Cell: The unit of life

The basic structural and functional unit of life that is capable of independent existence and performing essential functions of life is called as the cell. All organisms including plants, animals are made up of cell. So, cells are considered as basic unit of life. **Robert Hooke** first discovered cells in a piece of cork.

Different types of cell

There are different types of cells found in human body. This includes hepatocytes in liver, nephrons in kidney, neurons in brain, etc. Different cells are grouped together to form tissues which perform specific function.

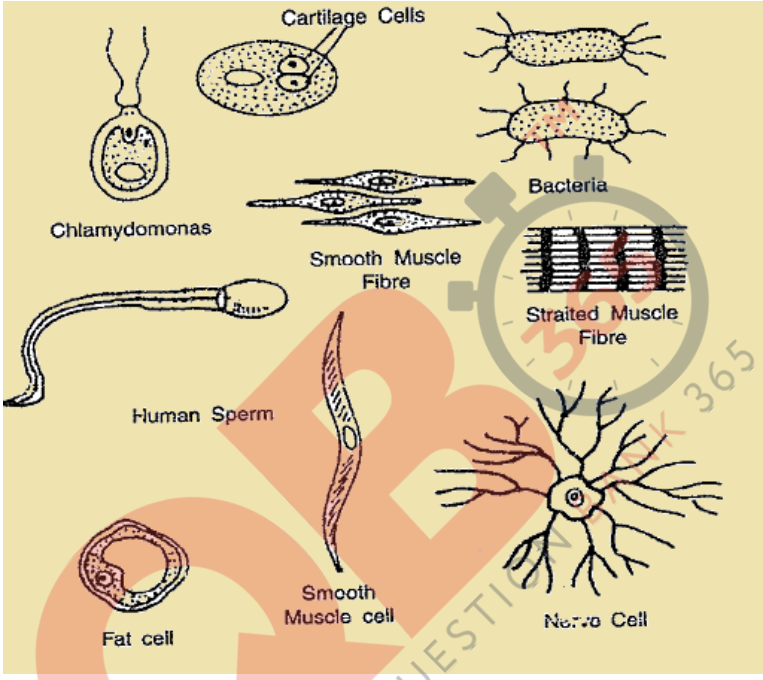


Fig.1. Different types of cells

Cell theory

In 1839, Schleiden, German botanist, and Schwann, a British zoologist, developed the cell theory or cell doctrine. The modern theory includes the following components-

- All living organisms are made up of cells.
- Cell is the structural and functional unit of life.
- All cells arise from the pre-existing cells. This was given by Rudolf Virchow.
- Energy flow occurs within the cells.
- Cells contains the heredity information which is passed from cell to cell.
- All cells have same chemical composition.

Structure of eukaryotic cells

Plasma membrane

Plasma membrane is a dynamic, fluid structure that forms the external boundary of the cell. It is a selectively permeable in nature. It allows only certain solutes to pass through it. In 1972, Jonathan Singer and Garth Nicolson proposed structure of the plasma membrane with the help of fluid mosaic model. According to this model, membrane is viewed as quasi-fluid structure in which proteins are embedded throughout the lipid bilayer. The bilayer is composed of two leaflets of amphipathic molecules with polar head and non-polar tails.

