

EXERCISE

SHORT QUESTIONS

2. Name three organelles revealed by an electron microscope.

Ans: The organelles in the cytoplasmic matrix of a cell are endoplasmic reticulum, ribosomes, Golgi complex, Peroxisomes, glyoxysomes, lysosomes, mitochondria, and chloroplasts etc.

3. Why cell wall is not present in animal cells?

Ans: The cell wall is present in plant cells, prokaryotes and fungi but animal cells do not have cell wall. This is probably due to their locomotor mode of life.

4. What holds the ribosomes together in a polysome?

Ans: 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). 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 some polypeptide can be produced in very less time.

So, rRNA holds together the ribosomes in a polysome.

5. How and where lysosomes are formed in the cell?

Ans: 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.

6. What are lysosomal storage diseases? Give example.

Ans: Lysosomal Storage Diseases:

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.

7. What would happen if there are no lysosomes in human cells?

Ans: Lysosomes are the membrane-bound vesicles, which contain digestive (hydrolytic) enzymes like acid hydrolase. They digest a variety of substances including worn out organelles, food particles, viruses and bacteria. If there were no lysosomes in the human cell, it will not be able to digest food and there would be accumulation of wastes like worn out parts inside the human cell. Thus, human cell will not be able to survive.

OR (Second answer)

If Lysosomes weren't present in the human cell, wore out organelles and proteins would go wasted. The Lysosomes are there to reprocess wore out organelles and such without them human would eventually die.

8. Why lysosomes are called suicide bags?

Ans: Because lysosomes contain large number of enzymes which can digest foreign particles that enter the cell. This process is called autolysis. This occurs while enzymes are released. Killing itself is called suicide, so they are called suicidal bags of cell.

9. Name the structures and organelles which are Common in plant cell, animal cell and a prokaryotic cell.

Ans: There are three structures and organelles which are common in plant cell, Animal cell and a prokaryotic cell.

- Cell Membrane
- Cytoplasm
- Ribosome

10. How is a chloroplast similar to a bacterium?

Ans: Mitochondria and chloroplasts display similarities with bacteria like both are self-replicating organelles. Both have their own genetic system and metabolic machinery i.e., both has small circular DNA, all kinds of RNA and ribosomes (70S)

An interesting fact about them is that they are capable to survive outside the cell in artificial medium if carefully fractionated.

Based upon these observations' evolutionists believe that they were independent organism and the early ancestor of eukaryotic cells engulfed them.

Eventually, the engulfed cells formed a relationship with the host cell in which they were enclosed, becoming an *endosymbiont* (a cell living within another cell). Therefore, they are supposed as organisms within organism.

OR (Second Answer)

Mitochondria and chloroplasts have striking similarities to bacteria cells. They have their own DNA, which is separate from the DNA found in the nucleus of the cell. And both organelles use their DNA to produce many proteins and enzymes required for their function.

11. Name the organelles of eukaryotic cell and write their specific functions.

Ans: Organelles of Eukaryotic Cells:

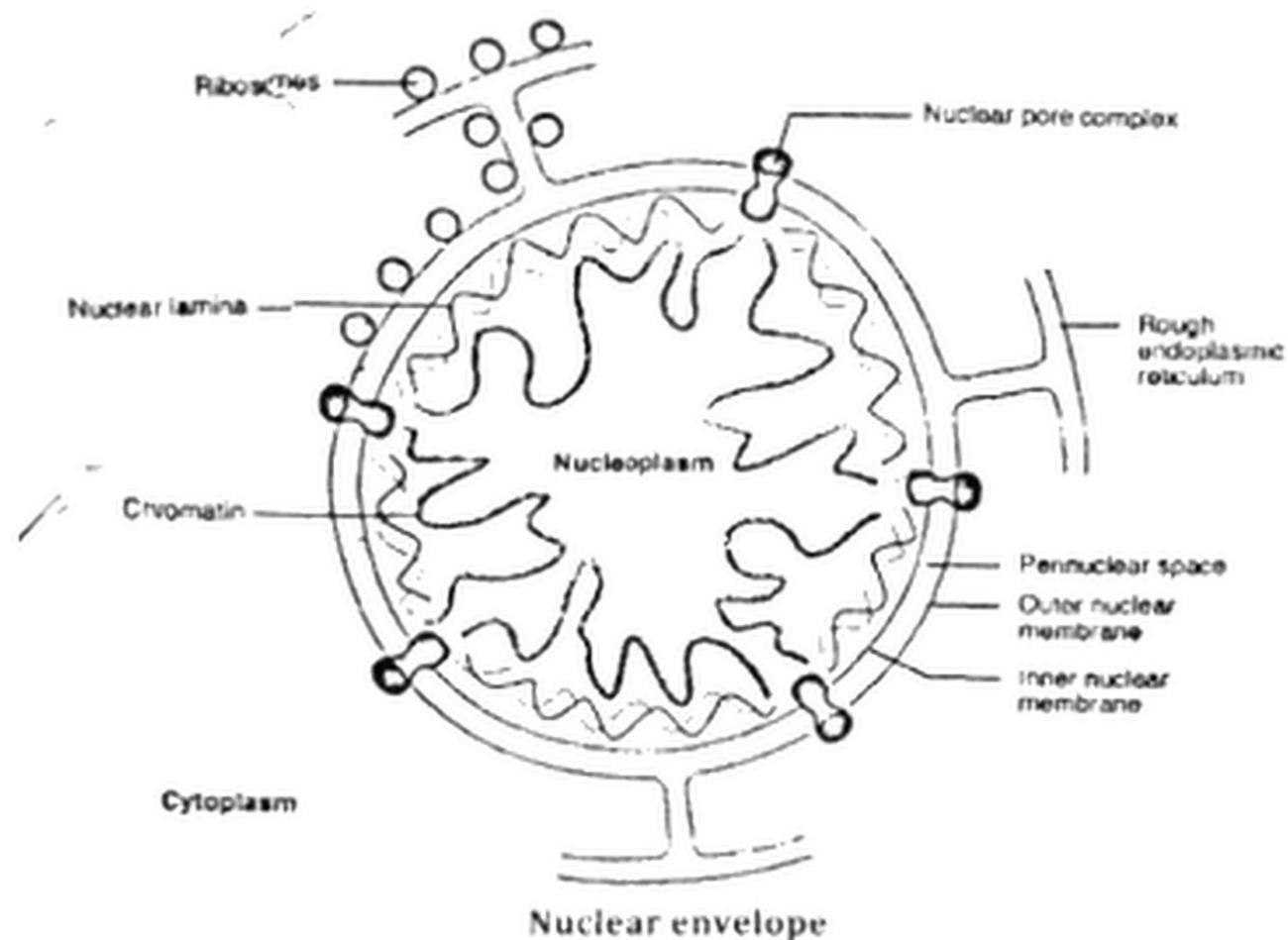
Below is a list of organelles that are commonly found in eukaryotic cells.

