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Living Science
Biology

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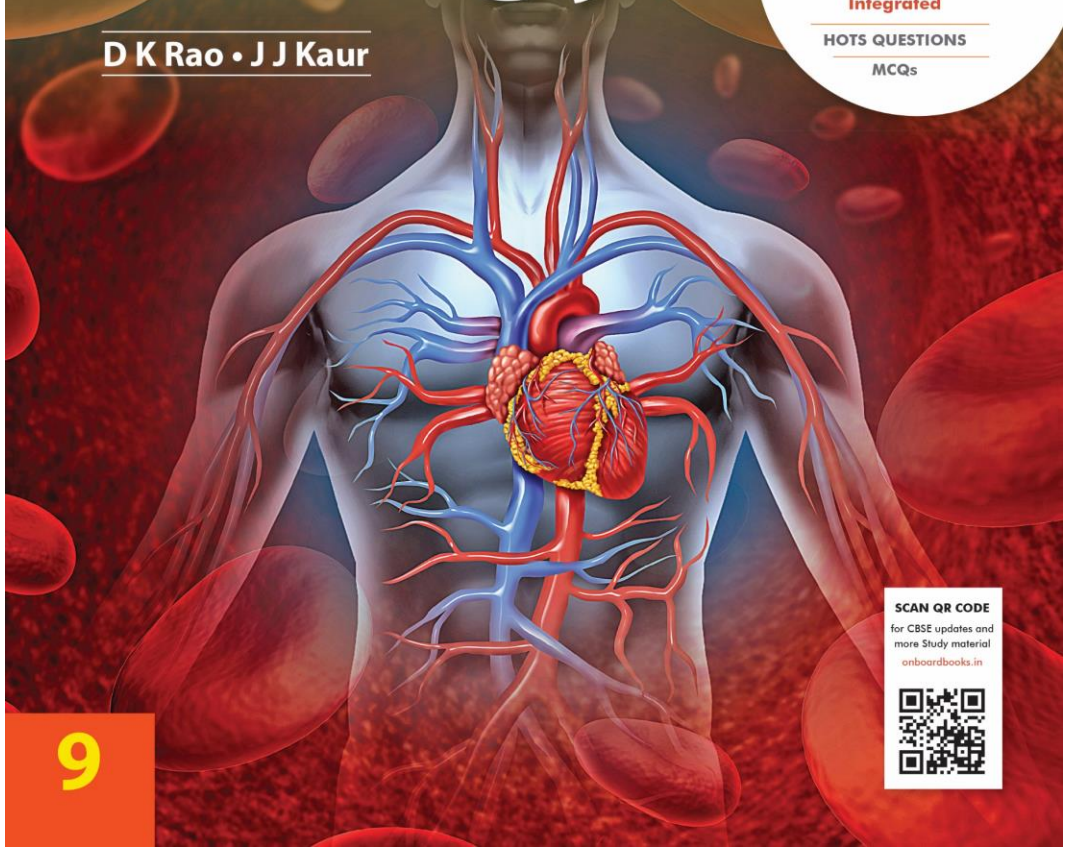

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CBSE
Living Science
Biology

Class 9

Chapter 1 The Fundamental Unit of Life

LEARNING OBJECTIVES

Discovery of Cell

- ❖Modern definition of valency
- ❖Cell- The fundamental unit of life

Microscope

- ❖The compound microscope
- ❖The electron microscope

Cell Theory

Unicellular and Multicellular Cell

Prokaryotic and Eukaryotic Cells

- ❖Prokaryotic cells
- ❖Eukaryotic cells

Cell- Shape, Size and Function

Structural Organisation of a Cell

- ❖Cell membrane or plasma membrane
- ❖Cell wall
- ❖Nucleus
- ❖Cytoplasm
- ❖Protoplasm

Cell Organelles

- ❖Endoplasmic reticulum
- ❖Golgi apparatus
- ❖Ribosomes
- ❖Lysosomes
- ❖Mitochondria
- ❖Plastids
- ❖Vacuoles
- ❖Centrosome

Cell Division

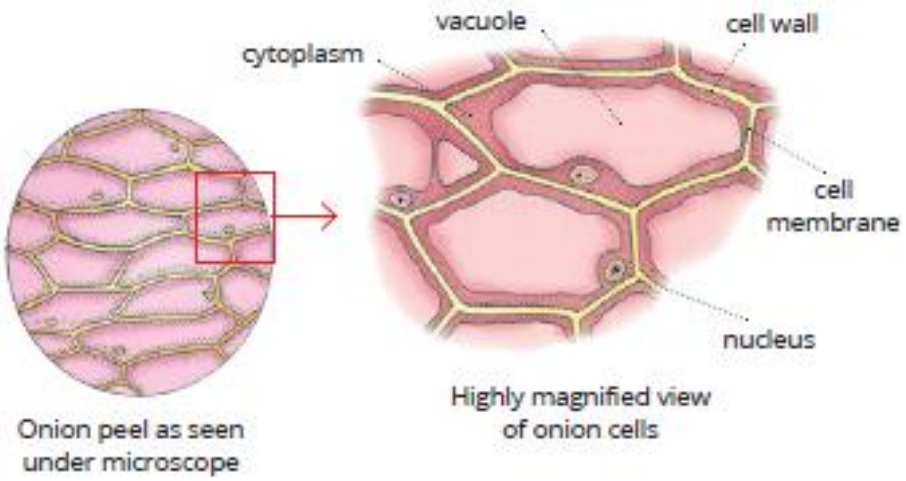
- ❖Mitosis
- ❖Meiosis

Discovery of Cell

A cell is the structural and functional unit of life. Cells were discovered by Robert Hooke in 1665. He observed a thin slice of cork (a substance obtained from the bark of a tree) under his compound microscope. He observed that the cork slice had a large number of compartments joined together in a honeycomb-like structure. He named these compartments as cells

Cell-The Fundamental Unit of Life

The cells are the basic building units of the onion bulb. The cells of onion peel are rectangular or polygonal in shape. All the cells are firmly bound together. Like onion, all organisms are made up of cells. Some organisms are made up of one cell while others are made up of many cells.



