



Department of biology



Department of Biology
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Cell Biology
Stage (-3-)

LEC- ((3))

Cell Structure

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Cell structure

1- Cell membrane

Both prokaryotic and eukaryotic cells have a cell Membrane is a phospholipid bilayer with proteins, separates the internal contents of the cell from its surrounding environment, is present in all organisms.

*The cell membrane is also known as the plasma membrane.

The main functions of the cell membrane include:

- Protecting the integrity of the interior cell.
- Providing support and maintaining the shape of the cell.
 - plays an important role in cell signaling and communication.
- It acts as a selectively permeable membrane by allowing the entry of only selected substances into the cell.

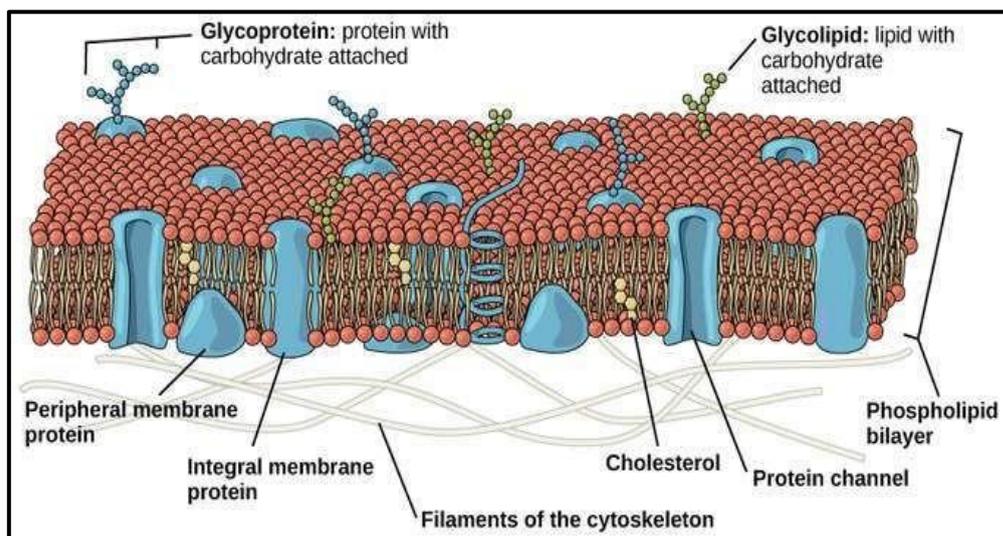


Figure1: Eukaryotic Plasma Membrane: The eukaryotic plasma membrane is a phospholipid bilayer with proteins and cholesterol embedded

2- Cell wall

The cell wall is present only in plants, fungi, and bacteria. The cell wall is the outer most covering of plant cells .It is present outside the cell membrane and is tough, flexible and sometimes rigid in its texture. It is mainly composed of cellulose, long fibres of carbohydrates including hemicellulose, lignin, and pectin.

The main functions of the cell wall



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Protecting the cell against physical damage and invading pathogens.

- *Regulate and controls the direction of cell growth
- *Providing the strength, structural support and maintaining the shape of the cell.
- *Functions as a storage unit by storing carbohydrates for use in plant growth, especially in seeds.
- *It acts as a selectively permeable membrane by allowing the entry of small molecules to pass through it.

Difference between cell wall and cell membrane

Cell Membrane	Cell wall
Present in all types of cells, in humans, animals, plants, bacteria, etc	Present only in plants, and in some fungi, bacteria, algae.
It is an outermost, living organelle of the cell which provides shape to the cell.	It is the outer non-living part of the cell and provides a fixed shape.
It is a bi-lipid layer. And is composed of lipo-proteins and carbohydrates.	It is made up of pectin, chitin, lignin, glycol proteins, glycolipids, sugar, and cellulose.
It is thin and delicate structure.	It is the thick and rigid structure.
metabolically active	metabolically inactive
The cell membrane has receptors	Cell wall lack receptors
membrane is permeable	cell wall is semi-permeable
Functions include permeability, signal reception, motility conduction, cell division, sexual reproduction etc.	Functions include protection from the external environment.

