M.Sc. III Semester
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Unit- I

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Biological Cell and its Constituents

Intoduction

History : Cells were discovered by Robert Hooke in 1665, who named them for their resemblance to cells inhabited by Christian monks in a monastery. He used simple lenses to observe cork in which he saw tiny components and called cells (cellulae). Cell theory, first developed in 1839 by Matthias Jakob Schleiden and Theodor Schwann, states that all organisms are composed of one or more cells, that cells are the fundamental unit of structure and function in all living organisms, and that all cells come from pre-existing cells.[9] Cells emerged on Earth at least 3.5 billion years ago.

Cell : The cell (from Latin cella, meaning "small room") is a basic unit of structure and function of life. In other word cells are the structural and functional unit of living organism. It is the basic structural, functional, and biological unit of all known organisms. A cell is the smallest unit of life. Cells are often called the "building blocks of life".
Cells consist of -
[1] Cytoplasm enclosed within a membrane, which contains many biomolecules such as proteins and nucleic acids.

[2] Most plant and animal cells are only visible under a microscope, with dimensions between 1 and 100 micrometres.

[3] Organisms can be classified as unicellular (consisting of a single cell such as bacteria) or multicellular (dozen or thousands cell such as plants and animals). Human body or corn plant is having at least10^{13} cells.
Most unicellular organisms are classed as microorganisms.

The number of cells in plants and animals varies from species to species; it has been estimated that humans contain somewhere around 40 trillion cells. The human brain accounts for around 80 billion of these cells.

All plant and animal cells have cell membranes. The cell membrane surrounds and protects the cytoplasm. Cytoplasm is part of the protoplasm and is the living component of the cell. The cell membrane is composed of a double layer (bilayer) of special lipids (fats) called phospholipids.

Basic aspects

Structural organization of cell: All cells have three basic parts

(1) Plasma membrane :- Separate each cell from the environment and permits the flow of molecules across the membrane.
(2) DNA :- containing region occupies a portion of the interior.
(3) The Cytoplasm contains membrane- bound compartments (except bacteria) particles and filament all bathed in a semifluid substances.

Types of cell

Cells are of two types: Eukaryotic, which contain a nucleus, and prokaryotic, which do not. Prokaryotes are single-celled organisms, while eukaryotes can be either single-celled or multicellular.

Prokaryotic cells
Main article: Prokaryote
Structure of a typical prokaryotic cell
Prokaryotes include bacteria and archaea, two of the three domains of life. Prokaryotic cells were the first form of life on Earth, characterized by having vital biological processes including cell signaling. They are simpler and smaller than eukaryotic cells, and lack a nucleus, and other membrane-bound organelles. The DNA of a prokaryotic cell consists of a single circular chromosome that is in direct contact with the cytoplasm. The nuclear region in the cytoplasm is called the nucleoid. Most prokaryotes are the smallest of all organisms ranging from 0.5 to 2.0 μm in diameter.
A prokaryotic cell has three regions:
Enclosing the cell is the cell envelope – generally consisting of a plasma membrane covered by a cell wall which, for some bacteria, may be further covered by a third layer called a capsule. Though most prokaryotes have both a cell membrane and a cell wall, there are exceptions such as Mycoplasma (bacteria) and Thermoplasma (archaea) which only possess the cell membrane layer. The envelope gives rigidity to the cell and separates the interior of the cell from its environment, serving as a protective filter. The cell wall consists of peptidoglycan in bacteria, and acts as an additional barrier against exterior forces. It also prevents the cell from expanding and bursting (cytolysis) from osmotic pressure due to a hypotonic environment. Some eukaryotic cells (plant cells and fungal cells) also have a cell wall.
Inside the cell is the cytoplasmic region that contains the genome (DNA), ribosomes and various sorts of inclusions. The genetic material is freely found in the cytoplasm. Prokaryotes can carry extrachromosomal DNA elements called plasmids, which are usually circular. Linear bacterial plasmids have been identified in several species of spirochete bacteria, including members of the genus Borrelia notably Borrelia burgdorferi, which causes Lyme disease. Though not forming a nucleus, the DNA is condensed in a nucleoid. Plasmids encode additional genes, such as antibiotic resistance genes.
On the outside, flagella and pili project from the cell's surface. These are structures (not present in all prokaryotes) made of proteins that facilitate movement and communication between cells.