Epidermal cells of onion peel

Microscope

Microscope is an instrument which is used to observe objects that are invisible to the naked eye. The two common types of microscopes are compound microscope and electron microscope.

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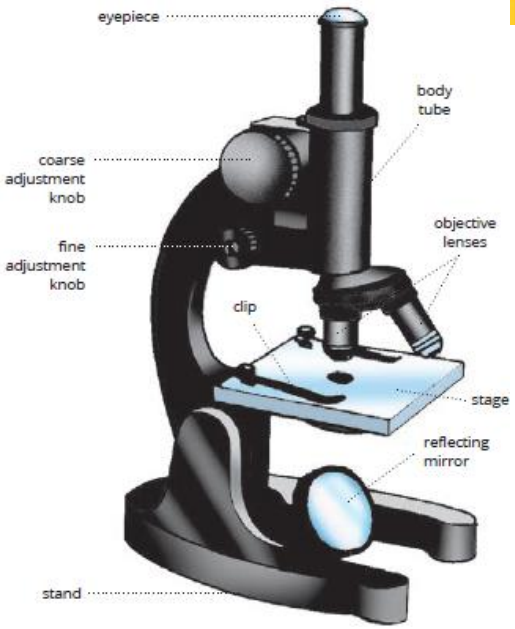
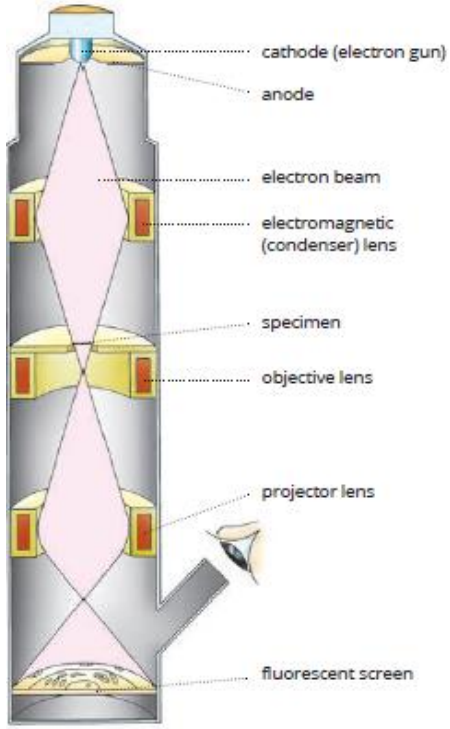
The compound microscope

The ordinary light or compound or optical microscope used extensively in laboratories these days is a greatly improved design of Hooke's microscope . It consists of two lenses, the eyepiece lens and the objective lens, which are combined to produce a greater magnification. The light microscope has a magnification up to 1500 times, good enough to see cells, larger organelles and bacteria.





The electron microscope

The electron microscope (EM) has much greater powers of magnification and resolution than those of an optical (light) microscope. An electron microscope can resolve points 1 nm apart. In this microscope, a beam of electrons is passed through the section of material to produce the image. The electron beam passing through the specimen section is focused by electromagnets and is projected on to a fluorescent screen for direct view or on to a photographic plate for permanent recording. The resulting photograph is called an **electron micrograph**.

Cell Theory

The major points of cell theory are as follows:

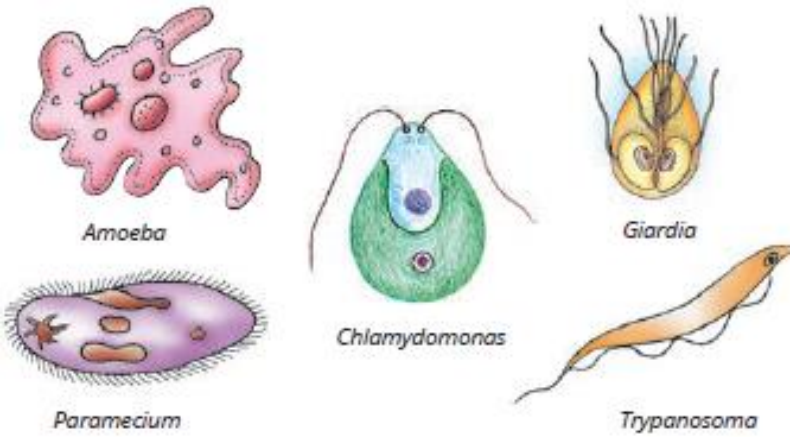
- All living organisms are composed of cells.
- Cell is the basic structural and functional unit of all living beings.
- All cells arise from pre-existing cells.

