CLASS 9th NOTES

SCIENCE

FUNDAMENTAL UNIT OF LIFE:CELL

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FUNDAMENTAL UNIT OF LIFE: CELL

Cell:

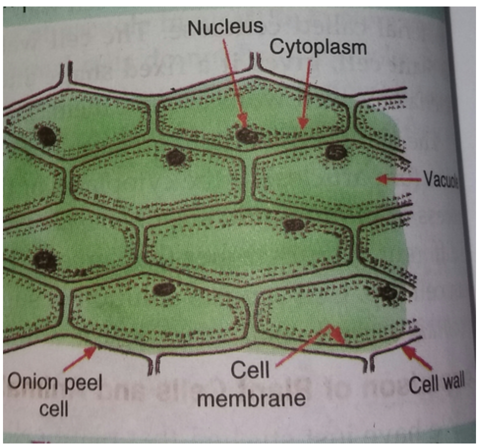
- It is known as the structural and fundamental unit of life because it is the basic building unit of an organism and is capable to perform basic functions of all living organisms.
- Cytology is the scientific study dedicated to understanding the structure and composition of cells.
- In 1665, Robert Hooke first observed cells in a thin slice of cork, marking the beginning of our understanding of cellular existence.
- A. V. Leeuwenhoek, in 1674, made the groundbreaking discovery of the first free-living cell.
- Protoplasm, the essential substance within cells, comprises water, ions, salts, organic molecules, cell organelles, and a nucleus, existing in sol-gel states.

Discovery of Living Cell ⟶ Anton Van Leeuwenhock (1674)
Discovery of Nucleus ⟶ Robert Brown (1831)
Discovery of Protoplasm ⟶ J. E. Purkinje (1839)

Cell Theory:

The cell theory was given by Schleiden and Schwann, in 1838 which states that:

1. All living things are made up of cells.
2. The cell is the basic unit of structure and function in living organisms.
3. Cells come from pre-existing cells through the process of cell division.



onion peel cell

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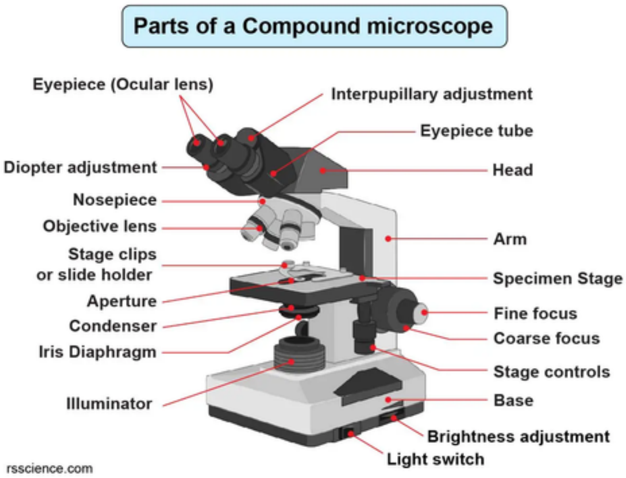

Types of Cells and Organisms

On basis of number of cells:

On the basis of number of cells, organisms are divided into two categories:

Unicellular Organisms	Multicellular Organisms
Unicellular organisms are composed of a single cell	Multicellular organisms are composed of more than one cell
Simple body organization	Complex body organization
A single cell carries out all necessary life processes	Multiple cells perform different functions
The total cell body is exposed to the environment	Only the outer cells are exposed to the environment
Division of labour is at the organelle level'	Division of labour is at cellular, tissue, organs and organ system level
Includes both eukaryotes and prokaryotes.	Includes only eukaryotes
A lifespan of a unicellular organism is usually short.	Multicellular organisms have a comparatively longer lifespan

On the basis of type of organizational cells:

