Ratna Sagar

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Rama Sagar
Education, Our Mission!

Revised and Updated

LIVING SCIENCE BIOLOGY

D K Rao • J J Kaur

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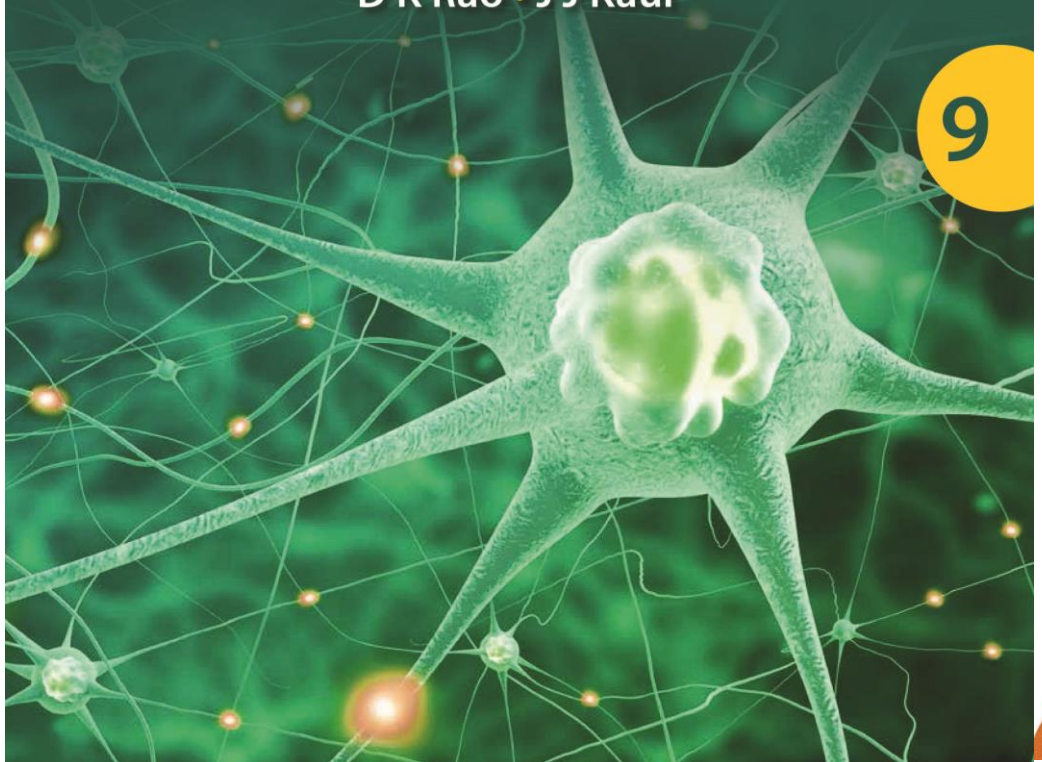


ICSE
Living Science
Biology

Class 9

Chapter 1 Cell – The Structural and Functional Unit of Life

LEARNING OBJECTIVES

Discovery of the cell

- Cell theory
- Prokaryotic and eukaryotic cells
- Cell – Shape, Size and Number

Structure of a typical cell

- Cell organelles found in cytoplasm
- Nucleus
- Protoplasm

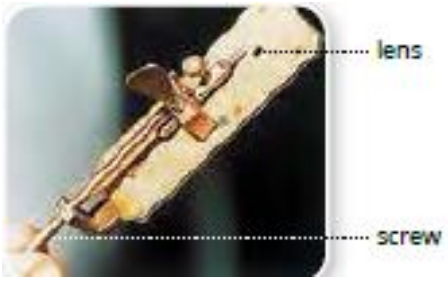
Differences between a plant cell and an animal cell

- Cell functions

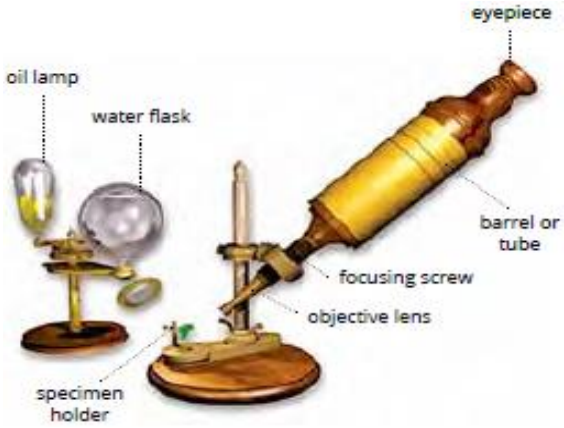
What is a Cell?

