

## Revision Notes

### Class 11 - Biology

#### Chapter 8 - Cell: The unit of life

The cell is the smallest, basic structural, and functional unit of living things; hence it is generally referred to as 'building blocks of life. Cells are capable of independent existence and performing essential functions of life. All organisms including plants, animals are made up of one or more cells and all that cells come from pre-existing cells. **Robert Hooke** was the scientist who first discovered cells in a piece of cork.

#### Different types of cell

In the human body, different types of cells are present such as hepatocytes in the liver, nephrons in the kidney, neurons in the brain, etc. The different types of cells are grouped to form tissues. These tissues perform specific functions.

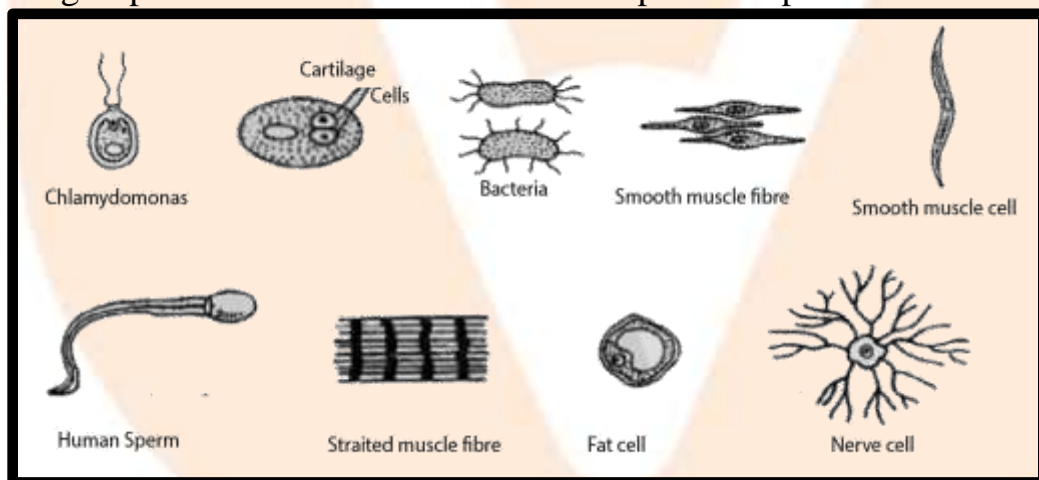


Fig.1. Different types of cells

#### Cell theory

In 1839, two scientists named **Schleiden** who was a German botanist, and **Schwann** who was a British zoologist, announced the cell theory. The modern theory of the cell includes-

- Every living organism is made up of cells.
- The cell is said to be the basic structural and functional unit of living things.

- All cells arise from the pre-existing cells by division method and this was given by Rudolf Virchow.
- All energy flow takes place within the cells.
- Cells contain the hereditary information which is passed from cell to cell during cell division.
- All cells have the same chemical composition.

## Structure of eukaryotic cells

### Plasma membrane

The plasma membrane is a dynamic, fluid-structure that is present in the external boundary of the cell and separates the interior of the cell from the outside environment. It is selectively permeable. Based on the fact that it only allows specific solutes to pass through it. In 1972, Jonathan Singer and Garth Nicolson proposed the fluid mosaic model of the plasma membrane. According to this model, the membrane is a quasi-fluid structure in which proteins are embedded throughout the lipid bilayer and this lipid bilayer provides fluidity and elasticity to the membrane. The bilayer is composed of two layers of amphipathic molecules that contain polar heads and nonpolar tails.

