11. Cell Structure and Micro-organisms

- **Cell**
  - Cells are the basic structural units and the building blocks of all living organisms.
- **Discovery of the Cell**
- Cell was discovered by Robert Hooke in 1665 after observing a piece of cork under a magnifying device.
- Robert Hooke coined the term “cell”.

1. Schleiden and Schwann proposed the cell theory. According to cell theory-

   Cells are the basic structural and functional units of life.

   All living organisms are made up of one or more cells.

   New cells arise from pre-existing cells.

- **Number of Cells**
- Organisms made of only a single cell are called unicellular organisms.
- For example: *Amoeba* and *Paramecium*
- Single cell in these organisms performs all the basic functions such as digestion, respiration, excretion, etc.
- Organisms made up of more than one cells are called multicellular organisms.
- For example: Humans, cow, rose, etc.
- In these organisms, the cells show division of labour as particular set of cells are involved in performing a specific body function.
- **Shape of the Cells**
- Most of the cells have a definite shape.
- Some cells such as that in *Amoeba* have no definite shape.
- The human red blood cell (RBC) is spherical-shaped.
- The muscle cells in humans are spindle-shaped.
- The human nerve cells have elongated branched structure.
- In plants and bacteria, the cell is enclosed in a protective covering called cell wall, which gives shape and rigidity to the cells.
- **Size of the Cells**

- The smallest cell is 0.1 to 0.5 micrometre in bacteria.
- The largest cell is of size 170 mm x 130 mm, which is the egg of an ostrich.
- Size of a cell has no relation with the size of an organism.
- **Cell Structure and Functions**
- In multicellular organisms, each organ system is made up of several organs.
- Organs are further made up of tissues.
- Tissues are groups of similar cells performing a specific function.

Organelles visible under compound microscope

- **Cell wall -** Outermost structure present in plant, fungal, and some bacterial cells; it is absent from animal cells
- **Plasma membrane or cell membrane -** Covering of the cell, separating the contents of the cell from the external environment

Important functions of **cell membrane:**

1. Regulates the entry and exit of substances in and out from the cell
2. Performs certain physical activities such as diffusion and osmosis

- **Cytoplasm -** Fluid that fills the cell; contains all cell organelles. It is amorphous, translucent, colloidal fluid. Organic molecules and enzymes float in it. It helps in exchange of materials between the cell organelles.
- **Nucleus -** Controls all the cellular activities of the cell; acts like the brain of a cell

Important components of **nucleus:**

1. Nuclear membrane
2. Nucleoplasm, containing chromatin
3. Nucleolus

- **Vacuole -** Found in both plant and animal cells. Provide turgidity and rigidity to plant cells and store the waste products of a cell
- **Endoplasmic reticulum** – interconnected system of membrane lined channels that run throughout the cytoplasm and helps in the synthesis and packaging of proteins and lipids

Two types:

1. SER - Smooth endoplasmic reticulum
2. RER - Rough endoplasmic reticulum

- **Ribosome -** Site of protein synthesis. They may be found free in the cytoplasm or attached to the RER.

- **Golgi apparatus -** Also known as dictyosomes in plant cells. It helps in the storage, modification, and packaging of products in vesicles and is involved in the formation of lysosomes and peroxisomes
- **Lysosome -** Contains digestive enzymes which can destroy any foreign material; also known as the 'suicidal bag' of a cell
- **Mitochondria -** Also known as the 'powerhouses of the cell'. Involved in cellular respiration and production of energy in the form of ATP (Adenosine triphosphate)
- **Plastids -** Present in plant cells

Two types:

1. **Chromoplasts (coloured plastids) -** Include chloroplasts which are important for photosynthesis in plants
2. **Leucoplasts (white or colourless plastids) -** Help in the storage of carbohydrates (starch), fats, and proteins

- **Number of cells**
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  - Single cell in unicellular organisms performs all the basic functions such as digestion, respiration, and excretion.
  - Organisms made up of more than one cells are called **multicellular organisms**. For example: Humans, cow, etc.
  - In multicellular organisms, the cells show division of labour as a particular set of cells are involved in performing a specific body function.
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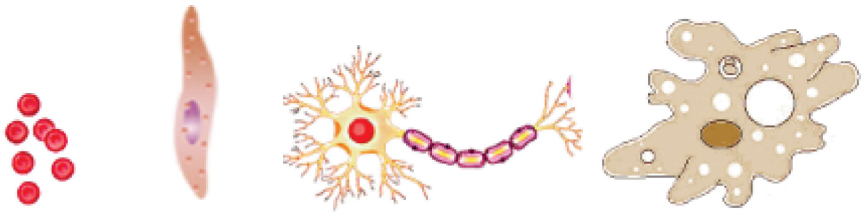