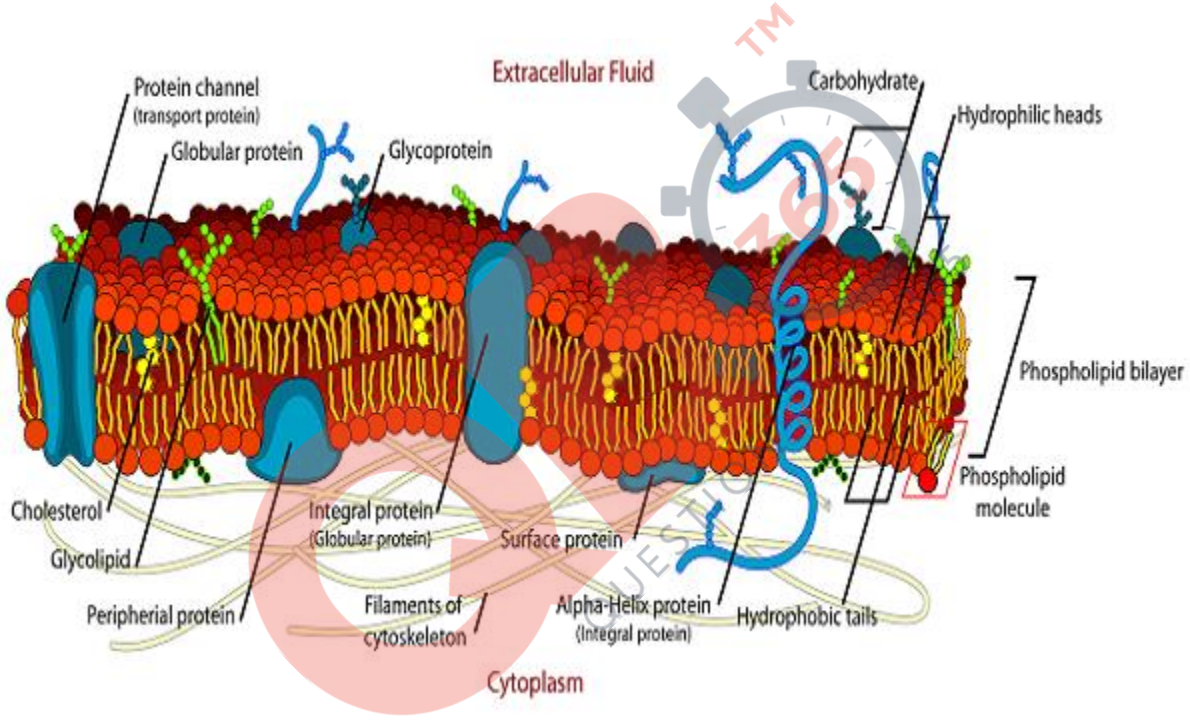


Fig. 2. Structure of the plasma membrane

The primary forces for organizing lipid bilayer are hydrophobic interactions. Three classes of lipids that are present in plasma membrane are phospholipids, glycolipids, and sterol. Membrane also contains two types of protein- peripheral proteins and integral proteins. Proteins which are held with the bilayer loosely and can be easily removed is known as peripheral proteins. Proteins that are held in the lipid bilayer very tightly and cannot be released easily is known as integral proteins.

Cell Wall:

A rigid non-living structure surrounding the plasma membrane is found in plant and fungal cells. It is called as cell wall. It provides shape to the cell. It also protects the cell against mechanical damage and infection. It prevents

the entry of unwanted macromolecules. Cell wall is essential for cell-to-cell transport and interaction. It consists of primary wall, middle lamella and secondary wall. Plasmodesmata which are connections between cytoplasm of neighboring cells are present in the middle lamella.

Ribosomes

Ribosomes are composed of RNAs and proteins. It translates genetic information stored in messenger RNA into proteins. Functional ribosomes consist of two subunits of unequal size, known as large and small subunits. Eukaryotes usually contain two types of ribosomes: cytosolic and organellar. The ribosome found in prokaryotes is 70S and in eukaryotes it is 80S. S stands for sedimentation coefficient. It is the ratio of a velocity to the centrifugal acceleration.