A cell is the structural and functional unit of all living beings. It is the smallest part of the body of an organism capable of independent existence.

Discovery of the Cell

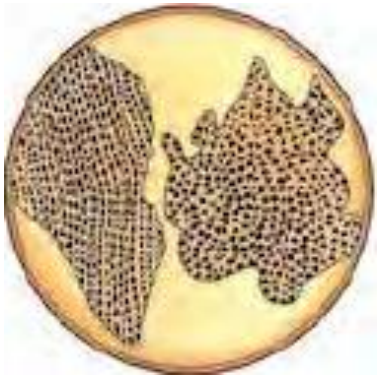


The invention of microscope helped in the discovery of the cell. The **first microscope** was constructed by **Anton von Leeuwenhoek**



Robert Hooke (1635–1703) developed a **compound microscope** by using two lenses for achieving greater magnification.
Robert Hooke's microscope used light from an oil flame passing through a water flask for focusing on an object kept below the microscope.

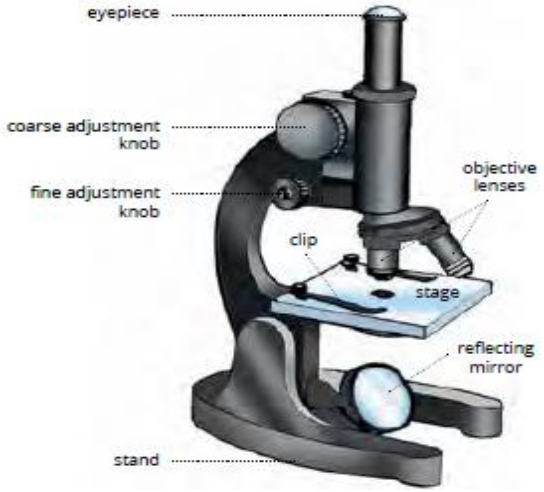
Cells were discovered by Robert Hooke in 1665. He studied a thin slice of cork under his microscope. He observed that the cork slice had a large number of compartments joined together in a honeycomb like structure. He named these compartments as cells.



The light microscope

The ordinary light or optical or compound microscope used extensively in laboratories these days is a fairly 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

Invention of electron microscope (EM) unfolded many new discoveries about cells. The electron microscope as power of magnification (over 200000 times) and resolution much greater 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 specimen material to produce the image.

Cell theory

The cell theory was formulated by two German biologists, **Matthias Schleiden (1838)** and **Theodor Schwann (1839)**. The cell theory can be stated as follows:

- ❖ Cell is structural and functional unit of all living beings.
- ❖ All living organisms are composed of cells.

- All new cells arise as a result of division of pre-existing cells.
- The cell is the smallest unit of all living organisms.

Prokaryotic and eukaryotic cells

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

Prokaryotic cells

Prokaryotic cells means cells having primitive nucleus. The nuclear material in these cells is not enclosed by a nuclear membrane. The genetic material is equivalent to a single molecule of DNA. It does not form chromatin. These are single-celled and do not have a well-organized nucleus. These cells lack several cell organelles like mitochondria, lysosome, endoplasmic reticulum, chloroplast and nucleolus. Bacteria and blue-green algae are examples of prokaryotic cells.

Eukaryotic cells

Eukaryotic cells means cells having a properly defined nuclear membrane. In these cells, the genetic material is made of two or more DNA molecules, which form chromatin fibres. The nuclear material is enclosed in a nuclear membrane. These cells have a well-organized nucleus and 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 Number Cell Shape

Cell shape

Cells show a great variation in their shapes to suit their functions. 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 chromatophores and so on .

Some cells may not have any definite shape, i.e. they have **irregular shapes** like *Amoeba* and leucocytes (white blood corpuscles).

Cell size

Smallest: The smallest known cell is *Mycoplasma* or PPLO (Pleuropneumonia-like Organisms). Its size varies from 0.1 to 0.5 µm (micrometre).