Organelles	Function
Nucleus	The "brains" of the cell the nucleus directs cell activities and contains genetic material called chromosomes made of DNA.
Mitochondria	Make energy out of food.
Ribosomes	Make protein.

Golgi Apparatus	Make process and package proteins.
Lysosome	Contains digestive enzymes to help break food down.
Endoplasmic Reticulum	Called the "intracellular highway" because it is for transporting all sorts of items around the cell.
Vacuole	Used for storage, vacuoles usually contain water or food.
Plant cells also have:	
Chloroplasts	Use sunlight to create food by photosynthesis.
Cell Wall	For support.

12. List the structure and molecules, which can cross the nuclear envelope.

Ans: Nuclear pores are large protein complexes that cross the nuclear envelope. There are numerous pores in nuclear envelope called nuclear pores which are composed of a specialized transport protein called **nucleoporin**.



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.

13. Why do eukaryotic cells need both membranous organelles and fibrous cytoskeleton components?

Ans:

- Eukaryotic cells are cells with a membrane bound nucleus. These cells have intricate transport system to carry food and information between organelles.

- Prokaryotes do not have membrane bound nuclei and therefore do not have intricate transport systems. Rather nutrients just slush around at the whim of Brownian motion.
- Eukaryotes need membranous organelles in order to compartmentalize the various functions of the cell
- Eukaryotes also need fibrous cytoskeletal components to hold the cell in place. By holding the organelles in place, the eukaryotic cell is able to facilitate transport.

OR (Second Answer)

Eukaryotes need membranous organelles in order to compartmentalize the various functions of the cell. Eukaryotes also need fibrous cytoskeletal components to hold the cell in place. By holding the organelles in place, the eukaryotic cell is able to facilitate transport.

14. What are prokaryotic cells? List the structures missing in prokaryotic cells.

Ans: Prokaryotic Cells:

Prokaryotic cells include archaea, bacteria and cyanobacteria whereas all other forms of life are composed of eukaryotic cells.

Prokaryotic cells are cells that do not have a true nucleus or most other cell organelles. Organisms that have prokaryotic cells are unicellular and called prokaryotes.

Structures Missing in Prokaryotic Cells:

A prokaryotic cell lacks definite membrane bounded nucleus and other organelles. Its DNA is dispersed in cytoplasm

Nucleus, endoplasmic reticulum, Golgi complex, mitochondrion, lysosomes nucleolus, chloroplast, cytoskeleton. 80S ribosomes (larger) and flagella or cilia which are made up of microtubules. All these structures are missing in prokaryotes.

15. Differentiate between the patterns of cell division in prokaryotic and eukaryotic cells.

Ans: Cell division is simpler in prokaryotes than eukaryotes because prokaryotic cells themselves are simpler.

- Prokaryotic cells have a single circular chromosome, no nucleus and few other organelles
- Eukaryotic cells, in contrast have multiple chromosomes contained within a nucleus and many other organelles.

16. Compare microfilaments and microtubules.

Ans:

	Microfilaments	Microtubules
Structure	Double Helix	Helical lattice
Size	7 nm in diameter	20 – 25 nm in diameter
Composition	Predominantly composed of contractile protein called actin	Composed of subunits of protein tubulin. These subunits are termed as alpha and Beta.
Strength	Flexible and relatively strong resist buckling due to compressive forces and	Stiff and resist bending forces.

	filament fracture by tensile forces.	
Function	Micro-filaments are smaller and thinner and mostly help cells move.	Microtubules are shaped similarly but are larger and help with cell functions such as mitosis and various cell transport functions.

17. Why ER is present in all eukaryotic cells but not in prokaryotic cells?

Ans: Eukaryotic cells are large in size. Therefore, they develop endoplasmic reticulum for transportation and support.

Unlike eukaryotic cells, prokaryotic cells do not have a cell nucleus or any membrane-bound organelles such as mitochondria. Therefore neither the DNA of prokaryotic cells nor any of the sites of metabolic activity within a prokaryotic cell are enclosed by a separate membrane.

18. What organelles are single membrane bound, double membrane bound and lacking any membrane?

Ans: Cell Organelles are organ like each performing specific function/s but formed of molecules and membranes only (sub- cellular).

Double Membrane bound Organelles:

Mitochondria, Chloroplasts, Endoplasmic Reticulum, Golgi body, and Nucleus.

Single Membrane bound Organelles:

Lysosomes Peroxisomes, Vacuoles.

Organelles lacking any membrane:

Ribosomes, Centrioles, Nucleolus.

19. How cytoskeletons are important to eukaryotic cells?

Ans: The eukaryotic cytoskeleton is made up of a network of long, thin protein fibers and has many functions. It helps to maintain cell shape. It holds organelles in place and for some cells, it enables cell movement.

The cytoskeleton also plays important roles in both the intracellular movement of substances and in cell division. Certain proteins act like a path that vesicles and organelles move along within the cell. The threadlike proteins that make up the cytoskeleton continually rebuild to adapt to the cell's constantly changing needs. Three main kinds of cytoskeleton fibers are microtubules, intermediate filaments, and microfilaments.

OR (Second Answer)

It forms a framework for the movement of organelles around the cytoplasm - most of the organelles are attached to the cytoskeleton. The network consists of protein microfilaments, intermediate filaments, and microtubules.

The cytoskeleton provides an important structural framework for: Cell shape.