1. Prokaryotic Cells
2. Eukaryotic Cells

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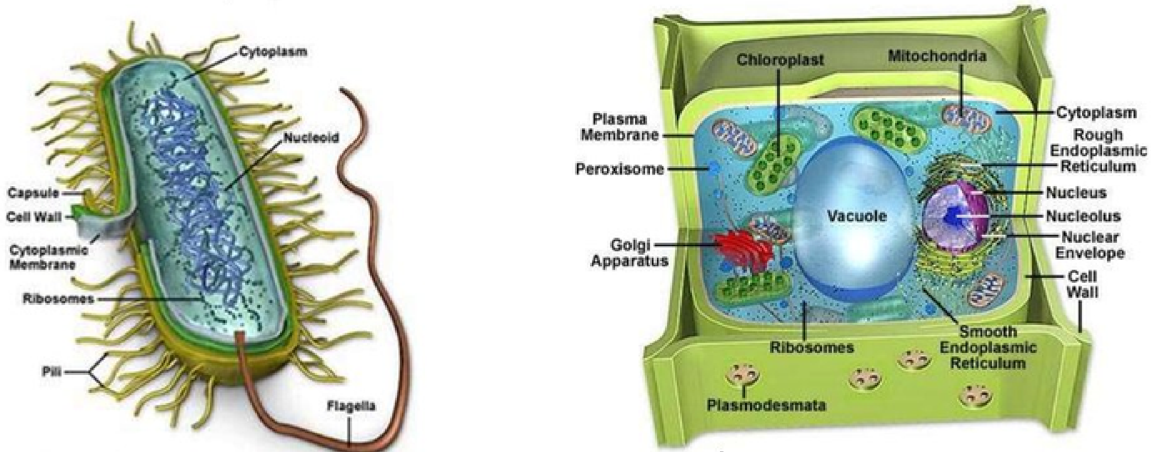
Prokaryotic vs. Eukaryotic



Prokaryotic	Eukaryotic
• no nucleus	• nucleus
• no membrane enclosed organelles	• membrane enclosed organelle
• single chromosome	• chromosomes in pairs
• no streaming in the cytoplasm	• streaming in the cytoplasm
• cell division without mitosis	• cell division by mitosis
• simple flagella	• complex flagella
• smaller ribosomes	• larger ribosomes
• simple cytoskeleton	• complex cytoskeleton
• no cellulose in cell walls	• cellulose in cell walls
• no histone proteins	• DNA bound to histone proteins

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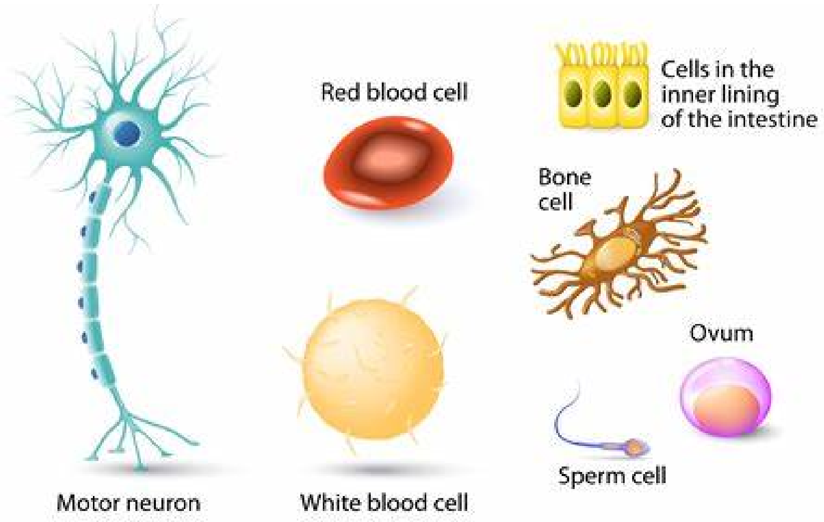
Cell Shape

Cells exhibit diverse shapes and sizes, influenced by their specific functions and locations within an organism. While some cells are typically spherical, such as in a general context, others take on distinct forms like elongated nerve cells, branched pigmented cells, discoidal red blood cells, or spindle-shaped muscle cells. The variability in cell shape is a reflection of their specialized roles and adaptations in different tissues.

Different shapes of cells:
1. Circular
2. Filamentous or spiral
3. Branched
4. Disc



Different shapes of cells

Sizes of Cells:

Cells range significantly in size. The smallest, like bacteria and certain blood cells, are mere micrometers. Conversely, nerve cells can be over a meter long, showcasing extremes in cellular dimensions within the intricate tapestry of life.

1. **Smallest Cells:**
   - Bacteria: About 0.2 to 2 micrometers in diameter.
   - Mycoplasma: One of the smallest bacteria, around 0.2 micrometers.
2. **Largest Cells:**
   - Bird Egg Cells: Ostrich egg cells can be around 170 millimeters in diameter.
   - Nerve Cells: Nerve cells, or neurons, can extend over a meter in length.