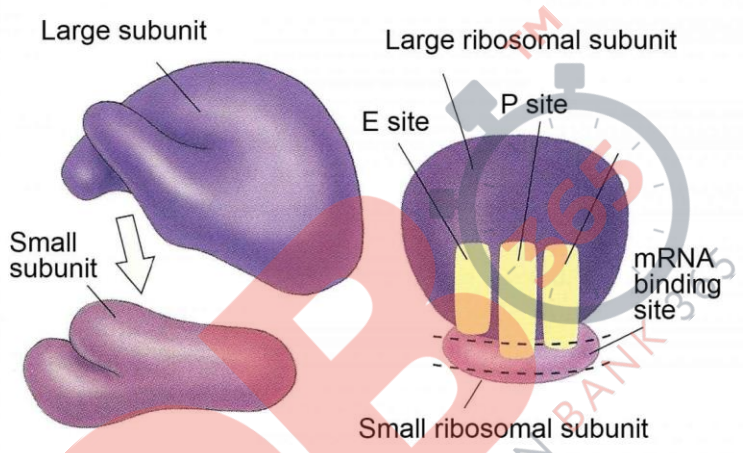


Fig. 3. Structure of the ribosomes

Endoplasmic reticulum

It is the largest single membrane bound intracellular compartment. It is an extensive network of closed and flattened membrane bound structure. The enclosed compartment is called lumen. ER can be rough or smooth based on the presence or absence of ribosomes. When ribosomes are attached to ER, it is known as rough ER. When ER membrane do not contain any ribosomes, it is known as smooth ER.

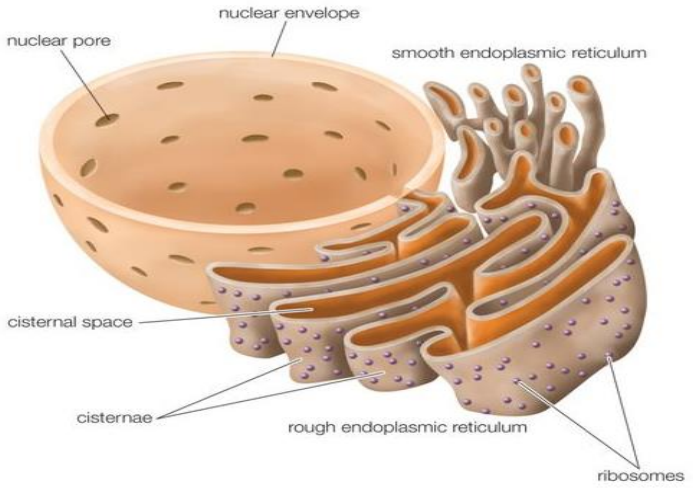


Fig. 4. Structure of endoplasmic reticulum

Proteins synthesized by ribosomes associated with the membrane of RER enter into the lumen and membrane of RER by the process of co-translational translocation. In the lumen of the RER, five principal modifications of proteins occur before they reach their final destination-addition and processing of carbohydrates, formation of disulfide bonds, proper folding, specific proteolytic cleavages and assembly into multimeric proteins. The SER have different functions such it acts as site for the lipid biosynthesis, detoxification and calcium regulation.

Golgi complex/Golgi apparatus

It is a single membrane bound organelle and forms a part of endomembrane system. It consists of flattened membrane sacs known as cisternae. Each stack is known as Golgi stack. Each Golgi stack has two faces- the cis face or the entry face and the trans face or exit face. The Golgi apparatus is especially prominent in cells that are specialized for secretion.