Exceptions to cell theory

- **Viruses** are non-cellular organisms. They do not have nucleus, cytoplasm or enzyme and do not perform any life activity. They can multiply only inside the living host by taking over their machinery.
- **Bacteria** and **blue-green algae** are not true cells. They do not have nuclear membrane and cell organelles.

Unicellular and Multicellular Organisms

On the basis of number of cells, there are basically two types of organisms – unicellular and multicellular. Unicellular organisms are those organisms that are made up of only one cell. For example, *Amoeba*, *Chlamydomonas*, *Euglena*, *Paramecium*, *Trypanosoma* and bacteria are unicellular organisms.



Multicellular (*multi* means many) organisms are those organisms which are made up of many cells that group together to perform many functions of the body. For example, fungi, plants and animals are multicellular organisms. All multicellular organisms have come from a single cell, zygote, through cell division.

On the basis of their nuclear organization, cells have been classified into two types:

Prokaryotic cells

Prokaryotic cells are single-celled and lack a nuclear membrane.These cells lack several cytoplasmic organelles like mitochondria, lysosome, endoplasmic reticulum, chloroplast and nucleolus. Many of the functions of these cells are performed by poorly organized parts of cytoplasm. Bacteria and blue-green algae are examples of prokaryotic cells.

Eukaryotic cells

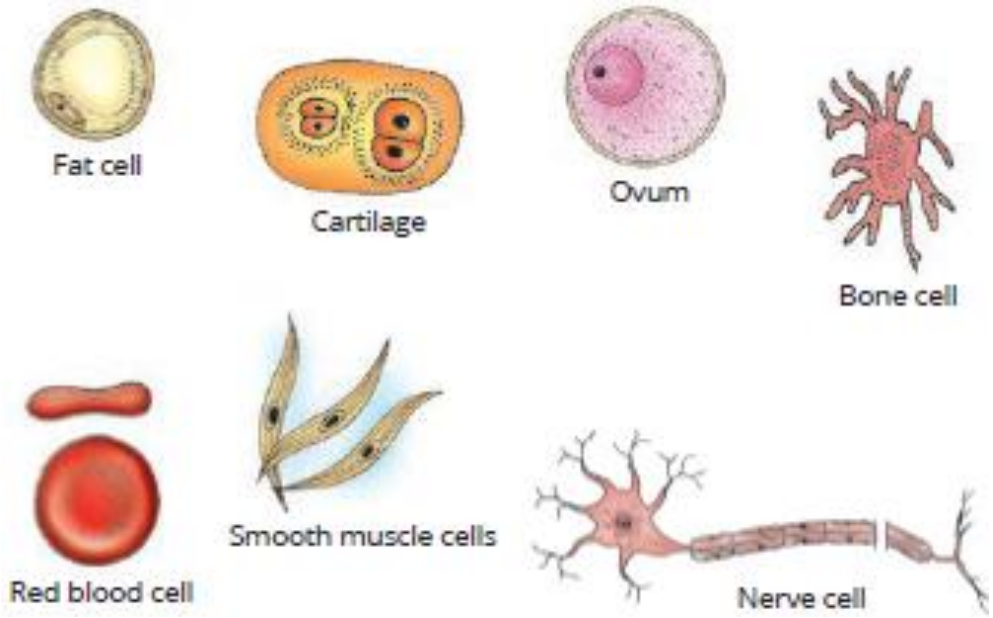
Eukaryotic cells have a well-defined nuclear membrane. These cells have a well-organized nucleus. These cells have well-developed membrane-bound organelles, such as mitochondria, endoplasmic reticulum, lysosome, chloroplast and nucleolus. Eukaryotic cells occur in plants, animals, fungi and protozoa.

Cell – Shape, Size and Function

Different organisms have cells of different kind. The shape and size of cells are related to the specific functions performed by the organisms.

Cell shape

Most cells have a definite shape. Cells may be spindle-shaped – muscle cells, elongated – nerve cells, oval – red blood corpuscles, cuboidal – germ cells, branched – osteocytes and so on. Some cells may not have any definite shape, for example, *Amoeba* and leucocytes (white blood corpuscles).



Shapes of various cells in the human body

Cell size

The smallest known cell is *Mycoplasma*. Its size is 0.1 to 0.5 µm (micrometre).