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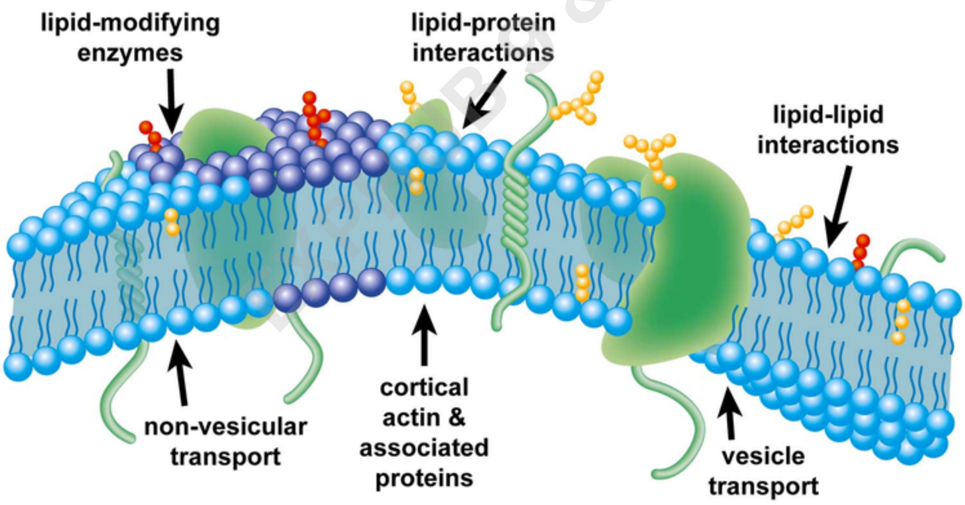
Components of Cell

Cells are complex structures with various components that work together to maintain life. The three basic components of cells are:

1. Plasma membrane
2. Nucleus
3. Cytoplasm

Plasma Membrane

1. The plasma membrane, also known as the cell membrane or plasma lemma, is selectively permeable, regulating the entry and exit of substances in and out of the cell.
2. Serving as the cell's outer boundary, it separates the cytoplasm from the external environment and is a key feature in both plant and animal cells.
3. In animals, it forms the outermost covering, while in plants, it lies beneath the cell wall.
4. According to the fluid mosaic model proposed by Singer and Nicholson, the plasma membrane is a dynamic structure comprising proteins and lipids arranged in a bilayer, with proteins interspersed between the lipid layers.
5. This lipid-protein composition grants flexibility to the membrane, allowing it to be folded, broken, and reunited, contributing to its adaptability in various cellular activities.



Functions of Plasma Membrane

1. The plasma membrane regulates the passage of substances, allowing some to enter or exit the cell while restricting others, thus maintaining internal balance.
2. Proteins embedded in the membrane facilitate communication between cells by receiving and transmitting signals.
3. The membrane provides structural integrity to the cell, defining its shape and acting as a protective barrier against the external environment.

Transportation of molecules across plasma membrane in cell

The transportation of molecules across the plasma membrane is crucial for the proper functioning of cells. This can be done in following ways:

- **Diffusion:** Molecules move from an area of higher concentration to an area of lower concentration. This process doesn't require energy.
- **Osmosis:** This is a specific type of diffusion involving water molecules. The solvent moves across the semipermeable membrane to equalize concentration on both sides.

Endosmosis: Endosmosis refers to the movement of water into a cell or a cell compartment.
Exosmosis: Exosmosis, on the other hand, describes the movement of water out of a cell or a cell compartment.

Types of solutions on the basis of concentration

1. **Isotonic Solution**:
   - Description: An isotonic solution has the same concentration of solutes as the cell's cytoplasm.
   - Effect on Cell: In an isotonic solution, there is no net movement of water. Cells maintain their shape and size because the water moves in and out at an equal rate. Animal cells, for example, are often best suited to isotonic environments.
2. **Hypotonic Solution**:
   - Description: A hypotonic solution has a lower concentration of solutes than the cell's cytoplasm.
   - Effect on Cell: Water moves into the cell, causing it to swell. In plant cells, this can lead to turgor pressure, making cell rigid. In animal cells, excessive swelling can lead to cell lysis, or bursting.
3. **Hypertonic Solution**:
   - Description: A hypertonic solution has a higher concentration of solutes than the cell's cytoplasm.
   - Effect on Cell: Water moves out of the cell, causing it to shrink. In plant cells, this can lead to plasmolysis, where the cell membrane pulls away from the cell wall. In animal cells, excessive shrinking can lead to cell crenation.

