EXTENSIVE QUESTIONS

26. Describe the principles and uses/applications of the apparatus used in the techniques of:

(a) Fractionation **(b) Microdissection**

(c) Tissue culture **(d) differential staining**

(e) Centrifugation **(e) Chromatography**

(g) Electrophoresis

Ans: (a) Fractionation

Cell Fractionation:

Use:

Cell fractionation is the combination of various methods used to separate a cell organelle and components based upon size and density. It is very useful for electron microscopy of cell components.

Principle:

The principle of cell fractionation consists of two steps i.e., homogenization and centrifugation.

(i) Homogenization:

It is the formation of a homogenous mass of cells (cell homogenate or cell suspension). It involves the grinding of cells in a suitable medium with correct pH, ionic composition, temperature and in the presence of certain enzymes that can break the cementing substance of cells.

For example, pectinase which digest middle lamella among plant cells. This can be done in a cell homogenizer (food mixer/blender). This procedure gives rise a uniform mixture of cells i.e., cell homogenate. The resulting mixture is then centrifuged.

(ii) Centrifugation:

Centrifugation is the process to separate substances on the basis of their size and densities under the influence of centrifugal force. It is done by the machine called centrifuge.

Use:

This machine can spin the tubes. Contents are kept in tubes that are much like the test tubes. Spinning the tubes exerts a centrifugal force on the contents.

Types of Centrifugation:

There are two major ways of centrifugation i.e., density gradient centrifugation and differential centrifugation.

Density Gradient Centrifugation:

In density gradient centrifugation the cell components of different sizes and densities are separated in different layers (sediments) in the tube containing ionic medium according to their size and densities. The upper sediments have smaller and less dense components than lower sediments.

A centrifuge

Differential Centrifugation:

In differential centrifugation the sedimentation rate for a particle of a given size and shape measure how fast the particle "settles" or sediments. The faster the rotation of the centrifuge, the smaller the particles will sediment.

Pellet and Supernatant:

A series of increasing speeds can be used. At each step, the content which make sediment in the bottom of the tube are called pellet and those that remain suspended above the sediment in the form of liquid are called supernatant. After each speed, the supernatant can be drawn off and centrifuge again. A series of pellets containing cell organelles of smaller and smaller size can therefore be obtained.

(b) Microdissection:

Microdissection refers to the variety of techniques where a microscope is used to assist in dissection.

Use:

It is done to remove tumor or granules from delicate tissue or cells like brain, heart and nerve cells.

Technique/ Principle:

In this technique, the image is seen on large TV screen or monitor while dissecting. Different kinds of techniques involve microdissection i.e.

(1) Chromosomal microdissection:

It involves the use of fine glass needle under a microscope to remove a portion from a complete chromosome

(2) Laser microdissection:

It involves the use of a laser through a microscope to dissect selected cells.

(c) Tissue culture:

Growth of a cell or a tissue on chemically defined nutrient medium under sterile conditions is called tissue culture.

Technique/ Use/ Principle:

This technique can be employed for both plants and animals.

Plant tissue culturing is mainly used for plant cloning i.e., production of genetically identical plants (clones). Animal tissue culture is usually set up by growing individual cells to form a single layer of cells over the surface of a glass container. Animal tissue cultures are used to see any abnormality in the cell, e.g., cancer, chromosomal disorder etc.

(d) Differential staining:

Most biological structures are transparent. In order to differentiate between these structures various color dyes are applied.


Differential staining

Such techniques are called staining techniques.

Technique/Use/Principle:

When only one stain, such as borax carmine (that stains nucleus) is used, it is called single staining. When two stains, one that will stain nucleus e.g., hematoxylin and other that will stain cytoplasm e.g., eosin are used, the process is called double staining or differential staining.

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(f) Chromatography:

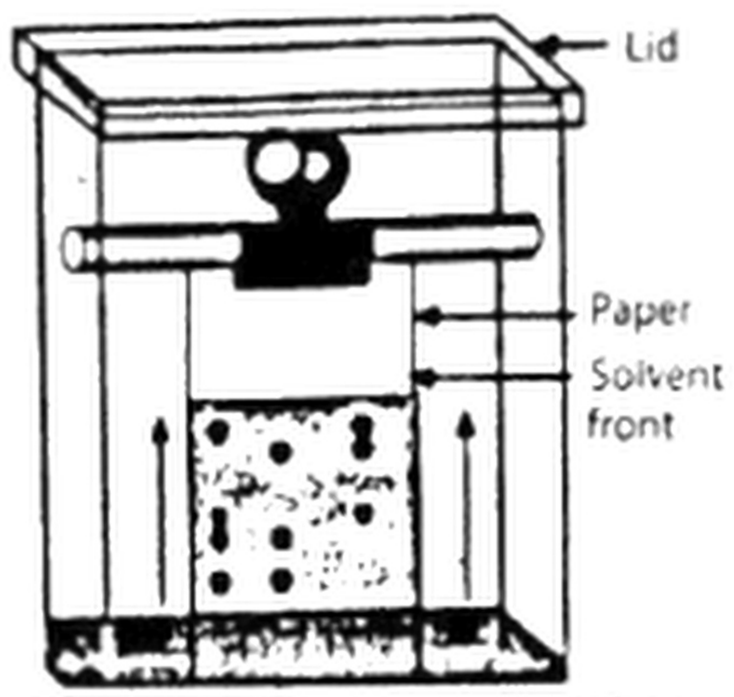
Chromatography is a technique which is used to separate different chemical compounds from a mixture. It is generally used for the separation of mixtures of proteins, amino acids or photosynthetic pigments.

Use/Techniques:

There are different types of chromatographic techniques. Paper chromatography is a simple and most widely used technique. It involves two phases i.e., stationary phase and mobile phase.

The mobile phase consists of a solvent in which mixture sample is dissolved. It is passed through the stationary phase which consists of a filter paper.

When mobile phase travels through the stationary phase the molecules mixture sample begin to separate as dots at different places on stationary phase according to their individual affinity. Then the paper is sprayed with a liquid locating agent (staining dye) that shows up the dots as colors that can be seen. This paper is called chromatogram and the apparatus is called chromatography chamber



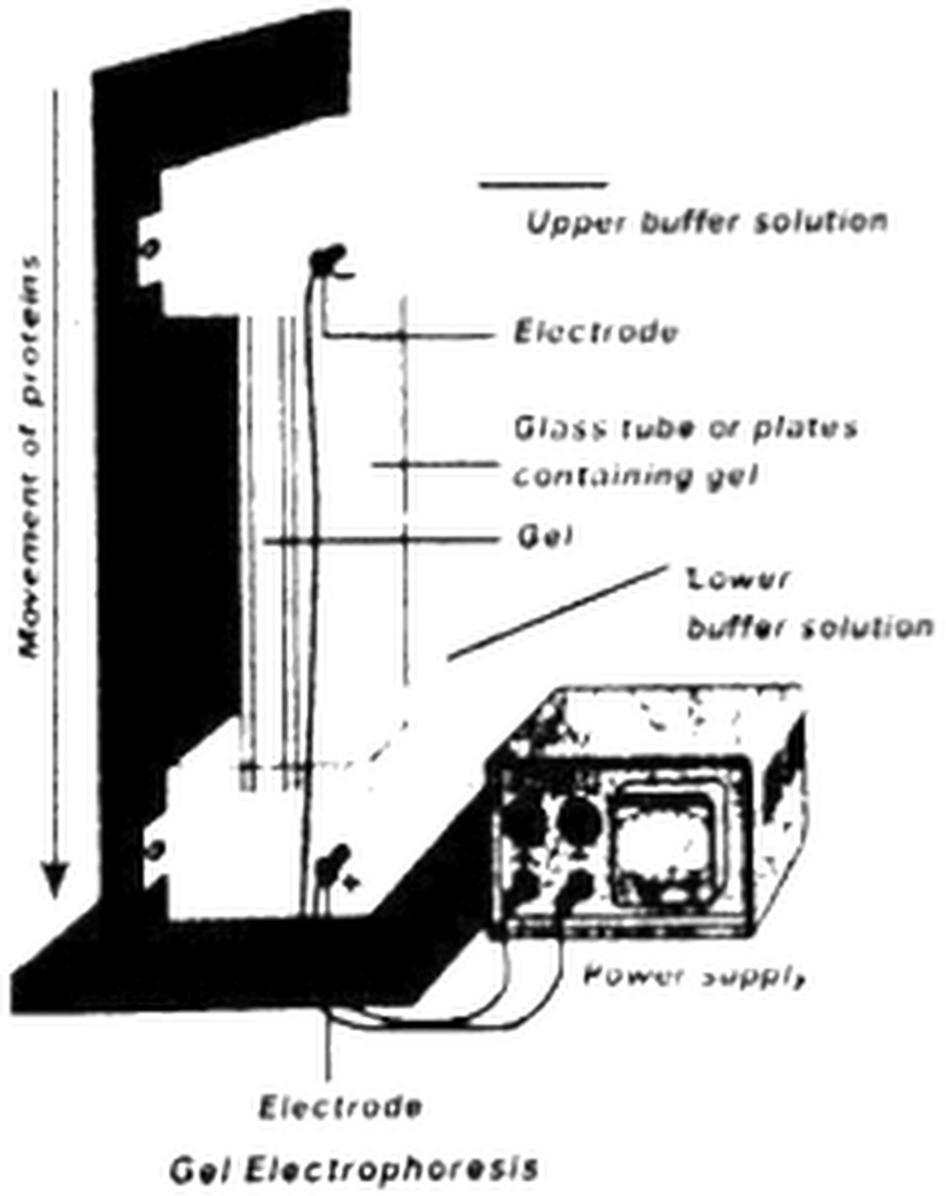
Chromatography chamber

(g) Electrophoresis:

It is a technique which is used to separate fragments of a charge bearing polymer molecule according to their size, shape, molecular weight and surface charge whether (+) or (-). Such charge bearing polymer molecules are DNA, RNA, protein etc.

Use/Technique:

This technique utilizes a gel medium (composed of agarose or polyacrylamide) for separation of fragments which is done under the influence of an electric field. Often the gel is sandwiched between glass or plastic plates to form a viscous slab. The two ends of the slabs are suspended in two salt solutions that are connected by electrodes to a power source. When voltage is applied to the apparatus, the molecules present in the gel migrate through the electric field according to their individual charge and they move away from one another in the gel.



Gel Electrophoresis

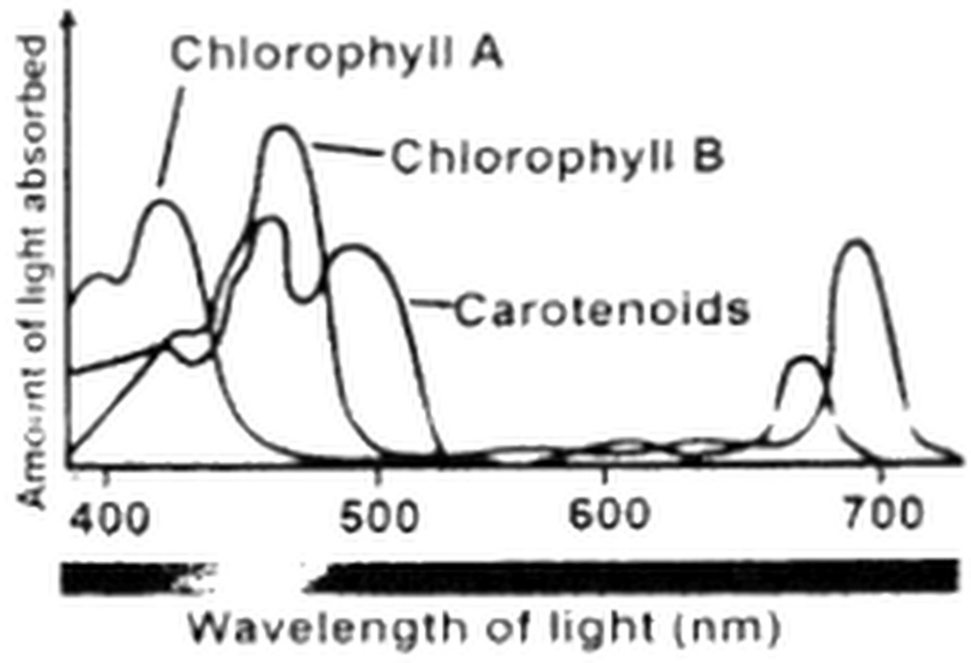
The negative charged molecule will move towards the positive pole and the molecule having positive charge will move towards the negative pole. The velocity of movement of fragments is inversely proportional to the size. Therefore, smaller fragments move faster than larger. In this way all the fragments are separated in the gel after some time. Later on, the molecules can be pin pointed by staining the gel.

(h) Spectrophotometry:

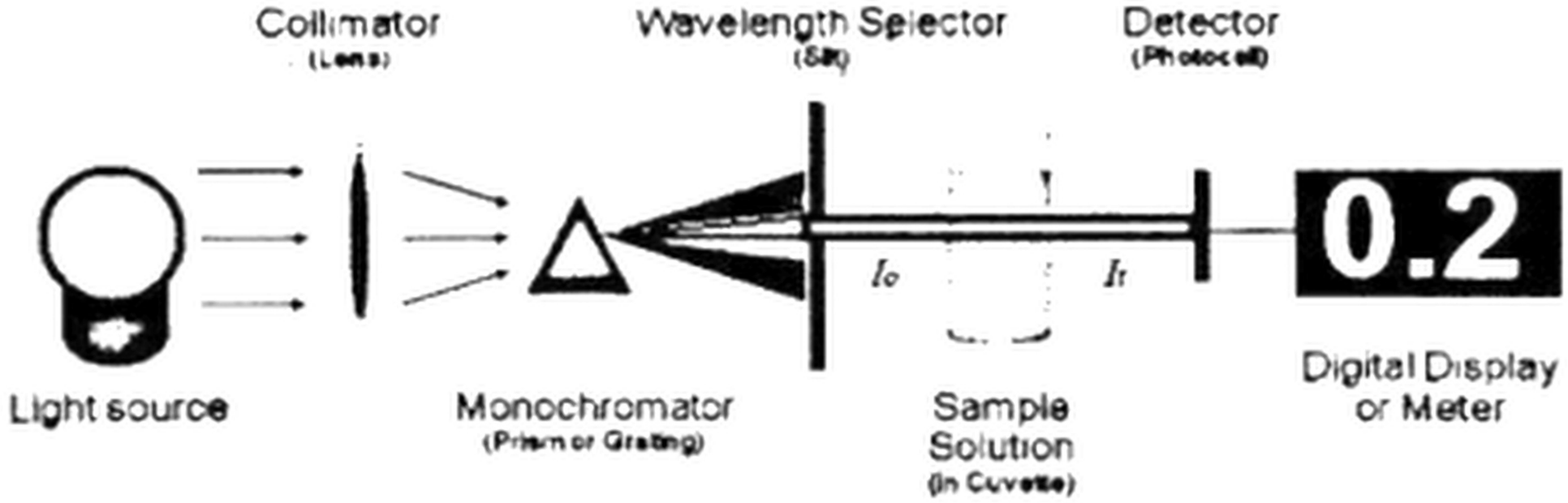
Spectrophotometry is a technique which is used to determine the absorption of different wavelength of light by a particular chemical compound or a photosynthetic pigment.

The spectrophotometer is an instrument that measures the amount of light that passes through the sample and from this it can be calculated how much light was absorbed.