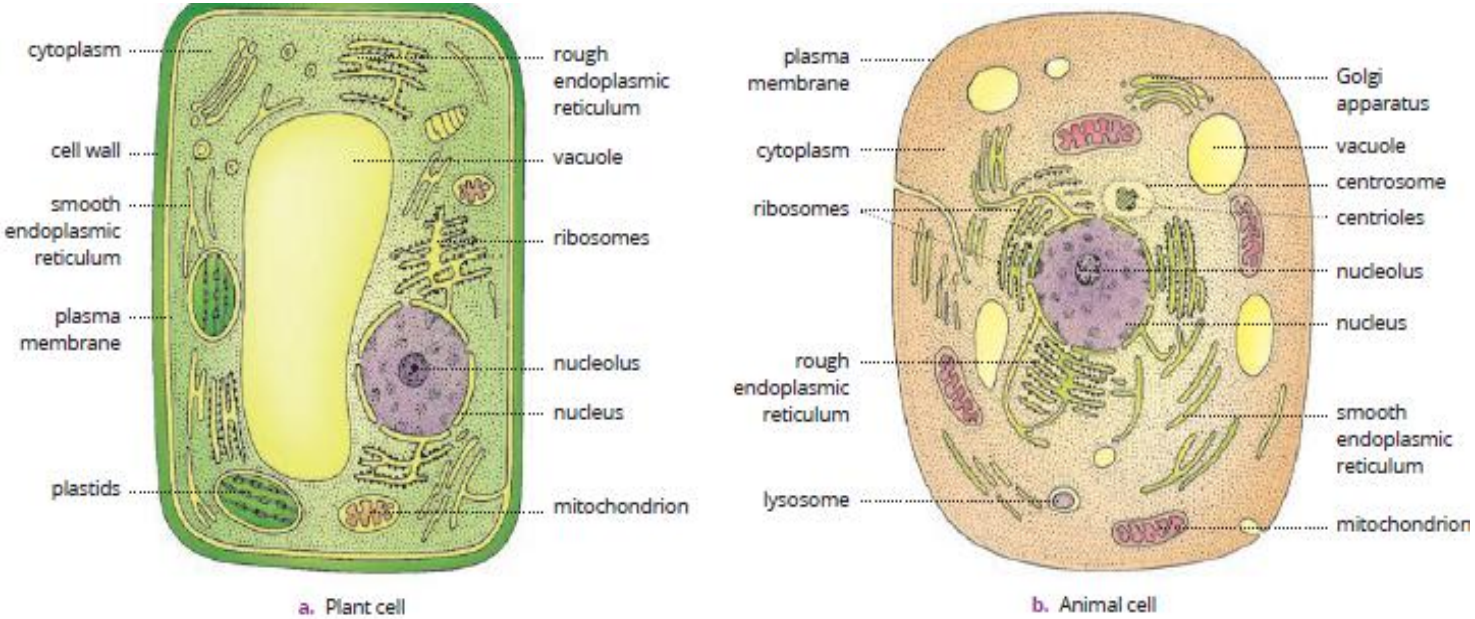
The bacterial cell is 0.5 to 5 mm, human red blood corpuscles are 7 to 20 mm, human liver and kidney cells are 20 to 30 mm and nerve cells are about 90 to 100 cm in size.

Cell function – Division of labour

Each cell performs certain basic functions that are characteristics of all living beings. Each cell has certain specific components within it known as cell organelles. Each cell organelle performs a specific function, such as producing energy, making new materials (proteins, etc.), clearing up the waste material, etc. These organelles together constitute the basic unit, i.e. the cell. A cell is able to perform its functions because of these cell organelles.

Structural Organization of a Cell

Every cell shows the same basic structure – cell membrane or plasma membrane, nucleus and cytoplasm.

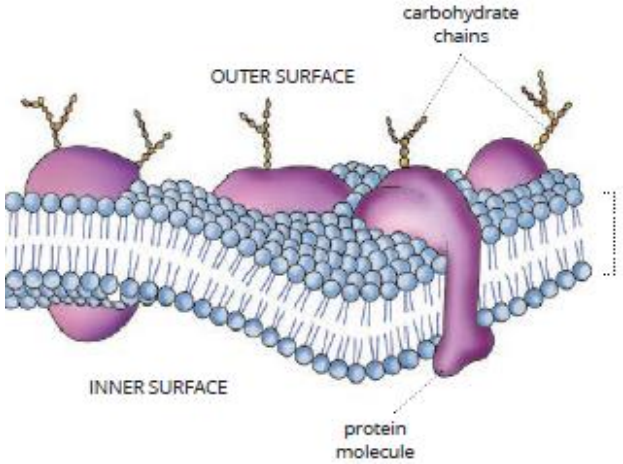


Ultrastructure of a plant and an animal cell

Cell Membrane or Plasma Membrane

Every cell is bound by a thin delicate membrane called cell membrane or plasma membrane. Plasma membrane is the outermost covering of the cell which separates the contents of a cell from its external environment. It is made up of organic molecules called **lipid** (which are present in a viscous bilayer) and **protein (**within lipid bilayer).

The flexibility of plasma membrane helps the cell to engulf in (take in) food and other substances from its external environment. This process of engulfing food and other material from outside environment is known as endocytosis.



Functions

- Plasma membrane is selectively permeable. Therefore, it allows or permits the entry and exit of only selected substances. It also prevents the movements of some other substances across it.
- Plasma membrane bounds the semi-fluid content of the cells.
- It protects the cell from injury and provides an outer boundary to the cell.
- It allows the flow of materials and information between different organelles within the cell as well as between one cell and another.
- It has carrier proteins for active transport.

How does movement of substances take place in and out of cells?

The movement of substances, in and out of the cells, occurs through the following processes:

Diffusion: The movement of molecules of a substance from a region of their higher concentration to a region of their lower concentration is called diffusion.

Importance of diffusion

- Diffusion plays an important role in gaseous exchange between the cells as well as between the cell and its outside (external) environment.
- It is a means of spreading ions and molecules throughout the protoplast.
- Transpiration from stomata occurs by diffusion.
- Aroma (smell) of flowers is due to diffusion of aromatic compounds of flowers to attract pollinators.

Osmosis: The diffusion of water molecules through a semi-permeable membrane from a region where water is more concentrated to a region where it is less concentrated is called osmosis.

Importance of osmosis

- Entry of soil water into root occurs through osmosis.
- Cell to cell movement of water occurs through osmosis.
- Living cells remain turgid by osmosis.

