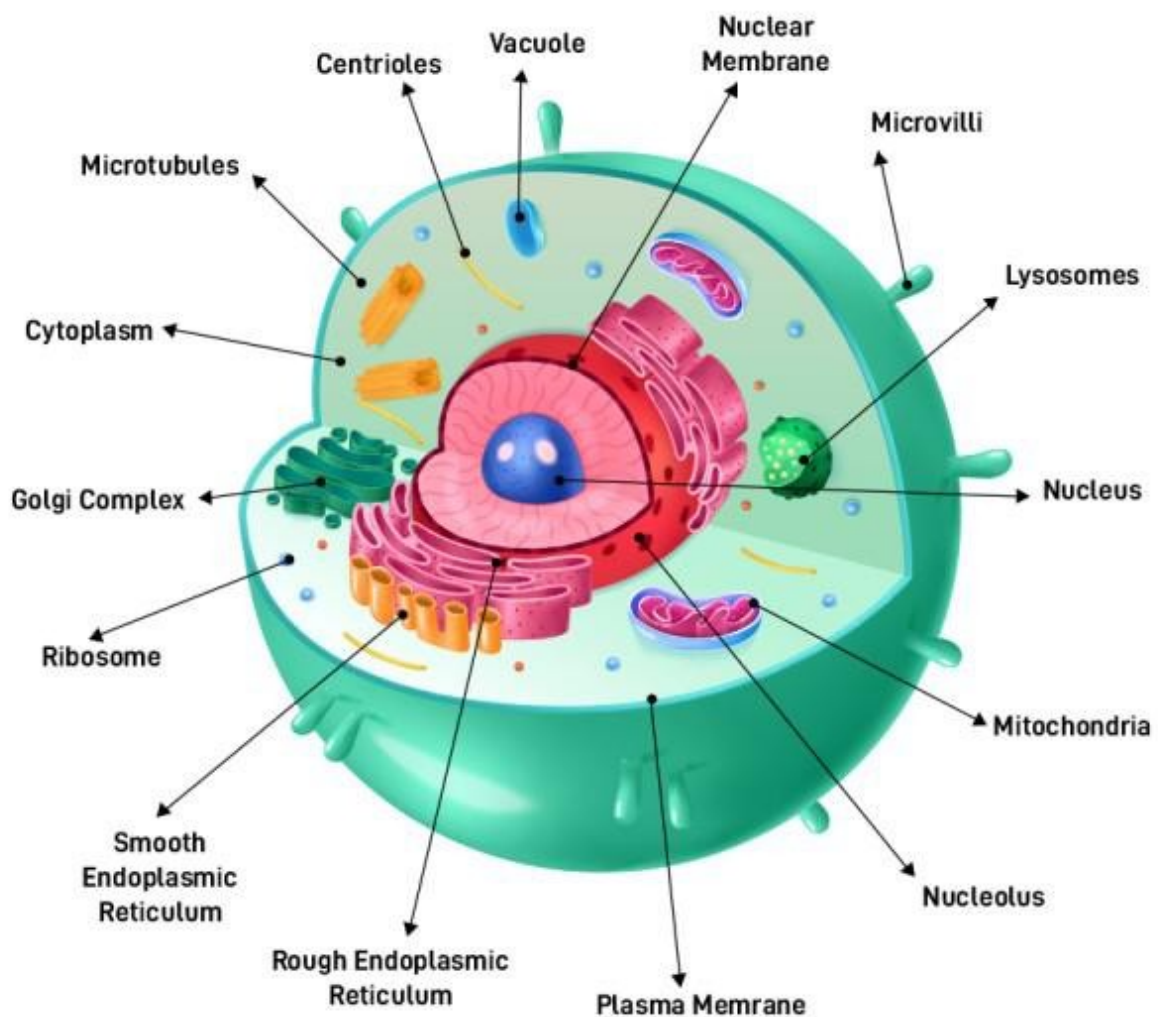


## CELL AND MOLECULAR BIOLOGY

### TOPIC 1: Cell, Basic Structure of All Living Creatures

#### The Cell Theory

1. All organisms are made of one or more cells.
2. The cell is the basic unit of all living things
3. All cells come from existing cells.

