CHAPTER – 5

THE FUNDAMENTAL UNIT OF LIFE

CELL

Cell is called the fundamental unit of life.

- A cell is capable of independent existence and can carry out all the functions which are necessary for a living being.
- A cell carries out nutrition, respiration, excretion, transportation and reproduction; the way an individual organism does.
- Study of structure and composition of cell is called as 'Cytology'.
- Cell was first observed by Robert Hooke in a dead cork slice in the year 1665.
- First living cell was discovered by A. V. Leeuwenhoek.

Activity 5.1

- Let us take a small piece from an onion bulb. With the help of a pair of forceps, we can peel off the skin (called epidermis) from the concave side (inner layer) of the onion. This layer can be put immediately in a watch-glass containing water. This will prevent the peel from getting folded or getting dry. What do we do with this peel?
- Let us take a glass slide, put a drop of water on it and transfer a small piece of the peel from the watch glass to the slide. Make sure that the peel is perfectly flat on the slide. A thin camel hair paintbrush might be necessary to avoid air bubbles while putting the cover slip with the help of a mounting needle. Ask your teacher for help. We have prepared a temporary mount of onion peel. We can observe this slide under low power followed by high powers of a compound microscope.

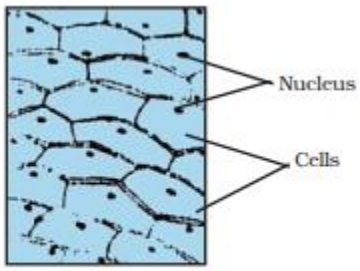


Fig. 5.2: *Cells of an onion peel*

Cell Theory :

Two biologists, Schleiden and Schwann gave the Cell theory which states that :
(i) All plants and animals are composed of cells.
(ii) Cell is the basic unit of life.
(iii) All cells arise from pre-existing cells.

Viruses are the exceptions of cell theory.

CELL SIZE, SHAPE AND NUMBER

- There is much variation in size, shape and number of cells in different organisms, and also in various parts of the body.
- Most of the cells are only a few micrometres in diameter and are visible only with the help of a microscope.
- Cells may be spherical, spindle shaped, elongated, polyhedral or irregular in shape. The shape of the cells is determined by the specific function they perform.
- The number of cells is related to the size of the organ or body. Thus, small organisms have limited number of cells, while the larger ones such as elephant, whale or banyan tree have a countless number of cells.

EXAMPLES OF VARIATION IN CELL

- The smallest known cell is Mycoplasma or PPLO (Pleuro Pneumonia like organisms).
- Acetabularia, a single-celled algae has a length of 10 cm.
- In plants, fibres are quite long, 4 cm in cotton in 1 metre in hemp.
- The largest cells is an **egg cell** of ostrich.

VARIATION IN CELL SIZE OF HUMAN

- The longest cell is the nerve cell.
- The largest cell in the human body is female ovum.
- Smallest cell in the human body is male gametes, that is, sperm.

Activity 5.2

- We can try preparing temporary mounts of leaf peels, tip of roots of onion or even peels of onions of different sizes.
- After performing the above activity, let us see what the answers to the following questions would be:
  (a) Do all cells look alike in terms of shape and size?
  (b) Do all cells look alike in structure?
  (c) Could we find differences among cells from different parts of a plant body?
  (d) What similarities could we find?

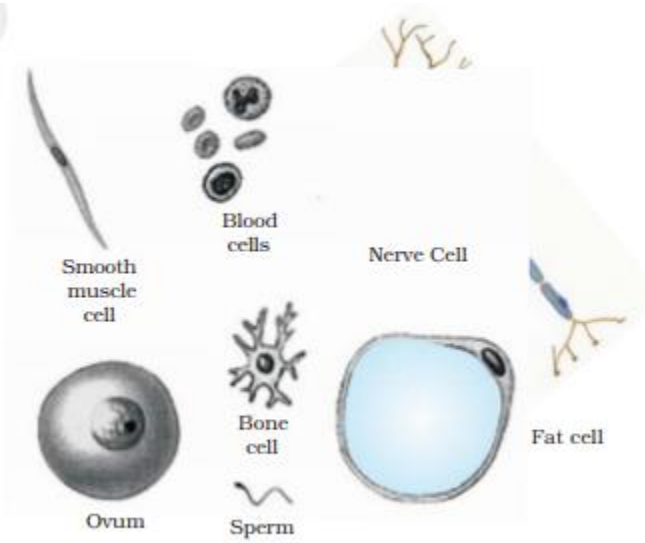


Fig. 5.3: *Various cells from the human body*

Components of Cell

There is an occurrence of division of labour within a cell as they all got certain specific components called 'Cell organelles'. Each of them perform a specific function.
The three basic components of all the cells are :
(i) Plasma membrane
(ii) Nucleus
(iii) Cytoplasm