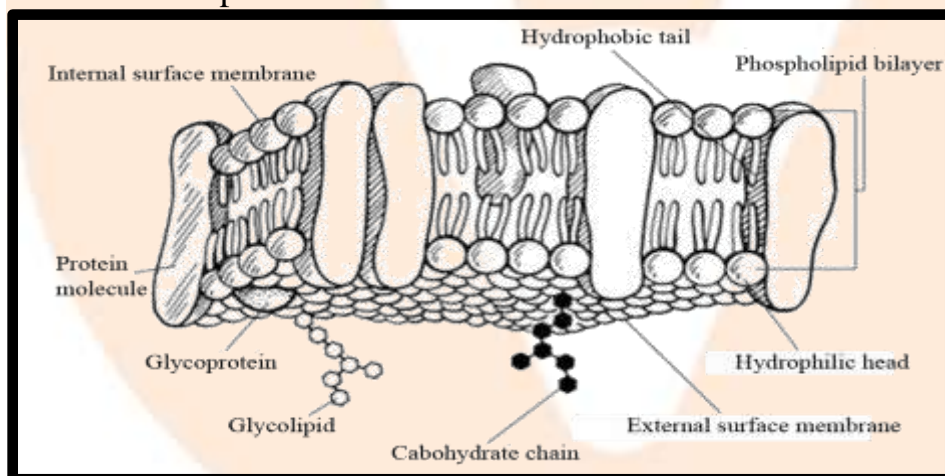


Fig. 2. Structure of the plasma membrane

Hydrophobic interactions are the primary forces for organizing lipid bilayer. There are three types of lipid and two types of protein present in the plasma membrane. Lipids are phospholipids, glycolipids, and sterol and the proteins are peripheral proteins and integral proteins. Peripheral proteins are proteins that are held with the bilayer loosely and can be easily removed. While the integral proteins are proteins that are held in the lipid bilayer very tightly and cannot be removed easily.

## Cell Wall

The cell wall is a rigid non-living structure that surrounds the plasma membrane. The cell wall is mostly found in plant and fungal cells that provide shape to the cell. It also protects the cell against mechanical damage or infection and also prevents the entry of unwanted macromolecules.

Cell walls are important for cell-to-cell interaction and transport. The cell wall is made up of three parts i.e., primary wall, middle lamella, and secondary wall. Plasmodesmata are the connections that are present between the cytoplasm of the neighboring cells and the middle lamella.

## Ribosomes

Ribosomes are specialized cell organelle which is composed of RNAs and proteins hence, they are known as ribonucleoprotein. Ribosomes units come together to translate genetic information which is stored in messenger RNA (mRNA) into proteins. Functional ribosomes consist of two subunits of unequal size, known as large and small subunits where small subunits read mRNA and large subunits form a polypeptide chain of amino acids. Eukaryotic cells generally possess two types of ribosomes: cytosolic and organellar. The ribosome found in prokaryotes is the 70S and 80S in eukaryotes where S stands for sedimentation coefficient. It is the ratio of a velocity to the centrifugal acceleration that helps to measure the particle's size based on the sedimentation rate.