The bacterial cell is 0.5 to 5 µm, human red blood corpuscles are 7 to 20 µm, human liver and kidney cells are 20 to 30 µm.

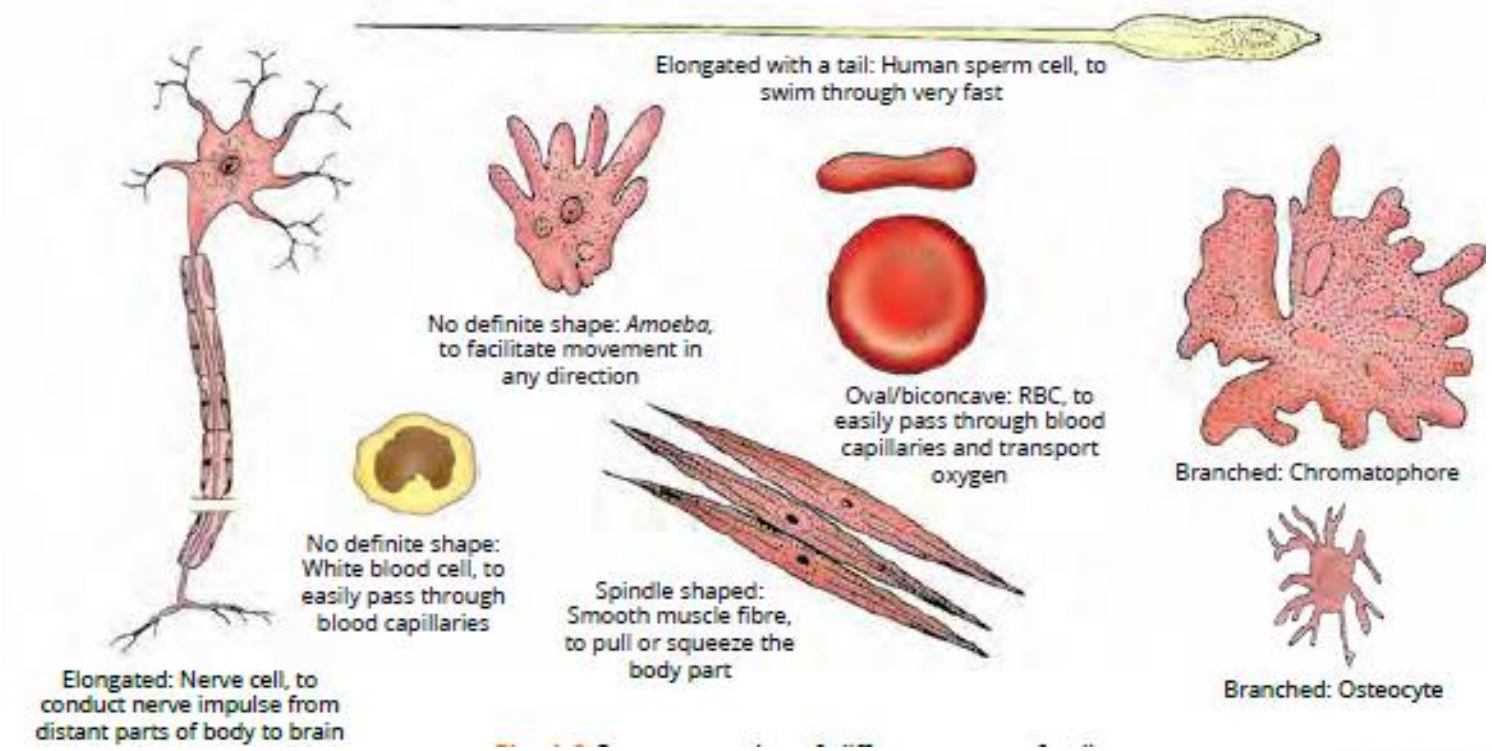
Longest: Nerve cells are about 90 to 100 cm in size.

Largest: The largest cells are birds' eggs. The egg of an ostrich is 170 × 135 mm (which is the largest single cell)

Cell number

Single-celled: Many organisms are made up of only one cell, they are called **single-celled** or **unicellular**, for example, bacteria, *Amoeba*, *Paramecium*, *Euglena*, *Chlamydomonas*, etc.

