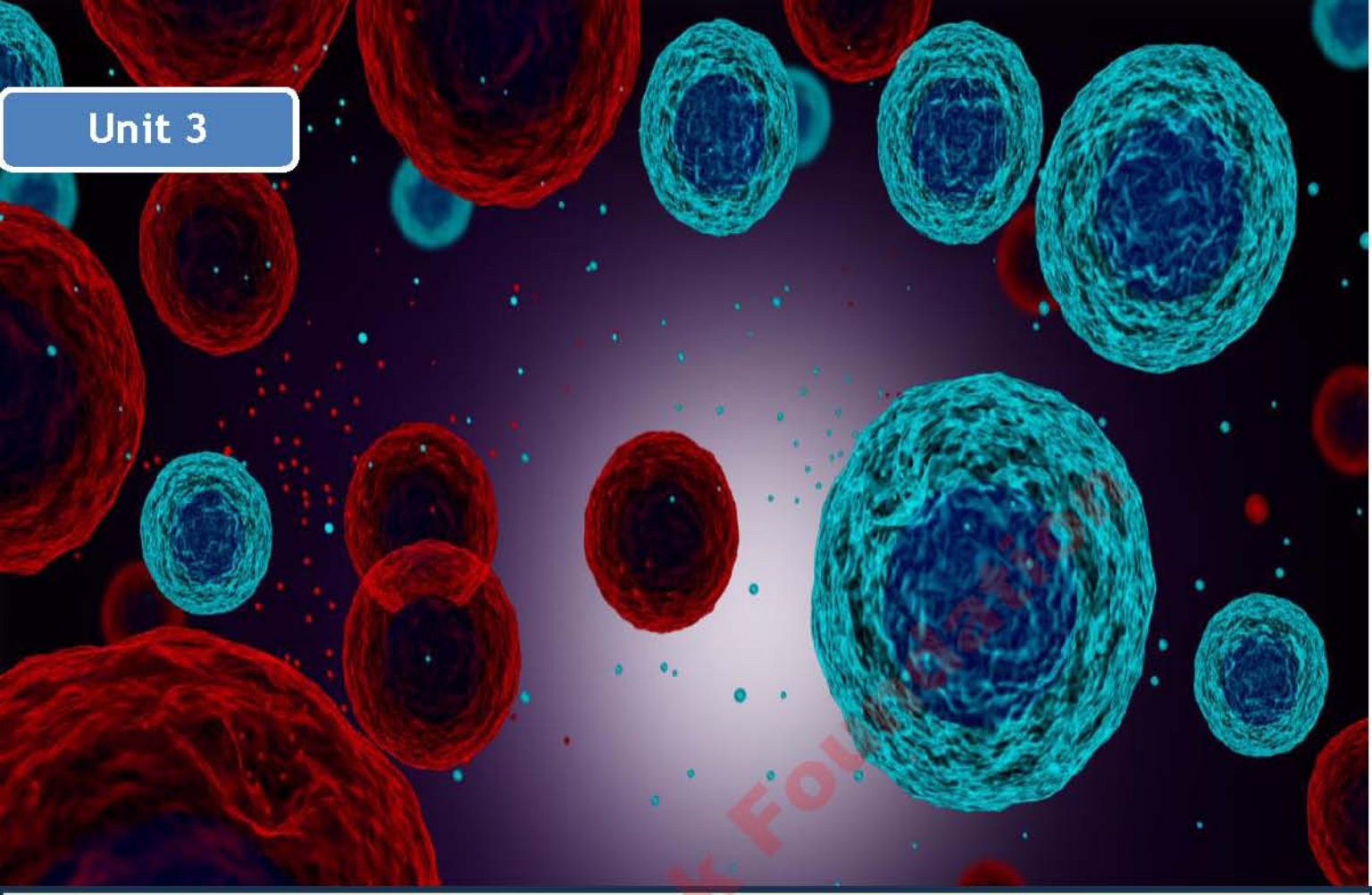


Unit 3

The Cell

SLOs: After completing this lesson, the student will be able to:

1. Describe cell as the basic unit of life
2. Compare with diagram the structure of animal and plant cell.
3. Sketch different subcellular organelles nucleus, mitochondria, cell membrane etc. and outline their roles.
4. Outline structural advantages of plant and animal cells.
5. Identify different types of cells mesophyll, epidermal cells, neurons, muscles, red blood cells, liver cells and sketch their structures
6. Describe the concept of division of labour and how it applies to
7. Within cell across subcellular organelles
8. Multicellular organisms across cell
9. Describe cell specialization
10. Define stem cells as unspecialized cells

3.1 CELL

Earth is a living planet. It is home of a huge variety of life from microscopic organisms to magnificent blue whales and giant redwood trees. Irrespective of their size and shape all life forms are made up of units called cells. The functions performed by the living organisms are also performed at the cell level. So cell is the basic unit of structure and function of all living organisms.

3.1.1 Structure of cell

In 1665, Robert Hooke discovered cell when he examined a thin slice of cork tissue under a compound microscope. He observed cells as empty chambers with thick outer coverings. However, the quality of microscope lenses improved greatly in the nineteenth century which lead to the discovery of cell nucleus in 1831 and many cytoplasmic organelles in coming years.

