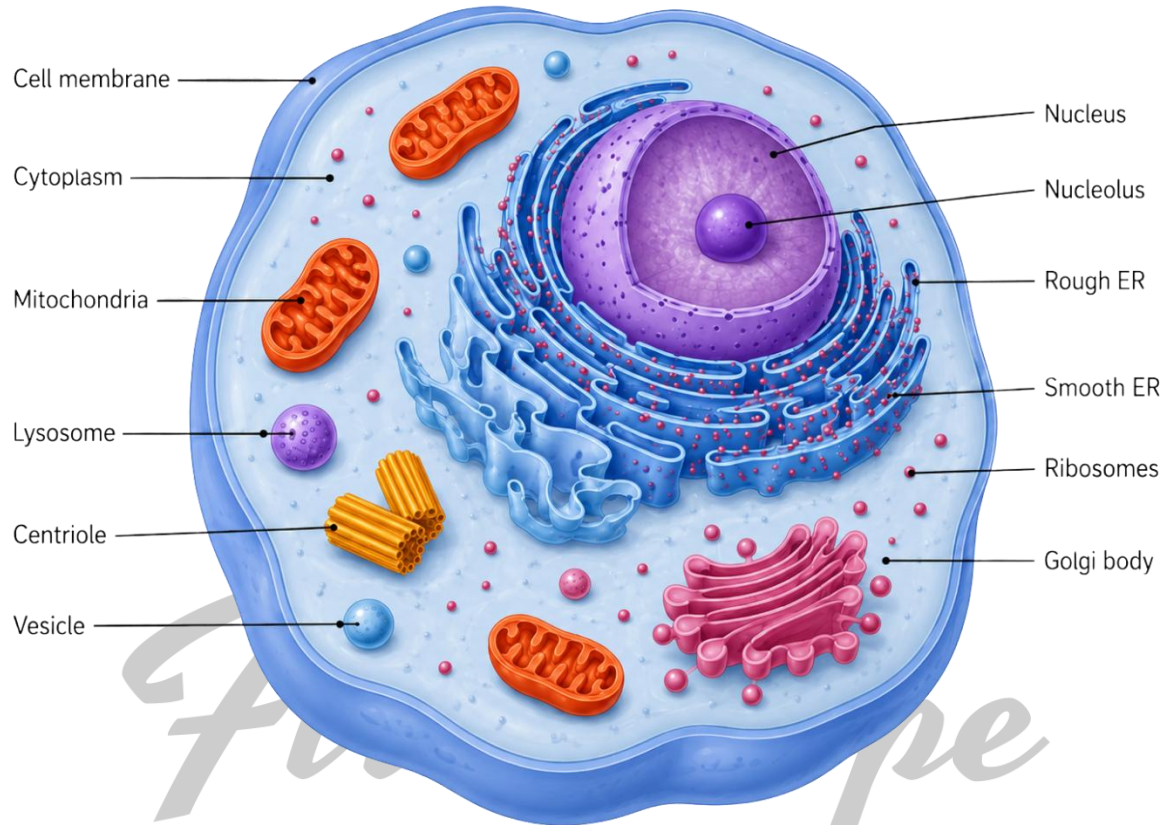


Cell Biology

Structure and Functions of Cell and Its Organelles

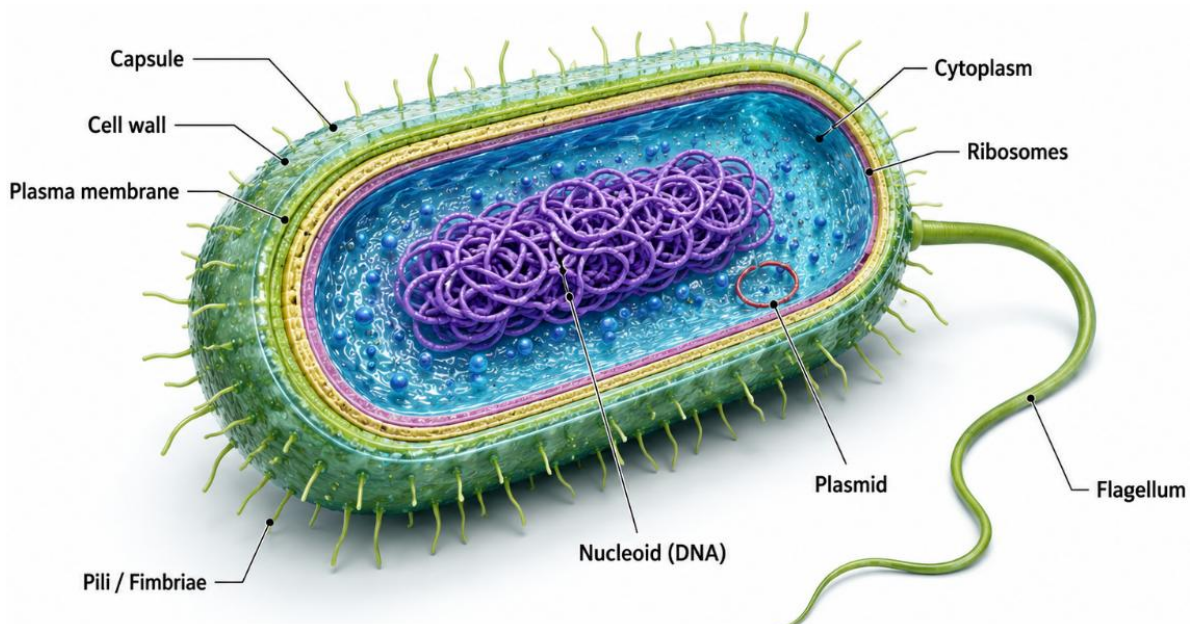
- The cell is the smallest unit of life that can carry out all basic functions such as metabolism, growth, and reproduction.



