A T M E
College of Engineering

Biology for Engineers
BBOK407

Module 1: INTRODUCTION TO BIOLOGY

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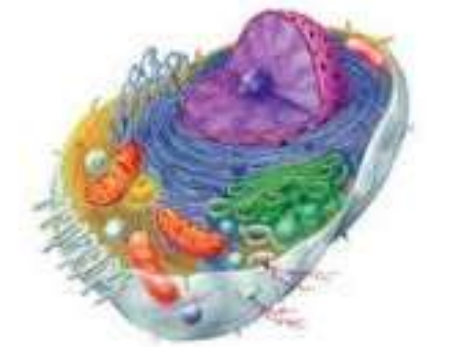
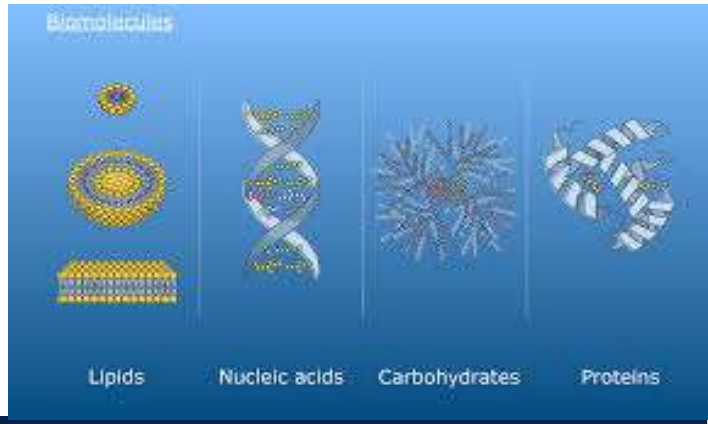
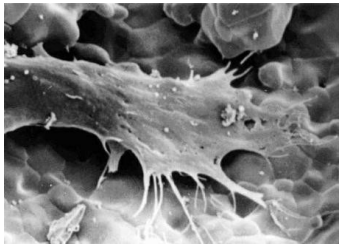


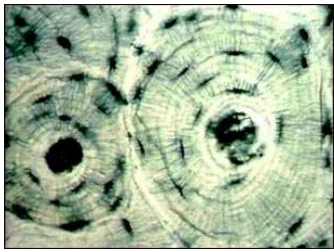
INTRODUCTION TO BIOLOGY:

The cell: the basic unit of life, Structure and functions of a cell. The Plant Cell and animal cell, Prokaryotic and Eukaryotic cell, Stem cells and their application. Biomolecules: Properties and functions of Carbohydrates, Nucleic acids, proteins, lipids. Importance of special biomolecules; Enzymes (Classification (with one example each),Properties and functions, vitamins and hormones.



Cell Biology



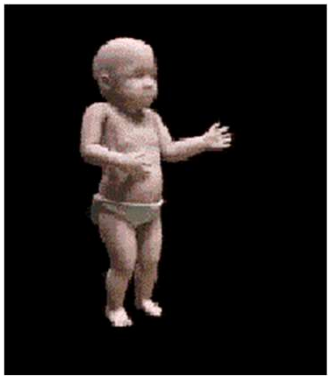


A cell is chemical system that is able to maintain its structure and reproduce.

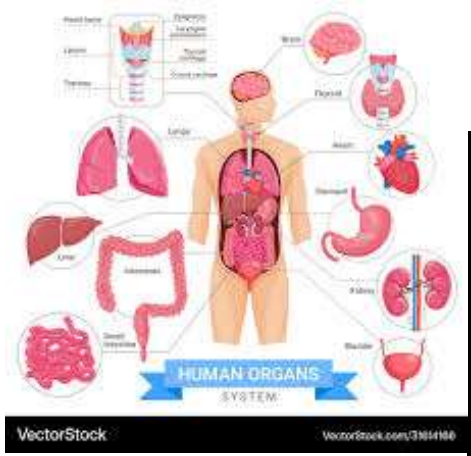
Cells are the fundamental unit of life.

All living things are cells or composed of cells.

Levels of Structural Organization



- Chemical – atoms combined to form molecules
- Cellular – cells are made of molecules
- Tissue – consists of similar types of cells
- Organ – made up of different types of tissues
- Organ system – consists of different organs that work closely together
- Organismal – made up of the organ systems

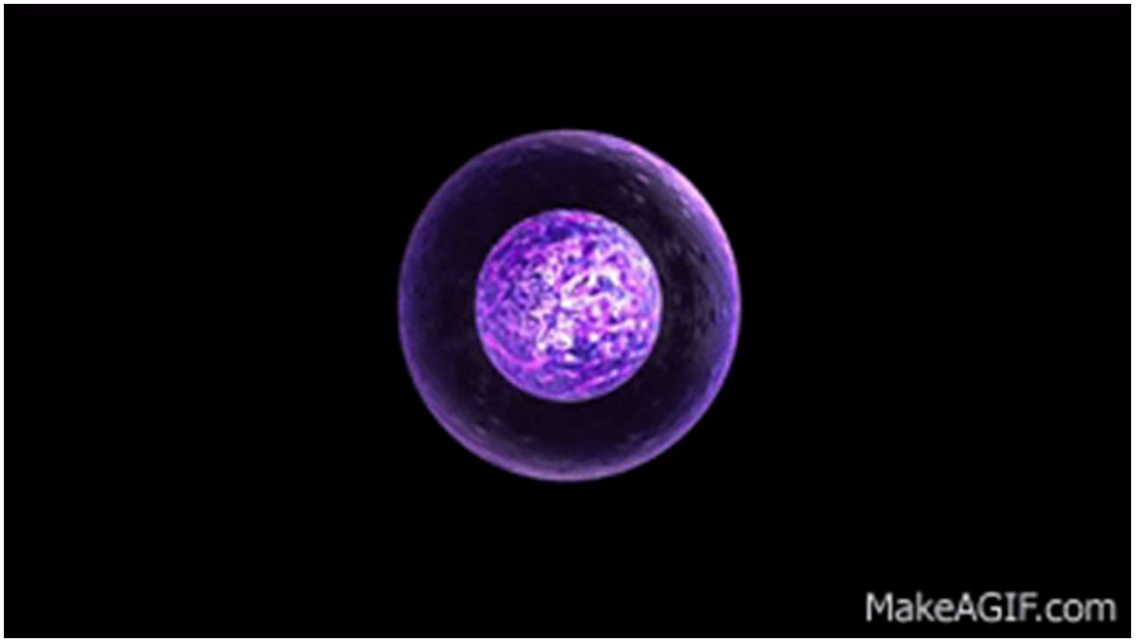


The Cell

- A cell is the smallest and most basic form of life.
- In all life forms, including bacteria, plants, animals, and humans, the cell was defined as the most basic structural and functional unit.

The cell theory incorporates three principles:

- Cells are the most basic building units of life.
- All living things are composed of cells.
- New cells are made from pre-existing cells, which divide into two.



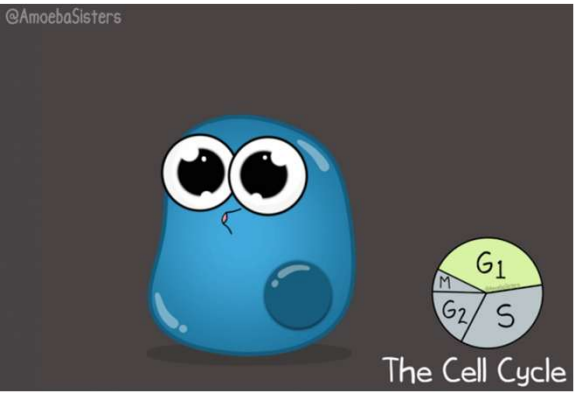
The Cell

- A cell is the structural and fundamental unit of life.
- The study of cells from their basic structure to the functions of every cell organelle is called Cell Biology.
- English scientist **Robert Hooke** first identified cells over 300 years ago while looking at cork under a microscope he built.

Did you know that- after this discovery Doctors and Scientists came up with a theory called the "Germ Theory"…. It was a crazy idea that states that diseases are caused my microscopic organisms

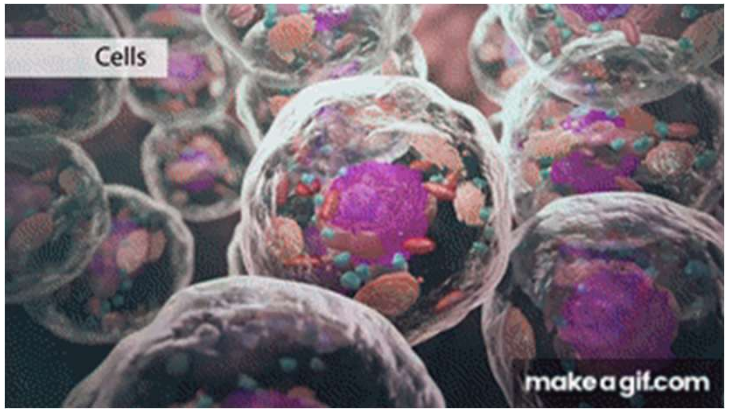
Cell Structure

"A cell is defined as the smallest, basic unit of life that is responsible for all of life's processes."



- Cells are the structural, functional, and biological units of all living beings.
- A cell can replicate itself independently. Hence, they are known as the building blocks of life.

- Each cell contains a fluid called the **cytoplasm**, which is **enclosed by a membrane**.
- Also present in **the cytoplasm** are several biomolecules like proteins, nucleic acids, DNA, and lipids. Moreover, cellular structures called **cell organelles** are suspended in the cytoplasm.

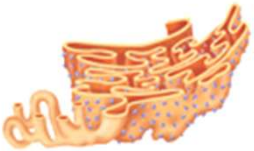


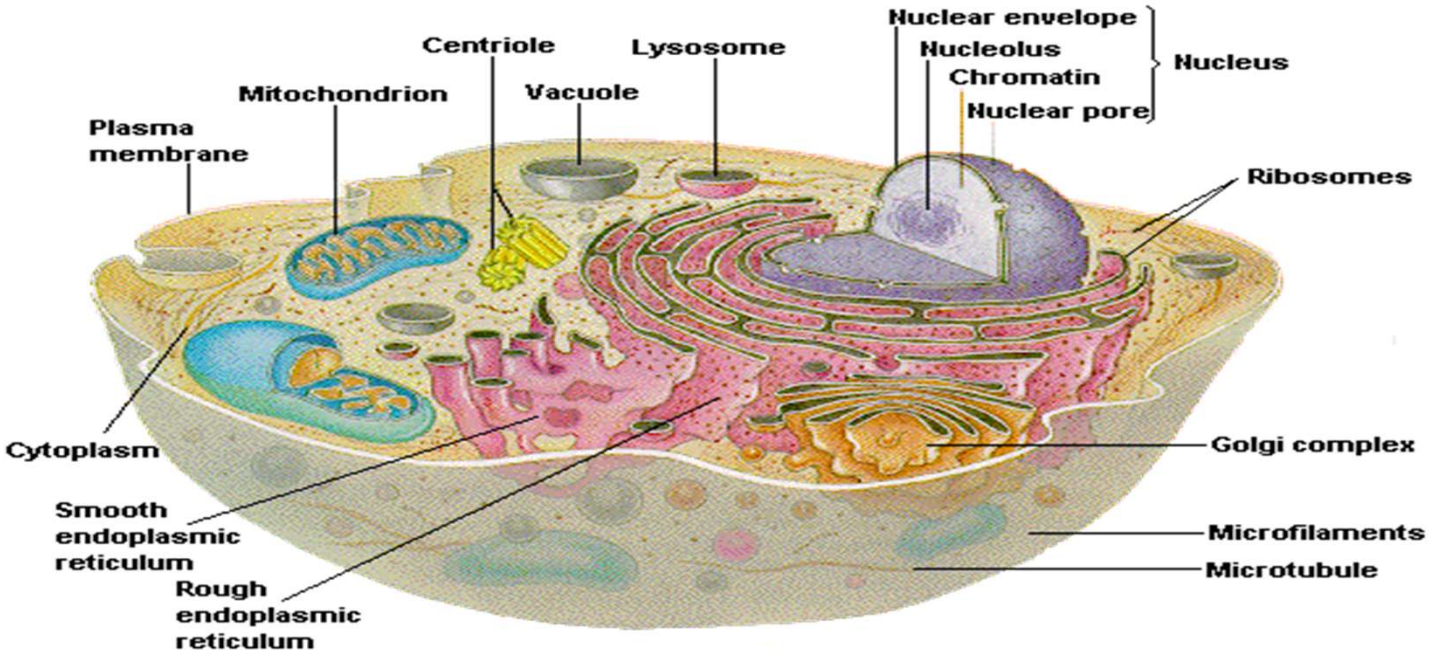
Organelles

Organelles are structures that enable the cell to live, grow and reproduce.



