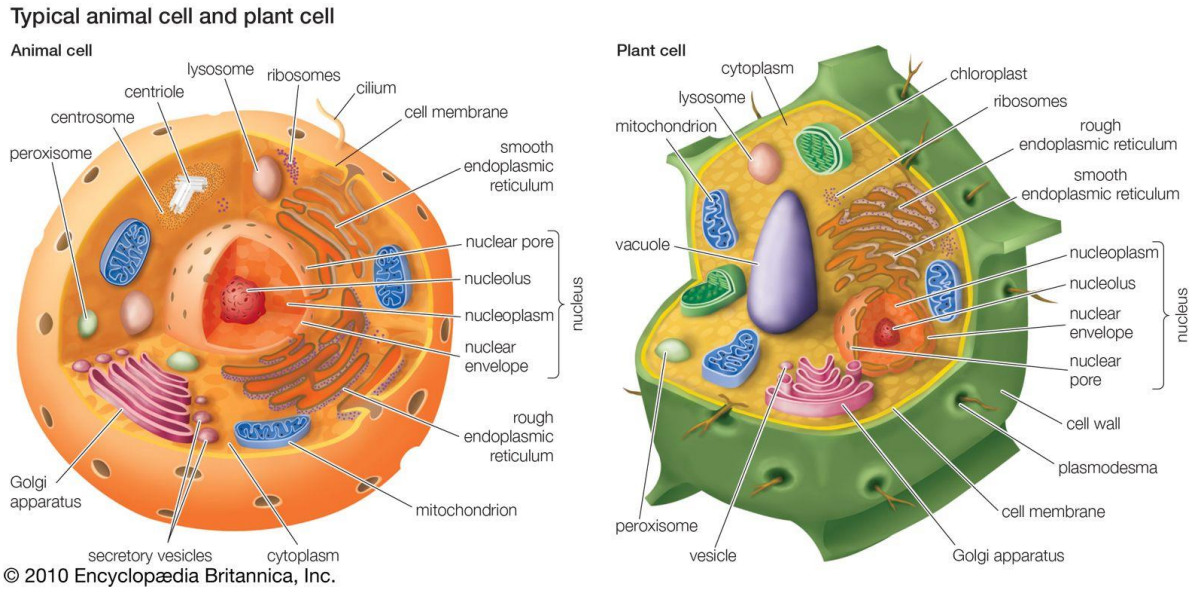
CELL THEORY - STRUCTURE OF PROKARYOTIC AND EUKARYOTIC CELL



PROKARYOTIC CELL

Prokaryotic cells are **single-celled microorganisms** known to be the earliest on earth. Prokaryotes include **Bacteria and Archaea.** The photosynthetic prokaryotes include **cyanobacteria** that perform **photosynthesis.**

A prokaryotic cell consists of a single membrane and therefore, all the reactions occur within the **cytoplasm**. They can be **free-living or parasites.**

Characteristics of Prokaryotic Cell

Prokaryotic cells have different characteristic features. The characteristics of the prokaryotic cells are mentioned below.

1. They lack a nuclear membrane.
2. Mitochondria, Golgi bodies, chloroplast, and lysosomes are absent.
3. The **genetic material** is present on a **single chromosome.**
4. The histone proteins, the important constituents of eukaryotic chromosomes, are lacking in them.
5. The cell wall is made up of carbohydrates and amino acids.
6. The **plasma membrane** acts as the mitochondrial membrane carrying respiratory enzymes.

