early stage of cell division in an animal cell showing two pairs of chromosomes that have condensed from the chromati network, inside the nucleus (diagrammatic). Chromosome number varies from one organism to another.

1.6 FINER STRUCTURE OF CELL – THE ORGANELLES

Organelles are the specialised *membrane-bound* structures in a cell, concerned with definite functions.

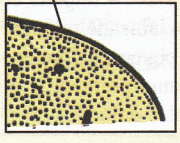
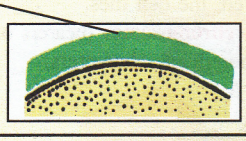
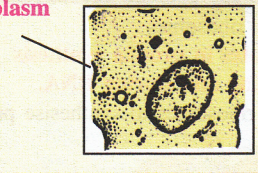
ORGAN and ORGANELLE

Just as there are organs in the body, so are the organelles inside a cell.

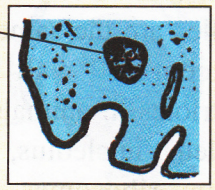
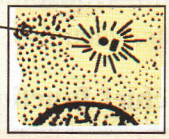
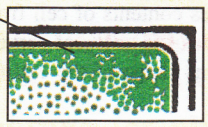
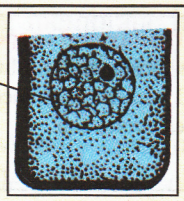
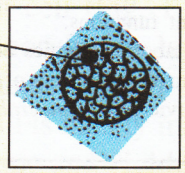
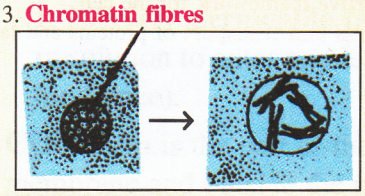
Just as each body organ performs one or more special functions, similarly, each organelle has a specific function in a cell.

The living parts of a cell which consist of cytoplasm, nucleus and other living bodies are collectively called **protoplasm** or **protoplast**. The latter term protoplast is more appropriately used for a plant cell after the removal of cell wall. The **living bodies** called organelles are the same in both plant and animal cells except cell wall in plants and centrosome with centrioles in animals. The various organelles are : Nucleus, nucleolus, mitochondria, endoplasmic reticulum, ribosomes, Golgi bodies, lysosomes, chloroplasts, vacuoles, cell membrane.

Table 1.1 Parts of cell and their main characteristics and chief functions

Part of cell	Main characteristics	Chief function(s)
1. **Cell membrane** (also called plasma membrane) 	1. Outermost in animal cells. 2. Lies next to cell wall in plant cells. 3. Very thin, flexible, **living membrane**. 4. Possesses **fine pores**. 5. **Semi-permeable.** 6. Made up of lipoproteins.	1. Separates contents of cell from its surroundings 2. **Regulates the entry** of certain solutes and ions. 3. Maintains shape of the cell (in animal cells).
2. **Cell wall** (Plant cells only) 	1. **Non-living** rigid layer surrounding plasma membrane 2. Mainly composed of **cellulose**. 3. **Freely permeable.**	1. **Gives rigidity and shape** to the plant cell. 2. Allows substances in solution to enter and leave the cell without hindrance. 3. Provides protection.
3. **Cytoplasm** 	1. All the parts together inside the plasma membrane excluding nucleus. 2. Contains a mixture of water and soluble inorganic and organic compounds, and various organelles.	1. Different organelles contained in it perform different functions. 2. All metabolic activities occur in it. 3. Medium of earlier steps of respiration (production of pyruvic acid) (*anaerobic* respiration).
4. **Endoplasmic reticulum** (ER) 	1. Irregular network of tubular double membrane. 2. It is continuous with the plasma membrane on the outside and the nuclear membrane on the inside. 3. May be smooth or rough (attached ribosomes).	1. **Supportive framework** for the cell. 2. **Synthesis and transport** of proteins and fat.
5. **Mitochondria** 	1. Various shapes but usually sausage-like. 2. Double walled; inner wall thrown into folds **(cristae)**. 3. Have their own DNA (containing several genes) 4. Also, contain their own ribosomes	1. **Release of energy** from pyruvic acid produced in cytoplasm in the form of ATP. (Seat of cellular aerobic respiration & stores energy). 2. Synthesis of respiratory enzymes.
6. **Golgi apparatus** (In animal cells) (called dictyosomes in plant cells) 	1. Stacks of **flattened membrane sacs**. 2. Consists of tubules, vesicles and vacuoles.	1. **Synthesis and secretion of enzymes, hormones,** etc. 2. Formation of acrosome of sperm.

(Contd.)