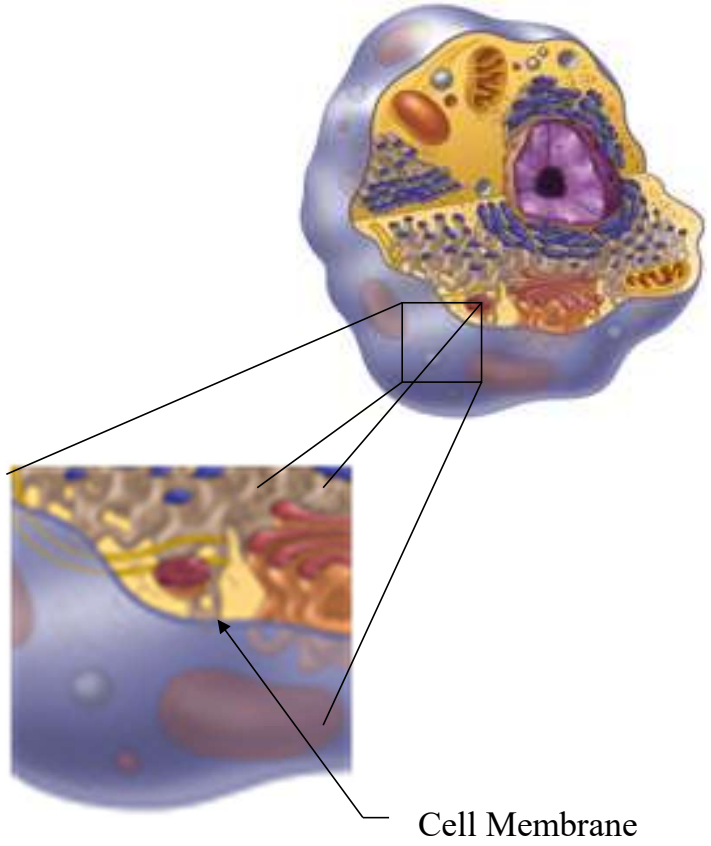




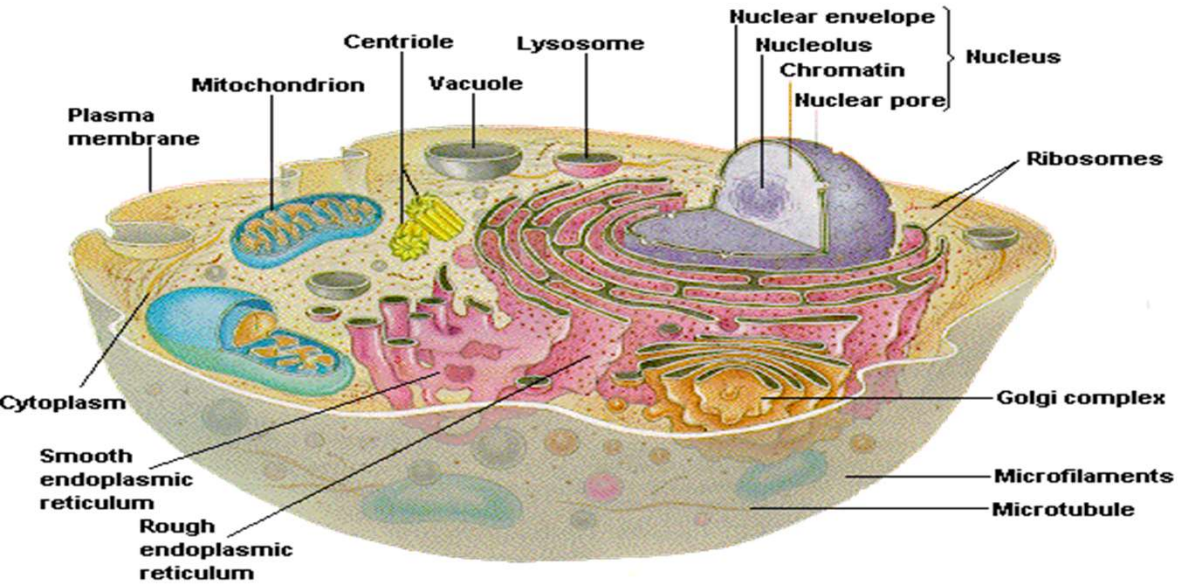
Cell Membrane

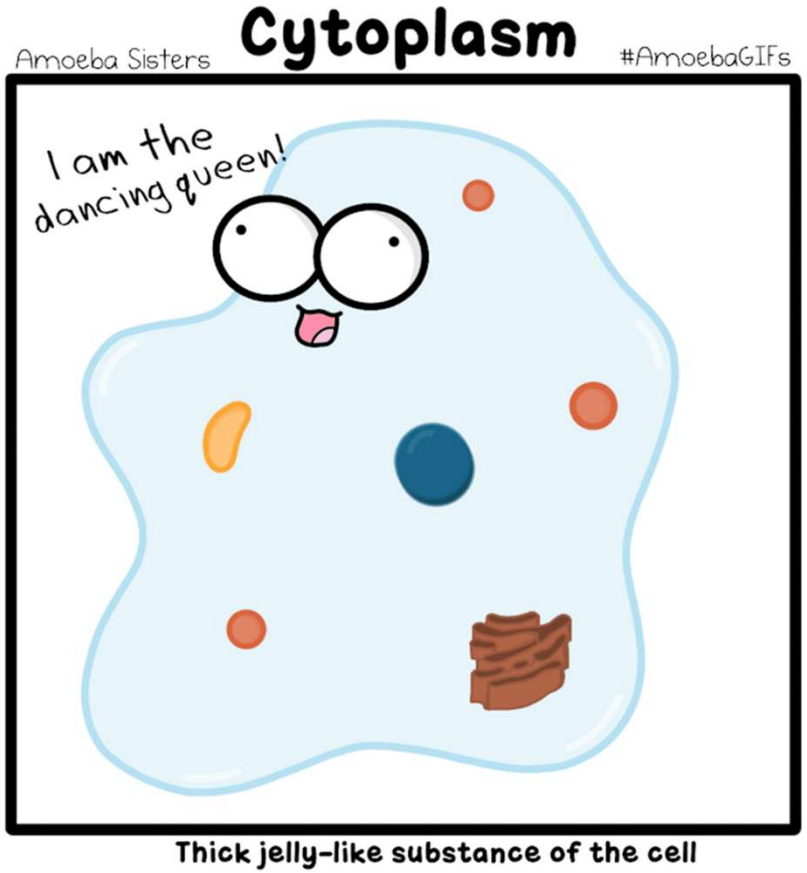
- Outer layer of cell
- Allows nutrients into the cell and wastes outside of the cell



Cytoplasm

- Cytoplasm a jelly-like fluid contained in the cell that holds the organelles.





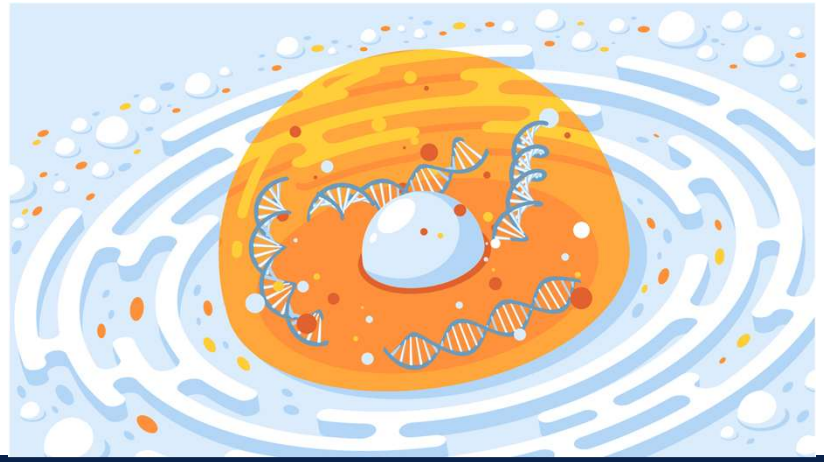
The Nucleus

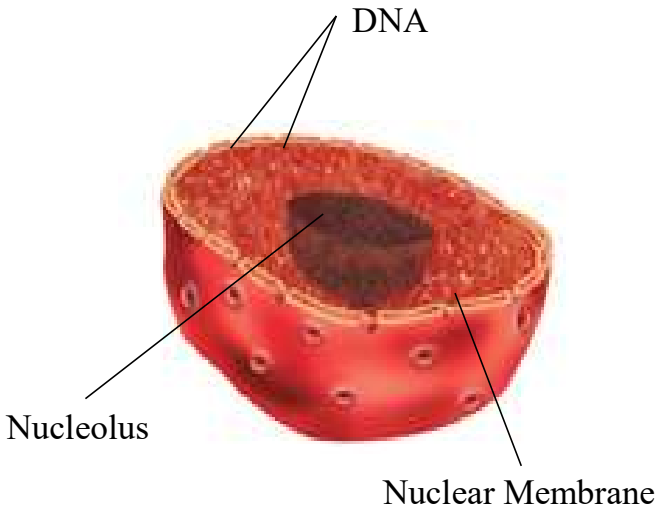
Nucleus - the largest and most obvious membrane bound compartment - controls cell activities.

It contains the **nucleolus** - a darkened region where ribosomal RNA is synthesized

contains **chromosomes** - consist of DNA wrapped around proteins.

Nuclear membrane has **nuclear pores** that control entry and exit of materials

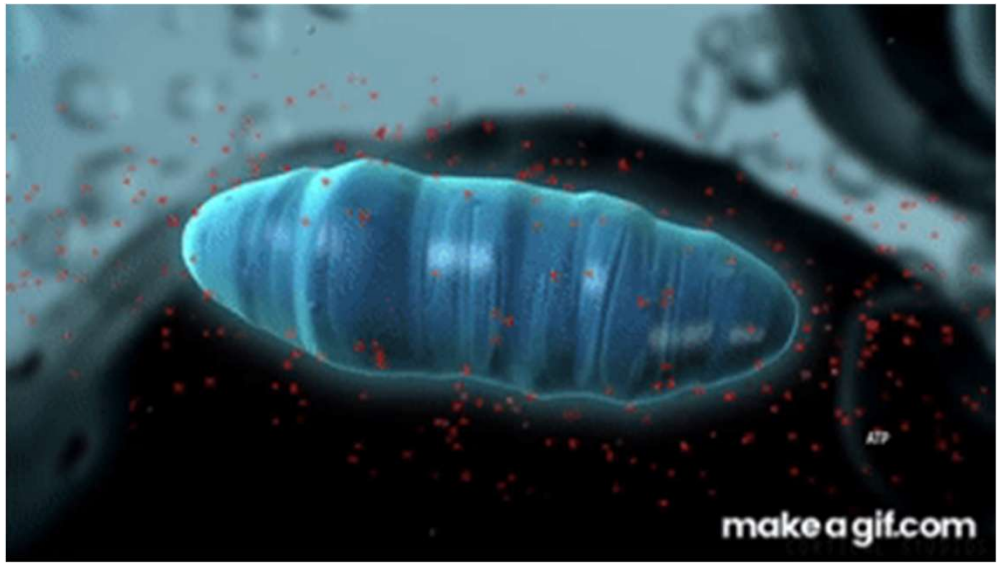




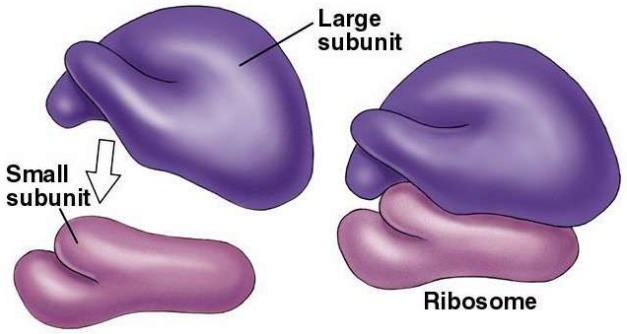
- The control center of the cell
- Contains the Cell's DNA

Mitochondria

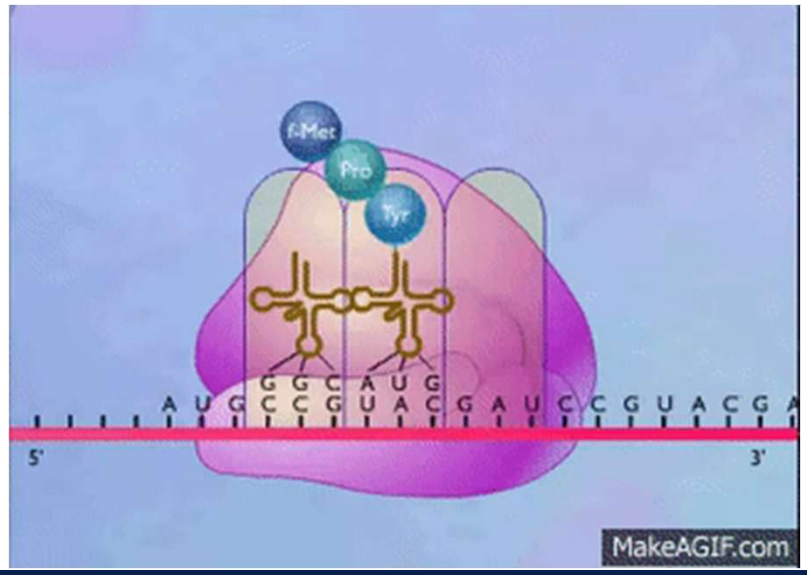
- Power center of cell
- Provides the energy the cell needs to move, divide, etc.



Ribosomes

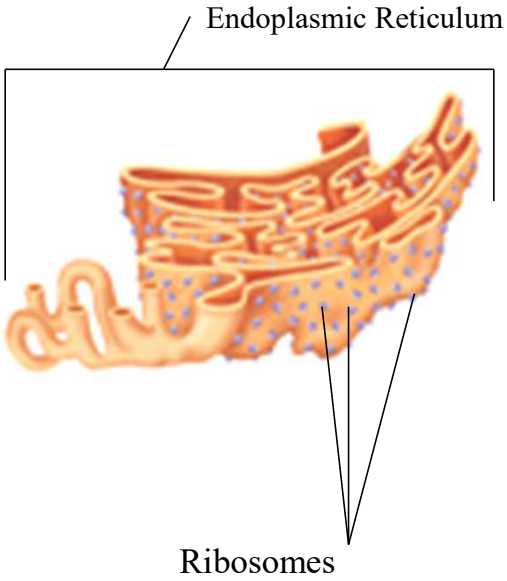


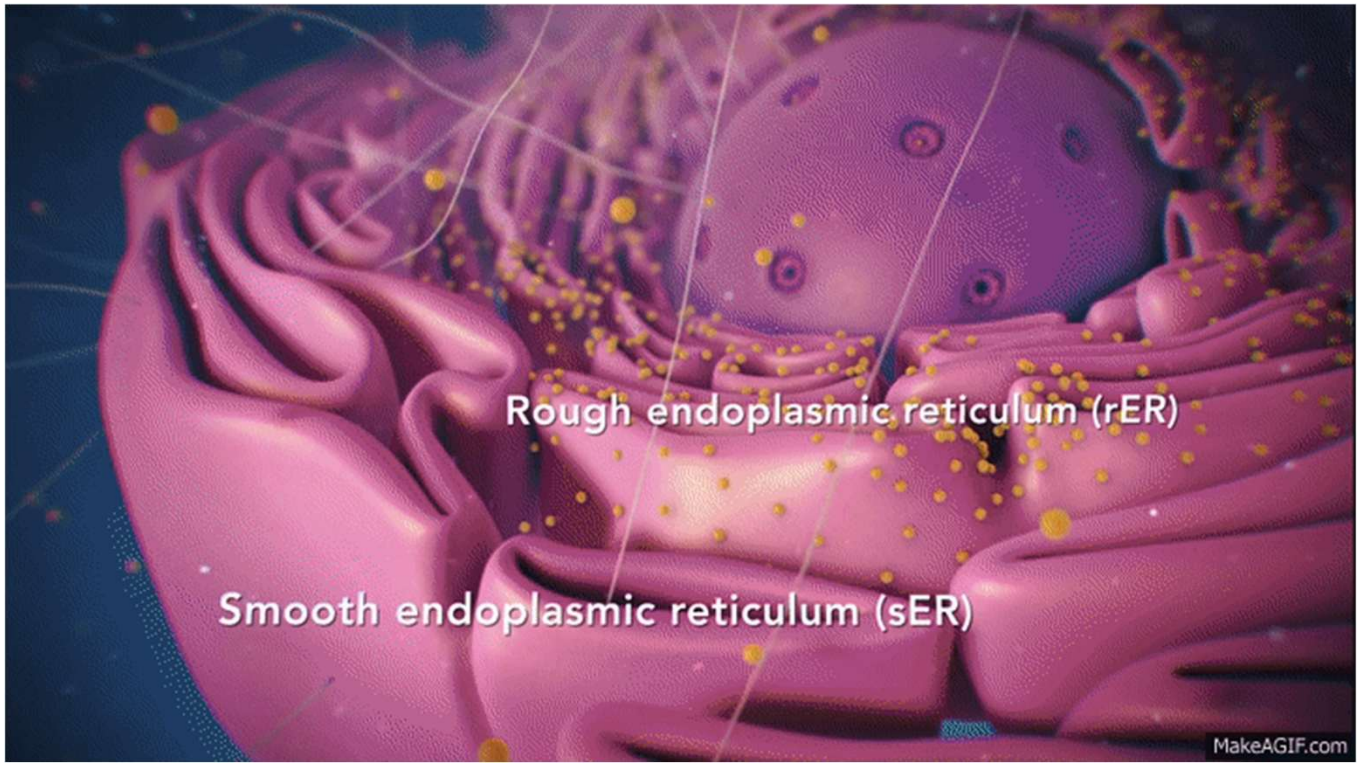
- Site where proteins are made
- Cell parts are made of proteins
- **Ribosomes** - protein synthetic machinery
  - two subunits - large and small - each made of protein and ribosomal RNA (rRNA)
  - subunits associate when they are synthesizing proteins
  - protein synthesis occurs on ribosomes that are free-floating in the cytoplasm and on ribosomes attached to ER
  - rRNA is synthesized in the nucleolus



