Biology

06 Structure & functions of the plant & animal cell

6.1 Basic unit of life

In 1665, Robert Hooke observed a section of a cork using a microscope prepared by him. He discovered a structure like chambers in a beehive and he named them as cells.

Fig 6.1-Robert Hooke, the microscope and the cells in a section of the cork

Schleiden, Schwann and Radolf Virchow introduced the cell theory, based on the facts revealed by observing different live tissues through the microscope.

The contents of the cell theory are as follows.

- The structural & functional unit of life is the cell.
- All organisms are made up of one or more cells.
- New cells are formed from pre-existing cells.

6.2 Concept of the cell

The cell is the smallest structural unit of the organization of the living body.

The organisms composed of a single cell are called unicellular organisms and those of many cells are called multicellular organisms.

Cells perform different functions in the body.

For example - The transportation of oxygen is done by red blood cells .

Transmission of impulses is done by neurons.

Accordingly, the smallest bio unit that is adapted to perform a particular function is the cell. So it is clear that the structural & functional unit of life is the cell.

The cells differ from one another from their shape, size and function. Except few occasions, mostly cells are not visible to the naked eye. Therefore they have to be observed using the light microscope.

6.3 Structure of cells

Let's do the following activities (01 & 02) to study the structure of animal cells and plant cells.

To study the animal cells we will observe cheek cells and for the plant cells, let's take onion epidermal cells, as these cells are easily obtained.

Activity 6.1

Study of animal cells (cheek cells)

Wash the mouth and scrape the inner side of the cheek using a yoghurt spoon. Obtain a clean glass slide and put a drop of water and transfer the specimen on to the slide. Cover the specimen using a cover slip without trapping any air bubbles and observe through the light microscope.

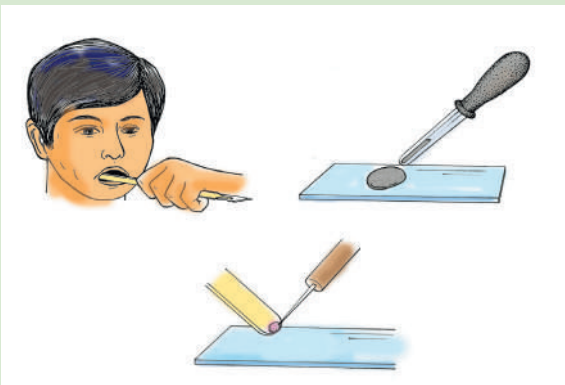
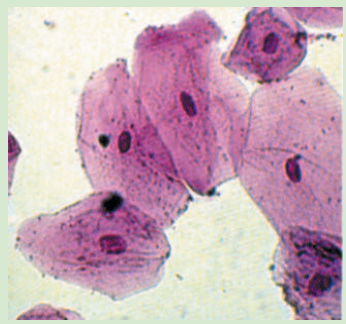


Fig 6.2 (a)



The appearance of stained cheek cells through the light microscope
Fig 6.2 (b)

Activity 6.2

Study of plant cells (onion peel cells)

Cut an onion and obtain an inner fleshy tissue as shown in the diagram. Remove a peel from inner or outer surface of it and transfer it on to a watch glass containing water. Put a water drop on to a clean glass slide and transfer the specimen on to the slide using a paint brush. Cover it with a cover slip without trapping any air bubbles and observe it.

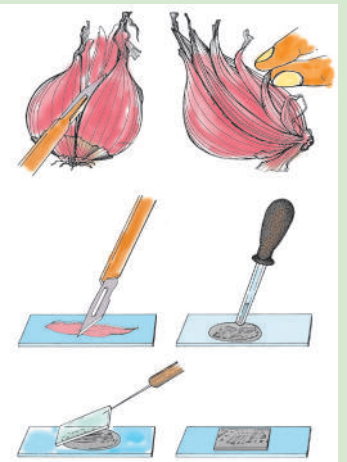


Fig. 6.3 (a)

The appearance of stained onion peel cells through the light microscope.
Fig. 6.3 (b)

• Typical cell

The small structures present within the cell to perform different functions are known as organelles.The types of organelles and the number of them differ according to the function performed by the cell.