7. They divide asexually by **binary fission.**
8. The sexual mode of reproduction involves conjugation.

Prokaryotic Cell Structure

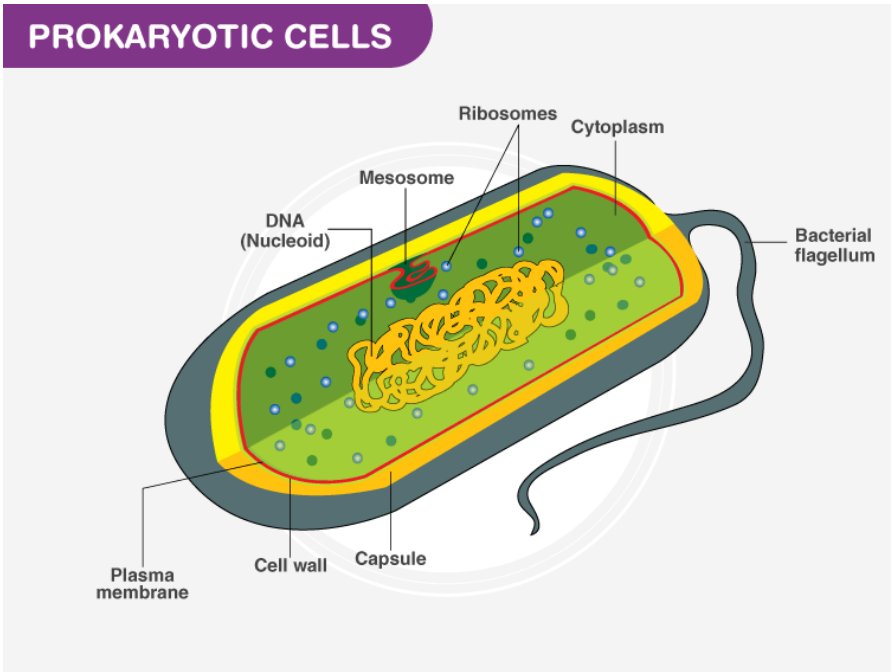
A prokaryotic cell does not have a nuclear membrane. The genetic material is present in a region in the cytoplasm known as the **nucleoid**. They may be spherical, rod-shaped, or spiral. A prokaryotic cell structure is as follows:

1. **Capsule**– It is an outer protective covering found in the bacterial cells, in addition to the cell wall.
2. It helps in moisture retention, protects the cell when engulfed and helps in the attachment of cells to nutrients and surfaces.
3. **Cell Wall**– It is the outermost layer of the cell which gives shape to the cell.
4. **Cytoplasm**– The cytoplasm is mainly composed of enzymes, salts, cell organelles and is a gel-like component.
5. **Cell Membrane**– This layer surrounds the cytoplasm and regulates the entry and exit of substances in the cells.
6. **Pili**– These are hair-like outgrowths that attach to the surface of other bacterial cells.
7. **Flagella**– These are long structures in the form of a whip, that helps in the locomotion of a cell.
8. **Ribosomes**– These are involved in protein synthesis.
9. **Plasmids**– Plasmids are non-chromosomal DNA structures. These are not involved in reproduction.
10. **Nucleoid Region**– It is the region in the cytoplasm where the genetic material is present.

A prokaryotic cell lacks certain organelles like **mitochondria, endoplasmic reticulum, and Golgi bodies.**

Prokaryotic Cell Diagram

The **prokaryotic cell diagram** given below represents a **bacterial cell.** It depicts the absence of a true nucleus and the presence of a flagellum that differentiates it from a eukaryotic cell.



Components of Prokaryotic Cells

The prokaryotic cells have four main components:

Plasma Membrane- It is an outer protective covering of phospholipid molecules which separates the cell from the surrounding environment.

Cytoplasm- It is a jelly-like substance present inside the cell.

All the cell organelles are suspended in it.

DNA - It is the genetic material of the cell. All the prokaryotes possess a circular DNA. It directs what proteins the cell creates. It also regulates the actions of the cell.

Ribosomes - Protein synthesis occurs here.

Some prokaryotic cells **possess cilia** and **flagella** which helps in locomotion.

Reproduction in Prokaryotes

A prokaryote reproduces in two ways:

- Asexually by binary fission
- Sexually by conjugation

Binary Fission

1. The **DNA of an organism** replicates and the new copies attach to the cell membrane.

2. The **cell wall** starts increasing in size and starts moving inwards.
3. **A cell wall** is then formed between each DNA, dividing the cell into two daughter cells.