Endoplasmic Reticulum

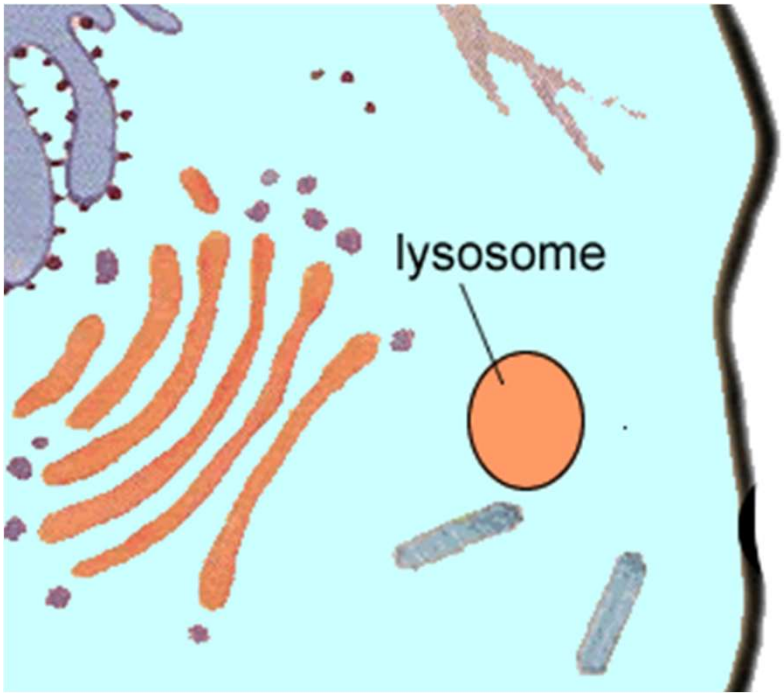
- Transportation system of cell
- Rough ER- ribosome's attached
- Smooth ER- no ribosome's





Lysosomes

- Digests food particles and cell parts
  - "Garbage men"
- Protects cell by digesting foreign invaders
  - "Police men

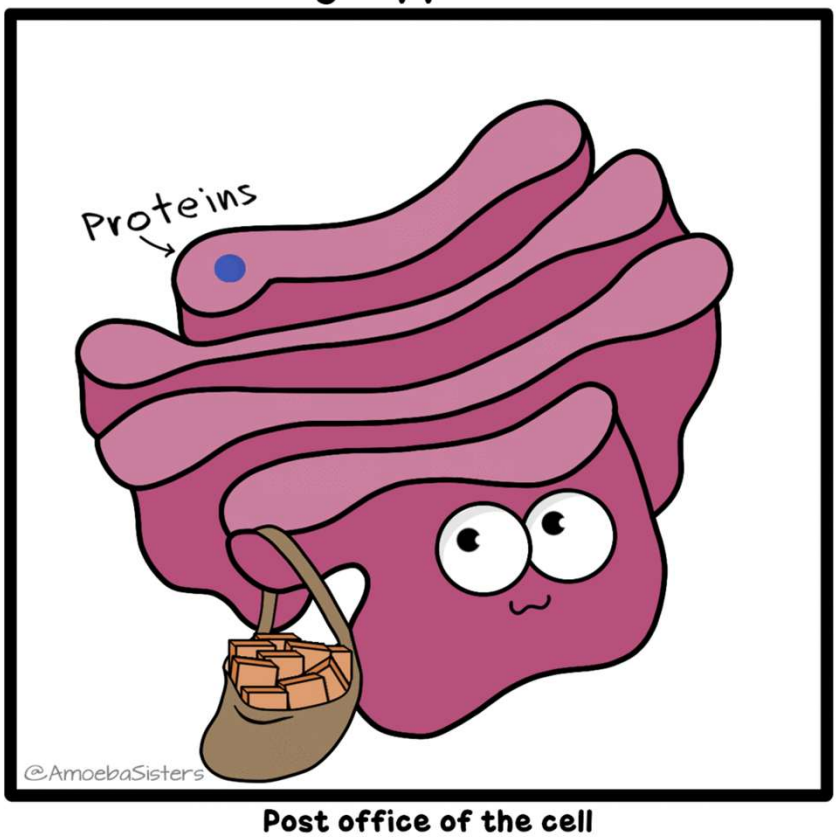


Golgi Bodies

Protein 'packaging plant'

Move materials within the cell

Move materials out of the cell



Cell Wall

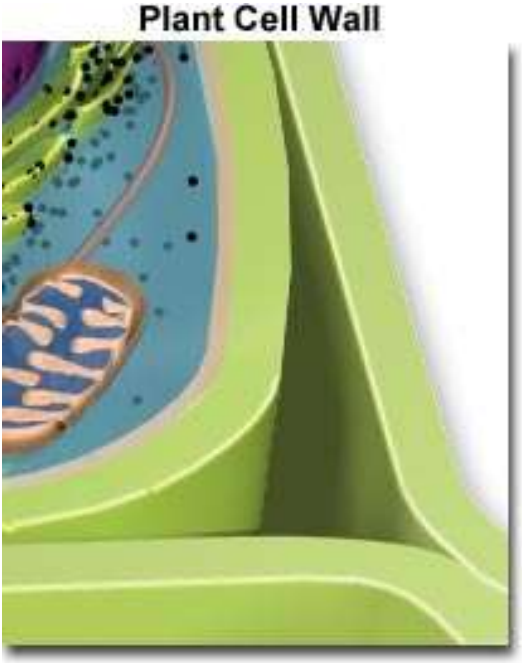


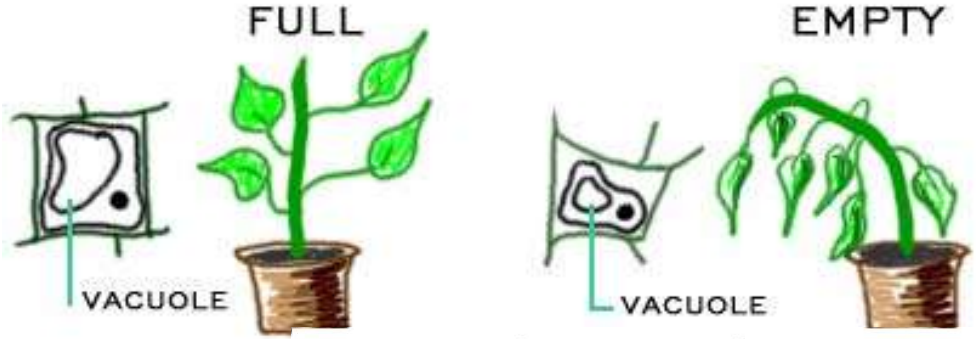
Figure 1

- Found only in plant cells
- Protects and supports the cell

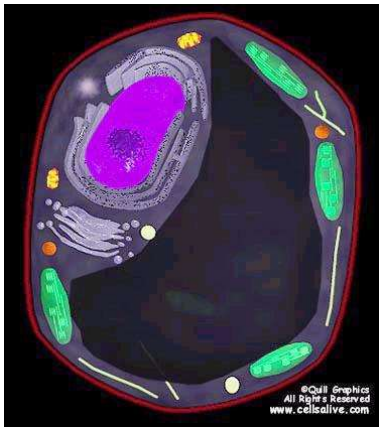
Vacuole

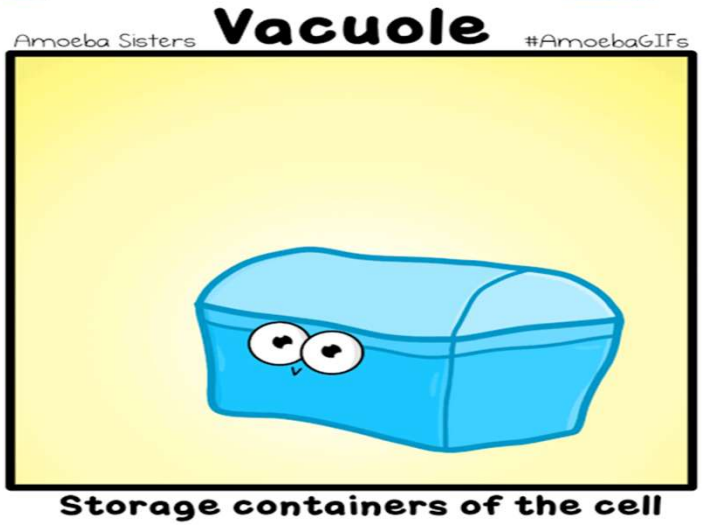
Vacuole

Stores water, food & wastes



Vacuole is largest organelle in plant cell





Chloroplasts

- Found only in plant cells
- Contains chlorophyll (makes plants green)
- Where photosynthesis takes place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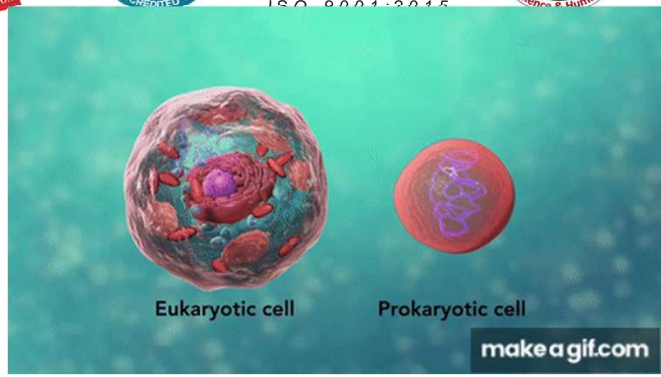
Types of Cell

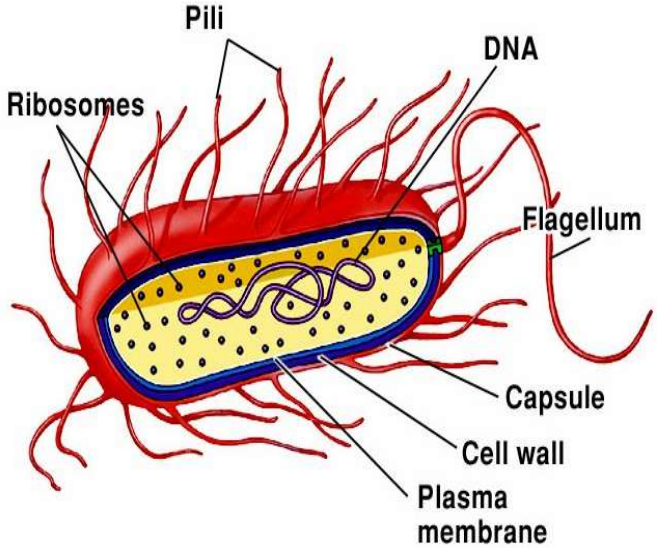
Cells are similar to factories with different laborers and departments that work towards a common objective. Various types of cells perform different functions. Based on cellular structure, there are two types of cells:

Prokaryotes & Eukaryotes

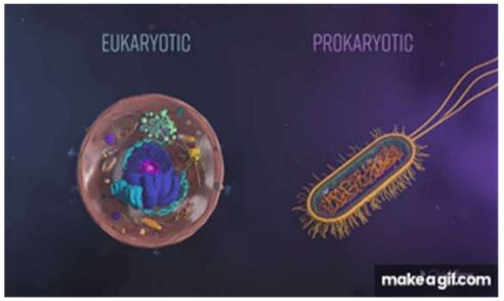


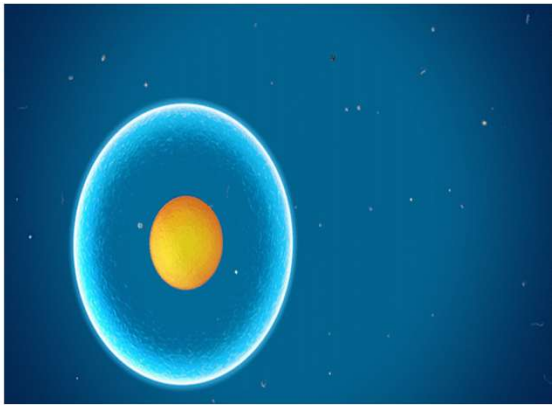
Prokaryotes:

- ***Prokaryotic cells have no nucleus***. Instead, some prokaryotes such as bacteria have a region within the cell where the genetic material is freely suspended. This region is called the nucleoid.
- They all are single-celled microorganisms. **Example** bacteria.
- The cell size ranges from **0.1 to 0.5 µm** in diameter.
- The hereditary material can either be **DNA or RNA**.
- Prokaryotes generally reproduce by **mitosis,** one cell divides to supply two genetically identical cells.