20. Compare the chemical composition of nucleoplasm with that of cytoplasm.

Ans: Nucleoplasm is the transparent semifluid ground substance formed of a mixture of proteins, enzymes (DNA and RNA polymerase), free nucleotide and some metal ions (Mg) for the synthesis of DNA and RNAs. It also contains histone and non-histone protein. So, the nucleoplasm is slightly different from cytoplasm.

21. Explain that nucleoli are the areas where ribosomes are assembled.

Ans: The genes that encode ribosomal proteins are transcribed outside of the nucleolus by RNA polymerase II, yielding mRNAs that are translated on cytoplasmic ribosomes. The ribosomal proteins are then transported from the cytoplasm to the nucleolus, where they are assembled with rRNAs to form pre ribosomal particles

22. Define/ Describe/ Explain briefly:

Cell theory, homogenization, centrifugation, density gradient centrifugation, differential centrifugation, pellet, supernatant, differential staining, microdissection, chromosomal microdissection, laser microdissection, tissue culture, chromatography, paper chromatography, chromatogram, chromatography chamber, electrophoresis, -spectrophotometry, absorption spectrum, resolution, magnification, microscopy, micrometry, fluid mosaic model, antigen, cell surface marker, endoplasmic reticulum, rough ER, smooth ER, ribosomes, polysome, Golgi complex, lysosomes, primary lysosomes, secondary lysosomes, autophagy, autophagosomes, autolysis, lysosomal storage disease, peroxisomes, glyoxysomes, vacuoles, food vacuole, contractile vacuole, cell sap, tonoplast, mitochondria, porins, ATP synthase, plastids, etioplast, leucoplast, amyloplast, elaioplast, proteinoplast, chromoplast, chloroplast, stroma, grana, thylakoid, inter grana, centriole, centrospheres, centrosome, mitotic apparatus, basal bodies, troponin, tropomyosin, myofibril, microfilament, nuclear envelope, nuclear lamina, nucleoplasm, nucleolus, chromosome, chromatin, centromere, nuclear organizer, satellite, junk DNA, telomeres, glycocalyx, slime layer, mesosomes, nucleoid, plasmid.

Ans: Cell Theory:

We are quite familiar with the word "cell" i.e., a basic unit of life. By the middle of the nineteenth century, biologists had formulated cell theory which is a fundamental concept in biology. According to cell theory are as follows:

- (1) The cell is the fundamental unit of structure and function in living things.
- (2) All organisms are made up of one or more cells.
- (3) Cells arise from other cells through cellular division.
- (4) Cells carry genetic material passed to daughter cells during cellular division.
- (5) All cells are essentially the same in chemical composition.
- (6) Energy flow (metabolism and biochemistry) occurs within cells.

Homogenization:

In cell biology or molecular biology research homogenization is a process whereby a biological sample is brought to a state such that all fractions of the sample are equal in composition.

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

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

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.

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:

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.

Supernatant:

Sediment that remains suspended above the tube in the form of liquid are called supernatant

OR

The soluble liquid fraction of a sample after centrifugation or precipitation of insoluble solids.

Differential Staining:

Most biological structures are transparent in order to differentiate between these structures various color dyes are applied. Such techniques are called staining techniques.

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.

OR

Differential Staining is a staining process which uses more than one chemical stain.

Microdissection:

Microdissection refers to the variety of techniques where a microscope is used to assist in dissection. It is done to remove tumor or granules from delicate tissue or cells, like brain, heart and nerve cells. In this technique, the *image* is seen on large TV screen or monitor while dissecting. Different kinds of techniques involve microdissection i.e.

Chromosomal Microdissection:

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

Laser Microdissection:

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

Tissue Culture:

Growth of a cell or a tissue on chemically defined nutrient medium under sterile conditions is called tissue culture. This technique can be employed for both plants and animals.

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.

Paper Chromatography:

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.

Chromatogram:

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

OR

A chromatogram is essentially the output of a chromatography run. It is an electronic file or hardcopy containing the information generated during the chromatography run.

Chromatography Chamber:

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.

Electrophoresis:

Electrophoresis is a technique used in laboratories in order to separate macromolecules based on size. The technique applies a negative charge so proteins move towards a positive charge. This is used for both DNA and RNA analysis.

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.

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 is a graph which shows the absorption of different wavelength of light by a particular pigment.

Resolution:

Our naked eye is capable to distinguish two points which have at least 0.1 mm distance. This minimum capacity of a lens to differentiate between two adjacent points is called resolution power of the lens. Therefore, resolution of naked eye is 0.1 mm.

Magnification:

The magnification is the capacity of an optical instrument to increase the size of an object than its original size. The objects which cannot be seen by naked eye can also be observed by increasing magnification. Different lenses have different magnification powers which are represented by letter "X" that means the number of times than original size. Therefore, a lens of 10X magnification power can increase the size of an object of 1 μm to 10 μm .

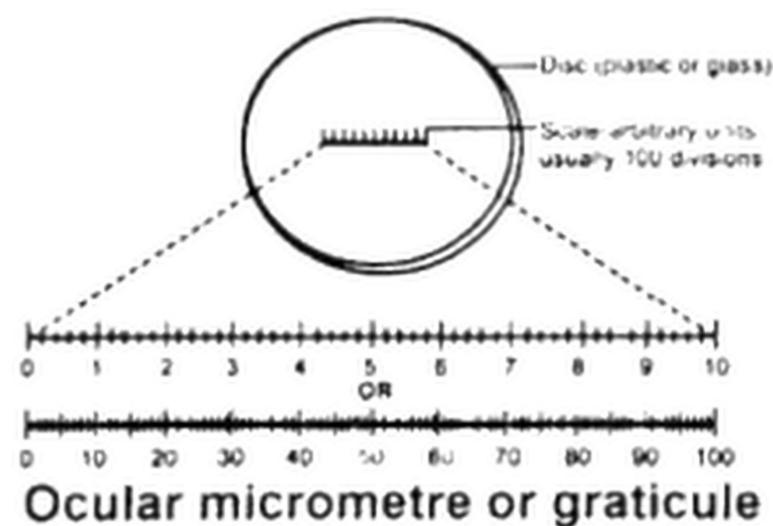
Microscopy:

Microscopy is the technique used to view objects that cannot be seen by the naked eye. The range can be anything between mm and nm. Most animal cells and plant cells are between 10 μm and 30 μm . A common compound

microscope consists of ocular lens and objective lens. The overall magnification power of such a microscope is equal to the product of magnification powers of both lenses. The resolving power of light microscope is $0.25\ \mu\text{m}$ or $250\ \text{nm}$ ($25000\ \text{angstrom}$) and its magnification is up to 4000. The resolving power of electron microscope is $0.5\text{-}5.0\ \text{angstrom}$ and its magnification is up to 300,000.

