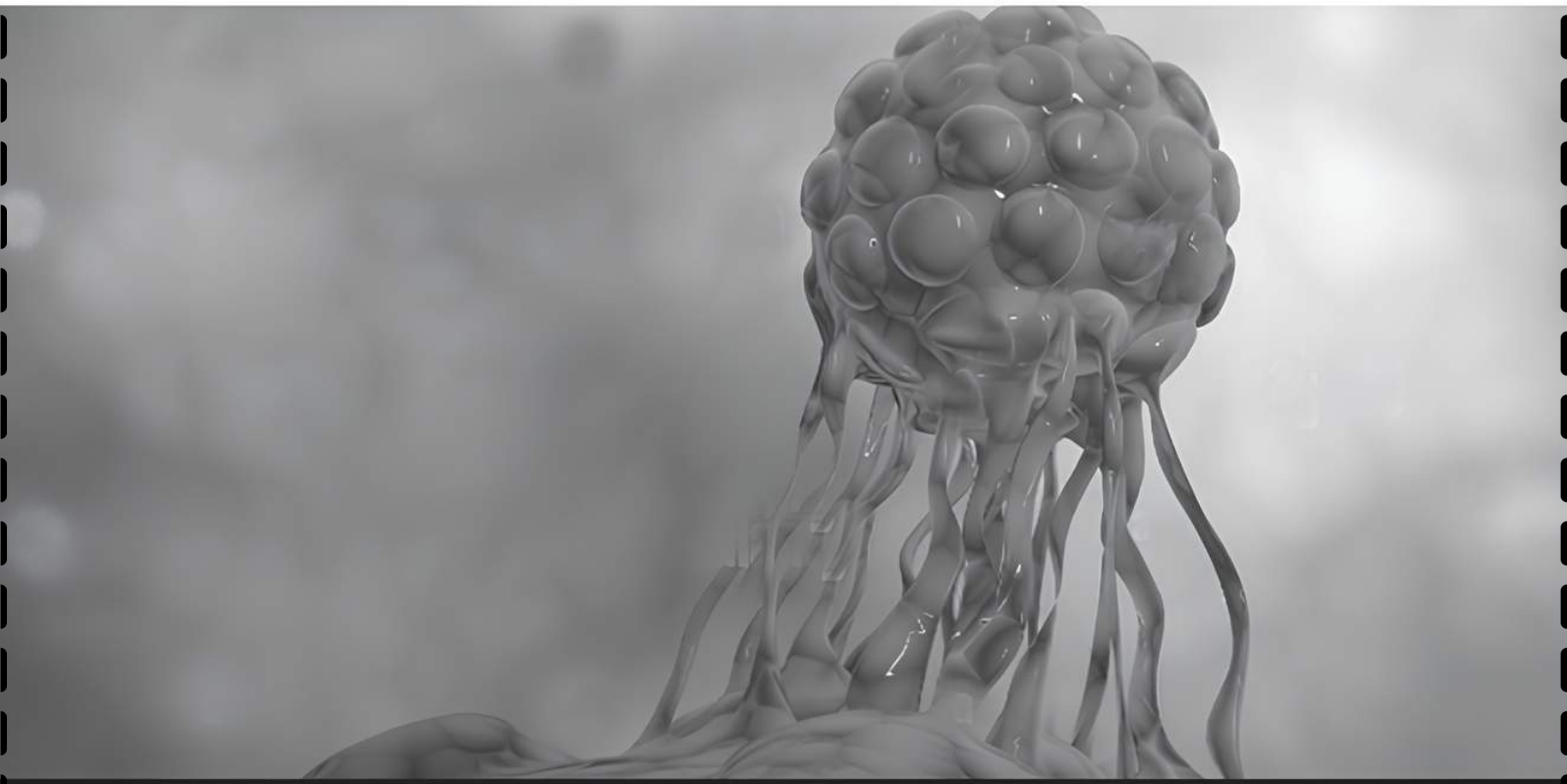
8 Cell: The Unit of Life



Stem cells have the potential to be grown to become new tissue for use in transplant and regenerative medicine. We can study how stem cell develop into heart muscle cell could provide clue about how we could induce heart muscle to repair itself after heart attack. The problem of stem cell research is politically fraught, causing biologists to engage in ethical discussions and generating exceptionally high levels of interest in this element of biology among the general public.

Topic Notes

- *Overview of Cell and Prokaryotic Cells*
- *Eukaryotic Cells*

OVERVIEW OF CELL AND PROKARYOTIC CELLS

1

TOPIC 1

WHAT IS A CELL?

Cells are the basic unit of life. It is present in all living organisms as no living organism can have life without being cellular because cell is a unit of both its structure and function. Life begins as a single cell. Cells are the building blocks of the body or act as the basic unit of body structure.

Important

➥ *Branch of biology that deals with various aspects of chemistry, structure, development, genetics and functioning of the cell is called cell biology. But the study of forms, composition and structure is called cytology.*

On the basis of number of cells present, organisms can be divided into:

(1) **Unicellular organisms:** These are made up of only a single cell and it is capable of independent existence. It is able to perform all the essential functions. Examples: *Amoeba*, yeast, etc.

(2) **Multicellular organisms:** These are made up of many cells. In multicellular organisms, cells are building blocks of the body or basic units of body structure but, the cell becomes specialised for performing different functions. Examples: Man, higher plants, etc.

Anything less than a complete cell can not perform the essential functions of life as it has no independent existence. Cell is the structural and functional unit of an organism.

Important

➥ *Besides structural units, the cells are also the functional unit of life. The activities of an organism are actually the sum total of the activities of its cells. Each cell consists of various organelles which perform different functions. Thus, the cell is the basic unit and also the structural and functional unit of life.*

Discovery of Cell

First time the word **cell** was referred red to tiny units of life in 1665 by a British Scientist named Robert Hooke. Hooke was one of the earliest scientists to study living things under the microscope. The microscopes of those days were not very strong, but Hooke was still able to make an important discovery. When he looked at a thin slice of cork under his microscope, he was surprised to see a honeycomb-like structure in that slide.

Soon after Robert Hooke discovered a cell in the cork cell, Anton van Leeuwenhoek in Holland made other important discoveries using a microscope. Leeuwenhoek made his own microscope lenses, and his microscope was almost as strong as modern light microscopes. Leeuwenhoek was the first person to observe human cells and bacterial cells.

Robert Brown discovered the presence of a nucleus inside the cell. With the invention of the electron microscope, the structural details of the cells had been revealed.

Example 1.1: Cell is the basic unit of life. Discuss in brief.

Ans. Cell is the basic unit of life and it is present in all living beings. Cells are the building blocks of the body and are capable of performing all the biochemical processes required for living. All the functions of the body take place within the cell, it is known as the structural and functional unit of an organism.

Cell Theory

This theory was put forward by both Schleiden and Schwann. Observations were started by Matthias Schleiden, a German botanist in 1837. He found that all plants are made up of different types of cells which form the tissues of plants. Theodore Schwann (1838), a British zoologist also studied different types of animal cells. He found that all the cells were covered by a thin membrane or outer layer, now called plasma membrane. He also concluded that the presence of a cell wall is a unique feature of plant cells.

Schwann proposed a cell hypothesis–bodies of animals and plants are made up of cells and their products. Schleiden and Schwann together proposed the cell theory. However, one of the limitations of this theory was that it could not explain the formation of new cells.

Rudolf Virchow (1855) observed that new cells arise from pre-existing cells *(Omnis cellula-e-cellula)* and he gave the final shape to the cell theory as:

(1) All living organisms are formed from the cells and products of cells.

(2) All cells arise from pre-existing cells.

Example 1.2: **New cells generate from:**

(a) Bacterial fermentation
(b) Regeneration of old cells
(c) Pre-existing cells
(d) Abiotic materials

Ans. *(c) Pre-existing cells*

Explanation: Rudolf Virchow (1855) observed that new cells arise from pre-existing cells *(Omnis cellula-e-cellula).*

An Overview of Cell

When we observe the onion peel cells or human cheek cells under a microscope we conclude certain things. There is a cell wall as its outer boundary in an onion cell which is a typical plant cell.

Inside the cell wall, there is a cell membrane. In the human cheek cell, the outer membrane acts as the delimiting structure of the cell.

Each cell contains a nucleus. Nucleus is a dense membrane-bound structure. It contains the chromosome which contains the genetic material DNA.

Genetic material is something which passes on from parents to their children and is responsible for hereditary characteristics.

Cheek cells *Onion peel tip cells*

On the basis of the presence of a membrane-bound nucleus, the cell is of two types—prokaryotic cell and eukaryotic cell.

(1) **Prokaryotic cell:** Cells that lack a membrane bound nucleus are called prokaryotic cells, *e.g.* bacteria, *Mycoplasma*, etc.

(2) **Eukaryotic cell:** Cells that have membrane -bound nuclei *e.g.* plants, animals, fungi, etc.

Inside each cell, there is a semi-fluid matrix called cytoplasm which occupies the main volume of the cell. Many cellular processes occur in cytoplasm as it is the main area of cellular activities. In eukaryotic cells, various other organelles are also present like endoplasmic reticulum, Golgi apparatus, chloroplast, lysosomes, mitochondria, microbodies, vacuoles, etc.

In both prokaryotic and eukaryotic cells, ribosomes are present. Ribosomes are non-membrane-bound organelles. They are present in the cytoplasm and they are also found within the two double membrane bound cell organelles—chloroplast (in plants) and mitochondria and they are also found on rough ER.

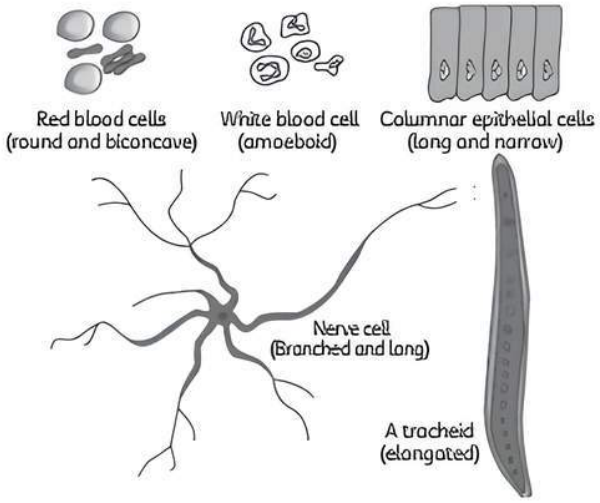
Centrosomes are present only in animal cells. It is a non-membrane-bound organelle. It helps in cell division

The shape of a cell can vary according to its function. They may be disc-like, polygonal, columnar, cuboid, thread-like or even irregular in shape sometimes.

