

MODULE 1 - CELL BASIC UNIT OF LIFE

Cell:

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

Cell Structure:

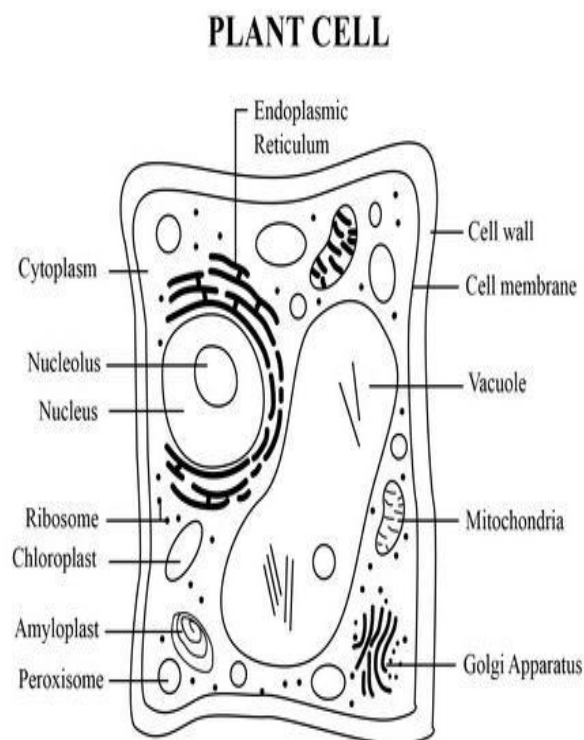
The cell structure comprises individual components with specific functions essential to carry out life's processes. These components include- cell wall, cell membrane, cytoplasm, nucleus, and cell organelles.

Cell Wall:

- The cell wall is the most prominent part of the plant's cell structure. It is made up of cellulose, hemicellulose and pectin.
- The cell wall is present exclusively in plant cells. It protects the plasma membrane and other cellular components. The cell wall is also the outermost layer of plant cells.
- It is a rigid and stiff structure surrounding the cell membrane.
- It provides shape and support to the cells and protects them from mechanical shocks and injuries.

Cell Membrane:

- The cell membrane supports and protects the cell. It controls the movement of substances in and out of the cells. It separates the cell from the external environment.
- The cell membrane is present in all the cells.
- The cell membrane is the outer covering of a cell within which all other organelles, such as the cytoplasm and nucleus, are enclosed.
- It is also referred to as the plasma membrane.



Cytoplasm:

- The cytoplasm is a thick, clear, jelly-like substance present inside the cell membrane.
- The cell organelles such as endoplasmic reticulum, vacuoles, mitochondria, ribosomes, are suspended in this cytoplasm.

Nucleus:

- The nucleus contains the hereditary material of the cell, the DNA.
- It sends signals to the cells to grow, mature, divide and die.
- The nucleus is surrounded by the nuclear envelope that separates the DNA from the rest of the cell.

Cell Organelles:

- Nuclear membrane: The nuclear membrane protects the nucleus by forming a boundary between the nucleus and other cell organelles.
- Chromosomes: Each human cell contains 23 pairs of chromosomes. Chromosomes play a crucial role in the gender determination of an individual.
- Endoplasmic reticulum: The endoplasmic reticulum is involved in the transportation of substances throughout the cell. It plays a primary role in the metabolism of carbohydrates, synthesis of lipids, steroids and proteins.
- Golgi Bodies: Golgi bodies are called the cell's post office as it is involved in the transportation of materials within the cell.
- Ribosome: Ribosomes are the protein synthesisers of the cell.
- Mitochondria: The mitochondrion is called "the powerhouse of the cell." It is called so because it produces ATP – the cell's energy currency.
- Lysosomes: Lysosomes protect the cell by engulfing the foreign bodies entering the cell and help in cell renewal. Therefore, they are known as the cell's suicide bags.
- Chloroplast: Chloroplasts are the primary organelles for photosynthesis. It contains the pigment called chlorophyll.
- Vacuoles: Vacuoles store food, water, and other waste materials in the cell.

Note: Amyloplast: The amyloplast is a colourless plant plastid (double-membrane organelle) that forms and stores starch.

Peroxisome: The main function of peroxisome is the lipid metabolism and the processing of reactive oxygen species. They take part in various oxidative processes.

Functions of Cell

A cell performs major functions essential for the growth and development of an organism.