Eukaryotic cells
Main article: Eukaryote
Structure of a typical Eukaryotic cells
Plants, animals, fungi, slime moulds, protozoa, and algae are all eukaryotic. These cells are about fifteen times wider than a typical prokaryote and can be as much as a thousand times greater in volume. The main distinguishing feature of eukaryotes as compared to prokaryotes is compartmentalization: the presence of membrane-bound organelles (compartments) in which

specific activities take place. Most important among these is a cell nucleus, an organelle that houses the cell's DNA. This nucleus gives the eukaryote its name, which means "true kernel (nucleus)". A well form/developed nucleus.
Other differences include:
The plasma membrane resembles that of prokaryotes in function, with minor differences in the setup. Cell walls may or may not be present.
The eukaryotic DNA is organized in one or more linear molecules, called chromosomes, which are associated with histone proteins. All chromosomal DNA is stored in the cell nucleus, separated from the cytoplasm by a membrane. Some eukaryotic organelles such as mitochondria also contain some DNA.
Many eukaryotic cells are ciliated with primary cilia. Primary cilia play important roles in chemosensation,
mechanosensation, and thermosensation. Each cilium may thus be "viewed as a sensory cellular antennae that coordinates a large number of cellular signaling pathways, sometimes coupling the signaling to ciliary motility or alternatively to cell division and differentiation.
Motile eukaryotes can move using motile cilia or flagella. Motile cells are absent in conifers and flowering plants. Eukaryotic flagella are more complex than those of prokaryotes.

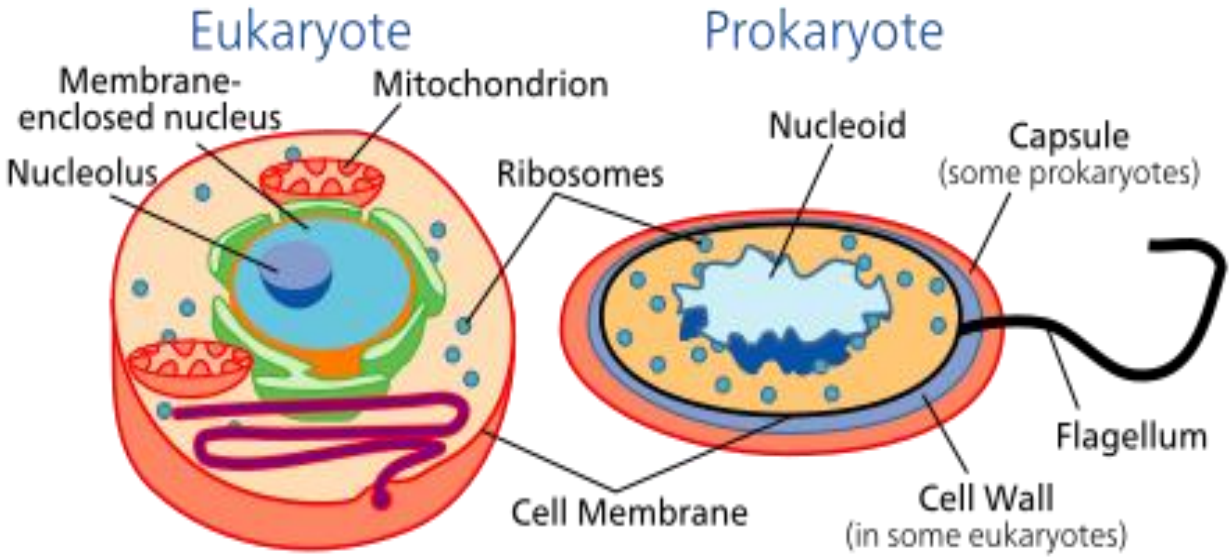

Fig. 1: Structure of Eukaryotic and Prokaryotic Cell

Structure of generalized cell

Ideas about cell structure have changed considerably over the years. Early biologists saw cells as simple membranous sacs containing fluid and a few floating particles. Today's biologists know that cells are infinitely more complex than this.