Micrometry:

Objects can be measured under the microscope by means of an eye piece graticule or ocular micrometer. This is a transparent scale mounted in the focal plane of the eye piece, so it can be seen in the field of view at the same time as an object is being examined under the microscope. Obviously, to be of any use the eye piece graticule scale must be calculated. This can be done by placing a stage micrometer under the microscope. This is a glass slide on which is etched a series of vertical lines separated by distances of $1.0\ \text{mm}$, $0.1\ \text{mm}$ and $0.01\ \text{mm}$ - rather like a miniature transparent ruler. By superimposing the images of the eye piece graticule and stage micrometer scales, it is possible to calibrate the graticule, so that the size of a given object viewed under the microscope can be estimated. You will study micrometry in detail and measure the size of microscopic objects in the practical class.



Fluid Mosaic Model:

The Fluid Mosaic Model states that membranes are composed of a Phospholipid Bilayer with various protein molecules floating around within it. The

'Fluid' part represents how some parts of the membrane can move around freely, if they are not attached to other parts of the cell.

Antigen:

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.

Cell Surface Marker:

Cell surface markers are the molecules present on outer surface of plasma membrane which provide the recognition of particular cell type so each type of cell can have its own specific markers. Mostly glycolipids 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 in sticking the correct cells together in tissues.

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).

Rough ER:

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

Smooth ER:

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

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. However, eukaryotic ribosomes are larger 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. 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.

OR

The ribosome is a complex molecular machine, found within all living cells that serve as the site of biological protein synthesis. Ribosomes link amino acids together in the order specified by messenger RNA molecules.

Polysome:

Sometimes, during protein synthesis, several ribosomes are attached to one mRNA molecule. Such a chain of many ribosomes is called polysome or polyribosomes.

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.

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 are 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 (transface) where the cisternae break up into vesicles again. The most important function of Golgi complex is the processing of cell secretions.

Lysosomes:

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 carry out enzymatic hydrolysis, a function shared by lysosomes in animal cells.

Secondary Lysosome:

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

Autophagy:

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

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.

Lysosomal Storage Disease:

Since, 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.

Peroxisomes:

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.

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.

Vacuoles:

Vacuoles are large vesicles originate from the endoplasmic reticulum and Golgi complex and plasma membrane. Vacuoles perform a variety of functions in different kinds of cells.

Food Vacuole:

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

Contractile Vacuole:

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

OR

A contractile vacuole (CV) is a sub-cellular structure (organelle) involved in osmoregulation. It is found predominantly in protists and in unicellular algae. It was previously known as pulsatile or pulsating vacuole.

Cell sap:

The solution inside the central vacuole, called cell sap.

OR

The solution that fills the vacuoles of plant cells, called cell sap. It contains sugars, amino acids, waste substances (such as tannins), and mineral salts.

Tonoplast:

The membrane separating the vacuole from cytoplasm is called tonoplast

OR

The cytoplasmic membrane surrounding the vacuole, separating the vacuolar contents from the cytoplasm in a cell.

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.

OR

The mitochondrion is a double membrane-bound organelle found in all eukaryotic organisms. Some cells in some multicellular organisms may however lack them.

Porins:

Each membrane is a phospholipid bilayer with a unique collection of embedded proteins. The outer membrane is smooth and somewhat like a sieve.

The outer membrane has special proteins embedded into the membrane called porins.

ATP Synthase:

The inner surface of cristae is furnished with granular structures called stalk particles or F₀ - F₁ particles. These particles are actually ATP synthase enzymes.

Plastids:

Plastids are found in plant and algal cells, and they are necessary for essential life processes, like photosynthesis and food storage. On the basis of presence or absence and type of pigments and the stage of development, plastids have been classified into proplastids, leucoplasts, chromoplasts and chloroplasts.

Etioplast:

Etioplast is a type of leucoplasts which on exposure to light develop into chloroplast. Similarly, chloroplasts may become leucoplasts; but colored plastids as in petals are mostly terminally differentiated.

Leucoplast:

Leucoplasts are found in parenchyma cells of root stem and seeds. They act as storage organelles.

OR

Leucoplasts are found in parenchyma cells of root stem and seeds. They act as storage organelles. Based on the kind of substance they store they are further classified into amyloplasts (store starch), elaioplast (store lipids) and proteinoplast (store protein).

Amyloplast:

Amyloplasts are non-pigmented organelles found in some plant cells. They are responsible for the synthesis and storage of starch granules, through the polymerization of glucose. Amyloplasts also convert this starch back into sugar when the plant needs energy.

Elaioplast:

Etioplast is a type of leucoplasts which on exposure to light develop into chloroplast. Similarly, chloroplasts may become leucoplasts; but colored plastids as in petals are mostly terminally differentiated.

OR

Elaioplasts are a type of leucoplast that is specialized for the storage of lipids in plants. Elaioplasts house oil body deposits as rounded plastoglobuli, which are essentially fat droplets.

Proteinoplast:

Proteinoplasts (sometimes called proteoplasts, aleuroplasts and aleuronoplasts) are specialized organelles found only in plant cells. Proteinoplasts belong to a broad category of organelles known as plastids. Because they lack pigment, proteinoplast are more specifically a kind of leucoplast.

Chromoplast:

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.

Chloroplast:

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

Stroma:

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

Grana:

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.

Thylakoid:

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.

Inter Grana:

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 CO_2 is reduced to make carbohydrates. The enzymes for this activity are found in stroma region of chloroplast.

Centriole:

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.

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.

Centrospheres:

Centrioles lie in a distinctly, staining region of the cytoplasm known as centrosphere.

Centrosome:

The centrioles and centrosphere are together called centrosome. Each centriole is composed of nine triplets of microtubule which are circularly arranged around a central axis.