- The stomata open and close in response to increase or decrease in osmotic pressure of the guard cell.

Isotonic, hypotonic and hypertonic solutions

If you take a plant cell and place it in solutions having different concentrations, then you will find that the cell shrinks in hypertonic solution, swells in hypotonic solution while it remains unchanged in isotonic solution

Note: Refer to the Table 1.3 for the Differences between isotonic, hypertonic and hypotonic solutions

Cell Wall (Plant Cell Only)

Plant cells contain a cell wall also. Cell wall is an outer, rigid, protective and supportive covering of plant cells only. The cell wall lies outside the plasma membrane. Its thickness varies in different types of cells. The cell wall is mainly composed of cellulose.

Functions

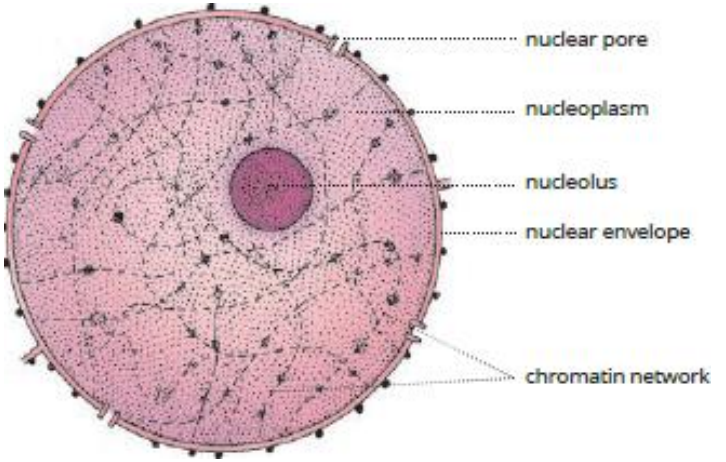
- It provides a definite shape to the cell.
- It protects plasma membrane and internal structures from the attack of pathogens and mechanical injury.
- It counteracts the osmotic pressure.
- It provides rigidity to the cell.

Plasmolysis: Shrinkage of the protoplast (cell content) of a cell from its cell wall under the influence of a hypertonic solution is called plasmolysis.

Nucleus

A dense, generally round (spherical) but sometimes cylindrical nucleus is present almost at the centre of a cell. The nucleus contains:

- nuclear envelope or nuclear membrane,
- nucleoplasm or nuclear sap,
- chromosomes (chromatin network), and
- nucleolus



Nuclear envelope: It is a double-membraned structure, and contains a large number of pores. It separates the nucleus from the cytoplasm.

Nucleoplasm: Inside the nuclear envelope is the nucleoplasm. It is transparent, semi-fluid and contains a large number of enzymes which are required for the synthesis and functioning of DNA, RNA, etc.

Chromatin network: Chromatin network is a tangled fibrous mass of thread-like structures. The chromatin threads organize to form chromosomes. Chromosomes are composed of DNA (deoxyribonucleic acid) molecules and proteins.

The information for inheritance of characteristics from parents to next generation passes in the form of DNA. Functional segments of DNA are called genes. Genes are the carriers of heredity.

Nucleolus: It is a dense, round structure attached to a chromatin fibre at a specific region. The nucleolus may be one or more in number and is not bound by any membrane. It is rich in protein and RNA (ribonucleic acid) molecules.

Functions

- The nucleus controls cell metabolism and other activities of the cell, hence, it is also called **Master or Director of the cell**.
- Chromatin part of the **nucleus** possesses all the genetic information that is required for growth and development of the organism, its reproduction, metabolism and behaviour.
- Nucleus plays a central role in cellular reproduction (division of single cell to form two cells).
- Along with environment, nucleus also directs the chemical activities of the cell. This determines the development and future form of the cell.

Cytoplasm

The space between the plasma membrane and the nucleus is filled by a homogeneous, translucent, colloidal liquid called **cytoplasm**.

Functions

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

Protoplasm

Protoplasm is the living component of the cell containing cytoplasm and the nucleus in a living cell. The common elements found in protoplasm are carbon, hydrogen, oxygen, nitrogen, iron, phosphorus, sulphur, etc. which constitute carbohydrates, proteins, fats, minerals and water. All the living components of a cell lie in the protoplasm and perform their functions.

Cell Organelles

To perform different activities, the cells have many organelles that float in the cytoplasm. The different cell organelles that are found in the cytoplasm of the cell are:

Endoplasmic reticulum (ER)

Endoplasmic reticulum (also known as ER) is an interconnected network of membrane-lined tubes and sheets that run through the cytoplasm. Endoplasmic reticulum is mainly of two types – smooth ER and rough ER.

Rough endoplasmic reticulum (RER) has a rough membrane because a number of ribosomes are found attached to its outer surface. Ribosomes are present in all active cells. Ribosomes are the site of protein synthesis.

Smooth endoplasmic reticulum (SER) does not have any ribosomes. This type of endoplasmic reticulum is found in liver cells, interstitial cells, adipose cells, muscle cells, etc. It helps in the manufacture of fat molecules and lipids.

Golgi apparatus

Golgi apparatus is present in all eukaryotic cells (except RBCs). There are three distinct components visible in the Golgi apparatus,

- flattened sacs or cisternae,
- clusters of tubules and vesicles, and
- large vesicles or vacuoles.