Spectrophotometer



Absorption spectrum



Principle of spectrophotometry

Absorption Spectrum:

The amount of light absorbed at each wavelength is plotted in a graph and the result is what we call the absorption spectrum. In other words, absorption spectrum 1s a graph which shows the absorption of different wavelength of light by a particular pigment

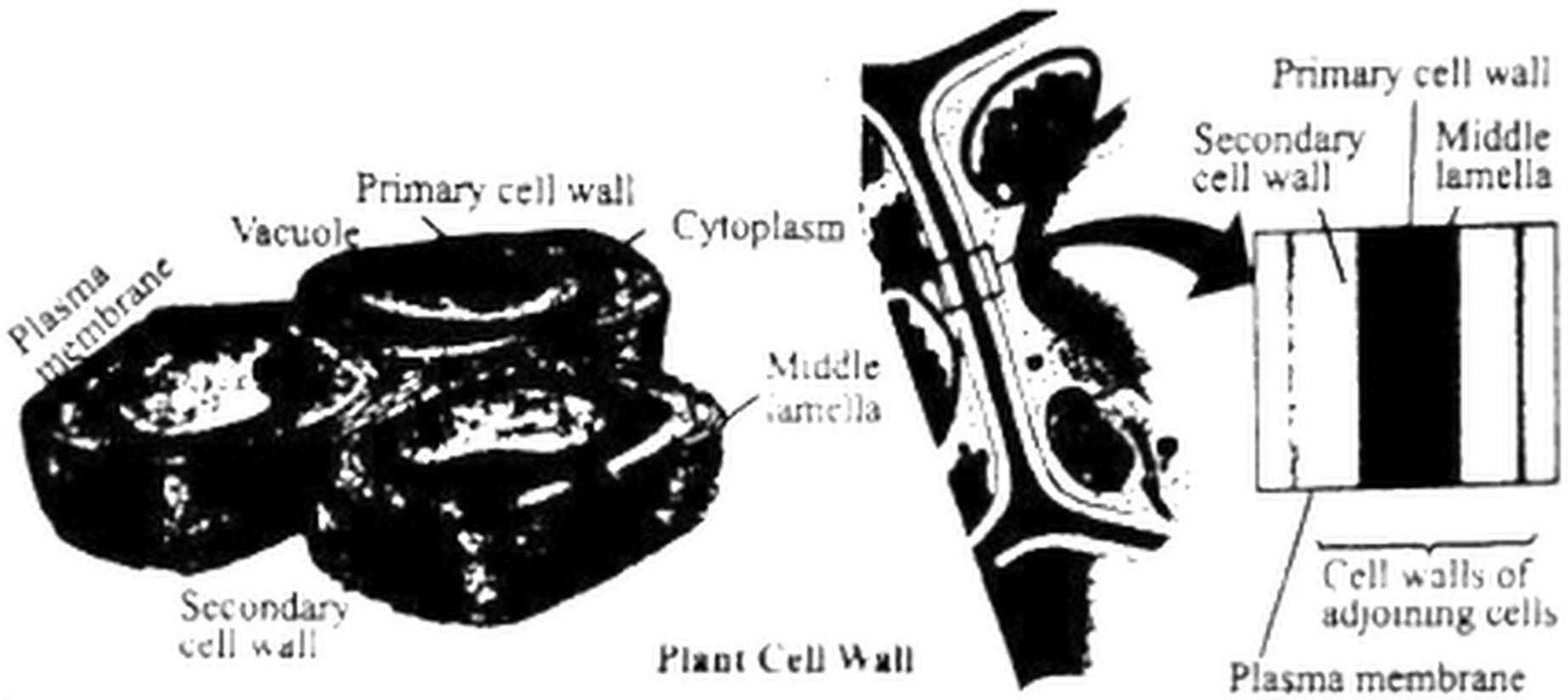
Use:

Spectrophotometry can be used to determine the wavelengths of light that take part in photosynthesis. It can also be used to determine the very minute quantity of a substance (such as DNA) in a sample.

27. What are the locations, chemical compositions and significance of the following in a plant cell wall? (a) Primary cell watt (b) Secondary cell wall (c) Middle lamella.

Ans: (a) Primary cell wall:

Primary cell wall is a true wall and develops in newly growing cell i.e., during cell division. Each cell produces a primary cell wall. The primary cell wall is present inner to the middle lamella. The primary cell wall is thin and slightly flexible. The primary cell wall is composed of cellulose microfibrils (bundles of cellulose chains), running through the matrix of other polysaccharides like hemicelluloses and pectin. The microfibrils show a crisscross arrangement in layers one above the others. This feature gives the cell great strength. The primary cell wall is adapted to growth. The wall stretches plastically i.e. irreversibly.



(b) Secondary cell wall:

Secondary cell wall is formed between the primary cell wall and plasma membrane only in sclerenchyma cells. The plant cells possessing secondary cell wall are generally dead and provide support for the plant. The secondary cell wall develops only when the cell has reached maximum size i.e., completes its growth because it is very much thick and rigid therefore it does not allow further growth. The secondary cell wall consists of cellulose, hemicelluloses, lignin inorganic salts and waxes. Its cellulose microfibrils also show crisscross arrangement Lignin cements and anchors cellulose microfibrils together and it is mainly responsible for rigidness.

(c) Middle lamella:

Middle lamella is present between adjacent primary cell walls of two cells. It is composed of sticky, gel-like magnesium and calcium salts (pectic acids) and pectin. The middle lamella holds neighboring cell walls together. The cell wall is porous (the pores are called pits) and allows free passage of water and dissolved material. The secondary cell wall provides definite shape and mechanical support to the cell.

28. Explain the (a) Chemical composition of plasma membrane (b) Role of plasma membrane in regulating cell's interactions with environment.

Ans: (a) Chemical composition of plasma membrane:

Plasma Membrane:

Plasma membrane is the boundary of protoplasm. It is found in all living prokaryotic and eukaryotic cells. Plasma membrane is also called cell membrane or plasmalemma or cell surface membrane. It gives shape and mechanical support to the cells.

Composition of plasma membrane:

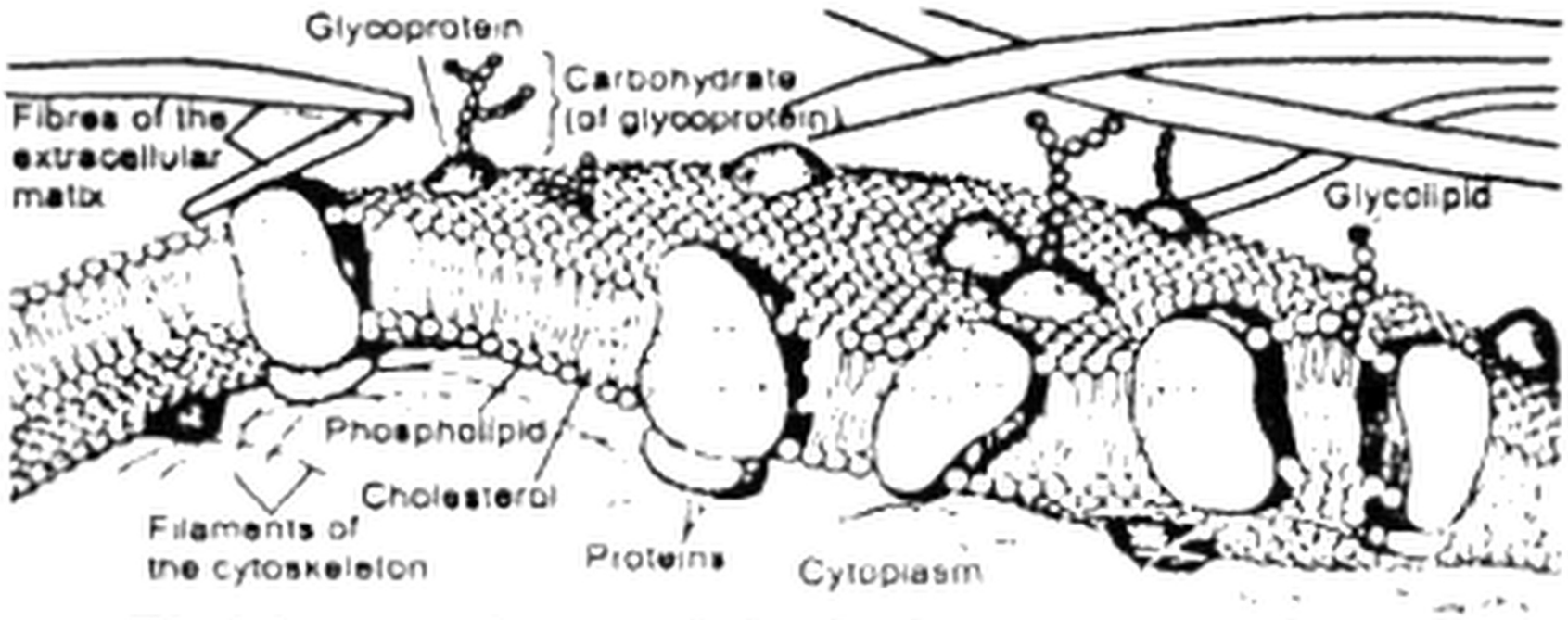
Chemically cell membrane consists of proteins 60-80%, lipids 20-40% and small quantity of carbohydrates. The lipid contents include phospholipids and cholesterols (absent in prokaryotic cell membrane). The protein contents include various structural and functional proteins. The carbohydrates are generally found in conjugated form like glycolipids and glycoproteins.

Structure of plasma membrane:

Fluid mosaic model of plasma membrane:

The model proposes that the membrane is a phospholipids bilayer in which protein molecules are either partially or wholly embedded. The proteins are scattered throughout the membrane in an irregular pattern just like large ice bergs float in the sea. The pattern of distribution of proteins can vary from membrane to membrane and also vary on both surfaces of membrane. The membrane is about 7 nm thick.

The lipid part of plasma membrane consists of two layers (bilayer) of phospholipids which are arranged in such a way that their hydrophobic ends face each other while hydrophilic ends are appeared on the surface. The steroids cholesterols are wedged into the phospholipid bilayer at some intervals. The plasma membrane is asymmetrical i.e., their two surface and halves are not identical.



Fluid mosaic model of plasma membrane

In general, most membrane proteins are observed to drift sideways in the fluid bilayer. The proteins within a membrane determine most of the functions. Many plasma membrane proteins are glycoproteins, which have an attached carbohydrate chain. Carbohydrates in the form of branched or unbranched oligosaccharides are either attached to proteins (glycoproteins) or lipids (glycolipids) generally on the outer side of membrane.

(b) Role of plasma membrane in regulating cell's interactions with environment:

Plasma membrane regulates cell's interaction with its environment by the controlling transport of material across the cell.

Transport across plasma membrane occurs to: (1) obtain nutrient (2) excrete waste substances (3) secrete useful substances (4) generate ionic gradients essential for nervous and muscular activity (5) maintain a suitable pH and ionic concentration within the cell for enzyme activity.

Plasma membrane acts as semipermeable membrane:

Plasma membrane acts as semipermeable membrane i.e., it allows some dissolved substances to move across while it inhibits the others. The substances which are lipid soluble cross it more easily than others. Many small gas molecules (O_2 and CO_2), water, glucose etc., being neutral can easily cross while ions being charged particles have some difficulty in crossing. For movement across the cell

surface membrane there are four basic mechanisms. Diffusion and osmosis are passive processes. Active transport and bulk transport (endocytosis and exocytosis) are energy consuming processes.

29. Describe the lipid foundation and variety of proteins of the plasma membrane.

Ans: Functions of plasma membrane lipids:

The lipid part of plasma membrane controls the fluidity of the membrane. When the concentration of unsaturated fatty acid in phospholipids becomes greater, the bilayer becomes more fluid that makes cell membrane more pliable i.e., flexible. The cholesterol also helps stabilize the phospholipids at a body temperature but helps keep the membrane fluid at lower temperature. The overall lipid bilayer provides the basic structure of membrane. It also restricts entry and exit of polar molecules and ions. The conjugated lipids (glycolipids) work as cell surface markers, their detailed role will be discussed later in this chapter.

Functions of plasma membrane proteins:

A great variety of proteins are found in plasma membrane which may act as transport channel or carrier enzyme, receptors or as antigens.

1. Channel proteins and Carrier proteins:

Certain plasma membrane proteins are involved in the passage of molecules through the membrane. Some of those have a channel through which a substance simply can move across the membrane, other are carriers that combine with a substance and help it to move across the membrane.

2. Enzymes:

Some plasma membrane proteins have enzymatic functions. They perform metabolic reactions directly, for example the membrane protein, adenylate

cyclase catalyzes the transformation of ATP to c cyclic AMP (cAMP), a second messenger.

Channel Protein: Allows a **particular** molecule **or ion to** cross the plasma membrane freely.		**Carrier Protein:** Selectively Interacts a specific molecule or **ion** so that it can cross the plasma **membrane.**	

Functions performed by protein in the plasma membrane

3. Receptor molecules:

Some proteins in the plasma membrane are receptors that receive signals from other cells. Each type of receptor has a shape that allows a specific charge to bind it. The binding of a molecule can cause the proteins to change its shape and bring about an intracellular response. For example, hormones circulate in the blood, but bind to specific target cells, which have the correct receptor sites. Some receptors are glycolipid in nature.

4. Antigens:

Some proteins are antigens which · enable the cells to recognize other cells for example the foreign antigens can be recognized and attacked by immune system.

30. What are the functions of the plasma membrane proteins?

Ans: Functions of plasma membrane proteins:

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31. What is the role of glycolipids and glycoproteins as the cell surface markers?

Ans: Roles of glycolipids and glycoproteins as cell surface markers:

Cell surface markers are the molecules present on outer surface of plasma membrane which provide the recognition of particular cell types so each type of cell can have its own specific markers. Mostly glycolipid and glycoproteins act as cell surface markers.

They act as cell identity markers or name tags just like the signboard of shops. They are involved in cell to cell recognition i.e., they are involved m sticking the correct cells together in tissues.

32. What is the chemical nature of cytoplasm? Explain the metabolic roles of cytoplasm.

Ans: Cytoplasm:

Cytoplasm is the region between nuclear membrane and plasma membrane. This is also a common component of both prokaryotic and eukaryotic cells. The major difference between the cytoplasm of these two kinds of cells is the presence or absence of cytoskeleton and membrane bounded organelles. These structures are absent in prokaryotic cells.

Physico-chemical nature of cytoplasm:

It is about 90% water and forms a solution that contains all the fundamental biochemicals of life. Some of these are ions and small molecules in true solution, such as salts, sugars, amino acids, fatty acids, nucleotides, vitamins

and dissolved gases. Others are large molecules, such as proteins, which form the colloidal solutions.

Cytosol and Cytogel:

The inner portion of cytoplasm i.e., towards the nucleus is less viscous and is called cytosol while the peripheral part of cytoplasm i.e., towards the plasma membrane is more viscous and is called cytogel.

Cyclosis:

A circular streaming movement can also be observed in cytoplasm due to the contractile activity of microfilaments. This movement is called cyclosis which is responsible for distribution of cell contents in cytoplasm.

Metabolic and storage role of cytoplasm:

The cytoplasm acts as a site of metabolism and store house of a cell. The metabolic pathways generally occur in the cytosol which includes protein biosynthesis, glycolysis, glycogenolysis, gluconeogenesis etc. The cytogel is usually concerned with storage of useful compounds which are subsequently used in various cellular activities and waste compounds which are eliminated from the cell time to time.

33. Describe the structures and functions of smooth and rough endoplasmic reticulum.

Ans: Endoplasmic reticulum:

An interconnecting network of cisternae (elongated closed sacs) which is generally extended from nuclear membrane to the plasma membrane throughout the cytoplasm of all eukaryotic cells is called endoplasmic reticulum (ER).