Size and Shapes of Cell

Cells differ greatly in size and shape.

(1) *Mycoplasma* is only 0.3 micrometres.
(2) Bacteria are 3 to 5 micrometres long.
(3) Largest single cell is present in the egg of an ostrich.
(4) Human red blood cell is about 7.0 micrometres.
(5) In multicellular organisms, nerve cells are the longest cells.



Cells of varying shape

Example 1.3: **Case Based:**

Shruti is curious to know how living organisms are formed. She asked her teacher about it. Her teacher told her about the cell. A cell is the structure that makes living organisms. Every organism, whether it is a single cell or a multi-celled, is made up of cells. Cells differ in shapes and sizes. The shape of cells varies with the function they perform.

(A) What is it that keeps a living creature alive?
(a) Blood **(b) Cells**
(c) Atoms **(d) Molecules**

(B) *Mycoplasma* cells are:
(a) the longest cell **(b) 0.5 micrometre**
(c) 0.03 micrometre **(d) 0.3 micrometre**

(C) Why are cells known as structural and functional units of life?

(D) How do unicellular organisms work?

(E) Assertion (A): Cells have different sizes and shapes.
Reason (R): The shape of a cell does not depend on the function they perform.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true and R is not the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

Ans. **(A)** *(b) Cells*

Explanation: Cell is the basic unit of life. It is the cell which makes the difference between living and non-living beings. As no body can have life if its constituent parts are not formed of cells. It is the cell that keeps the living creatures alive.

(B) *(d) 0.3 micrometre*

Explanation: *Mycoplasma* cells are only 0.3 micrometre in size. Other options are not correct as it is the nerve cell which is the longest cell in multicellular organisms. Bacteria are 3 to 5 micrometres long. Human red blood cell is about 7.0 micrometres.

(C) Cells are the building blocks of the body or act as the basic unit of body structure. Besides the structural unit, the cells are also the functional unit of life. The activities of an organism are actually the sum total of the activities of its cells. So, a cell is called a structural and functional unit of life.

(D) Unicellular organisms are those that are made up of single cells. All the functions of the unicellular organisms are performed by the single cell. Anything less than a complete cell can not perform the essential functions of life as it has no independent existence.

(E) *(c) A is true but R is false.*

Explanation: Cells have different shapes and sizes as they can be of disc-shaped, polygonal, cuboid, columnar or even irregular shape. The shape of the cell may vary with the function they perform.

TOPIC 2

PROKARYOTIC CELLS

Prokaryotic cells are primitive type of cell in which the genetic material is not organised in the form of a nucleus but instead lies freely in the cytoplasm in a naked supercoiled state and known as **nucleoid**.

Prokaryotic cells are smaller than eukaryotic cells and they are known for their rapid division capacity.

Defining characteristics of Prokaryotic organisms/ Prokaryotes:

(1) It is represented by bacteria, blue-green algae, *Mycoplasma* and PPLO (Pleuropneumonia-like Organisms).

(2) Lack a membrane-bound nucleus, thus nucleus is not well defined and DNA (genetic material) lies naked in the cytoplasm.

(3) Cell wall is present, except in *Mycoplasma*.

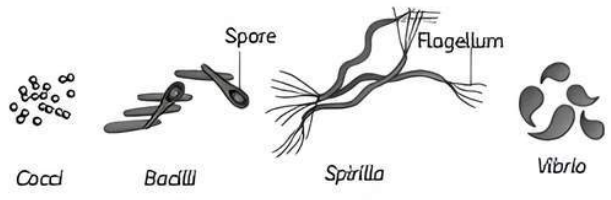
(4) Ribosomes are present.

(5) Some bacterial cells have a self-replicating, extrachromosomal segment of double-stranded, circular naked DNA called **Plasmid**.

(6) They have something unique in the form of inclusions.

(7) Mesosome is present, which is a specialised differentiated form of cell membrane, characteristic of prokaryotes. Mesosomes are infoldings of cell membranes.

(8) In shape, the bacterial cell is of four types—Bacillus (rod-like), Coccus (spherical), Vibrio (comma-shaped) and Spirillum (spiral).



Different shapes of bacteria

Components of Bacterial cell

A bacterial cell consists of a cell envelope, cytoplasm, nucleoid, plasmids, inclusion bodies, flagella, pili and fimbriae.

Cell envelope and its modifications

It is the outer covering of protoplasm of bacterial cell. Cell envelope consists of 3 components:

(1) **Glycocalyx:** It is the outermost mucilage layer of the cell envelope. Glycocalyx can occur in the form of a loose sheath, then it is called slime layer. If it is thick and tough, the mucilage covering is called capsule. Glycocalyx provides protection from phagocytosis, toxic chemicals and drugs, viruses and prevents the bacteria from desiccation. It also helps in attachment.

(2) **Cell wall:** It is a rigid solid covering which generally provides shape and structural support to the cell. Cell wall lies between plasma membrane and glycocalyx.

(3) **Plasma membrane:** It is selectively permeable covering of the cytoplasm that forms the innermost component of cell envelope.

Important

➥ *In Gram-negative bacteria, cell wall is 8-12 nm thick, complex, wavy and double-layered. The outer layer is consist of lipopolysaccharides, lipids and proteins. In Gram-positive bacteria, the cell wall is 20-80 nm thick, it is single-layered and smooth. The single layer of Gram-positive bacteria and inner layer of Gram-negative bacteria is made up of peptidoglycan, proteins, non-cellulosic, carbohydrates, lipids, amino acids, etc.*

➥ *Gram-positive bacteria remain blue or purple after the Gram staining but Gram-negative bacteria do not retain the stain due to the high lipid content of cell wall which gets dissolved in organic solvents like acetone.*

Cytoplasm

It is a crystalloid colloidal complex that forms the protoplasm excluding its nucleoid. Cytoplasm is a little granular in structure due to the presence of ribosomes in large quantities. Membrane-bound organelles are absent in prokaryotic cells but found in eukaryotic cells. All the biochemical pathways found in prokaryotes are similar to eukaryotes. Cytoplasmic streaming is absent. Sap vacuoles are absent. Instead, they have some gas vacuoles. Various structures present in the cytoplasm are as follows:

(1) **Mesosome:** Mesosome is the extension of plasma membrane into the cell. It consists of vesicles, tubules and lamellae. They aid in the development of cell walls, DNA replication, and distribution to daughter cells. They also aid respiration, secretion, and the expansion of the plasma membrane's surface area and enzymatic content. In cyanobacteria, chromatophores are present. It is also the membranous extension into the cytoplasm which possesses photosynthetic pigments.

(2) **Ribosomes:** Ribosomes are small, non-membranous bound structures. Mainly, they are attached to the plasma membrane of a prokaryotic cell. They are 15 nm to 20 nm in size. The ribosomes of prokaryotes are 70S, which is made up of 30S (smaller) and 50S (larger) subunits. Each ribosome has two subunits, larger and smaller. They act as the site of protein synthesis. Polyribosomes or polysomes are formed when many ribosomes are attached to a single strand of messenger or mRNA. They translate the mRNA into proteins.

Example 1.4: What is a mesosome in a prokaryotic cell? Mention the functions that it performs.

Ans. Mesosome is a special membranous structure in a prokaryotic cell. It is formed by the extension of plasma membranes into the cell. It can be in the form of vesicles, tubules and lamellae. They help in the formation of cell walls, DNA replication, and distribution to daughter cells. They also aid respiration, secretion, and the expansion of the plasma membrane's surface area and enzymatic content.

Nucleoids

These represent the genetic material of prokaryotes. Nucleoid consists of a single circular strand of DNA duplex which is supercoiled with the help of RNA and polyamines to form a nearly oval or spherical complex. Polyamines or nucleoid proteins are different from histone proteins and absence of nuclear envelope around them. Nucleoid is embedded freely in cytoplasm. It is equivalent to a single chromosome of eukaryotes because nucleoid consists of a single DNA double-stranded. Nucleoids may be directly attached to the plasma membrane through the mesosomes.

Plasmids

They are self-replicating, extracellular chromosomal segments of double-stranded, circular, naked DNA. Plasmids provide unique phenotype characters to the bacteria. Most of the time they are independent of nucleoids but if they are temporarily associated with nucleoids then known as episomes. Some of the plasmids contain important genes like fertility genes, *nif*genes, resistance genes, etc. Plasmids are used as a vector in genetic engineering.

Inclusion bodies

They are non-membranous, non-living structures lying freely in the cytoplasm. Reserve material is stored in the form of inclusion bodies. Examples: Phosphate granules, cyanophycean granules, and glycogen granules. Gas vacuoles are found in blue-green, purple, and green photosynthetic bacteria.

Flagella

Bacterial cells can be motile or non-motile. If motile, they have flagella. Flagella is a thin membranous extensions from their cell wall. Bacterial flagellum is made up of three parts– filament, hook and basal body. Filament extends from the cell surface to the outside. It is a tubular structure that is the longest among the three.

Pili and fimbriae

These are the structures present on the surface of bacteria but are not involved in locomotion. Pili are elongated with fewer and thicker tubular outgrowth. They are made up of a special protein, pilin. Fimbriae are small bristle-like fibres sprouting from the cell surface in large numbers. They are involved in attaching bacteria to solid surfaces like rocks in streams and also to the host tissues.

Example 1.5: What are the characteristics of prokaryotic cells?

Ans. Following are the characteristics of prokaryotic cells:

(1) **Nuclear material:** DNA is naked.

(2) **Nucleus:** Not well–defined, nuclear membrane is absent.

(3) **Plasmid:** Besides nuclear DNA, plasmids (circular DNA) are also present.

(4) **Cell wall:** All prokaryotes have a cell wall except *Mycoplasma*.

(5) **Organelles:** Prokaryotic cells lack membrane bound organelles.

(6) **Flagella:** In some bacteria, flagella are present which helps in locomotion. Non-motile structures like pili and fimbriae are also present in some bacteria.

(7) **Ribosomes:** It is of 70S type.

(8) **Vacuoles:** Gas vacuoles are present.

Example 1.6: Case Based:

There are two types of cells–prokaryotic and eukaryotic on the basis of the presence of a nucleus in the cell. If the nucleus is membrane-bound, it is a eukaryotic cell and if a cell lacks a membrane-bound nucleus, it is called a prokaryotic cell. They lack membrane-bound organelles. Ribosome is 70S type.

(A) What are the two subunits present in a prokaryotic ribosome?