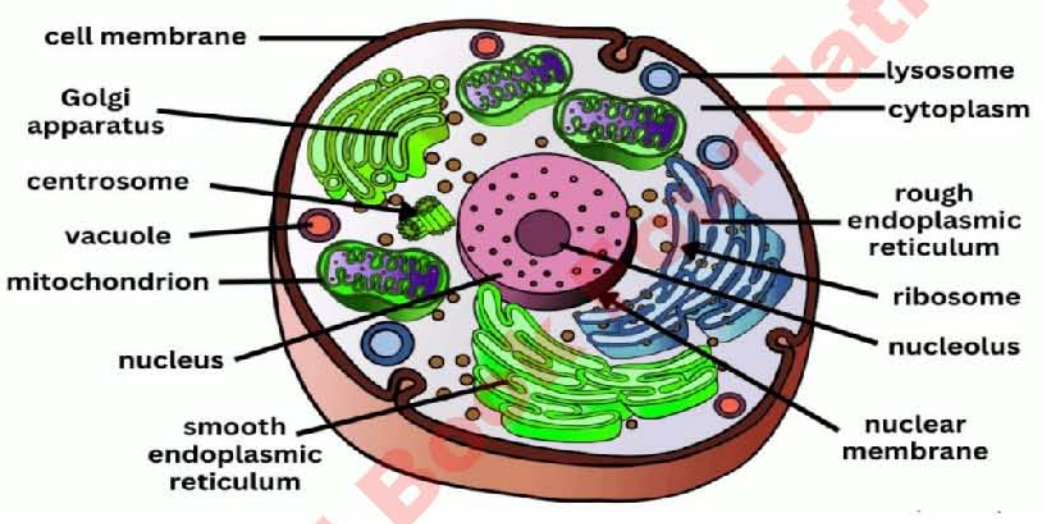


Fig 3.1: Animal cell

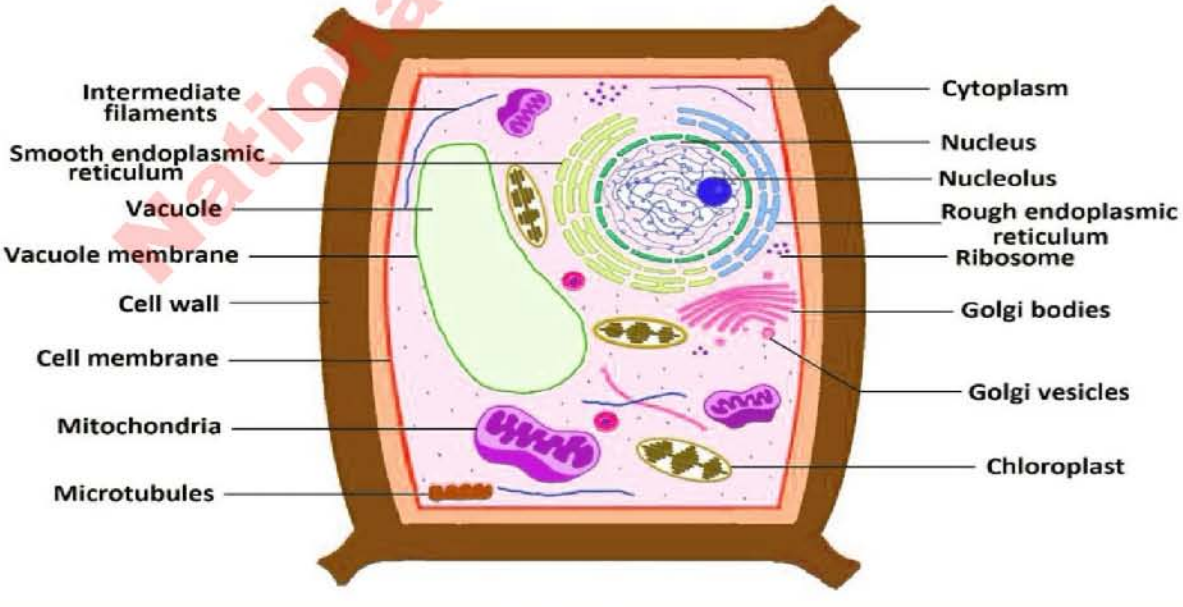


Fig 3.2: Plant cell

Cell wall

The cell wall surrounds the plasma membrane of plant cells. It is rigid, inert covering secreted and deposited outside the cell membrane. It consists of three layers namely middle lamella, primary wall and secondary wall.

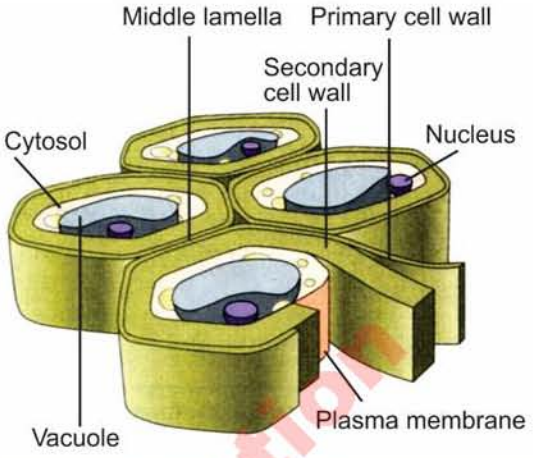


Fig 3.3: Plant Cell wall

Middle lamella is a made up of magnesium and calcium salts of **pectin**. It is sticky in nature that holds the neighbouring cell walls together. **Primary wall** contains cellulose fibres arranged in a criss-cross fashion. It is thin and flexible. Some plant cells like xylem vessels form **secondary wall** inside the primary wall. It is very thick and rigid structure due to presence of lignin which cements the cellulose fibres together. Cell wall bears tiny pores through which neighbouring cells form cytoplasmic connections called plasmodesmata.

Algae have cellulose in their cell wall. Fungal cell wall is made up of chitin. Prokaryotes also possess cell wall made up of peptidoglycan. Cell wall is absent in animals and animal like protists (protozoa).

Cell wall supports the structure of individual cells and the plant as a whole. It protects and gives shape to the cell. Plant cells can develop turgor pressure due to presence of cell wall.

Cell membrane

Cell membrane is a thin sheet like covering of the cell. Chemically it is composed of proteins 60-80 %, phospholipids 20-40 % and traces of carbohydrates. The structure of cell membrane is explained according to **fluid mosaic model**. It postulates that cell membrane consists of a double layer of phospholipids in which proteins are incorporated in a mosaic fashion. In fact, protein molecules float like icebergs in a sea like fluid of phospholipids. Cell membranes of eukaryotes also contain cholesterol. It prevents stiffening of cell membrane. Cholesterol is required for the fusion of secretory vesicles with membrane. Carbohydrates are either linked with proteins or lipids.

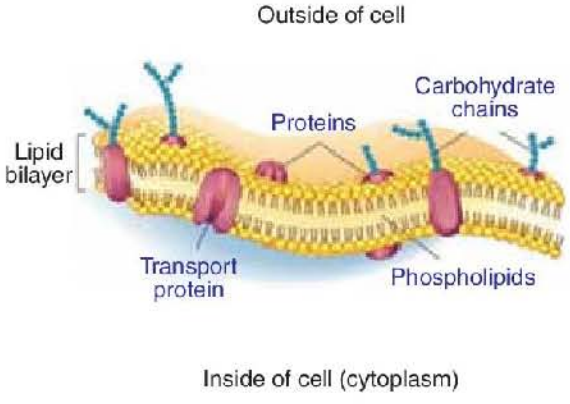


Fig 3.4. Fluid mosaic model of cell membrane

Cell membrane acts as barrier and gatekeeper for the cell. It is semipermeable so some molecules can move across the lipid bilayer but others are blocked. It maintains fixed environment inside the cell. Cell membrane acts as a barrier between the cell and its environment. It regulates the exchange of materials between cell and its environment.

Cytoplasm

Between the cell membrane and nucleus of the cell is an aqueous substance called cytoplasm. It is about 90% water having many dissolved and suspended materials. It is the site for many biochemical processes. It stores food granules and waste materials. It is home for a variety of cell organelles which are discussed below.

Endoplasmic reticulum

It is a system of membranes present throughout the cytoplasm of eukaryotic cells. Flattened sacs of the endoplasmic reticulum are called cisternae which form a network of interconnected channels. There are two forms of endoplasmic reticulum. **Rough Endoplasmic Reticulum (RER)** are covered with ribosomes. If ribosomes are absent it is **Smooth Endoplasmic Reticulum (SER)**.