The cell prepared by including all the organelles is known as the typical cell. In the living world such cells do not exist. But cells with a certain number of organelles of the typical cell can be found in living organisms.

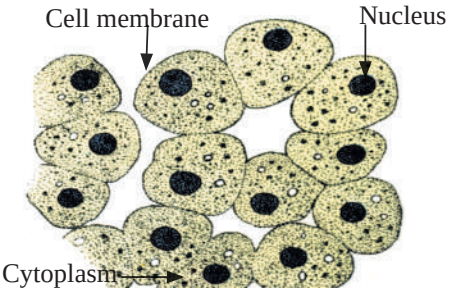


Fig 6.4 -Animal cells

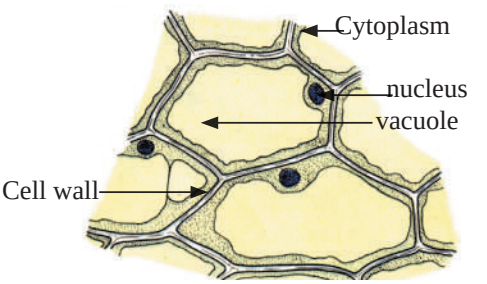


Fig 6.4 - Plant cells

(seen through a light microscope)

All animal cells are covered by a plasma membrane or a cell membrane. It is a live semi permeable membrane as well as a selective permeable membrane. There is a centralized nucleus in an animal cell. The cytoplasm is a gelatinous material.The outer covering of the plant cell is the cell wall . It is made up of cellulose. Inner to the cell wall is the plasma membrane. At the center of plant cell is a large vacuole. Generally there are no such vacuoles in animal cells.

Animal cells as well as plant cells possess different organelles that perform different functions.

Most of the above organelles cannot be observed through the light microscope. Therefore the electron microscope should be used. Below are the typical plant and animal cells created based on electron microscopic information.