(a) 55S and 35S (b) 50S and 40S

(c) 50S and 30S (d) 55S and 30S

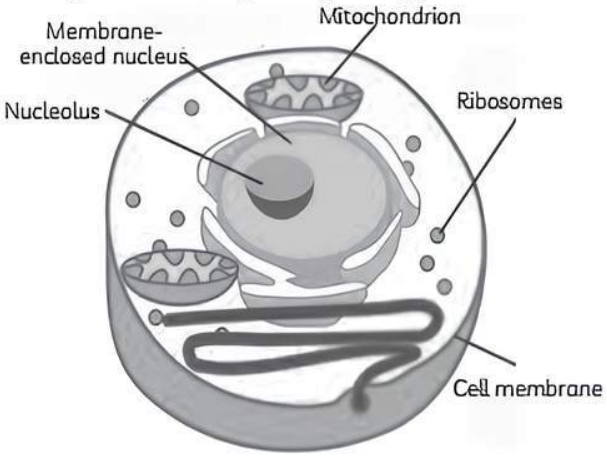
(B) Prokaryotes are represented by:

(a) protista (b) plant cell

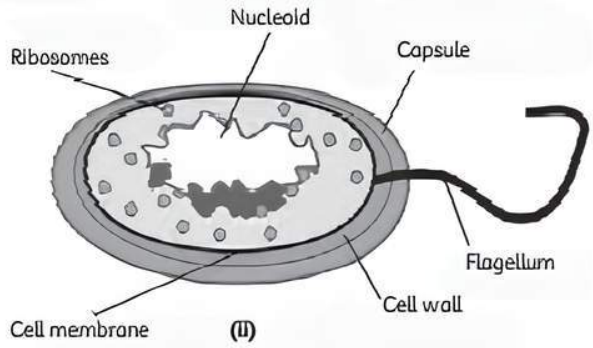
(c) PPLO (d) animal cell

(C) What is the main difference between prokaryotic and eukaryotic cells?

(D) Identify both the diagram (i) and (ii).



(i)



(ii)

(E) Assertion (A): Bacteria are prokaryotes.

Reason (R): Bacteria do not possess true nucleus and membrane-bound cell organelles.

(a) **Both A and R are true and R is the correct explanation of A.**

(b) **Both A and R are true and R is not the correct explanation of A.**

(c) **A is true but R is false.**

(d) **A is false but R is true.**

Ans. (A) *(c) 50S and 30S*

Explanation: Ribosomes are of the 70S type in prokaryotes. They are made up of two subunits, a larger subunit is 50S type and a smaller subunit is 30S type. Other options are incorrect as the given subunits are wrong.

(B) *(c) PPLO*

Explanation: Prokaryotes are represented by bacteria, blue green algae, *Mycoplasma* or PPLO (Pleuropneumonia-like organisms). The simplest prokaryotes are *Mycoplasma*, which is free-living creatures. They are named PPLO (Pleuropneumonia-like organisms) because they lack cell walls and were discovered in the pleural fluid of animals suffering from pleuropneumonia. Protista, Fungi, Plantae and Animalia represent eukaryotic cells.

(C) Prokaryotic cell: Cells that lack a membrane-bound nucleus and double membrane-bound cell organelles are known as prokaryotic cells, *e.g.* bacteria, *Mycoplasma*, etc.

Eukaryotic cell: Cells that have membrane-bound nucleus and have a double membrane-bound cell organelles like mitochondria, plastids, etc., are known as eukaryotic cells, *e.g.* plants, animals, fungi, etc.

(D) The diagram (i) represents a eukaryotic cell. Eukaryotes contain membrane-bound organelles and a true nucleus.

The diagram (ii) represents prokaryotic cells. Prokaryotes lack membrane-bound organelles and a well defined nucleus.

(E) *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: Bacterial cells are prokaryotic and they do not possess a true nucleus as DNA is naked. They also lack membrane-bound organelles.

OBJECTIVE Type Questions

[1 mark]

Multiple Choice Questions

1. Which of the following is a non-membrane-bound organelle?
(a) Ribosome
(b) Mitochondria
(c) Golgi apparatus
(d) Endoplasmic reticulum

Ans. *(a) Ribosome*

Explanation: Ribosome is a non-membrane bound organelle whereas the other given organelles are membrane bound.

2. Different cells have different sizes. Arrange the following cells in ascending order of their size.
(I) *Mycoplasma* **(II) Ostrich's egg**
(III) Human's RBCs **(IV) Bacteria**
Select the correct option:
(a) (I), (IV), (III), (II) **(b) (I), (III), (IV), (II)**
(c) (II), (I), (III), (IV) **(d) (III), (II), (I), (IV)**
[NCERT Exemplar]

Ans. *(a) (I), (IV), (III), (II)*

Explanation: *Mycoplasma* (0.3 micrometre) < Bacteria (3 to 5 micrometres) < Human's RBCs (7.0 micrometres) < Ostrich's egg (130 micrometres).

3. Which of the following statement is true?
(a) In prokaryotes, a nuclear membrane is present.
(b) *Mycoplasma* has a cell wall.
(c) Mesosomes are formed by the extension of plasma membrane.
(d) In prokaryotes, the ribosome is of 80S type.

Ans. *(c) Mesosomes are formed by the extension of plasma membrane.*

Explanation: Mesosomes are the extension of plasma membrane into the cell. The other given options are incorrect. These can be corrected as:

In prokaryotes, no nuclear membrane is present as DNA is naked. *Mycoplasma* does not have a cell wall. In prokaryotes, ribosomes are of the 70S type.

4. The difference between eukaryotic and prokaryotic cells is in having:
(a) ribosomes
(b) cell wall
(c) nuclear envelope
(d) none of these

Ans. *(c) nuclear envelope*

Explanation: Cells that lack a membrane surrounding the nucleus are prokaryotes. Thus, nucleus is not well-defined and DNA (genetic material) lies naked in prokaryotic cells whereas cells that have a nuclear envelope and well-defined nuclei are eukaryotes.

5. Statement A: Prokaryotic cells lack mitochondria.
Statement B: Their plasma membrane bears digestive enzymes.
(a) Both A and B are correct.
(b) Both A and B are incorrect.
(c) Only A is correct.
(d) Only B is correct.

Ans. *(c) Only A is correct.*

Explanation: Cells in prokaryotes lack mitochondria. Their plasma membrane contains enzymes for respiration. Organelles in prokaryotic cells that are membrane-bound are absent, and respiration takes place in the cytoplasmic mesosome. Respiratory enzymes that are a part of an electron transport chain are located in the mesosome, which is formed when the plasma membrane folds inward.

6. Statement A: Cell is the fundamental unit of living organisms.
Statement B: Body of all organisms is made up of cells.
(a) Both A and B are correct.
(b) Both A and B are incorrect.
(c) Only A is correct.
(d) Only B is correct.

Ans. *(a) Both A and B are correct.*

Explanation: Cell is the fundamental structural and functional unit of all living organisms. Body of all organisms is made up of cells and all the functions are carried out by cells.

7. You are asked to examine a cell using a powerful light microscope. The image you see has a clearly defined nucleus and mitochondria. It also has a large central vacuole and chloroplasts. From what group of organisms did this cell most likely come?
(a) Bacteria **(b) Protists**
(c) Fungi **(d) Plants**

Ans. *(d) Plants*

Explanation: We can eliminate bacteria because they lack organelles completely. Of the organelles listed the only unique one is the chloroplast, which is found exclusively in plants.

8. Cell organelle which is present in cell - cytoplasm, mitochondria, ER and plastids:

(a) Lysosome **(b) Ribosome**

(c) Centriole **(d) Golgi body [Diksha]**

Ans. *(b) Ribosome*

Explanation: Ribosomes are found bound to the endoplasmic reticulum and the nuclear envelope, as well as freely scattered throughout the cytoplasm, depending upon whether the cell is a plant animal, or bacteria.

Caution

Students usually get confused and do not choose ribosome as an answer. They think that ribosomes are only found bound to ER and nucleus. But it is also found in free state.

9. Statement A: Pili and Fimbriae are surface structures of the bacteria.

Statement B: Pili do not play a role in motility.

(a) Both A and B are correct.

(b) Both A and B are incorrect.

(c) Only A is correct.

(d) Only B is correct.

Ans. *(b) Only B is correct.*

Explanation: Pili and fimbriae are surface structures of the bacteria that do not play a role in motility but are still important for bacteria. They are known to help attach the bacteria to rocks in streams and also to the host tissues.

10. Which is the characteristic of prokaryotes?

(a) Plastids **(b) Mesosome**

(c) Golgi apparatus **(d) Fibrin**

Ans. *(b) Mesosome*

Explanation: Mesosomes are formed by the extension of plasma membrane into cells. A specialised differentiated form of cell membrane called mesosome is the characteristic of prokaryotes.

11. Which of the following provides strong structural support to the cell?

(a) Cell wall **(b) Glycocalyx**

(c) DNA **(d) Plasma membrane**

Ans. *(a) Cell wall*

Explanation: Cell wall is a rigid solid covering which provides shape and structural support to the cell. It prevents the cell from bursting or collapsing.

12. Which of the following contain chromatophores?

(a) *Mycoplasma* **(b) Bacteria**

(c) Cyanobacteria **(d) Viruses**

Ans. *(c) Cyanobacteria*

Explanation: Chromatophores are present in cyanobacteria. It is the membranous extension into the cytoplasm which possesses photosynthetic pigments.

13. Who gave the cell theory?

(a) Robert Hooke

(b) Schwann and Anton van Leeuwenhoek

(c) Robert Brown and Schleiden

(d) Schleiden and Schwann

Ans. *(d) Schleiden and Schwann*

Explanation: Schleiden and Schwann together formulated the cell theory.

Related Theory

Rudolf Virchow gave a revised cell theory as he modified the hypothesis of Schleiden and Schwann to give cell theory a final shape. He added that cells arise from pre-existing cells (Omnis Cellua-e Cellula).

Assertion-Reason (A-R)

Given below are two statements labelled as Assertion (A) and Reason (R). Select the most appropriate answer from the options given below:

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true and R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true.

14. Assertion (A): Rudolf Virchow modified the hypothesis of cell theory given by Schleiden and Schwann.

Reason (R): Cell theory says that all cells arise from pre-existing cells.