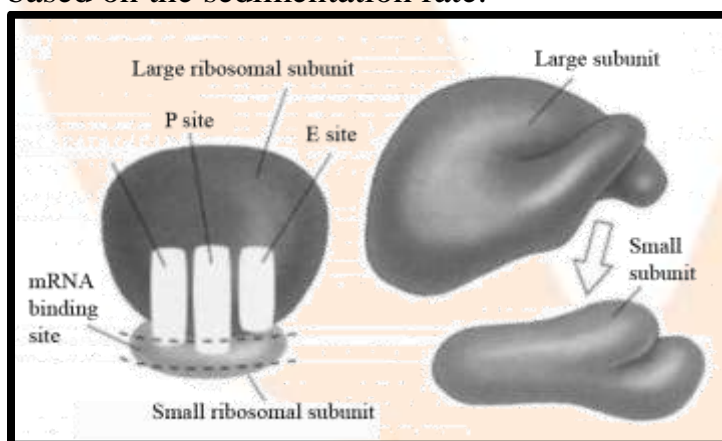
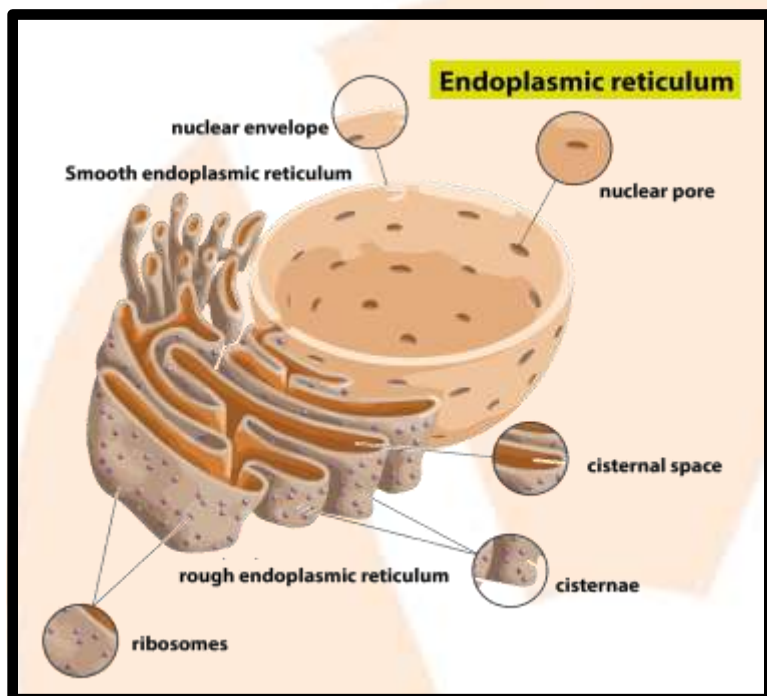


Fig. 3. Structure of the ribosomes

## Endoplasmic reticulum

It is the largest single membrane-bound intracellular compartment which is mainly found in eukaryotic cells. It is formed by an interconnected network of closed and flattened membrane-bound structures and the membrane-enclosed sac is called the

lumen. Based on the presence or absence of ribosomes, ER can be of two types i.e., rough endoplasmic reticulum (RER) and smooth endoplasmic reticulum (SER). When ribosomes are present on ER, it gives a rough appearance to the structure hence it is known as rough ER. When ribosomes are absent in the ER membrane, it is known as smooth ER.



Proteins synthesized by ribosomes that are present on the membrane of RER enter into the lumen by the process of co-translational translocation. Before reaching their final destination there are five principal modifications of proteins that take place in the lumen. These modifications are - addition and processing of carbohydrates, formation of disulfide bonds, proper folding, specific proteolytic cleavages, and assembly into multimeric proteins. The SER performs different functions like the synthesis of essential lipids, steroid hormones, metabolism of carbohydrates, detoxification, and calcium regulation.

### **Golgi complex/Golgi apparatus:**

It is a single membrane-bound organelle that forms a part of the endomembrane system. Golgi complex is mainly found in the cytosol of the eukaryotic cells and is made up of flattened membrane sacs known as cisternae. A Golgi stack normally contains 4-8 cisternae. Each Golgi stack has two faces- the cis face and the trans face. Both faces are also called the entry face and exit face, respectively. The main functions of the Golgi apparatus include protein packaging and secretion.