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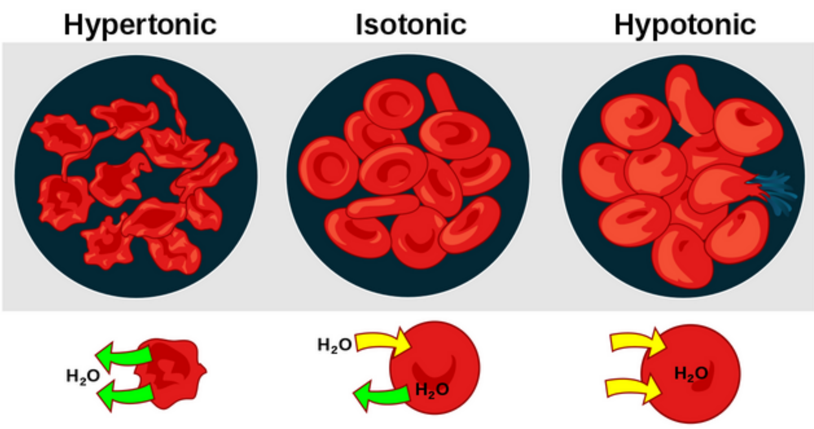
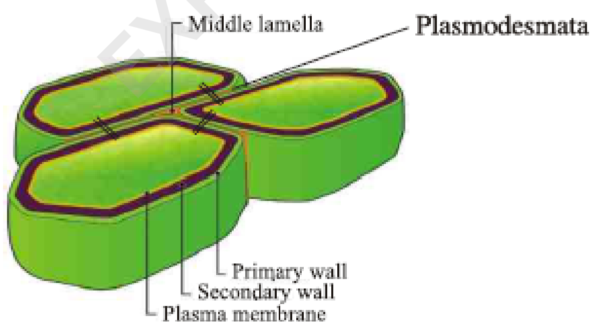


Cell Wall

1. The outermost protective layer of plant cells and fungal cells is known as the cell wall, distinguishing them from animal cells which lack this structure.
2. The cell wall is a sturdy, rigid, and thick layer that is porous and non-living. In plant cells, it consists mainly of cellulose and hemicelluloses, while in fungi, it is primarily composed of chitin.
3. The connection between the cell walls of two adjacent cells is facilitated by a layer called the middle lamellae. Additionally, microscopic channels known as plasmodesmata allow the transport of substances between these connected cells.

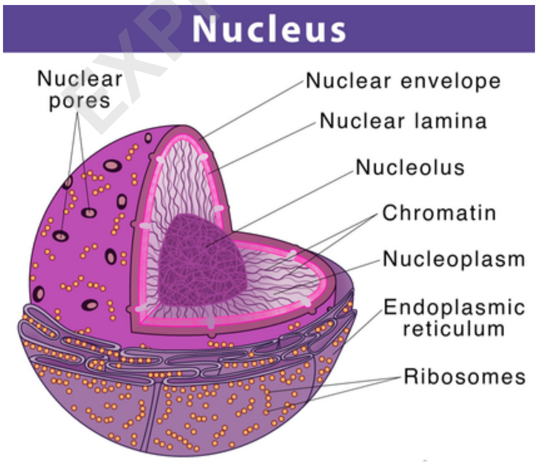


Functions of Cell Wall

1. The primary role of the cell wall is to provide structural support and rigidity to the cell. It helps maintain the shape of the cell and prevents it from collapsing.
2. The porous nature of the cell wall allows for the controlled movement of water, ions, and other molecules.
3. It enables plants to stand upright and withstand various external pressures, such as wind and gravity.

Nucleus

- The nucleus is a membrane-bound organelle that serves as the control center of eukaryotic cells, containing genetic material in the form of DNA.
- It is surrounded by a double membrane called the nuclear envelope, which has nuclear pores that allow the exchange of materials between the nucleus and the cytoplasm.
- The genetic material within the nucleus consists of chromosomes, which carry the instructions for cellular processes and inheritance.
- The nucleolus, located within the nucleus, is responsible for the synthesis of ribosomal RNA and the assembly of ribosomes.
- The nucleus regulates cellular activities by controlling gene expression, determining which genes are transcribed into RNA for protein synthesis.
- During cell division, the nucleus undergoes a process called mitosis, ensuring that each daughter cell receives a complete and identical set of genetic information.
- The organization and function of the nucleus play a crucial role in the overall growth, development, and maintenance of the cell and, by extension, the entire organism.



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Functions of Nucleus

1. It control all the metabolic activities of the cell and regulate the cell cycle.
2. It help in transmission of hereditary characters from parent to their offsprings.

Cytoplasm

1. Cytoplasm is the gel-like substance that fills the entire cell and surrounds its organelles, creating a semi-fluid environment.
2. It serves as the medium for various cellular activities, including metabolic reactions, protein synthesis, and transportation of molecules within the cell.

It can be divided into two parts:
1. **Cytosol**: Aqueous soluble part contain various fibrous proteins forming cytoskeleton. It contain about 90% water, 7% Protein 2% carbohydrates & 1% etc.
2. **Cell organelles**: Living part of the cells having definite shape, structure and function bounded by plasma membrane. There are single membrane bound, double membrane bound and non membrane bound Cell organelles.