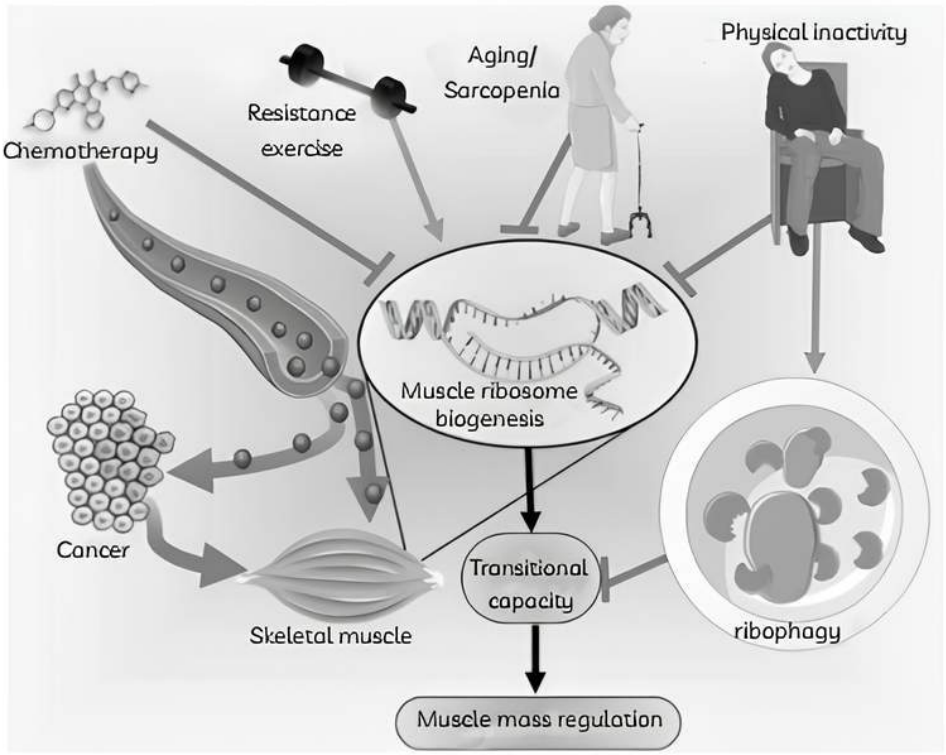
Ans. *(b) Both A and R are true and R is not the correct explanation of A.*

Explanation: Rudolf Virchow (1855) observed that new cells arise from pre-existing cells. *(Omnis-cellula-e-cellula).* He gave the final shape to cell theory which states that:

(1) All living organisms are made up of cells and product of cells.

(2) All cells arise from pre-existing cells.

15. Many antibiotics in clinical use target the bacterial ribosome by interfering with the protein synthesis machinery. However, targeting the human ribosome in the case of protein synthesis deregulations such as in highly proliferating cancer cells has not been investigated at the molecular level up to now.



Assertion (A): Ribosomes are non-membrane-bound organelles found in both prokaryotic and eukaryotic cells.

Reason (R): Ribosomes are present only in the cytoplasm.

Ans. *(c) A is true but R is false.*

Explanation: Ribosomes are non-membrane bound organelles. It is found in both prokaryotic and eukaryotic cells. Besides cytoplasm, they are also found within the two organelles—chloroplast (in plants) and mitochondria and on rough ER.

16. **Assertion (A):** The fimbriae are elongated tubular structures made up of a special protein.

Reason (R): The pili are elongated tubular structures made up of a special protein.

Ans. *(d) A is false but R is true.*

Explanation: Pili are the elongated tubular structure. They are made up of special proteins. Fimbriae are small bristles-like fibres sprouting out of the cell.

Related Theory

- *Pili are made up of a protein called as pilin. It forms a conjugation tube and helps in the transfer of genetic material between cells.*
- *Fimbriae help the bacteria to attach to solid surfaces and to host tissues.*

17. **Assertion (A):** Prokaryotes have a single envelope system.

Reason (R): There is not even a single membrane that surrounds the prokaryotic cell.

Ans. *(c)) A is true but R is false.*

Explanation: The cell envelope of most prokaryotic organisms, particularly bacterial cells, is chemically complex. The cell envelope is made up of three layers, the outermost of which is the glycocalyx, followed by the cell wall and plasma membrane. Despite the fact that each layer of the envelope serves a separate purpose, they all work together to produce a single protective unit.

18. **Assertion (A):** Specialisation of cells is useful for organisms.

Reason (R): It increases the operational efficiency of an organism.

[Delhi Gov. QB 2022]

Ans. *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: Animal bodies are made up of a variety of cell types. The human body has

roughly 200 different types of specialised cells. The cells of one or more types are grouped together in a certain way and work together to play a particular purpose. A tissue is a collection of such cells. It is helpful for an organism when cells get specialised into a tissue, organ, or organ system. By avoiding duplication of effort through the division of labour, it improves operational efficiency.

CASE BASED Questions (CBQs)

[**4** & **5** marks]

Read the following passages and answer the questions that follow:

19. *Cells are something which are present in all living beings whether they are unicellular or multicellular. Unicellular organisms have an independent existence but anything less than a complete cell does not have an independent existence. Anton Van Leeuwenhoek was the first to observe and describe a live cell. Robert Brown discovered the presence of a nucleus. Schwann and Schleiden together put forward the cell theory. On the basis of the membrane -bound nucleus, cells are of two types– prokaryotic and eukaryotic. The cell envelope of prokaryotes is made up of three layers– glycocalyx, cell wall and cell membrane.*

(A) Who gave the cell theory that is widely accepted now?

(a) Anton van Leeuwenhoek
(b) Rudolf Brown
(c) Rudolf Virchow
(d) Schwann and Schleiden

(B) Which of the following statement is correct with regard to glycocalyx?

(a) They are of three types.
(b) They differ in composition and thickness among different bacteria.
(c) Thick and tough layer is called a loose sheath.
(d) Glycocalyx is the innermost layer.

(C) Which thing differentiates living things from non-living things?

(a) Atoms **(b) Molecules**
(c) Compounds **(d) Cells**

(D) Rudolf Virchow said that:

(a) New cells do not arise from pre- existing cells.
(b) Unicellular organisms are capable of independent existence.
(c) New cells arise from pre-existing cells.
(d) Anything less than a complete cell does not have an independent existence.

(E) Prokaryotic cell envelope is made up of ..... , cell wall and cell membrane.

(a) glycocalyx **(b) chitin**
(c) lipid **(d) protein**

Ans. (A) *(c) Rudolf Virchow*

Explanation: Revised cell theory, that is widely accepted, was given by Rudolf Virchow. Others were part of the discoveries that led to the final one.

(B) *(b) They differ in composition and thickness among different bacteria.*

Explanation: Glycocalyx (outermost layer) differ in composition and thickness among different bacteria. It could be a loose sheath called the slime layer in some, while in others it may be thick and tough, called the capsule.

(C) *(d) Cells*

Explanation: Cells are something which are present in all living beings whether they are unicellular or multicellular. Others are present in both living and non-living.

(D) *(c) New cells arise from pre-existing cells.*

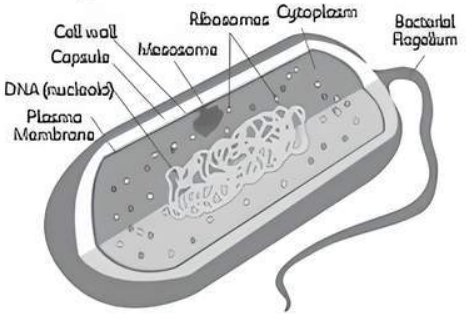
Explanation: Revised cell theory was given by Rudolf Virchow and according to it, new cells arise from pre-existing cells. Other options like (b) and (d) were given by other scientists.

(E) *(a) glycocalyx*

Explanation: The cell envelope of prokaryotes is made up of three layers– glycocalyx, cell wall and cell membrane.

20. *Prokaryotes are different from eukaryotes in various aspects. Cells that have membrane-bound nuclei are called eukaryotes whereas cells that lack a membrane-bound nucleus are prokaryotic. Prokaryotes lack membrane bound organelles. In prokaryotes, ribosomes are of the 70S type. Division of labour is absent in prokaryotes. Many prokaryotes also have additional small circular DNA entities called plasmids. Bacteria with plasmid DNA have distinct phenotypic characteristics. One is*

resistance to antibiotics. They have something unique in the form of inclusions. Mesosome is the characteristic of prokaryotes. It is the infolding of the cell membrane.



(A) Why are plasmids present in prokaryotes only?

(B) How does the nucleoid stay in one place in the cell even though they do not have a membrane surrounding them in prokaryotic cells?

(C) Why is there no division of labour in prokaryotes?

Ans. (A) Only prokaryotes have plasmids. Plasmids are small circular DNA. Besides genomic DNA, many bacterial cells contain plasmids. Bacteria with plasmid DNA have distinct phenotypic characteristics. One is resistance to antibiotics. Plasmid helps in the transfer of genetic material from one cell to another.

(B) DNA and proteins make up the majority of the nucleoid. Proteins that carry out dynamic spatial organisation are in charge of keeping the nucleoid's compact form and position. Mutations in chromosomal DNA, on the other hand, can disrupt nucleoid shape and cause the origins to be mislocated.

(C) Prokaryotes are single-celled organisms. Their body structure is not so complex and they lack organelles. Whole organisms work as a single unit as no division of labour is present.

VERY SHORT ANSWER Type Questions (VSA)

[1 mark]

21. Sahil's mother is a biology teacher. She told him that our body is made up of small units. What is she talking about?

Ans. His mother is talking about the cell. Cells are the basic unit of life. It is present in all living organisms as no living organism can have life without being cellular.

22. What is plasmid?

Ans. Many prokaryotes have additional small circular DNA entities called plasmids. Bacteria with plasmid DNA have distinct phenotypic characteristics such as resistance to antibiotics.

23. What is the function of polyribosomes or polysomes? [NCERT Exemplar]

Ans. Many ribosomes attach to a single *m*RNA to form a chain called the polyribosome or polysomes. They translate *m*RNA into proteins.

24. Which cells are called the longest cells in multicellular organisms?

Ans. Nerve cells are the longest cells present in multicellular organisms.

SHORT ANSWER Type-I Questions (SA-I)

[2 marks]

25. Write the name of any four prokaryotic cells. Write the name of two types of bacterial cell, classified on the basis of its cell envelope. [Diksha]

Ans. Bacteria, blue-green algae, *Mycoplasma* (the smallest cell) and PPLO (Pleuropneumonia-like organisms).

Gram-positive and Gram-negative are the two types of bacterial cell, classified on the basis of its cell envelope.

26. Two statements are mentioned below. Read them carefully and describe why both of the statements are incorrect.

(1) Eukaryotic cells show various membrane-bound organelles such as chloroplasts and nucleus while ribosomes are the only membrane-bound organelles found in prokaryotes.

(2) No special respiratory organelles are found in prokaryotes. Hence they respire at a much lesser rate than eukaryotes.