Types of Endoplasmic reticulum:

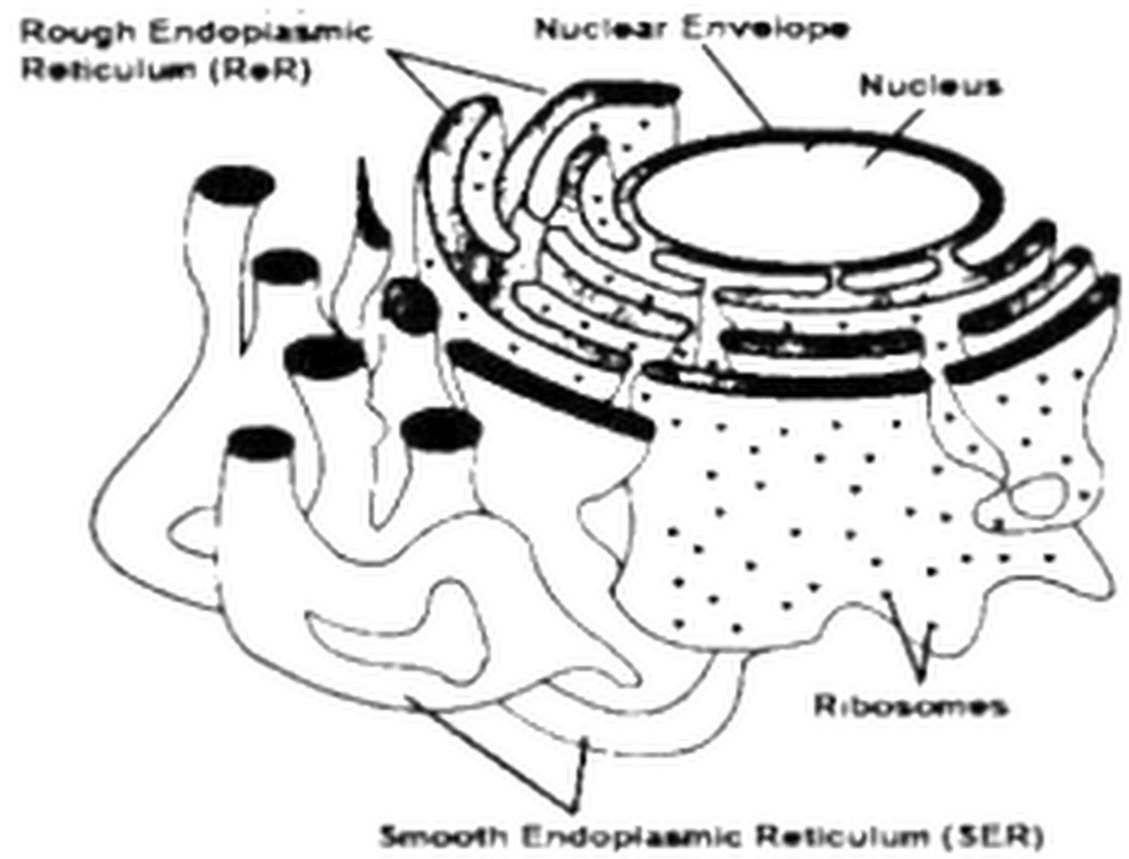
There are two types of ER, rough ER and smooth ER. Most cells contain both types of ER. However, some cells (skeletal muscle cells) have smooth ER more, where these are called sarcoplasmic reticulum.

Rough Endoplasmic Reticulum:

Rough ER has ribosomes attached to the sides facing the cytoplasm and has rough appearance under electron microscope.

Functions:

Rough ER is mainly concerned with the events of protein synthesis (translation) due to the association of ribosomes; however, their presence in the cell also provides a mechanical support to the cell.



Endoplasmic reticulum

Smooth Endoplasmic Reticulum:

Smooth ER is continuous with the RER. Since, ribosomes are not attached to it, therefore, it has smooth appearance under electron microscope.

Functions:

The smooth ER functions in various metabolic processes, e.g., metabolism of carbohydrates. The detoxification of drugs and poison especially in the liver cells and synthesis of lipids including oils, phospholipids and steroid take place in smooth ER. It also stores calcium ions, when released calcium ions trigger contraction of

the muscle. Smooth ER also transports various cellular products within the cell or out of the cell e.g., proteins from rough ER are also transported to the Golgi complex through smooth ER. Like rough ER, the presence smooth ER in the cell also provides a mechanical support to the cell.

34. Explain the structure, chemical composition and function of ribosomes.

Ans: Ribosomes:

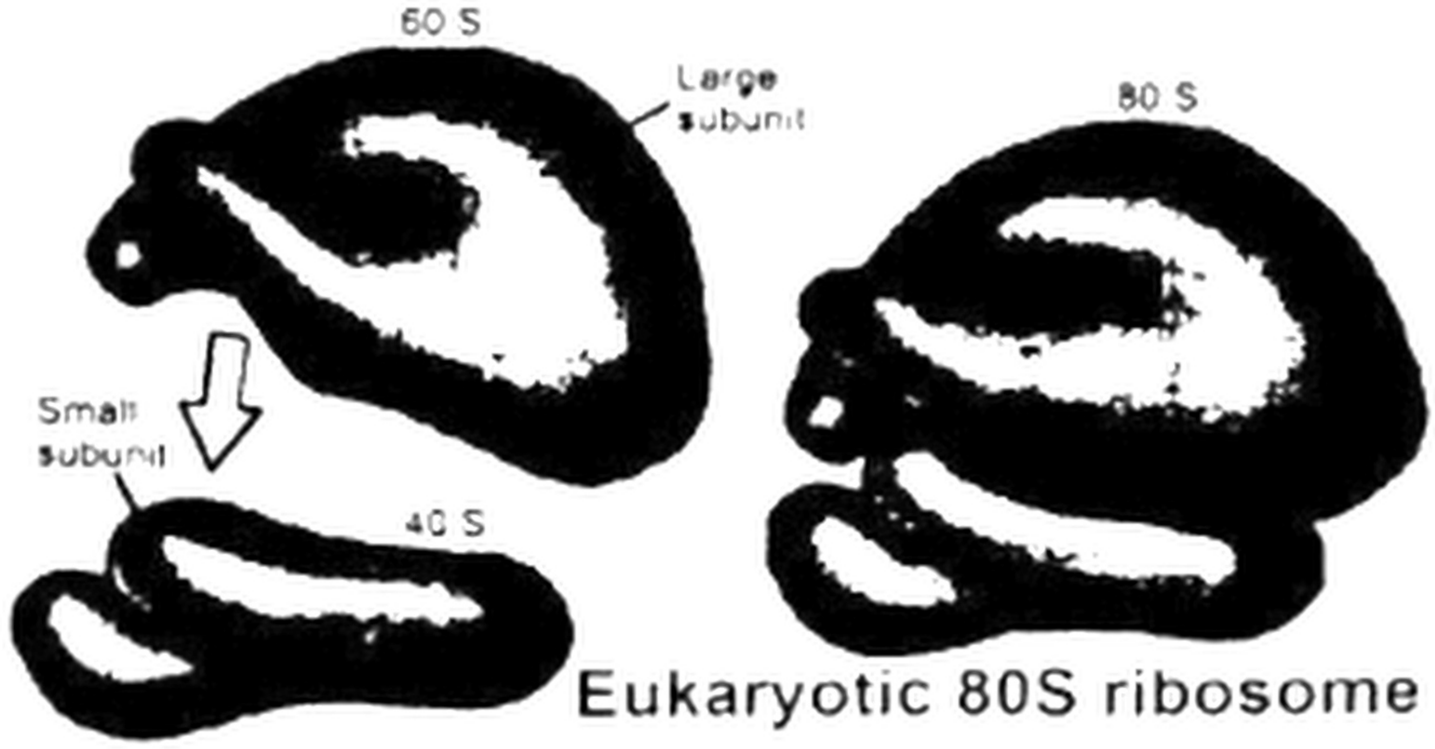
Ribosomes were first observed using electron microscope as dense granules. Ribosomes are roughly spherical granular non-membranous bodies found in both eukaryotic as well as prokaryotic cells.

Structure:

However, eukaryotic ribosomes are lager i.e., are about 20 to 24 nm in diameter and characterized as 80S ribosomes while the prokaryotic ribosomes are slightly smaller and are characterized as 70S ribosomes. They can be seen only under the electron microscope.

Chemical Composition:

They are made of almost an equal amount of RNA and protein so they are ribonucleoprotein. Ribosomes are formed in the nucleolus. Then these are transported to the cytoplasm through the nuclear pore.



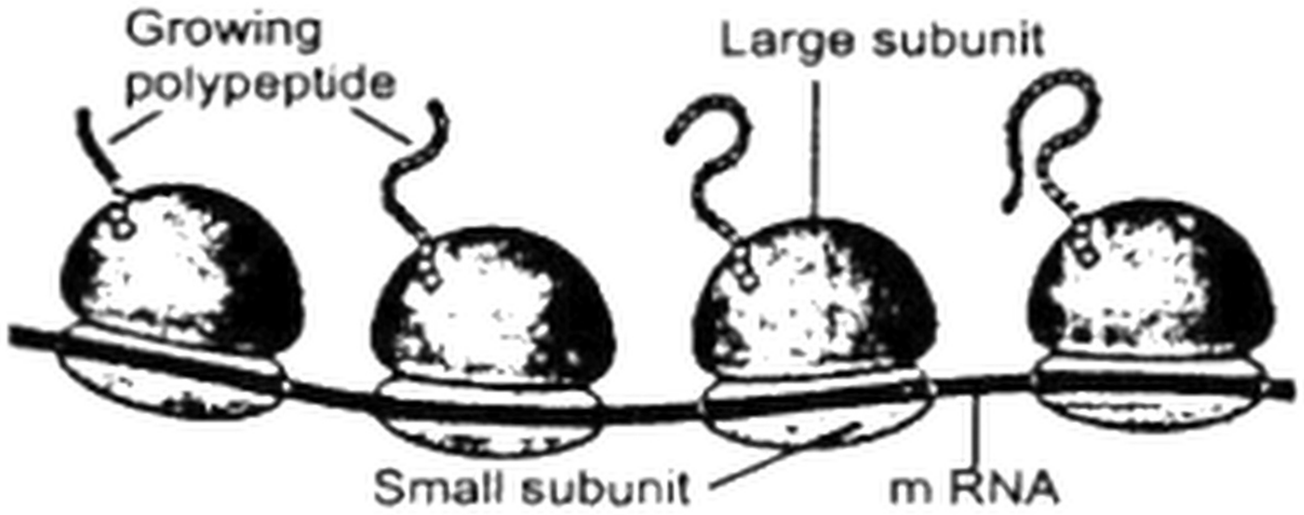
Eukaryotic 80S ribosome

In a eukaryotic cell, the ribosomes may be found as attached with RER or freely dispersed in the cytoplasm. Ribosomes are also found in matrix of mitochondria and stroma of chloroplast but these ribosomes are prokaryotic (70S) in nature. The eukaryotic ribosomes are composed of two subunits (particles) of different sizes. The larger one is 60S particles and the smaller one is 40S particles. The two subunits on attachment form 80S particles.

The attachment is controlled by presence of magnesium ions concentration or forming salt bonds between phosphate group of RNA and amino group of amino acid or both by magnesium ions and salt bonds. Both ribosomal subunits are generally attached together at the time of their function (translation).

Functions:

The ribosomes are involved in the events of protein synthesis (translation). Sometimes, during protein synthesis, several ribosomes are attached to one mRNA molecule. Such a chain of many ribosomes is called polysome or polyribosomes. In this way several copies of same polypeptide can be produced in very less time.



Polysome

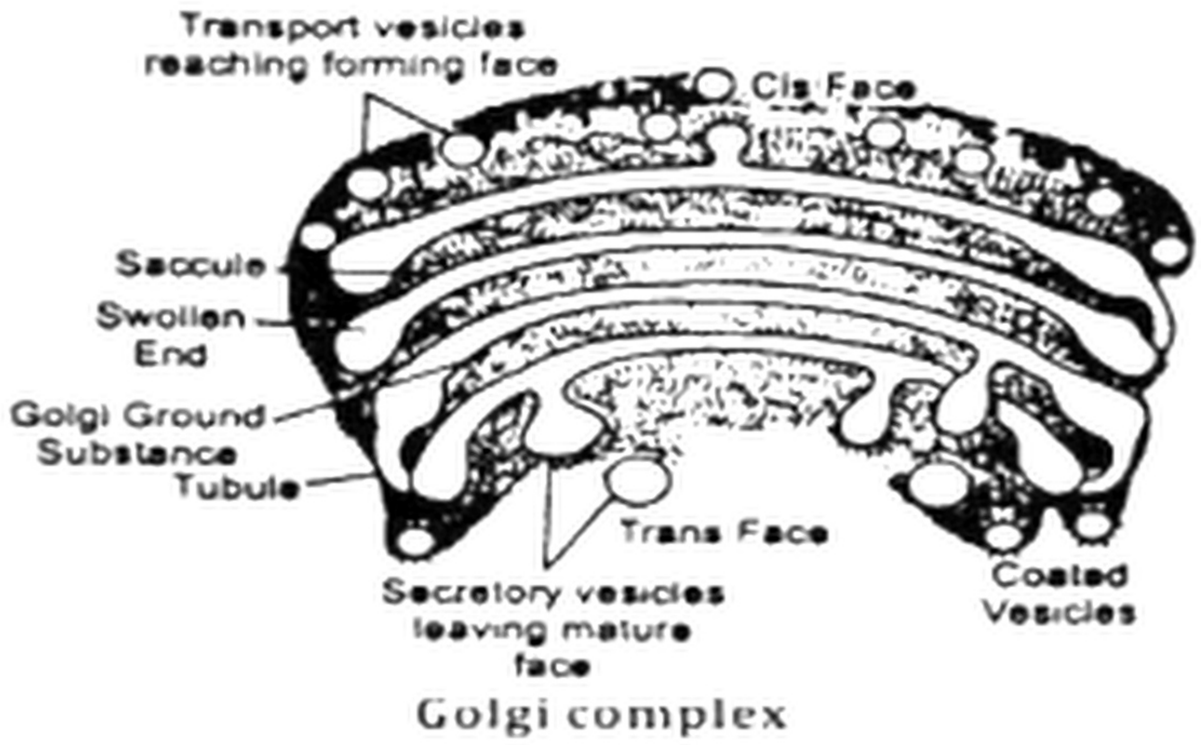
35. Explain the structure, and functions of Golgi complex.

Ans: Golgi complex:

It was discovered by Italian biologist Camillo Golgi in 1898 for which he was awarded Nobel. Prize. Its structure was revealed by electron microscope. It is found in all eukaryotic cells.

