

UNIT I BASIC ELEMENTS OF HUMAN BODY

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Cell – Cell Structure and organelles - Functions of each component in the cell. Cell membrane – transport across membrane - Action potential (Nernst, Goldman equation), Homeostasis. Tissue: Types, functions..

Definitions:

1. Anatomy is a branch of biology and medicine that is the consideration of the structure of living things.
2. Physiology is the science of the function of living systems. It is a subcategory of biology. In physiology, the scientific method is applied to determine how organisms, organ systems, organs, cells and biomolecules carry out the chemical or physical function that they have in a living system

Cells as the Living Units of the Body:

The basic living unit of the body is the cell. Each organ is an aggregate of many different cells held together by intercellular supporting structures.

Each type of cell is specially adapted to perform one or a few particular functions. For instance, the red blood cells, numbering 25 trillion in each human being, transport oxygen from the lungs to the tissues. Although the red cells are the most abundant of any single type of cell in the body, there are about 75 trillion additional cells of other types that perform functions different from those of the red cell. The entire body, then, contains about 100 trillion cells. 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 and lipids. Moreover, cellular structures called cell organelles are suspended in the cytoplasm.

Characteristics of Cells

Following are the various essential characteristics of cells:

- Cells provide structure and support to the body of an organism.

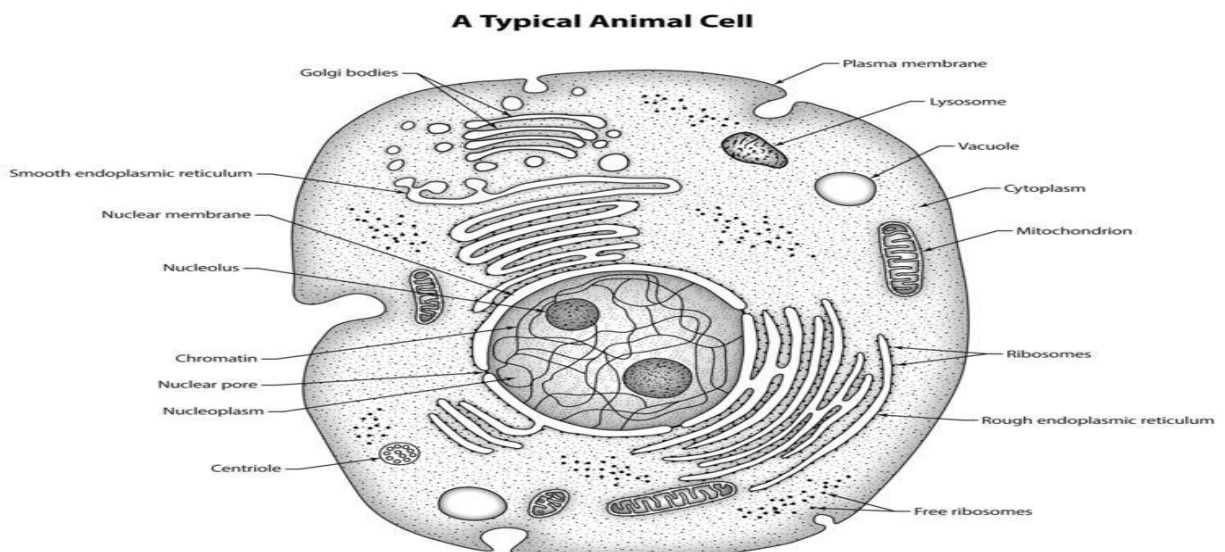
- The cell interior is organised into different individual organelles surrounded by a separate membrane.
- The nucleus (major organelle) holds genetic information necessary for reproduction and cell growth.
- Every cell has one nucleus and membrane-bound organelles in the cytoplasm.
- Mitochondria, a double membrane-bound organelle is mainly responsible for the energy transactions vital for the survival of the cell.
- Lysosomes digest unwanted materials in the cell.
- Endoplasmic reticulum plays a significant role in the internal organisation of the cell by synthesising selective molecules and processing, directing and sorting them to their appropriate locations.

Functions of cells:

1. Growth and metabolism
2. Creation
3. Protein synthesis
4. Movement or motility
5. Evolution

Organization of the Cell

Its two major parts are the nucleus and the cytoplasm. The nucleus is separated from the cytoplasm by a nuclear membrane, and the cytoplasm is separated from the surrounding fluids by a cell membrane, also called the plasma membrane



The different substances that make up the cell are collectively called protoplasm. Protoplasm is composed mainly of five basic substances: water, electrolytes, proteins, lipids, and carbohydrates

Prokaryotic Cells

1. 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.
2. They all are single-celled microorganisms. Examples include archaea, bacteria, and cyanobacteria.
3. The cell size ranges from 0.1 to 0.5 μm in diameter.
4. The hereditary material can either be DNA or RNA.
5. Prokaryotes generally reproduce by binary fission, a form of asexual reproduction. They are also known to use conjugation – which is often seen as the prokaryotic equivalent to sexual reproduction (however, it is NOT sexual reproduction).

Eukaryotic Cells

1. Eukaryotic cells are characterised by a true nucleus.
2. The size of the cells ranges between 10–100 μm in diameter.
3. This broad category involves plants, fungi, protozoans, and animals.
4. 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.
5. They reproduce sexually as well as asexually.
6. 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.

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. Read on to explore more insights on cell structure and function.