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Endoplasmic Reticulum

- Network of membranes throughout the cell
- Acts as an intracellular highway
- Facilitates transport of proteins and lipids within the cell

It is of two types:

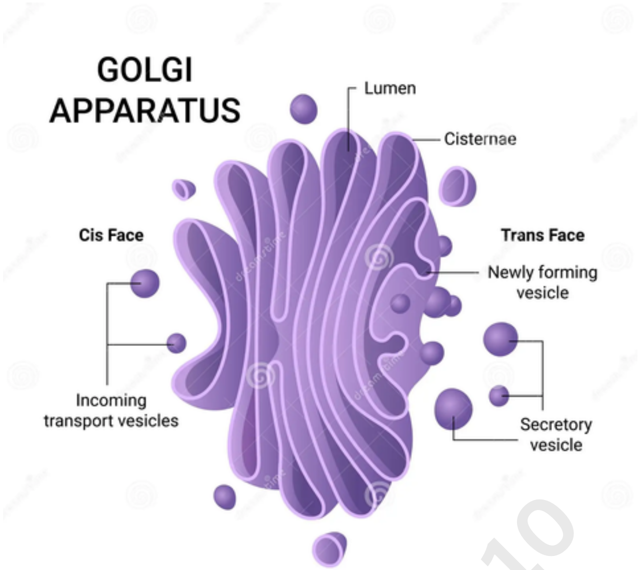
	Smooth ER	Rough ER
1.	Well developed in steroid hormone secreting cells.	Well developed in protein secreting cells.
2.	It tends to be tubular.	It tends to be cisternal.
3.	It is less stable and autolysis readily.	It is com-aratively more stable. It may persist for sometime after the death of the cell.
4.	It is devopd of ribosomes	Ribosomes are found associated.

Functions of ER

1.The rough endoplasmic reticulum (ER) is involved in the synthesis of proteins. Ribosomes on its surface aid in the production of proteins that may be secreted from the cell or incorporated into cell membranes.
2. The ER acts as an intracellular highway, facilitating the transport of proteins and lipids to different parts of the cell, ensuring their proper delivery to specific cellular locations.

3. The smooth endoplasmic reticulum (ER) is responsible for lipid synthesis, contributing to the production of lipids and steroids. Additionally, it plays a role in detoxifying drugs and poisons in the cell.

Golgi Apparatus



The Golgi apparatus is made up of a network of membrane-enclosed vesicles, arranged in stacks known as cisternae. These stacks run parallel to each other and include large, spherical vesicles. The structure was first identified by Camillo Golgi. Notably, it is not present in prokaryotic cells, mammalian red blood cells (RBCs), and sieve cells.

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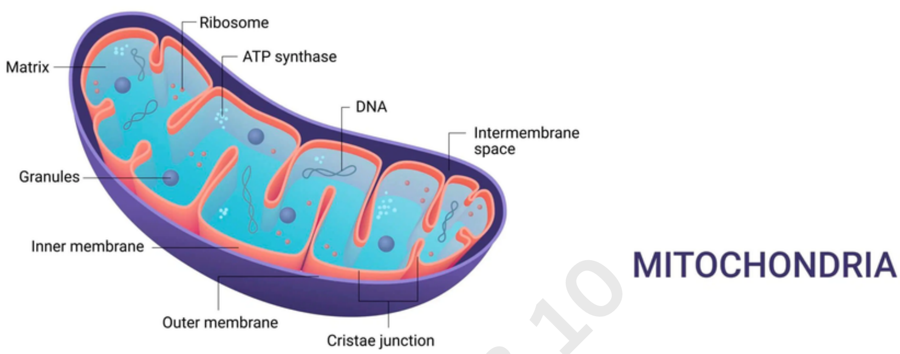
Functions of Golgi Apparatus

1. Golgi packages and modifies proteins for transport within or outside the cell.
2. It attaches carbohydrates to proteins, influencing their function and recognition.
3. Golgi directs proteins to specific cell locations, packaging them into vesicles.
4. It contributes to the creation of lysosomes, aiding in cellular waste breakdown.
5. Golgi processes lipids, preparing them for various cellular roles.

Mitochondria

1. Mitochondria, often referred to as the 'Power House of the Cell' or the 'Storage Battery,' exhibit a double-membrane structure. The outer membrane contains specific proteins, and the inner membrane is intricately folded, forming chambers known as Cristae.
2. Notably, mitochondria possess their own DNA and ribosomes. These rod-shaped structures are present in the cytoplasm of all eukaryotic cells except mammalian red blood cells and are absent in prokaryotes.
3. The first observation of mitochondria was made by Kolliker in insect cells in the year 1880.