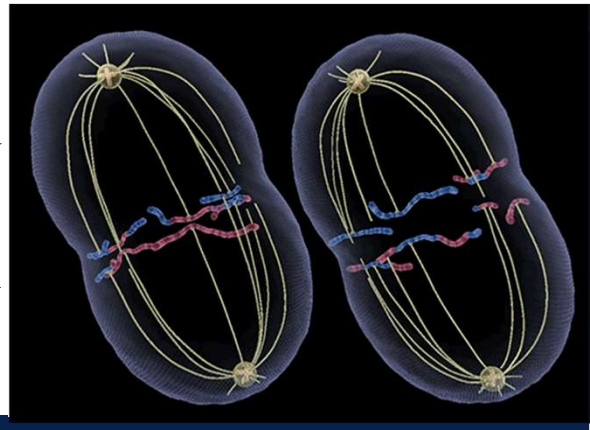
Types of Cell



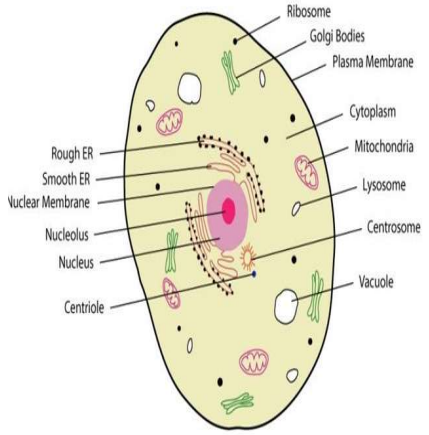


Eukaryotic Cells:

- Eukaryotic cells are characterized by a **true nucleus.**
- The size of the cells ranges between **10–100 µm in diameter**.
- This broad category involves **plants, fungi, and animals**.
- The **plasma membrane** is responsible for monitoring **the transport of nutrients** and **electrolytes** in and out of the cells. It is also responsible for **cell-to-cell communication**.
- Eukaryotes can reproduce both in **mitosis and through meiosis**.
  - In mitosis, one cell divides to supply two genetically identical cells.
  - In meiosis, DNA replication is followed by cellular division to produce four haploid daughter cells.
- There are some contrasting features between plant and animal cells. For eg., the plant cell contains chloroplast, central vacuoles, and other plastids, whereas the animal cells do not.



Animal Cell



- An animal cell is a typical eukaryotic cell with a membrane-bound nucleus with the presence of DNA inside the nucleus.
- Unlike the eukaryotic cells of plants and, animal cells do not have a cell wall.
- They comprise of **other organelles** and **cellular structures** which carry out specific functions necessary for the cell to function properly.
- The main difference between the animal and plant cell is that the animal cell **is not able to make their own food.** There are trillions of cells in the animal body and each one is different depending on the function and type.
- Most animal cells have at least three main parts: **nucleus, cell membrane, and cytoplasm.**
- The nucleus of the cell gives direction to the cell. It directs all the activity to the cell. The nucleus can make their cell organelles as needed. The Nucleus is the brain of the cell. The nucleus of the animal cell is bound by membrane.
- The cell membrane protects animal cells. They keep the harmful objects out of the cell and allow only helpful objects to enter. It is the guard of the cell.
- Cytoplasm fills most of the animal cell. It helps to give the cell shape and keep the organelles in the correct place. When organelles need to transport materials around the cell, this cytoplasm allows the process to occur smoothly. It also helps to break down the cell waste.

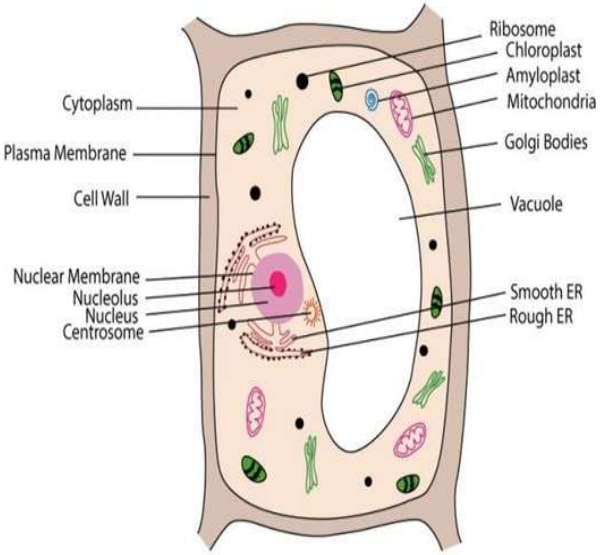
Animal Cell

Functions of Animal Cell:

- The cells are highly specialized to carry out the specific tasks. All the cells function together in coordination with each other and help the organism to sustain.
- Multiple cells will form the tissues into a group of cells which will help in carrying out the various functions. The group of similar tissues will form the various organs of the body like heart, lungs, etc. and these organs work together to form the organ system like the nervous system, digestive system, circulatory system etc. Depending upon the organism the organ system will vary accordingly. Example,

Plant Cell

- Plant cells are a type of **eukaryotic cell** found in the organism within the plant kingdom.
- Some of the organelles present in plant cell differs from other eukaryotic cells.
- The major difference in the plant cell is that the plant cell contains a **rigid cell wall** around its cell wall. The cell wall provides the cell with the protection and gives the plant its **shape and structure.**
- The plant cell contains the **chlorophyll**. The chlorophyll gives the plants their green pigment and allows them to perform **photosynthesis.**
- Photosynthesis is the process that plants use to make their food by using carbon dioxide, water, and sunlight.
- The plant cells contain **large central vacuoles**. Vacuoles are larger structures in plant cells as in some other eukaryotes.



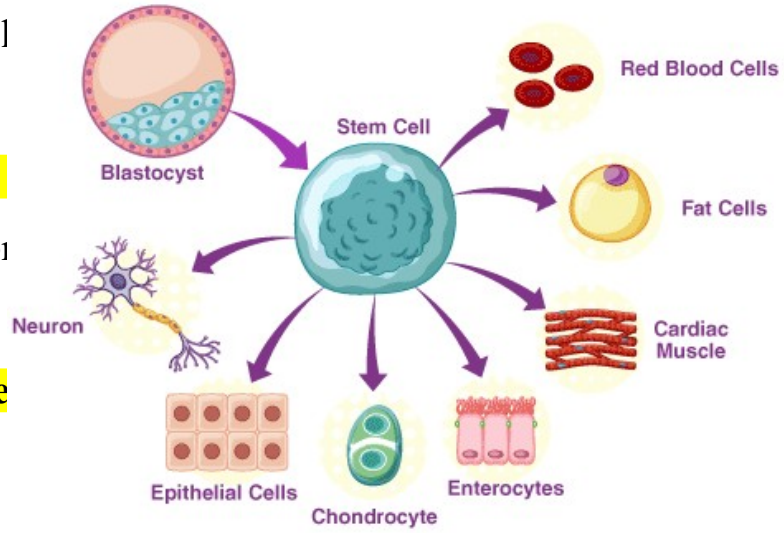
Functions of Plant Cell:

- Plant cells are the basic building block of plant life, and they carry out all the functions necessary for survival.
- Photosynthesis is the process of making food from light energy, carbon dioxide, and water. It occurs in the chloroplasts of the cell.

Feature	Plant Cells	Animal Cells
Cell Wall	The cell wall is present only in plant cells and is made up of cellulose. The cell wall is the outermost layer of plant cells.	It Is Absent In The Animal Cell.
Shape	They have a definite and rigid shape which means they usually exist in rectangular or cubical shapes.	They exist in round and irregular shapes.
Chloroplast	Chloroplasts are present in plant cells that make their own food.	Chloroplast absent in animal cell
Mitochondria	It is present in a small number in plant cells. Plants cells generally have approximately 200-600 mitochondria per cell.	It is present in a large number compared to plant cells, Animal cells generally have approximately 2000 per cell.
Nucleus	It is present and controls the functioning of cells.	It is present and stores the cell's DNA,
Plasma Membrane	PM is present and is surrounded by cell walls in the plant cell.	PM present in animal cells provides protection for the cell.
Vacuoles	Vacuoles are few large or single and centrally positioned and provide structural support. One huge vacuole.	Vacuoles are commonly small and sometimes they are absent.
Mode of Nutrition	It is autotrophic mode of nutrition, which means they synthesize their own nutrients such as amino acids, vitamins coenzymes that are required by the plant.	The mode of nutrition is heterotrophic. which means they cannot synthesize their own nutrients.
Golgi apparatus	A Single highly difficult and prominent Golgi apparatus is present.	

Stem Cells

- In multicellular organisms, stem cells are partially differentiated cells that can **change into various types of cells.**
- Stem cells have remarkable potential to develop into many different cell types in the body during early life and growth.
- They serve as a **sort of repair system for the body**, dividing essentiall without limit to replenish other cells.
- When a stem cell divides, each new cell has the potential either to **remain stem cell or become another type of cell** with a more specialized functio such as a muscle cell, a red blood cell, or a brain cell.
- The stem cells can be used to repair or **regenerate damaged or disease cells.** These cells can develop into any kind of cell.

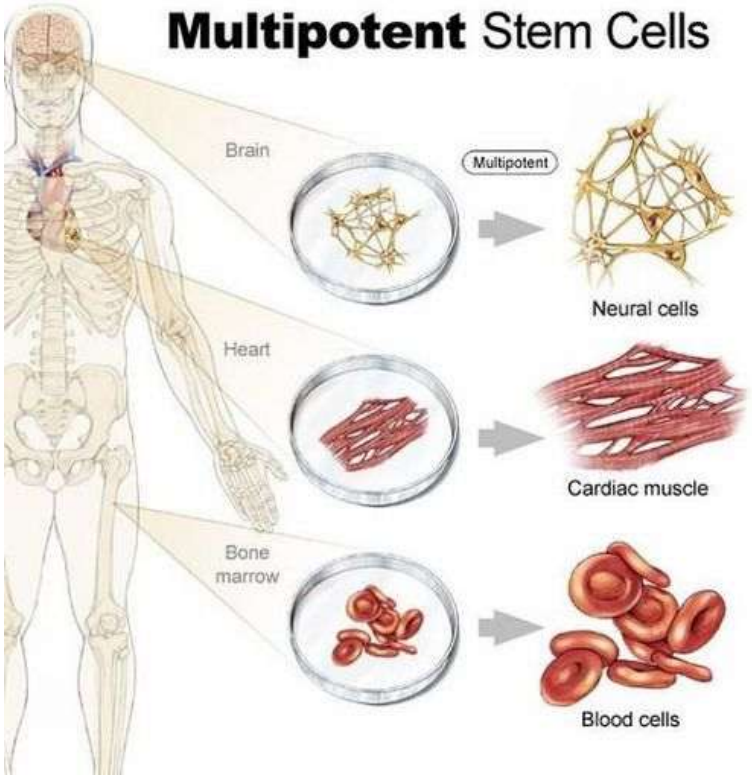


Stem Cells

Stem cells are categorized into two main types based on their source and potential:

1. **Adult stem cells**

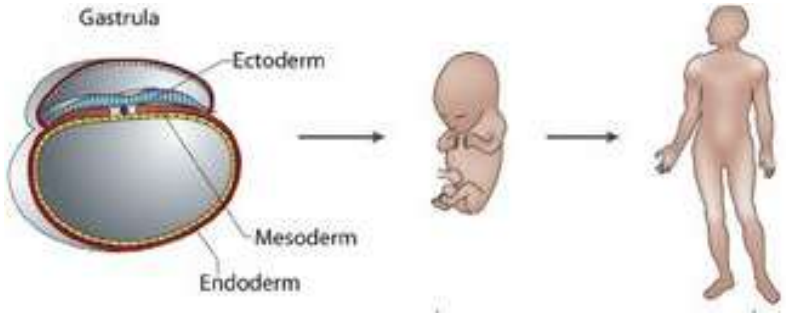
- Also known as **somatic or tissue-specific** stem cells, are found in **various tissues** and **organs throughout the body**. They are multipotent, meaning they can differentiate into a limited range of cell types.
- **These stem cells are acquired from fully-grown adult organs** and tissues found in differentiated tissues (bone marrow and brain). They can fix and supplant the harmed tissues in the area where they are located.



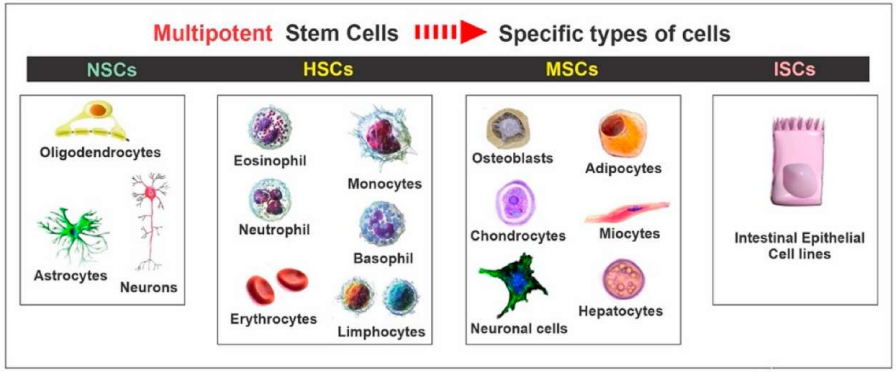
Stem Cells

2. Embryonic stem cells (ESCs)

- are derived from embryos. They are pluripotent, meaning they **can give rise to all cell types in the body.**
- The **pluripotent cells** play a vital role in developing the **fetus.** Thus, these stem cells are found only during the embryonic stage and are termed embryonic stem cells. These cells can differentiate into any type of cell.

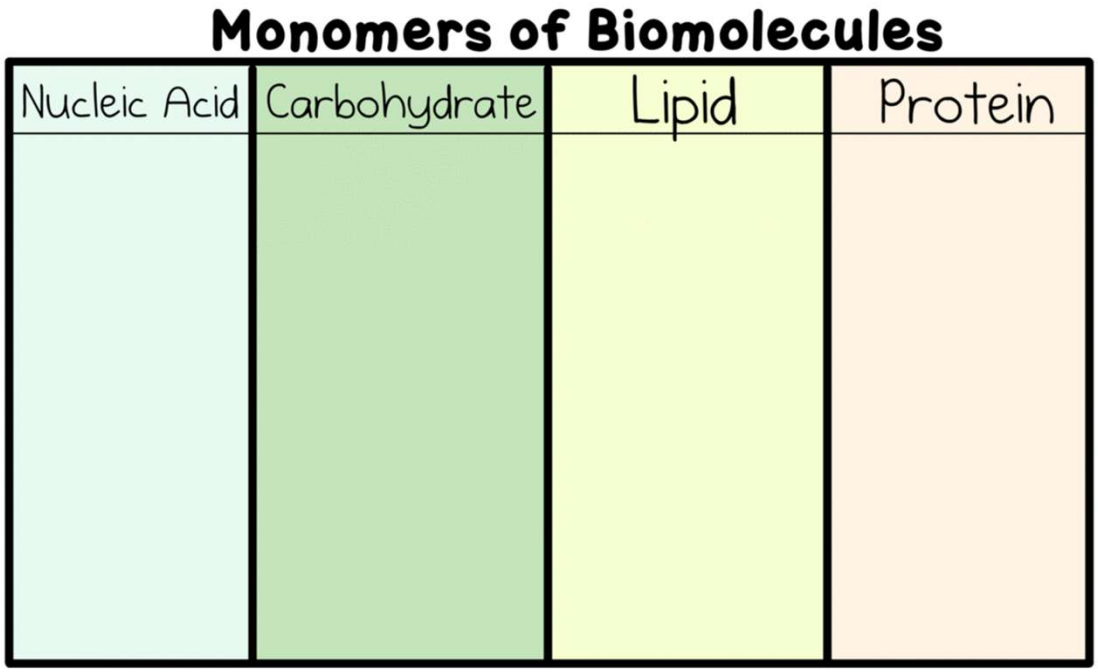


Adult Stem Cells	Embryonic Stem Cells
Adult stem cells are undifferentiated stem cells in differentiated organs/tissues.	Embryonic stem cells are found during the early blastocyst stage.
They are multipotent. It means they can develop only into closely related cell types.	They are pluripotent. Hence, they can develop into any cell.