7. **Ribosomes** 	1. **Small granules** either scattered in the cytoplasm or attached to the outside of endoplasmic reticulum. 2. **Single walled** dense, spherical bodies composed mainly of RNA.	1. **Protein synthesis.**
8. **Lysosomes** 	1. **Membranous sacs** budded off from Golgi body. 2. Contain 40 different types of enzymes.	1. **Intracellular digestion.** 2. **Destroy foreign substances.** 3. When cell is old or injured, these rapidly **destroy organelles** (hence called "suicide bags"). 4. Digest cartilages during formation of bones.
9. **Centrosome** (Animal cells only) 	1. A region surrounding the centrioles, located near nucleus. 2. Contains **one or two centrioles** 3. Centrioles are surrounded by microtubules.	1. **Initiates and regulates cell division.** 2. Forms spindle fibres, with the help of asters.
10. **Plastids** (Plant cells only) 	1. Several kinds, most common ones are **chloroplasts** containing the green pigment chlorophyll. 2. **Double membraned**, proteinaceous matrix, **contain DNA.** 3. Disc-like structures called thylakoids contain **chlorophyll.**	1. **Chloroplast** (green) trap solar energy for photosynthesis, contans the pigment chlorophyll. 2. **Leucoplast** – stores starch. 3. **Chromoplast** – imparts colour to flowers and fruits, contains the pigment Xanthophyll (yellow coloured pigment); Carotene (orange-red pigment). 4. Anthocyanin pigment is dissolved in cytoplasm (blue-violet colour).
11. **Nucleus** 	1. Largest cell organelle. 2. Mostly spherical and dense. 3. Nuclear membrane with pores to allow substances to enter and leave. 4. Contains network of thread-like structures called chromatin fibres which contain DNA.	1. **Regulates cell functions.** 2. If removed, the cell dies. 3. **Contains chromosomes** (bearers of genes that control hereditary characters).
12. **Nucleolus** 	1. One or more round-shaped nucleoli inside the nucleus.	1. Produces ribosomes 2. **Participates in protein synthesis by forming and storing RNA.** 3. Dictates ribosomes to synthesise proteins.
13. **Chromatin fibres** 	1. The network in resting stage of the nucleus condenses into chromosomes during cell division. 2. Made up of **DNA threads.**	1. Chromosomes carry **hereditary information** or the genes.

The next two parts, i.e. vacuoles and granules, are non-living. These are important in their own way.

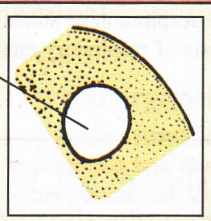
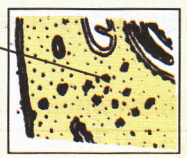
14. **Vacuoles** 	1. Clear spaces with water or other substances in solution. 2. Plant cells have larger vacuoles, while the animal cells have fewer and smaller ones. 3. Covered by a covering called **tonoplast.**	1. **Storage of water** and other substances, food, pigments, and waste products. 2. Give **turgidity** to the plant cells by pressing against cell wall.
15. **Granules** 	1. Small particles, crystals or droplets.	1. Starch (in plant cells), glycogen (in animal cells) and fat-containing granules serve as **food for the cell.**

Table 1.2 Differences between Plant and Animal Cells

FEATURE	PLANT CELLS	ANIMAL CELLS
1. Cell wall	A definite *cell wall*, made up of cellulose.	1. No cell wall
2. Centrosome	Absent.	2. Present.
3. Vacuoles	Prominent, one or more.	3. Vacuoles, if any, are small and temporary; concerned with excretion or secretion.
4. Plastids	Usually present.	4. No plastids.
5. Size	Usually larger.	5. Usually smaller.
6. Cytoplasm	Cytoplasm not so dense.	6. Cytoplasm denser and more granular.
7. Arrangment of cytoplasm	Only a thin lining of cytoplasm, mostly pushed to the periphery.	7. Cytoplasm fills almost the entire cell.

1.7 MICROSCOPIC EXAMINATION OF ONION PEEL

Epidermal cells of onion

The epidermal peel from onion is easy to prepare. You can proceed as follows :

Cut the onion bulb into four pieces (quarters) lengthwise (Fig. 1.4).