Important functions of cell are as follows:

- i. Provides support and structure
- ii. Facilitate growth mitosis
- iii. Allows transport of substances
- iv. Energy production
- v. Aids in reproduction

STEM CELLS:

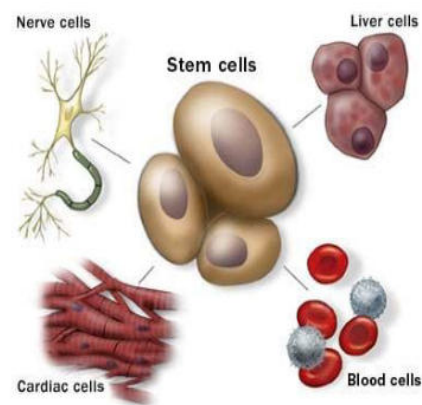
Stem cells are the body's raw materials — cells from which all other cells with specialized functions are generated. Under the right conditions in the body or a laboratory, stem cells divide to form more cells called daughter cells.

Embryonic stem cells:

- Stem cells come from embryos that are 3 to 5 days old.
- At this stage, an embryo is called a blastocyst and has about 150 cells.
- These are pluripotent stem cells (they can divide into more stem cells or can become any type of cell in the body).
- They are used to regenerate or repair diseased tissue and organs.

Adult stem cells:

- These stem cells are found in small numbers in most adult tissues, such as bone marrow or fat.



- Compared with embryonic stem cells, adult stem cells have a more limited ability to give rise to various cells of the body.

Applications of stem cells:

- Tissue regeneration
- Cardiovascular disease treatment
- Brain disease treatment
- Cell deficiency therapy
- Blood disease treatments

BIOMOLECULES:

- Biomolecule, also called biological molecule, that are produced by cells and living organisms
- Biomolecules have a wide range of sizes and structures and perform a vast array of functions
- The four major types of biomolecules are carbohydrates, lipids, nucleic acids, and proteins

Carbohydrates:

- The carbohydrates are macronutrients by which our body obtains its energy.
- They are called carbohydrates as they comprise carbon, hydrogen and oxygen at their chemical level.
- Carbohydrates are essential nutrients which include sugars, fibres and starches
- The building blocks of all carbohydrates are simple sugars called monosaccharides.

Properties:

- Stereoisomerism – Compounds having the same structural formula but they differ in spatial configuration. Example: Glucose has two isomers. They are D-glucose and L-glucose.
- Optical Activity– It is the rotation of plane-polarized light forming (+) glucose and (-) glucose.

- Most monosaccharides have a sweet taste (fructose is sweetest; 73% sweeter than sucrose).
- They are solids at room temperature
- They are extremely soluble in water
- Glucose can dissolve in minute amounts of water to make a syrup

Functions:

- Carbohydrates are helpful in performing many functions such as breakdown of protein molecules, dehydration as well as eliminating ketosis
- They serve as primary energy sources
- They help in the regulation of blood glucose
- They provide the carbon skeleton for the synthesis of some non-essential amino acids.

Nucleic acids:

- Nucleic acids are long-chain polymeric molecules, the monomer (the repeating unit) is known as the nucleotides and hence sometimes nucleic acids are referred to as polynucleotides.
- Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) are two major types of nucleic acids. DNA and RNA are responsible for the inheritance and transmission of specific characteristics from one generation to the other.

Physical and Chemical properties:

1. Solubility: DNA is polar in nature and thus soluble in water.
2. Absorption: At 260 nano meters, the DNA bases can absorb ultraviolet light
3. Denaturation and Renaturation: On heating, both strands denature, and on cooling, they can renature.

Functions:

1. Nucleic Acid is responsible for the synthesis of protein in our body
2. RNA is a vital component of protein synthesis.
3. Loss of DNA content is linked to many diseases.
4. DNA is an essential component required for transferring genes from parents to offspring.
5. All the information of a cell is stored in DNA.

6. DNA fingerprinting is a method used by forensic experts to determine paternity. It is also used for the identification of criminals. It has also played a major role in studies regarding biological evolution and genetics.

Proteins:

- Proteins are the fundamental building blocks of our body.
- They are large and complex macromolecules or bio-molecules which perform a major role in the functioning and regulating of our body cells, tissues and other organs in the human body.

Properties:

- All proteins contain carbon, hydrogen, oxygen, and nitrogen, the presence of nitrogen distinguishing them from carbohydrates and fats. Proteins contain 16% nitrogen
- Some proteins also have sulphur and a few proteins have phosphorus and other elements may be present
- Protein is colourless and tasteless
- All proteins typically range in size from a spherical structure of a crystal to a long fibrillar structure
- The protein's molecules are amphoteric type, they act as acids and alkalis
- Proteins are formed by the repetition of amino acids, linked by peptide bonds

Functions:

- Digestion – The digestive enzymes, which are primarily proteinaceous in origin, carry out digestion.
- Movement – Muscles include a protein called myosin, which helps muscles contract, allowing for movement.
- Structure and Support – The structural protein known as keratin gives humans and other animals hair, nails, and horns.
- Cellular communication – Through receptors on their surface, cells can communicate with other cells and the outside world. These receptors are made of proteins.
- Act as a messenger – These proteins serve as chemical messengers that facilitate communication among cells, tissues, and organs.