Mitotic Apparatus:

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 fibres) during cell division. The whole structure of spindle fibres is known as mitotic apparatus which helps in the distribution of chromosomes between the daughter cells during cell division.

Basal Bodies:

In addition, centrioles also give rise to basal bodies or kinetosome of cilia and flagella.

Troponin:

Troponin, or the troponin complex is a complex of three regulatory proteins that is integral to muscle contraction in skeletal muscle and cardiac muscle but not smooth muscle.

Tropomyosin:

Tropomyosin is a two-stranded alpha-helical coiled coil protein found in cell cytoskeletons.

Myofibril:

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.

Microfilament:

Microfilaments, also called actin filaments are filaments in the cytoplasm of eukaryotic cells that form part of the cytoskeleton.

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

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.

Nucleoplasm:

Nucleoplasm is the transparent semi-fluid ground substance formed of a mixture of proteins, enzymes (DNA and RNA polymerase), free nucleotide and some metal ions (Mg) for the synthesis of DNA and RNAs. It also contains histone and non-histone protein. So, the nucleoplasm is slightly different from cytoplasm.

Nucleolus:

Nucleolus (plural *nucleoli*) is a non-membrane bound structure in the nucleoplasm. A cell may have one or more nucleoli. Nucleolus appears during interphase and disappears during cell division.

A nucleolus consists of a peripheral granular area (contains ribosomal subunits) and a central fibrillar area (contains rRNA and rDNA). Therefore, nucleolus is involved in the construction of ribosomes.

Chromosome:

During cell division chromatin fibres begin to condense and coil up into separate structures called chromosomes which are thick enough to be seen with a light microscope.

Chromatin:

Chromatin is a network of thin thread like structures made up of DNA and associated protein molecules.

Centromere:

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

Nuclear 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. At least, one pair of homologous chromosomes possesses nucleolar organizer region.

Satellite:

Beside secondary constriction, the end becomes a knob like structure called satellite.

Junk DNA:

In genetics, the term junk DNA refers to regions of DNA that are noncoding. Some of this noncoding DNA is used to produce non-coding RNA components such as transfer RNA, Regulatory, RNA and ribosomal RNA.

Telomeres:

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

OR

A telomere is a region of repetitive nucleotide sequences at each end of a chromosome, which protects the end of the chromosome from deterioration or from fusion with neighboring chromosomes.

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.

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.

Mesosomes:

The cell membrane or plasma membrane lies beneath the cell wall which lacks cholesterol in lipid bilayer unlike eukaryotic plasma membrane. At certain points this membrane invaginates into the cytoplasm to form infoldings, these are known as mesosomes.

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.

OR

The nucleoid (meaning nucleus-like) is an irregularly shaped region within the cell of a prokaryote that contains all or most of the genetic material, called genophore. In contrast to the nucleus of a eukaryotic cell, it is not surrounded by a nuclear membrane

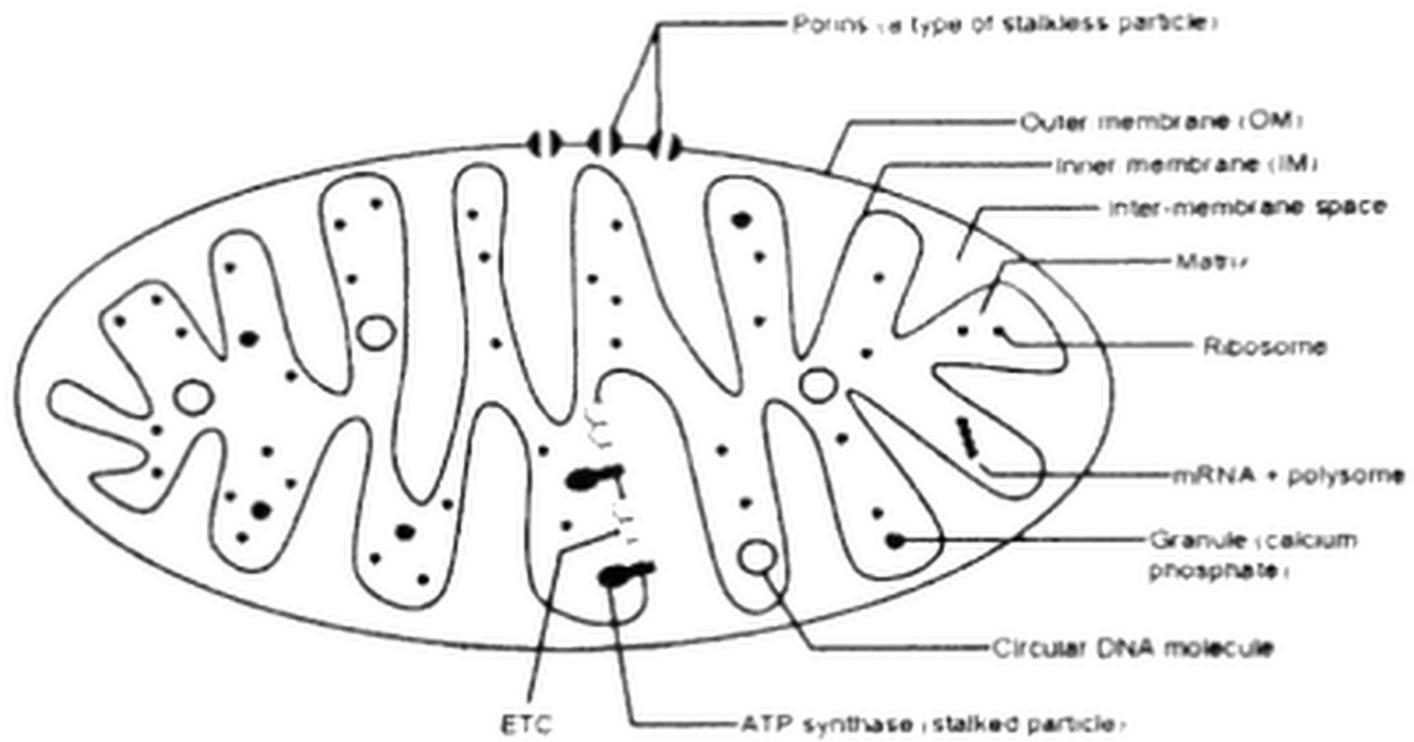
Plasmid:

Plasmids are important vectors in modern genetic engineering techniques. Plasmids also occur in lower eukaryotes e.g., yeast. Several different types of plasmids can exist in one cell. Transmissible plasmids can be transferred from cell to cell by conjugation. Non-transmissible plasmids are small: they are frequently present in many copies per cell.