- All living organisms are made up of one or more cells, and each cell comes from a pre-existing cell.

Types of Cells

1. Prokaryotic Cells



- These cells do not have a true nucleus, and their genetic material is present freely in the cytoplasm.
- They are simple in structure and include bacteria and archaea.

2. Eukaryotic Cells

- These cells have a well-defined nucleus enclosed by a nuclear membrane.
- They contain membrane-bound organelles and are found in animals, plants, fungi, and protists.

Cell Structure (Main Parts)

1. Plasma Membrane (Cell Membrane)

- It is a thin, flexible boundary that surrounds the cell.
- It controls the movement of substances in and out of the cell and maintains internal balance.

2. Cytoplasm

- It is a jelly-like substance present inside the cell.
- It contains organelles and is the site of many chemical reactions.

3. Nucleus

- It is the control center of the cell that contains genetic material (DNA).
- It regulates cell activities such as growth, metabolism, and reproduction.

Cell Organelles and Their Functions

A. Mitochondria

- These are known as the powerhouse of the cell.
- They produce energy in the form of ATP through cellular respiration.

B. Endoplasmic Reticulum (ER)

- It is a network of membranes involved in synthesis and transport.
- Rough ER has ribosomes and helps in protein synthesis.
- Smooth ER lacks ribosomes and helps in lipid synthesis and detoxification.

C. Ribosomes

- These are small particles that help in protein synthesis.
- They can be free in the cytoplasm or attached to rough ER.

D. Golgi Apparatus

- It modifies, packages, and transports proteins and lipids.
- It plays a key role in secretion.

E. Lysosomes

- These contain digestive enzymes.
- They break down waste materials and damaged organelles.

F. Peroxisomes

- These help in detoxification and breakdown of fatty acids.
- They contain enzymes that produce and degrade hydrogen peroxide.

G. Cytoskeleton

- It is a network of protein fibers.
- It provides shape, support, and helps in movement.

H. Centrosome (in animal cells)

- It helps in cell division by organizing microtubules.

I. Chloroplast (in plant cells)

- It carries out photosynthesis.
- It contains chlorophyll which captures light energy.

J. Vacuole

- It stores water, nutrients, and waste products.
- In plant cells, it maintains cell pressure and structure.

Genome Organization

- Genome organization refers to how genetic material (DNA) is arranged, packaged, and managed inside a cell.
- It determines how genes are stored, accessed, and expressed in an organism.

Types of Genetic Material Organization

1. Prokaryotic Genome Organization

- The DNA is usually circular and located in a region called the nucleoid.
- There are no histone proteins, and DNA is less organized compared to eukaryotes.
- Plasmids are small extra DNA molecules that can carry additional genes.

2. Eukaryotic Genome Organization

- The DNA is linear and organized into chromosomes inside the nucleus.
- It is tightly packed with proteins called histones.

Levels of DNA Packaging in Eukaryotes

1. Nucleosome

- DNA wraps around histone proteins forming a bead-like structure.
- This is the basic unit of DNA packaging.

2. Chromatin

- It is a complex of DNA and proteins.
- **It exists in two forms:**
 - **Euchromatin:** loosely packed and active in gene expression.
 - **Heterochromatin:** tightly packed and inactive.

3. Chromosome

- Highly condensed form of DNA visible during cell division.
- Each chromosome contains many genes.

Components of Genome

1. Coding DNA (Genes)

- These sequences code for proteins.
- They are responsible for most biological functions.

2. Non-Coding DNA

- These do not code for proteins but have regulatory roles.
- Includes introns, regulatory sequences, and repetitive DNA.

Types of Repetitive DNA

1. Tandem Repeats

- Repeated sequences located next to each other.

2. Interspersed Repeats

- Repeated sequences scattered throughout the genome.

Functional Organization

- Genes are arranged in a way that allows proper regulation and expression.
- Regulatory elements such as promoters and enhancers control gene activity.

Chromosomal Regions

1. Centromere

- It is the region where spindle fibers attach during cell division.

2. Telomere

- It is the protective end of chromosomes.
- It prevents loss of genetic material during replication.

Gene Expression and Its Regulation

- Gene expression is the process by which information stored in DNA is used to produce functional products such as proteins or RNA molecules.
- It allows cells to perform specific functions and respond to internal and external changes.

Steps of Gene Expression

1. Transcription

- DNA is copied into messenger RNA (mRNA) inside the nucleus.
- RNA polymerase is the main enzyme that helps in this process.

2. RNA Processing (in eukaryotes)

- The primary RNA transcript is modified before it becomes functional mRNA.
- Introns (non-coding regions) are removed, and exons (coding regions) are joined.
- A 5' cap and a poly-A tail are added to protect mRNA.

3. Translation

- mRNA is used as a template to synthesize proteins in the cytoplasm.
- Ribosomes read the mRNA sequence and assemble amino acids into a protein.

Types of RNA Involved

1. mRNA (Messenger RNA)

- It carries genetic information from DNA to ribosomes.

2. tRNA (Transfer RNA)

- It brings amino acids to the ribosome during protein synthesis.

3. rRNA (Ribosomal RNA)

- It forms a major part of ribosomes and helps in protein synthesis.

Regulation of Gene Expression

Gene expression is tightly controlled so that **proteins are made only when needed**.

Levels of Regulation

1. Transcriptional Regulation

- It controls whether a gene is turned on or off.



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