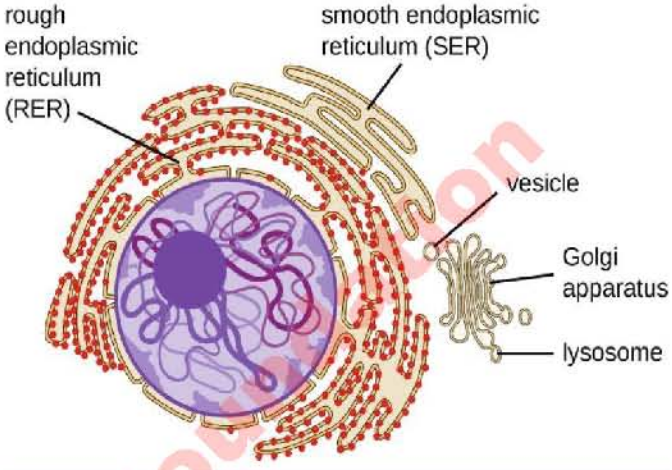


Fig 3.5: Structure of Rough and Smooth Endoplasmic Reticulum

A complex network of endoplasmic reticulum provides mechanical support to the cell. They are also involved in transport of substances within the cell. Due to attached ribosomes RER have role in the synthesis of some proteins. SER synthesize lipids including steroids. SER also detoxify harmful substances. In muscle cells SER have important role in contraction process.

Ribosomes

Proteins make up to about 55 % dry weight of a cell. A cell thus needs protein synthesis at high rate. This role is performed by the ribosomes. Ribosomes are tiny granular structures found both in prokaryotic and eukaryotic cells. They are not bound by any membrane. They are composed of roughly equal amount of proteins and ribosomal RNA (rRNA). The prokaryotic ribosomes, however, are smaller in size. A large number of ribosomes are scattered in the cytoplasm. In eukaryotes many ribosomes are also attached on the surface of RER.

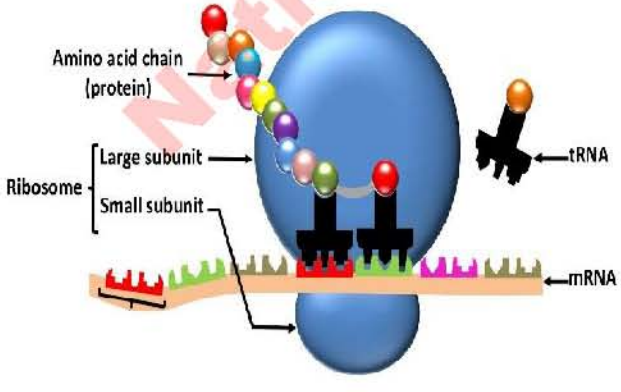


Fig 3.6: Function of ribosome

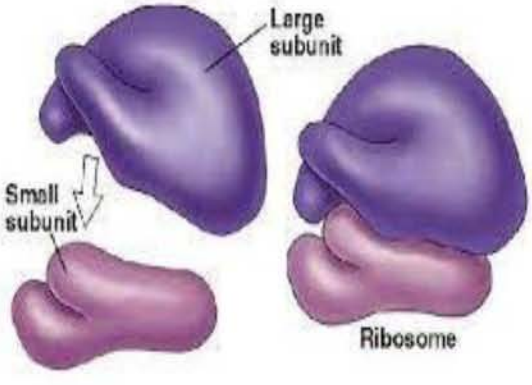


Fig 3.7: Subunits of ribosomes

Each ribosome consists of two subunits, one small and one large. These two subunits join when ribosome has to perform its function.

Golgi apparatus

Golgi apparatus was discovered by Camillo Golgi. It is present in all eukaryotic cells. Like endoplasmic reticulum, Golgi apparatus is also collection of flattened sacs called cisternae. However, in Golgi apparatus many cisternae are stacked over each other. They are constantly formed at one end and breakup into vesicles at the other end.

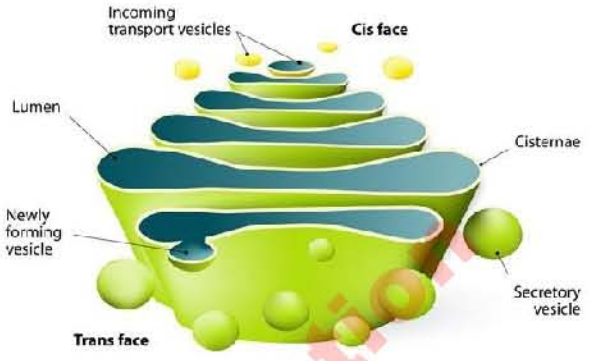


Fig 3.8: Structure of Golgi apparatus

Golgi apparatus store and modify materials into finished form before packing into vesicles. Some of these vesicles settle in cytoplasm as organelles like lysosomes. Others fuse with the cell membrane to release out packed material as cell secretion. Products of glands like enzymes, hormones, mucus etc. are secreted in this way. In plant cell, it secretes cellulose fibres which arrange themselves to form cell wall.

Lysosomes

They are single membrane bound small sac like structures. They contain a variety of digestive enzymes. The enzymes contained in lysosomes are synthesized on RER and then transported to Golgi apparatus. Lysosomes then bud off from Golgi apparatus with their processed enzymes.

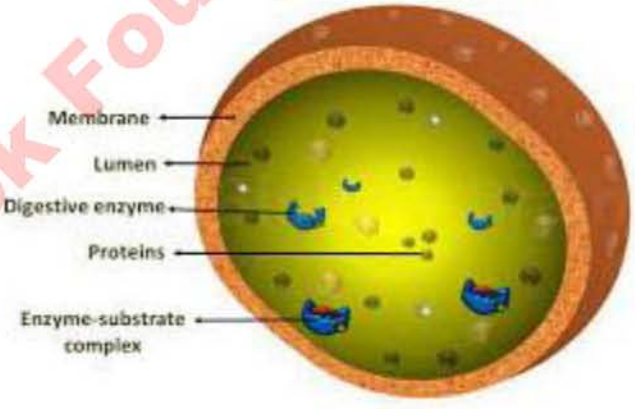


Fig 3.9: Structure of Lysosome

One important role of lysosome is **intracellular digestion**. In this process lysosomes digest materials taken up by the cell from outside as food vacuole. When lysosome fuses with the food vacuole, the lysosomal enzymes act on complex food substances and convert them into simple form. They also engulf and digest unwanted cell organelles. This process is termed as **autophagy**.

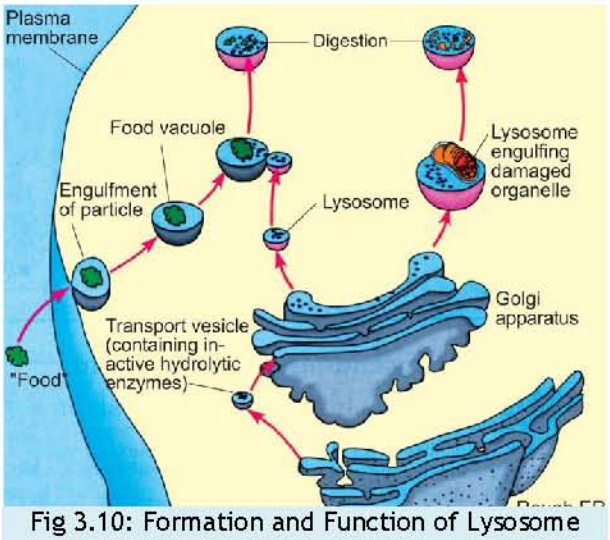


Fig 3.10: Formation and Function of Lysosome

Mitochondria

Energy is an important theme is biology. All systems, from cells to ecosystems require energy to work. Cells get energy by the breakdown of organic food in a process called respiration. If it requires oxygen, it is called

aerobic respiration. It takes place in mitochondria. Mitochondria are found in all aerobic eukaryotic cells. Mitochondria are double membrane bound structures. The outer membrane is smooth and inner membrane forms finger like projections called **cristae**. They increase the surface area for the respiration. The fluid inside the mitochondrion is called **matrix**. Mitochondria have their own DNA and ribosomes. They can multiply within the cell at their own. They produce energy in the form of ATP that is why they are called power house of cell.

