

9th – Fundamental Unit of Life I



A cell is the structural and functional unit of life. It is the building block of which all living organisms are made and the smallest unit of life capable of all living functions. It is defined as 'a mass of protoplasm bounded by a plasma membrane'.

Discovery of cell

Robert Hooke (1665) while examining a thin slice of cork under the primitive microscope, observed that cork consists of small box like structure resembling honeycomb. He called these boxes 'cells'. The substance called cork comes from the bark of a tree. The use of word 'cell' to describe these units is used till today in biology. Cell is a Latin word for 'a little room'.

Basic characteristics of cells are as follows:

1. They have the ability to replicate independently
2. They contain hereditary information
3. They can perform all the life sustaining activities in their own
4. They show similar chemical composition and metabolic activities

Major Discoveries related to Cell

Scientist	Year	Work
Robert Hooke	1665	Discovered cells for first time in cork slice with the help of a primitive microscope.
Leeuwenhoek	1674	Discovered free living cells in pond water by his improved microscope.
Robert Brown	1831	Discovered nucleus in cell
Schleiden and Schwan	1838 - 1839	Presented cell theory, which states that all plants and animals are composed of cells and the cell is the basic unit of life
Purkinje	1839	Coined the term 'protoplasm' for the fluid substance of cell
Virchow	1855	Expanded the cell theory by suggesting that all cells arise from pre existing cells
Knoll and Ruska	1940	Built an electron microscope that made understanding of the complex structure of cell and its organelles possible.

Difference between Unicellular and Multicellular organism

Unicellular Organism	Multicellular Organism
A single cell constitutes the whole organism.	Multiple cells are grouped together in a single body which assume different functions in the body to form various body parts
There is no division of labour in prokaryotic unicellular organism but it may be seen within the cell in eukaryotic organism	All cells are specialised to perform different functions of the multicellular body so that there is a division of labour within a single cell as well as group of cells.
E.g. amoeba, paramoecium, bacteria etc	E.g. fungi, plants, animals including humans.

Shape of cells

Some cells have fixed shape like most plants and animal cells, while some cells like WBC and amoeba keep changing their shapes. Fixed shaped cells may be of various types like elliptical like fat cells, spherical like ovum, spindle shaped like smooth muscle cell, knobbed thread like sperm, discoidal like RBC, elongated like nerve cells.





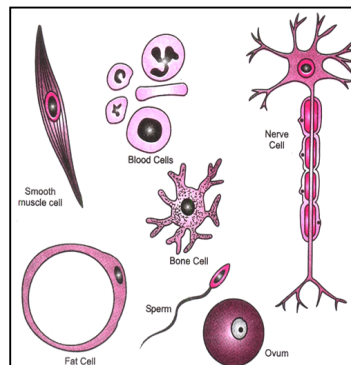
Size of cells

The size of cell varies significantly from the smallest cell of Mycoplasma (0.1 - 0.5µm) to very large egg cells of the ostrich (1gcm). Longest cells of human body are the nerve cells, which may reach upto a length of 90cm.

Functions of cells

Each living cell has the capacity to perform some basic functions that characterise the living organism:

1. The shape and size of cells are related to the specific functions they perform.
2. Multicellular organism like human beings perform these functions by division of labour i.e. different parts of human body are specified to perform different functions such as heart is made to pump blood, stomach to digest food and kidney to filter urine.
3. A division of labour is also seen within a single cell. Every cell possess certain specific components known as cell organelles which enable it to live and perform special functions.
4. Cell organelles together constitute the basic unit of life called the cell. Each kind of cell organelle performs a specific function like obtaining nutrition, respiration, clearing waste material or forming new progeny.



Cells vary in size. Most cells are very small (microscopic), some may be very large (macroscopic). They vary considerably in shape. Variation depends mainly upon the functions of cells. For example, a nerve cell has a cell body with long cell processes extending from it. Its function is to receive and transmit nervous signals. Some cells may exist as independent unit of life. Some cells like 'Euglena and Amoeba' can change their shape, but most cells have a fixed shape. The number of cells vary organism to organism. An 'amoeba' is single celled while human body weighing about 60 kg may have as many as 60×10^{15} cells.

In unicellular organism, like amoeba, parmoecium, all basic functions of a living being are performed in one cell, while multicellular organisms have well developed division of labour. So, their different functions are performed by different organs.

Microscope: they are high resolution instruments that are used for observing the fine details of very minute objects. By a microscope, the size of a small cell can be magnified upto 300 - 1500 times.

Exercise 1

- Q1. Who discovered free living cells?
- Q2. There is no division of labour in unicellular organisms. Give reasons.
- Q3. Which is the longest cell in human body?
- Q4. Why is cell called the structural and functional unit of life?
- Q5. Who discovered cells and how?