Recombination

In this process, genes from one bacteria are transferred to the genome of other bacteria. It takes place in **three ways-conjugation, transformation, and transduction**.

- **Conjugation** is the process in which genes are transferred between two bacteria through a protein tube structure called a pilus.
- **Transformation** is the mode of sexual reproduction in which the DNA from the surroundings is taken by the bacterial cell and incorporated in its DNA.
- **Transduction** is the process in which the genetic material is transferred into the bacterial cell with the help of viruses. Bacteriophages are the virus that initiates the process.

EUKARYOTIC CELLS

Eukaryotic cells have **a nucleus** enclosed within the **nuclear membrane** and **form large and complex organisms**.

Protozoa, fungi, plants, and animals all have eukaryotic cells. They are classified under the **kingdom Eukaryote**.

They can **maintain different environments in a single cell** that allows them to carry out various **metabolic reactions**. This helps them **grow many times** larger than the prokaryotic cells.

Characteristics of Eukaryotic Cells

The features of eukaryotic cells are as follows:

1. Eukaryotic cells have **the nucleus** enclosed within **the nuclear membrane**.
2. The **cell has mitochondria.**
3. **Flagella and cilia** are the locomotory organs in a eukaryotic cell.
4. **A cell wall** is the outermost layer of the **eukaryotic cells.**
5. The **cells divide** by a process called **mitosis.**
6. The **eukaryotic cells** contain a **cytoskeletal structure.**
7. The **nucleus contains a single, linear DNA**, which carries all the genetic information.

Structure of Eukaryotic Cell

The eukaryotic cell structure comprises the following:

Plasma Membrane

- The plasma membrane separates **the cell from the outside environment.**
- It comprises **specific embedded proteins**, which help in the exchange of substances in and out of the cell.

Cell Wall

- A **cell wall** is a rigid structure present outside the plant cell.
- Cell wall is absent in animal cells.
- It provides shape to the cell and helps in cell-to-cell interaction.
- It is a protective layer that protects the cell from any injury or pathogen attacks.
- It is composed of **cellulose, hemicellulose, pectins, proteins, etc.**

Cytoskeleton

The **cytoskeleton** is present inside the **cytoplasm,** which consists of microfilaments, microtubules, and fibres to provide perfect shape to the cell, anchor the organelles, and stimulate the cell movement.

Endoplasmic Reticulum

It is a network of small, tubular structures that divides the cell surface into two parts: luminal and extra luminal.

Endoplasmic Reticulum is of two types:

- **Rough Endoplasmic Reticulum** contains **ribosomes**.
- **Smooth Endoplasmic Reticulum** that lacks **ribosomes** and is therefore smooth.

Nucleus

- The **nucleoplasm** enclosed within **the nucleus contains DNA and proteins.**
- The **nuclear envelop** consists of **two layers- the outer membrane and the inner membrane.**
- Both the membranes are **permeable to ions, molecules, and RNA material.**
- Ribosome production also takes place inside the nucleus.

Golgi apparatus

- It is made up of **flat disc-shaped structures** called **cisternae.**
- It is absent in **red blood cells** of humans and **sieve cells of plants.**
- They are arranged parallel and concentrically near the nucleus.
- It is an important site for the formation of glycoproteins and glycolipids.

Ribosomes

These are the main site for protein synthesis and are composed of proteins and ribonucleic acids.

Mitochondria

- These are also known as "**powerhouse of cells"** because they produce **energy.**
- It consists of an **outer membrane and an inner membrane**.
- The inner membrane is divided into folds called **cristae.**
- They help in the regulation of cell metabolism.

Lysosomes

They are known as "suicidal bags" because they possess **hydrolytic enzymes** to digest protein, lipids, carbohydrates, and nucleic acids.