Ans. Eukaryotic cells have various cell organelles but prokaryotes lack such organelles (except ribosomes). Ribosomes are the only cytoplasmic organelles in prokaryotes and they are not membrane-bound. Prokaryotes contain simple unicellular organisms that have simple body structures as they do not have complex body structures. So, prokaryotes do not have membrane-bound organelles for respiration but any enzymes needed for cellular respiration are attached to the plasma membrane, which may fold and extend into the cell.

27. How will you define inclusion bodies?

Ans. Inclusion bodies are present in prokaryotes. Reserve material is stored in the cytoplasm in the form of inclusion bodies. They are not bounded by any membrane, *e.g.*, phosphate granules, cyanophycean granules and glycogen granules.

28. Discuss the structure of flagella in prokaryotes.

Ans. Flagella is a thin membranous extensions from their cell wall. It is made up of three parts–filament, hook and basal body. Filament extends from the cell surface to the outside. It is a long tubular structure. It helps in the locomotion of bacteria.

29. A student placed two cells in the same solution in two different containers. The observation was given in a table.

Container	Observation
I	Cell burst
II	Cell does not changes its shape

Which structure maintains the shape of the cell present in container II and provides the most significant difference between the two cells?

Ans. The cell wall protects the cell, maintains its shape and provides support and strength to it. The cell membrane holds the parts of the cell together and also separates the cell from its surroundings.

30. Write names of any four prokaryotic cells. Write the name of two types of bacterial cells on the basis of their cell envelope.

[Diksha]

Ans. Bacteria, blue-green algae, *Mycoplasma* (the smallest cell), PPLO (Pleuropneumonia-like organisms).

On the basis of cell envelope, two types of bacterial cells are Gram-positive and Gram-negative.

SHORT ANSWER Type-II Questions (SA-II)

[3 marks]

31. Briefly describe the cell theory.

[NCERT Exemplar]

Ans. Schwann and Schleiden together put forward the cell theory. Schleiden (1838) stated that cells are the building blocks of all plants. Schwann (1839) stated that cells are the fundamental units of animals too. He also found that cells have a thin outer layer, *i.e.* plasma membrane and plant cells specifically have a cell wall. But they did not explain that how new cells were formed. Rudolf Virchow explains that new cells arise from pre-existing cells. Therefore, he modified the cell theory given by Schwann and Schleiden to give it final shape. The theory given by him stated that:

(1) All living organisms are made up of cells and product of cells.

(2) All cells arise from pre-existing cells.

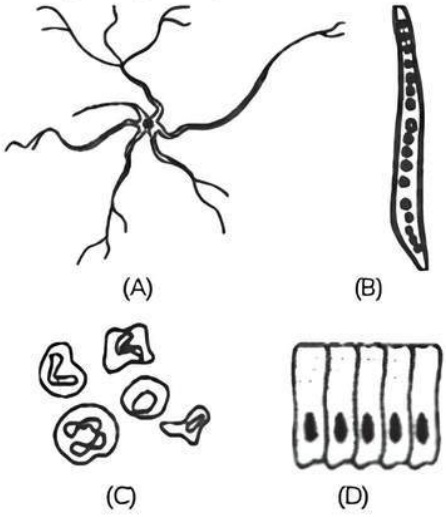
32. Differentiate between prokaryotes and eukaryotes.

[NCERT Exemplar]

Ans.

S. No.	Prokaryotes	Eukaryotes
(1)	Cells that lack a membrane-bound nucleus are called prokaryotes.	Cells that have a membrane-bound nucleus are called eukaryotes.
(2)	Genetic material is naked.	Genetic material is not naked.
(3)	Prokaryotic cells lack membrane-bound organelles	Membrane-bound organelles are present.
(4)	Their cell structure is unicellular.	Their cell structure is mostly multicellular; some unicellular.
(5)	They have a simple organisation.	They have a complex organisation.
(6)	**Examples:** *Mycoplasma*, cyanobacteria, etc.	**Examples:** Fungi, plant cells, protists, etc.

33. **Identify the given pictures:**



Ans. (A) Nerve cell (branched and long)
(B) Tracheid (elongated)
(C) White blood cells (amoeboid)
(D) Columnar epithelial cells (long and narrow)

34. **Gram staining is a common method used in laboratories. Discuss the types of bacteria on the basis of Gram staining.**

Ans. Based on Gram staining, bacteria are of two types–Gram-positive and Gram-negative.

Bacteria which retain the stain are called Gram-positive.

Bacteria which do not retain any stain are called Gram-negative bacteria.

Related Theory

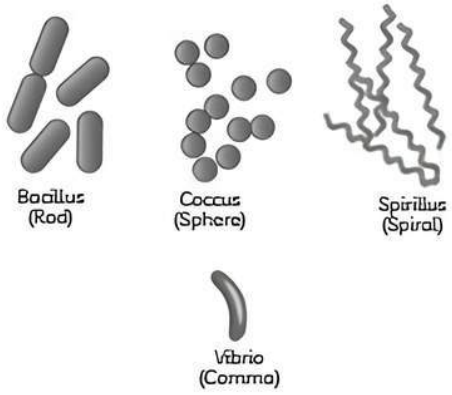
Gram staining is the most important and most used differential technique used in microbiology. This test differentiates the bacteria into Gram-positive and Gram-negative bacteria, which helps in the classification and differentiation of microorganisms. Gram-positive bacteria have a thick peptidoglycan layer and no outer lipid membrane while Gram-negative bacteria have a thin peptidoglycan layer and an outer lipid membrane.

LONG ANSWER Type Questions (LA)

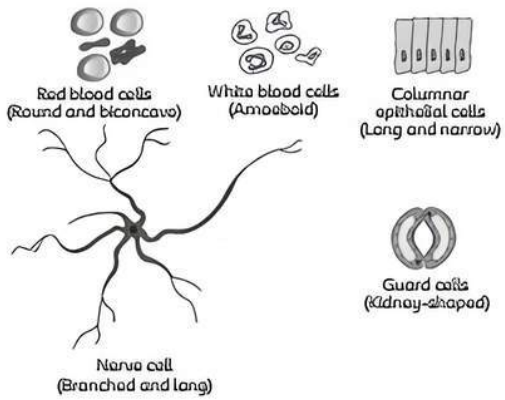
[**4** & **5** marks]

35. **Cells are of various shapes and sizes. Show this by drawing a few of them.**

Ans. Following are various types of bacterial cells on the basis of their shape:



Following are various types of cells found in living things with varying shapes and sizes:



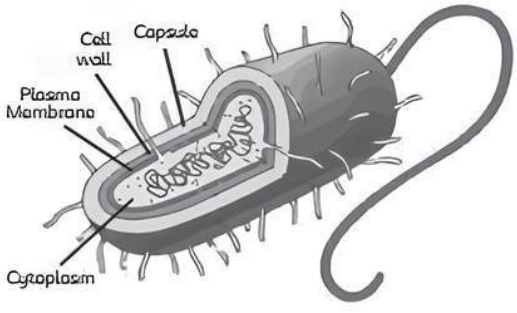
36. **Prokaryotes have a structure known as cell envelope. Explain.**

Ans. Bacterial cells have a complex cell envelope. It consists of three layers–the outermost glycocalyx, then cell wall and then plasma membrane. Together, they act as a single protective unit.

(1) **Glycocalyx:** It varies in composition and thickness among different organisms. It is the outermost covering of a bacterial cell. It could be a thin, filmy, loose sheath termed the slime layer in certain cases, or a thick, strong sheath called the capsule in others.

(2) **Cell wall:** Cell wall is a rigid solid covering which provides shape and structural support to the cell. It prevents the cell from bursting or collapsing.

(3) **Plasma membrane:** Plasma membrane is selectively permeable covering of the cytoplasm. Bacterial plasma membranes have the same structure as eukaryotes.



Cell envelope in prokaryotes

37. What structural and functional characteristics must a cell possess in order to be classified as a living cell? [NCERT Exemplar]

Ans. The cell membrane is the outer membrane of all cells. The nucleus is a compact membrane-bound structure found inside each cell. The chromosomes, which contain the genetic material, DNA, are housed in this nucleus. Eukaryotic cells have membrane-bound nuclei, whereas prokaryotic cells do not have a membrane-bound nucleus. A semi-fluid matrix termed cytoplasm fills the volume of both bacterial and eukaryotic cells. In both plant and animal cells, the cytoplasm is the primary site of cellular activity. It undergoes a series of chemical reactions in order to maintain the cell's 'living state.'

Eukaryotic cells have additional membranes besides the nucleus. Organelles such as the endoplasmic reticulum (ER), the Golgi complex, lysosomes, mitochondria, microbodies, and vacuoles are membrane-bound unique structures found in eukaryotic cells in addition to the nucleus. Such membrane-bound organelles are not found in prokaryotic cells. Ribosomes are non-membrane-bound organelles that can be found in both eukaryotic and prokaryotic cells.

EUKARYOTIC CELLS 2

TOPIC 1

STRUCTURE AND COMPONENTS OF EUKARYOTIC CELLS

Eukaryotic cells have a nucleus with a nuclear envelope and the cells also have locomotory and cytoskeletal structures. Chromosomes contain genetic material in eukaryotic cells. Plant and animal cells are different cell types as plant cells contain cell wall and plastids, a large central vacuole but these are absent in animal cells and animal cells have centrioles that are absent in plant cells. Let's have a look at cell organelles of eukaryotic cells.

Cell Membrane

In eukaryotic cells, the plasma membrane surrounds a cytoplasm filled with ribosomes and organelles. Organelles are structures that are themselves encased in membranes. Some organelles (nuclei, mitochondria and chloroplasts) are even surrounded by double membranes. All cellular membranes are composed of two layers of phospholipids embedded with proteins. All are selectively permeable (semi-permeable), allowing only certain substances to cross the membrane.

Biochemical investigations that were conducted later proved that plasma membranes also possess protein and carbohydrates. The ratio of protein and lipid varies in different cell types. The membranes of erythrocytes in human beings, for example, have 52 per cent protein and 40 per cent lipids.

The structure of plasma membrane as proved by various studies is:

(1) It is made up of lipids and proteins.

(2) Lipids-mainly phospholipids, arranged in a bilayer with polar heads of lipid molecules on the outer side and hydrophobic tails are inside. This arrangement protects the nonpolar tails from aqueous environment.

(3) Phospholipid membrane contains cholesterol and phosphoglycerides.

(4) Membrane proteins can be integral (buried partially or completely in the membrane) or peripheral (present on the surface).