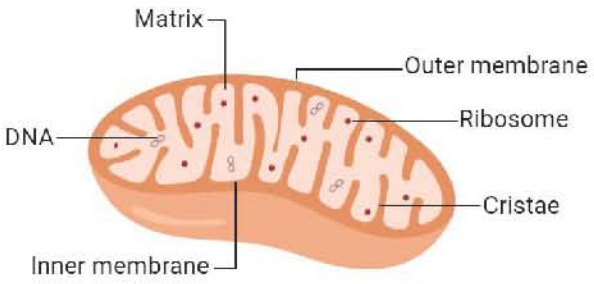


Fig 3.11: Structure of Mitochondria

PLASTIDS

Plastids are double membrane bound organelles. They are found in plants and algae. There are three types of plastids i.e., chloroplast, chromoplast and leucoplast.

Chloroplast

Chloroplasts are usually oval in structure. Two membranes of the chloroplasts form chloroplast envelope. They have their own DNA and ribosomes. They can multiply within the cell at their own. They have a system of membranes containing chlorophylls and other photosynthetic pigments. This system consists of hollow coin like membranous structures called **thylakoids**. Many thylakoids stack to form **granum**. Some thylakoids of adjacent grana fuse to from intergrana. The fluid part of chloroplast is called **stroma**. Chloroplasts synthesize food by photosynthesis process. It takes place in two phases;

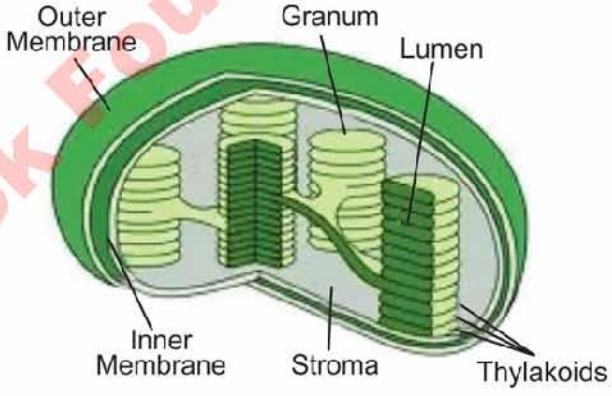


Fig 3.12: Structure of Chloroplast

a. Light-dependent phase which takes place in thylakoid membranes.
b. Light-independent phase which takes place in stroma.

Chromoplast

Chromoplasts are coloured other than green. They may be red, pink, yellow, blue, purple etc. They are found in flower petals to attract insects. Insects help in pollination. They are also present in the wall of ripened fruits where they attract birds and other animals which help in seed dispersal.

Leucoplasts

Leucoplasts are non-pigmented plastids. They are food storing organelles usually found in roots, bulbs and stem tubers. They store carbohydrates, proteins or lipids.

Vacuole

A vacuole is a membrane bound fluid filled sac. Animal cell may have many small vacuoles which exist temporarily. They contain water and food substances. Some freshwater organisms like amoeba and sponges have **contractile vacuoles** which collect and pump out extra water and other wastes. Some cells ingest food by forming **food vacuoles** which is then digested into simple molecules. Food vacuoles also store food.

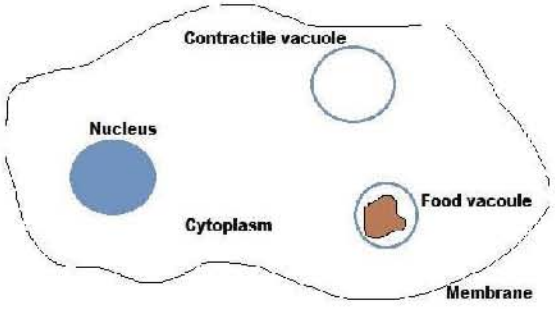


Fig 3.13: Structure and types of vacuole in animal cell

Plants cells have a large central vacuole as shown in figure 4.1. It is formed by joining small vacuoles. The membrane of plant vacuole is called **tonoplast**. It contains liquid called **cell sap**. Cell sap has dissolved materials like mineral salts, sugars, and amino acids. It also provides support and helps in growth. The primary role of the central vacuole in a plant cell is to maintain turgor pressure within the plant cell. **Turgor pressure** occurs when the fluid content of a cell pushes the cell membrane against the cell wall in order to provide shape to the plant cell.

Centrioles

Centrioles are hollow open ended cylinder like structures. They are found in animal cell. They exist in pairs near the nuclear envelope. Each centriole consists of nine triplets of microtubules. At the start of cell division centrioles duplicate and two pairs move to the opposite poles, thus help in the formation of **spindle apparatus**. They are also involved in the formation of cilia and flagella.

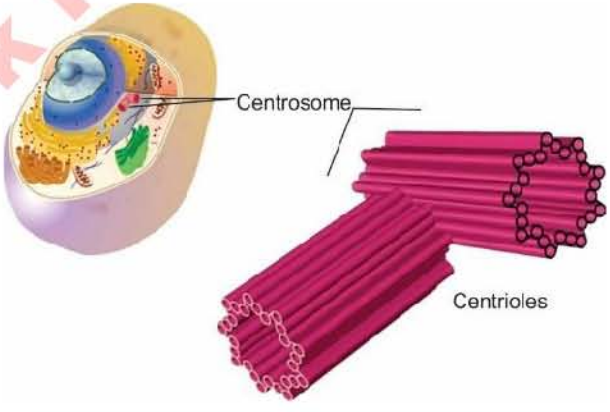


Fig 3.14: Pair of Centrioles

Cytoskeleton

Cell has a system of a variety of fibrous proteins throughout the cytoplasm. These proteins collectively form cytoskeleton. Three types of cytoskeletal fibres are identified in the cell. These include; microtubules, microfilaments and intermediate filaments.

Microtubules are made up of **tubulin** protein. They are unbranched hollow tube like structures. Microtubules give rise to spindle fibres, cilia and flagella. **Microfilaments** are very thin protein fibres. They consist of contractile proteins mainly **actin**. They are responsible for the streaming movements of the cytoplasm. The overall cell movement is also regulated by the microfilaments. **Intermediate filaments** are composed of a variety of proteins including **keratin** and **vimentin**. They form a branching network in the cell. They maintain the cell structure. In tissues, they fix cells with each other.