3-Cytoplasm

The cytoplasm is the entire region of a cell between the plasma membrane



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and the nuclear envelope. It is made up of organelles suspended in the gel-like cytosol, the cytoskeleton, and various chemicals.

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.

Functions of the cytoplasm:

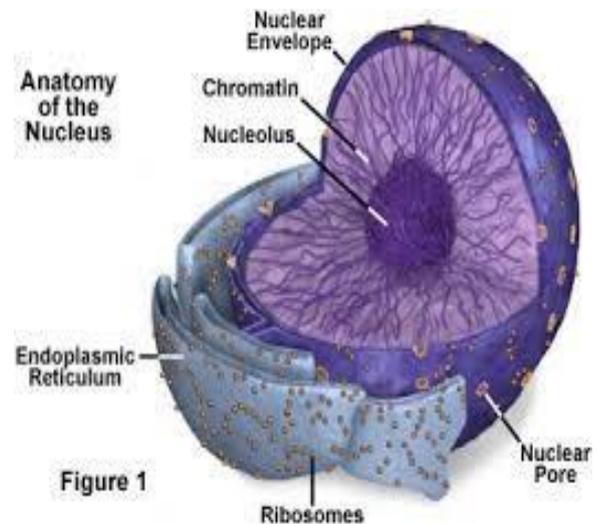
- 1)Energy production through metabolic reactions.
- 2)Biosynthetic processes, and photosynthesis in plants.
- 3)The cytoplasm is also the storage place of energy within the cell.

4- Nucleus

The nucleus, the largest organelle of the cell, includes the nuclear envelope, nucleolus, and chromatin and contains the genetic material encoded in the deoxyribonucleic acid (DNA) of chromosomes.

Chromatin :- consists of double-stranded DNA complexed with proteins histones. It is responsible for RNA synthesis

Functions of the nucleus: directs protein synthesis in the cytoplasm via ribosomal ribonucleic acid (r RNA), messenger RNA (mRNA), and transfer RNA (t RNA). All forms of RNA are synthesized in the nucleus





5- Ribosomes

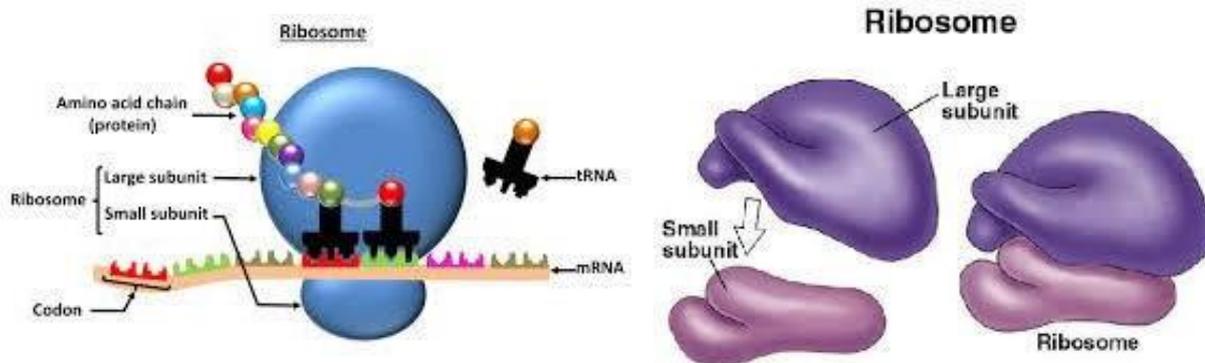
Ribosomes are a cell structure that makes protein. Protein is needed for many cell functions such as repairing damage or directing chemical processes. Ribosomes can be found floating within the cytoplasm or attached to the endoplasmic reticulum. Ribosomes are small organelles found in each type of cell Prokaryotic and Eukaryotic