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Functions of mitochondria

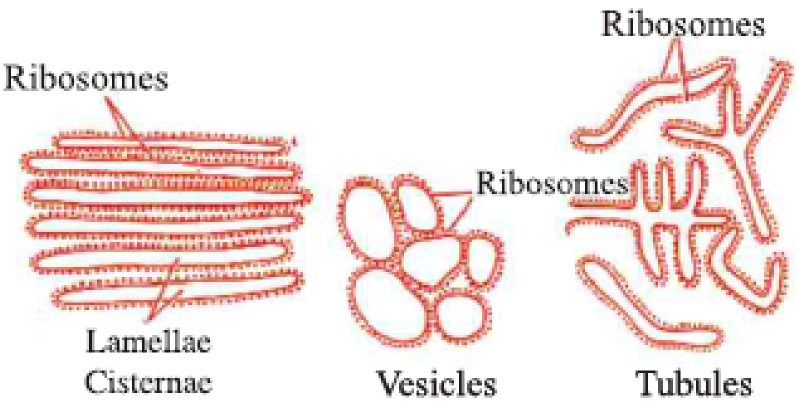
1. Mitochondria generate energy (ATP) through cellular respiration, converting nutrients into a form usable by the cell.
2. They play a key role in various metabolic processes, including the breakdown of fatty acids and amino acids.
3. Mitochondria participate in signaling pathways that regulate cell growth, differentiation, and death.

Ribosomes

Ribosomes are cellular structures essential for protein synthesis. Composed of RNA and proteins, they are found in the cytoplasm or attached to the endoplasmic reticulum. Ribosomes read messenger RNA (mRNA) and assemble amino acids into polypeptide chains, creating proteins vital for cell structure and function. They play a fundamental role in the translation of genetic information from DNA to functional proteins in all living cells.

Functions of ribosomes

1. Ribosomes translate genetic instructions from mRNA to build proteins essential for cell structure and function.
2. They play a vital role in ongoing protein production, contributing to cell growth, repair, and overall maintenance.



Plastids

1. Plastids are membrane-bound organelles found in plant cells, responsible for crucial processes like photosynthesis. Chloroplasts, a type of plastid, contain chlorophyll, the pigment essential for capturing light energy and converting it into chemical energy.
2. Plastids act as storage centers for various substances, including starch, lipids, and pigments. Chromoplasts, another type of plastid, store pigments that give fruits and flowers their vibrant colors.

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Types of plastids on the type of pigment present in them:

1. **Chloroplast**: Chloroplasts contain chlorophyll pigments, which are essential for photosynthesis. They are primarily found in the cells of green plant tissues. Chlorophyll absorbs light energy and converts it into chemical energy.

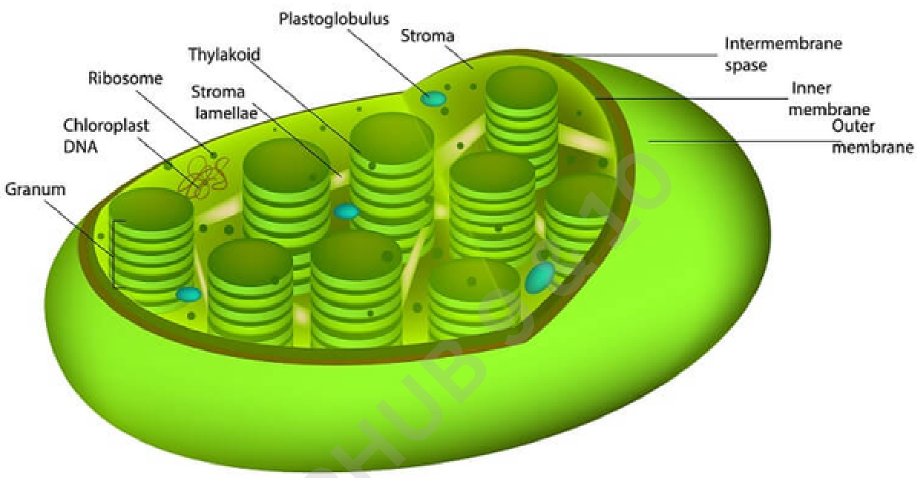
2. **Chromoplast**: They contain various pigments such as carotenoids (e.g., carotenes and xanthophylls) that give fruits and flowers their characteristic colors. They are involved in the synthesis and storage of pigments other than chlorophyll.

3. **Leucoplast**: Leucoplasts are colorless and do not contain pigments like chlorophyll or carotenoids. They are involved in the storage of starch, lipids, or proteins.