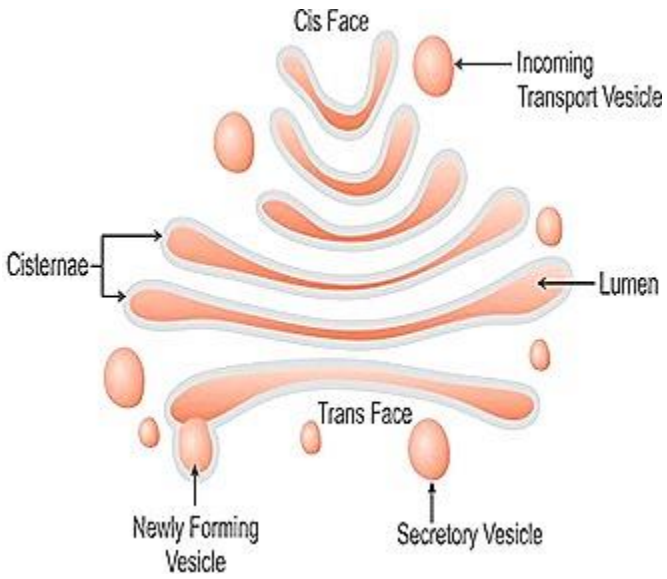


Fig. 5. Structure of Golgi apparatus

Lysosomes

It is a single membrane enclosed organelle which contains hydrolytic enzymes. Hydrolytic enzymes include proteases, nucleases, glycosidases, lipases, phospholipases, phosphatase and sulphatases. The environment is acidic inside the lysosomes with a pH of about 5.0. There is a proton pump inside the lysosomal membrane which pumps proton inside the membrane using ATP as a source of energy. Lysosomes are responsible for the digestion of both intracellular as well as extracellular materials.

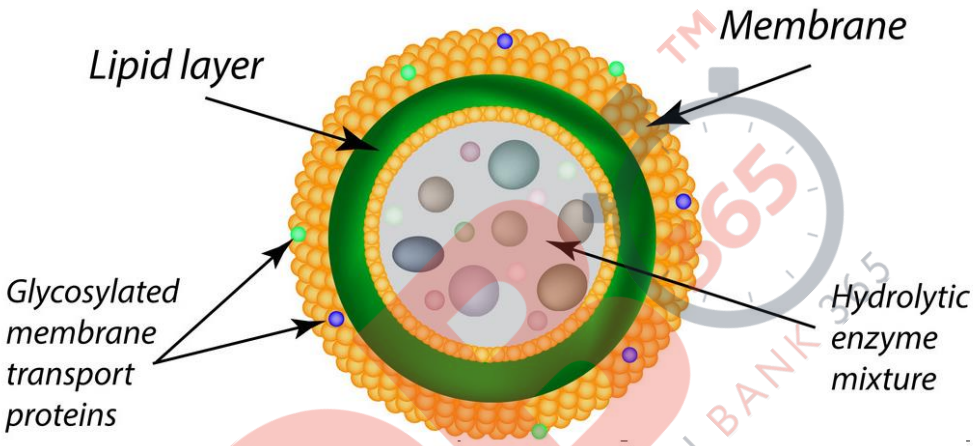


Fig. 6. Structure of lysosomes

Vacuoles

Fluid filled vesicles are known as vacuoles. A membrane known as tonoplast surrounds the vacuole. The pH of the lumen is similar to that of lysosomes and is therefore acidic. Vacuoles in plant cells contain water, dissolved inorganic ions, sugars, enzymes etc. This vacuole is different from another type of vacuole called contractile vacuole. Contractile vacuole is an organelle that functions in osmoregulation. It pumps excess of water out of the cell. For example, it is found in *Amoeba*.