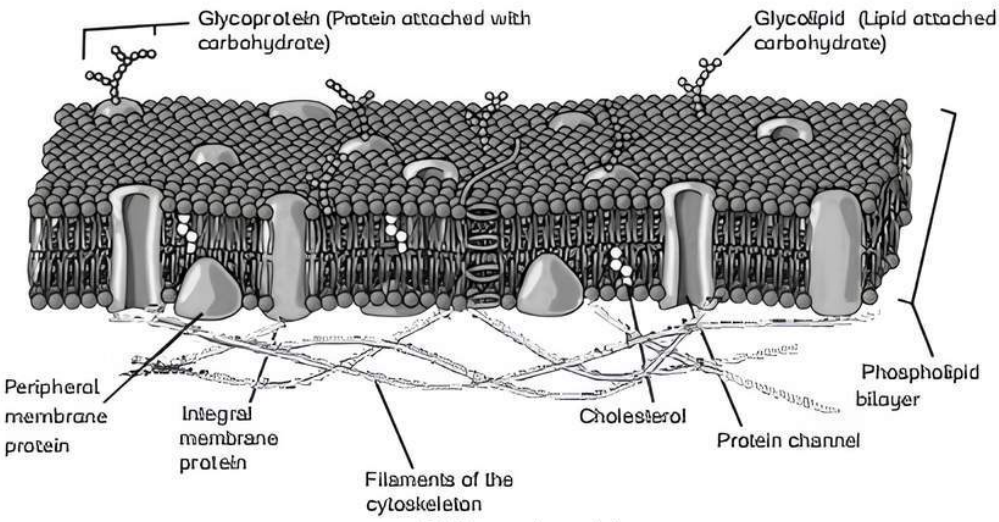
Fluid Mosaic Model

(1) It is the most recent model of a biomembrane given by Singer and Nicolson in the year 1972.

(2) According to this model, the membrane does not have a uniform deposition of lipids and proteins but is instead, a mosaic of two layers.

(3) The membrane in the fluid mosaic model is stated as quasi-fluid.

(4) The quasi-fluid nature of the biomembranes is shown by their properties of quick repair, ability to fuse, dynamic nature, contract and expand, cell growth and cell division, secretion, formation of intercellular junctions and endocytosis.



Fluid mosaic model

Functions of plasma membrane

(1) It transports molecules across it and is selectively permeable to some molecules.

(2) Plasma membrane protects the cell from injury.

(3) This membrane allows the flow of material and information between different organelles of the same cell as well as between one cell and another.

(4) As plasmodesmata or gap junctions, the membranes provide organic connections between adjacent cells.

(5) Membrane infolds are used for bulk intake of material by endocytosis.

(6) Secretory, excretory and waste products are thrown out by plasma membrane through exocytosis.

(7) **Transport in Membrane:** The transport of molecules occurs in the following ways:

(i) **Passive transport:** When molecules move across the membrane without the requirement of energy. It occurs as:

(a) **Simple diffusion:** Neutral solutes may move by simple diffusion from higher to lower concentration and water also moves in a similar fashion across the membrane.

(b) **Osmosis:** The movement of water from higher to lower concentration through a semi-permeable membrane by diffusion is called osmosis.

(ii) **Active transport:** It is difficult for polar molecules to move across the non-polar bilayer membrane so, they require a carrier protein. When ions are transported against their concentration gradient from lower to higher concentration then ATP is utilised (energy-dependent process) and it is called active transport. Example: Na^+/K^+ pump.

Important

➥ *The Components of the Plasma Membrane:*

Component	*Location*
Phospholipids	*Main component of the membrane.*
Cholesterol	*Tucked between the hydrophobic tails of the membrane phospholipid.*
Integral Proteins	*Embedded in the phospholipid bilayer, may or may not extend through both layers.*
Peripheral Protein	*On the inner or outer surface of the phospholipid bilayer, but not embedded in its hydrophobic core.*
Carbohydrates	*Attached to proteins or lipids on the extracellular side of the membrane. (forming glycoproteins and glycolipids).*

Cell Wall

(1) The plasma membrane of plants and fungi is protected by an additional covering called as cell wall.

(2) Cell wall is a non-living, solid structure which aids cell-to-cell communication, acts as a barrier against unwanted macromolecules, gives the cell structure, and protects the cell from damage and infection.

(3) Algae have cellulose, galactans, mannans, and minerals (calcium carbonate) in their cell walls, whereas plants have cellulose, pectins, hemicellulose, and proteins in their cell walls.

(4) The cell wall of immature plant cells is termed the main wall, and it is capable of expansion. As the cell matures, the primary wall becomes less capable of growth. The secondary wall is then created on the cell's inner side. The middle lamella, which is composed of calcium pectate, connects the adjacent cells. Furthermore, the plasmodesmata may traverse the cell which connects the cytoplasm of neighbouring cells.

Important

➥ *A cell wall can have three parts:*

1) Middle lamella: It is a thin, amorphous and cementing layer between two adjacent cells. Middle lamella is made up of calcium and magnesium pectate.

2) Primary Wall: It is the first layer produced inside the middle lamella. Primary wall consists of a number of microfibrils embedded in the amorphous gel-like matrix. In plants, Microfibrils made up of cellulose.

3) Secondary wall: It is laid inner to primary wall. It grows when the cell stop growing. Cellulose content is generally high than the primary wall.

Example 2.1: Case Based:

A cell wall is an exterior layer that surrounds certain cells and is located outside of the cell membrane. Additionally, every cell will have a cell membrane, demonstrating the distinction between the cell wall and the cell membrane. Furthermore, the cell wall offers structural support and strength to the cell, as well as determining the sorts of molecules entering and leaving the cell, as well as their concentrations. A double layer of proteins and lipids that surrounds a cell is referred to as the cell membrane, also known as the plasma membrane. It also aids in the isolation of the cytoplasm from the surrounding environment.

(A) The movement of water from higher to lower concentration is known as:

(a) Active transport (b) Downhill transport

(c) Osmosis (d) Facilitated diffusion

(B) What is the middle lamella made up of?

(a) Calcium pectate

(b) Calcium hypochlorite

(c) Sodium bicarbonate

(d) Magnesium hydroxide

(C) **Plants have a cell wall around their cells. What is the composition of this cell wall?**

(D) **Why is the fluidity of cell membranes important?**

(E) **Assertion (A): Carrier proteins are required by some molecules to move across the cell membrane.**

Reason (R): It is difficult for some polar molecules to travel across the non-polar membrane bilayer.

(a) **Both A and R are true and R is the correct explanation of A.**

(b) **Both A and R are true and R is not the correct explanation of A.**

(c) **A is true but R is false.**

(d) **A is false but R is true.**

Ans. **(A)** *(c) Osmosis*

Explanation: When water moves from a higher to a lower concentration without using any energy then the process is called osmosis. Although it is a kind of passive transport, but the correct term for water movement will be osmosis. Therefore, all the other options are incorrect.

(B) *(a) Calcium pectate*

Explanation: The middle lamella is composed of calcium or magnesium pectates and so. Thus, only option (a) will be correct.

(C) The cell wall is made up of cellulose, pectins, hemicellulose, and proteins in the plants.

(D) The fluidity and fluid nature of cell membrane is essential for several important functions performed by cell like secretion, cell growth, endocytosis, formation of intercellular junctions, etc.

(E) *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: The assertion statement is true as certain molecules do require carrier proteins to move across the membrane and this happens because the membrane is nonpolar and some molecules are polar and thus, cannot pass through it easily. So, the reason is also true and represents the correct explanation of assertion.

Endomembrane System

Endomembrane system is a group of some membrane-bound cell organelles which function in a close coordination with one another. These organelles are distinct with respect to structure and function but when they work together they form an endomembrane system. For example, the endoplasmic reticulum, Golgi complex, lysosomes, and vacuoles form an endomembrane system.

Endoplasmic Reticulum

(1) It is a network of tiny tube-like structures that are scattered in the cytoplasm, as revealed by studying eukaryotic cells with an electron microscope.

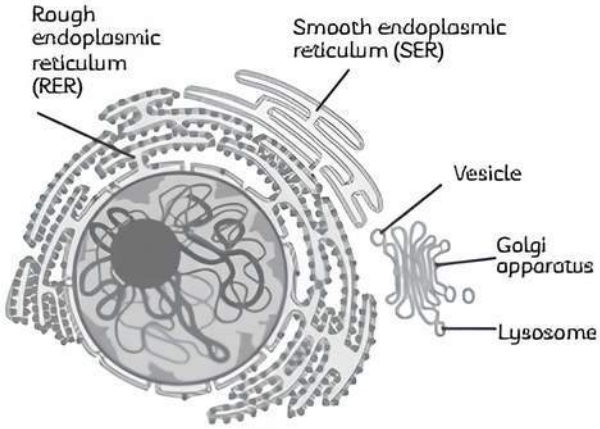
(2) The ER divides the intracellular space into two compartments:

(i) Luminal (inside ER): Means space within the ER.

(ii) Extra-luminal (rest of cytoplasm): Meaning in the cytoplasm.

(3) Sometimes ribosomes are attached on the surface of ER and then it is called the rough endoplasmic reticulum (RER). Without ribosomes, the ER appears smooth and is called the smooth endoplasmic reticulum (SER).

(4) RER is found in the cells that are actively involved in protein synthesis and secretion and it is continuous with the outer nuclear membrane. On the other hand, lipid-like steroidal hormones are produced by SER and it is a site of lipid synthesis in animal cells.



Endoplasmic reticulum

Important

➥ *RER provides a larger surface area to ribosome. Proteins and enzymes synthesised by ribosomes enter the channels of RER both for intercellular use as well as secretion.*

➥ *SER can develop from RER by discarding ribosomes.*

Golgi Apparatus

(1) Discovered by Camillo Golgi in 1898 and named Golgi bodies after him.

(2) They are densely stained reticular structures, found near the nucleus and consist of flat, disc-shaped sacs or cisternae of 0.5 to 1.0 μm diameter.

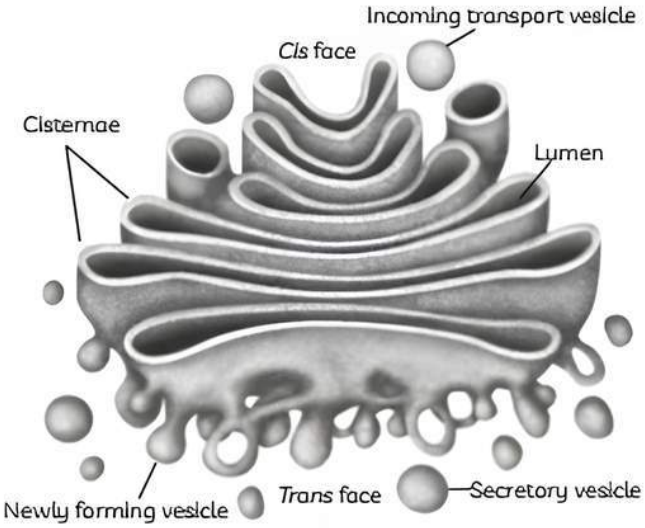
(3) Cisternae are stacked parallel to each other and a varied number of cisternae are present in a Golgi complex. The cisternae of the Golgi apparatus are concentrically arranged near the nucleus. They have a convex or (cis or forming face) and a concave (trans or maturing face), and although these faces are entirely different, they are interconnected.