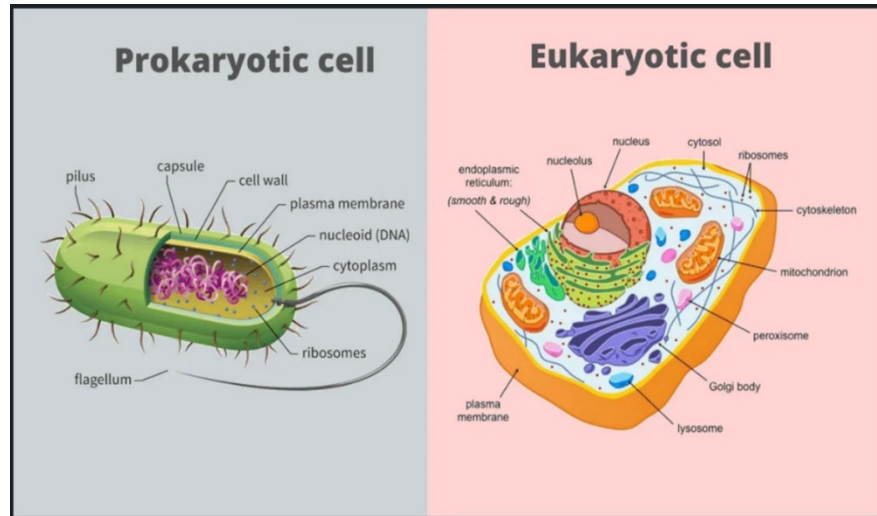


| <b>Name</b>           | <b>Memorable phase</b>  | <b>Description</b>                                                                                    |
|-----------------------|-------------------------|-------------------------------------------------------------------------------------------------------|
| Plasma membrane       | Cell' s fortification   | Separates the interior of the cell from the outside environment                                       |
| Cytoplasm             | Cell' s environment     | Fluid part enclosed by the membrane, contains organelles                                              |
| Nucleus               | Cell' s brain           | Contains most of the genetic material , in the form of DNA                                            |
| Endoplasmic reticulum | Cell' s pipe system     | Smooth ER- System of metabolic processes<br>Rough ER- Protein manufacturing ribosomes                 |
| Golgi apparatus       | Cell' s delivery center | It tags vesicles and proteins to help them get carried to their destinations                          |
| Centrosome            | Cell' s anchor          | Organizes and produces the microtubules of the cell' s cytoskeleton                                   |
| Mitochondria          | Cell' s powerplant      | Produce energy for the cell, break down carbohydrates and some durations lipids to form molecule ATP  |
| Ribosome              | Cell' s factories       | Translate RNA into proteins                                                                           |
| Lysosome              | Cell' s stomach         | Vesicles filled with digestive proteins can absorb something and break it down into recyclable pieces |
| Peroxisome            | Cell' s firemen         | Vesicles that defend (or neutralize) the cell from free radicals                                      |

|              |                      |                                                                                                 |
|--------------|----------------------|-------------------------------------------------------------------------------------------------|
| Cytoskeleton | Cell' s shapeshifter | It modifies the cell' s shape and ensures mechanical resistance                                 |
| Vacuole      | Cell' s compartments | Enclosed storage vessels which are filled with water containing inorganic and organic molecules |

### Anatomy of Human Cells

- Red Blood cells
- Ovum Cell
- Nerve cell
- Columnar epithelial cell
- Smooth muscle cell
- Bone cell
- Sperm Cell



### Kinds of cells:

#### A. Eukaryotic cell

- Eukaryota, whose members are known as eukaryotes, is a device domain of organisms whose cells have a nuclues.
- All animals, plants, fungi and many unicellular organisms, are eukaryotes. they

belong to the group of organisms eukaryota or eukarya, which is one of the three domains of life.

- defined as cells containing organized nucleus and organelles which are enveloped by membrane-bound organelles.
- Examples of eukaryotic cells are plants, animals, protists, fungi. Their genetic material is organized in chromosomes.
- 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 Eukaryota.
- 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:
- Eukaryotic cells have the nucleus enclosed within the nuclear membrane.
- The cell has mitochondria.
- Flagella and cilia are the locomotory organs in a eukaryotic cell.
- A cell wall is the outermost layer of the eukaryotic cells.
- The cells divide by a process called mitosis.
- The eukaryotic cells contain a cytoskeletal structure.
- The nucleus contains a single, linear DNA, which carries all the genetic information.

## Structure of Eukaryotic Cell

### 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. It is, however, 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 extraluminal. 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-membraned 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.