Cell Structure

the majority of cells range between 3 and 30 microns. the detailed structure of a cell has been studied under 'compound microscope' that use light and can magnify an object up to 2000 times. Structurally the cell is formed of three parts:

1. Plasma membrane
2. Cytoplasm
3. Nucleus

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Plasma Membrane or Cell Membrane: Each cell is bounded by an extremely delicate, thin, elastic, living membrane, called the plasma membrane. It is about ten thousandth of a millimetre in thickness. In plant cell, it is present on the inner side of the cell wall. The plasma membrane is made up of two layers of lipid (fat) molecules with protein molecules sandwiching it and embedded in it.

It is a selectively permeable membrane which allows the flow of only some substances into the cell and out of the cell. Thus, it helps in maintaining the distinct chemical composition of the cell.

Functions of Plasma membrane:

1. It allows or permits the entry and exit of some selective material in and out of the cell. The cell membrane therefore acts as semi permeable, selectively permeable, partially permeable or differentially permeable membrane.
2. It helps to maintain the shape of the cell.
3. It acts as a mechanical barrier and protects the internal contents of the cell from leaking out.
4. It provides protection against microbes and foreign substances.
5. It gets modified to perform different functions, e.g. microvilli in intestine of human beings for absorption.
6. Its semi permeable enables the cell to maintain cellular homeostatis.

Cell wall: Plant cells have an additional protective wall outside the plasma membrane called cell wall. It is relatively thick, non living and rigid envelope. It is permeable and is made up of cellulose, a complex substance that provides structural strength to plants.

Functions of cell wall:

1. Cell wall permits the cell of plants, fungi and bacteria to withstand hypotonic conditions without bursting. In hypotonic media, the cells tend to take up water by osmosis. The cell swells up, building up pressure against the cell wall. The wall exerts an equal pressure against the swollen cell. Due to the presence of the wall, plant cells can tolerate much greater changes in surrounding medium than animal cells.
2. It has narrow pores, called **pits**, through which fine strands of cytoplasm called plasmodesmata are able to cross the cell walls. Plant cell interact with each other through these cytoplasmic channels.
3. It prevents drying up of cells
4. It protects the plasma membrane and internal structure of the cell.
5. It helps in the transport of various substances in and out of the cell.
6. Provide structural strength to plants.

Protoplasm: All the components of a cell including cell membrane is known as 'protoplasm'. It is a colourless, jelly like, viscous semi fluid substance which can be distinguished into a centrally located nucleoplasm and the surrounding cytoplasm. It consists of cytoplasm and nucleoplasm.

Cytoplasm : The protoplasm which surrounds the nucleus is called 'cytoplasm'. It is formed of proteins, nucleic acids, carbohydrates, lipids and certain inorganic substances. Many small organelles are found inside the cytoplasm. These are known as cytoplasmic organelles. These organelles are the sites for various metabolic functions of the cell.

Functions of cytoplasm:

1. It helps in the exchange of material between cell organelle.



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2. It acts as a storehouse of vital molecules such as amino acids, glucose, vitamin, iron etc.
3. It acts as the site for certain metabolic pathways such as glycolysis.

Nucleus

It is popularly called 'brain of cell'. It is composed of a double layered covering called nuclear membrane. It has numerous pores called nuclear pores for the transfer of materials from inside the nucleus to cytoplasm. The nucleus contains 'chromosomes', which are visible as rod shaped structures only when the cell is about to divide. It encloses a liquid ground substance called nucleoplasm, which contains nucleolus and chromatin material.

Nucleolus: is spheroidal organelle inside the nucleus. It is the densest organelle and is prominent in cells that synthesize proteins. The number of nucleoli in a cell may be one to several thousand. It contains DNA which synthesizes ribosomal RNA.

Chromatin: is an entangled network of long, thread like structure which condenses to form chromosomes during cell division.

Chromosomes: contain information for the inheritance of features from parents to next generation in the form of DNA molecules (Deoxyribonucleic Acid). They are composed of two components: i.e. DNA and protein. The DNA molecules contain information necessary for constructing and organizing cells. The functional segments of DNA are called 'genes'.

Functions of nucleus:

1. Nucleus plays an important role in cellular reproduction in which a cell divides to form two new cells.
2. It also determines the cell development and maturity by directing the chemical activities of the cell.
3. It helps in the transmission of heredity traits from parents to offspring.
4. It controls all metabolic activities of cell and if it is removed, the protoplasm dries up.

In some organisms like bacteria, the nuclear region of the cell is poorly defined because of the absence of nuclear membrane. The nuclear region in these organisms contains only nucleic acid. Such an undefined nuclear region is called **nucleoid**.

Organisms whose cells lack a nuclear membrane are called prokaryotes (means primitive nucleus). They also lack cytoplasmic organelles. Most functions are thus performed by poorly developed parts of cytoplasm. The organisms having a well defined nucleus enclosed in nuclear membrane are called 'eukaryotes'. Eukaryotic cells are further categorised into **Plant Cell and Animal Cell**.

Exercise 2

- Q1. What is the role of nuclear pores in a cell?
- Q2. What are genes? Where are they located?
- Q3. Why plasma membrane called selectively permeable membrane?
- Q4. Which component of plant cell provides it the structural strength?