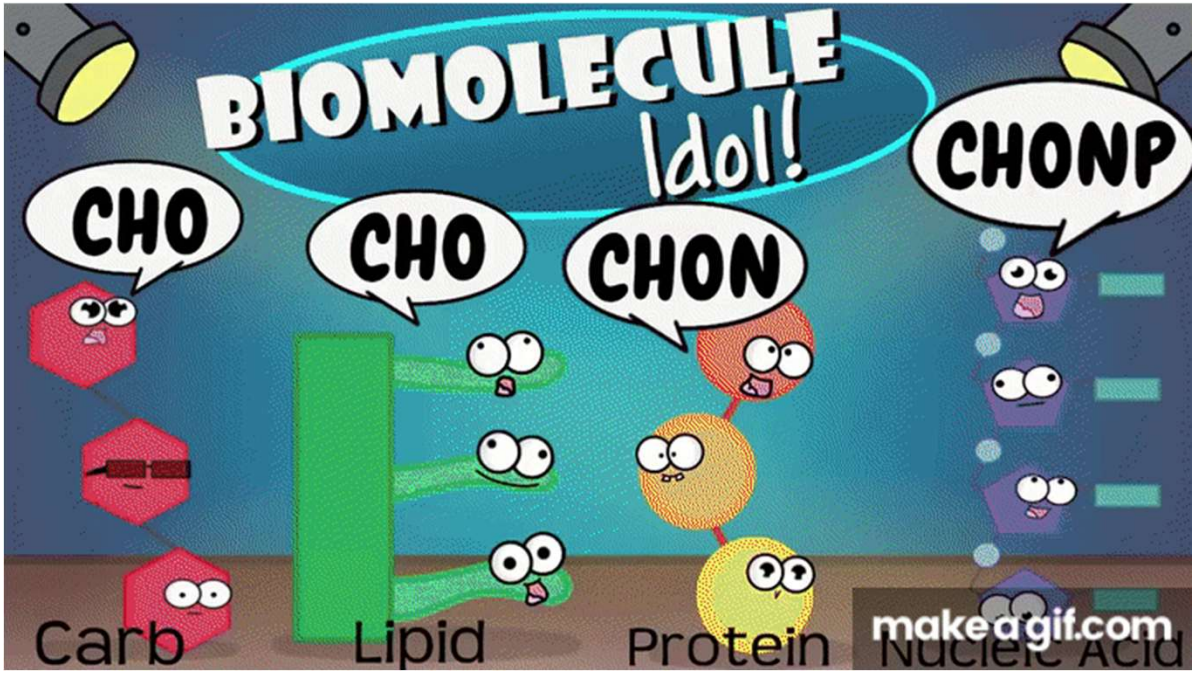
BIOMOLECULES

- Biomolecules are biological molecules produced by the cells of the living organism. They are critical for life as it help organisms to carry out basic biological processes.
- Biomolecules are the most essential organic molecules, which are involved in the maintenance and metabolic processes of living organisms.
- The large molecules necessary for life that are built from smaller organic molecules are called biological macromolecules.

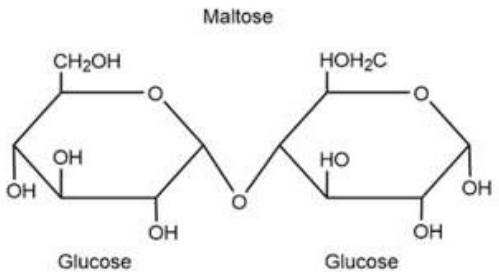
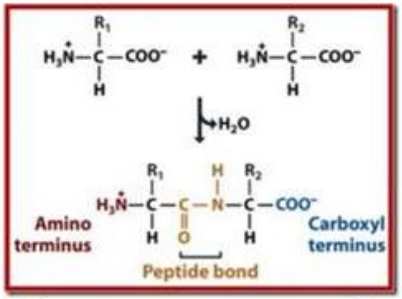
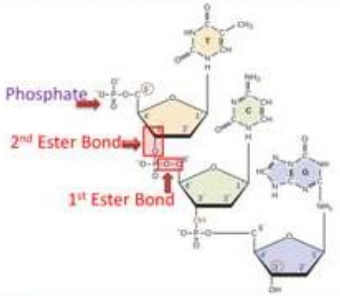
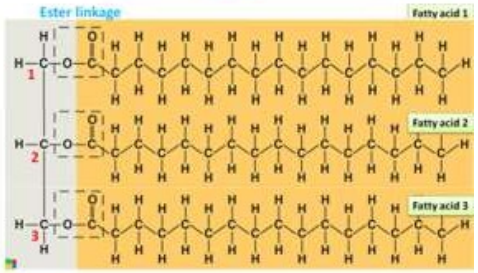


BIOMOLECULES

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



Biomolecules

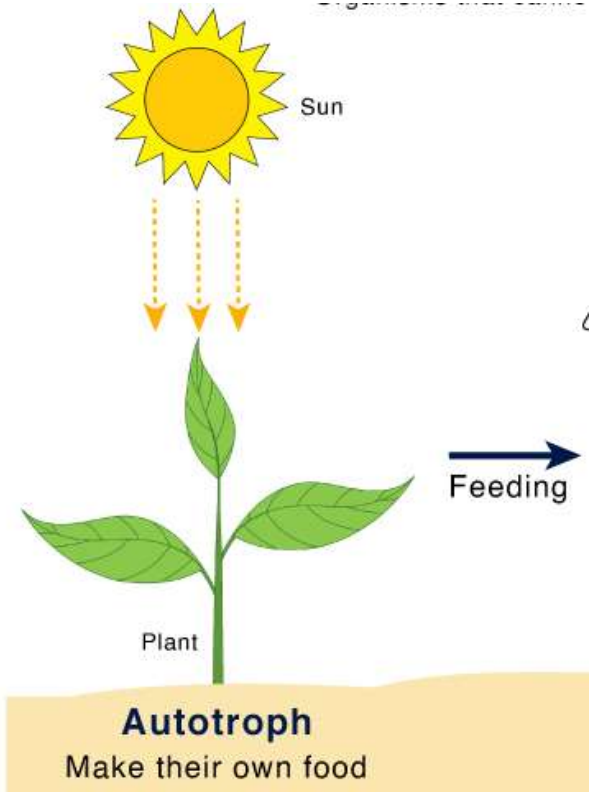
	Carbohydrates	Proteins	Nucleic acids	Lipids
				
Monomers	Monosaccharides joined by glyocosidic bond	Amino acids joined by peptide bond	Nucleotides joined by phosphodiester bond	Fatty acids and glycerol joined by ester bond
Examples	Starch, Cellulose	Insulin, Collagen	DNA, RNA	Fats, Oils, waxes
Elements	C,H,O	C,H,O,N, S	C,H,O,N,P	C,H,O
Functions	Energy source Structural component Reserve food	Enzyme, structure movement, defence hormones	Stores genetic information	energy source, insulation, membrane components, hormone

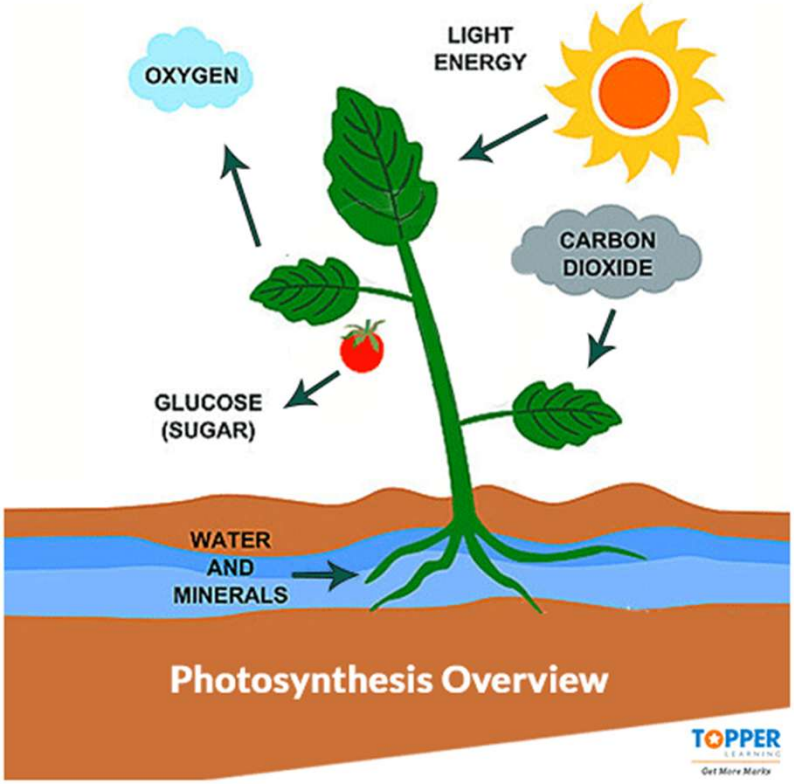
CARBOHYDRATES

- Plants are the primary producers of carbohydrates, which comprise a **large group of naturally occurring organic compounds.** Cane sugar, glucose, starch, etc are examples The majority of them have the general formula $\mathbf{C_xH_{2y}O_y}$
- They were thought to be **carbon hydrates**, hence the name carbohydrate.
- The molecular formula of glucose $\mathbf{C_6H_{12}O_6}$ hence fits into this general formula.

$$C_x(H_2O)_y$$

Animals and **Human beings cannot biosynthesise Carbohydrates** predominantly.





Plants predominantly biosynthesize carbohydrates through **photosynthesis**.

Photosynthesis.

$$6CO_2 + 6H_2O \xrightarrow[\text{Sunlight}]{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2$$

Sugars
Simple carbohydrate

Sugars $\rightleftharpoons$ **Starch or Cellulose**

Complex carbohydrates of plants

TO EAT OR NOT TO EAT?

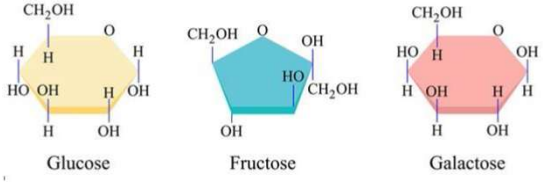
SLOTHILDA.COM

Carbohydrates

Simple sugars

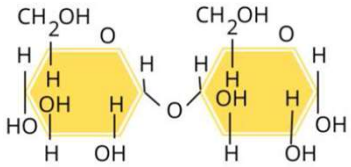
Monosaccharides

The simplest carbohydrates are termed simple sugars. The monosaccharides most commonly contain three to six carbon atoms in an unbranched single-bonded chain.



Disaccharides

two monosaccharides are joined by glycosidic linkage

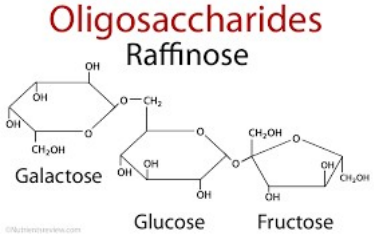


Maltose
glucose + glucose

Complex sugars

Oligosaccharides

Carbohydrates that contain between 3 and 10 single sugar residues

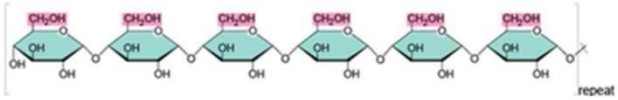


raffinose,

stachyose

Polysaccharides

long chains of carbohydrate molecules, composed of several smaller monosaccharides.



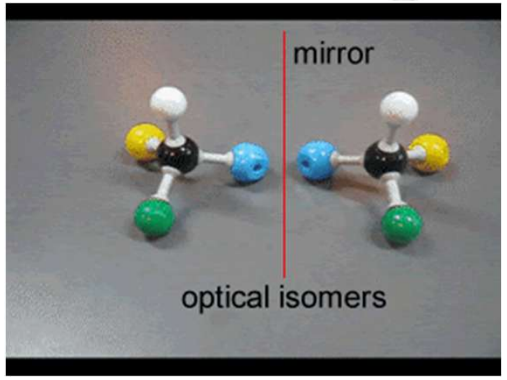
Starch

Cellulose

CARBOHYDRATES

Properties

- **Isomerism:** Carbohydrates exhibit isomerism. They have the same molecular formula but different structural formulas. For example, glucose and fructose both have the formula C6H12O6, but their structures are different.



- **Solubility:** Most carbohydrates are soluble in water. The solubility is due to the presence of multiple hydroxyl (-OH) groups that can form hydrogen bonds with water.
- **Crystalline Structure:** Many carbohydrates, especially simple sugars, are crystalline solids at room temperature.
- **Chemical Reactions:** Carbohydrates undergo a variety of chemical reactions, including oxidation, reduction, and esterification.

CARBOHYDRATES

Applications

- **Energy Supply:** Carbohydrates are the body's main source of energy. They are broken down into glucose, which can be used immediately or stored in the liver and muscles for later use.
- **Protein Sparing:** Carbohydrates help to protect the body's proteins. When there are enough carbohydrates, the body can use proteins for growth and repair rather than as an energy source.
- **Digestive Health:** Certain types of carbohydrates, known as dietary fiber, aid in digestion by adding bulk to the diet and helping to prevent constipation.
- **Disease Prevention:** Some types of carbohydrates, such as whole grains and dietary fiber, may help to reduce the risk of certain diseases, including heart disease and type 2 diabetes.
- **Energy Storage:** Excess glucose is converted and stored as glycogen in animals, primarily in the liver and muscles. Plants store excess glucose as starch in specialized storage organs.