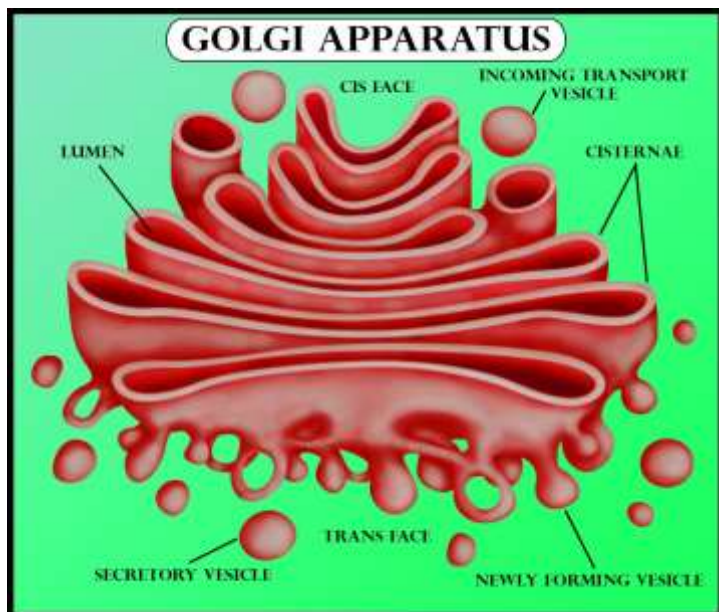
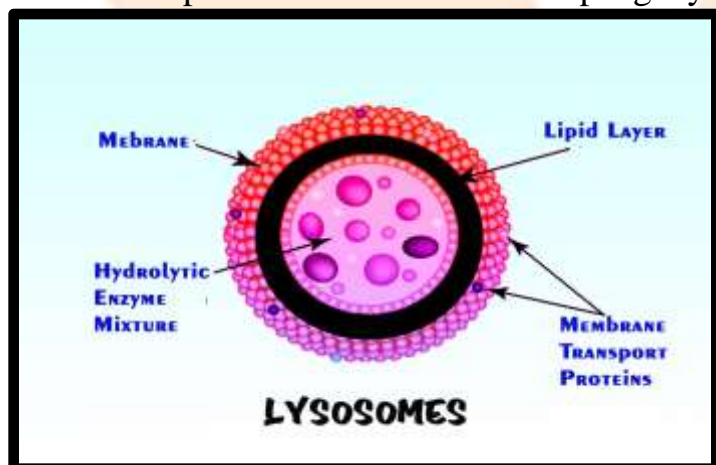


Fig. 5. Structure of Golgi apparatus

### Lysosomes

It is a single membrane-enclosed organelle that contains hydrolytic enzymes that are responsible for the breakdown of various biomolecules. These hydrolytic enzymes include nucleases, proteases, lipases, glycosidases, phosphatase, phospholipases, and sulphatases. For optimal activity, the enzyme requires an acidic environment inside the lysosomes with a pH of about 5.0. There remains present a proton pump inside the lysosomal membrane. This proton pump transports the proton from inside the membrane using ATP as a source of energy. Lysosomes are responsible for the digestion of both intracellular as well as extracellular materials as they can break down virus particles or bacteria in the phagocytosis of macrophages.