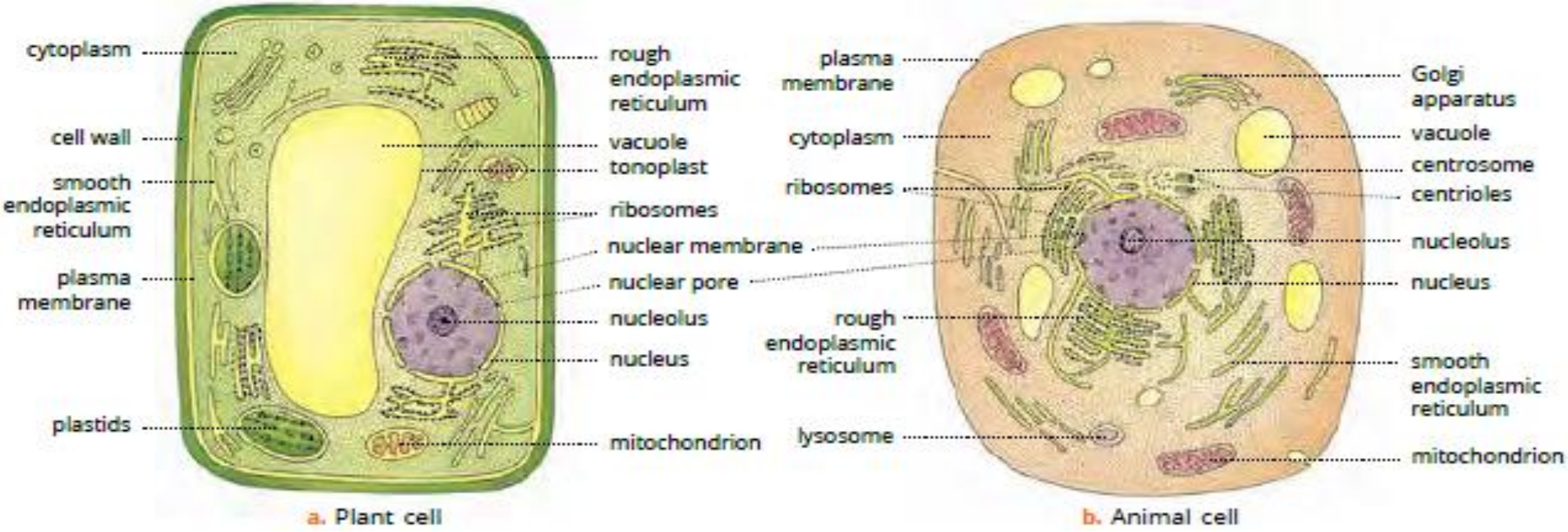
Multicelled: Most organisms are **multicellular**, i.e. they are made up of several cells.



Some examples of different types of cells

Structure of a typical cell

Although cells of different organisms differ in structure, cells within the body of a multicellular organism differ in shape, size and functions. In spite of these differences, every cell shows the same basic structure – cell membrane, cytoplasm and nucleus.



Ultrastructures of a plant cell and an animal cell

Cell wall (Plant cell only)

Plants cells have a **cell wall** surrounding cell membrane. Cell wall is an outer, rigid, protective and supportive covering of plant cells.

It lies outside plasma membrane. It is made up of cellulose. Cellulose provides mechanical strength and rigidity to the cell.

Functions

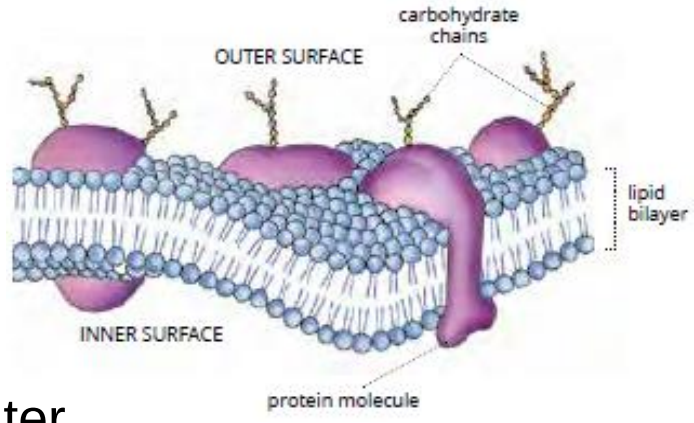
- ❖ It **provides** a **definite shape to the cell**.
- ❖ It protects cell membrane and internal structures from the attack of pathogens and mechanical injury.
- ❖ It is freely permeable, allowing the substances to move in and out of cells without hindrance.
- ❖ It **provides rigidity and mechanical strength** to the cell.