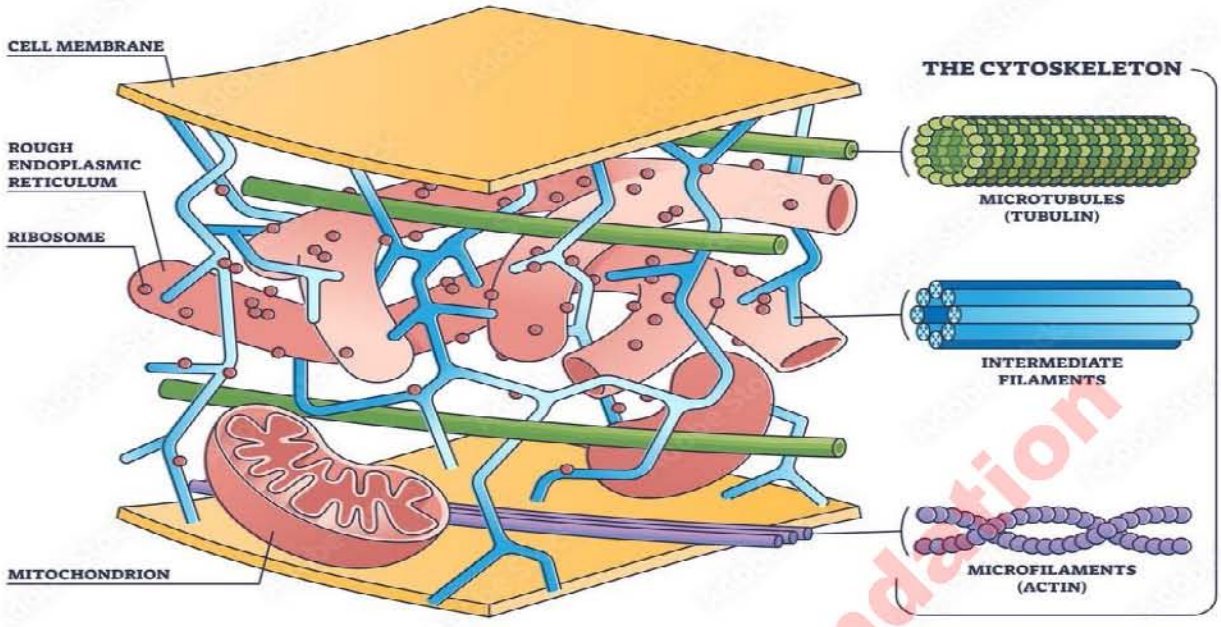


Fig 3.15: Structure and types of Cytoskeleton

Cilia and Flagella

Some eukaryotic cells have extensions that look somewhat like hair. These structures are called **cilia**. Some cells have whip like extensions called **flagella**. Cilia and flagella consist of nine pairs of microtubules which surround a single central pair of microtubules. Cilia and flagella are connected to the **basal body**. The basal body serves to anchor a cilium or flagellum to the cell. The function of cilia and flagella is movement.

Fig. 3.15: Cilia and Flagella

Nucleus

Cell activities like metabolism, growth and reproduction need to be well regulated. In eukaryotic cell this role is served by the nucleus. Nucleus acts as control centre of the cell because it contains hereditary material DNA.

Nucleus is surrounded by two membranes which collectively form the **nuclear envelope**. Nuclear envelope bears **nuclear pores** at points where both membranes fuse with each other. Through nuclear pore nucleus communicates with the cytoplasm. Some nutrients and proteins enter the nucleus through these pores and ribosomes and mRNA leave the nucleus. Nucleus contains a fluid called **nucleoplasm**.

Nucleolus is a round darkly stained area in the nucleus. Ribosomes are assembled at this point. Here ribosomal RNA (rRNA) is formed which combines with proteins to form ribosomes. It disappears for some time during cell division.

Hereditary material in the nucleus is actually in the form of chromatin. Chromatin consists of **DNA** fibres coiled on **histone** proteins. During cell division chromatin fibres condense into more tightly coiled threads known as **chromosomes**. Each species has its own unique chromosomal set different from other species.

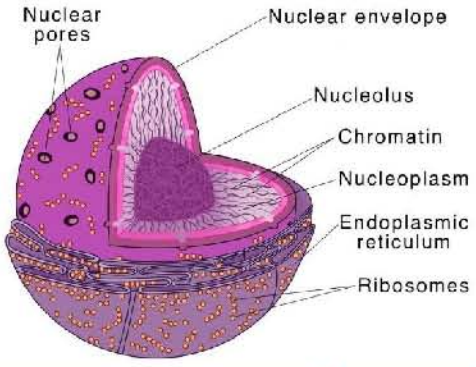


Fig 3.16: Structure of Nucleus

3.1.2 Structural advantages of animal and plant cell

The cells of living organisms have basic similarities in structure due to common origin, however, they differ in many respects. Cell wall makes a major difference in plant and animal cell. The presence of cell wall in plant cell and absence in animal cell is reflected in their life styles.

Plant cell advantages/ disadvantages	Animal cell advantages/ disadvantages
Due to cell wall adjoining plant cells are cemented with each other. Supportive structure of plant as a whole is thus formed by cell wall.	The supportive structure of an animal as a whole is not dependent on a cell wall but rather on the collective arrangement and organization of tissues, organs, and skeletal systems present in the animal's body.
Transport channels in plants, xylem and phloem, are also formed because of presence of cell walls.	In animal cells, since they lack a cell wall, the transport of fluids, nutrients, and gases occurs through different structures and mechanisms.
The rigid wall helps plant cell to withstand high osmotic stress and store water.	Animal cells cannot withstand high osmotic pressure and cannot store larger volumes of water.
Plant cell can become turgid which allows plant parts to maintain structure and stay upright.	Animal cell cannot become turgid to provide support to the body
Plants cannot move from place to place because of rigidness provided by the cell wall.	Lack cell walls which makes then very flexible. Animal cells can move. Animal cells/ animals can move to suitable environmental conditions, find shelter and better feeding fields and opportunities for reproduction.
Due to rigid structure plant cell cannot reproduce at a faster rate.	It also helps animal cell to divide and reproduce at faster rate.

3.2 CELL SPECIALIZATION

In multicellular organisms, cells are specialized to perform their specific roles. Daughter cells formed by mitosis process undergo changes in a process called **differentiation**. They alter in size, stricture, metabolic activities and physiological responses. As a result, they become specialized in their role in the body. Some examples of the specialized cells are given below.

Epidermal cells of plants form protective covering of root, stem and leaves. They are flattened cells which pack tightly to form a continuous outer layer of plant body. Epidermal cells having some additional role are modified accordingly. For example, **root hair cells** which absorb water and minerals from the soil and **guard cells** of leaves which regulate the opening and closing of stomata.