Cell Membrane OR Plasma Membrane :

- Cell membrane is also called as plasma membrane or plasma lemma.
- It is the limiting boundary of each cell which separates the
- cytoplasm from its surroundings.
- It is found in both plant as well as animal cells.
- It is the outermost covering of a cell in case of animals and lies
- below the cell wall in case of plants.
- It is made up of proteins and lipids where proteins are sandwiched between bilayer of lipids.
- Plasma membrane is selectively permeable in nature. It allows or permits the entry and exit of some materials in and out of the cell.
- It is flexible and can be folded, broken and reunited.

Functions of Plasma Membrane

- Plasma membrane selectively regulates the entry and exit of the substances into and out of the cell. Therefore, it is called a selectively permeable membrane or semipermeable membrane.
- It provides an outer boundary to the cell and protects the cell from injury.
- It allows the flow of materials and information between different organelles of the same cell, as well as between the adjacent cells.
- It provides some organic connections between the adjacent cells.

Transportation of molecules across the Plasma Membrane :

This can be done by following ways :

- Diffusion : Movement of solutes or ions from higher concentration to lower concentration is called as diffusion. It does not require energy therefore, it is called as passive transport.

- Osmosis : The movement of solvent or water from higher concentration (solvent) to lower concentration (solvent) through a semipermeable membrane is called as osmosis Or the movement of solvent or water from lower concentration to higher concentration of solution through a semipermeable membrane is called as osmosis.

  Osmosis can also be called as 'Diffusion of solvents'.

  • Endomosis : Movement of solvent into the cell is called as Endomosis.

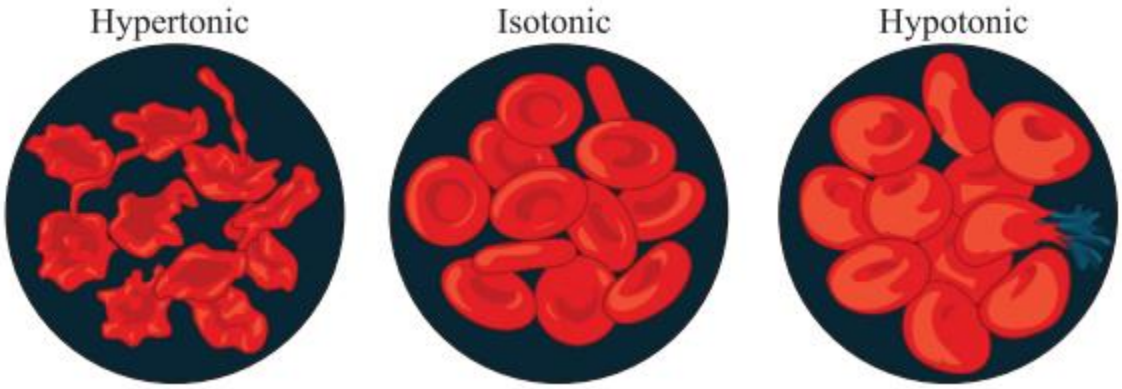
  • Exosmosis : Movement of solvent outside the cell is called as Exomosis.

Types of Solutions on the Basis of Concentration

(a) **Isotonic Solution :** When the concentration of the solution outside the cell is equal to the concentration of cytoplasm of the cell, it is called as isotonic solution.

(b) **Hypertonic Solution :** When the concentration of the solution outside the cell is more than the inside the cell. Due to this, cell looses water and becomes plasmolysed.

(c) Hypotonic Solution : When the concentration of the solution outside the cell is lesser than that of cytoplasm of cell. Due to this, cell swells up and bursts.



Activity 5.3

Osmosis with an egg

(a) Remove the shell of an egg by dissolving it in dilute hydrochloric acid. The shell is mostly calcium carbonate. A thin outer skin now encloses the egg. Put the egg in pure water and observe after 5 minutes. What do we observe?
The egg swells because water passes into it by osmosis.

(b) Place a similar de-shelled egg in a concentrated salt solution and observe for 5 minutes. The egg shrinks. Why?
Water passes out of the egg solution into the salt solution because the salt solution is more concentrated.

Activity 5.4

- Put dried raisins or apricots in plain water and leave them for some time. Then place them into a concentrated solution of sugar or salt. You will observe the following:

(a) Each gains water and swells when placed in water.