Chloroplast

Chloroplast have two main parts:

1. **Grana**: Grana are stacks of thylakoid discs within chloroplasts, where the chlorophyll pigments are located. Their function is to facilitate the light-dependent reactions of photosynthesis by capturing and processing light energy to generate chemical energy in the form of ATP.
2. **Stroma**: The stroma is the gel-like matrix within chloroplasts where the Calvin cycle of photosynthesis takes place. Its function is to facilitate the synthesis of glucose by providing a location for the enzymes and molecules involved in the conversion of carbon dioxide into carbohydrates.



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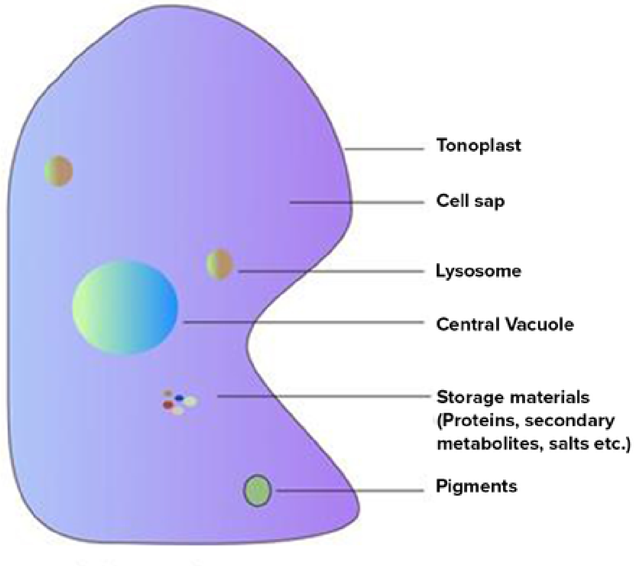
Vacuoles

1. Vacuoles are membrane-bound organelles found in the cells of plants, fungi, and some protists.
2. They serve various functions, including storage of nutrients, waste products, and pigments. Vacuoles also play a role in maintaining turgor pressure, which contributes to the rigidity of plant cells.
3. Vacuoles store essential nutrients such as sugars, ions, and amino acids.
4. In animal cells vacuums are absent or smaller in size. In plant cells a single large vacuum is found which occupies about 90% of the volume of cell.

Functions of vacuoles

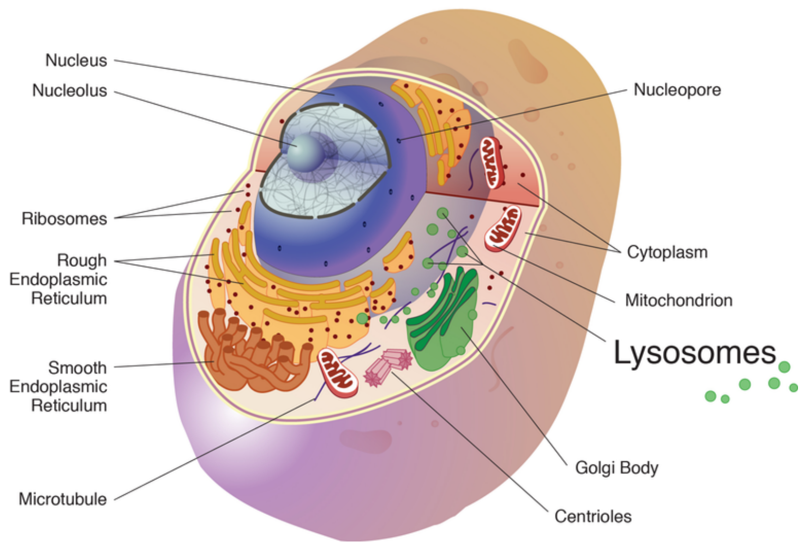
1. They aid in the breakdown and storage of cellular waste, contributing to detoxification and overall cell health.

2. They store nutrients like sugars and ions, serving as reservoirs for essential cellular components.



Lysosome

1. Lysosomes are membrane-bound organelles containing digestive enzymes, typically spherical in shape.
2. They play a crucial role in cellular digestion, breaking down unwanted materials such as damaged organelles, foreign substances, and cellular waste.
3. Lysosomes are involved in autophagy, a process where they digest and recycle cellular components, helping to maintain cell health and remove dysfunctional structures.



Functions of Lysosome

(a) Their main function is phagy (digestion). Means they breakdown worn out cell parts.

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(b) They are kind of waste disposal system of the cell.
(c) They help in digesting foreign materials like invading viruses and bacteria in the cell.

Why it is called suicidal bag?