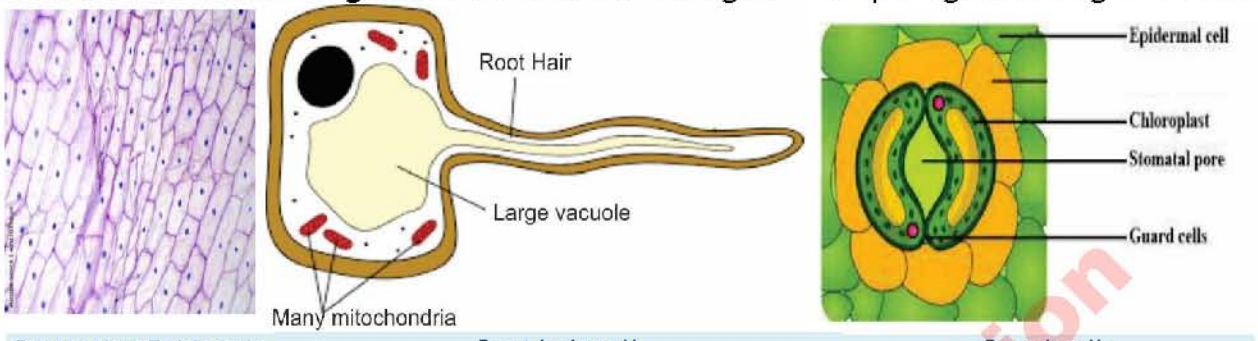


Fig 3.17: Epidermal cells

Mesophyll cells are photosynthetic cells of plants. They are present in plant leaves. They contain a large number of chloroplasts. Chlorophyll and other photosynthetic pigments are anchored in the thylakoid membranes of chloroplasts. These pigments absorb light energy and use it to produce food in photosynthesis process.

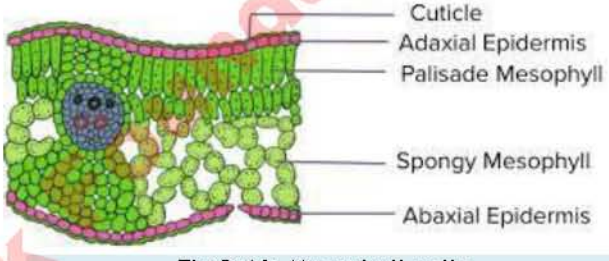


Fig 3.18: Mesophyll cells

Red blood cells (RBCs) are haemoglobin filled cells to transport oxygen in the body. They are biconcave disk shaped cells. This shape provides more surface area to absorb and release oxygen. Nucleus, mitochondria, endoplasmic reticulum etc. are absent. It helps to accommodate more haemoglobin. These cells are very flexible so they can easily pass through blood capillaries. The average age of RBCs is 120 days.

Fig 3.19: Red Blood Cells

Neurons are the cells of nervous system. They are responsible for coordination in the animal bodies. To accomplish this job their structure is very unique. A neuron cell has a **cell body** and two types of cytoplasmic fibres. One of them are **dendrites** which conduct nerve impulses to the cell body. Others are **axons** which conduct messages away from the cell body. The dendrites and axons make it possible for neurons to communicate with far away cells of the body.

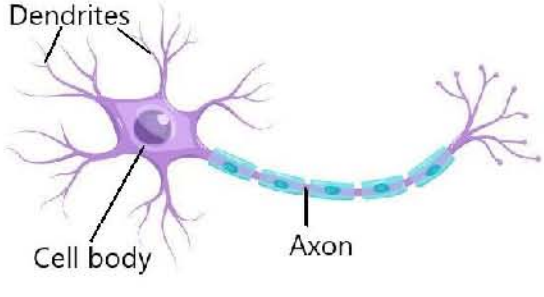


Fig 3.20: Neuron

Muscles cells have ability to contract and relax. Locomotion, breathing movements, blood pumping by the heart, change in size of eye pupil, peristaltic contraction of the gut, speech movements of tongue, lips etc. are result of the muscle contraction. To produce contractions muscle cells have elongated shape and are filled with **actin** and its associated contractile proteins.

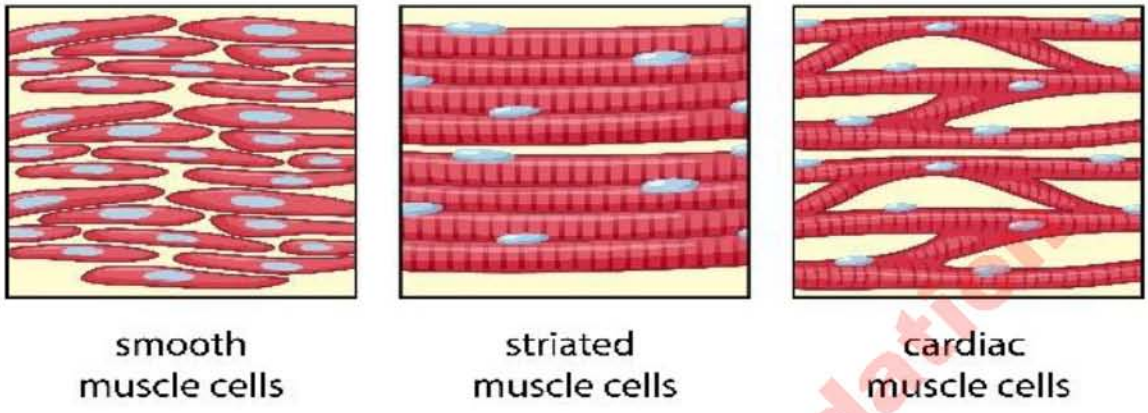


Fig 3.21: Types of muscles

Liver cells are almost round in shape and have prominent nucleus and abundance of cytoplasmic organelles. They are metabolically most active cells of the body. Their few important roles are;

a. Storage of glycogen, iron and some vitamins.
b. Detoxification of toxic substances.
c. Production of clotting proteins of blood.
d. Recycling of old red blood cells.

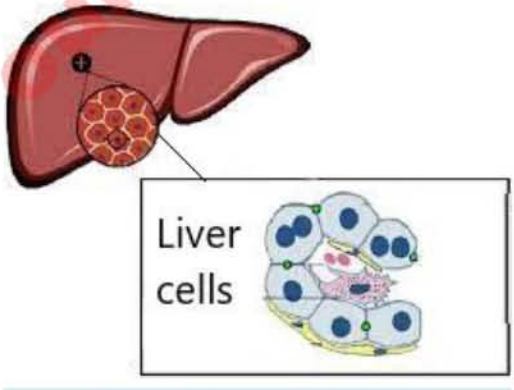


Fig 3.22: Liver and liver cells

3.3 DIVISION OF LABOUR

Within a cell different organelles perform their assigned roles. **Mitochondria** act as powerhouse of the cell as they produce energy for the cell. **Ribosomes** remain engaged in protein synthesis. **Chloroplasts** harvest light energy to manufacture organic food. For the normal survival and functioning of a cell its organelles must do their specified jobs. The performance of given function by different organelles is the division of labour.

Cell is the unit of life, so a cell can perform all basic function of life. A cell can respire, take and utilize nutrients, grow in size, reproduce, show movements etc. In unicellular organisms, a single cell lives as an organism and performs all these life processes independently.