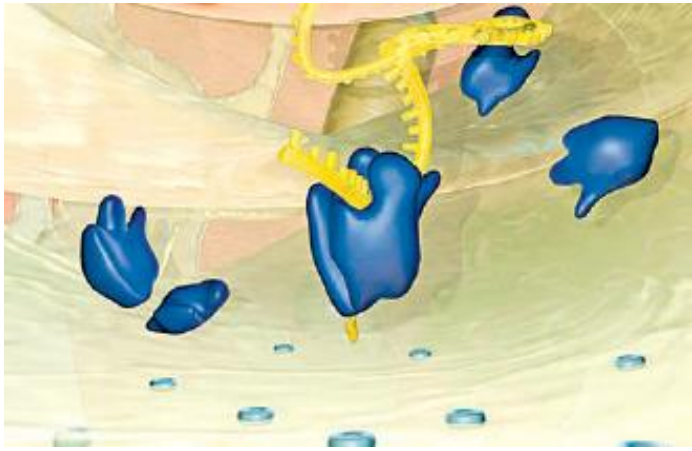
In plant cells, Golgi apparatus consists of freely scattered sub-units called **dictyosomes**.

Functions

- Golgi apparatus helps in the secretion of mucus, enzymes and hormones.
- It helps in the storage, modification and packaging of secretory products in the vesicles.
- In some cases, Golgi apparatus also helps in the manufacture of complex sugars from simple sugars.
- The Golgi apparatus also helps in the formation of lysosomes.

Ribosomes

Ribosomes are found in all cells, both prokaryotes and eukaryotes, except in mature sperms and RBCs. In prokaryotic cells, they are found floating freely in the cytoplasm. In eukaryotic cells, they occur freely in the cytoplasm as well as attached to the outer surface of the rough endoplasmic reticulum. They are also found in the mitochondria and plastids.



Functions

Ribosomes help in protein synthesis inside the cell. Hence, they are called **protein factories of the cell**.

Lysosomes

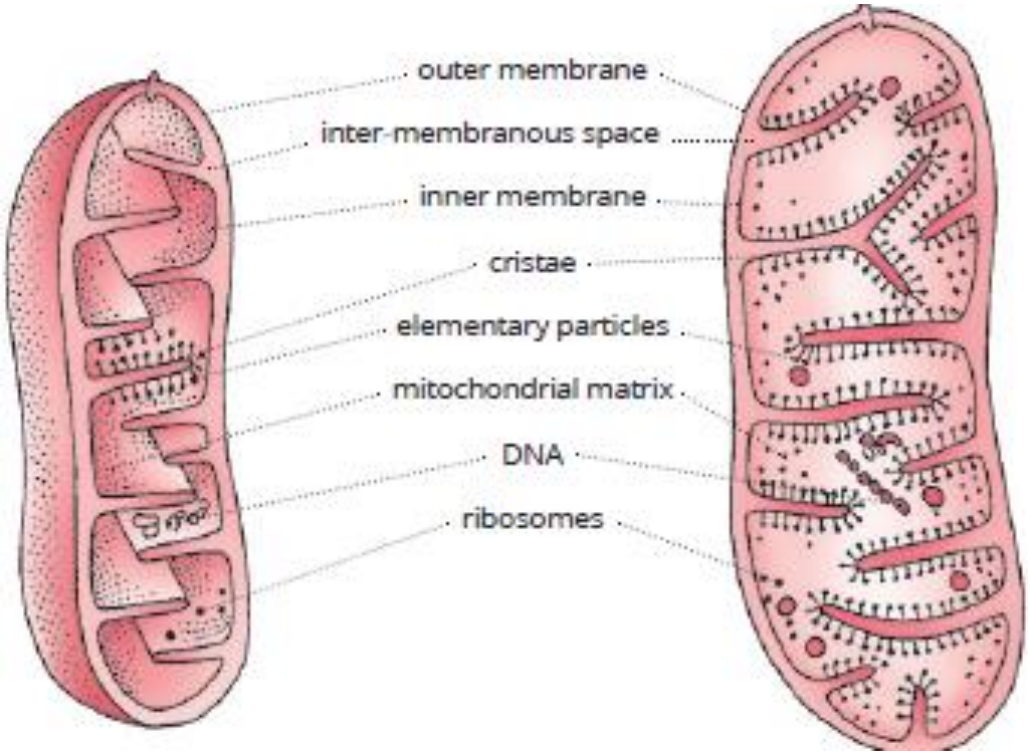
Lysosomes are membrane-bound sacs filled with digestive enzymes. These enzymes are made by rough endoplasmic reticulum. Lysosomes have a resistant covering membrane which protects the cell from the digestive enzymes. Lysosomes help in waste disposal from the cell.
In case the cell gets damaged, lysosomes burst and release the enzymes, which digest their own cell. Hence, they are called **suicide bags** of the cell.

Functions

1.Lysosomes help in **intracellular digestion**.
2.They provide energy during starvation by controlled breakdown of stored food.
3. Lysosomes **bring about cellular breakdown** and are associated with ageing.

Mitochondria – the powerhouse of cell

Typically, mitochondria are sausage-shaped cell organelles covered by a double-membrane envelope. Outer membrane is smooth and porous, while inner membrane is folded into structure known as **cristae**. These folds create a large surface area for the generation of **ATP** (Adenosine triphosphate) during respiration. Mitochondria release energy in the form of ATP molecules. This energy is required for performing various activities. Hence, mitochondria are also known as the **powerhouses of the cell**.