Lysosomes are often referred to as "suicidal bags" because of their role in programmed cell death (apoptosis). During apoptosis, lysosomes release digestive enzymes that break down cellular components, contributing to the controlled self-destruction of the cell. This process is crucial for eliminating damaged or unnecessary cells in a regulated manner.

Difference between Animal cell and Plant Cell

PLANT CELL	ANIMAL CELL
Plant cells are relatively larger in size.	Animal cells are relatively smaller in size.
The cell membrane is surrounded by a cell wall in plant cells.	Cell wall is absent in animal cells.
Plastids like chloroplast are present in plant cells.	Plastids are absent in animal cells.
The vacuoles are very large in size.	The vacuoles are very small in size.
Centrioles are absent in plant cells	Centrioles are present in animal cells.

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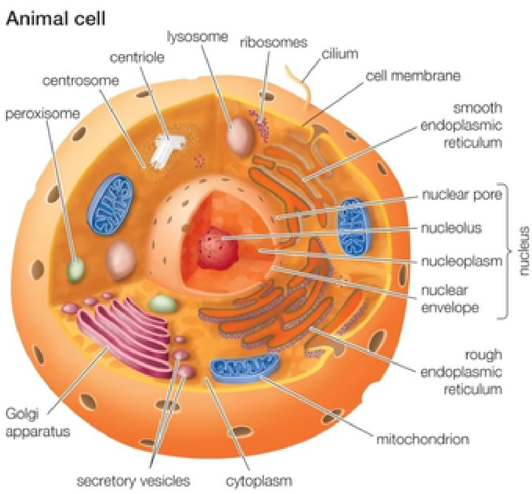
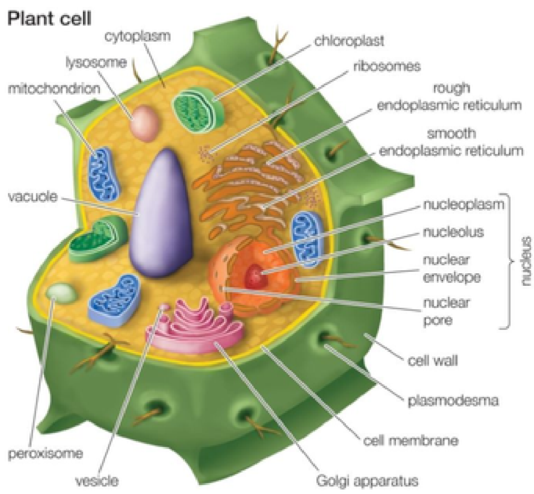




Cell Division

Cell division is the process by which a parent cell divides into two or more daughter cells. It is a fundamental mechanism for growth, development, and the replacement of damaged or old cells in living organisms. Cell division is crucial for maintaining the continuity of life and ensuring the proper functioning of tissues and organs.

Two main types of cell divisions are:

1. **Mitosis**:

(a) Mitosis is the type of cell division responsible for the growth and maintenance of somatic (body) cells.

(b) It results in the production of two genetically identical daughter cells, each having the same number of chromosomes as the parent cell.

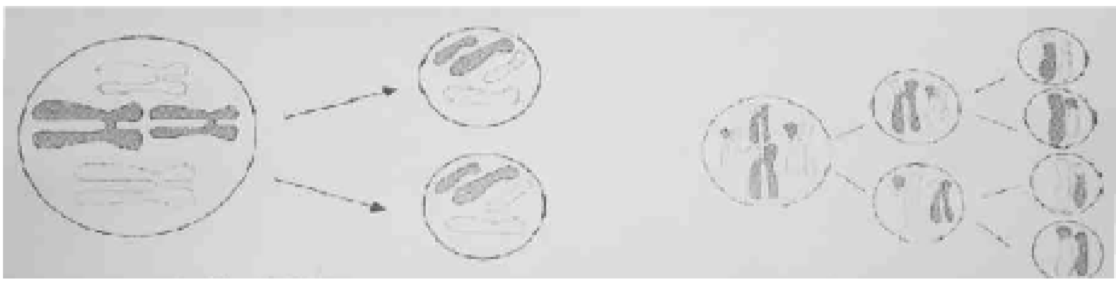
(c) Mitosis is essential for tissue repair, growth, and the replacement of damaged or worn-out cells.

2. **Meiosis**:

(a) Meiosis is a specialized type of cell division involved in the formation of gametes (sex cells - sperm and egg).

(b) It produces four non-identical daughter cells, each with half the number of chromosomes as the parent cell.

(c) Meiosis is crucial for sexual reproduction, introducing genetic diversity by shuffling genetic material during the formation of gametes.



Mitosis Meiosis

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