### **Examples of Eukaryotic Cells**

- Eukaryotic cells are exclusively found in plants, animals, fungi, protozoa, and other complex organisms. The examples of eukaryotic cells are

### **Plant Cells**

- The cell wall is made up of cellulose, which provides support to the plant. It has a large vacuole which maintains the turgor pressure. The plant cell contains chloroplast, which aids in the process of photosynthesis.

### **Fungal Cells**

- The cell wall is made of chitin. Some fungi have holes known as septa which allow the organelles and cytoplasm to pass through them.

### **Animal Cells**

- These do not have cell walls. Instead, they have a cell membrane. That is why animals have varied shapes. They have the ability to perform phagocytosis and pinocytosis.

### Protozoa

- Protozoans are unicellular organisms. Some protozoa have cilia for locomotion. A thin layer called pellicle provides supports to the cell.

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. The sexual mode of reproduction involves conjugation.

### Prokaryotic Cell Structure

A prokaryotic cell does not have a nuclear membrane. However, 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:

- **Capsule**– It is an outer protective covering found in the bacterial cells, in addition to the cell wall. It helps in moisture retention, protects the cell when engulfed, and helps in the attachment of cells to nutrients and surfaces.
- **Cell Wall**– It is the outermost layer of the cell which gives shape to the cell.
- **Cytoplasm**– The cytoplasm is mainly composed of enzymes, salts, cell organelles and is a gel-like component.
- **Cell Membrane**– This layer surrounds the cytoplasm and regulates the entry and exit of substances in the cells.
- **Pili**– These are hair-like outgrowths that attach to the surface of other bacterial cells.

### B. Prokaryotic cell

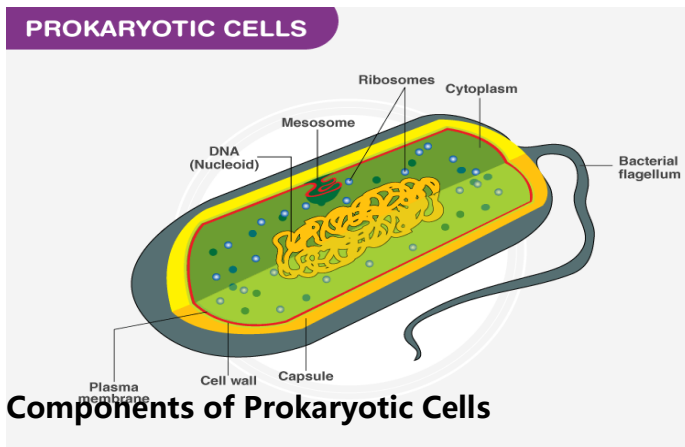
- lack both, a well-defined nucleus and membrane-bound cell organelles. Examples of prokaryotes are blue-green algae, bacteria and mycoplasma, among prokaryotes, bacteria are the most common and multiply very fast.
- is a type of cell that does not have a true nucleus or membrane-bound organelles. Organisms within the domains Bacteria and Archaea are based on the prokaryotic cell.
- 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

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.

- **Flagella**– These are long structures in the form of a whip, that help in the locomotion of a cell.
- **Ribosomes**– These are involved in protein synthesis.

- **Plasmids**– Plasmids are non-chromosomal DNA structures. These are not involved in reproduction.
- **Nucleoid Region**– It is the region in the cytoplasm where the genetic material is present.



The prokaryotic cells have four main components

1. **Plasma Membrane** - It is an outer protective covering of phospholipid molecules which separates the cell from the surrounding environment.
2. **Cytoplasm**- It is a jelly-like substance present inside the cell. All the cell organelles are suspended in it.
3. **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.
4. **Ribosomes**- Protein synthesis occurs here.

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

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

## Reproduction in Prokaryotes

### A. Asexually by binary fission

#### Binary Fission

- The DNA of an organism replicates and the new copies attach to the cell membrane.
- The cell wall starts increasing in size and starts moving inwards.
- A cell wall is then formed between each DNA, dividing the cell into two daughter cells.

### B. Sexually by conjugation

## Examples of Prokaryotic Cells

### A. Bacterial Cells

- These are unicellular organisms found everywhere on earth from soil to the human body.
- They have different shapes and structures.
- The cell wall is composed of peptidoglycan that provides structure to the cell wall.
- Bacteria have some unique structures such as pili, flagella and capsule.
- They also possess extrachromosomal DNA known as plasmids.
- They have the ability to form tough, dormant structures known as endospores that helps them to survive under unfavourable conditions. The endospores become active when the conditions are favourable again.