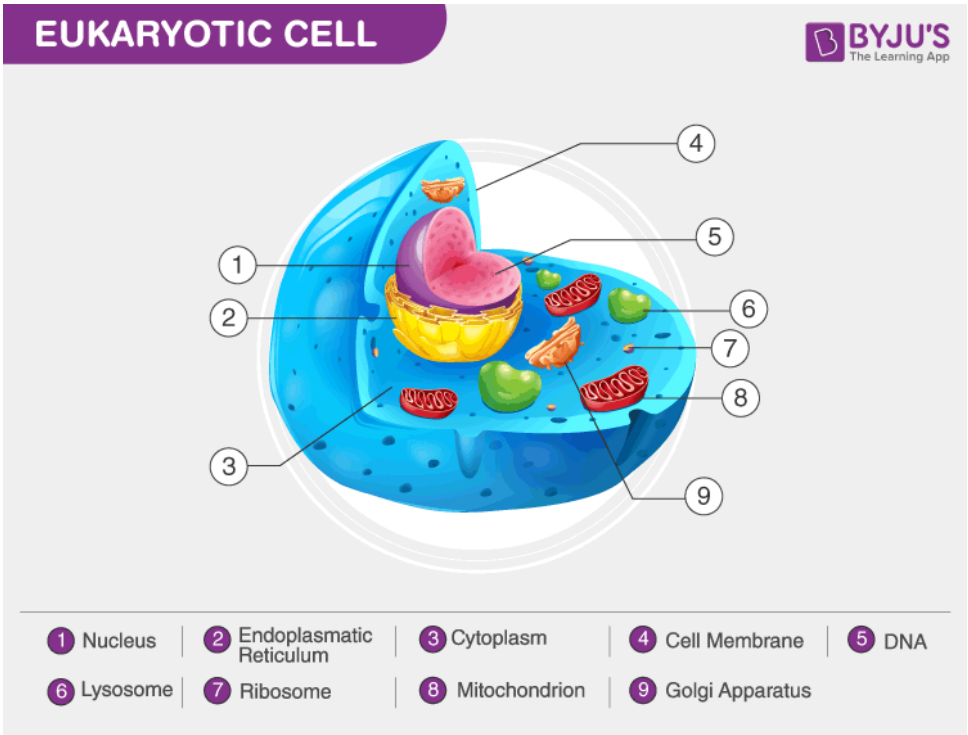
Plastids

These are double-membrane structures and are found only in **plant cells**. These are of three types:

- **Chloroplast** that contains **chlorophyll** and is involved in photosynthesis.
- **Chromoplast** that contains a pigment called carotene that provides the plants yellow, red, or orange colours.
- **Leucoplasts** that are colourless and store oil, fats, carbohydrates, or proteins.

Eukaryotic Cell Diagram

Eukaryotic cell diagram depicts different **cell organelles** present in eukaryotic cells. The **nucleus, endoplasmic reticulum, cytoplasm, mitochondria, ribosomes, lysosomes** are clearly mentioned in the diagram.



Eukaryotic Cell Diagram illustrated above shows the presence of a true nucleus.

BIOLOGICAL MOLECULES

The large molecules necessary for life that are built from **smaller organic molecules** are called **biological macromolecules**.

There are four major classes of **biological macromolecules (carbohydrates, lipids, proteins, and nucleic acids),** and each is an important component of the cell and performs a wide array of functions.

Combined, these molecules make up the majority of a cell's mass.

Biological macromolecules are **organic**, meaning that they contain carbon (with some exceptions, like carbon dioxide).

In addition, they may contain **hydrogen, oxygen, nitrogen, phosphorus, sulfur,** and additional minor elements.

Carbon

It is often said that life is **"carbon-based."**

This means that carbon atoms, bonded to other carbon atoms or other elements, form the fundamental components in living things.

Other elements play important roles in biological molecules, but carbon qualifies as the "foundation" element for molecules in living things. It is the bonding properties of carbon atoms that are responsible for its important role.

Carbon Bonding

Carbon contains **four electrons** in its outer shell. Therefore, it can form four covalent bonds with other atoms or molecules. The simplest organic carbon molecule is methane (CH_4), in which four hydrogen atoms bind to a carbon atom (***Figure 1***).