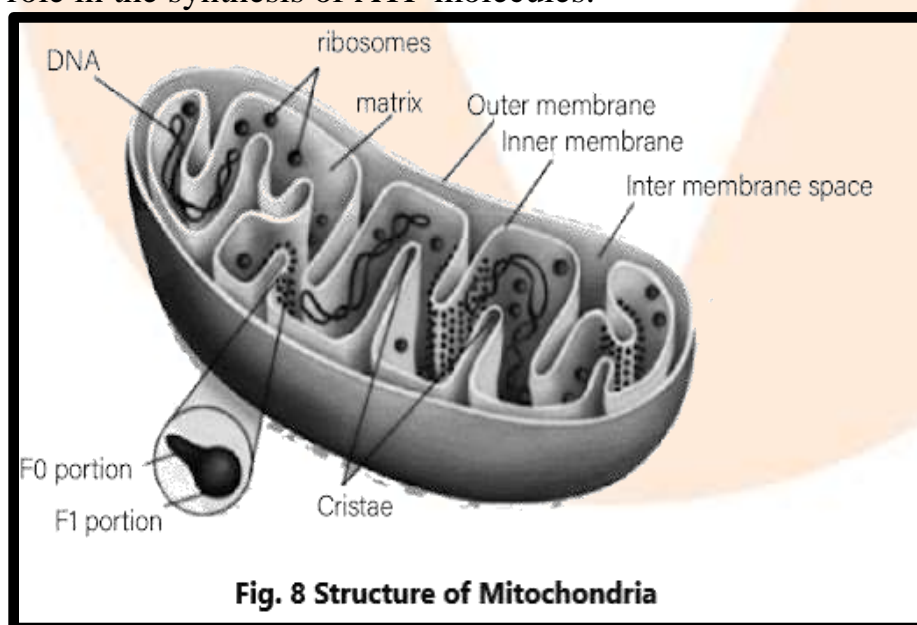
## Vacuoles

Fluid-filled vesicles are known as vacuoles and are mostly found in the cytoplasmic matrix of the cell. There is a membrane that surrounds the vacuole known as tonoplast. Similar to the pH of lysosomes the lumen's pH is also acidic. Vacuoles in plant cells are larger than those in animal cells and they contain water, dissolved inorganic ions, sugars, enzymes, etc. it is different from another type of vacuole called contractile vacuule because they perform osmoregulation and pumps excess water out of the cell. The example includes the vacuole in Amoeba.

## Mitochondria:

It is found in all eukaryotic cells and is known as a site for aerobic respiration. They are called the powerhouse of the cell because it synthesizes ATP as the energy currency of the cell. They are the double membrane-bound cell organelle that contains circular DNA molecules and ribosomes. The space present between the outer and the inner membrane is known as intermembrane space. The inner membrane structure is complex because it is convoluted to form cristae. Cristae help in increasing the surface area inside the mitochondria.

The inner membrane is rich in phospholipid known as cardiolipin that makes the membrane-impermeable to solutes. The inner membrane contains enzyme complexes known as ATP synthase or F<sub>0</sub>-F<sub>1</sub> ATPase and they play an important role in the synthesis of ATP molecules.

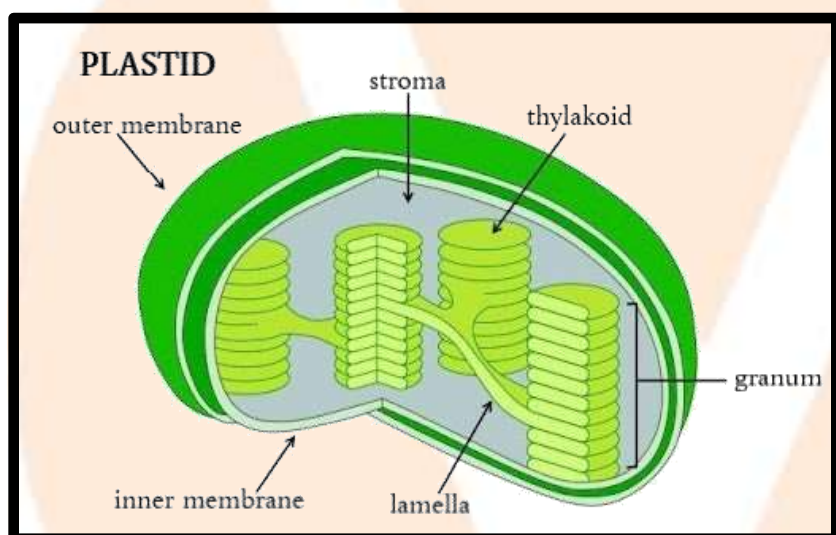


**Fig. 8 Structure of Mitochondria**

## Plastids

They are double-membrane cell organelle that is generally found in algae and plant cells. Like mitochondria, they also contain double-stranded DNA and ribosomes in their structure. They are divided into three different types- leucoplast, chromoplast, and chloroplast. Plastids contain a pigment that plays an important role in photosynthesis and is also responsible for the synthesis and storage of food.

The Chloroplast surrounds the fluid-filled structure known as stroma that contains a stack of sacs called a granum. There are some organized flattened membranous sacs called the thylakoids. Each granum is connected to the other with the help of flat membranous tubules known as stroma lamellae.



chromoplasts are the type of plastids that are responsible for pigment synthesis and storage. They give different colors to the fruit, flowers, and aging leaves like yellow, orange, or red colors.