Cell membrane or plasma membrane

Every cell is bound by a thin delicate membrane called **cell membrane** or **plasma membrane.**

Functions

- ❖ Plasma membrane is **selectively permeable**, therefore, it allows only selective substances to pass in and out of the cell.
- ❖ It **bounds the semi-fluid contents of the cell**.
- ❖ 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.

Cytoplasm – the house of cell organelles

The space between the plasma membrane and the nucleus is filled by translucent, homogeneous, semiliquid 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.

❖ Breakdown of glucose takes place in the cytoplasm.

❖ Biosynthesis of nucleotides, proteins and fatty acids takes place in cytoplasm.

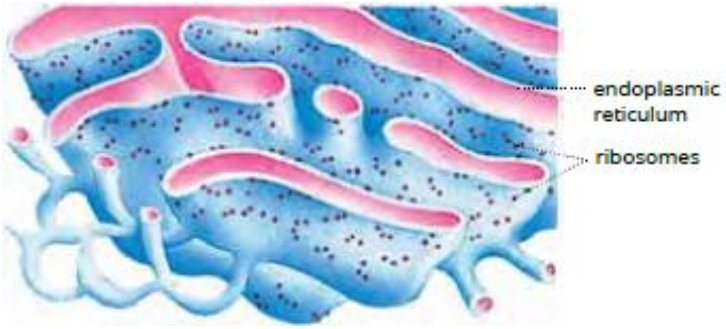
Cell organelles found in cytoplasm

The following cell organelles lie embedded in the cytoplasm:

Endoplasmic reticulum (ER) – the skeletal framework of cell

Endoplasmic reticulum is an interconnected network of double membrane-lined channels distributed over the entire cytoplasm. Endoplasmic reticulum is of two main types – smooth and rough. **Smooth endoplasmic reticulum (SER) does not bear ribosomes.** This type of endoplasmic reticulum is found in liver cells and muscle cells.

Rough endoplasmic reticulum (RER) has a rough appearance because a number of ribosomes are attached to its outer surface . It is very well developed in plasma cells, fibroblasts and goblet cells.



Rough endoplasmic reticulum

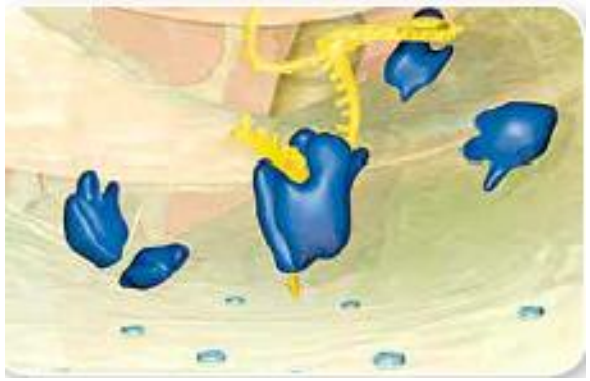
Functions

❖ Endoplasmic reticulum **divides the cytoplasm into small compartments**. It **gives rigidity** to the cell, therefore, it **acts as a skeletal or supporting framework of the cell**.

❖ It helps in intracellular transport (distribution of material from one part of the cell to other parts), hence it is also known as the **circulatory system of the cell**.

❖ It provides a large surface area inside the cells for various biochemical activities.

Ribosomes – the sites of protein synthesis

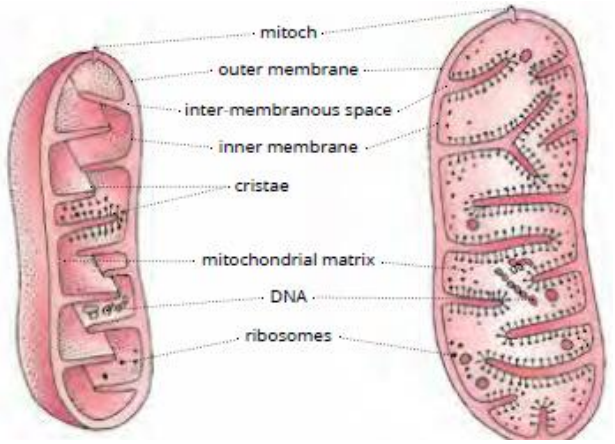


Ribosomes are small granules found freely in the cytoplasm as well as attached to the outer surface of the rough endoplasmic reticulum.