Structure of Golgi complex:

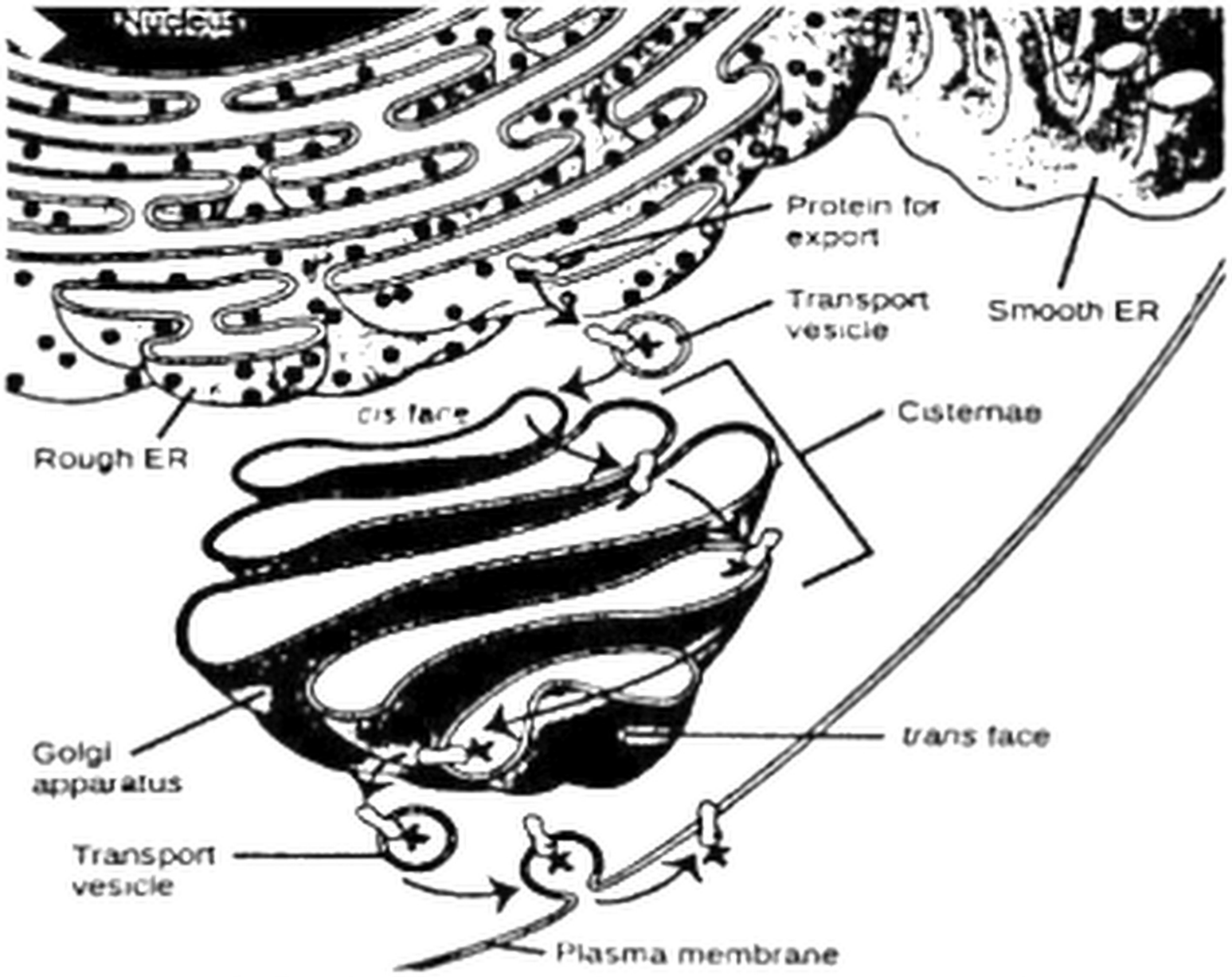
Golgi complex consists of a stack of flattened, membrane bound sacs called cisternae, together with system of associated vesicles (small sacs) called Golgi vesicles. It is believed that a complex system of interconnected tubules is formed around the central stack. At one end of the stack a new cisterna is constantly being formed by the fusion of vesicles from the smooth ER. This outer or forming face (cis face) is convex, while the inner end is concave and is called maturing face (Trans face) where the cisternae break up into vesicles again.



Golgi complex

Functions of Golgi complex:

The most important function of Golgi complex is the processing of cell secretions. Therefore, these organelles are abundant in secretory (glandular) cells. In many cases the cell secretions consist of proteins Golgi complex collects these proteins from RER through SER, modifies them to perform specific function and then exports these modified products in the form of vesicle. Certain organelles, such as lysosomes, peroxisomes and glyoxysomes also originates from Golgi complex.



Role of Golgi complex in a glandular cell

Golgi complex is also involved in the formation of conjugated molecules like glycoprotein, lipoprotein etc. In plant cell during cell division, Golgi complex also gives rise vesicles which contain cell wall synthesizing materials. At the time of cytoplasmic division (cytokinesis), these Golgi vesicles are arranged on the cell equator, fuse together and form a structure, called phragmoplast. Later on new cell wall is derived from this structure.

36. Explain the structure and functions of the peroxisomes and glyoxysomes in animal and plant cells.

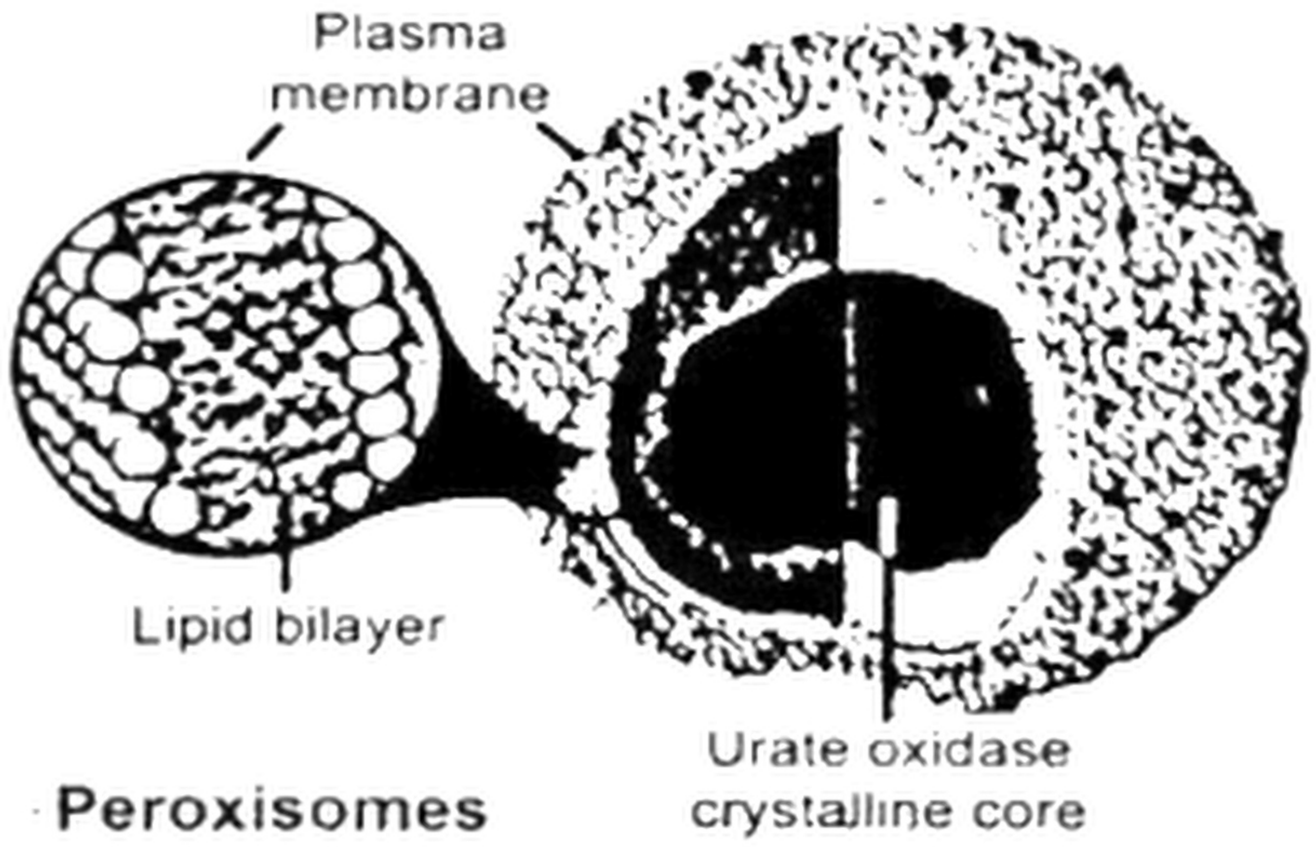
Ans: Peroxisomes and Glyoxysomes:

Peroxisomes and glyoxysomes are collectively called microbodies. These are similar to lysosomes in the sense that they are single membranous, vesicular

structures. They contain enzymes (although different than lysosome) and originate from Golgi complex but they are smaller than lysosome.

Structure and Functions of Peroxisomes in animal and plant cells:

Peroxisomes were discovered in 1965 in liver cells. Peroxisomes are approximately 0.5 to 1 micrometer in diameter. Peroxisomes contain some oxidative enzymes like peroxidases, catalases and glycolic acid oxidases. They are abundant in liver cells where they are specifically involved in the formation and decomposition of hydrogen peroxide so they are named peroxisomes. They are mainly concerned with the detoxification of alcohol. In this activity alcohol is oxidized into hydrogen peroxide (H_2O_2) with the help of peroxidase enzyme.



Peroxisomes

Hydrogen peroxide is itself a toxic molecule, which is immediately broken down to water and oxygen by another enzyme called catalase. In plant cell, peroxisomes are involved in photorespiration. A step of photorespiration takes place in peroxisomes in which glycolate is converted into glycine with the help of an enzyme called glycolic acid oxidase.

Structure and Functions of the Glyoxysomes in animal and plant cells:

Glyoxysomes are found only at seedling stage in oil seed plants. These organelles have a number of enzymes specific for plant lipid metabolism that are not found in animal cells. The germinating seedlings convert stored fatty acids to carbohydrates. This is achieved through a metabolic pathway called glyoxylate cycle. The enzymes of which are located in the glyoxysomes.

37. Explain the formation, structure and functions of the lysosomes.

Ans: Lysosomes:

Formation:

Lyso means splitting and soma means body. These are single membranous spherical sacs (vesicles). They contain digestive or hydrolytic enzymes. The lysosomal enzymes are manufactured on the RER. Then these enzymes are transported to Golgi complex through SER. After modification, these enzymes are released from Golgi complex in the form of vesicles. Such vesicles are called lysosomes.

Primary lysosomes:

The newly formed lysosomes before the start of their functions are usually called primary lysosomes. They vary in size, and usually 0.2-0.5 μm in diameter. In plant and fungi, certain vacuoles carryout enzymatic hydrolysis, a function shared by lysosomes in animal cells.

Structure:

Lysosomes contain about 40 different digestive enzymes. These enzymes can breakdown every major macromolecule of the cell. The contents of the lysosome are acidic (with pH around 4-4.5).

Its main function is the breakdown and removing of old parts of the cell or microorganism. The lysosomes fuses with membrane bound vesicle that arises from any of these pathways - endocytosis, phagocytosis or auto phagocytosis. These vesicles are referred to as endosomes, phagosomes and autophagosomes

respectively. These endosomes fuses with lysosomes (primary lysosomes) and forms secondary lysosomes (sometimes referred to as endolysosomes). The biomolecules are further broken down into smaller forms like amino acids monosaccharides, nucleotides and fatty acids which are then recycled in the cell.

Functions:

Major functions of lysosomes include intracellular digestion, autophagy, and autolysis.

Food Vacuoles:

The ingested food of cell is stored in vesicles, called food vacuoles.

Secondary Lysosome:

Once a lysosome has fused with food vacuole, the resulting structure is called secondary lysosome in which food begins to digest.

Contractile Vacuole:

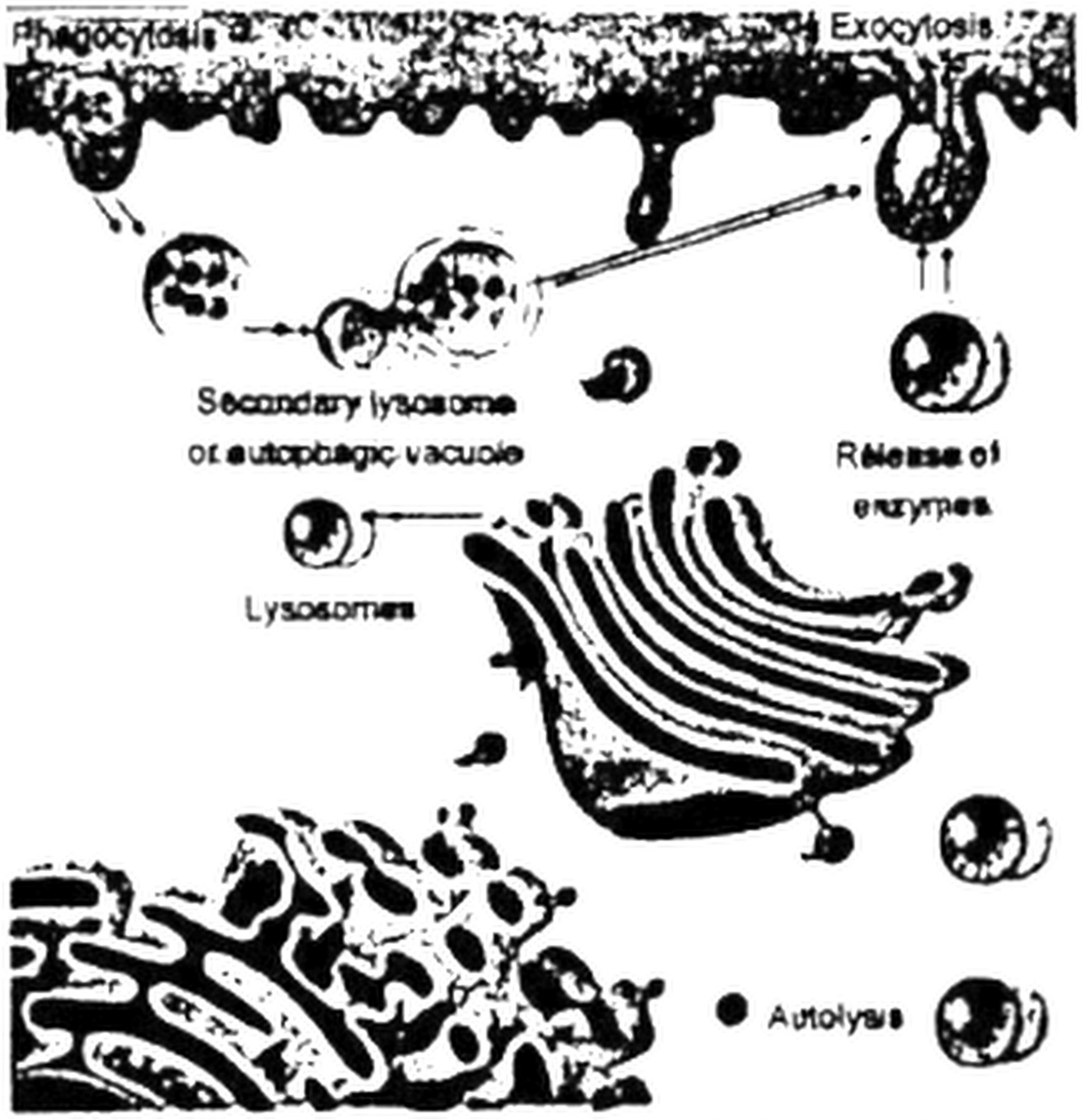
The digested products are absorbed by the cytoplasm while the remaining wastes containing vesicle is now called contractile vacuole.

Intracellular Digestion:

Later on, these vacuoles fuse with cell membrane (exocytosis) to eliminate undigested wastes. This whole process is known as intracellular digestion.

Autophagy:

The process by which unwanted structures within the cell are engulfed and digested within the lysosomes is called autophagy.



Lysosomes: form and functions

Autophagosomes:

This is self-eating process of a cell in which a lysosome begins to digest cell's own organelles. Such lysosomes are also called autophagosomes.

This process either takes place in starvation period in order to obtain energy or it occurs in routine in order to control number of specific organelles.