A huge number of cells assemble a body of multicellular organism. In multicellular organism it is not possible for billions or trillions cells to perform all life tasks independently. So cells arrange in groups to perform some given role. A group of cells performing same function is called **tissue**.

The cell originating from same zygote change their cell lines and differentiate into unique structures suitable for their roles. Muscles cells are elongated to make the body parts move by their contractions. Neurons form thin cytoplasmic fibres to conduct messages in the body. Muscles cells and neurons cannot exchange their function. Similarly, RBCs transport oxygen and

bone tissue provides mechanical support. In plants mesophyll cells prepare food by photosynthesis process and phloem cells transport this food to all parts of the plant body.

3.4 Stem cells

Around 220 types of cells are identified in human body. These cells vary in their size, shape and role. However, all these types of cells have a common origin. They all develop from a single cell the **zygote**. A cell which gives rise to cells of other types is called the **stem cell**. The zygote is very basic stem cell which has ability to produce all kinds of cell an organism.

In sexually reproducing organisms, life starts from zygote. As the development progresses, different cell lines are formed. Each cell line has its own stem cell. Brain, liver, and other body tissues are products of stem cells.

Stem cells by themselves are not differentiated and are un-specialized. Each daughter cell produced by division of a stem cell has capacity to remain un-specialized stem cell or differentiate into mature cell of some tissue. So stem cells divide, renew themselves and daughter cells differentiate into distinct cell type.

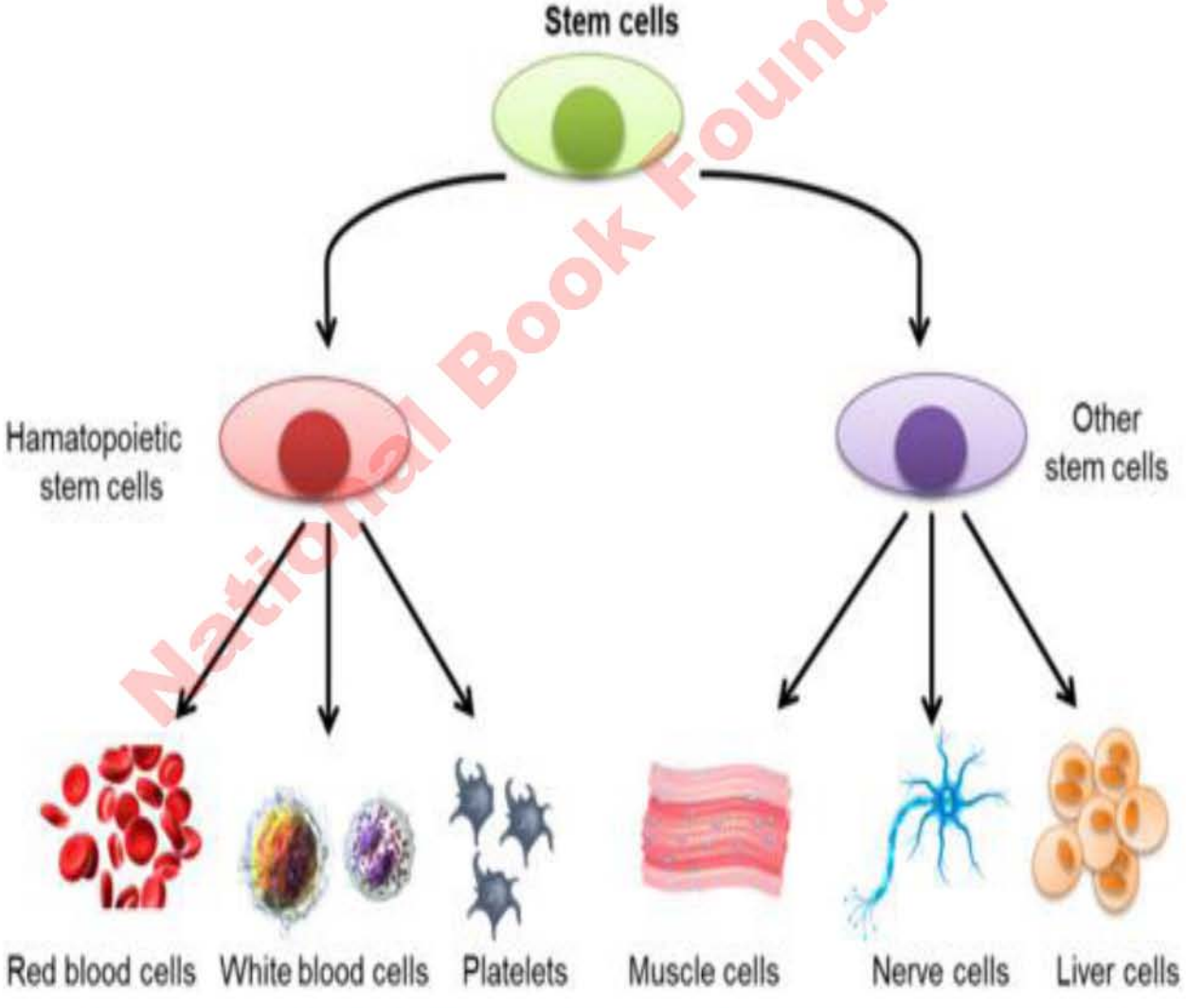


Fig 3.23: Stem cells and formation of specialized cells

STEAM ACTIVITY 3.1

Study of a plant cell

a. Place a small piece of onion skin in a drop of water on a slide and cover it with a cover slip.
b. Observe it under the microscope first under low power objective then under the high power objective.
c. Draw diagrams of onion skin cells in following table.

Diagram under low power objective lens	Diagram under high power objective lens

Steam Activity 3.2

Study of an animal cell

a. Gently pass the broad end of tooth pick on the inner side of your cheek.
b. Place the material o tooth pick in a drop of methylene blue solution on a slide and cover it with a cover slip.
c. Observe it under the microscope first under low power objective then under the high power objective.
d. Draw diagrams of human cheek cells in following table.

Diagram under low power objective lens	Diagram under high power objective lens

SUMMARY

1. The cell is considered as the basic unit of life because it is the smallest unit of living material.
2. Every cell is surrounded by cell membrane. The cell membrane is a highly fluid mixture of phospholipids and proteins.
3. A nucleus is a double membrane system with pores that communicates with the cytoplasm. It contains genetic information, which is carried by the DNA. Nucleolus is a region in the nucleus that is the site for ribosomal RNA synthesis and ribosome assembly.

4. Mitochondria are double membrane organelles in which the inner membrane is folded to form cristae. Mitochondrion is the site of aerobic respiration.
5. Golgi bodies are a series of flattened membrane sacs that process, sort, and modify proteins synthesized on the ER, and transport proteins to the plasma membrane, to the outside the cell and the lysosomes.
6. The endoplasmic reticulum is a series of internal membranes with many functions, i.e., protein synthesis lipid synthesis and transport.
7. Ribosomes are the site of protein synthesis.
8. Lysosomes breakdown organic molecules like proteins into simpler compounds that can be used by the cells.
9. Plant cell has cell wall, plastids and large vacuole.
10. Mesophyll cells, epidermal cells, neurons, muscles, red blood cells and liver cells are adapted to their particular functions.
11. Within a cell different organelles perform their assigned roles as there is division of labour.
12. A cell which gives rise to cells of other types is called the stem cell.