A ribosome has two main constituent elements

Protein = 25-40% and RNA = 37-62%

Two main subunits are present : A larger subunit

A smaller subunit



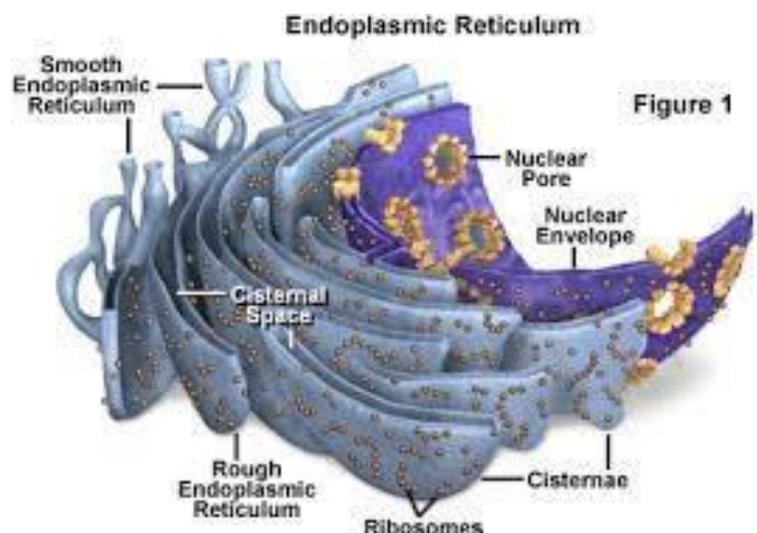
6 - Endoplasmic reticulum (ER)

The endoplasmic reticulum (ER) is a type of organelle found in eukaryotic cells that forms an interconnected network.

The membranes of the ER are continuous with the outer nuclear membrane. The endoplasmic reticulum occurs in most eukaryotic cells, but is absent from red blood cells and spermatozoa.

- There are two types of ER: rough endoplasmic reticulum (RER) and smooth endoplasmic reticulum (SER).

The outer face of the rough endoplasmic reticulum is studded with ribosomes that are the sites of





protein synthesis. The rough endoplasmic reticulum is especially prominent in cells such as hepatocytes.

The smooth endoplasmic reticulum lacks ribosomes and functions in lipid synthesis but not metabolism, the production of steroid hormones, and detoxification. The smooth ER is especially abundant in mammalian liver and gonad cells.

7- Golgi apparatus

The Golgi apparatus is a major collection and **transmission station of protein products received from the endoplasmic reticulum (ER)**, and also **stores and modify proteins for specific functions and prepare them for transport to other parts of the cell.**

Proteins synthesized in the ER are packaged into vesicles, which then integrate with the Golgi apparatus.

Golgi apparatus composed of stacks of membrane bound structures known as Cisternae (Cisternae is a flattened membrane disk).

The Golgi apparatus occurs in all cells except the prokaryotic (viz., mycoplasmas, bacteria and blue green algae) and eukaryotic cells of certain fungi, sperm cells of bryophytes mature sperms or red blood cells of animals.

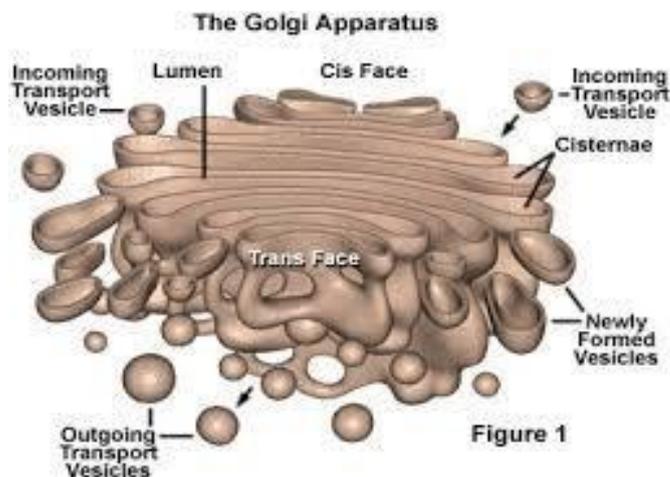
One animal cell usually contain a single Golgi apparatus. But number vary from cell to cell and from animal to animal. • Nerve cells ,liver cell and oocytes have multiple Golgi apparatuses.