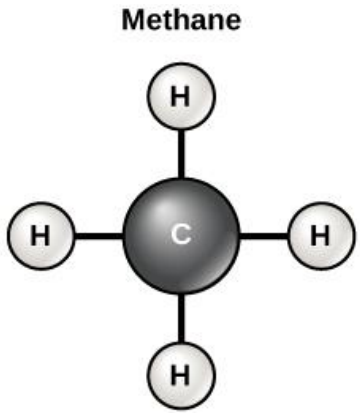


Figure 1. Carbon can form four covalent bonds to create an organic molecule. The simplest carbon molecule is methane (CH4), depicted here.

Any of the hydrogen atoms can be replaced with another carbon atom covalently bonded to the first carbon atom.

In this way, long and branching chains of carbon compounds can be made (***Figure 2a***).

The **carbon atoms** may bond with atoms of other elements, such as **nitrogen, oxygen, and phosphorus** (***Figure 2b***).

The molecules may also form rings, which themselves can link with other rings (***Figure 2c***).

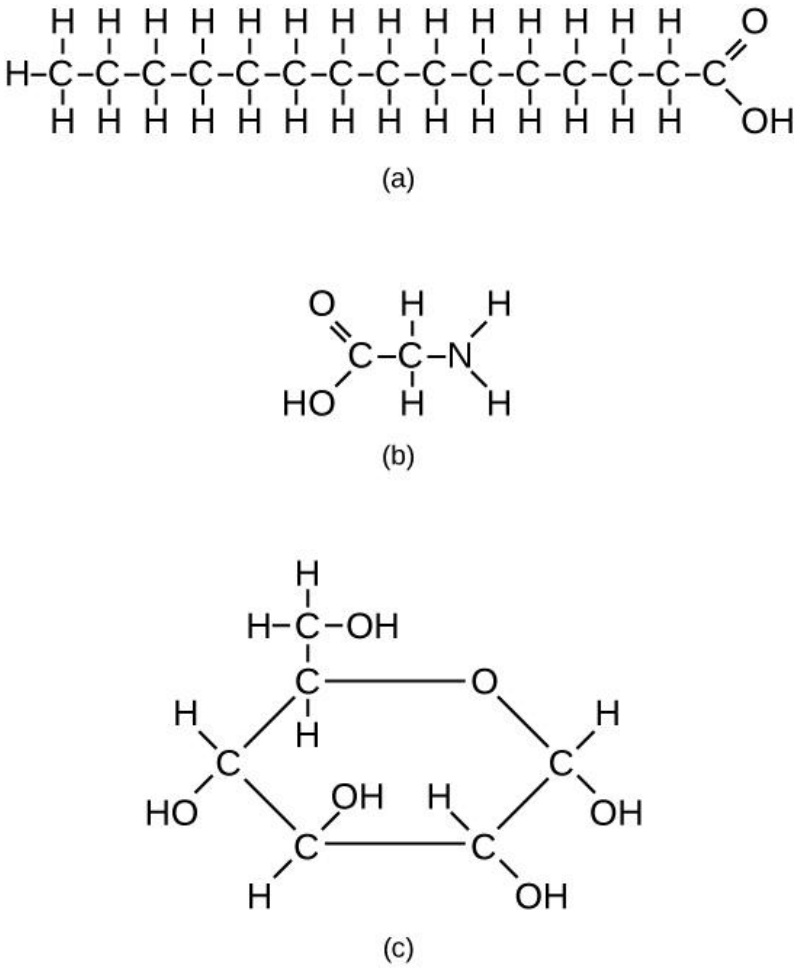


Figure 2. These examples show three molecules (found in living organisms) that contain carbon atoms bonded in various ways to other carbon atoms and the atoms of other elements.

(a) This molecule of stearic acid has a long chain of carbon atoms.

(b) Glycine, a component of proteins, contains carbon, nitrogen, oxygen, and hydrogen atoms.

(c) Glucose, a sugar, has a ring of carbon atoms and one oxygen atom.