CARBOHYDRATES

Applications

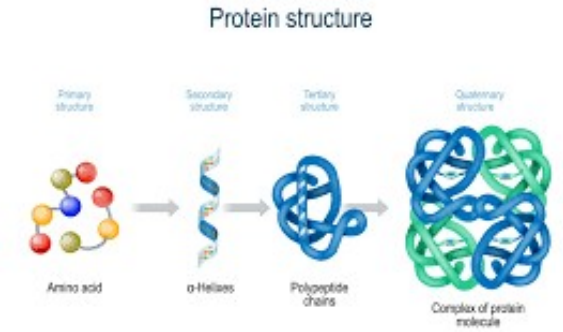
- **Structural Support:** Carbohydrates play a structural role in living organisms. In plants, cellulose provides structural support to cell walls, while chitin, a type of carbohydrate, is a major component of the exoskeleton of arthropods.
- **Cellular Recognition:** Carbohydrates on the surface of cells play a crucial role in cell-cell recognition and communication. They are involved in various cellular processes, including immune responses and cell signaling.
- **Dietary Fiber:** Certain carbohydrates, such as cellulose and pectin, are considered dietary fiber. Fiber is important for maintaining digestive health and can help prevent constipation.
- **Plant Structure:** Carbohydrates are essential for the structural integrity of plants. They provide rigidity to plant cells and help maintain the overall structure of the plant.

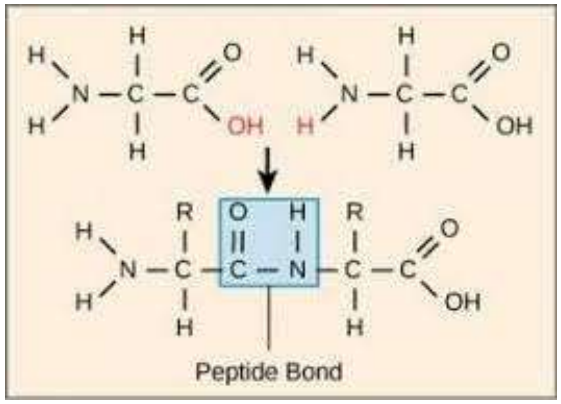
Proteins

- Proteins are polymers of amino acids that are linked covalently through peptide bonds.
- Amino acid: an organic compound containing both amino and carboxyl functional groups; they are the simplest units of proteins
- There are 20 different kinds of amino acids, combined in different proportion and arrangements to build all protein molecules
- When only two amino acids combine by peptide bond ,it is called dipeptide, when amino acids involved in the bond formation become 3, 4, 5 they are named as tri-, tetra-, and penta-peptides respectively.

All proteins contain carbon, hydrogen, oxygen, and nitrogen; some proteins may also contain sulfur phosphorous, copper, iron, zinc, iodine, and other elements.

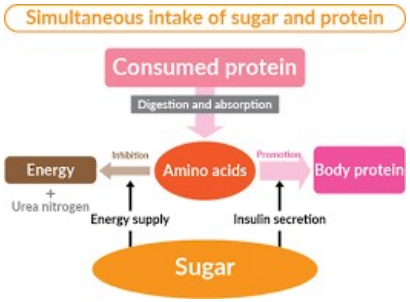
The presence of nitrogen in all proteins sets them apart from carbohydrates and lipids.

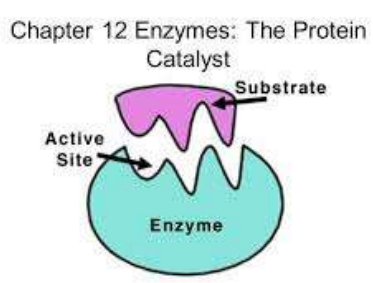


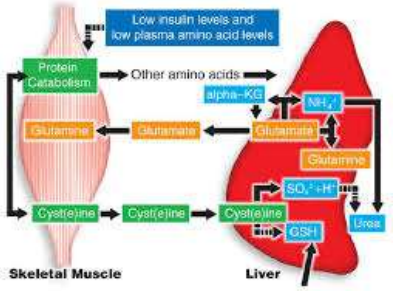


Function of Proteins

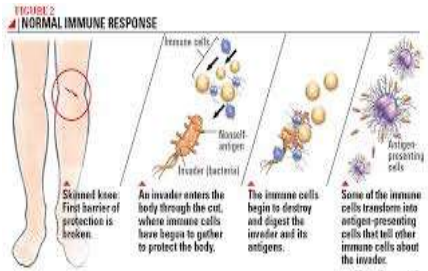
- Used to construct or build our body
- Catalyze biochemical reactions as an enzyme
- Regulate body metabolism as hormones

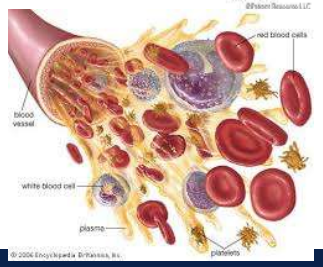


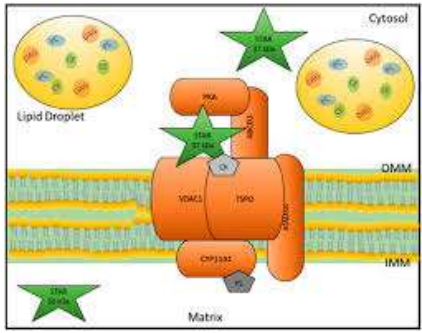




- Protect our body from foreign body attack as an antibody and components of complement
- Maintain osmotic pressure in plasma
- Transport different lipids, minerals, hormones, vitamins etc as hemoglobin, apolipoprotein, albumin etc
- Assist to arrest bleeding and maintain homeostasis as coagulation factor

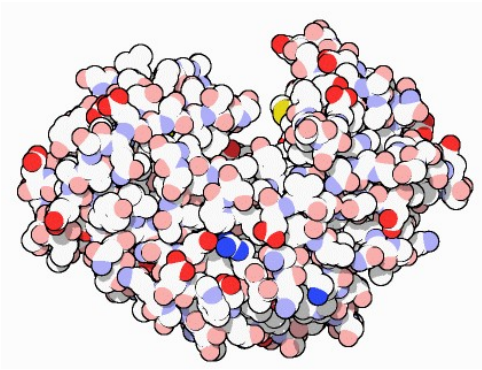


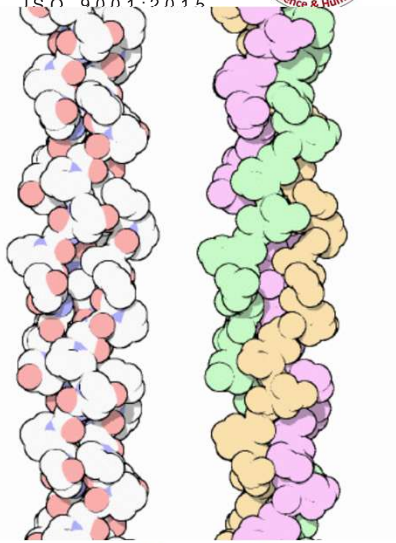


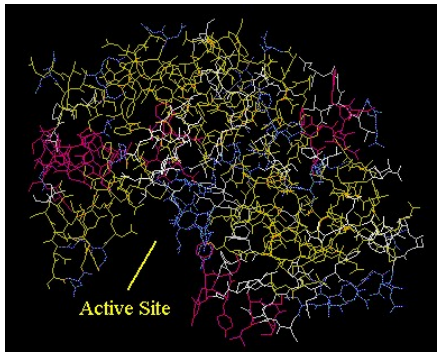


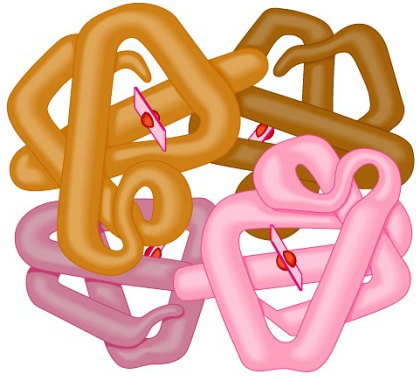
Protein structure & function

- Function depends on structure
  - 3-D structure
    - twisted, folded, coiled into unique shape



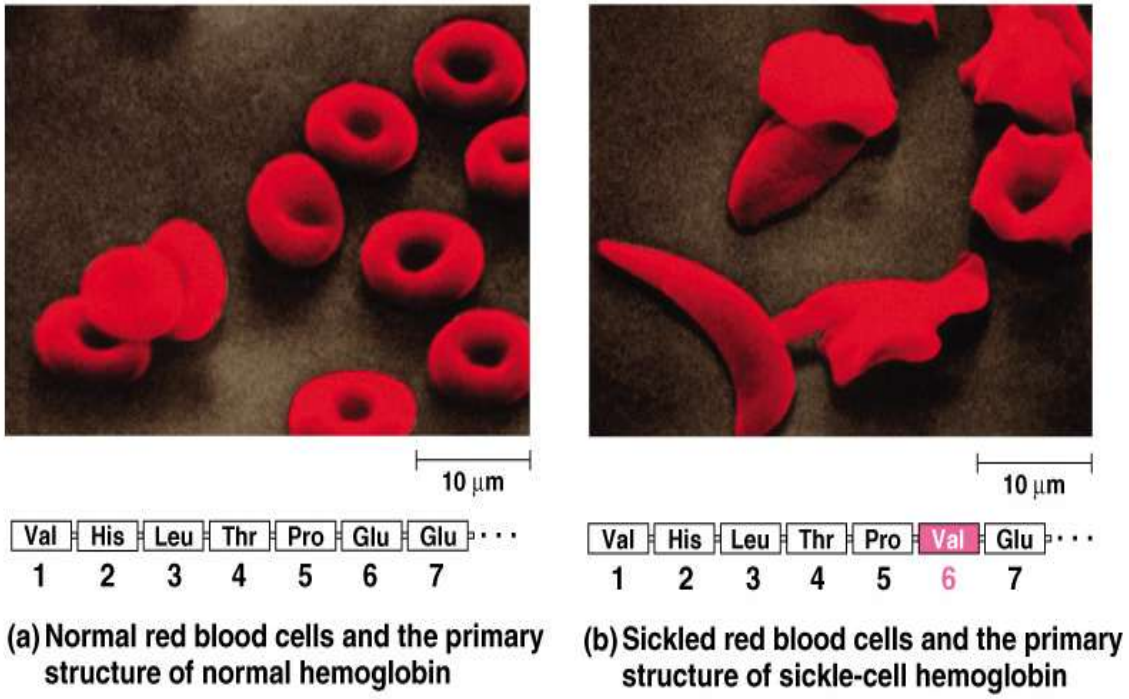






Primary (1°) structure

- Order of amino acids in chain
  - amino acid sequence determined by gene (DNA)
  - slight change in amino acid sequence can affect protein's structure & it's function
  - even just one amino acid change can make all the difference!

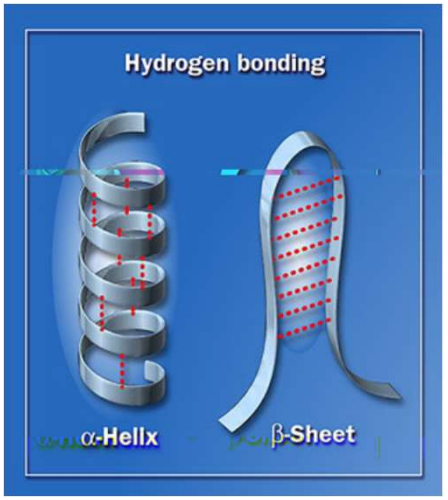


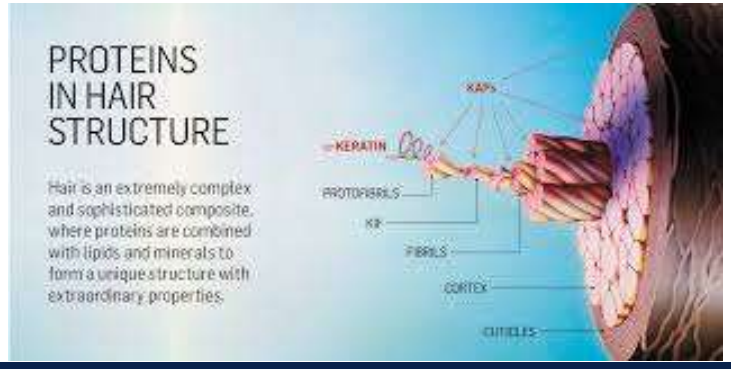
(a) Normal red blood cells and the primary structure of normal hemoglobin

(b) Sickled red blood cells and the primary structure of sickle-cell hemoglobin

Secondary (2°) structure

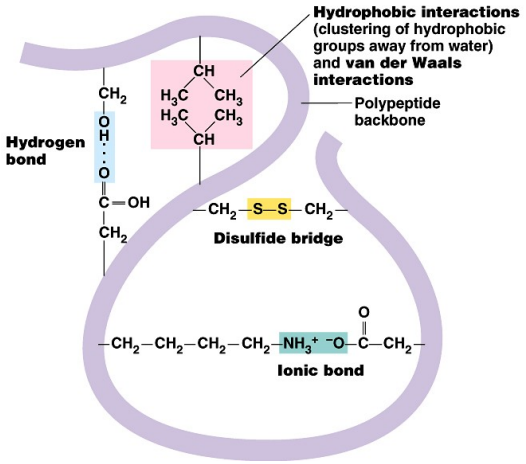
- "**Local folding**"
  - folding along short sections of polypeptide
    - interaction between adjacent amino acids
    - H bonds between backbones (O:H)
    - Fibrous proteins – only have secondary structure
      - Keratin
      - Silk





Tertiary (3°) structure

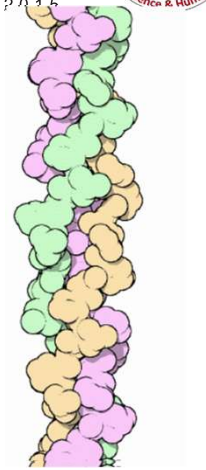
- "**Whole molecule folding**"
  - **created when the secondary structure fold and form bonds to stabilize the structure into a unique shape**
  - determined by interactions between R groups
    - Hydrophobic interactions
    - anchored by disulfide bridges
    - Ionic Bonds between R groups
    - Hydrogen bonds between backbones
    - Van der Waals Force (velcro)
      - Globular (spherical) proteins – have tertiary structure
        - enzymes