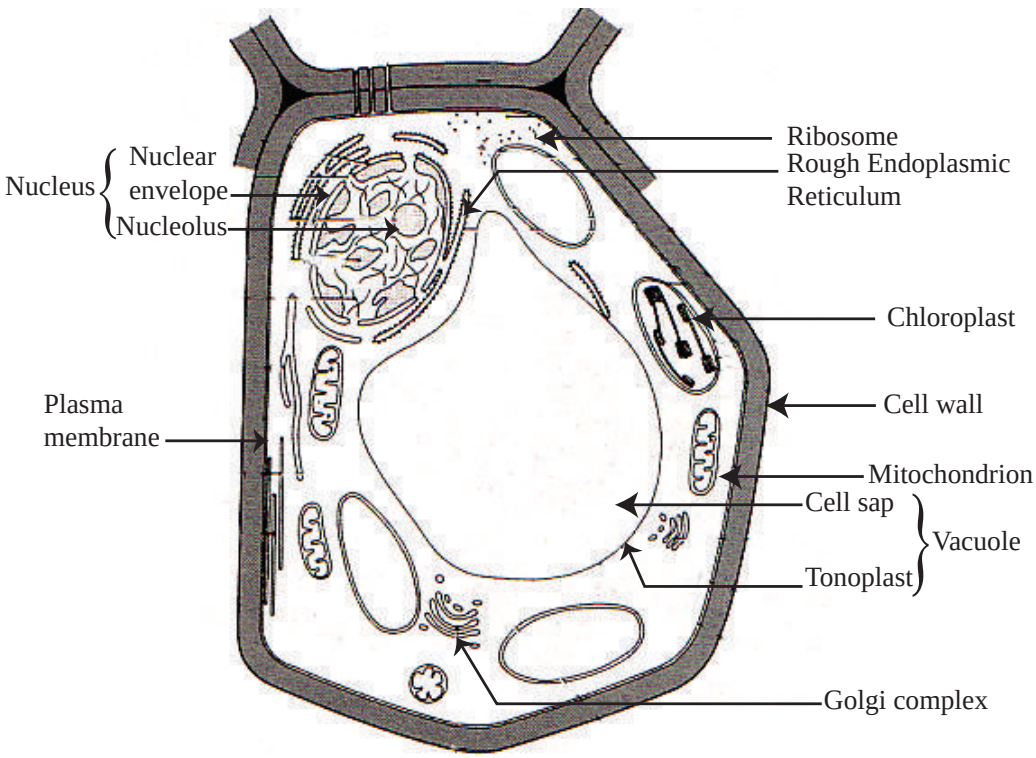


Fig 6.6 - Typical plant cell created using electron microscopic information

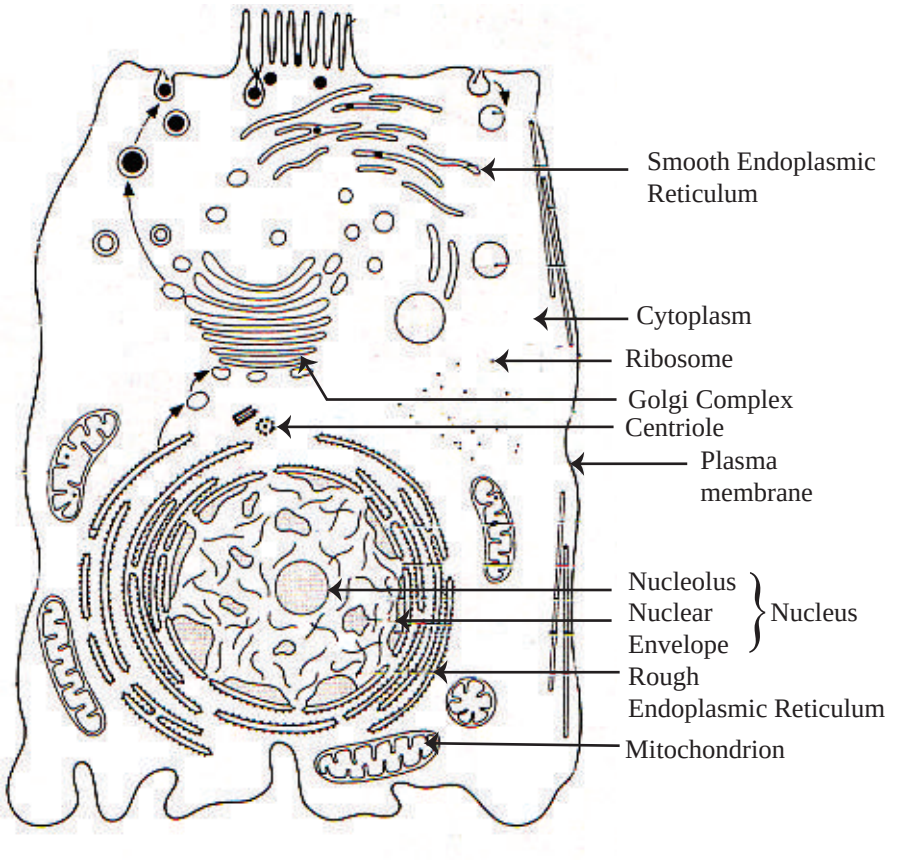


Fig 6.7 -Typical animal cell created using electron microscopic information

There are similarities & differences between animal & plant cells.

The table below contains the differences between animal and plant cells.

Table 6.1- Differences between animal cells & plant cells

Animal Cell	Plant Cell
01) Cell wall absent	01) Cell wall present
02) Large content of it contains cytoplasm	02) Cytoplasm is pushed towards periphery
03) A large vacuole is absent. (Some times few small vacuoles may present)	03) A large central vacuole or few vacuoles may present
04) Chloroplasts absent	04) Chloroplasts present

6.4 Cell organelles and structures present in a cell

Every organelle and structures present in a cell perform a specific function. The cell shows a division of labour.