Functions

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

Mitochondria – the powerhouse of cell

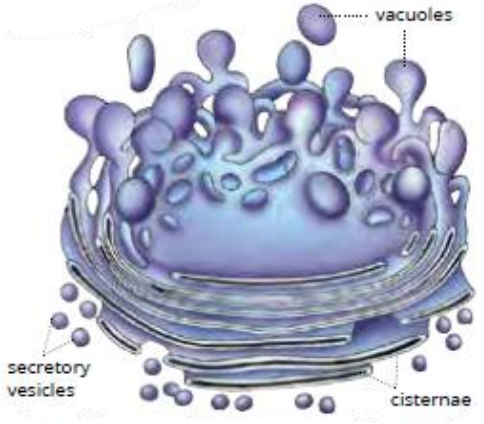


Mitochondria are the double-walled envelope where cellular respiration occurs to release energy. Typically, mitochondria are sausage-shaped, but these may be granular, rod-shaped, spherical or thread-like also.

Functions

❖ Mitochondria are miniature biochemical factories where **foodstuffs are oxidized and energy is released**. This energy is stored in the form of ATP (adenosine triphosphate). Hence, mitochondria are called the **powerhouse of the cell**.

Golgi apparatus – the delivery system of cell



The Golgi apparatus are very small vesicles of different shapes generally located near the nucleus. Golgi complex contains three distinct components. They are:

❖ flattened sacs or cisternae, running somewhat parallel to each other,
❖ clusters of tubules and vesicles, and
❖ large vesicles or vacuoles.

Functions

❖ Golgi apparatus **helps in the secretion** of mucus, enzymes and hormones. The material synthesized near endoplasmic reticulum is transported to various target sites inside and outside cell through Golgi apparatus.

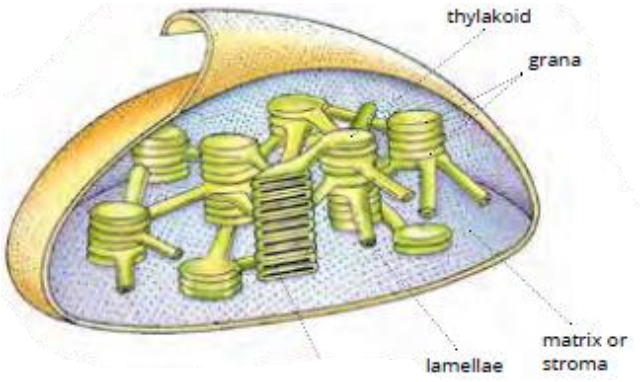
❖ It helps in the storage of secretory products.

Plastids – the kitchen of a plant cell

Plastids are cell organelles found only in plant cell. Depending on colour, these are of three types – chromoplasts, chloroplasts and leucoplasts.

❖ **Chromoplasts** – They contain fat-soluble yellow, orange or red coloured pigments. These are mostly present in petals and fruits. **These provide colour to flowers and fruits**.

❖ **Chloroplasts**– They are green plastids. **They possess photosynthetic pigments – chlorophyll and carotenoids**. They form bulk of the green parts of the plant like leaves, young stems, etc. They trap solar light energy and absorb carbon dioxide for manufacturing food through photosynthesis.



Chloroplasts also contain other pigments (yellow, orange, etc.), but these are masked to large quantity of chlorophyll.

Chloroplast contains DNA, RNA and the various enzymes essential for photosynthesis.

❖ **Leucoplasts** – These are colourless plastids. They have no pigment and are named on the basis of the substances they store. They store starch. Cells of potato have a ton of large amount of leucoplast.

Functions

❖ The green plastids called chloroplasts, help in photosynthesis and thus help in the synthesis of food. These are called **kitchen rooms of the cell**.

❖ Chromoplasts are coloured plastids which provide colour to the flowers and fruits.

❖ Leucoplasts help in the storage of food.