However, the leucoplast is colorless plastids that are generally present in unexposed areas of plants. It plays an important role in the storage of starch, lipid, and proteins and is divided into three different parts- amyloplast that stores starch, Elaioplast that stores lipids in fats, proteinoplast stores proteins.

## Nucleus

The nucleus is a double membrane structure found in all eukaryotic cells except RBCs (red blood cells). It contains the majority of the genetic material that transfers from parents to offspring during cell division. In the nucleus, the DNA is packed in the form of chromosomes with histones proteins, it controls the function and growth

of the cell. The gene is a fragment of DNA that codes for a protein.

There are two types of chromosomes found- Euchromatin and heterochromatin where euchromatin is a less compact structure and can be transcribed into mRNA, while Heterochromatin is a compact structure and hence cannot be transcribed into mRNA.

The Nuclear membrane is a double-layered system that is impermeable to large molecules. The outer layer is combined with the Endoplasmic reticulum. The presence of nuclear pores in the membrane regulates the movement of solutes in and out of the nucleus. A perinuclear space is a space that presents between these two layers.

The nucleolus is the solid and spherical structure that is present inside the nucleus of eukaryotic cells. It is involved in the assembly of ribosomes during protein synthesis. It disappears during the cell division and reappears after the cell division.

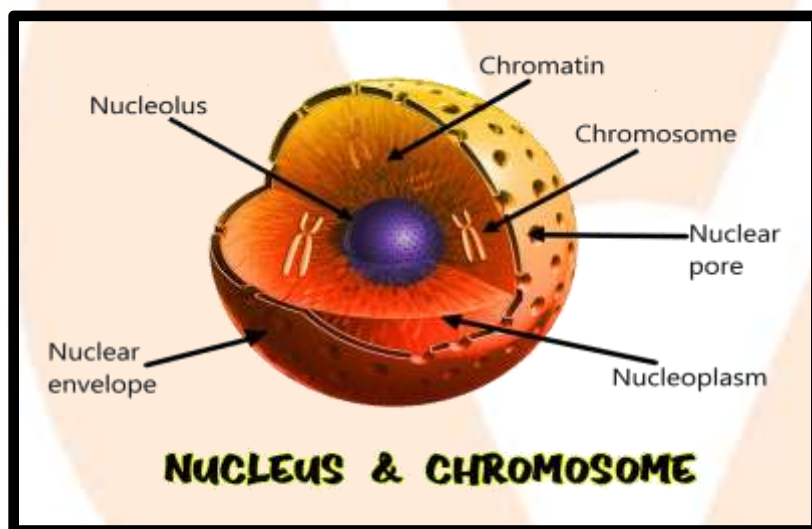
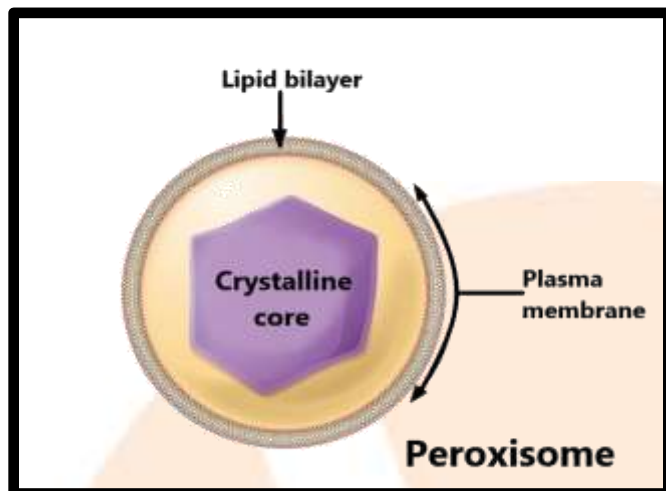


Fig. 10. Structure of nucleus

### Peroxisomes

Peroxisomes are small, membrane-bound cell organelles that are mainly found in all eukaryotic cells. They contain oxidative enzymes that help in various metabolic activities. The major function of peroxisomes is the breakdown of fatty acids. Peroxisomes can be derived from the smooth endoplasmic reticulum of the cell. Proteins found in peroxisomes are matrix soluble proteins and membrane proteins known as peroxins.