Single algal cell contains 25,000 Golgi apparatuses

The main function of the **Golgi apparatus is to modify, sort and package the macromolecules that are synthesized by the cells.**They are also **involved in the transport of lipid molecules around the cell and also formation of lysosomes**

8- Mitochondria

Mitochondria are most plentiful in cells that require significant amounts of energy to function, such as liver and muscle cells.



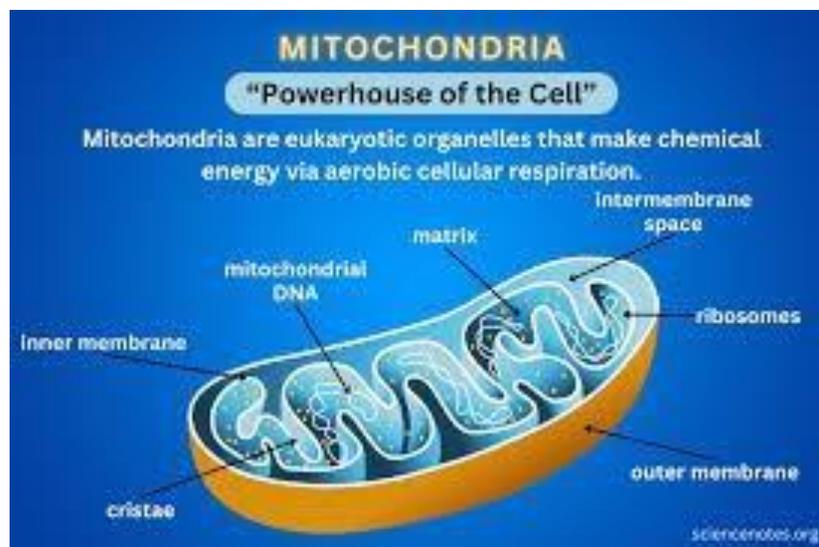


The number of mitochondria in a cell can vary widely by organism, tissue, and cell type. For instance, red blood cells have no mitochondria, whereas liver cells can have more than 2000.

A mitochondrion contains DNA, which is organized as several copies of a single, usually circular chromosome.

The structure of a mitochondrion supports the hypothesis that mitochondria were originally prokaryotes that became engulfed by a cell. Mitochondria are bound by a double membrane. Mitochondria have their own genes—and they reproduce themselves ATP-ADP Cycle. The ATP resembles that of a rechargeable battery.

The inner membrane is folded to form little shelves called cristae. This project into the matrix, an inner space filled with a gel-like fluid (Figure 3). The matrix of a mitochondrion contains enzymes for breaking down glucose products. ATP production then occurs at the cristae. Protein complexes that aid in the conversion of energy are located in an assembly-line fashion on these membranous shelves.



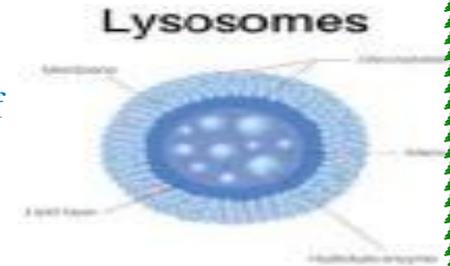


9- Lysosomes

Lysosomes a membrane bounded organelle (spherical shape) , found in the cytoplasm of eukaryotic cells, which contains digestive enzymes.