(b) However, when placed in the concentrated solution it loses water, and consequently shrinks.

Cell Wall

It is the outermost covering of the plant cells.

- It is absent in animal cells.
- Cell wall is rigid, strong, thick, porous and non-living structure. It is
- made up of cellulose and hemicelluloses. Cell walls of two adjacent cells are joined by a layer called middle lamellae.

Functions of Cell Wall :

(a) It provides definite shape to the cell.
(b) It provides strength to the cell.
(c) It is permeable and allows entry of molecules of different sizes.
(d) It has the characteristics of repair and regeneration.

Activity 5.6

- Mount the peel of a Rheo leaf in water on a slide and examine cells under the high power of a microscope. Note the small green granules, called chloroplasts. They contain a green substance called chlorophyll. Put a strong solution of sugar or salt on the mounted leaf on the slide. Wait for a minute and observe under a microscope. What do we see?
- Now place some Rheo leaves in boiling water for a few minutes. This kills the cells. Then mount one leaf on a slide and observe it under a microscope. Put a strong solution of sugar or salt on the mounted leaf on the slide. Wait for a minute and observe it again. What do we find? Did plasmolysis occur now?

CYTOPLASM:-

- The space between the plasma-membrane and the nucleus is filled by an amorphous,
- translucent, homogenous, colloidal liquid called cytoplasma.
- It consists of various inorganic molecules, such as water, salts of Na, K, and various organic compounds vic., carbohydrates, lipids, proteins, nucleoproteins, nucleic acids, and a variety of enzymes.
- In the cytoplasm, various cell organelles are found floating.

FUNCTIONS:

1. It helps in intra-cellular distribution of molecules, enzymes and nutrients within the cell
2. It helps in exchange of materials between different cell organelles.
3. Biosynthesis of nucleotides, proteins and fatty acids takes place in the cytoplasm
4. Breaking down of glucose (glycolysis) takes place in the cytoplasm.

5. Continuous nucleo-cytoplasmic interaction takes place between the nucleus and the cytoplasm.;

Nucleus

- Nucleus is the most important cell organelle which directs and controls all its cellular activities.
- It is called as 'Headquarter of the cell'.
- It was discovered by Robert Brown in 1831.
- In Eukaryotes, a well-defined nucleus is present while in Prokaryotes, a well-defined nucleus is absent.
- Prokaryotes contain a primitive nucleus.
- It has double layered covering called as nuclear membrane.
- Nuclear membrane has pores which regulate the movement of materials in & out of the cell.
- Besides nuclear membrane, nucleus also contains nucleolus and chromatinmaterial and the substance filled inside the nucleus is nucleolus.
- Chromosomes or chromatin material consists of DNA which stores and transmits hereditary information for the cell to function, grow and reproduce.

Functions of Nucleus :

(a) It controls all the metabolic activities of the cell and regulates the cell cycle.
(b) It helps in transmission of hereditary characters from parents to off springs.

Activity _____ 5.7

- Let us take a glass slide with a drop of water on it. Using an ice-cream spoon gently scrape the inside surface of the cheek. Does any material get stuck on the spoon? With the help of a needle we can transfer this material and spread it evenly on the glass slide kept ready for this. To colour the material we can put a drop of methylene blue solution on it. Now the material is ready for observation under microscope. Do not forget to put a cover-slip on it!
- What do we observe? What is the shape of the cells we see? Draw it on the observation sheet.
- Was there a darkly coloured, spherical or oval, dot-like structure near the centre of each cell? This structure is called nucleus. Were there similar structures in onion peel cells?

Depending upon nucleus a cell can be divided into two parts-

Prokaryotic Cell		Eukaryotic Cell	
1.	It is generally smaller (1-10 micro metre) in size	1.	It is comparatively larger (5-100 micro metre) in size.
2.	It lacks a well organised nucleus as its nuclear material is not surrounded by a nuclear membrane.	2.	It contains a well organized nucleus as its nuclear material is surrounded by a nuclear membrane.
3.	It has a single chromosome	3.	It has more than one chromosome.
4.	Nucleolus is absent	4	Nucleolus is present
5.	It lacks membrane bound cell organelles.	5.	It possess membrane bound cell organelles.
6.	Cell division occurs by fission or budding. Mitotic and meiotic divisions are absent	6.	Cell division takes place by mitosis and meiosis.
7.	Ribosomes are smaller	7.	Ribosomes are larger