(4) **Functions:**

(i) To wrap/package materials, which are either carried into the intracellular domain or secreted extracellularly.

(ii) The material to be packaged is released from the ER in the form of vesicles, from which it fuses with the Golgi's *cis* face and travels towards the *trans* face. This explains why the Golgi apparatus is so close to the ER.

(iii) Many proteins made in the ribosomes of endoplasmic reticulum are modified by the Golgi apparatus, which is an important synthetic site for glycoproteins and glycolipids.



Golgi apparatus

Lysosomes

(1) Membrane-bound vesicular structures, generated by packaging in the Golgi apparatus.

(2) Lysosomal vesicles are abundant in nearly all types of hydrolytic enzymes (hydrolases-lipases, proteases, carbohydrases) that are ideally active at an acidic pH. Carbohydrates, proteins, lipids, and nucleic acids can all be digested by the enzymes found in lysosomes.

(3) Lysosomes are called suicide bags of the cell because of the presence of large number of different digestive enzymes or acid hydrolases in them.

Vacuoles

(1) Membrane-bound spaces found in the cytoplasm containing water, sap, excretory products, and other materials not used by the cell.

(2) Vacuoles have a single membrane called tonoplast and in plant cells, they occupy 90 per cent of the volume of the cell.

(3) Tonoplast transports ions and other materials against their concentration gradients into the vacuole and this makes their concentration higher in the vacuole.

(4) In *Amoeba*, there is a contractile vacuole for excretion and in many cells, like protists, there are food vacuoles formed by the intake of food particles.

(5) Plants, fungi, algae, and other organisms store potent secondary metabolites like tannins or other biological pigments in their vacuoles to protect themselves against self-toxicity.

Mitochondria

(1) The number of mitochondria is variable in each cell depending on their physiological activity and they are not visible under the microscope unless stained specifically.

(2) Their shape and size are also variable but typically, they are sausage-shaped or cylindrical having a length of 1.0-4.1 μm and a diameter of 0.2-1.0 μm.

(3) Double membrane-bound structure with a lumen having two aqueous compartments, *i.e.* an outer compartment and an inner compartment divided by the outer membrane and the inner membrane.

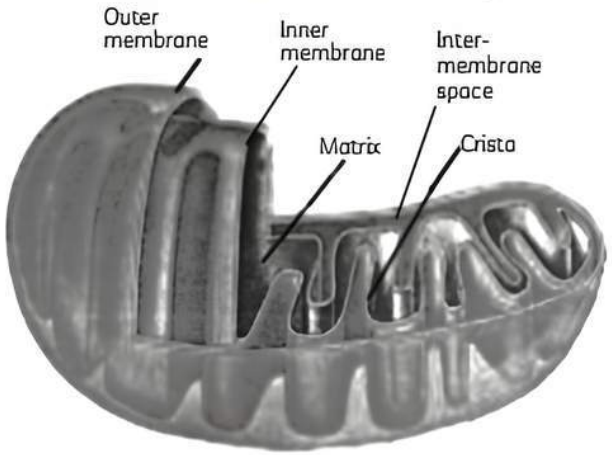
(4) The outer membrane forms the limiting boundary of the mitochondrion while the inner compartment has a dense homogeneous substance called the **matrix**.

(5) The inner membrane also forms many infoldings called cristae into the matrix and the cristae increase the surface area.

(6) The two membranes have their own enzymes for mitochondrial function and mitochondria are the site of aerobic respiration. They produce energy in the form of ATP so they are called the '**powerhouse of the cell**'.

(7) Mitochondrial matrix has ribosomes (70S), a single circular DNA, a few RNA molecules, and some components for protein synthesis.

(8) The division of mitochondria occurs by fission.



Mitochondria

Important

➥ *Mitochondria are not fully autonomous. Both their structure and functioning are partially controlled by nucleus of the cell and availability of material from cytoplasm. Mitochondria are believed to be symbionts in eukaryotic cells which become associated with them quite early in the evolution.*

Example 2.2: Case Based:

Organelles are specialised structures within the cells that come in a variety of shapes and sizes. Within a cell, organelles are also known as vesicles. And they serve a crucial purpose because we must compartmentalise all of the operations within the cell. As a result, a membrane must surround the systems within a cell that produce a separate product. Organelles are entirely membrane-bound. In other words, they also distinguish one function from another. The mitochondrion, for example, has the role of creating energy, whereas the lysosome has the function of breaking down large molecules into smaller molecules.

(A) Why the concentration is higher in vacuole than in the cytoplasm?

(a) Because the vacuole is covered by a single membrane.

(b) Because of the presence of concentration gradient.

(c) Because tonoplast facilitates the entry of ions against concentration gradient.

(d) None of the above.

(B) In the endomembrane system, which of the four organelles is present?

(a) Mitochondria, endoplasmic reticulum, Golgi apparatus, lysosomes

(b) Lysosomes, vacuoles, plastids, Golgi apparatus

(c) Ribosomes, Golgi apparatus, endoplasmic reticulum, vacuoles

(d) Endoplasmic reticulum, Golgi apparatus, lysosomes, vacuoles

(C) Why mitochondria is known as the powerhouse of the cell?

(D) What are the functions performed by the Golgi apparatus?

(E) Assertion (A): Eukaryotic cells have more DNA than prokaryotic cells.

Reason (R): Eukaryotic cells are genetically more complex than prokaryotic cells.

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true and R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true.

Ans. **(A)** *(c) Because tonoplast facilitates the entry of ions against concentration gradient.*

Explanation: Tonoplast facilitates the transport of a number of ions and other materials against concentration gradients. That is why the concentration is more in the vacuole than in the cytoplasm.

(B) *(d) Endoplasmic reticulum, Golgi apparatus, lysosomes, vacuoles*

Explanation: The endomembrane system includes Endoplasmic Reticulum (ER), Golgi apparatus, lysosomes, vacuoles whereas mitochondria, plastids and ribosomes are not part of the endomembrane system.

(C) The mitochondria are the site of aerobic respiration. They produce energy in the form of ATP so they are called the 'powerhouse of the cell'.

(D) The Golgi's function is to wrap materials, which are either carried into the intracellular domain or secreted extracellularly. The material to be packaged is released from the ER in the form of vesicles, from which it fuses with the Golgi's *cis* face and travels towards the *trans* face.

(E) *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: Most eukaryotes' DNA is bigger than that of prokaryotes. Complex eukaryotes are characterised by the presence of a huge quantity of DNA.

Plastids

Mostly found in plant cells and euglenoids and because of their large size they are easily observed under the microscope.

Plastids contain different types of pigments that give the plant certain colours. Based on the kind of pigment, they are classified as chloroplasts, chromoplasts and leucoplasts.

Chromoplast

Chromoplasts have fat-soluble carotenoid pigments like carotene and xanthophylls giving yellow, orange, or red colour to the part of the plant.

Leucoplasts

Leucoplasts are colourless plastids of varied shapes or sizes that store nutrients. Now leucoplasts can be further divided into three categories on the basis of stored substances in them. They are amyloplasts that store carbohydrates (*e.g.* potato); elaioplasts that store oils and fats and lastly, aleuroplasts that store proteins.

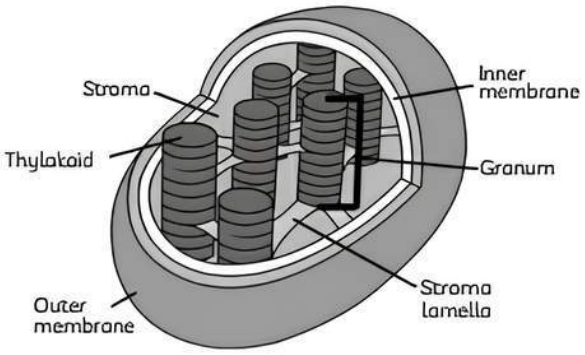
Chloroplast

Chloroplasts contain chlorophyll that traps light energy for photosynthesis. Chloroplasts of green plants are usually found in the mesophyll cells of leaves and they can be oval, spherical, lens-shaped, discoid, or ribbon-like with variable length or width.

Their number per cell also varies ranging from 1 per cell *(Chlamydomonas)* to 20–40 per cell in the mesophyll (green alga).

Structure of chloroplasts

They are double membrane-bound with the inner membrane being relatively less permeable of the two membranes. The space bound by the inner membrane is called stroma and the stroma has many flattened membranous sac-like structures called thylakoids. When thylakoids are organised in stacks like piles of coins, they are called grana (intergranular thylakoids), and additionally, there can be flat, membranous tubules that connect thylakoids of different grana. The thylakoids enclose a space called a lumen and chlorophyll pigments are present in the thylakoids. The stroma contains enzymes for the synthesis of carbohydrates and proteins and it also has double-stranded circular DNA and ribosome (70S) molecules. Ribosomes are 70S and they are smaller than the ribosomes found in the cytoplasm that are 80S.



Chloroplast

Example 2.3: Match the following

Column I	Column II
(A) Cristae	(i) Flat membranous sacs in stroma.
(B) Cisternae	(ii) Infoldings in mitochondria.
(C) Thylakoids	(iii) Disc-shaped sacs in Golgi apparatus.

[NCERT]

Ans. (A)–(ii) Infoldings in mitochondria
(B)–(iii) Disc-shaped sacs in Golgi apparatus
(C)–(i) Flat membranous sacs in stroma
Explanation: Cristae are found in the mitochondria and are infoldings of the inner membrane. Cisternae are found in the Golgi apparatus and are membrane-bound disc-shaped sacs. On the other hand, thylakoids are found in the stroma of chloroplasts.

Ribosomes

(1) Ribosomes were discovered by Robinson and Brown in plant cells in the year 1953 while George Palade discovered ribosomes in 1955 in animals and also termed the granular structure as ribosomes.

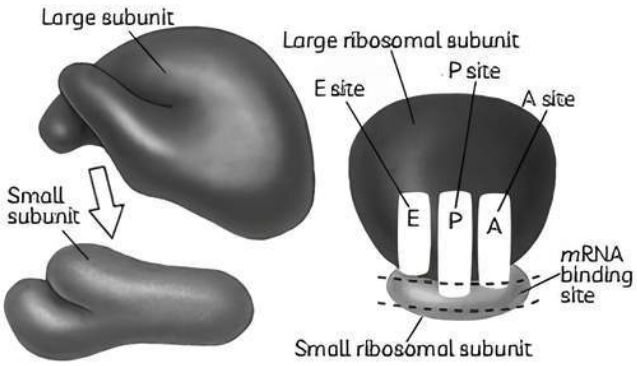
(2) Made up of ribonucleic acids (RNA) and proteins.