- **Cell wall**

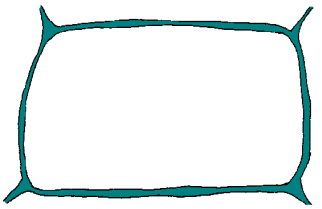


Fig 6.8

The outer most covering of the plant cell is the cell wall. It is a dead structure. The main constituent of it is cellulose. Other than it, Hemi cellulose & Pectin are also present. The main functions of the cell wall are , to maintain the shape of the cell, support & protection of the cell.

- **Plasma Membrane (Cell membrane)**

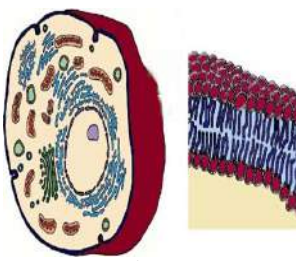


Fig 6.9

Plasma membrane is present interior to the cell wall of plant cells.The boundary of the animal cell is the plasma membrane. It is made up of phospholipids & proteins. Plasma membrane is a semi permeable membrane. The main function of it is to enclose the cell, allow entry of water, ions, some molecules and thereby control the entry & exit of materials into and out of the cell. Plasma membrane is also known as cell membrane.

- **Cytoplasm**

The gelatinous liquid part of the cell excluding organelles is known as the cytoplasm. Inorganic and organic substances are present in it. The functions of the cytoplasm are to maintain a shape to the cell, bear cell organelles and carryout different metabolic processes.

The structures submerged in the cytoplasm are named as organnells. some organelles are surrounded by cell membranes. Eg.- mitochondrion, nucleus, endoplasmic reticulum, golgi complex.

- **Nucleus**

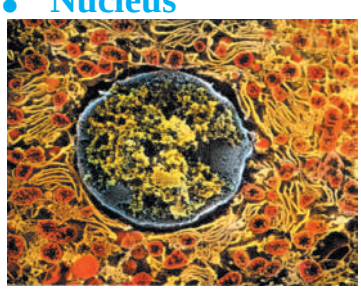


Fig. 6.10

Nucleus is the main organelle in a cell. It is surrounded by a nuclear envelope. One or two nucleolus and the chromatin body are present inside the nucleus. During cell division, the chromatin body converts into chromosome. The functions of chromosomes are the storage of genetic material and transfer inherited characters from generation to generation.

The number of chromosomes is specific to a species.

Eg : There are 46 chromosomes in a human being.There are 26 chromosomes in a frog There are 24 chromosomes in a paddy plant.

The main function of the nucleus is the control of life activities of the cell.

• Mitochondrion

Fig. 6.11

It is an oval or rod shaped membrane bounded organelle. Aerobic respiratory reactions take place within the mitochondrion to release energy. So it is known as the power house of the cell. The energy produced within the mitochondrion is used for the metabolic activities of the cell.

• Golgi Complex

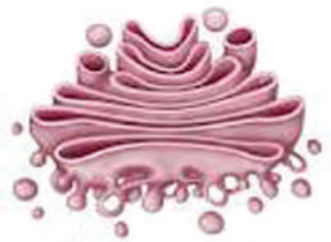


Fig. 6.12

Membrane bounded sacs stacked on top of the other with associated secretory vesicles are collectively known as golgi complex.The functions of golgi complex is the production of secretory substances, packaging and secretion.

• Ribosome

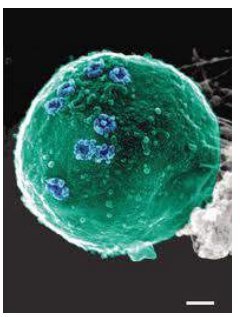


Fig. 6.13

They are small organelles without a membrane. It is made up of a large subunit and a small subunit. They can be found freely in the cytoplasm or attached to Endoplasmic Reticulum. The function of it is the protein synthesis.