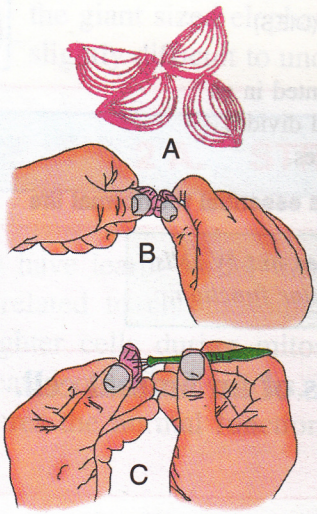


Fig. 1.4 : Preparation of an onion peel

From one of these quarters, remove one thick scale leaf. Take the fleshy scale of onion in your hand and tear it from the inner (concave) side so as to get a thin transparent strip (Fig. 1.4B). Using a pair of forceps, remove this strip (peel) (Fig. 1.4 C) and put it in a watch glass containing water. Cut a square piece of this peel (about 5 × 5 mm) and mount it on a slide in a drop of water as shown in Fig. 1.5. Cover the peel with a coverslip carefully so that the tissue does not get wrinkled. Examine the preparation under a low power microscope. You may as well stain the material with ***iodine*** or ***eosin*** solution, which will ***make the nucleus more distinct.*** More details of the cell structure will be seen under a high power microscope.

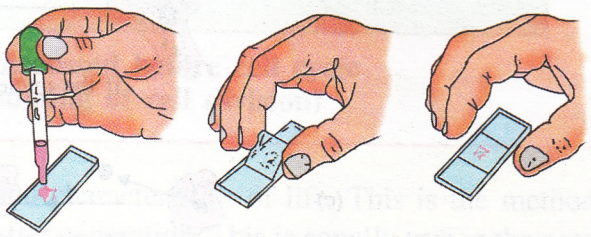


Fig. 1.5 : Preparation of a slide of onion peel

The cells of onion peel have a somewhat regular shape, linear or rectangular (Fig. 1.6). Each cell has a prominent cell wall, a nucleus and the cytoplasm encircling one or two large vacuoles. The details are better seen in high power, especially the thick cell wall. Note that the cells are

- firmly bound together and
- the nucleus is placed towards one side, which is usually the case in almost all plant cells.

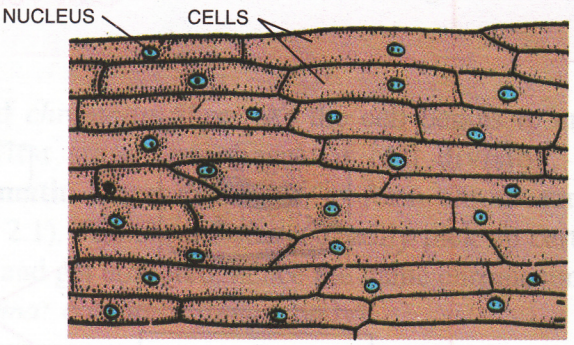
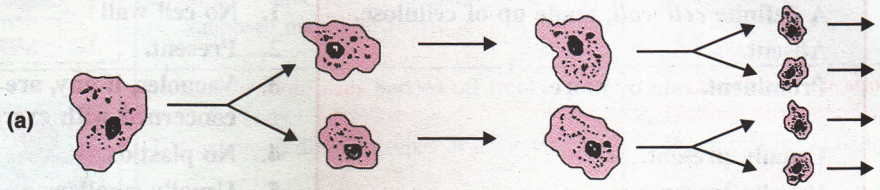


Fig. 1.6 : Cells from a peeling of onion scale leaf as seen under the low power of microscope

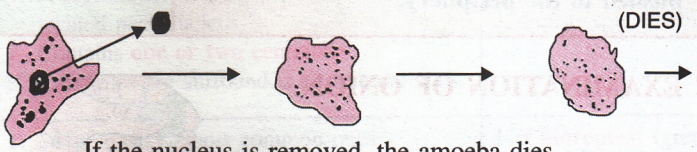
1.8 THE NUCLEUS — KEY TO THE LIFE OF A CELL

Although every part of a cell contributes to the life of the cell as a whole, yet the key performer or the

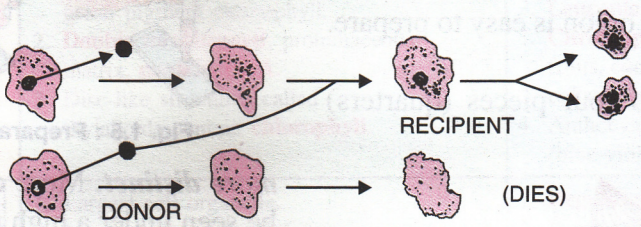
master of each cell is the nucleus. This can be easily understood by an experiment performed on Amoeba, a single cell organism (Fig. 1.7).



Amoeba is a single-celled organism. It grows, divides into two amoebae which re-grow and divide, thus the race continues.



If the nucleus is removed, the amoeba dies.



If the nucleus from another amoeba is transplanted in an enucleated amoeba, the recipient survives and divides while the donor (enucleated) amoeba dies.

Fig. 1.7 : An experiment on amoeba to show that nucleus is essential for normal life

Every activity of the body of an organism is carried out by cells. But each kind of cell is specialized for a particular function.

Shown below are some of the cell organelles of an animal cell.
Can you identify these ?