For example:

If someone starts to perform heavy muscular exercise, the number of mitochondria begins to increase in his muscle cells, but if he leaves exercise, the number of mitochondria is again decreased by the process of autophagy.

Autolysis:

Sometimes, especially during developmental phase, when a particular cell is required to be disintegrated, a type of cell death is committed, called autolysis.

Suicidal Bags:

This is a programmed cell death in which lysosomes burst and their enzyme contents are quickly dispersed throughout the cytoplasm. In this way the cell is disintegrated into fragments which are phagocytosed by other cells. Due to this function lysosomes are also called suicidal bags.

38. What are the storage diseases? Explain with reference to the malfunctioning of lysosomes.

Ans: Lysosomal-Storage Disease:

Lysosomes contain various digestive enzymes if a particular lysosomal enzyme is missing in an individual, the digestion of that particular substance (for which enzyme was specific) will be affected. As a result, the substance begins to accumulate in the cell and cause different problems. Such complications which are caused by the accumulation of various substances in the cell due to lack of certain lysosomal enzymes are called lysosomal storage diseases.

These diseases are hereditary and congenital therefore run in particular families and exist by birth in an individual. Most of these diseases are fatal in early childhood. About more than 20 such diseases have been discovered so far.

Example:

One of the common examples is Tay-Sachs disease in which a lipid digesting enzyme is missing or inactive and the brain becomes impaired by an accumulation of lipids in the cell.

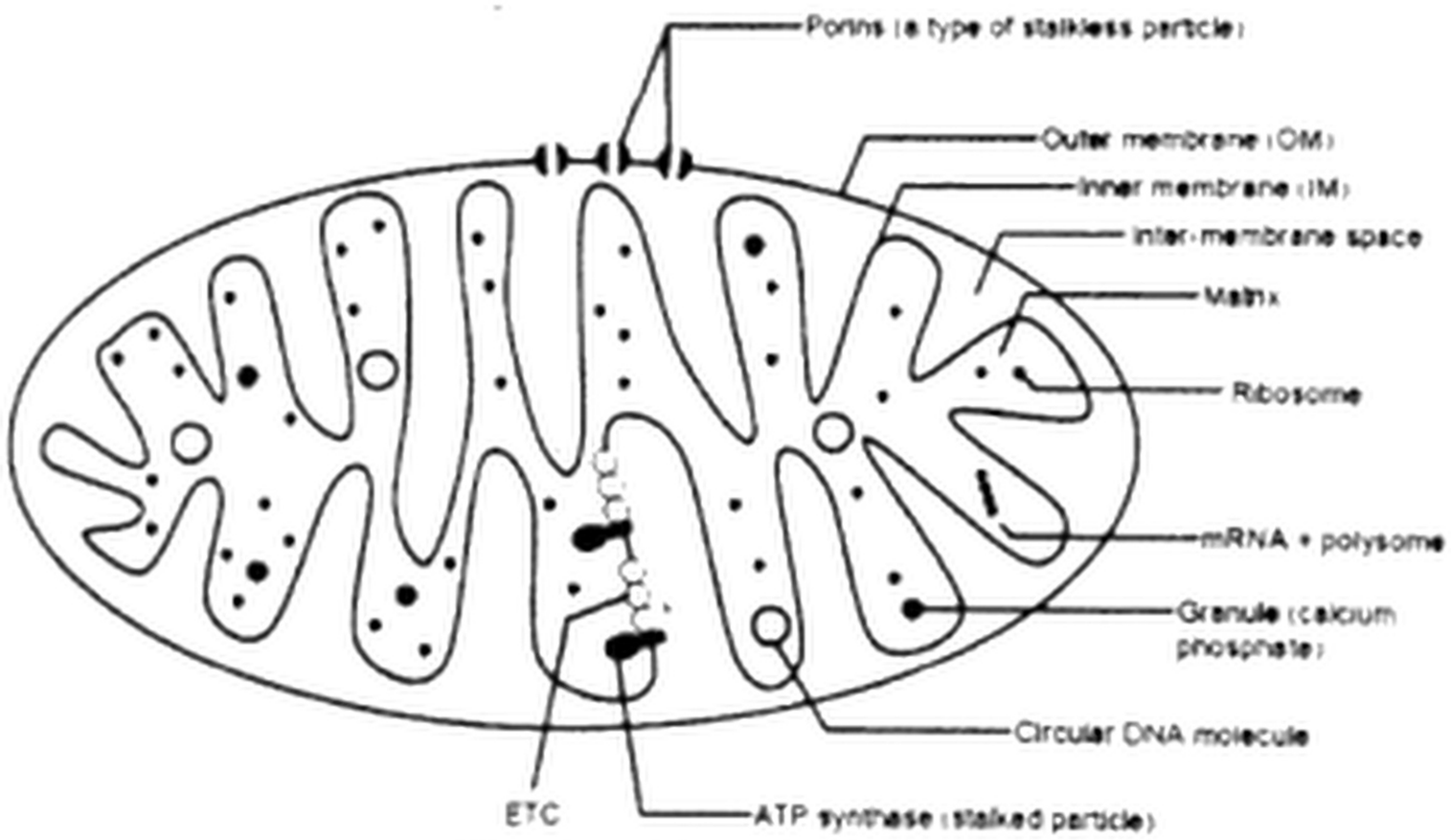
39. Describe the external and internal structure of mitochondrion? What are the functions of these Structures present in mitochondria?

Ans: Mitochondria:

Mitochondria (singular: mitochondrion) are present in all eukaryotic cells. Some cells have a single large mitochondrion. but more Often a cell has hundreds or even thousands of mitochondria; the number correlates with the cell's level of metabolic activity For example, cells that move or contract have proportionally more mitochondria per volume than less active cells.

External and Internal Structure of Mitochondrion:

Mitochondria are capable to divide themselves (self-replicating) in order to increase their number. They divided by fission.



Mitochondrion with F1 particles

Mitochondria are cylindrical or rod-shaped structures. Its' length ranges from 2 to 5 μm and are 0.5 to 1.0 μm diameters.

They are enclosed by double membrane, the outer membrane and the inner membrane. Each membrane is a phospholipid bilayer with a unique collection of embedded proteins: The outer membrane is smooth and somewhat like a sieve.

Porins:

The outer membrane has special proteins embedded into the membrane called porins. These are responsible for the transport of molecules across the membrane, Prions allow free passage of various molecules into the inner membrane space. **Cristae:**

The inner membrane is selectively permeable and folded inwards. The folds are called cristae (singular crista) which serve to increase the surface area.

Stalk Particles or F0-F1 Particles: The Inner surface of cristae is furnished with granular structures called stalk.

Particles or F0-F1 Particles.

These particles are actually ATP synthase enzymes. In addition, several other complexes are also found in inner mitochondrial membrane, which serve as electron carriers in electron transport chain. The inner membrane divides the mitochondrion into two internal compartments. The first is the intermembrane space, the narrow region between the inner and outer membranes. The second compartment, the mitochondrial matrix, is enclosed by the inner membrane.

Mitochondrial matrix is a jelly like material that contains a small circular DNA, all kinds of RNA ribosomes (70S) and enzymes. The presence of these components indicates that mitochondria have their own genetic system. It means, the protein, which are required by mitochondria are synthesized by their own metabolic machinery.

Mitochondria are the sites of cellular respiration, the metabolic process that uses oxygen to generate ATP by extracting energy from sugars, fats, and other organic compounds. Enzymes in the matrix catalyze some of the steps of cellular respiration like Krebs cycle, other proteins that function in ATP generation through electron transport chain are found into the inner membrane.

40. Describe the external and internal structure of chloroplast? What are the functions of these structures present in chloroplast?

Ans: Chloroplasts:

Chromoplasts synthesize and store different colored pigments other than green. Therefore, they are found in colored parts of plant such as flower petals and fruit wall where they attract insects and thus help in pollination.

Chloroplasts are found in green parts of the plants and act as site of photosynthesis.

External and Internal Structure and Functions of Chloroplast:

Chloroplast is a discoid structure which consists of three parts i.e. envelope, stroma and thylakoids. Each chloroplast is bounded by a smooth double membrane (envelope). The outer membrane tike mitochondria contain porins and therefore freely permeable to small molecules. The inner membrane is semipermeable and rich in protein. Between the two-intermembrane space is 25 - 75 angstrom (Å) wide.

Stroma:

The ground mass of chloroplast is called stroma. It is the colorless proteinaceous substance which Mike mitochondrial matrix also contains a small circular DNA, all kinds of RNA, ribosomes (70S) and various enzymes.

Thylakoids:

The stroma contains a system of chlorophyll bearing double membrane lamellae that form flattened sac-like structures called thylakoids.

There are two types of thylakoids: smaller thylakoids and the larger thylakoids.

Smaller thylakoids (grana lamellae):

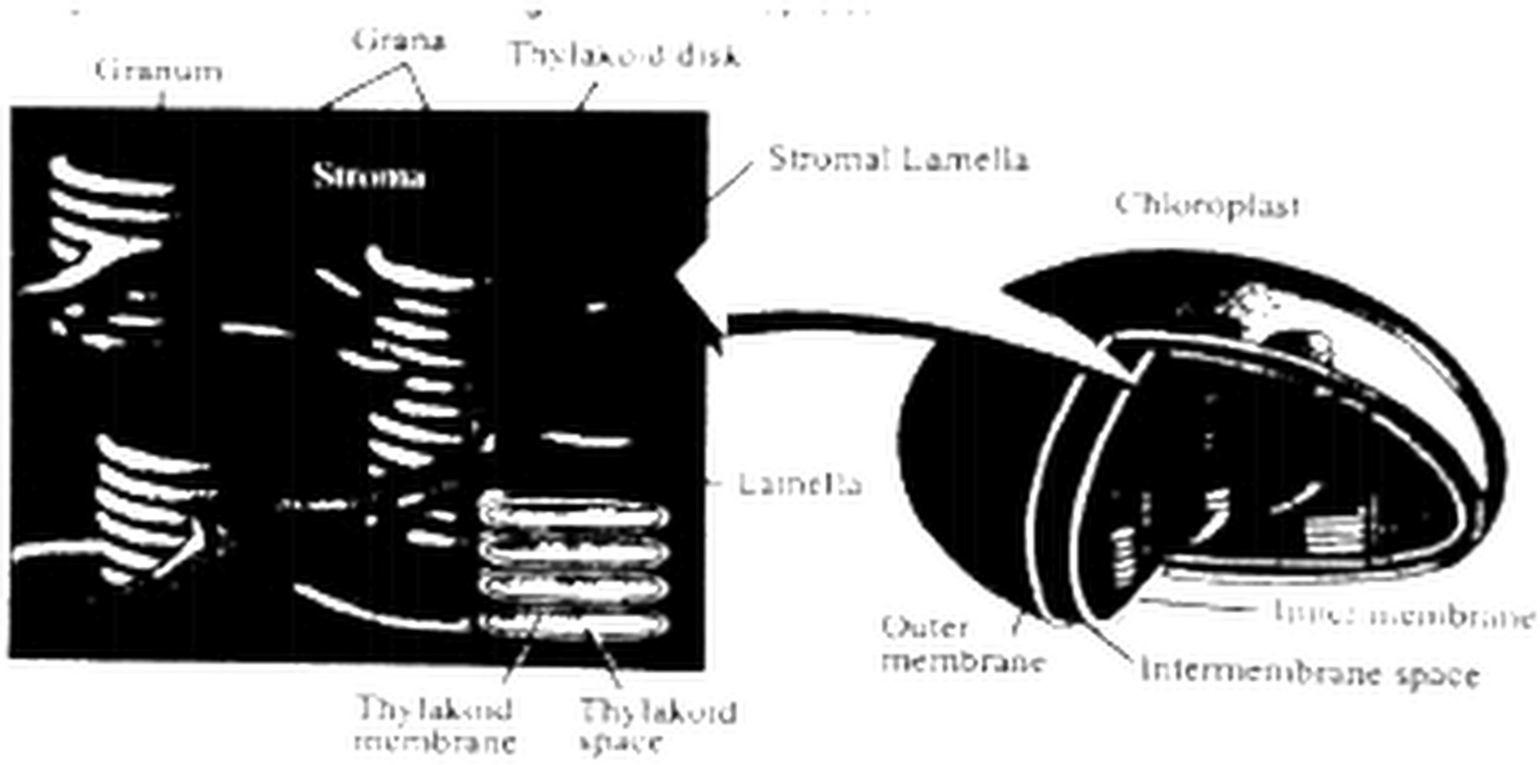
Smaller thylakoids (grana lamellae) are disc like sacs which are piled over one another like Stack of coins. Each stack of smaller thylakoids is called granum (plural grana). Each granum consists of 25-50 thylakoids and there are about 40 - 60 grana found in each chloroplast. Photosynthetic pigments are also found in the membranes of smaller thylakoids.

Larger thylakoids (stroma lamellae):

Larger thylakoids (stroma lamellae) connect the grana with each other and are also called intergrana. These membranes are colorless as they do not have pigments Chloroplast is the site of photosynthesis in a plant cell.

The first phase of photosynthesis is Light dependent reaction in which sunlight is captured and transformed into ATP. This phase takes place in grana region of chloroplast.

The second phase of photosynthesis is light independent reaction (dark reaction) in which C02 is reduced to make carbohydrates. The enzymes for this activity are found in stroma region of chloroplast.



Chloroplast

41. Compare and contrast the structure and functions of mitochondria and chloroplasts.

Ans: Similarities:

Mitochondria and chloroplast both have:

- A double membrane surrounding the organelles.
- Purportedly prokaryotic origins according to the endosymbiotic theory which suggests that mitochondria and chloroplast were once prokaryotic bacteria engulfed by endocytosis in early eukaryotes.
- Their own circular DNA which codes for certain enzymes required for the chemical reactions that take place in these organelles.
- Their Own 70S ribosomes made up of 50S and 30S subunits to translate proteins.
- The enzyme ATP synthase which utilizes the energy released from the movement of protons across (proton-motive force) to phosphorylate ADP to AT P. (Thus. another similarity would be that they both produce AT P).
- Electron transport chains, which are embedded in the inner mitochondrial membrane and thylakoid membrane in mitochondria and chloroplasts respectively.
- Both organelles have chemical cycles in which the initial acceptor is regenerated at the end of the cycle in mitochondria, the Krebs cycle occurs after which oxaloacetate is regenerated at the end of the reaction. In chloroplasts, the Calvin cycle occurs in which ribulose bisphosphate (RuBP) is regenerated at the end of the reaction.

Differences:

- Obvious structural and naming differences that you should be able to figure out from the diagram above.
- Mitochondria are involved in cellular respiration whereas chloroplasts are involved in photosynthesis. Thus, the overall chemical reactions for the processes occurring in them are different and reversed.

- Respiration: $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$

- Photosynthesis: $6C0_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

- Mitochondria are found in all animal and plant cells. Chloroplasts. However, are found in only specific types of plant cells, such as the palisade mesophyll and spongy mesophyll cells of leaves. These cells are the ones involved in carrying out photosynthesis. Other types of plant cells, such as root cells do not contain chloroplasts.
- Chloroplasts contain pigments such as chlorophyll a, chlorophyll b and carotenoids Mitochondria do not contain any such pigments.
- The ATP synthase in mitochondria and chloroplast are orientated differently. ATP synthase in mitochondria points into the matrix, with protons flowing from the intermembrane space to the matrix, in chloroplasts however, ATP synthase points towards the stroma, and protons flow from the thylakoid space into the stroma.
- The types of electron acceptors present in mitochondria and chloroplast vary. While mitochondria contain NAD and FAD, chloroplasts contain NADP.
- The sources of energy used to synthesize ATP in mitochondria and chloroplasts are different. In mitochondria, this energy comes from the oxidation of glucose, and is hence termed oxidative phosphorylation. In this energy comes from light, so it is called chloroplast, photophosphorylation.
- Mitochondria function under both light and dark conditions Chloroplasts. On the other-hand, do need light to function
- Electron transport chains. The final electron acceptor in mitochondria is oxygen, whereas the final electron acceptor in chloroplasts IS NADP.
- In mitochondria, the root source of electrons is generally glucose (it could be other substrates depending on what was utilized). In chloroplasts, however the root source of electrons is the photolysis of water occurring at photosystem II. Water (H_20) is broken down to release 2 protons, 2 electrons and a molecule of oxygen.