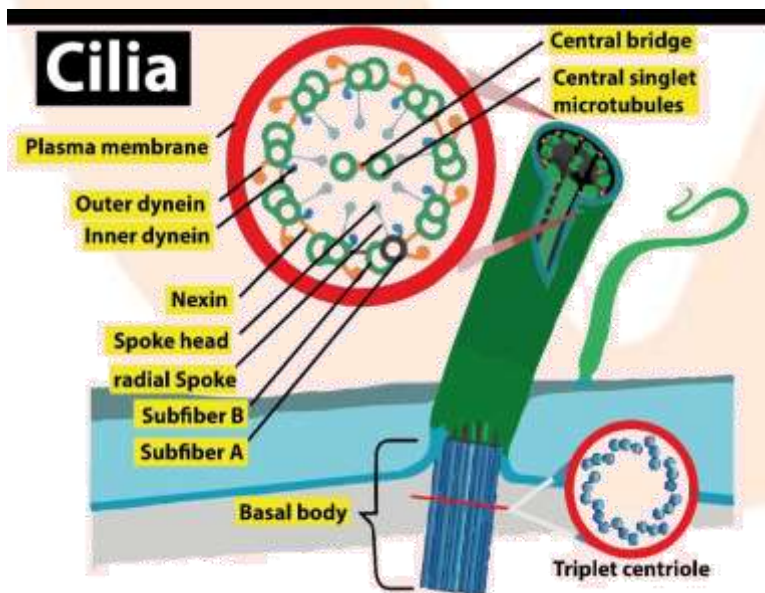




### Cytoskeleton:

It is made up of a network of proteinaceous filaments in the cytoplasm that provides mechanical support to the cells. The cytoskeleton maintains the shape of the cell and helps in cell motility. It also organizes the organelles and facilitates the movement of solutes across the cell.

### Cilia and Flagella:



They are the hairy outgrowths that help in the locomotion of the organisms. Cilia are the short structure that helps in attachment while flagella are relatively long structures in the form of a whip and it helps in movement of the organism. They are

covered by a plasma membrane and possess a core made from numerous microtubules running parallel to the long axis. This core is called an axoneme which shows a 9+2 arrangement. Here 9 is the number of pairs of radially arranged microtubule doublets and 2 is the central pair of microtubules.

### **Centrosomes and centrioles:**

Centrioles are a pair of cylindrical structures that compose the centrosome. Centrioles are perpendicular to each other and present in the cytoplasm where they help in organizing microtubules. It is made up of nine symmetrically arranged peripheral triplet fibrils of tubulin protein. The proteinaceous part that presents in the center of the centriole is called a hub; it is connected by spokes to the peripheral fibrils. The centrioles form the network of threads across the cell during cell division. Apart from this, they also form the base of flagella.

### **Structure of a prokaryotic cell:**

Prokaryotic cells are small, single-celled organisms that lack a true nucleus and membrane-bound organelles.

Prokaryotes mainly include bacteria, mycoplasma, cyanobacteria, and PPLOs. The prokaryotes are much smaller and more rapidly dividing than eukaryotes. They have generally been divided asexually by binary fission and conjugation. They vary in shape and size but their basic organization remains the same. In prokaryotes, a cell wall surrounds the cell except for mycoplasma. In the case of bacteria, they also contain an extra circular DNA called plasmids. They lack all cell organelles except for ribosomes where protein synthesis takes place.

In motile bacterial cells, they possess one or more flagella. A flagellum is a long structure in the form of a whip that is made up of basic parts: filament, hook, and the basal body. A pilus can also help the bacteria in conjugation while Pili and fimbriae help in attachment to substrate or host.