CELL ORGANELLES

A cell performs a variety of functions such as

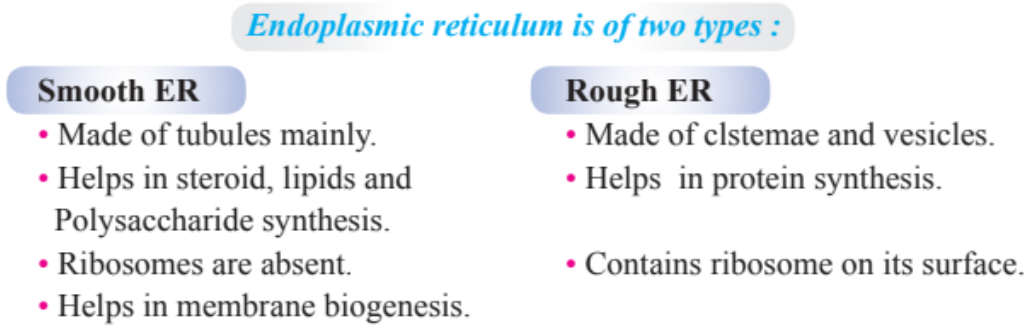
i) Synthesis of complex molecules and their breakdown,
ii) Production of energy,
iii) Secretion of certain substances, etc.

These activities of the cell are performed by different cell organelles. These organelles are enclosed by membranes. To understand the functioning of the cell, it is necessary to know briefly about the structure of cell organelles.

ENDOPLASMIC RETICULUM

- Endoplasmic reticulum is a complicated and interconnected system of membrane bound channels and tubules.
- It is spread throughout the cytoplasm and is continuous with the plasma membrane and nuclear membrane.

There are two types of Endoplasmic Reticulum.



Functions of Endoplasmic Reticulum

- Endoplasmic Reticulum (E.R) provides large surface area for the metabolic activities of the cell.
- Rough endoplasmic reticulum plays an important role in protein synthesis.
- Smooth endoplasmic reticulum is involved in the synthesis of steroid, hormones and lipids.
- SER plays a crucial role in detoxification of drugs and poisonous by-products.

GOLGI COMPLEX OR GOLGI APPARATUS

The Golgi apparatus was first described by Camillo Golgi. Golgi complex consist of saucer-like compartments called cisternae, network of interconnecting tubules, vesicles and vacuoles at the peripheral regions. In plant cells, Golgi apparatus is referred to as dictyosomes.

Functions of Golgi apparatus :

(a) It helps in formation of lipids.
(b) It helps in formation of middle lamellae.
(c) It is secretary in nature.
(d) It helps in melanin synthesis.
(e) Lipids and proteins synthesized in endoplasmic reticulum are packed at Golgi complex. They provide the site for assembly of new membrane material.

LYSOSOMES

Lysosomes are membrane-bound sacs filled with digestive enzymes. These enzymes are made by RER.

- Lysosomes are a kind of waste disposal system of the cell.
- Lysosomes help to keep the cell clean by digesting any foreign material as well as worn-out cell organelles.
- Foreign materials entering the cell, such as bacteria or food, as well as old organelles end up in the lysosomes, which break them up into small pieces.

- Lysosomes are able to do this because they contain powerful digestive enzymes capable of breaking down all organic material. During the disturbance in cellular metabolism,

  for example, when the cell gets damaged, lysosomes may burst and the enzymes digest their own cell. Therefore, lysosomes are also known as the 'suicide bags' of a cell.

Functions of Lysosomes

- Lysosomes are involved in the intracellular digestion of food particles ingested by the cell through endocytosis.
- The lysosomes of WBCs (White blood cells) destroy pathogens and other foreign particles and thus take part in natural defence of the body.

RIBOSOMES

- Ribosomes are small granular structures made up of ribo nucleic acids (RNA) and proteins.
- They occur free in the cytoplasm as well as attached to the outer surface of the rough endoplasmic reticulum.
- Each ribosome consists of two subunits – a small subunit and a large subunit. At the time of protein synthesis many ribosomes get attached to messenger RNA and form a structure called polyribosome or polysome.

- **Functions of Ribosomes**

Ribosomes play an important role in protein synthesis. So they are called, 'protein factories' of the cell

VACUOLES

- Vacuoles are fluid– filled sacs bound by a single membrane and are present in plant cells as well as in certain protozoans as food vacuoles and contractile vacuoles.
- In plant cells, major portion of the cell is occupied by vacuoles and are bound by the definite membrane called tonoplast.
- Vacuoles of plants are filled with cell sap containing minerals, sugars, amino acids and dissolved waste products.