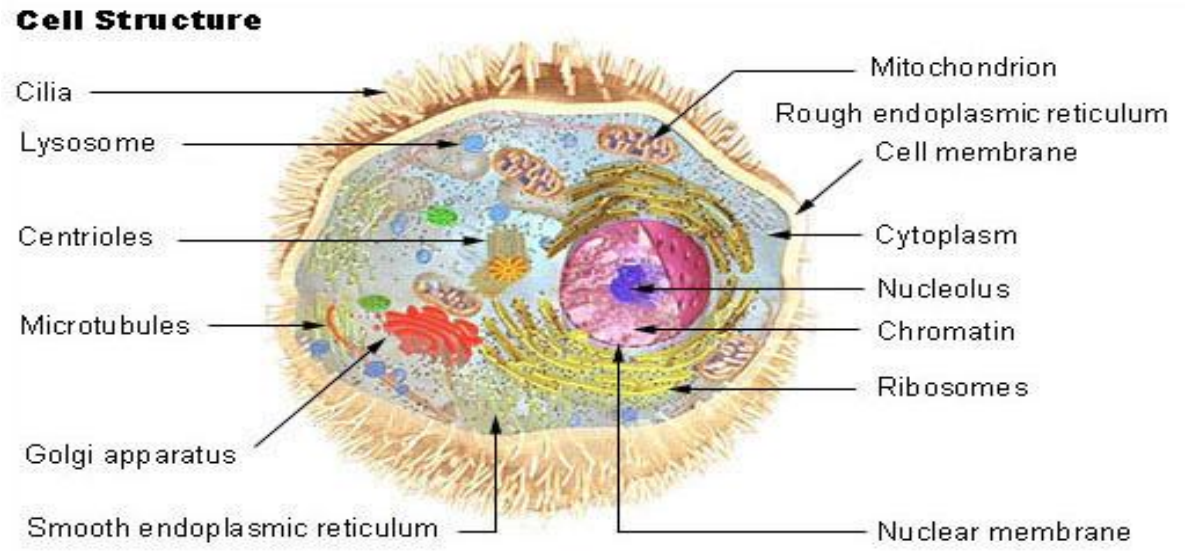

Fig. 2: Generalized Structure of the Cell

There are many different types, sizes, and shapes of cells in the body. For descriptive purposes, the concept of a "generalized cell" is introduced. It includes features from all cell types. A cell consists of three parts: the cell membrane, the nucleus, and, between the two, the cytoplasm. Within the cytoplasm lie intricate arrangements of fine fibers and hundreds or even thousands of miniscule but distinct structures called organelles.

Cell membrane

Every cell in the body is enclosed by a cell (Plasma) membrane. The cell membrane separates the material outside the cell, extracellular, from the material inside the cell, intracellular. It maintains the integrity of a cell and controls passage of materials into and out of the cell. All materials within a cell must have access to the cell membrane (the cell's boundary) for the needed exchange.

The cell membrane is a double layer of phospholipid molecules. Proteins in the cell membrane provide structural support, form channels for passage of materials, act as receptor sites, function as carrier molecules, and provide identification markers.

Nucleus and Nucleolus

The nucleus, formed by a nuclear membrane around a fluid nucleoplasm, is the control center of the cell. Threads of chromatin in the nucleus contain deoxyribonucleic acid (DNA), the genetic material of the cell. The nucleolus is a dense region of ribonucleic acid (RNA) in the nucleus and is the site of ribosome formation. The nucleus determines how the cell will function, as well as the basic structure of that cell.

Cytoplasm

The cytoplasm is the gel-like fluid inside the cell. It is the medium for chemical reaction. It provides a platform upon which other organelles can operate within the cell. All of the functions for cell expansion, growth and replication are carried out in the cytoplasm of a cell. Within the cytoplasm, materials move by diffusion, a physical process that can work only for short distances.

Cytoplasmic organelles

Cytoplasmic organelles are "little organs" that are suspended in the cytoplasm of the cell. Each type of organelle has a definite structure and a specific role in the function of the cell. Examples of cytoplasmic organelles are mitochondrion, ribosomes , endoplasmic reticulum, golgi apparatus, and lysosomes.

Cell function

The structural and functional characteristics of different types of cells are determined by the nature of the proteins present. Cells of various types have different functions because cell structure and function are closely related. It is apparent that a cell that is very thin is not well suited for a protective function. Bone cells do not have an appropriate structure for nerve impulse conduction. Just as there are many cell types, there are varied cell functions. The generalized cell functions include movement of

substances across the cell membrane, cell division to make new cells, and protein synthesis.

Movement of substances across the cell membrane

The survival of the cell depends on maintaining the difference between extracellular and intracellular material. Mechanisms of movement across the cell membrane include simple diffusion, osmosis, filtration, active transport, endocytosis, and exocytosis.

Simple diffusion is the movement of particles (solutes) from a region of higher solute concentration to a region of lower solute concentration. Osmosis is the diffusion of solvent or water molecules through a selectively permeable membrane. Filtration utilizes pressure to push substances through a membrane. Active transport moves substances against a concentration gradient from a region of lower concentration to a region of higher concentration. It requires a carrier molecule and uses energy. Endocytosis refers to the formation of vesicles to transfer particles and droplets from outside to inside the cell. Secretory vesicles are moved from the inside to the outside of the cell by exocytosis.