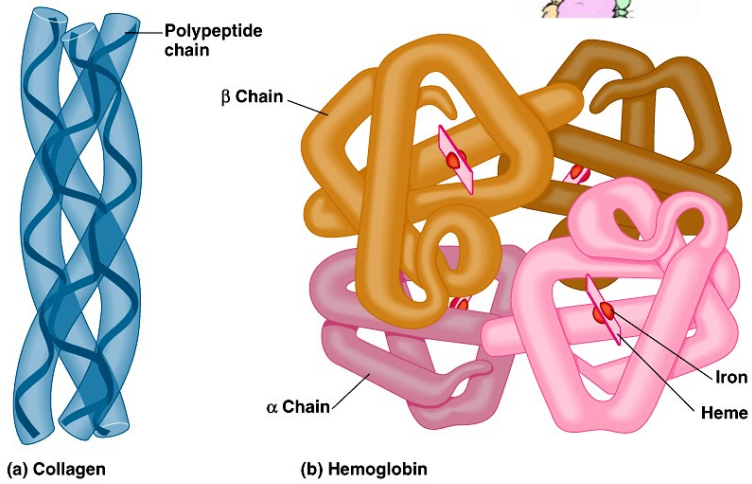


Quaternary (4°) structure

- **two or more tertiary folded peptide subunits bonded together to make a functional protein**
  - Hemoglobin – 4 polypeptides
  - Collagen – 3 polypeptides

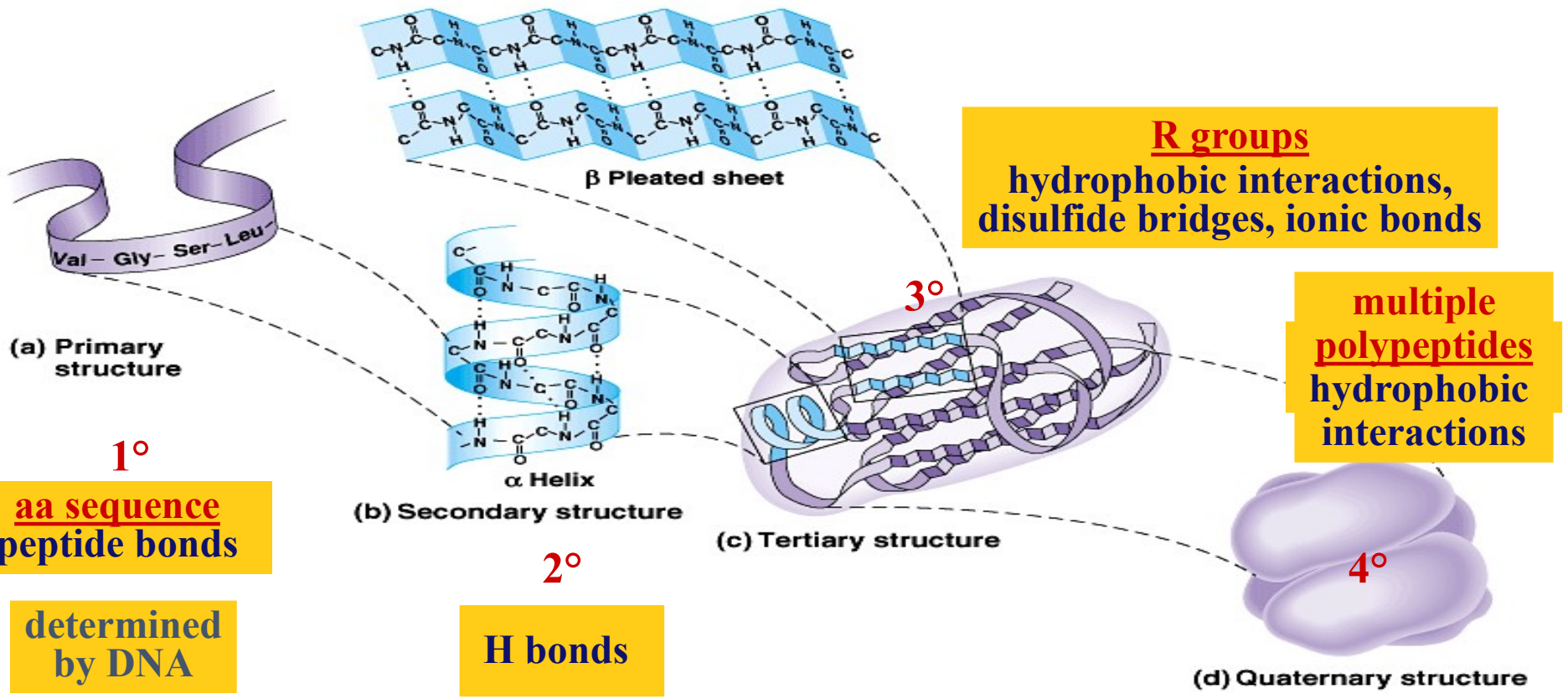
collagen = skin & tendons





hemoglobin

Protein structure (review)



1°

aa sequence
peptide bonds

determined by DNA

2°

H bonds

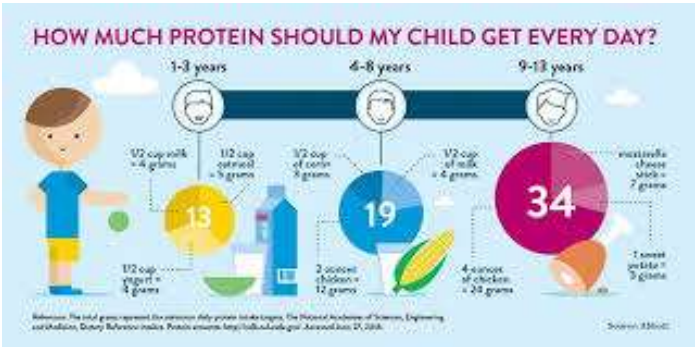
3°

R groups
hydrophobic interactions, disulfide bridges, ionic bonds

multiple polypeptides
hydrophobic interactions

4°

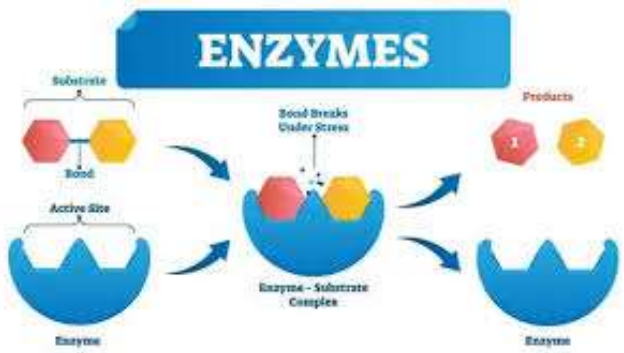
Roles of Proteins



Building material

- Growth, a matrix of protein underlies almost all structures in the body including bones, muscles ligaments, tendons, connecting matrix between cell walls, scar tissue, hair and nails. The whole body has its cells renewed every seven years.

Proteins as Enzymes



- Enzymes are usually composed of a protein, a vitamin and a trace mineral.
- They act as catalysts, allowing reactions to occur more quickly and efficiently.
- They can cause two substances to come together making a new structure or can split a compound apart.
- An enzyme is not affected by the chemical reactions it allows to take place.

Roles of Proteins

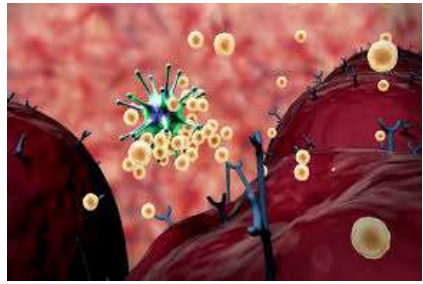
Hormones

Hormones are proteins that coordinate different functions in your body by carrying messages through your blood to your organs, skin, muscles and other tissues. These signals tell your body what to do and when to do it. Hormones are essential for life and your health.

Proteins in Immunity

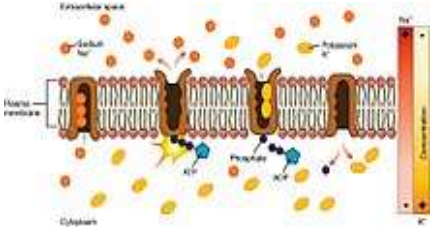
Antibodies are giant proteins that bind up specific invaders like viruses or antigens

Antigens are substances that cause the body to produce antibodies. They may include bacteria, allergens, toxins or anything that causes an inflammatory response.

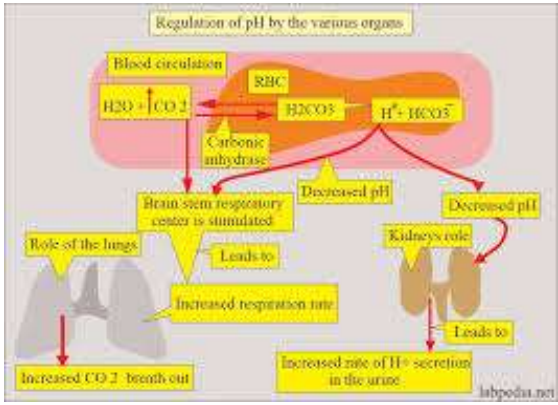


Transport Proteins

A **transport protein** is a protein that serves the function of moving other materials within an organism. Transport proteins are vital to the growth and life of all living things.



Roles of Proteins



Regulation of fluid balance

Dependent edema may be caused when there is too much fluid between cells and not enough hydrophilic protein within the cells.

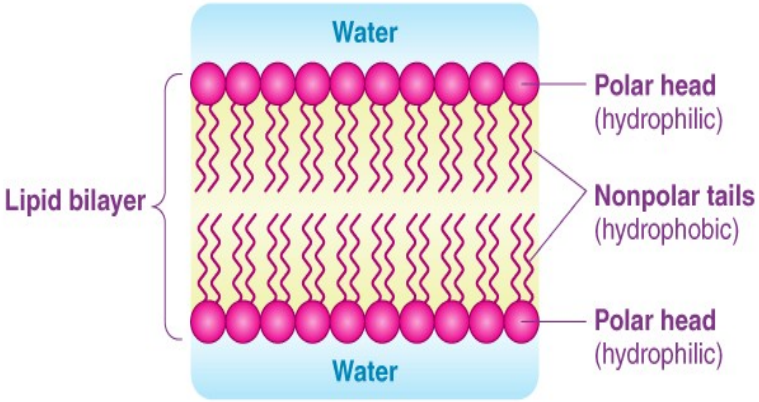
Acid-base regulation, proteins act as buffers accepting and releasing hydrogen ions thus preventing acidosis or alkalosis.

Source of energy. The brain and nervous system must have glucose. Once the amino group is removed from the protein, the remaining carbon molecules can be used to create energy - 4 Kcal per gram or stored as fat.

Other roles include being converted to other proteins or making neurotransmitters norepinephrine and epinephrine, melanin, fibrin and as precursor to the vitamin niacin.

LIPIDS

- "Lipids are organic compounds that contain hydrogen, carbon, and oxygen atoms, which form the framework for the structure and function of living cells."
- Lipids are a family of organic compounds, composed of fats and oils.
- These organic compounds are nonpolar molecules, which are soluble only in nonpolar solvents and insoluble in water because water is a polar molecule.
- These molecules yield high energy and are responsible for different functions within the human body.



CLASSIFICATION OF LIPIDS

Lipids

Simple

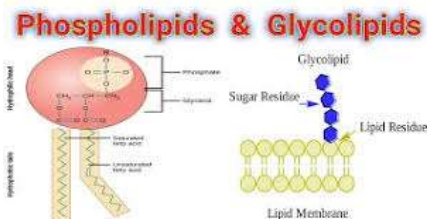
They are esters of FA with various alcohols

- Oils
- Waxes

Complex

These are esters of FA with alcohol containing additional[prosthetic] groups.

- Phospholipids
- Glycolipids
- Lipoproteins



Derrived

These are the derivatives obtained on the hydrolysis of group 1 and group 2 lipids which possess the characteristics of lipids.

Example

- Fatty acids
- Steroids
- Cholesterol
- Vitamin A and D

Saturated fat

Saturated fats occur naturally in many foods. Most come from animal sources, including meat and dairy products, as well as tropical fats like coconut, palm, and palm kernel.

Examples of saturated fats

•beef
•lamb
•pork
•poultry, especially with skin
•beef fat (tallow)
•lard and cream
•butter

Unsaturated fat

An **unsaturated fat** is a fat or fatty acid in which there is at least one double bond within the fatty acid chain. A fatty acid chain is monounsaturated if it contains one double bond, and polyunsaturated if it contains more than one double bond.

Examples of unsaturated fats

•Olive, peanut, and canola oils.
•Avocados.
•Nuts such as almonds, hazelnuts, and pecans.
•Seeds such as pumpkin and sesame seeds.

Roles of Fats

Fats play several major roles in our bodies. Some of the important roles of fats are mentioned below:

- Fats in the correct amounts are necessary for the proper functioning of our body.
- Many fat-soluble vitamins need to be associated with fats to be effectively absorbed by the body.
- They also provide insulation to the body.
- They are an efficient way to store energy for longer periods.

Properties of Lipids

Physical properties

- Lipids may be either liquids or non-crystalline solids at room temperature.
- Pure fats and oils are colourless, odourless, and tasteless.
- They are energy-rich organic molecules
- Insoluble in water
- Soluble in organic solvents like alcohol, chloroform, acetone, benzene, etc.
- No ionic charges

Properties of Lipids

Chemical properties

1. Hydrolysis of Tri glycerol's

Tri glycerol like any other esters react with water to form their carboxylic acid and alcohol– a process known as hydrolysis.

2. Saponification:

Triacylglycerols may be hydrolyzed by several procedures, the most common of which utilizes alkali or enzymes called lipases. Alkaline hydrolysis is termed saponification because one of the products of the hydrolysis is a soap, generally sodium or potassium salts of fatty acids.

3. Hydrogenation

The carbon-carbon double bonds in unsaturated fatty acids can be hydrogenated by reacting with hydrogen to produce saturated fatty acids.

4. Halogenation

Unsaturated fatty acids, whether they are free or combined as esters in fats and oils, react with halogens by addition at the double bond(s). The reaction results in the decolorization of the halogen solution.

5. Rancidity:

The term rancid is applied to any fat or oil that develops a disagreeable odor. Hydrolysis and oxidation reactions are responsible for causing rancidity.