Centrosome and centrioles (In animal cell only)

Centrosome and centrioles are found in animal cell only. Centrosome is a small, naked, protoplasmic structure present near the nucleus. 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 initiate and regulate cell division.

❖ They **help in spindle formation during cell division**.

Lysosomes

Lysosomes are membranous sacs budded-off from Golgi bodies. The enzymes released by the rupture of lysosomes help in intracellular digestion by destroying and digesting foreign substances around them. Hence, they are called **suicide bags of the cell**.

Functions

- Lysosomes **help in intracellular digestion**.
- They digest stored food substance during starvation of cell.
- They bring about cellular breakdown and are associated with ageing.
- They dissolve damaged cells.

Vacuoles (Non-living)

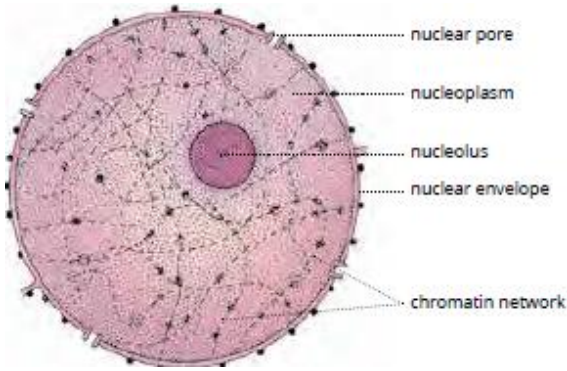
Vacuoles are fluid-filled membrane-bound spaces in the cytoplasm. In animal cells, vacuoles are small. In mature plant cells, the small vacuoles fuse to form a single large central vacuole.

Functions

- Vacuoles help the cell to remain turgid.
- They play an important role in growth by helping in the elongation of cells.
- They provide a watery environment to store water-soluble compounds.
- In *Amoeba* and *Paramecium*, vacuoles help in getting rid of body wastes.

Nucleus

Nucleus is a small round spherical mass (sometimes cylindrical) present almost at the centre of a cell. It is the most important part of the cell. The nucleus contains:



- Nuclear envelope or nuclear membrane
- Nucleoplasm or nuclear sap
- Chromatin network or chromosomes
- Nucleolus

Functions

- The nucleus **controls cell metabolism** and other activities of the cell, hence it is also called **Master or Director of the cell**.
- It regulates and coordinates various life processes 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.
- It contains genes which are carriers of heredity.
- All variations are caused by changes in the genetic material present in the nucleus.

Protoplasm

Protoplasm is the **living substance containing cytoplasm and the nucleus** in a living cell. The chemical composition of protoplasm varies from one cell to another.

The common elements found in protoplasm are carbon, hydrogen, oxygen, nitrogen, iron, phosphorus, sulphur, etc., which constitute carbohydrates, proteins, fats, minerals and water.

Note: The differences between a plant cell and an animal cell are given in Table 1.3.

Cell functions

Functions of cells in all living beings

❖ **Growth:** Growth is the result of new cells being produced by cell division. Any substance added to increase the bulk of the body of the organism is also due to the activity of the cells.

❖ **Reproduction:** No matter how an organism reproduces, whether sexually or asexually, it is again the cells that carry out the process. The male sperm is a cell and so is the female egg. When you grow a new plant from a cutting, such as rose or sugarcane, it is again the cells in the cutting that redivide and result in growth of a new plant.

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.
- Prokaryotic cells do not have well-organized nucleus and lack several cell organelles.
- Eukaryotic cells have a well-organized nucleus and well-developed organelles.
- The space between the plasma membrane and nucleus is filled by translucent, homogeneous, semi-liquid called cytoplasm.
- Protoplasm is the living substance containing cytoplasm and the nucleus in a living cell.
- Cell is enclosed by a plasma membrane which is made up of lipids and proteins.
- In plant cells, a cell wall is also present. It is mainly composed of cellulose and is located outside the cell membrane.
- In eukaryotes, nucleus is separated from the cytoplasm by double-layered membrane.

❖ 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 cisternae.

❖ Mitochondria are miniature biochemical factories, where foodstuffs are oxidized and energy is released.

❖ Plastids are cell organelles found only in plant cells. Plastids are of three types – chromoplasts, chloroplasts and leucoplasts.

❖ 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.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