## **B. Archaeal Cells**

- Archaeobacteria are unicellular organisms similar to bacteria in shape and size.
- They are found in extreme environments such as hot springs and other places such as soil, marshes, and even inside humans.
- They have a cell wall and flagella. The cell wall of archaea does not contain peptidoglycan.
- The membranes of the archaea have different lipids with a completely different stereochemistry.
- Just like bacteria, archaea have one circular chromosome. They also possess plasmids.

**What are the structural features of prokaryotic cells?**

The prokaryotic cell structure is composed of:

- Cell wall
- Cell membrane
- Capsule
- Pili
- Flagella
- Ribosomes
- Plasmids

### **How is the prokaryotic cell structure different from that of the eukaryotic cell?**

Prokaryotic cells lack a true nucleus. The nucleus is devoid of the nuclear membrane. On the contrary, the nucleus of the eukaryotic cells is enclosed by a nuclear membrane. A prokaryotic cell also lacks mitochondria and chloroplast, unlike a eukaryotic cell.

### **How does a prokaryotic cell divide?**

Prokaryotic cells undergo asexual reproduction. Most prokaryotic cells divide by binary fission, where the cells divide into two daughter cells.

### **Why is the process of cell division in prokaryotic cells different from that in eukaryotes?**

Prokaryotic cells are simpler than eukaryotic cells. They do not have a nuclear membrane surrounding their DNA, therefore, cell division is different than that in eukaryotes.

### **When did the prokaryotic cells evolve?**

The first prokaryotic cells evolved around 3.5 billion years ago. The eukaryotic cells were formed after the prokaryotic cells and are believed to have evolved from them.

### **What are the difference between EUKARYOTIC AND PROKARYOTIC CELLS?**

Prokaryotic cell:

1. The cell which lacks a well-defined nucleus is called prokaryotic cells.
2. These cells have a primitive organization of genetic material.

Eukaryotic cell:

1. The cell having a well-defined nucleus is called a eukaryotic cell.
2. It lacks respiratory enzymes.

| Prokaryotic cell                                                                                                                                                                                                                                                                                           | Eukaryotic cell                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>- The nucleus is not well defined and is called the nucleoid.</li> <li>- A single length of only deoxyribonucleic acid (DNA)</li> <li>- Small ribosomes</li> <li>- No other cell organelles</li> </ul> <p>Examples: Bacteria, Blue- green algae (Cyanobacteria)</p> | <ul style="list-style-type: none"> <li>- The nuclear region well-defined nucleus with a nuclear membrane</li> <li>- Several lengths of genetic material (chromosomes) containing DNA are wound around certain proteins.</li> <li>- Larger ribosomes</li> <li>- Several organelles like mitochondria, endoplasmic reticulum, chloroplasts, etc</li> </ul> <p>Examples: Euglena, Amoeba, and all plants and animals</p> |

### When did the first eukaryotic cell evolve?

- The first eukaryotic cells evolved about 2 billion years ago. This is explained by the endosymbiotic theory that explains the origin of eukaryotic cells by the prokaryotic organisms. Mitochondria and chloroplasts are believed to have evolved from symbiotic bacteria.

**Endosymbiotic theory:** - Prokaryotes existed first. Eukaryotes evolved from prokaryotes that begin to live within one another.

*Proof:* **Mitochondria & Chloroplasts** have their own DNA, so they existed independently as bacteria at one time; this is how eukaryotes evolved from prokaryote ancestors

Mitochondria and chloroplast originated as bacterial cells that came to live inside larger cells

### Cell Evolution

Most membrane-enclosed organelles including the nucleus, ER and golgi probably originated from deep folds in the plasma membrane

## Evolution of the Eukaryotic Cell

### ENDOSYMBIOSIS:

1. Start with two independent bacteria
  2. One bacterium engulf the other
  3. One bacterium now lives inside the other
  4. Both bacteria benefit from the arrangement
  5. The internal bacteria are passed on from generation to generation
- **Endosymbiosis theory** was proposed by **Lynn Margulis**
  - Endosymbiosis theory states that larger bacterial cells lost their cell walls and engulfed smaller bacterial cells
  - Eukaryotes come from prokaryotes
  - Symbiosis means "living together"

## THREE DOMAINS OF LIFE AND THEIR CHARACTERISTICS

The **three-domain system biological classification of life**, which classifies life on the planet into three different domains – **Archaea, Bacteria and Eukaryote**, was put forth by American microbiologist and physicist **Carl Woese in 1990**.