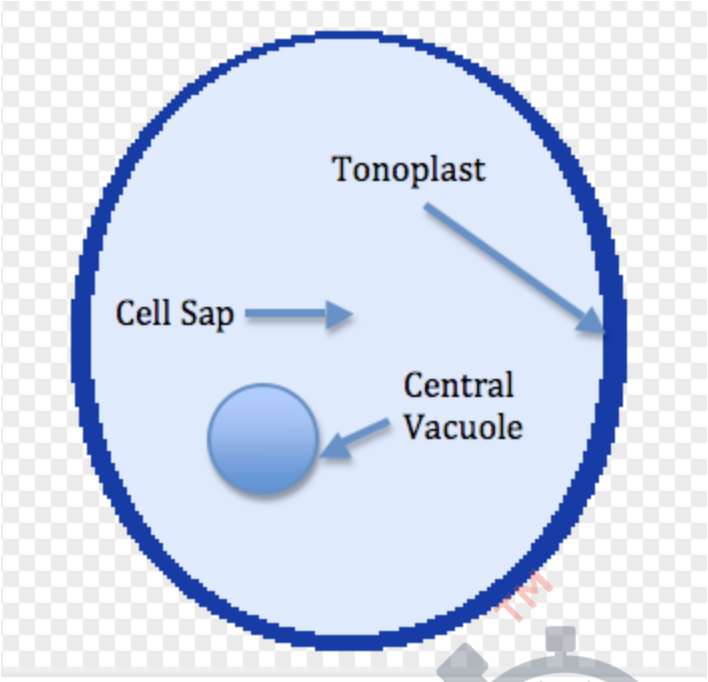


Fig. 7. Structure of vacuoles

Mitochondria

It is found in all eukaryotic cell. It is a site for aerobic respiration. They are known as the power house of the cell as it synthesizes ATP, energy currency of the cell. They are the double membrane bound cell organelle. It contains circular DNA molecule and ribosomes. The space between the outer and the inner membrane is known as intermembrane space. The inner membrane is convoluted to form cristae. The inner membrane is impermeable to solutes and they are rich in phospholipid known as cardiolipin. Inner membrane contains enzyme complex known as ATP synthase or F_0-F_1 ATPase.

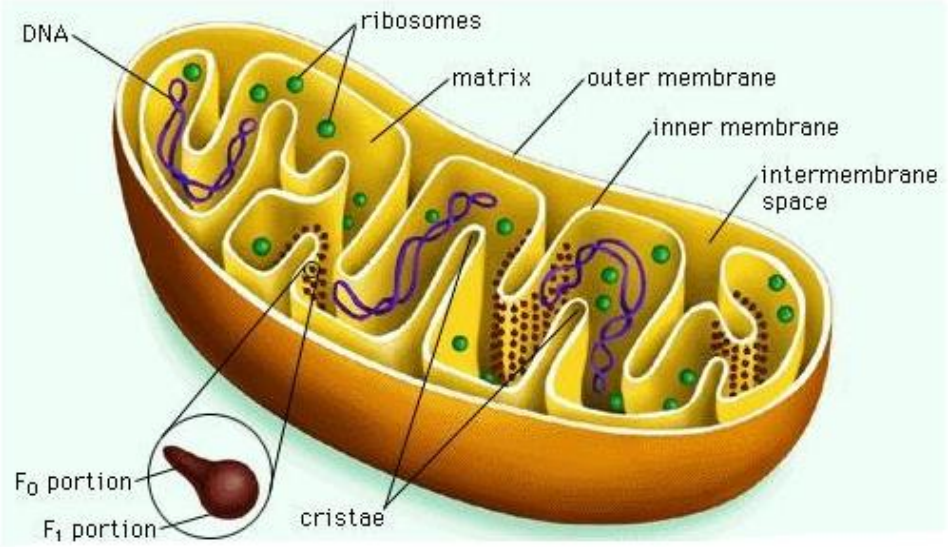


Fig. 8. Structure of mitochondria

Plastids

They are double membrane cell organelle found in plant cells. They also contain double stranded DNA and ribosomes. They are differentiated into- leucoplast, chromoplast and chloroplast.

Chloroplast encloses the fluid filled structure known as stroma. Stroma contains a stack of sacs called as granum. Each of the flattened sacs present in the granum is called a thylakoid. Each granum is connected to each other by stroma lamellae.