Functions of Vacuoles

- Vacuoles store and concentrate mineral salts as well as nutrients.
- They maintain proper osmotic pressure in the cell for its turgidity and absorption of water.

PLASTIDS

- Plastids are present only in plant cells
- The internal organisation of the plastids consists of numerous membrane layers embedded in a material called the stroma.
- It is double membranous discoidal structure.
- Plastids are similar to mitochondria in external structure. Like the mitochondria, plastids also have their own DNA and ribosomes.

  Depending upon the type of pigment present in them, they are of following three types :

  (i) Leucoplast – White, found in underground parts
  (ii) Chloroplast – Red, brown
  (iii) Chloroplast – Green in colour, found in aerial parts of plants

  Function : They are the sites of light reaction of photosynthesis as they contain photosynthetic pigment chlorophyll.

Mitochondria

- It is a rod shaped structure found in cytoplasm of all eukaryotic cells except mammalian RBC's.
- These are also absent in prokaryotes.
- It was first seen by Kolliker in insect cells.
- Maximum mitochondria are found in metabolically active cells.
- It is also called as 'Power House of the Cell' or the 'Storage Battery'.
- It is double membranous structure where outer membrane has specific proteins while inner membrane is folded inside to form chambers called Cristae.
- The mitochondria contain proteins, lipids and a small amount of DNA.

Functions of Mitochondria :

- Mitochondria synthesize energy rich compounds such as ATP.
- Mitochondria provide important intermediates for the synthesis of several biochemicals like chlorophyll, cytochromes, steroids, aminoacids etc.

Differences between Plant cell and Animal cell

S.No.	Plant cell	Animal cell
1.	Plant cell has an outer rigid cell wall which is made up of cellulose.	Animal cell lacks a cell wall.
2.	Plant cell is larger than animal cell.	Animal cell is comparatively smaller in size.
3.	Plant cell has large vacuoles which occupy more space in the cell.	Animal cell usually lacks vacuoles. Even if they are present, they occur in minute sizes.
4.	Centrosome is present only in the cells of some lower plants.	All the animal cells have centrosomes.
5.	Lysosomes are found only in the eukaryotic plant cells.	Lysosomes are found in all animal cells.
6.	Plant cell contains plastids.	Plastids are absent
7.	Mostly, starch is the storage material.	Glycogen is the storage material.

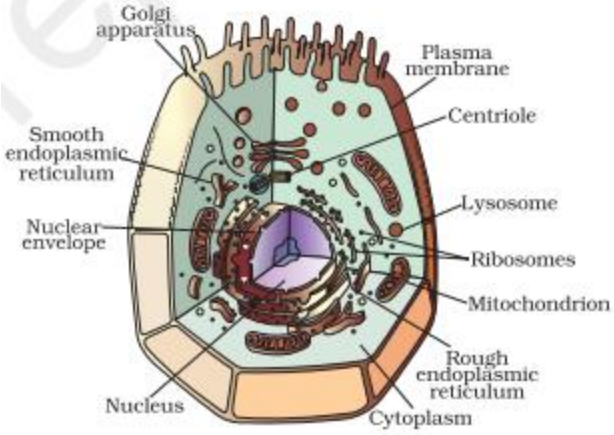


Fig. 5.5: *Animal cell*

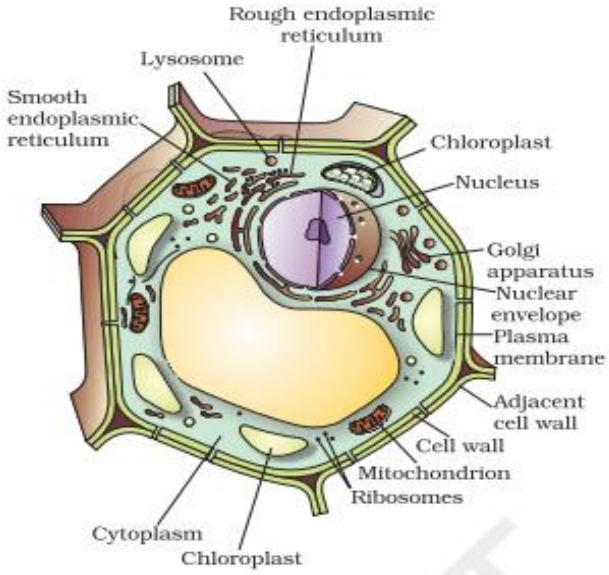


Fig. 5.6: *Plant cell*