- Mitochondria give out carbon dioxide from the decarboxylation (removal of carbon) reactions that occur during the link reaction and Krebs cycle but chloroplasts give out oxygen due to photolysis as explained above.

OR (Second Answer)

	Mitochondria	Chloroplast
Meaning	A large, membrane-bound bean-shaped organelle found in almost all kind of eukaryotic organism. also known as 'powerhouse of the cell Mitochondria are responsible for cellular respiration and energy metabolism	The chloroplast is found only in green plants and in few algae. they are the Sites Of photosynthesis This organelle of the cell is much more complex and larger than the mitochondria
Found in	Mitochondria are present in the cells of all types of aerobic organisms, like plants and animals	Chloroplast is present in green plants and green algae, protists like Euglena.
Color	Mitochondria are colorless organelles.	The chloroplast is green in colors.
Shape	Bean shape	Disc shape.
Chamber	Mitochondria have two chambers: matrix and cristae	Chloroplast also has two chambers stroma and thylakoid
Inner membrane	The inner membrane mitochondria is folded cristae	The inner membrane of the chloroplast rises into

		flattened sacs called as thylakoids.
Pigments	Mitochondria do not possess any pigments.	The thylakoid membrane in chloroplast contains carotenoids. Chlorophyll and photosynthetic pigments
Other characteristics	Mitochondria convert sugar (glucose) into chemical energy called as ATP (adenosine triphosphate).	In the chemical bonds of glucose, the solar energy is stored
	It consumes Oxygen	It liberates or releases oxygen.
	Mitochondria release energy by the breakdown of the organic food and produce carbon dioxide and water. Mitochondria are the site beta oxidative photorespiration, oxidative phosphorylation, ETC.	Chloroplast helps in storing the energy and uses carbon dioxide and water to make glucose (energy). Of The chloroplast is the site the photorespiration and photosynthesis.

OR (Second Answer)

Difference between Mitochondria and Chloroplast:

Mitochondria:

1. They are colorless cell organelles.

2. Mitochondria are found in all types of cells Of aerobic organisms, both plants and animals
3. They are generally cylindrical in outline.
4. Their inner membrane is folded into cristae
5. Cristae do not form grana
6. Pigments do not occur in mitochondria
7. Mitochondria do not take part in the conversion of light energy into chemical energy
8. They liberate energy by breaking down of organic food to produce carbon dioxide and water.
9. Mitochondria consume oxygen.
10. Site of electron transport chain. Beta oxidation, Oxidative phosphorylation Photorespiration.

Chloroplast:

1. Chloroplast are green organelles
2. They are restricted to only some profits (Euglena) and in plants
3. Chloroplasts are generally disc shaped
4. The inner membrane gives rise to flattened sacs called thylakoids
5. At places, thylakoids produce stacks of disc called grana
6. The membranes of thylakoids possess photosynthetic pigments. chlorophylls and carotenoids
7. Chloroplasts are the centers of conversion of solar energy into chemical energy
8. They store energy by building up organic food for which carbon dioxide and water are used as raw materials in the process-of photosynthesis
9. Chloroplasts liberate oxygen
10. Site of Photosynthesis. Photorespiration

42. What are centrioles? Describe the structure, composition and functions of centriole.

Ans: Centrioles:

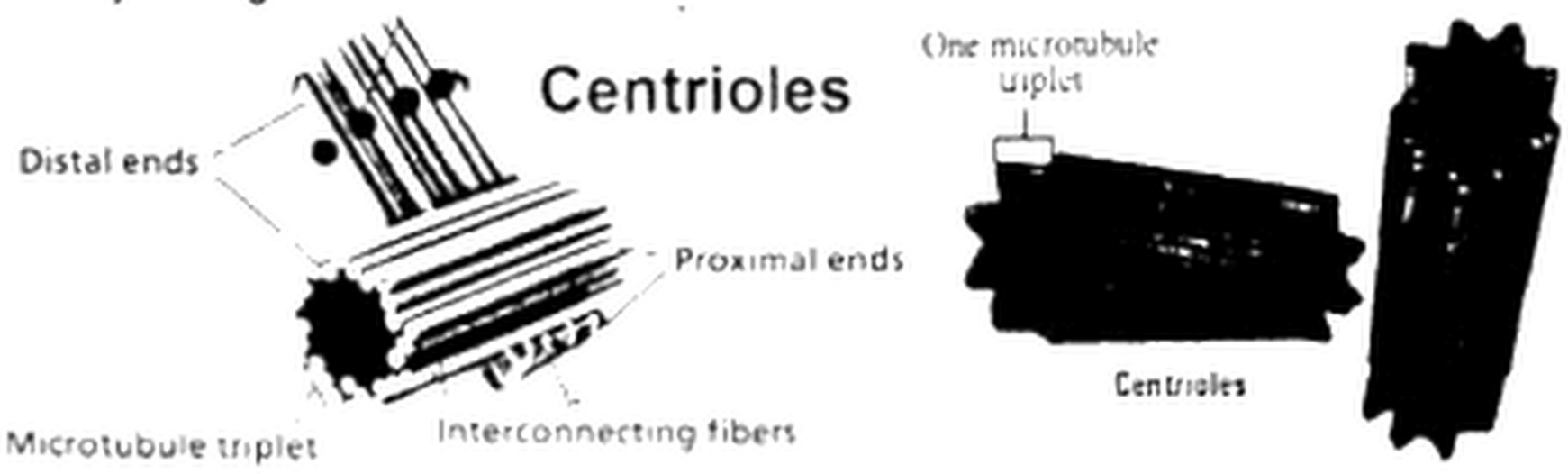
Centrioles are non-membranous cell organelles found mainly in animal cells. They are also found in fungi like protists such as slime molds and water molds.

Structure of Centrioles:

Centrioles are rod shaped structures and usually occur in pairs. These occur at right angle to each other near one pole of the nucleus. Centrioles are about 0.15- 0.25 µm in diameter and 0.3-2 µm in length. Centrioles lie in a distinctly, staining region of the cytoplasm known as centrosphere the centrioles and centrosphere are together called centrosome.

Composition of Centrioles:

Each centriole is composed of nine triplets of microtubule which are circularly arranged around a central axis.



Functions of Centriole:

Just before the cell division, the pair of centrioles duplicates and becomes two pairs which later on migrate to the opposite Sides of the nucleus. Both centriole pairs give rise microtubules (spindle fibers) during cell division.

The whole structure of spindle fibers is known as mitotic apparatus which helps in the distribution of chromosomes between the daughter cells during cell division. In addition, centrioles also give rise to basal bodies or kinetosome of cilia and flagella.

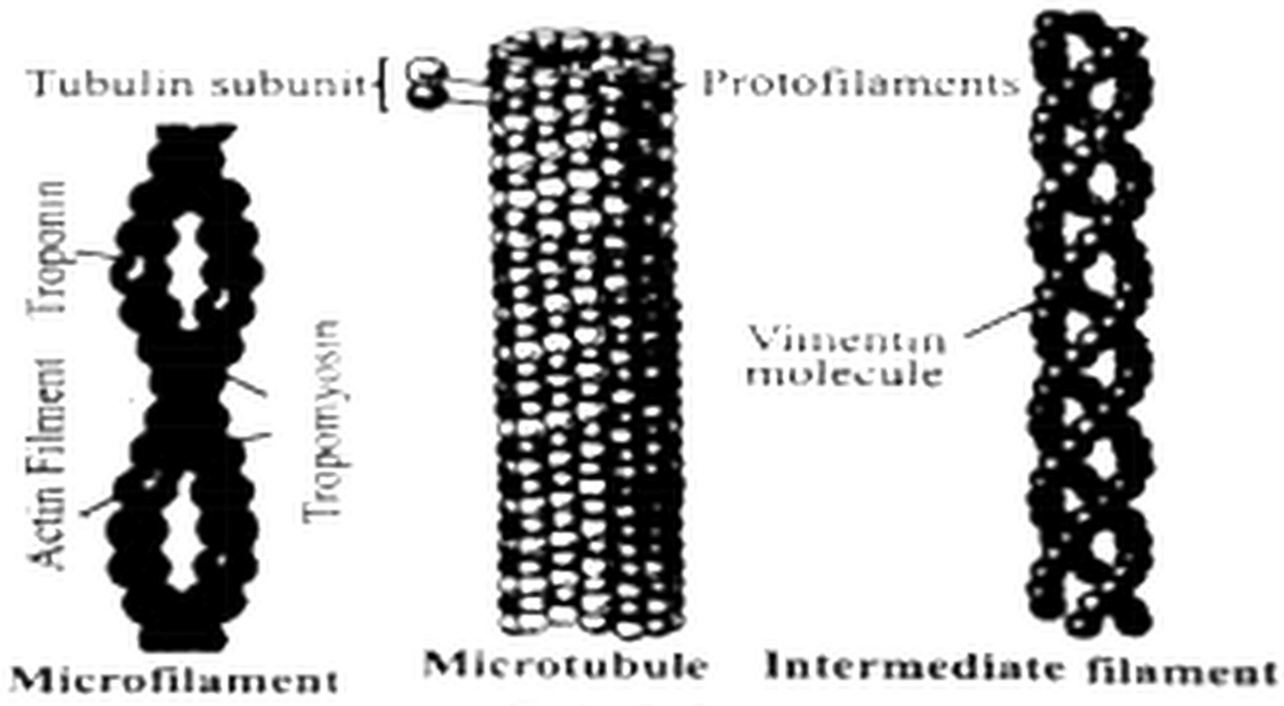
43. What are cytoskeletons? Describe the types, structure, composition and functions of cytoskeleton.

Ans: Cytoskeleton:

The term cytoskeleton is generally applied to three different kinds of fibrous structures which are distributed from nucleus to the plasma membrane throughout the cytoplasm of a eukaryotic cell.

Types of Cytoskeleton:

These fibers include microfilaments, microtubules and intermediate filaments.



Cytoskeleton
Three types of cytoskeleton

Microfilaments:

Microfilaments are also known as actin filaments.

Structure:

These are extremely thin contractile fibers about 7 nm in diameter that occur in bundles or mesh like networks. The actin filament contains two chains of globular actin (G-actin) monomers twisted about each other in a helical manner. Each chain is called fibrous or filamentous actin (F-action).

Composition:

Two chains of tropomyosin also twist around an actin filament and another protein troponin Occurs in the form of triplets at intervals along the length of filament.

Function:

Generally, these filaments are found just under the plasma membrane where they ensure the Circular streaming movement of cytoplasm due to their contractile activity in some cells (muscles). They are very abundant and found as bundles called myofibrils, in this form they enable the cells for contraction and relaxation.

Microtubules:

Structure:

Microtubules are small hollow cylinders about 25nm in diameter and 0.2-25 µm in length.

Composition:

They are composed of a protein, the tubulin. Each tubulin is a dimer i.e. consists of two subunits which are known as alpha and beta subunits. These tubulin dimers form paired filaments by their linear arrangements. Such paired filaments are coiled or twisted to form tubular structures, the microtubules.

Function:

In plant cells, the microtubules are freely dispersed in cytoplasm at the time of cell division these freely dispersed microtubules organize themselves in the form of spindle shaped structure called mitotic apparatus which ensures the distribution of chromosomes between the daughter cells.

In animal cells, the microtubules are involved in the formation of centrioles cilia, flagella and basal body

Intermediate Filaments:

Structure:

Intermediate filaments are 8 to 10 nm in diameter i.e._, intermediate in size between actin filaments and microtubules, this is why they are called intermediate filaments. The basic protein subunit of the filament is vimentin. The vimentin subunits also form chains or strings by linear arrangement.

Composition:

Each intermediate filament is composed of three chains of vimentin which are twisted about each other in such a way that no hollow space is left between them.

Function:

They usually form a network in the cytoplasm which provide a mechanical support to nuclear envelope and plasma membrane.

44. Describe the structure of cilia and flagella. Explain the mechanism of movement of cilia and flagella.

Ans: Cilia and Flagella:

Cilia (L. cilium, eyelash, hair) and flagella (L. flagella. whip) are hair like projection on the surface of the cells. The internal structure of both cilia and

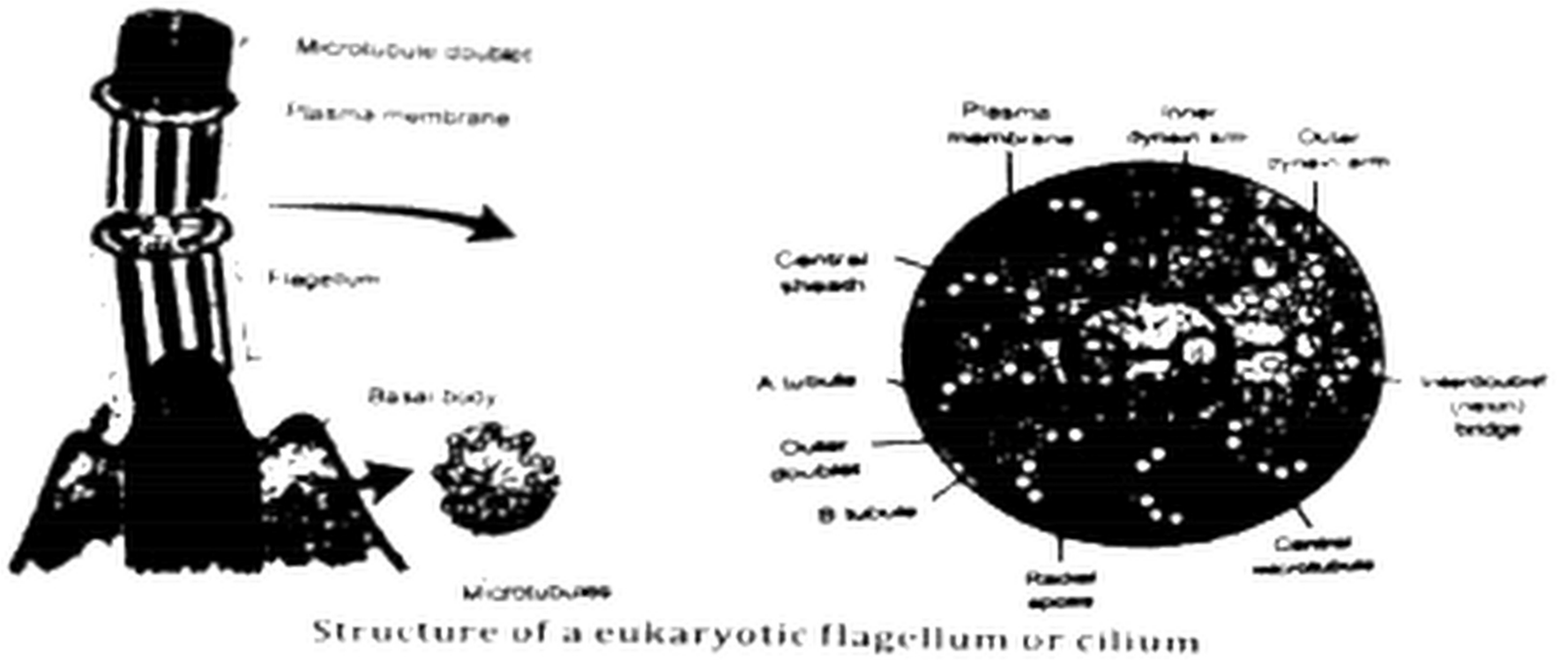
flagella is quite same but they may differ in size, number and pattern of movement the flagella are longer, few in number i.e. 1, 2 or 4, exhibit undulating motion and beat independently Whereas cilia are numerous and relatively short and beat perpendicularly in metachronous (cilia of a row beating one after the other) or In synchronous rhythm (all cilia of a row beating simultaneously)

Structure of cilia and flagella:

Cilia and flagella originate from their basal bodies embedded in the cytoplasm. Each cilium and flagellum consist of a longitudinal axoneme enclosed in a spiral sheath of cytoplasm and a plasma membrane continuous with the cell membrane. Axoneme made up of a bundle of eleven longitudinal microfibrils or bundles of microtubules. Nine are peripheral and arranged in a ring. In the center of the ring are two microtubules. This arrangement is caned "9 + 2" pattern. There is a bridge connecting the two central microtubules.