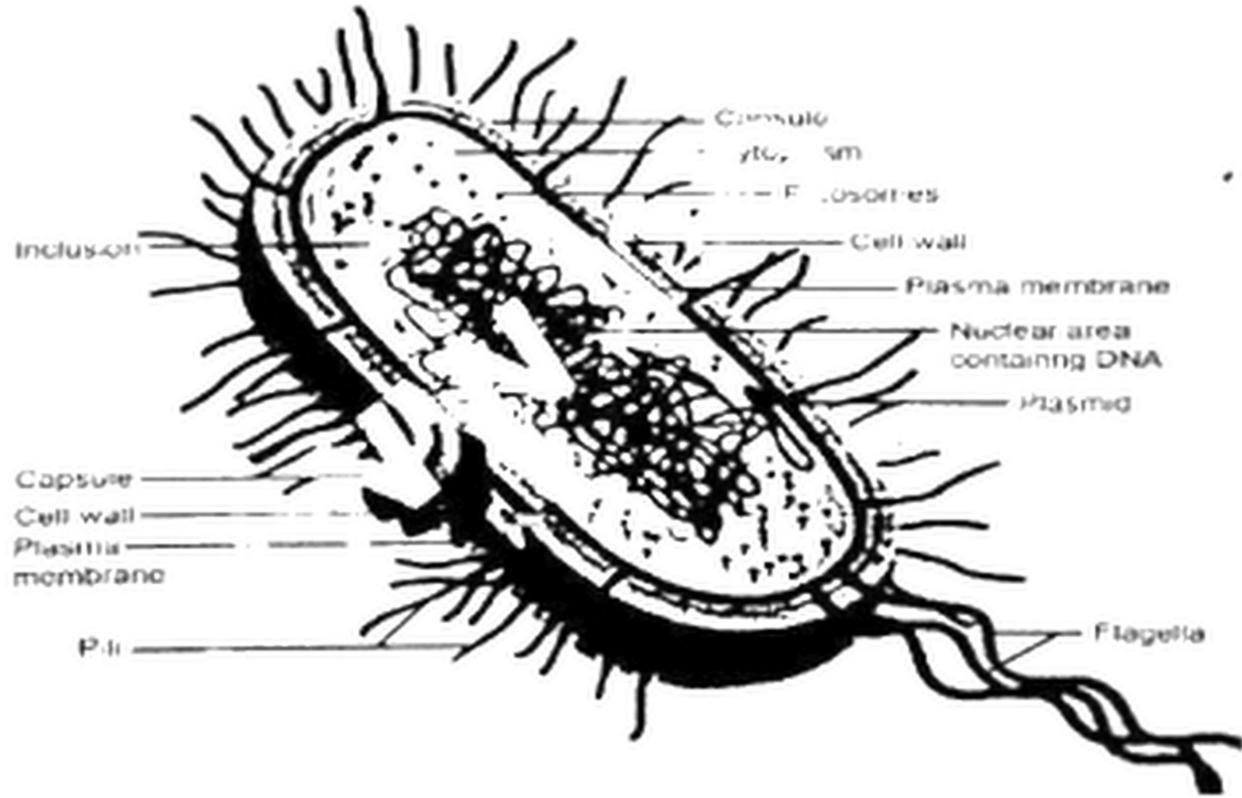
23. Draw a labelled diagram of a section through:

(a) Mitochondrion (b) bacterium (c) chloroplast

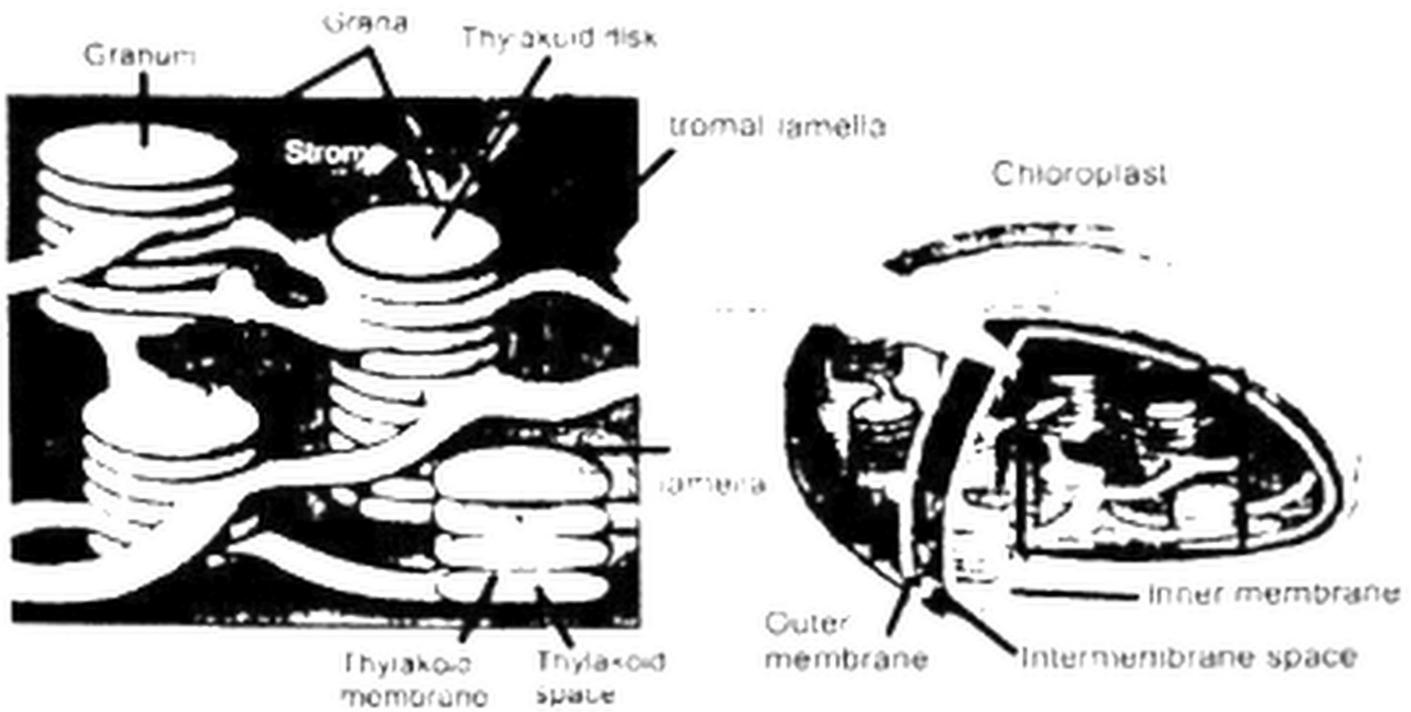
Ans: (a) mitochondrion:



(b) Bacterium:



(c) Chloroplast:



25. Write the difference between:

- (a) Resolution and magnification
- (b) Plant cell wall and bacterial cell wall

- (c) Cytoplasm of eukaryotic and prokaryotic cell
- (d) Flagella of eukaryotic and prokaryotic cell
- (e) Rough ER and smooth ER
- (f) Chromatin and chromosome
- (g) Euchromatin and heterochromatin
- (h) Nuclear lamina and chromatin

Ans: (a) Resolution and magnification:

Resolution	Magnification
<p>Our naked eye is capable to distinguish two points which have at least 0.1 mm distance. This minimum capacity of a lens to differentiate between two adjacent points is called resolution power of the lens.</p>	<p>The magnification is the capacity of an optical instrument to increase the size of an object than its original size</p> <p>The objects which cannot be seen by naked eye can also be observed by magnification.</p> <p>Different increasing lenses have different magnification powers which are represented by letter "X" that means the number of times than original size.</p>
<p>Therefore, the resolution of naked eye is 0.1 mm. This resolution can be increased by using magnification.</p>	<p>Therefore, a lens of 10X magnification power can increase the size of an object of 1 μm to 10 μm.</p>

OR

- Magnification gives how many times the image has been magnified by the instrument. Resolution gives the ability to separate between two closely placed objects on an image.
- The resolution is the quality or the sharpness of the image. This is why SLR cameras, which have large apertures produce very sharp images whereas point and shoot cameras lack in sharpness.
- For instruments such as telescopes and microscopes the resolution also determines the maximum magnification the instrument can obtain.

(b) Plant cell wall and bacteria cell wall:

Plant Cell Wall	Bacteria Cell Wall
Plant cell walls are mostly made up of chitin, cellulose and hemicellulose which are both alpha and beta linked polysaccharides these not only are significant stronger but also render plant cell walls that strength.	Bacterial cell walls mostly contain types of glucosamines called N acetyl glucose amine and N acetyl muramic acid, both are cross linked by a penta glycine inter bridge this crosslinking capability gives it significant strength.

OR

We can differentiate Bacteria cell wall from plant cell wall on the basis of

Plant Cell Wall	Bacteria Cell Wall
Structure	

<p>One main difference between plant and bacterial cell walls is their structure. Plant cell walls are made up of cellulose, hemicellulose, pectin and lignin. Plant cells have both a primary and a secondary cell wall. Primary surround growing and dividing plant cells. The secondary cell walls are important because they facilitate the transport of water and nutrients and allow for upright growth, such as the growth of plants' stems.</p>	<p>Bacteria cell walls are made up of peptidoglycan. They do not contain cellulose like plant cell walls. The bacteria cell wall is rigid. The cell wall is crucial to cell survival, as it plays a vital role in the interaction of the bacterial cell and the environment.</p>
<p>Function</p>	
<p>The cell walls in plant cells serve many functions. For example, they determine and maintain cell shape; provide structural support; control direction and speed of growth; store carbohydrates; protect the cell against outside elements; regulate the flow of materials in and out of the cell; and aid in cell-to-cell communication.</p>	<p>The cell wall of bacteria serves several functions, such as maintaining the shape of the cell, serving as an anchor for flagella; and providing protection. Bacteria have three different shapes: spiral (spirillum), spherical (coccus) and rod shaped (bacillus). Some bacteria, such as mycoplasma, have no cell wall and no specific shape. Bacteria have two different types of cell walls: gram-positive and gram-negative. Gram-positive bacteria have a cell wall that can be penetrated. Gram-negative bacteria have an outer membrane for protection, meaning gram-negative bacteria are more likely to fend off harm</p>

	to the cell from outside environmental forces
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(c) Cytoplasm of eukaryotic and prokaryotic cell:

In a eukaryotic cell, the cytoplasm contains highly organized discrete structures which are specific for various cellular functions are called cell organelles. The **cell organelles** are generally enclosed by the membrane except few such as ribosome.

On the other hand, the nonliving granules of storage or waste compounds of the cell that do not possess metabolic activity and are not bounded by membranes are called cytoplasmic inclusions. The most common inclusions are glycogen, lipid droplets, crystals and pigments. The organelles in the cytoplasmic matrix of a cell are: endoplasmic reticulum ribosomes Golgi complex peroxisomes, glyoxysomes, lysosomes, mitochondria, and chloroplasts etc.

OR (Second Answer)

- In eukaryotic cells (which are nucleated), the cytoplasm is everything between the plasma membrane and the nuclear envelope.
- In prokaryotes, cytoplasm encompasses everything within the plasma membrane.
- The cytosol is one major component of the cytoplasm in both prokaryotes and eukaryotes - this solution contains numerous ions, molecules and organelles. Therefore, it is also the site of many metabolic reactions, such as protein synthesis.
- In eukaryotes, the cytoskeleton is also part of the cytoplasm.

(d) Flagella of eukaryotic and prokaryotic cell:

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.

OR (Second Answer)

A Flagellum is a whip-like structure found in various micro-organisms. But the eukaryotic and prokaryotic (bacterial) versions are utterly different in their mechanisms and proteins. Almost certainly two separate developments, convergent evolution. Eukaryotic flagella resemble cilia and may have a common origin.