Alongside the three-domain system, there exists a **six kingdom system of life**, i.e. **Archaeobacteria** (comprising ancient bacteria), **Eubacteria** (comprising true bacteria), **Protista** (comprising one-celled organisms), **Fungi, Plantae, and Animalia**. While Archaeobacteria and Eubacteria constitute the Archaea and Bacteria domains respectively, Protista, Fungi, Plantae and Animalia together form the Eukaryote domain of life.

### • BACTERIA

- A member of a large group of unicellular microorganisms which have cell walls but lack of organelles and an organized nucleus, including some that can cause disease.
- Are single-celled organisms that are pretty much everywhere: in the ground, in the ocean, on your hand and in your gut. While some are harmful, most are not - and some are even beneficial to human health. In many cases, humans live in symbiosis with bacteria, maintaining a mutually beneficial relationship without even knowing it.
- are ubiquitous, mostly free-living organisms often consisting of one biological cell. They constitute a large domain of prokaryotic microorganisms. Typically a few micrometres in length, bacteria were among the first life forms appear on earth, and are present in most of its habitats.
- Even though bacteria are prokaryotic cells just like Archaea, their membranes are made of unbranched fatty acid chains attached to glycerol by ester linkages. Cyanobacteria and mycoplasmas are the best examples of bacteria.
- As they don't have ether containing linkages like Archaea, they are grouped into a different category – and hence a different domain. There is a great deal of diversity in

this domain, such that it is next to impossible to determine how many species of bacteria exist on the planet.

### • ARCHAEA

- Archaea are prokaryotic cells which are typically characterized by membranes that are branched hydrocarbon chains attached to glycerol by ether linkages. The presence of this ether containing linkages in Archaea adds to their ability of withstanding extreme temperature and highly acidic conditions.

#### Examples of Archaea

- **Extreme halophiles** – organisms which thrive in highly salty environment
- **Hyperthermophiles** – organisms which thrive in extremely hot environment

### • EUKARYA

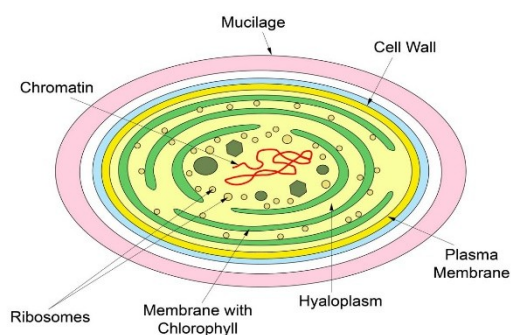
- As the name suggests, the Eukaryote are eukaryotic cells which have membranes that are pretty similar to that of bacteria. Eukaryote are further grouped into Kingdom Protista (algae, protozoans, etc.),

Kingdom Fungi (yeast, mold, etc.), Kingdom Plantae (flowering plants, ferns, etc.) and Kingdom Animalia (insects, vertebrates, etc.).

- Not all Eukaryotes have a cell wall, and even if they do they don't contain peptidoglycan as bacteria do. While cells are organized into tissues in case of kingdom Plantae as well as kingdom Animalia, the presence of cell walls is only restricted to the members of kingdom Plantae.

Each of these three domains recognized by biologists today contain **rRNA** which is unique to them, and this fact in itself forms the basis of three-domain system. While the presence of nuclear membrane differentiates the Eukarya domain from Archaea domain and Bacteria domain – both of which lack nuclear membrane, the distinct biochemistry and RNA markers differentiate Archaea and Bacteria domains from each other.

Scheme of Cyanobacteria Cell



Bacteria Cell Anatomy

### Topic 2:

### MOLECULAR BIOLOGY

is the branch of biology that seeks to understand the molecular basis of biological activity in and between cells, including molecular synthesis, modification, mechanisms, and interactions.

- The study of chemical and physical structure of biological macromolecules
- coined by an American scientist, Warren Weaver in the year 1938.