Lipids:

“Lipids are organic compounds that contain hydrogen, carbon, and oxygen atoms, which form the framework for the structure and function of living cells.”

These organic compounds are nonpolar molecules

Properties:

- Energy-rich organic molecules
- Soluble in non-polar solvents such as acetone, ether, chloroform, benzene, and alcohol
- Insoluble in water
- Greasy in texture
- Hydrophobic or amphiphilic
- Present either in saturated or unsaturated structural form
- Stored in adipose tissues in the body

Functions:

- Triglycerides transport and store energy.
- Steroid hormones send messages in cells.
- Bile salts from cholesterol help to digest fat.
- Fatty acids metabolize to create energy
- Phospholipids and cholesterol make biological membranes. Phospholipids are like gatekeepers that let some molecules into the cells

SPECIAL BIOMOLECULES:

Enzymes:

“Enzymes can be defined as biological polymers that catalyse biochemical reactions.”

Properties:

1. Enzymes are complex macromolecules with high molecular weight
2. They catalyze biochemical reactions in a cell. They help in the breakdown of large molecules into smaller molecules or bring together two smaller molecules to form a larger molecule
3. Enzymes do not start a reaction. However, they help in accelerating it
4. Enzymes affect the rate of biochemical reaction and not the direction
5. Enzymatic activity decreases with increase in temperature

6. They show maximum activity at an optimum pH of 6 – 8

Functions:

1. Enzymes help in signal transduction. The most common enzyme used in the process includes protein kinase that catalyzes the phosphorylation of proteins.
2. They break down large molecules into smaller substances that can be easily absorbed by the body.
3. They help in generating energy in the body. ATP synthase is the enzyme involved in the synthesis of energy.
4. Enzymes are responsible for the movement of ions across the plasma membrane.
5. Enzymes perform a number of biochemical reactions, including oxidation, reduction, hydrolysis, etc. to eliminate the non-nutritive substances from the body.
6. They function to reorganize the internal structure of the cell to regulate cellular activities.

Vitamins: The vitamins are natural and essential nutrients, required in small quantities and play a major role in growth and development, repair and healing wounds, maintaining healthy bones and tissues, for the proper functioning of an immune system, and other biological functions. These essential organic compounds have diverse biochemical functions.

Fat-soluble vitamin: Fat-soluble vitamins are stored in the fat cells, these vitamins require fat in order to be absorbed. Vitamin A, D, E and K are fat-soluble vitamins.

Water-soluble vitamin: Water-soluble vitamins are not stored in our body as its excess gets excrete through the urine. Therefore, these vitamins need to be replenished constantly. Vitamin B and C are water-soluble vitamins.

Properties:

- Fat soluble vitamins are soluble in fats and fat solvents
- Water soluble vitamins are soluble in water
- Loss of vitamin A in cooking, canning and freezing of food stuffs is small
- Vitamin B1 odour resembles yeast

- Some vitamins are destroyed on exposure to sunlight and few are fairly heat resistant
- Vitamin K is sensitive to light so need to be placed in dark bottle
- Vitamin D is a white and colourless crystalline substance

Functions:

- Vitamin A helps to form and maintain healthy teeth, bones, soft tissue, mucous membranes, and skin
- Vitamin B6 is also called pyridoxine. Vitamin B6 helps to form red blood cells and maintain brain function
- Vitamin B12: Is important for metabolism. It also helps to form red blood cells and maintain the central and peripheral nervous systems.
- Vitamin C, also called ascorbic acid, is an antioxidant that promotes healthy teeth and gums
- Vitamin D is also known as the "sunshine vitamin," Vitamin D helps the body to absorb calcium. Calcium is required for the normal development and maintenance of healthy teeth and bones
- Vitamin E is an antioxidant also known as tocopherol. It helps the body to form red blood cells and use vitamin K
- Vitamin K is needed for blood coagulation

Hormones:

Hormones are various chemicals released within the human body that regulate and control the activities of multiple organs. The introduction of hormones to the blood takes place via endocrine glands.

Properties:

1. They have a low molecular weight; thus, they can easily pass through capillaries
2. They are soluble in water so that they can be transported via blood
3. The importance of hormones is that they are non-antigenic. They are organic catalysts. Hormones act as coenzymes of other enzymes in the human body
4. Hormones, in their first action, cause a limited number of reactions and do not influence any metabolic activities of a cell directly
5. A significant characteristic of hormones is that, after their function is over, they are readily destroyed, excreted or inactivated

Functions:

1. Regulating mood and cognitive functions
2. Growth and development
3. Food metabolism
4. Maintaining body temperature
5. Controlling thirst and hunger
6. Initiating and maintaining sexual development and reproduction