• Endoplasmic reticulum

It is an inter membranous network made up of flat or tubular sacs within the cytoplasm. Endoplasmic reticulum is of two types. They are rough endoplasmic reticulum and smooth endoplasmic reticulum.

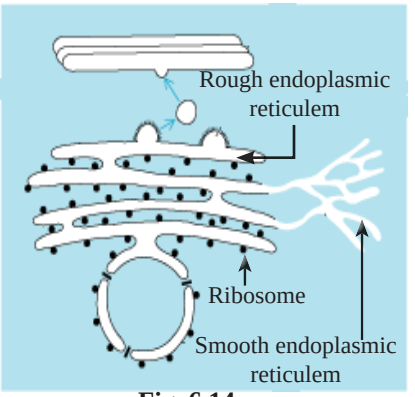


Fig. 6.14

Rough endoplasmic reticulum

Endoplasmic reticulum become rough due to ribosomes attahed to the membrane. The function of it is the transportation of proteins within the cell.

Smooth endoplasmic reticulum

It is a network of tubular sacs without Ribosomes on the membrane. Synthesis of Lipids, steroids and to transport them within the cell are the functions of it.

• Vacuole

Fig. 6.15

It is a fluid filled large organelle found in plant cells which is surrounded by a membrane. The membrane that surrounds the vacuole is known as tonoplast. The fluid contained in it is known as the cell sap. Water, sugar, ions and pigments store within the vacuole. Generally no vacuoles are found and sometimes small vacoules may present in animl cells. Contractile vacuoles can be found in unicellular organisms. Maintenance of water balance, support and provision of colour to the cell by the pigments within it are the functions of the vacuole.

Activity 6.3

- Identify cells and organelles by observing the permanent slides through the light microscope with the help of your science teacher.
- Observe and study the nature of organelles using electron micrographs.

6.5 Cell Growth & Cell Division

• Cell growth

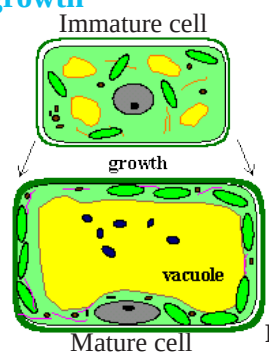


Fig. 6.16

Growth is a basic feature of organisms. **Growth of a cell is the irreversible increase of size or dry mass.** But a cell has a maximum limit to grow. Beyond that level the cell will not grow, instead it divides.

• Cell division

The cell has the ability to grow and multiply its number. Accordingly a cell can multiply into two, four and eight cells. By multiplication new cells are formed. The cells multiply by cell division.

The cell division is the process by which new cells are formed by the division of cellular materials.

To complete the cell division of an eukaryotic cell, first the nucleus should divide and then the cytoplasm.

Before the division of nucleus, the chromosomes which contains and transfers genetic materials, the inherited characters from generation to ganaration can be seen clearly as in the figures below.

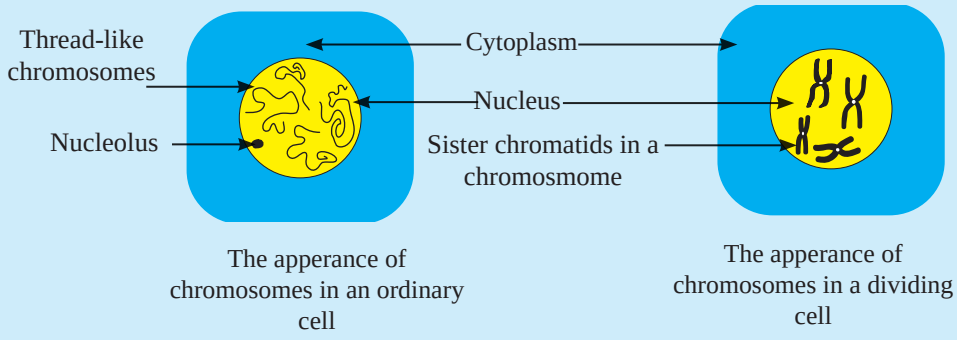


Fig. 6.17

The number of chromosomes in an ordinary somatic cell of a species is constant. That is specific to a species.