Each peripheral microfibrils is composed of two subfibres forming a doublet. The inner subfIbre of the doublet is complete (A tubule) and the outer sub fibre is C- shaped (B tubule). Each inner subfIbre has two -arms, the outer dynein arm and inner dynein arm. The arms are composed of dynein protein. A radial spoke extends from a tubule to the inner sheath Nexin IS a proteinous inter-doublet linkage. The axoneme is held together by three sets of protein crosslinks: i.e. (1) Bridge connecting the two central tubules (2) Radial spokes (3) Nexin

Cilia and flagella originate from their basal bodies embedded in the cytoplasm. Each cilium and a flagellum have a basal body lying in the cytoplasm at its base. Basal bodies have the same circular arrangement of microtubule triplets as centrioles



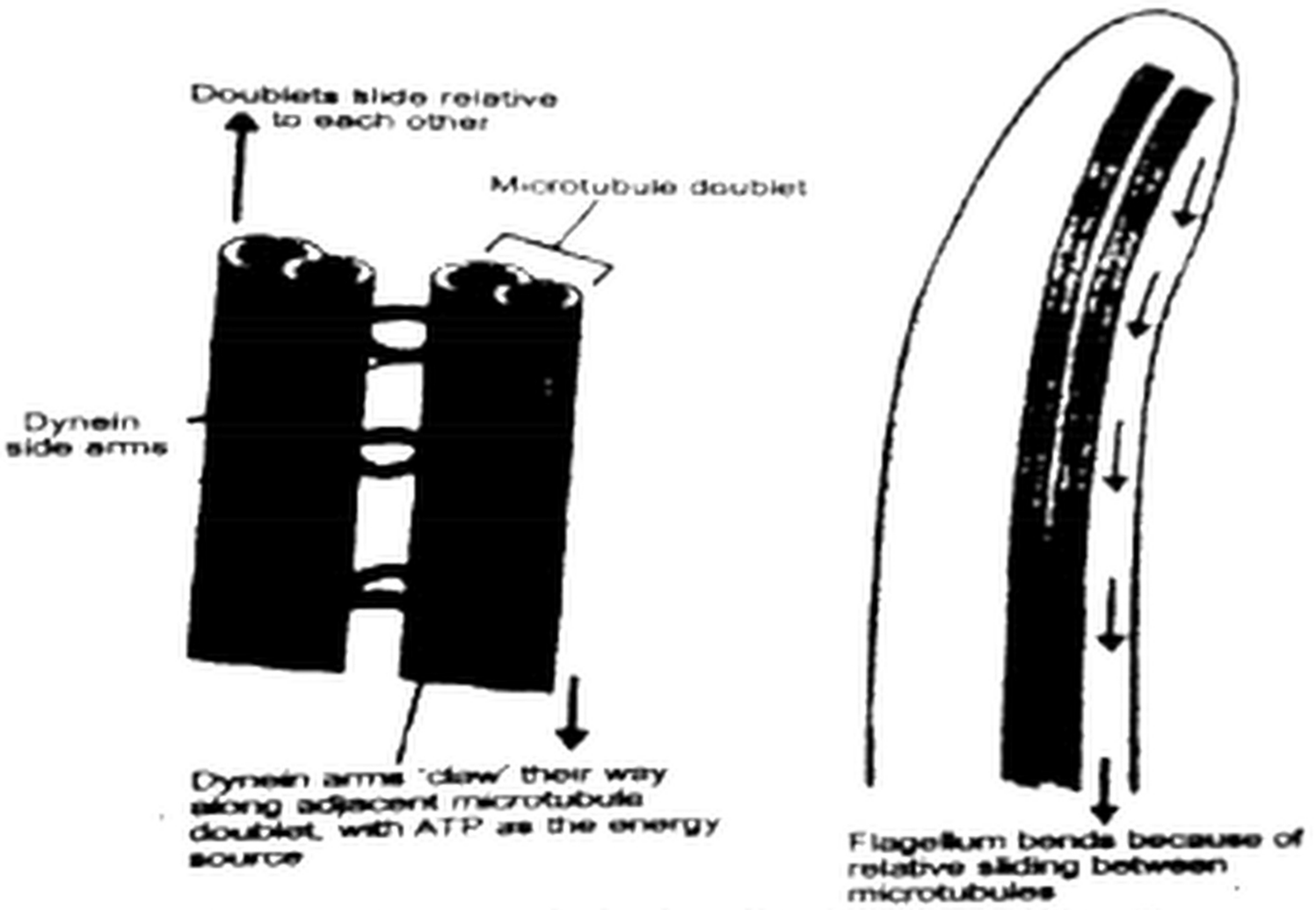
Structure of a eukaryotic flagellum or cilium

Mechanism of movement of cilia and flagella:

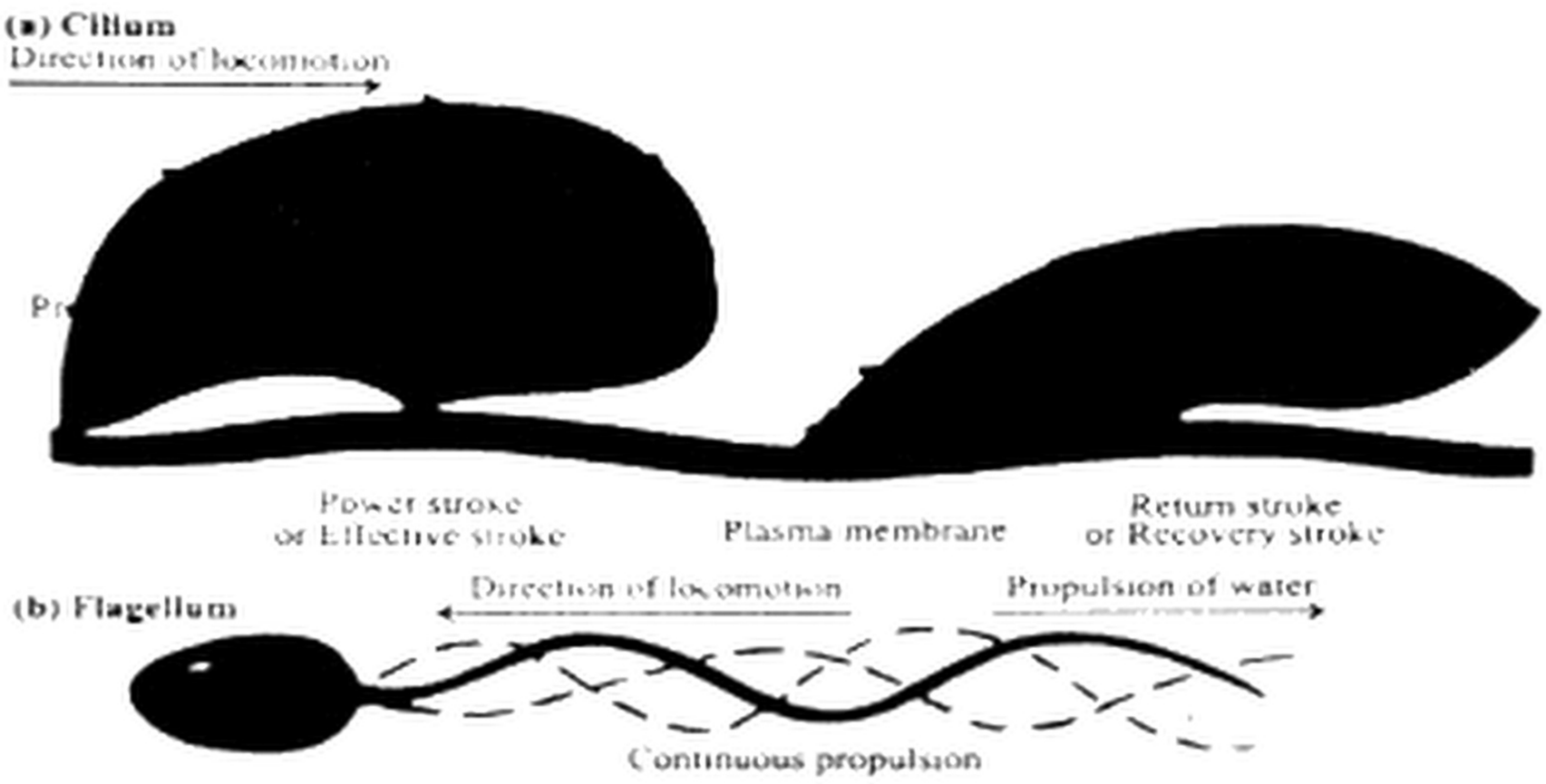
The mechanics of dynein 'walking" are reminiscent of eat climbing a tree by attaching its Claw, moving Its legs, releasing its front claws, and grabbing again farther up the tree.

Similarly, the dynein arms of one doublet attach to an adjacent doublet and pun so that the doublets slide past each other in opposite direction. The arms then release from the other doublet and reattach a little farther along its length as a result the cilia or flageilum elongates rather than bending.

For lateral movement of a cilium or flageilum, the dynein "walking" must have something to pull against The dynein arms are respon9ible for the bending movement of cilia and flagella Dynein in the axoneme forms bridges between neighboring microtubule doublets The dynein hydrolyses ATP to provide energy When ATP activates the motor domain of dynein, it attempts to walk along the adjoining microtubule doublet This would force the adjacent doublets to slide over one another The sliding over IS prevented by the connecting/cross links" i.e. (1) Bridge connecting the two central tubules. (2) Radial spokes (3) Nexin Thus, neighboring doublets cannot slide past each other very far. Instead, the forces exerted by dynein arms cause the doublets to curve, bending cilium or flageilum.



Mechanism of microtubules bending in cilia and flagella



Cilium

Fig: Characteristic movement Of Cilia and flagella (a) Cilia usually "row" along. Providing a force of movement to the plasma just as oars provide movement parallel to Sides of a rowboat. (b) Flagella often move in a wave like motion with a continuous bending that starts at the base and move up to the tip. This motion provides a force of movements perpendicular to the

plasma membrane. In this way a flagellum attached to a sperm can move the straight ahead.

Movement of cilia:

1) In 1955 it was suggested that the movement of cilia is due to sliding of double fibrils in two groups one after the other.
2) Five out of nine double fibrils contract simultaneously.
3) As a result cilium bends or shortens
4) It is called effective stroke.
5) Four out of nine double fibrils contract and cilium becomes straight. It IS called recovery stroke

Movement of flagellum:

A flagellum causes movement by the passage of rapid successive waves of bending from the attached to the free end, as it can be seen in flagellar movement of human sperms, which propel them forward within the fluid medium of the female reproductive tract.

45. What is nuclear envelope? Describe the chemical composition and structure of nuclear envelope.

Ans: Nuclear envelope:

Nuclear envelope (also called nuclear membrane) is a double membrane covering which makes the boundary of nucleus. Both membranes of nuclear envelope are separated by a fluid-filled perinuclear space.

Chemical Composition of Nuclear Envelope:

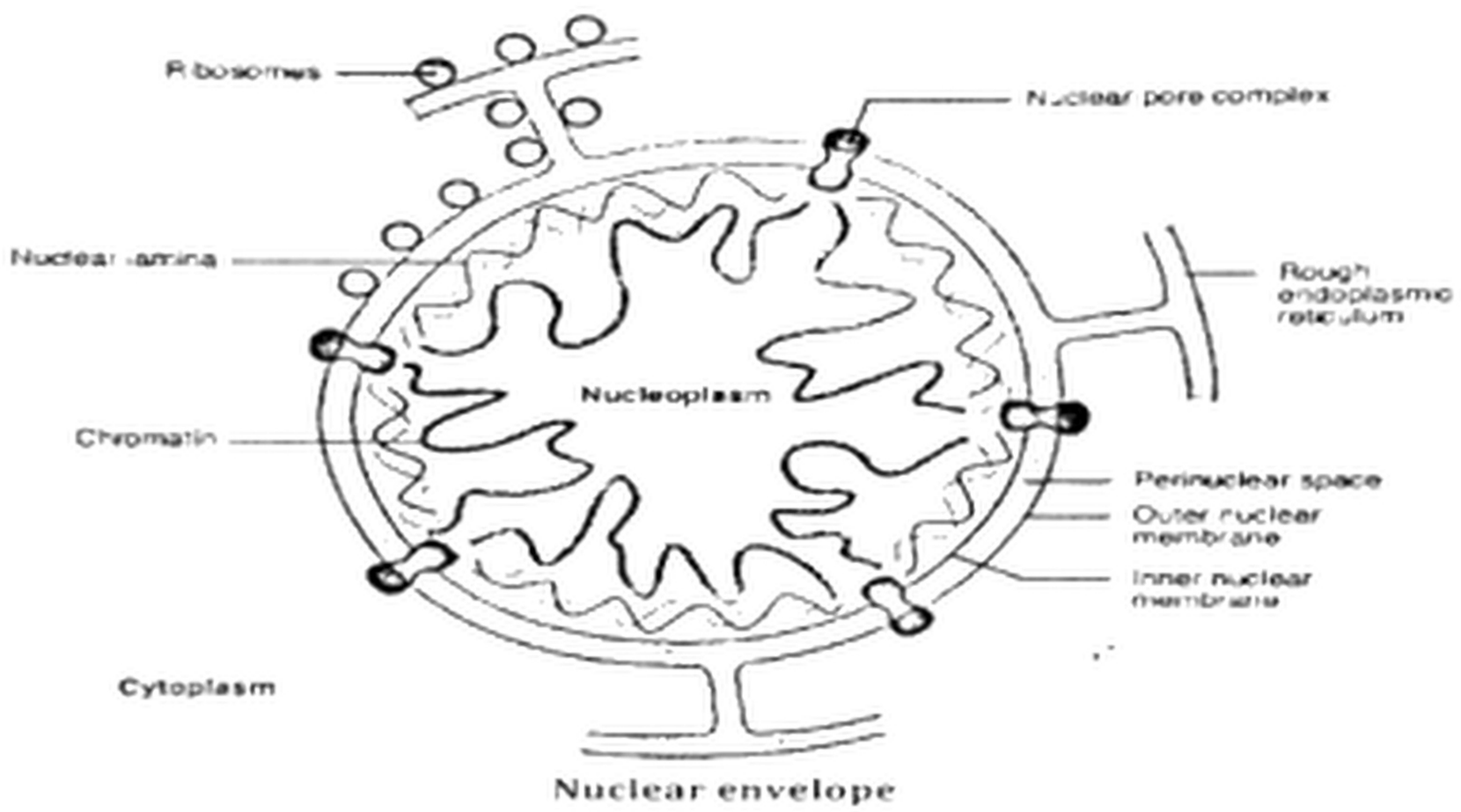
The membranes are composed of lipid bilayer and proteins.