Functions of Lipids

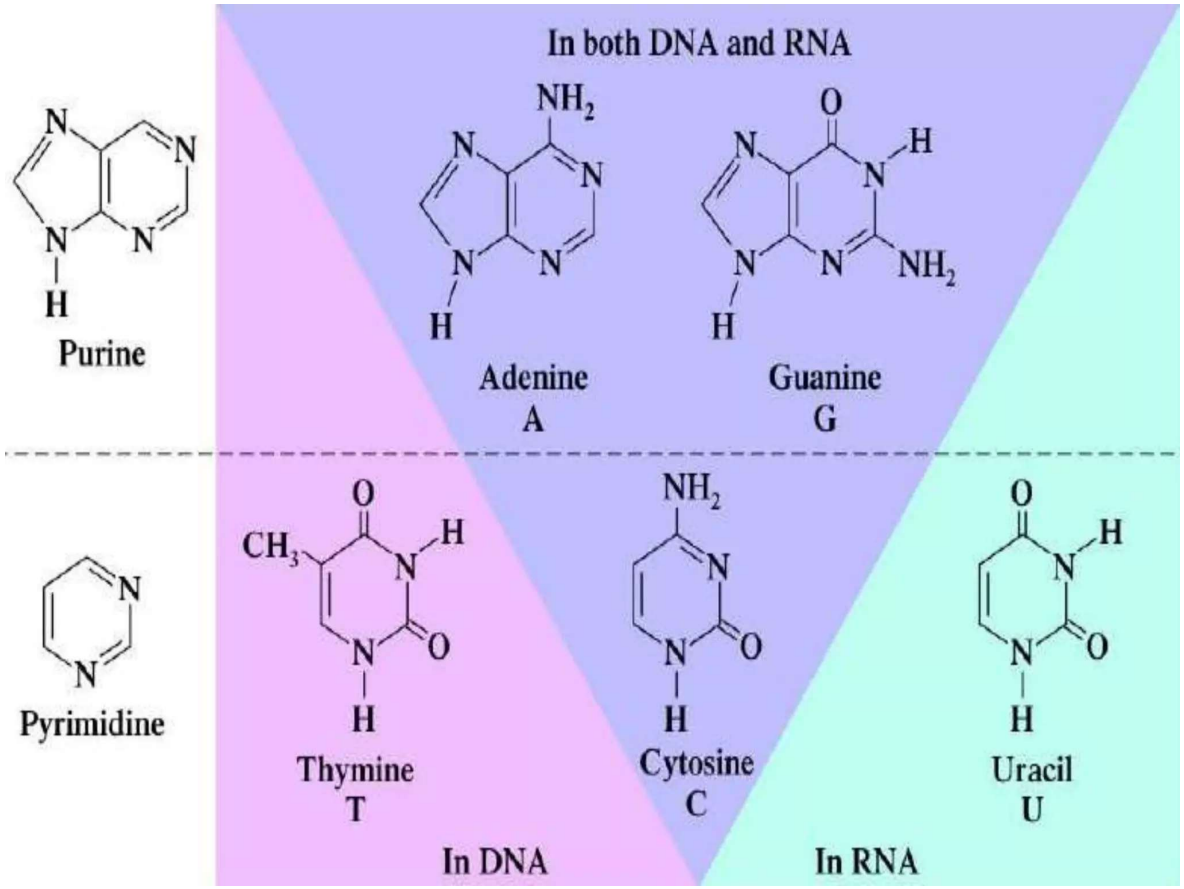
- Lipids, like adipose tissue, act as **insulators and help to maintain body temperature** by reducing heat loss.
- Lipids, especially triglycerides, act as **energy storage in organisms**, providing a reserve of **metabolic fuel**.
- Phospholipids form the lipid bilayers of cell membranes and regulate the passage of molecules in and out of cells.
- Protecting the plant leaves from **direct heat and drying**.
- Steroid hormones, derived from cholesterol, play vital roles in regulating various physiological processes, including **metabolism, growth, and reproduction**.
- It acts as the structural component of the body and acts as the **hydrophobic barrier**.
- In plants, lipids can be stored as oils in seeds, providing a source of **energy for germination** and early growth.
- Lipids form **waterproofing structures**, such as the **waxy cuticle on plant leaves** or the **oil on the feathers of water birds**.
- It provides color to many fruits and vegetables with the presence of **carotenoid pigment**.

Lipids

Nucleic acids

- Nucleic acids are vital components of all living systems, Responsible for all storage and transmission of genetic information from parents to offspring. Hence, they control growth and reproduction in the cell living system
- Nucleic acids occur as a major component of the nucleus, they are generally associated with proteins to form a Nucleoprotein.
- Nucleic acids are naturally occurring chemical compounds that serve as the primary information-carrying molecules in cells.
- Nucleic acids are biopolymers or a large number of biomolecules essential for all forms of life
- Elemental composition – **carbon, hydrogen, oxygen, nitrogen and phosphorus**

Nitrogenous base

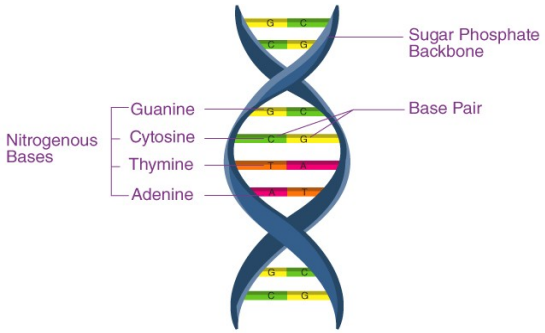


Nucleic acids

DNA

DNA is double-stranded, forming a double helix

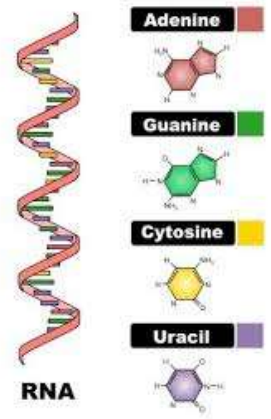
In cells, DNA (Deoxyribonucleic acid) is the nucleic acid that functions as the original blueprint for the synthesis of proteins.



RNA

RNA is usually single-stranded.

Ribonucleic acid (RNA) is a nucleic acid which is directly involved in protein synthesis.



DNA

- DNA or deoxyribonucleic acid is a genetic material that transfers genetic information from one organism to its offspring.
- Located in the nucleus and mitochondria
- The information in DNA is stored as code (made up of A,G,C,T).
- 99% of bases are the same. The order of bases determines the individuality.

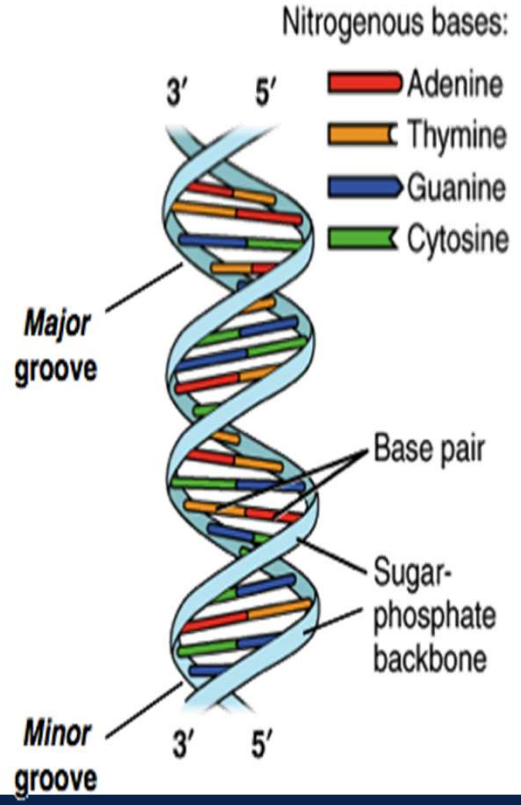
STRUCTURE OF DNA

DNA is a long chain polymer of nucleotides. It consist of:

Deoxyribose=5 pentose sugar, Phosphate group, Oganic bases

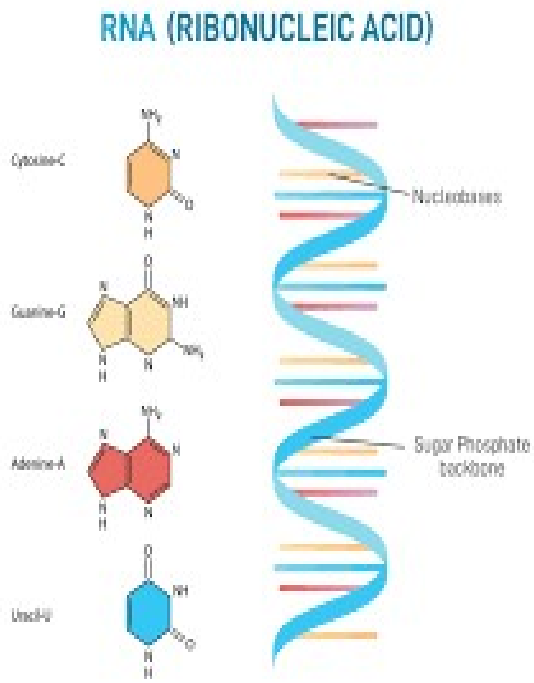
Adenine, Guanine (purines), Cytosine, thymine (pyrimidines)

- DNA is a double helix with 2 strands which gives a ladder-like shape with base pairs
- Base pairing is an application of hydrogen bonding principle
- Adenine= Thymine pair interacts through 2 hydrogen bonds
- Guanine= Cytosine pair interacts through 3 hydrogen bonds



RNA

- Ribonucleic acid (RNA) is a molecule that is present in the majority of living organisms and viruses.
- RNA is single-stranded. An RNA molecule has a backbone made of alternating phosphate groups and the sugar ribose,
- RNA's most important roles is the transcription and delivery of genetic instructions from the
- The information in RNA is stored as code (made up of A,G,U,T).



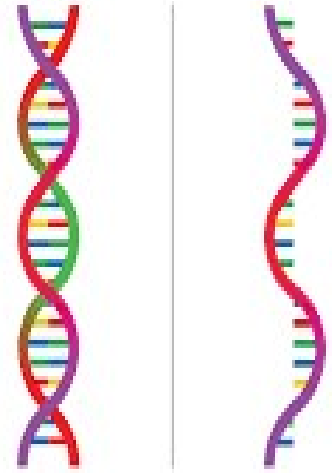
STRUCTURE OF RNA

- Ribonucleic acid Ribonucleic acid, or RNA is one of the major biological macromolecules that are essential for all known forms of life (along with DNA and proteins)
- Each nucleotide in RNA contains a ribose sugar, with carbons numbered 1' through 5'. A base is attached to the 1' position,

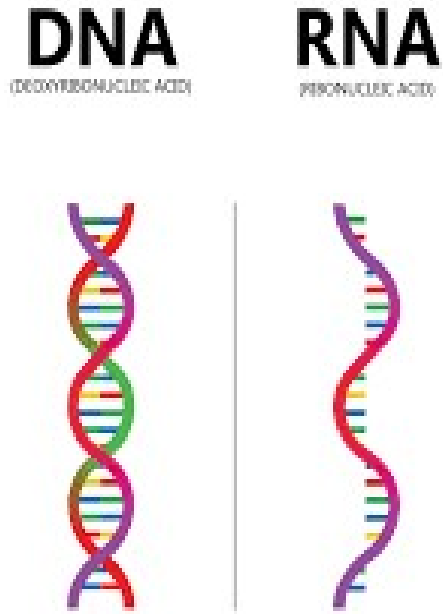
In general,

- adenine (A), cytosine (C),
- guanine(G), and uracil (U).

DNA (Deoxyribonucleic acid)	RNA (Ribonucleic acid)
Definition	
It is a long polymer. It has a deoxyribose and phosphate backbone having four distinct bases: thymine, adenine, cytosine and guanine.	Is a polymer with a ribose and phosphate backbone with four varying bases: uracil, cytosine, adenine and guanine.
Location	
It is located in the nucleus of a cell and in the mitochondria.	It is found in the cytoplasm, nucleus and in the ribosome.
Sugar portion	
It has 2-deoxyribose.	It has Ribose.
Function	
The function of DNA is the transmission of genetic information. It acts as a medium for long-term storage.	RNA is critical for the transmission of the genetic code that is necessary for protein creation from the nucleus to the ribosome.



Predominant Structure	
DNA is a double-stranded molecule that has a long chain of nucleotides.	RNA is a single-stranded molecule which has a shorter chain of nucleotides.
Propagation	
DNA replicates on its own, it is self-replicating.	RNA does not replicate on its own. It is synthesized from DNA when required.
Nitrogenous Bases and Pairing	
The base pairing is as follows: GC (Guanine pairs with Cytosine) A-T (Adenine pairs with Thymine).	The base pairing is as follows: GC (Guanine pairs with Cytosine) A-U (Adenine pairs with Uracil).



FUNCTION OF DNA

1. REPLICATION

- Double helix unwinds and act as an INFORMATION
- A codon specifies a particular template and forms a double helix with the aid of DNA polymerase.

2. ENCODING INFORMATION

- A codon specifies a particular amino acid that produces a particular protein

3. MUTATION/RECOMBINATION

DNA plays a role in evolution of a species

- DNA can repair itself through recombination and mutation occurs due to illegal base pairing
- Both mutation and recombination either beneficial or create genetic diseases

4. GENE EXPRESSION

- Cells from different tissues & organ, look & behave differently
- DNA can respond to produce a particular protein by expressing a particular protein through transcription and translation.

Transcription-making RNA

- Translation-making protein

FUNCTIONS OF DIFFERENT RNA

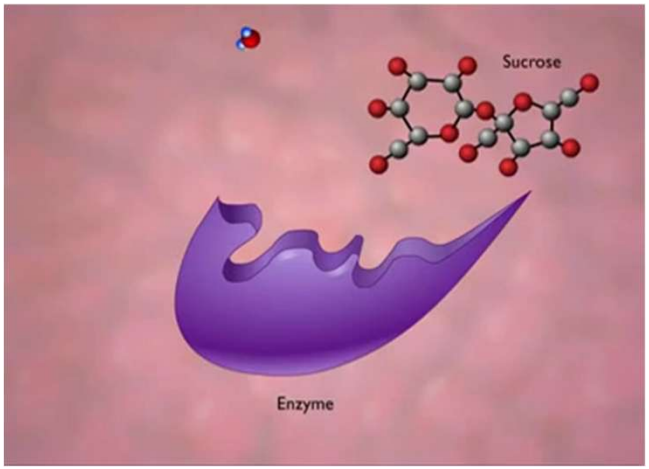
mRNA - It carries genetic formation of DNA (Gene) for protein synthesis from nucleus to ribosome in the form of genetic code

tRNA - Acts as adapter molecule, carries Amino Acid and drops it to particular location by recognising codon on mRNA by virtue of having anticodon

rRNA-It makes complex with proteins and form ribosomal subunits which provide space for protein synthesis, single ribosomal RNA of smaller subunit helps correct orientation of mRNA during attachment with respect to P and A sites

Enzymes

- Enzymes are proteins that help speed up chemical reactions in our bodies.
- Enzymes are essential for digestion, liver function, and much more. Too much or too little of a certain enzyme can cause health problems
- Enzymes in our blood can also help healthcare providers check for injuries and diseases.
- They build some substances and break others down. All living things have enzymes.
- Our bodies naturally produce enzymes. But enzymes are also in manufactured products and food.



THANK YOU!