Example - There are 46 chromosomes in a chromosomal set of human. This is comprised of 23 pairs of chromosomes. The same heraditary information is born by each pair of chromosomes.

A pair of chromosomes which contains same heriditary information is called as homologous pair of chromosomes. One of these homologous chromosomes is inherited from father where as the other is from mother.
Accordingly human inherits 46 chromosomes receiving 23 chromosomes from father and 23 chromosomes from mother.

The cell division takes place in 2 methods.

- Mitosis
- Meiosis

Mitosis

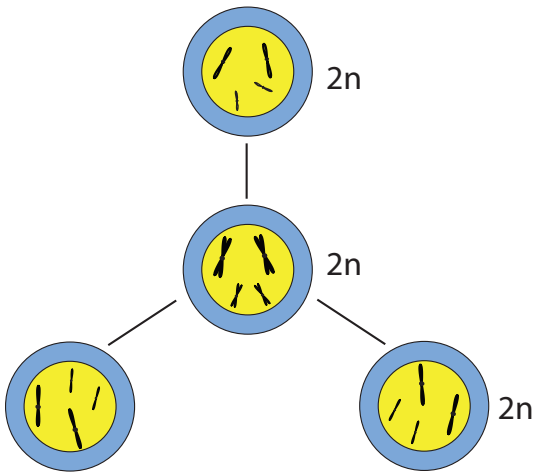


Fig. 6.18

It is the type of division which multiplies the number of cells by maintaining a constant number of chromosomes in the cells. First the nucleus divides and then the cytoplasm divides to produce two identical daughter cells equal to mother cell.

Significance of Mitosis

- For the growth of multicellular organisms.
- As an asexual reproduction method.
- Wound healing and cell replacement.

Meiosis

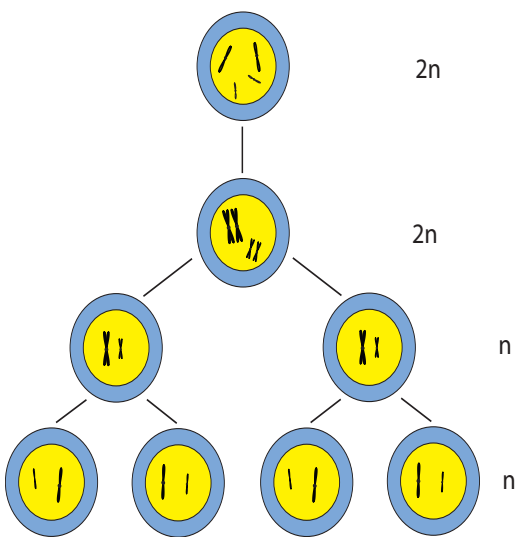


Fig.6.19

After the gametes being fused, the number of chromosomes of a species should be maintained, constant. For that the number of chromosomes should be halved during the formation of gametes and become n (haploid). The cell division that halved the number of chromosomes is the **meiosis.**

The meiosis takes place during formation of gametes (eggs & sperms) in higher organisms. Eggs and sperms possess only one chromosome of each pair of chromosomal set. (2n → n) When these gametes fuse to form the zygote, the chromosomes become n + n → 2n again.

Meiosis takes place in 2 stages. The first stage is a meiotic division (reduction division) and the next is a mitosis.
During meiosis, structural changes occur in chromosome. Therefore, new variations or new characters appear in organisms and this is a very important phenomena in evolution.

Significance of Meiosis

- Maintenance of the constant number of chromosomes from generation to generation.
- Help in evolution due to variations occur in chromosomes.