Red blood cell Muscle cells Nerve cells Amoeba

- **Size of the cells**
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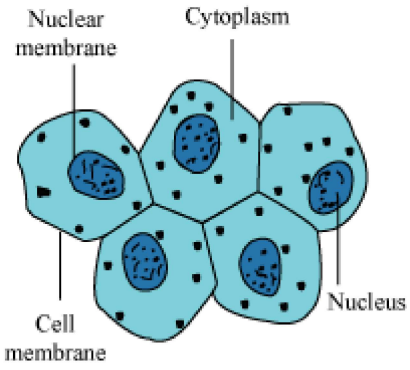
- **Cell structure and functions**
  - In multicellular organisms, each organ system is made up of several organs.
  - Organs are further made up of tissues.

- **Tissues are groups of similar cells performing a specific function.**
- **Types of cell**
  - **Prokaryotic cells -** Cells which do not have a well defined nuclear membrane and the nuclear material lies freely in the cytoplasm of the cell. For example - bacteria, blue green algae.
  - **Eukaryotic cells -** Cells having nucleus with well defined nuclear membrane. For example - plant and animal cells
- **Components of the cell**



Human cheek cells

- **Cell membrane**
  - It is the protective layer that surrounds the cell.
  - Cell membrane selectively allows the entry of only some substances and prevents the movement of other materials. Hence, it checks the transport of substances in and out of the cell.
- **Cell wall**
  - In plants, an extra protective covering of a polysaccharide, cellulose is present.
  - It is called cell wall that protects plant cells from environmental variations.
- **Cytoplasm**
  - It is a jelly-like substance present between cell membrane and nucleus.
  - It contains various cell organelles such as mitochondria, Golgi bodies, lysosomes etc.
- **Nucleus**
  - It is a dense spherical body located at the centre of the cell.
  - It is surrounded by porous nuclear membrane.
  - It contains spherical body called nucleolus.
  - It also contains thread-like structures called **chromosomes**.
  - Chromosomes are the structures that carry genes and play an important role in inheritance.
  - **Genes** are the structural and functional unit of inheritance.
  - The entire living substance in a cell is known as **protoplast**.
- **Vacuoles**
  - Vacuoles are fluid-filled membrane-bound structures in the cell.
  - In plant cells, a single large vacuole is present.
  - In animal cells, numerous small vacuoles are present.
- **Plastids**
  - They are present only in plant cells.
  - Plastids that contain green colour pigment **chlorophyll** are known as chloroplasts. It is the chlorophyll that gives green colour to the leaves.
- **Chloroplast traps solar energy and utilizes this energy to manufacture food for the plant.**

- **Vacuoles**

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3. In animal cells, numerous small vacuoles are present.

4. The membrane of the vacuole is called tonoplast. This membrane encloses a fluid called cell sap.

- **Plastids**

1. They are present in plant cells.

2. Chloroplast is a plastid containing green pigment called chlorophyll that is required in photosynthesis.

3. Plastids are of two types – leucoplasts and chromoplasts

4. Leucoplasts are colourless and are used to store food while chromoplasts are plastids containing pigments. Chloroplasts are a type of chromoplasts.

5. Chloroplasts consist of two regions – grana (stacks of sac like membrane bound structures that contain pigment chlorophyll) and stroma (ground substance containing enzymes and starch grains)

- **Endoplasmic Reticulum (ER)**

They are of two types:

1. Rough Endoplasmic Reticulum (RER) is important for synthesis and packaging of proteins.

2. Smooth Endoplasmic Reticulum (SER) acts as storage organelle. It also helps in lipid (fat) synthesis.

- **Golgi Apparatus**

1. It is made up of parallel arranged membrane-bound vesicles called cisternae.

2. It helps in storage, modification, and packaging of products in vesicles.

3. It helps in formation of glycoproteins and glycolipids.

- **Lysosomes**

1. It is a membrane-bound structure that holds variety of enzymes.

2. Rich in all types of hydrolytic enzymes, which are active at acidic pH.

3. It is involved in the digestion of carbohydrates, proteins, lipids, and nucleic acids.

- **Mitochondria**

1. It is a double membrane-bound structure.

2. The inner membrane of mitochondria is deeply folded to form cristae.

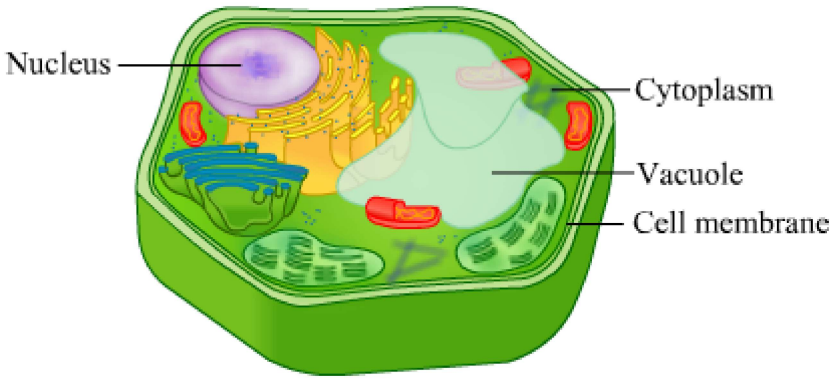
3. Cristae increase the surface area in the organelle.

4. It is the site of cellular respiration and hence known as ‘power house of cell’.

5. They have their own circular DNA.

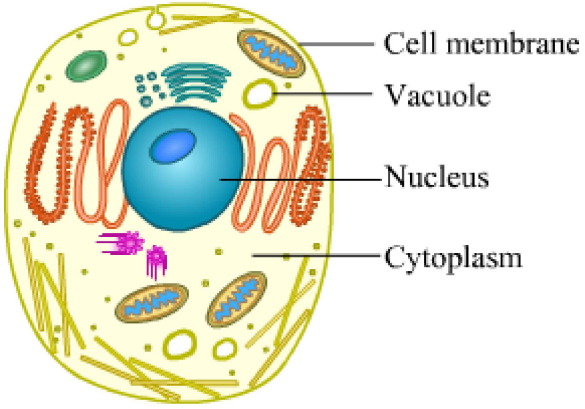
6. They divide by fission.

- **Differences between plant and animal cells**
- **Plant cell**
    - Cell wall is present.
    - Nucleus is located in the periphery of the cell.
    - Plastids are present.
    - A large single vacuole is present in the centre of the cytoplasm.



Plant Cell

- **Animal cells**
    - Cell wall is absent.
    - Nucleus is located in the centre of the cell.
    - Plastids are absent.
    - Numerous small vacuoles are present in the cytoplasm.

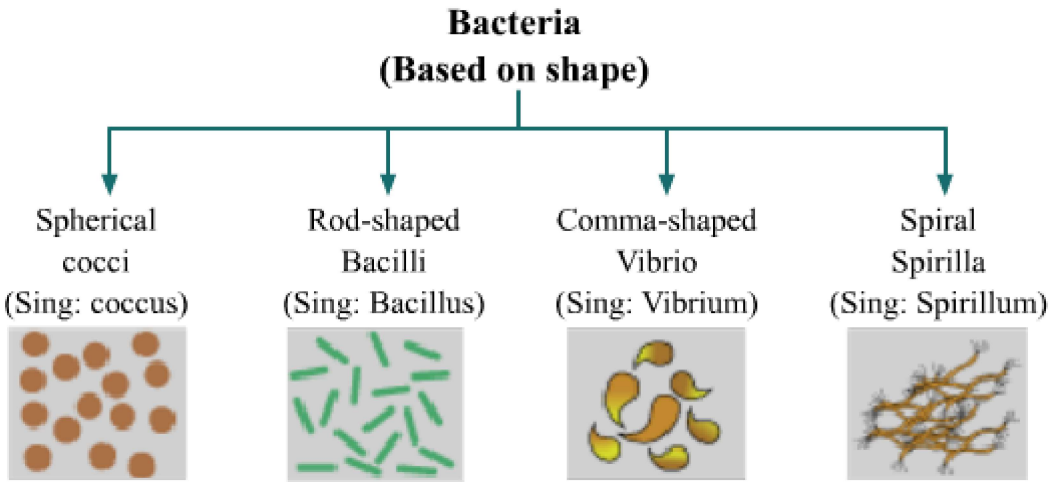


Animal Cell

- **Microorganism**
    - The living organisms that cannot be seen with unaided eye are called microorganisms.
    - The study of microorganisms is called microbiology.
    - They are cosmopolitan in distribution and found everywhere around us.
    - All the tiny organisms around us like in air and soil do not fall into the category of microbes.
    - Antony Van Leewanhoek observed bacteria for the first time using his self built microscope.
- Microorganisms are classified into four major groups- bacteria, fungi, protozoa and some algae.

Shapes of bacteria:

Bacteria are of different shapes. They can be classified in four groups based on their shape.