Functions

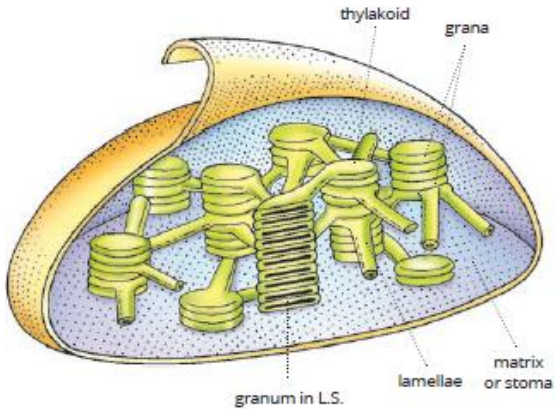
- Mitochondria are miniature biochemical factories where food is oxidized and energy is released. This energy is stored in the form of ATP. Hence, mitochondria are called the powerhouses of the cell.
- They provide important intermediates for the synthesis of several biochemical substances like chlorophyll, cytochromes and steroids.
- Synthesis of many amino acids occurs in mitochondria.
- Mitochondria can manufacture some of their own proteins.

Plastids – Kitchen of the cell

Plastids are cell organelles found only in plant cell. Structurally, plastids contain many membrane layers embedded in a material called the **stroma**. Like the mitochondria, plastids also have their own DNA and ribosomes. There are three types of plastids – chromoplasts (coloured plastids), chloroplasts and leucoplasts (white or colourless plastids).

❖ **Chromoplasts :** They contain fat soluble yellow, orange or red coloured pigment. They provide colour to flowers and fruits. Chromoplasts are formed either from leucoplasts or chloroplasts.

❖ **Chloroplasts :** They are green plastids. Inside, each chloroplast has a colourless ground matrix, **stroma** and a membranous system, **grana**. Each granus has membrane-bound sacs called **thylakoids**. Thylakoids of chloroplasts possess photosynthetic green pigment, i.e. chlorophyll. They also contain various yellow or orange pigments in addition to chlorophyll.



❖**Leucoplasts:** These are colourless plastids and are named on the basis of the substances they store. They store starch, oils and protein granules.

Functions

- Chromoplasts are coloured plastids which provide colour to the flowers and fruits.
- Chloroplasts, the green plastids, help in photosynthesis and thus, help in the synthesis of food. These are called **kitchen of the cell**.
- Leucoplasts help in the storage of food.

Vacuoles

These are fluid-filled membrane-bound spaces. Vacuoles are storage sacs for liquid or solid contents. They are bound by a membrane known as tonoplast.

Functions

- Vacuoles help the plant cells to remain turgid.
- They play an important role in growth by helping in the elongation of cells.
- They provide an aqueous environment for the accumulation and storage of water-soluble compounds (sugars, minerals, pigments, etc.).
- In protozoans like *Amoeba* and *Paramecium*, vacuoles help in digestion and excretion

Note: Refer to the Table 1.4 for Differences between an animal cell and a plant cell

Centrosome

Centrosome is a small, naked protoplasmic structure present near the nucleus. It is present only in animal cells. Centrosome consists of two small granules called **centrioles**, which lie at right angles to each other. During cell division, centrioles migrate to the opposite poles of the cell.

Functions

- They help in spindle formation during cell division.
- They act as basal bodies and give rise to cilia and flagella.

Cell Division

All new cells arise from pre-existing cells by the process of **cell division**. New cells are required for growth, replacement of old and worn out cells and to form gametes during reproduction. Cell division is primarily of two kinds – **mitosis** and **meiosis.**