### BIOMOLECULES

- also called **biological molecule**
- any of **numerous substances** that are produced by cells and living organisms.
- Have a **wide range of sizes and structures** and perform a vast array of functions.

### ***The 4 major types of biomolecules***

- **carbohydrates**
- **lipids**
- **nucleic acids**
- **proteins**

#### ➤ **Nucleic acids**, namely **DNA** and **RNA**

Function: **Storing an organism's genetic code**—

**Genetic code** is the the sequence of nucleotides that determines the amino acid sequence of proteins

#### ➤ **Protein** has **20** different amino acids; the order in which they occur plays a fundamental role in determining **protein structure and function**

Function:

- **Transporters**, moving nutrients and other molecules in and out of cells
- Acts as **enzymes and catalysts** for the vast majority of chemical reactions that take place in living organisms
- Form **antibodies and hormones**
- **influence gene activity**.

#### ➤ **Carbohydrates** are built from four types of sugar units—**monosaccharides, disaccharides, oligosaccharides (2-10), and polysaccharides(10 or more)**.

Function:

- **source of stored energy**
- acting as **chemical messengers**

- Form **membranes**, which separate cells from their environments and compartmentalize the cell interior, giving rise to organelles, such as the nucleus and the mitochondrion, in higher (more complex) organisms.

All biomolecules share in common a fundamental relationship between structure and function, which is influenced by factors such as the **environment** in which a given biomolecule occurs.

- **Lipids**, for example, are **hydrophobic** ( "**water-fearing**" ); in water, many spontaneously arrange themselves in such a way that the **hydrophobic ends** of the molecules are **protected** from the water, while the **hydrophilic ends** are **exposed** to the water. This arrangement gives rise to **lipid bilayers**, or two layers of phospholipid molecules, which form the membranes of cells and organelles.

In another example, **DNA**, which is a very long molecule—in humans the combined length of all the DNA molecules in a single cell stretched end to end would be about **1.8 metres (6 feet)**, whereas the **cell nucleus** is about **6 µm (6 10-6 metre)** in diameter—has a highly **flexible helical structure** that allows the molecule to become tightly coiled and looped

This structural feature plays a key role in enabling DNA to fit in the cell nucleus, where it carries out its function in coding genetic traits.

### **MOLECULAR BASIS OF HEREDITY**

- DNA consists of long chains of nucleotides lying parallel to one another.
- Each nucleotide has a backbone of **sugar and phosphate linked to a base**.

- There are four complementary bases in DNA: **adenine and thymine**, which always bond together, as do **cytosine and guanine**.

**Molecular basis of inheritance** is the **study of genes, hereditary and genetic variations** which explains how an offspring looks similar to its maternal or paternal features. **DNA, RNA and genetic code** are the fundamental parts of the molecular basis of inheritance and are responsible to transmit genes from parents to offspring.

### DNA (Deoxyribonucleic acid)

- a **self-replicating material** that is present in nearly all living organisms as the main constituent of chromosomes. It is the carrier of genetic information.
- the fundamental and distinctive characteristics or qualities of someone or something, especially when regarded as unchangeable
- It contains units of biological building blocks called **nucleotides**.
- DNA is a vitally important molecule for not only humans but also most other organisms. DNA contains our hereditary material and our genes, the things that make us unique.