EXERCISE

Section I: Multiple Choice Questions

Select the correct answer:

1. A network of channels extending from cell membrane to nuclear membrane is called:

   A) centriole B) endoplasmic reticulum

   C) ribosomes D) centrosome

2. The site of enzyme synthesis in cells is:

   A) lysosome B) smooth endoplasmic reticulum

   C) Golgi bodies D) ribosome

3. What are the functions of mitochondria?

   A) lipid synthesis B) protein synthesis

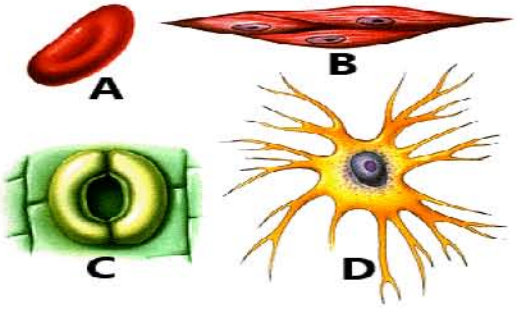
   C) photosynthesis D) cellular respiration

4. A red blood cell and a plant root hair cell both have:

   A) Cellulose cell wall B) haemoglobin

   C) Large surface area D) nucleus

5. The diagrams show cells from different types of tissues (not drawn on scale). Which type of cell contracts when it is stimulated?



6. Which of the following cell organelles does not contain DNA?

A) Nucleus
B) Lysosomes
C) Chloroplast
D) Mitochondria

7. Phospholipids are required for cell membrane formation are synthesized in:

A) Mitochondria
D) Cytoplasm
C) Endoplasmic Reticulum
D) Smooth Endoplasmic Reticulum

8. Cytoskeleton is an important component of eukaryotic cells. Which of the following statement correctly describes cytoskeleton?

A) All the cytoskeletal structures are made up of same protein
B) There is no contractile protein in any cytoskeletal component.
C) Cytoskeleton provides mechanical support and has role in cell division.
D) The entire cytoskeleton is present around the cell membrane.

9. The shape of normal red blood cells is:

A) Oval
B) Crescent
C) Biconvex
D) Biconcave

10. Plastids of different types are correctly represented by:

	Photosynthetic	Pigmented	Food storage	Colour variety
A)	Chloroplasts	Leucoplasts	Chromoplasts	Chloroplasts
B)	Chromoplasts	Chloroplasts and chromoplasts	Chromoplasts and leucoplasts	Chromoplasts
C)	Leucoplasts and chloroplasts	Chromoplasts and leucoplasts	Leucoplasts	Chloroplasts
D)	Chloroplasts	Chloroplasts and chromoplasts	Leucoplasts	Chromoplasts

11. Which of the following statement correctly represents ribosomes?

A) They are present only in eukaryotic cell.

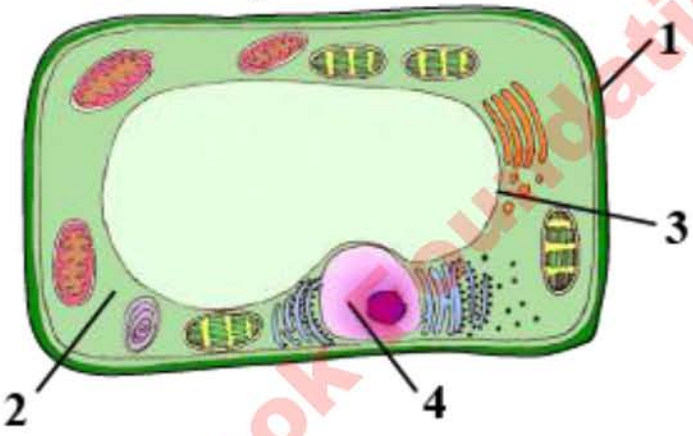
B) They are produced in the nucleus then migrate to the cytoplasm where they synthesize proteins.

C) They are covered by single membrane.

D) All ribosomes are attached to the inner surface of RER.

Section II: Short Answer Questions

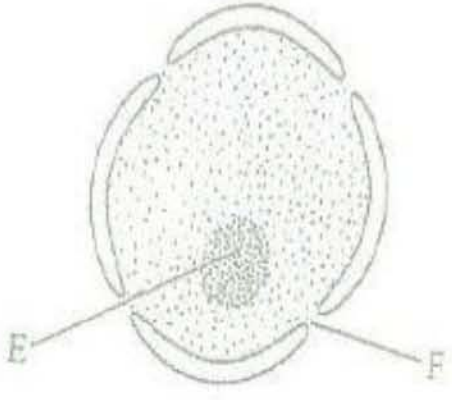
1. Why mitochondria are known as powerhouse of the cell?
2. What makes red blood cells more suitable for the transport of oxygen?
3. Give the modifications of epidermal cells for;
    a. Exchange of gases
    b. Absorption of water and minerals.
4. Following diagram shows a plant cell;



Keeping in view the parts labeled 1 to 4, answer the following questions:

a. Give the number indicating the structure which controls the cell activities?
b. Name a biochemical process taking place in part 2.
c. What will happen to cell if part 1 is removed and part 3 is overfilled with water?

5. The diagram below represents a nucleus.



a. Name the structure labeled E and F.
b. Give the function of F.
c. Which cytoplasmic organelles are formed by E?
d. What happens to E during cell division?

6. Cell shape is related to cell function. Give three examples to support your answer.
7. Plasma membrane has two main components according to fluid mosaic model. Which component represents fluid and which component represents mosaic?
8. Select the structures which are present in all cells of all kingdoms. Write one function of each selected structure.

   Cell membrane; Nucleus; Chromosomes; Cytoplasm; Ribosome; RER; SER; Golgi apparatus; Lysosome; Mitochondria; Centriole; Cilia; Flagella; Cell wall; Cytoskeleton; Vacuole; Plastids
9. Which cells in animals and plants do not have a nucleus? How do these cells perform their functions without nucleus?
10. Unripe oranges are green in colour. After ripening their colour changes. Suggest which organelles' number changed in them during ripening.
11. Which organelles are abundant in the salivary gland cell? Explain.

Section III: Extensive Answer Questions

1. Explain the structural model of cell membrane and give the roles of cell membrane.
2. How cell wall is important in the lifestyle of plants?
3. If a cell is rich in SER, list the roles in which this cell will be more efficient.
4. Give the significance of muscles in the life of animals.
5. Give the types of plastids and enlist the roles of each type.
6. Describe the structure and functions of animal cell. How it is different from plant cell?
7. Justify how the cells of leaf have a variety of specialized structure and function.
8. State the relationship between structure and function of mesophyll cells, epidermal cells, neurons, muscles, red blood cells and liver cells
9. Describe the role of the cell membrane in maintaining equilibrium while exchanging matter?

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قومی ترانہ

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مرکزِ یقین شاد باد!

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