Differences between Meiosis and Mitosis are mentioned in table 6.2

Table 6.2- Differences between meiosis & mitosis

Meiosis	Mitosis
1. Takes place in two divisions	Only one division
2. Takes place only in diploid cells	Takes place in both diploid & haploid cells
3. Variations occur Thus changes take place in chromosomes	No variations. The changes in chromosome are rare
4. Four daughter cells result at the end of the division	Two daughter cells result at the end of the division
5. Daughter cell receives half of the chromosomal number of mother cell	Two daughter cells receive the same chrosomals number as the mother cell
6. Daughter cells are different from mother cell	Daughter cells are similar to mother cell

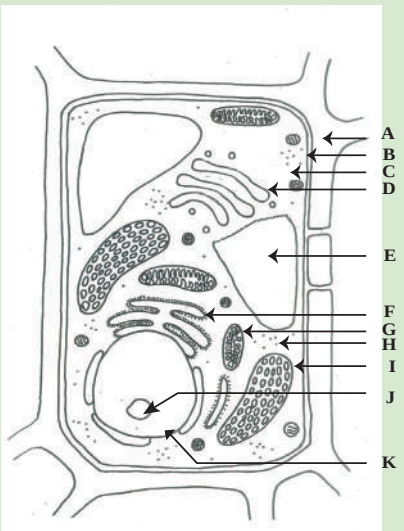
Summary

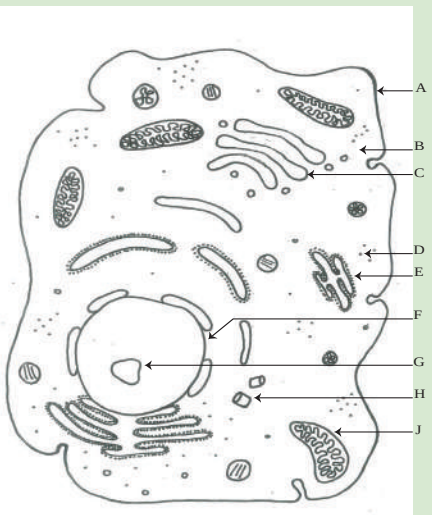
- The basic structural unit of the organism is the cell.
- The structural & functional unit of life is the cell.
- New cells are formed from pre-existing cells.
- Different functions are performed by different organelles in the cell.
- All animal cells are surrounded by the plasma membrane. Generally the nucleus is present at the center of the cell. The area between nucleus and the plasma membrane is the cytoplasm. There are different organelles present in the cytoplasm. Eg : Mitochondrion, Golgi complex, Endoplasmic reticulum.

- Most of the cell organelles are present in both animal and plant cells. But some organelles like cell wall, chloroplast, large central vacuole are present only in plant cells.
- The cellular structures that carry genetic information are the chromosomes in the nucleus.
- The cell growth is the irreversible increase of dry mass or the size of the cell.
- The cell divides at a particular stage during the growth.
- The cell division takes place according to two methods. They are Mitosis & Meiosis.

Exericises

1.





1.1 Name A,B,C,D,E..... structures and organelles in the above cells.

1.2 Differentiate between a plant cell and an animal cell.

1.3 Mention the functions of the following organelles.

(1) Mitochondrion (2) Golgi complex

(3) Rough endoplasmic reteculum (4) Vacuole

2. Explain the importance of meiosis.

Glossary of technical terms

Typical cell	දර්ශීය සෛලය	பொதுமைப்பாடடைந்த கலம்
Organelle	ඉන්ද්‍රියිකාව	புன்னங்கம்
Chromosomal number	වර්ණදේහ සංඛ්‍යාව	நிறமூர்த்தங்களின் எண்ணிக்கை
Cell division	සෛල විභාජනය	கலப்பிரிவு
Mitosis	අනූනනය	இழையுருப்பிரிவு
Meiosis	ඌනනය	ஒடுங்கற் பிரிவு