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.
- By structure, it is a porous membrane (with pores) which permits the movement of selective substances in and out of the cell. Besides this, the cell membrane also protects the cellular component from damage and leakage.
- It forms the wall-like structure between two cells as well as between the cell and its surroundings.
- Plants are immobile, so their cell structures are well-adapted to protect them from external factors. The cell wall helps to reinforce this function.

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.

Cytoplasm

The cytoplasm is a jelly-like substance that fills the interior space of cells. It is mainly composed of water, but also contains salts, enzymes, and other organic molecules. The cytoplasm surrounds and protects the organelles of the cell and is where many cellular processes (such as protein synthesis and glycolysis) take place.

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

Nucleus

The nucleus is the control center of the cell and houses all of the cell's genetic information. Usually, a cell has a single nucleus that contains all of its DNA molecules, but some (such as skeletal muscle cells) have more than one nucleus.

The nucleus protects the cell's DNA while controlling all other cellular activities, such as cell division, growth, protein production, and cell death

- 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.
- The nucleus protects the DNA and is an integral component of a plant's cell structure.

Cell Organelles

Cells are composed of various cell organelles that perform certain specific functions to carry out life's processes. The different cell organelles, along with its principal functions, are as follows:

Nucleolus
The nucleolus is the site of ribosome synthesis. Also, it is involved in controlling cellular activities and cellular reproduction.
Nuclear membrane
The nuclear membrane protects the nucleus by forming a boundary between the nucleus and other cell organelles.
Chromosomes

Chromosomes play a crucial role in determining the sex of an individual. Each human cells contain 23 pairs of chromosomes.

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. The endoplasmic reticulum is a network of membranes inside a cell, and its main functions are to process and transport new materials. There are two types of endoplasmic reticulum; the rough ER, and the smooth ER. The rough ER is studded with ribosomes, giving it a bumpy or 'rough' appearance. It folds and tags newly-synthesized proteins before transporting them to wherever they are needed in the body. The smooth ER does not have ribosomes attached to it and is instead involved in hormone and lipid synthesis.

Golgi Bodies

Golgi bodies are called the cell's post office as it is involved in the transportation of materials within the cell. Once newly-synthesized substances have left the ER, they are sent to the Golgi apparatus. This is a series of flattened, membrane-bound sacs that packages and distributes substances to the outer cell membrane, where they either become part of the lipid bilayer or leave the cell.

Ribosome

Ribosomes are the protein synthesisers of the cell. The DNA molecules housed in the nucleus also contain blueprints for all of the proteins produced by a cell. These blueprints are 'read' and interpreted by ribosomes, which are the site of protein production in plant and animal cells. Ribosomes produce proteins by assembling amino acid sequences according to the instructions contained in the genetic code. The resulting polypeptide chains are then folded into specific primary, tertiary, or quaternary 3D structures by other cell organelles.

Mitochondria

The mitochondrion is called "the powerhouse of the cell." It is called so because it produces ATP – the cell's energy currency. Cells need energy to power their biochemical reactions, and most of that energy is released by mitochondria. Mitochondria are the site of respiration and the 'powerhouses' of cells, pumping out energy which is then stored in ATP (adenosine triphosphate). ATP molecules are the energy currency of cells and are used to fuel all the other activities of the cell.

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. Lysosomes are small, spherical organelles that are packed full of digestive enzymes. Their key function is to break down and recycle unwanted material for the cell, such as old cell parts or invading bacteria and viruses. Lysosomes also play an important role in apoptosis

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.

Cell Theory

Cell Theory was proposed by the German scientists, Theodor Schwann, Matthias Schleiden, and Rudolf Virchow. The cell theory states that:

- All living species on Earth are composed of cells.
- A cell is the basic unit of life.
- All cells arise from pre-existing cells.

A **modern version of the cell theory** was eventually formulated, and it contains the following postulates:

- Energy flows within the cells.
- Genetic information is passed on from one cell to the other.
- The chemical composition of all the cells is the same.

Functions of Cell

A cell performs major functions essential for the growth and development of an organism. Important functions of cell are as follows:

Provides Support and Structure

All the organisms are made up of cells. They form the structural basis of all the organisms. The cell wall and the cell membrane are the main components that function to provide support and structure to the organism. For eg., the skin is made up of a large number of cells. Xylem present in the vascular plants is made of cells that provide structural support to the plants.

Facilitate Growth Mitosis

In the process of mitosis, the parent cell divides into the daughter cells. Thus, the cells multiply and facilitate the growth in an organism.

Allows Transport of Substances

Various nutrients are imported by the cells to carry out various chemical processes going on inside the cells. The waste produced by the chemical processes is eliminated from the cells by active and passive transport. Small molecules such as oxygen, carbon dioxide, and ethanol diffuse across the cell membrane along the concentration gradient. This is known as passive transport. The larger molecules diffuse across the cell membrane through active transport where the cells require a lot of energy to transport the substances.

Energy Production

Cells require energy to carry out various chemical processes. This energy is produced by the cells through a process called photosynthesis in plants and respiration in animals.

Aids in Reproduction

A cell aids in reproduction through the processes called mitosis and meiosis. Mitosis is termed as the asexual reproduction where the parent cell divides to form daughter cells. Meiosis causes the daughter cells to be genetically different from the parent cells.

Thus, we can understand why cells are known as the structural and functional unit of life. This is because they are responsible for providing structure to the organisms and perform several functions necessary for carrying out life's processes.