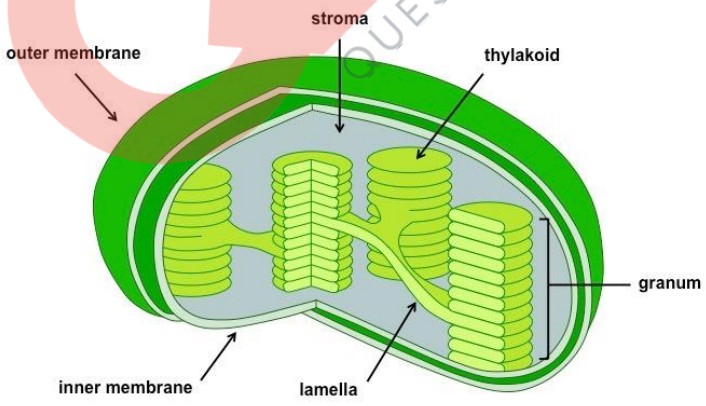


Fig. 9. Structure of chloroplast

Chromoplasts are plastids responsible for pigment synthesis and storage. They give yellow, orange, red colors to fruits and flowers. Leucoplast are colorless plastids and acts as storage organelles.

Leucoplast are colorless plastids that are divided into- amyloplast that store starch, Elaioplast stores lipids in fats, proteinoplast stores proteins.

Nucleus

Nucleus is a double membrane structure found in eukaryotes. Eukaryotes have single nucleus except the red blood cells which do not contain nucleus. Nucleus contain genetic material known as DNA packed in the form of chromosomes with proteins known as histones.

There are two types of chromosomes found- Euchromatin and heterochromatin. Euchromatin is a less compact structure that can be transcribed (formation of messenger RNA from DNA). Heterochromatin is a compact structure that cannot be transcribed.

The fragment of DNA that codes for a protein is known as gene. Nuclear membrane is impermeable to large molecules, so nuclear pores are present that regulates the movement of solutes in and out of the nucleus. Nucleolus is the largest structure found inside the nucleus of eukaryotes. It is involved in the assembly of the ribosomes.

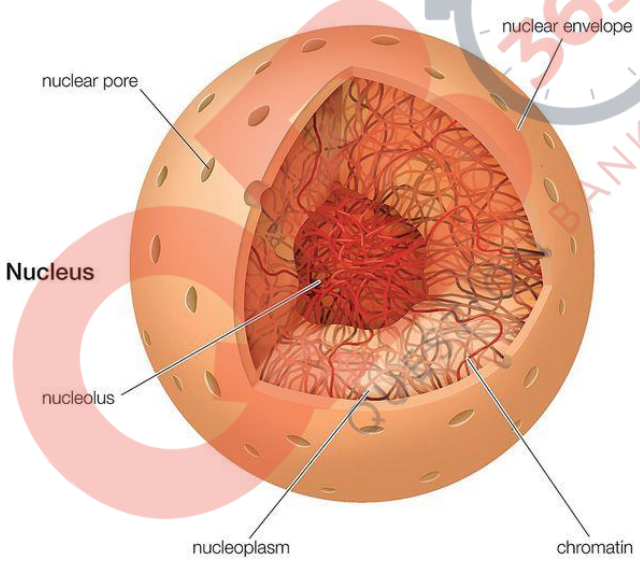


Fig. 10. Structure of nucleus

Peroxisomes

Peroxisomes are found in all prokaryotic cell. The major function of peroxisomes is to breakdown of fatty acids. Peroxisomes are derived from the endoplasmic reticulum. Proteins found in peroxisomes are known as peroxins.