### What is the structure of DNA?

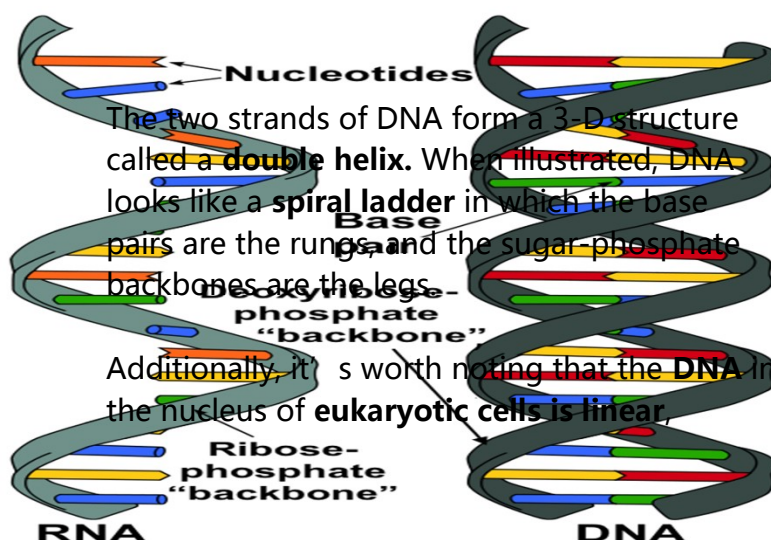
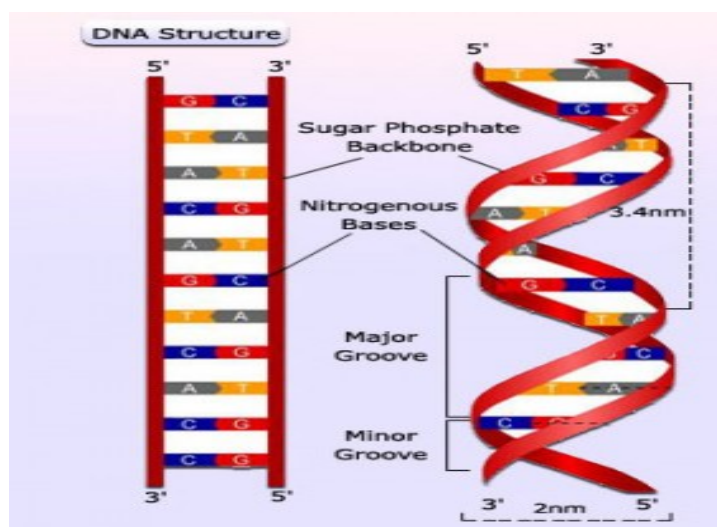
A collection of nucleotides makes a DNA molecule. Each nucleotide contains three components:

- a sugar
- a phosphate group
- a nitrogen base

The sugar in DNA is called **2-deoxyribose**. These sugar molecules alternate with the phosphate groups, making up the "backbone" of the DNA strand.

Each sugar in a nucleotide has a nitrogen base attached to it. There are four different types of nitrogen bases in DNA

- adenine (A)
- thymine (T)
- cytosine (C)
- guanine (G)



Additionally, it's worth noting that the **DNA** in the nucleus of **eukaryotic cells** is **linear**.

meaning that the ends of each strand are free. In a **prokaryotic cell**, the **DNA forms a circular** structure.

## DNA Structure

- DNA is a long polymer made up of many smaller units called nucleotides
- A nucleotide consists of a phosphate group, 5 carbon sugar and nitrogenous base
- DNA contains 4 nitrogenous bases

## What does DNA do?

DNA contains the instructions that are necessary for an organism **to grow, develop, and reproduce**. These instructions exist within the sequence of nucleotide base pairs.

## DNA helps your body grow

Your cells read this code three bases at a time to generate proteins that are essential for growth and survival. The DNA sequence that **houses the information to make a protein** is called a **gene**.

Each group of three bases corresponds to specific amino acids, which are the building blocks of proteins. For example, the base pairs **T-G-G** specify the amino acid **tryptophan**, while the base pairs **G-G-C** specify the amino acid **glycine**.

Some combinations, like **T-A-A**, **T-A-G**, and **T-G-A**, also indicate the end of a protein sequence. This tells the cell not to add more amino acids to the protein.

Proteins contain different combinations of amino acids. When placed together in the correct order, each protein has a unique structure and function within your body.

## How do you get from the DNA code to a protein?

First, the two DNA strands split apart. Then, special proteins within the nucleus read the base pairs on a DNA strand to create an intermediate messenger molecule.

This process creates the messenger molecule RNA (mRNA). mRNA is another type of nucleic acid. It travels outside the nucleus, serving as a message to the cellular machinery that builds proteins.

In the second step, specialized components of the cell read the mRNA's message three base pairs at a time and work to assemble a protein, amino acid by amino acid. This process is called translation.

## DNA damage and mutations

The DNA code is prone to damage. According to estimates, **tens of thousands** of DNA damage events occur every day in each of our cells. Damage can occur due to errors in **DNA replication**, **free radicals**, and **exposure to UV radiation**.

Your cells have specialized proteins that can detect and repair many cases of DNA damage. There are at least five major DNA repair pathways.

Mutations are permanent changes in the DNA sequence. Changes in the DNA code can negatively impact how the body produces proteins.

If the protein doesn't work properly, diseases can develop. Some diseases that occur due to mutations in a single gene include cystic fibrosis and sickle cell anemia.