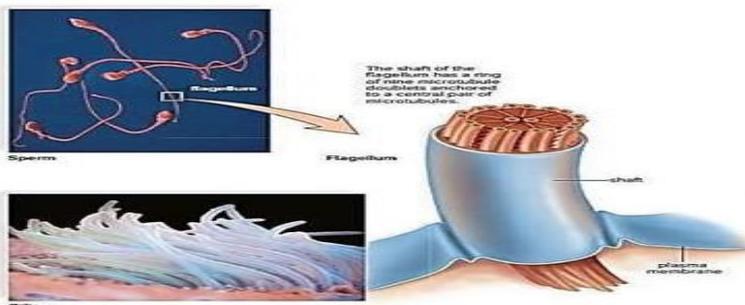
The primary function of lysosomes is **degradation of extra and intra cellular material**. Some important enzymes found within lysosomes include:

Lipase, which digests lipids
Amylase, which digest carbohydrates
Proteases, which digest proteins
Nucleases, which digest nucleic acid .



10 - Cilia and Flagella

Cilia (sing., cilium) and flagella (sing., flagellum) are involved in movement. The ciliated cells that line our respiratory tract sweep back up the throat the debris trapped within mucus. Similarly, ciliated cells move an egg along the uterine tube, where it may be fertilized by a flagellated sperm cell (Figure 5). Motor molecules, powered by ATP, allow the microtubules in cilia and flagella to interact and bend and, thereby, move.



Structure of cilia and flagella

11- Centriole

In cell biology a centriole is a cylindrical organelle composed mainly of a protein called tubulin. Centrioles are found in most eukaryotic cells. A bound pair of centrioles, surrounded by a shapeless mass of dense material, called the pericentriolar material (PCM), makes up a structure called a centrosome.



Centrioles are typically made up of nine sets of short microtubule triplets, arranged in a cylinder. The main function of centrioles is to produce cilia during interphase and the aster and the spindle during cell division. Centrioles are involved in the organization of the mitotic spindle and in the completion of cytokinesis. The centrioles can self-replicate during cell division. Centrioles are a very important part of centrosomes, which are involved in organizing microtubules in the cytoplasm. The position of the centriole determines the position of the nucleus and plays a crucial role in the spatial arrangement of the cell.

12-The Cytoskeleton

Movement and Cell Junctions

It took a high-powered electron microscope to discover that the cytoplasm of the cell is containing by several types of protein fibers, called the **cytoskeleton**. The cytoskeleton helps maintain a cell's shape and either anchors the organelles or assists in their movement, as appropriate. In the cytoskeleton, **microtubules** are much larger than **actin** filaments. Each is a cylinder that contains rows of a protein called **tubulin**. Microtubules help maintain the shape of the cell and act as tracks along which organelles move. During cell division, microtubules form spindle fibers, which assist in the movement of chromosomes.

Actin filaments, made of a protein called actin, are long; extremely thin fibers that usually occur in bundles or other groupings. Actin filaments are involved in movement. Microvilli, which project from certain cells, contain actin filaments.

Intermediate filaments, as their name implies, are intermediate in size between microtubules and actin filaments.



12-Vacuole

A vacuole is a membrane-bound organelle which is present in all plant and fungal cells and some protist, animal, and bacterial cells. Vacuoles are essentially enclosed compartments which are filled with water containing inorganic and organic molecules including enzymes in solution, though in certain cases they may contain solids which have been engulfed. Vacuoles are formed by the fusion of multiple membrane vesicles and are effectively just larger forms of these. The organelle has no basic shape or size.

Vacuole Functions

The function of vacuoles varies according to the type of cell in which they are present. In general, the functions of the vacuole include:

Isolating materials that might be harmful or a threat to the cell.

- 1) Containing waste products.
- 2) Containing water in plant cells.
- 3) Maintaining internal hydrostatic pressure within the cell.
- 4) Maintaining an acidic internal pH.

In protists, vacuoles have the function of storing food which has been absorbed by the organism and assisting in the digestive and waste management process for the cell. In animal cells, vacuoles assist in processes of exocytosis and endocytosis, (there are some animal cells that do not have any vacuoles).