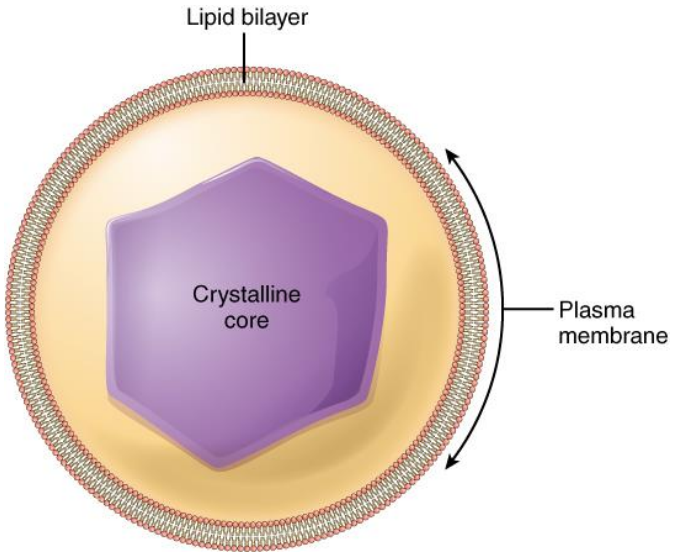


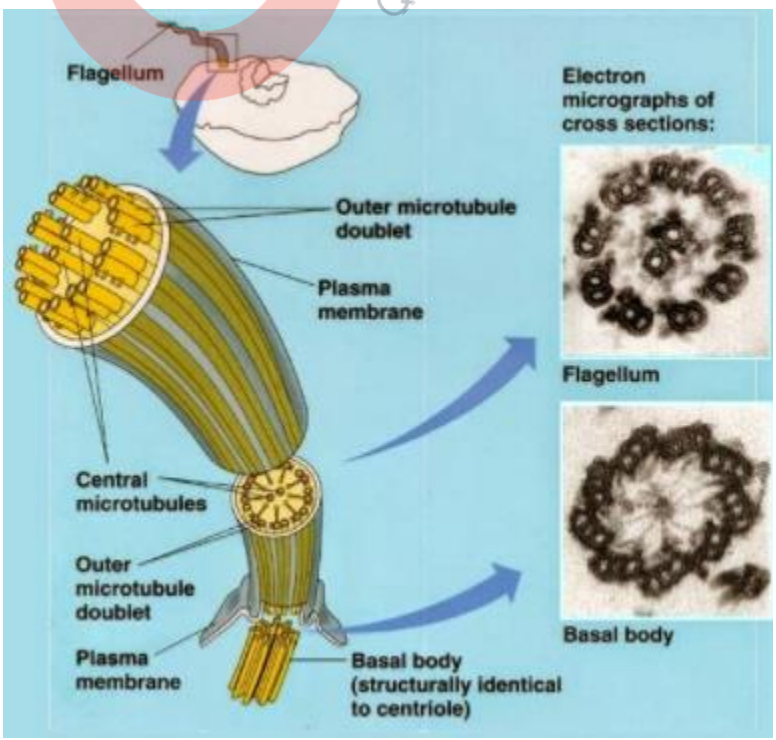
Fig. 11. Structure of peroxisomes

Cytoskeleton:

It consists of a network of proteinaceous filaments in the cytoplasm. It provides mechanical support and aids in cell motility and maintenance of cell shape.

Cilia and Flagella:

Hairy outgrowths that function in locomotion. Cilia are short and flagella are relatively long. They are covered by plasma membrane. They possess a core made up of numerous microtubules running parallel to the long axis. This core is called as axoneme. It shows a 9+2 arrangement, where 9 is the number of pairs of radially arranged microtubule doublets and 2 is the central pair of microtubules.



Centrosomes and centrioles:

A pair of cylindrical structures called as centrioles compose the centrosome. Centrioles are perpendicular to each other. A centriole is made up of nine peripheral triplet fibrils of tubulin protein. The proteinaceous center of the centriole is called as hub. It is connected by spokes to the peripheral fibrils. The centrioles form the base of flagella and also form the spindle during cell division.

Structure of a prokaryotic cell:

Represented by bacteria, mycoplasma, cyanobacteria, PPLOs the prokaryotes are much smaller and more rapidly dividing than eukaryotes. They vary in shape but their basic organization remains similar. Except mycoplasmas, a cell wall surrounds the cell. They do not have a well-defined nucleus. Additionally they may also have extra-nuclear circular DNA called as plasmids in case of bacteria. They lack all cell organelles except for ribosomes.

Bacterial cells, if motile, possess one or more flagella. A flagellum has three parts: filament, hook and basal body.

Pili and fimbriae help the bacteria to attach to substrate or host. A pilus can also help in conjugation.