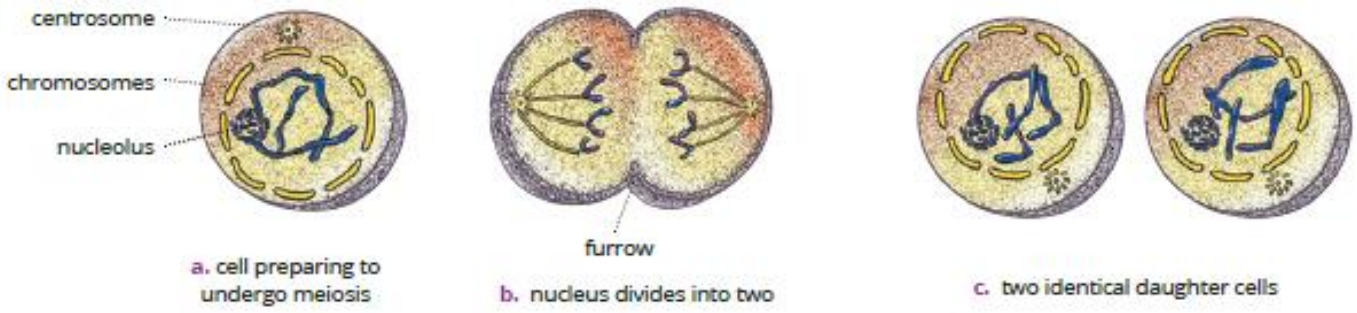
Mitosis

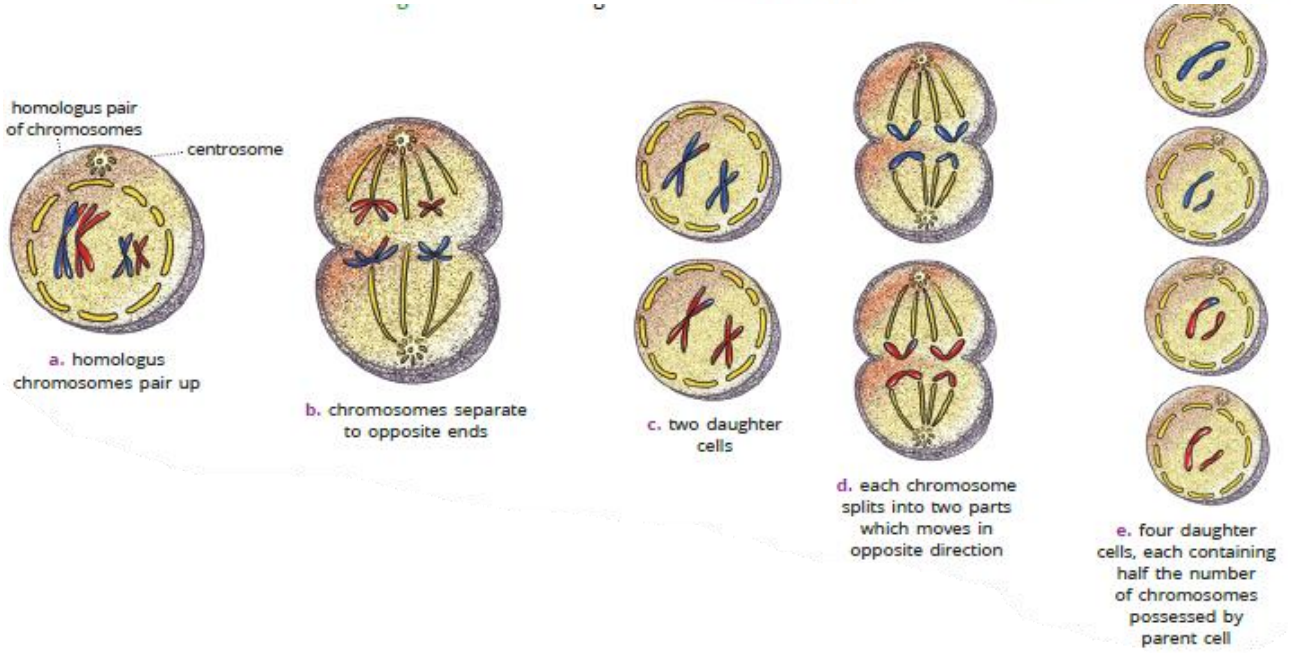
Mitosis or mitotic cell division is an equational division in which one parent cell divides to form two daughter cells. The daughter cells are identical to each other and also to the parent cell in every respect. In mitosis, the same normal chromosome number of the parent cell is maintained at each stage of mitotic division of the cell.

Meiosis

Meiosis takes place in the reproductive cells that produce gametes, sperms and ova. Meiosis is a modified mitosis in which chromosomes divide once and the nucleus divides twice. As a result of which the number of chromosomes is reduced to half. Hence meiosis is a reductional division.

Different stages of mitosis in an animal cell





Different stages of meiosis in an animal cell

SUMMARY...

- Cell is the structural and functional unit of life.
- Cell was discovered by Robert Hooke in 1665 while studying a thin slice of cork under a self-built microscope.
- Cell theory was formulated by two biologists, M J Schleiden (1838) and T Schwann (1839).
- On the basis of nuclear organization, cells are of two types – prokaryotic cells and eukaryotic cells.
- Cell is enclosed by a plasma membrane which is made up of lipids and proteins. Plasma membrane is a living membrane. It is selectively permeable and allows only selected substances to pass through it.
- In plant cells, a cell wall is also present. It is mainly composed of cellulose and is located outside the cell membrane. Cell wall provides a definite shape to the cell. It protects plasma membrane and internal structures from pathogens and mechanical injury.
- In eukaryotes, nucleus is separated from the cytoplasm by double-layered membrane. It controls all metabolic and other activities of the cell. Hence, it is called the master of the cell.
- Endoplasmic reticulum helps in intracellular transport. Hence, it is known as the circulatory system of the cell.

- Ribosomes help in protein synthesis inside the cell. Hence, they are called protein factories of the cell.
- Golgi apparatus consists of a system of membrane-bound vesicles which are arranged somewhat parallel to each other in stacks called cisterns.
- Golgi apparatus helps in storage, modification and packaging of substances manufactured in cell.
- Mitochondria are miniature biochemical factories, where foodstuffs are oxidized and energy is released. The energy is stored in the form of ATP.
- Plastids are cell organelles found only in plant cells. Plastids are of three types – chromoplasts, chloroplasts and leucoplasts. Chloroplasts help in photosynthesis, and thus in the synthesis of food. These are called kitchen of the cell.
- Lysosomes help in intracellular digestion. They also bring about cellular breakdown, and hence are called suicide bags of the cell.
- In animal cells, vacuoles are usually absent. If present, they are small and scattered. But in mature plant cells, usually a single large central vacuole is present. It helps in maintaining the turgidity of the cell and stores important substances including waste.

THANK YOU