OR (Second Answer)

Difference between Prokaryotic and Eukaryotic Flagella:

- Prokaryotic flagella are smaller and simple in structure whereas eukaryotic flagella are larger and complex in structure.
- Prokaryotic flagella are made up of flagellin protein while eukaryotic flagella are made up of tubulin.
- The movement of prokaryotic flagella is proton driven, whereas the movement of eukaryotic flagella is ATP driven.
- Prokaryotic flagella have rotator movement, whereas eukaryotic flagella have blending movement.
- Unlike the prokaryotic flagella, eukaryotic flagella have 9+2 arrangement of microtubules.
- Prokaryotic flagella are located outside of the plasma membrane whereas the flagella in eukaryotes are covered with the plasma membrane.

OR (Second Answer)

Prokaryotic Flagella	Eukaryotic Flagella
They are single stranded.	They are 11 stranded.
A covering membranous sheath is absent.	The size is larger.
They are narrower.	They are thicker.
Each flagellum has three parts basal body hook and filament.	There are two parts: basal body and shaft.
Basal body bears rings.	Basal body bears rootlets.
They are formed of protein flagellin.	The strands are formed of protein tubulin.
They perform rotatory movements.	They perform lashing or undulatory

(e) Rough ER and smooth ER:

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

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

OR (Second Answer)

Smooth ER	Rough ER
Ribosomes	
Ribosomes are absent in smooth ER.	Ribosomes are present in rough ER
Location	
Smooth ER is mainly found near the cell membrane.	Rough ER is mainly found near the cytoplasm.
Origin	
Smooth ER originates from rough ER by shedding the ribosomes.	Rough ER originates from nuclear membranes.
Composition	
Smooth ER is mainly composed of tubules.	Rough ER is mainly composed of cisternae.
Function	
Major function is to synthesis lipids. They also store lipids and proteins.	Major function is to synthesize and store proteins
Localization	
Smooth ER is mainly present in lipid forming cells such as adipocytes, interstitial cells of	Rough ER is mainly present in protein forming cells such as pancreatic

the testis, glycogen storing cells in the liver, adrenal cortex cells, muscle cells, leukocytes etc.	acinal cells, goblet cells, antibody producing plasma cells, Nissl's granules of nerve cells etc.
<p>Conclusion:</p> <p>ER is considered as an interconnected system consisting of membrane-bound channels in the cytoplasm. Both smooth and rough ER play a role in the synthesis and storage of macromolecules. Smooth ER produces lipids. They also store lipids and proteins. On the contrary, rough ER synthesizes proteins and stores them. The presence of ribosomes, bound on the surface of the rough ER lets them synthesize proteins. Therefore, the main difference between smooth and rough ER is in the presence or absence of ribosomes on their surfaces.</p>	

OR (Second Answer)

Difference between Rough ER and smooth ER	
Rough Endoplasmic Reticulum	Smooth Endoplasmic Reticulum
1. Membrane covered with ribosomes.	1. Membrane not covered with Ribosomes.
2. Found in cells which actively synthesize proteins, E.g., Enzyme cells.	2. Found in cells which are involved in the synthesis of non-protein molecules, E.g., Steroids, Phospholipids.
3. Involved in protein synthesis.	3. Involved in other functions.
4. More stable.	4. Less stable.
5. Found in pancreatic Exocrine cells.	5. Found in Epithelial cells, Intestinal cells, Sarcoplasmic Reticulum.

(f) Chromatin and chromosomes:

	Chromatin	Chromosomes
Definition	In the nucleus, the DNA double helix is packaged by special proteins (histones) to form a complex called chromatin. The chromatin undergoes further condensation to form the chromosome.	A compact structure of nucleic acids and protein found in the nucleus of most living cells carrying genetic information in form of genes.
Structure	Composed of nucleosomes-a complex of DNA and proteins (called histones). Represent DNA folded on nucleoproteins by a magnitude of 50. The chromatin fibre is app. 10 nm in diameter.	Chromosomes are condensed chromatin fibres. They are a higher order of DNA organization, where DNA is condensed at least by 10,000 times onto itself.
Appearance	Chromatin Fibers are Long and thin. They are uncoiled structures found inside the nucleus.	Chromosomes are compact, thick and ribbon-like. These are coiled structures seen prominently during cell division
Pairs	Chromatin is unpaired.	Chromosome is paired
Metabolic activity	Permissive to DNA replication RNA synthesis (transcription) and recombination events.	Refractory to these processes.
Presence	Found throughout the cell cycle.	Distinctly visible during cell division (metaphase,

		anaphase) as highly condensed structures upto several thousand nm.
Confirmation	May have open (euchromatin) or compact (heterochromatin) conformations which is dynamically regulated during the cell-cycle stages.	Predominantly heterochromatic state with a predetermined position in the nucleus and a specific shape such as metacentric, sub metacentric acrocentric, telocentric.
Visualization	Electron microscope (beads on string appearance)	Light microscope (classic four-arm structure when duplicated)

(g) Euchromatin and heterochromatin:

	Euchromatin	Heterochromatin
Definition	A chromosome material which does not stain strongly except during cell division.	Chromosome material of different density from standard or usually greater, in which the activity of the genes gets modified or suppressed.

Packages	Loosely packed regions of chromatin that help them in performing various tasks.	Tightly packed particles that assist in performing them various tasks
Color	Lighter colors due to the loose packaging.	Darker color due to the densely packed chromatin regions.
Task	Protection of the integrity of gene to the handling or processes like regulation of the gene.	The transcription of the DNA to the mRNA products.
State	Transcriptionally inactive.	Transcriptionally active.

OR (Second Answer)

Heterochromatin	Euchromatin
1. It is darkly stained region of the chromatin (chromosome).	1. It is lightly stained region.
2. It is compactly coiled regions and with more DNA.	2. It is loosely coiled region and with less DNA.
3. It is genetically inert as cannot transcribe mRNA due to tight coiling.	3. It is genetically active.
4. It is late replicative.	4. It is early replicative.

(h) Nuclear lamina and chromatin

Nuclear Lamina	Chromatin

<p>Except at the pores, the nuclear side of 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.</p>	<p>Chromatin is a network of thin thread like structures made up of DNA and lamina associated protein molecules.</p>
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