**Mutations** can also lead to the development of cancer. For example, if genes coding for proteins involved in cellular growth mutate, cells may grow and divide out of control. Some cancer-causing mutations are heritable, while others develop through exposure to carcinogens like UV radiation, chemicals, or cigarette smoke.

But not all mutations are bad. Some are harmless, while others contribute to our diversity as a species.

Changes that occur in at least or more than 1 of the population are called polymorphisms. Examples of some polymorphisms are hair and eye color.

### **DNA and aging**

Unrepaired DNA damage can accumulate as we age, helping to drive the aging process. Something that may play a large role in the DNA damage associated with aging is damage due to free radicals. However, this one mechanism of damage may not be sufficient to explain the aging process. Several factors may also be involved.

One theory as to why DNA damage accumulates as we age concerns evolution. It's thought that DNA damage is repaired more faithfully when we're of reproductive age and having children. After we've passed our peak reproductive years, the repair process naturally declines.

Another part of DNA that may be involved in aging is telomeres. Telomeres are stretches of repetitive DNA sequences at the ends of your chromosomes. They help protect DNA from

damage, but they also shorten with each round of DNA replication.

Studies associate telomere shortening with the aging process. Some lifestyle factors such as obesity, exposure to cigarette smoke, and psychological stress can also contribute to telomere shortening.

### **Where is DNA found?**

DNA is present in our cells. The exact location of it depends on the type of cell.

### **Eukaryotic cells**

In a eukaryotic cell, DNA is within the nucleus.

### **Prokaryotic cells**

In prokaryotic cells, DNA resides in the middle of the cell, called a nucleoid, coiled tightly.

### **RNA**

(Ribonucleic Acid)

is a nucleic acid present in all living cells that has structural similarities to DNA. Unlike DNA, however, RNA is most often **single-stranded**. An RNA molecule has a **backbone** made of **alternating phosphate groups and the sugar ribose**, rather than the deoxyribose found in DNA

Attached to each sugar is one of four bases: **adenine (A), uracil (U), cytosine (C) or guanine (G)**.

Different types of RNA exist in cells: messenger RNA (mRNA), ribosomal RNA (rRNA) and transfer RNA (tRNA). In addition, some RNAs are involved in regulating gene expression. Certain viruses use RNA as their genomic material.

Different types of RNA exist in cells:

- messenger RNA (mRNA),
- ribosomal RNA (rRNA)
- transfer RNA (tRNA).

In addition, some RNAs are involved in regulating gene expression. Certain viruses use RNA as their genomic material.

### **messenger RNA (mRNA)**

molecule in cells that carries codes from the DNA in the nucleus to the sites of protein synthesis in the cytoplasm (the ribosomes).

The molecule that would eventually become known as mRNA was first described in 1956 by scientists Elliot Volkin and Lazarus Astrachan

### **ribosomal RNA (rRNA)**

molecule in cells that forms part of the protein-synthesizing organelle known as a ribosome and that is exported to the cytoplasm to help translate the information in messenger RNA (mRNA) into protein

### **transfer RNA (tRNA)**

small molecule in cells that carries amino acids to organelles called ribosomes, where they are linked into proteins.

## **PROTEIN**

highly complex substance that is present in all living organisms. Proteins are of great nutritional value and are directly involved in the chemical processes essential for life.

The importance of proteins was recognized by chemists in the early **19th century**, including Swedish chemist **Jöns Jacob Berzelius**, who in **1838** coined the term protein, a word derived from the Greek **prōteios**, meaning **"holding first place."**

A protein molecule is very large compared with molecules of sugar or salt and consists of many amino acids joined together to form long chains, much as beads are arranged on a string.

There are about **20** different amino acids that occur naturally in proteins. Proteins of similar function have similar amino acid composition and sequence.

Basic players in molecular biology: **DNA, RNA and proteins**

What they do is this:

## **WHAT IS THE IMPORTANCE OF BIOCHEMISTRY IN AN ORGANISM**

Biochemistry combines biology and chemistry to study living matter. It powers scientific and medical discovery in fields such as **pharmaceuticals, forensics and nutrition**. With biochemistry, you will **study chemical reactions at a molecular level** to better understand the world and develop new ways to harness these.

Biochemistry leads us to an **understanding of structures and functions of DNA** which is the genetic carrier in all living organisms.