Structure of Nuclear Envelope:

The membranes are composed of lipid bilayer and proteins The Outer membrane of nuclear envelope is covered with ribosomes and is connected with the membranes of ER.

Nuclear pores and Nucleoporin:

There are numerous pores in nuclear envelope called nuclear pores which are composed of a specialized transport protein called nucleoporin.



Nuclear envelope

At the point of nuclear pore both the membranes are interconnected. These pores regulate the nucleo-cytoplasmic exchange of materials. This exchange includes RNA and ribosomal proteins moving from nucleus to the cytoplasm and proteins (such as DNA polymerase), carbohydrates, signaling and lipids moving Into the nucleus Although smaller molecules simply diffuse through the pores, larger molecules may be recognized by specific signal sequences and then be diffused with the help of nucleoporin into or out of the nucleus.

Nuclear lamina:

Except at the pores, the nuclear Side of the envelope is lined by the nuclear lamina, a net like array of protein filaments that maintains the shape of the nucleus by mechanically supporting the nuclear envelope.

46. What are chromosomes? Describe the structure, chemical composition and function of chromosome.

Ans: Chromosomes:

Chromatin is a network of thin thread like structures made up of DNA and associated protein molecules. During cell division chromatin fibers begin to condense and coil up into separate structures called chromosomes which are truck enough to be seen with a light microscope.

Chemical Composition of Chromosome:

The major chemical components 0t the chromosome are DNA, RNA (nucleic acids), and proteins (histones and nonhistones).

Structure of Chromosome:

Chromatids and Centromere:

A typical chromosome consists of two strands called chromatids which are attached with each other at a point known as centromere.

Primary Constriction:

The centromere lies within a thinner segment of the chromosome called primary constriction.

The centromere is a constriction functionally related to the movement of chromosomes during cell division.

Kinetochores:

Each centromere has two plaques of protein called kinetochores that are Oriented on the opposite sides of the constriction. Each kinetochore forms the site of attachment for a single microtubule during cell division.

Secondary Constriction or Nucleolar Organizer:

Some chromosomes may have another point of union along the length of chromatids, called secondary constriction or nucleolar organizer. It gives rise to nucleoli during interphase.

Satellite and junk DNA:

At least, one pair of homologous chromosomes possesses nucleolar organizer region. Beside secondary constriction, the end becomes a knob like structure called satellite. This region has a useless sequence of DNA called junk.

DNA

Telomeres:

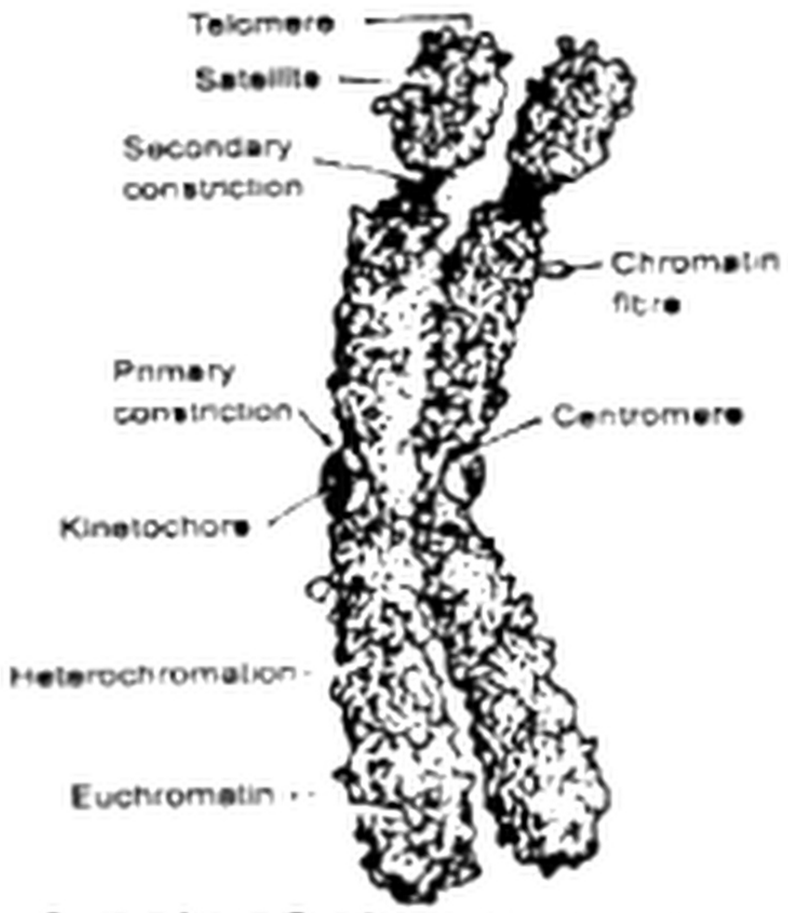
The terminal ends of chromosomes are called telomeres which prevent the two chromosomes to attach with each other from their ends. Chromosomes are stained with acetocarmine or acetoorcein.

Euchromatin:

Some parts of the chromosome take less stain and appear lighter in color. These areas are called euchromatin.

Heterochromatin:

Some parts of the chromosomes take more stain and appear darker. These areas are called heterochromatin. Individual chromosomes can be identified by their size and shape.



A pair of chromosome

Function of Chromosome:

Functions of Chromosomes are as follows.

i. **Genetic Code Storage:**

Chromosome contains the genetic material that is required by the organism to develop and grow DNA molecules are made of chain of units called genes. Genes are those sections of the DNA which code for specific proteins required by the cell for its proper functioning.

ii. **sex Determination:**

Humans have 23 pairs of chromosomes out of which one pair is the sex chromosome Females have two X chromosomes and males have one X and one Y chromosome. The sex of the child is determined by the chromosome passed down by the male. If X chromosome is passed out Of XY chromosome, the child will be a female and if a Y chromosome is passed, a male child develops.

iii. **Control of Cell Division:**

Chromosomes check successful division of cells during the process of mitosis. The chromosomes of the parent cells insure that the correct

Information passed on to the daughter cells required by the cell to grow and develop correctly.

iv. Formation of Proteins and Storage:

Proteins are essential for the activity of a cell. The chromosomes direct the sequences of proteins formed in our body and also maintain the order of DNA. The proteins are also stored in the coiled structure of the chromosomes. These proteins bound to the DNA help in proper packaging of the DNA.

47. Describe the cell envelope in a bacterial cell.

Ans: The bacterial cell consists of cell envelope (glycocalyx and cell wall), cell membrane, cytoplasm, nucleoid and cell appendages (flagella and pilli) Cell envelope is outer wrapping of a bacterial cell which consists of glycocalyx and cell wall.

48. Describe the Structure Of bacteria as a model prokaryotic cell.

Ans: Prokaryotic and Eukaryotic Cells:

Two kinds of structurally different cells have been evolved overtime Prokaryotic cells include archaea, bacteria and Cyanobacteria whereas all other forms of life are composed of eukaryotic cells. A prokaryotic cell lacks definite membrane bounded nucleus and other organelles. Its DNA is dispersed in cytoplasm on the other hand, a eukaryotic cell contains a nucleus, endoplasmic reticulum, Golgi complex, mitochondrion, lysosomes, nucleolus, chloroplast, and cytoskeleton, 80S ribosomes, (larger), and flagella or cilia which are made up of microtubules. All these structures are missing in prokaryotes.

Structure of Bacteria as a Model Prokaryotic Cell:

The bacterial ceil consists of cell envelope (glycocalyx and cell wall), cell membrane, cytoplasm, nucleoid and cell appendages (flagella and Pilli)

Cell envelope:

Cell envelope is outer wrapping of a bacterial cell which consists of glycocalyx and cell wall.

Glycocalyx:

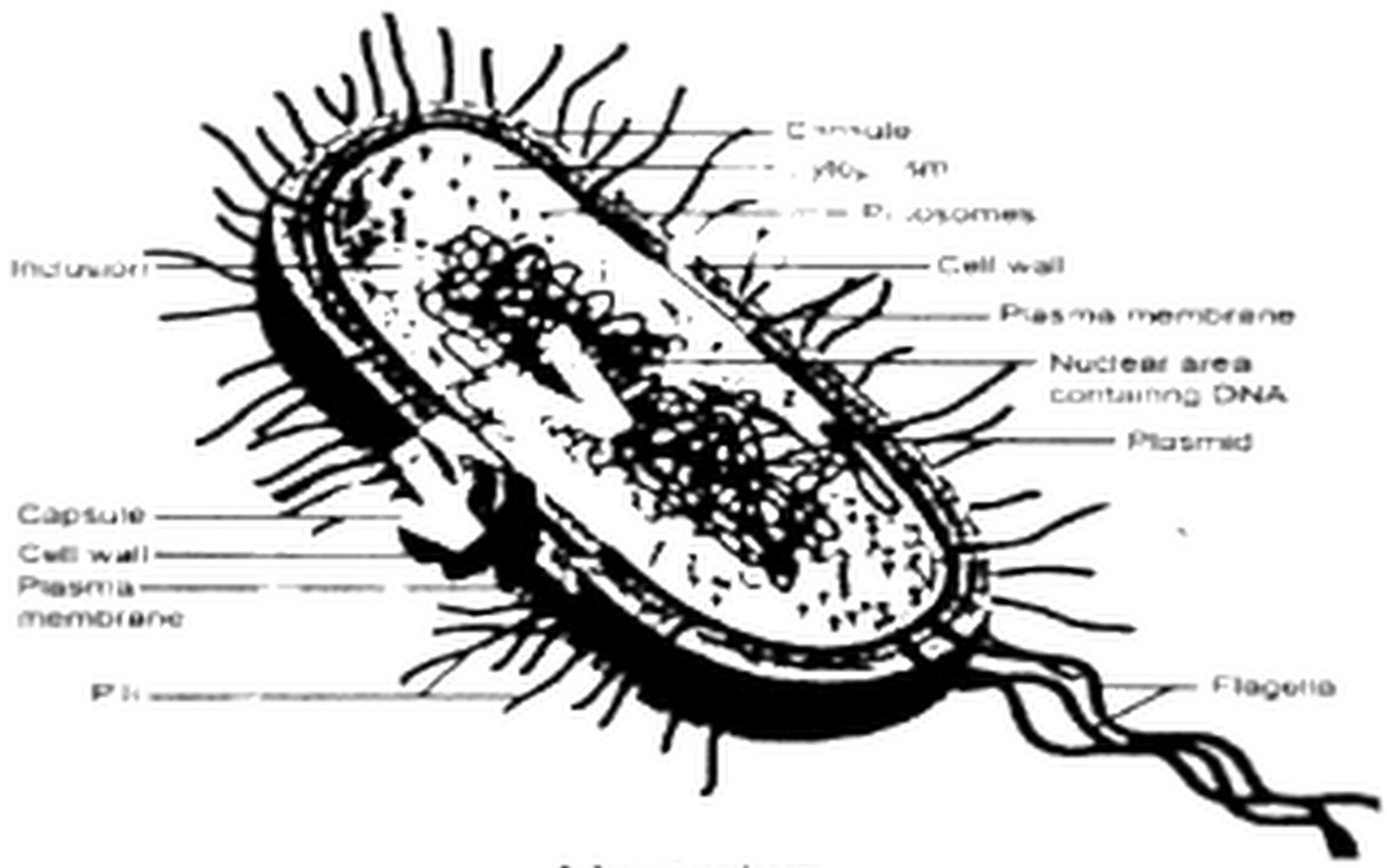
The glycocalyx is a glycoprotein-polysaccharide covering that surrounds the cell wall of some bacteria. There are two types of glycocalyx of bacteria i.e. capsule and slime layer.

Capsule:

The capsule is highly condensed form that is relatively tightly associated with the underlying cell wall. It provides sticky or gummy nature to the bacteria and helps them to attach with the surface of host tissues.

Slime layer:

Slime layer is a more loosely attached glycocalyx that can be removed from the cell more easily it makes the cell slippery and thus, prevents them to be phagocytosed by the host cells. Almost all bacteria have cell wall outside the cell membrane except mycoplasma which lacks cell wall, unlike eukaryotic cell wall (plant and fungi), the bacterial cell wall IS mainly composed of peptidoglycan or murein. Further composition and structural features of cell wall differ greatly in different groups of bacteria which will be discussed in chapter six.



A bacterium

Cell membrane or Plasma membrane:

The cell membrane or plasma membrane lies beneath the cell wall which lacks cholesterols in lipid bilayer unlike eukaryotic plasma membrane.

Mesosomes:

At certain points cell membrane invaginates into the cytoplasm to form infoldings, these are known as mesosomes. In addition to the control of transport of materials across the cell, bacterial plasma membrane also involves in cellular respiration, photosynthesis and DNA replication.

Bacterial Cytoplasm:

The bacterial cytoplasm is also a jelly like dense mass which lacks cytoskeleton and cellular organelles except ribosomes.

Ribosomes:

The ribosomes are large in number and freely dispersed in the cytoplasm. These are smaller than eukaryotic ribosomes and characterized as 70S Bacterial ribosomes also consist of two subunits i.e., smaller subunit (30S) and a larger subunit (50S). Ribosomes are the sites of protein synthesis Small granules of stored food and waste materials are also present in bacterial

cytoplasm. Stored food includes glycogen proteins, fats etc. whereas; wastes may consist of alcohol, lactic acid, acetic acid etc.

Nucleoid:

The nucleoid is the nuclear region of bacteria which is not separated from the cytoplasm by nuclear membrane It is seen in the electron microscope as an area lighter than the cytoplasmic contents It consists of a large circular double stranded DNA molecule which IS also known as bacterial chromosome. Due to this single chromosome bacteria are considered as haploid organisms. A short duration of diploid state comes in their life cycle just before cell division when they replicate their DNA Bacterial DNA differs from eukaryotic DNA as it is circular molecule and contains no intron (see glossary) sequences. The nuclear 'DNA controls growth and metabolic activities of bacteria in addition to the nuclear DNA some bacteria also contain one or more extra nuclear small circular double stranded DNA molecules, the plasmids They often contain genes for antibiotics or drug resistance and heavy metals resistance.

Flagella and Pili or Fimbriae:

The structures that project from the surface of bacterial cell include flagella and pili or fimbriae.

Flagella are long thread like structures which are used for locomotion. Bacterial flagella are composed of flagellin protein and lack microtubules, in this way they differ from eukaryotic flagella.

Pili or fimbriae are tubular extensions of cell membrane and project through the cell wall. They are composed of pilin protein and can only be seen by electron microscope and are found only on certain species of Gram-negative bacteria. Pili are used to transfer genetic material during conjugation. The Other function of pili is attachment on the surface of tissues of an infected person.

49. What is the relationship of endoplasmic reticulum with Golgi complex, lysosome and plasma membrane?

Ans: The relationship between endoplasmic reticulum, Golgi complex, lysosome and plasma membrane are given as follows:

a) RER prepare enzymes of lysosomes.

b) Then these enzymes are transferred to Golgi complex through SER.

c) Golgi complex modifies these enzymes

d) Golgi complex releases enzymes in the form of vesicles. Such vesicles are called lysosomes.

Plasma membrane exports the content of lysosome by exocytosis