Important Scientists

- Robert Koch ((1843-1910)
  - Robert Koch developed the germ theory of disease that established the microbial cause of disease.
  - He identified anthrax disease.
  - He developed agar growth medium.
- Louis Pasteur (1822-1895)
  - He disapproved the theory of spontaneous generation of life. He proved this by his famous experiment known as swan neck flask experiment.
  - He developed the method of pasteurization.
  - He also contributed to the development of vaccines.

- **Classification of microorganisms**
  - There are five major groups of microorganisms.

- **Bacteria**
  - Single-celled organisms
  - Found in wide range of habitats ranging from glaciers to deserts and hot springs
  - For example – curd bacteria (*Lactobacillus*)

- **Fungi**
  - Multicellular, heterotrophic organisms
  - Lack chlorophyll and are generally found in colonies
  - For example – *Penicillium*, *Aspergillus*

- **Protozoa**
  - Unicellular or multicellular microorganisms
  - Usually found in water
  - For example – *Amoeba* and *Paramecium*

- **Algae**
  - Unicellular or multicellular autotrophic organisms
  - Contain chlorophyll pigment and carry out photosynthesis
  - For example – *Chlamydomonas* and *Spirogyra*

- **Viruses**
  - Ultramicroscopic organisms
  - Require host cells to reproduce and complete their life cycle.
  - For example – Influenza virus, polio virus
- **Favourable conditions for growth of microbes**

- Temperature plays an important role in the growth of microorganisms.
- Neutral pH is best suited for bacterial growth.
- Microorganisms also require water as they absorb all the essential nutrients from theor surrounding water.
- Gases like carbon, hydrogen and oxygen are also needed for their development.

- **Importance of microorganisms**
- **In food industry**
  - *Lactobacillus* bacteria promote the conversion of milk into curd.
  - Yeast is used in preparation of breads, pastries and cakes.
- **In beverage industry**
  - Yeast is used for commercial production of alcohol, wine and vinegar (acetic acid).
  - Yeast acts on sugar and converts it into alcohol by the process of fermentation. Louis Pasteur discovered fermentation.

- **In medicine production**
  - Medicines produced by certain microorganisms to kill or stop the growth of other disease-causing microorganisms are called **antibiotics**.
  - Antibiotics are obtained from bacteria and fungi.
  - They are classified as narrow-spectrum and broad-spectrum antibiotics.
  - Commonly used antibiotics are streptomycin, tetracycline, and erythromycin.
  - First antibiotic penicillin was prepared by Alexander Fleming
- **In vaccine production**
  - Protection of the body from the attack of various disease-causing microorganisms through vaccines is known as **vaccination.**
  - Vaccine includes dead or weakened microbes that trigger the production of antibodies in the body.
  - These antibodies help in preventing the attack from disease-causing microorganisms.
  - Vaccination helps in controlling diseases such as cholera, polio, small pox, hepatitis etc.
  - Vaccine for small pox was discovered by Edward Jenner.
- **Serum**
  - Serum is a pale yellow coloured blood component which lacks any blood cell as well as clotting factors.
  - Due to presence of antitoxins/antibodies in serum, it can be used as a preventive measure against bacterial invasions.
  - Few serum compounds have been produced by genetically modified bacteria as well, for example, blood clotting factor VIII (for treatment of Haemophilia A), Factor IX (for treatment of Haemophilia B).

- **Harmful microorganisms** – Disease-causing microorganisms are called **pathogens**.
- **Diseases in humans caused by microorganisms**
  - Diseases caused by microorganisms that spread from an infected person to a healthy person through air, water, or food are called **communicable diseases.**
  - The example includes cholera, chicken pox, and tuberculosis.
  - The organisms that transmit diseases from one place to the other are called **carriers**. Example of carriers:
  - Housefly spreads diseases such as cholera, dysentery, and typhoid.
  - Female *Anopheles* mosquito spreads malarial parasites.
  - Female *Aedes* mosquito spreads dengue virus.

- **Examples of human diseases caused by bacteria**
  - Tuberculosis
  - Cholera
  - Typhoid

- **Examples of human diseases caused by virus**
  - Measles
  - Chicken pox
  - Polio
  - Hepatitis-B
- **Examples of human diseases caused by protozoa**
  - Malaria
  - Sleeping Sickness
- **Diseases in animals caused by microorganisms**
  - Anthrax is caused by bacteria
  - Foot and mouth disease in cattle is caused by virus
- **Diseases in plants caused by microorganisms**
  - Citrus canker disease is caused by bacteria
  - Rust of wheat is caused by fungi
  - Yellow vein mosaic of *Bhindi* (Okra) is caused by virus