(3) Ribosomes lack a membrane and eukaryotic ribosomes are 80S while prokaryotic ribosomes are 70S.

(4) Ribosomes are popularly known as protein factories.

(5) Every ribosome has two subunits (larger and smaller) while the two subunits of 80S ribosomes are 60S and 40S, the two subunits of 70S ribosomes are 50S and 30S. Here, S is an indirect measure of density or size and it is the Svedberg's unit that stands for sedimentation coefficient.

70S Ribosomes	80S Ribosomes
A small 30S subunit and a large 50S subunit.	A large 60S subunit and a small 40S subunit.
They are found in both prokaryotes and eukaryotes.	They are found exclusively in eukaryotes.
Prokaryotes have a lot of ribosomes in their cytoplasm. It is also found in eukaryotic cell organelles like mitochondria and chloroplasts.	In eukaryotes, ribosomes are found freely inside the cytoplasm or they can be found attached to RER.
They are made in the cytoplasm of prokaryotes.	They are formed inside the nucleolus.



Ribosomes

Cytoskeleton

(1) Cytoskeleton is extremely minute, fibrous and tubular structure which forms the structural framework inside the cell.

(2) Cytoskeleton is only found in eukaryotic cells.

(3) It is a network of filamentous, proteinaceous structures present in the cytoplasm and it has many functions like motility, mechanical support, maintenance of cell shape, etc.

(4) They are of the following three types:

(i) **Microfilaments:** They are ultramicroscopic long, narrow, cylindrical rods and protein filaments which occur in eukaryotic plant and animal cells. They are made up of **Actin protein.**

(ii) **Intermediate filament:** They are almost solid unbranched filaments of about 10 nm thickness which are formed by a variety of proteins.

(iii) **Microtubules:** They are unbranched hollow submicroscopic tubules of protein tubulin which develop on a specific region.

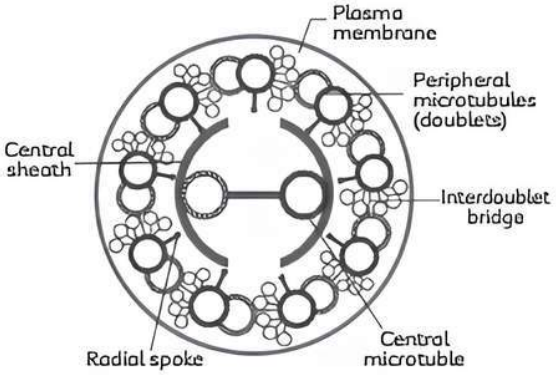
Cilia and Flagella

(1) Hair-like outgrowths of the cell membrane.

(2) Cilia (*sing*: cilium) are small structures that work like oars and cause the movement of the cell or surrounding fluid while flagella (*sing*: flagellum) are comparatively longer and cause cell movement.

(3) Prokaryotic and eukaryotic flagella are structurally different.

(4) Both cilia and flagella have a plasma membrane and their core is called an axoneme that contains several microtubules running parallel to the long axis. In the axoneme, there are nine pairs of doublets of radially arranged peripheral microtubules together with a pair of centrally located microtubules, and such an arrangement is called the 9+2 or 11 stranded. The central tubules are enclosed by a sheath and connected by bridges and they are connected by radial spokes to one of the tubules of each peripheral doublet. Also, the peripheral doublets are connected by linkers and there are a total of nine radial spokes. The centriole-like structures are called basal bodies which give rise to the cilium and flagellum.



Diagrammatic representation of internal structure of cilia and flagella

Important

➥ *Cilia and flagella help in cell movement and they are outgrowths of the cell membrane. Cilia and flagella create current to obtain their food in aquatic medium.*

Differences between Cilia and Flagella:

Cilia	Flagella
The number of cilia is higher in comparison (typically ranges in the thousands).	In comparison, the number of flagella is lower (usually ranges from 1 to 8).
They can be found in only eukaryotic cells.	Flagella are found in both eukaryotic and prokaryotic cells.
They are shorter in length than the flagella.	The flagella are comparatively longer than the cilia.
The cilia beating pattern is quite complex - Can move in a variety of ways.	Flagella has a circular, wave-like, or propeller-like beating pattern.

Centrosome and Centrioles

(1) The centrosome is an organelle with two cylindrical structures called centrioles that are surrounded by pericentriolar material.

(2) The centrosome's centrioles are organised in a cartwheel pattern, and both centrioles are perpendicular to each other. They are made up of nine tubulin protein peripheral fibrils, each of which is made up of three triplets. The adjacent triplets are interconnected, and radial spokes of protein connect the central part of the proximal region of the centriole to the tubules of the peripheral triplets. Hub refers to the centre proteinaceous portion.

(3) During cell division in animal cells, centrioles give rise to the spindle apparatus and serve as the foundation for cilia, flagella, and spindle fibres.

Nucleus

(1) Robert Brown first identified nucleus in 1831, and Flemming subsequently named it chromatin after staining the nucleus' components with basic dyes.

(2) Nucleus is a specialised double-membrane-bound protoplasmic body which contains all the genetic material for controlling cellular metabolism and transmission of information.

(3) Usually, there is one nucleus per cell but their number per cell is variable and some mature cells like erythrocytes (in mammals) and sieve tube cells (in vascular plants) even lack a nucleus.

(4) The nucleolus and chromatin are present in the nuclear matrix or nucleoplasm and the nucleoli are spherical structures. The nucleolus is not membrane-bound and their content is continuous with the nucleoplasm. Ribosomal RNA synthesis occurs in the nucleolus and in cells actively carrying out protein synthesis, there are larger and more numerous nucleoli.

Structure of nucleus

(1) It has elaborate and extensive nucleoprotein fibres termed as chromatin.

(2) It contains one or more spherical structures called nucleoli (*sing*: nucleolus).

(3) Nuclear envelope contains large number of pores or perforations. The nuclear envelope has two parallel membranes with a space between them termed perinuclear space, which forms a barrier between the cytoplasm and the content of the nucleus, as revealed by the electron microscope.

(4) The outer membrane is continuous with the endoplasmic reticulum and also has ribosomes on it and at a number of places, there are minute pores on the nuclear envelope formed by the fusion of its two membranes. The movement of RNA and protein molecules between the nucleus and cytoplasm take place through these nuclear pores.

During interphase, chromatin is a loose, indistinct network of fibres, but during cell division, the cell displays organised chromosomes in their place. In a single human cell, chromatin contains RNA, histone proteins, non-histone proteins, and DNA, which is dispersed throughout forty-six chromosomes and is approximately two metres long.

The centromere is the major constriction on chromosomes, while kinetochores, which are disc-shaped, are found on the sides.

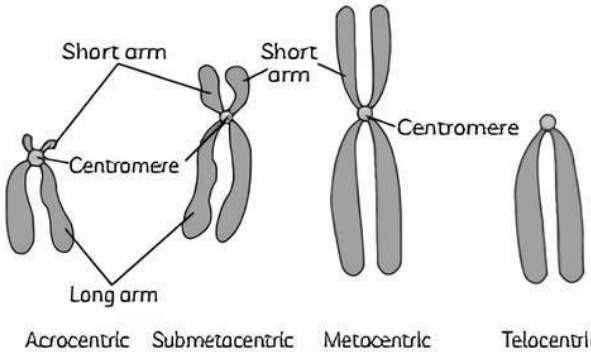
The centromere holds the chromosome's two chromatids, and chromosomes are classified into four categories based on where the centromere is located:

(1) Metacentric chromosomes: They have two equal chromosome arms formed by the middle centromere.

(2) Sub-metacentric chromosomes: They have one long and one short arm because the centromere is slightly moved away from the middle.

(3) Acrocentric chromosomes: The centromere is situated close to one end forming one very long arm and one extremely short arm.

(4) Telocentric chromosomes: There is a terminal centromere.



Types of chromosomes based on the position of centromere

Example 2.4: What are nuclear pores? State their function. [NCERT]

Ans. The nuclear envelope has two parallel membranes with a space between them termed as perinuclear space. There are minute pores on the nuclear envelope formed by the fusion of its two membranes. The movement of RNA and protein molecules between the nucleus and cytoplasm takes place through these nuclear pores.

Microbodies

They are minute vesicles that are membrane-bound containing various enzymes and they are found in both plant and animal cells.

Differences between Prokaryotic and Eukaryotic cell

S. No.	Prokaryotic cell	Eukaryotic cell
(1)	Cell size is usually small between (1.0 – 5.0 μm).	The cell is comparatively larger from (5 – 100 μm).
(2)	Cell wall possesses muramic acid if present.	Cell wall, if present, without muramic acid.
(3)	DNA is naked, that is, without histones.	Nuclear DNA is associated with histones.
(4)	DNA is circular.	Nuclear DNA is cellular but extra nuclear DNA is circular.
(5)	DNA lies freely in the cytoplasm. It is not associated with organelle.	Most of the cell DNA lies in the nucleus. A small quantity is also found in the cell organelles like mitochondria and plastids.
(6)	Protein synthesis occurs only in cytoplasm.	Protein synthesis takes place in cytoplasm, mitochondria and plastids.
(7)	Ribosomes are 70S types	Ribosomes are 80S type. 70S ribosomes. However, It occur in plastid and mitochondria.
(8)	Membrane-bound organelles like ER, mitochondria, Golgi apparatus, centrioles, lysosomes and other microbodies are absent.	Mitochondria, ER, Golgi apparatus, microbodies including lysosomes and centrioles are present in the cell of eukaryotic organisms.

OBJECTIVE Type Questions

[1 mark]

Multiple Choice Questions

1. A common characteristic feature of plant sieve tube cells and most of the mammalian erythrocytes is:

(a) Absence of mitochondria
(b) Presence of cell wall
(c) Presence of haemoglobin
(d) Absence of nucleus [NCERT Exemplar]

Ans. *(d) Absence of nucleus*

Explanation: The common characteristic of mammalian erythrocytes and sieve tube plant cells would be the absence of a nucleus.

Related Theory

Usually, there is one nucleus per cell but their number per cell is variable and some mature cells like erythrocytes (in mammals) and sieve tube cells (in vascular plants) even lack a nucleus.

2. Select one which is not true for ribosomes.

(a) Made of two subunits
(b) Form polysome
(c) May attach to mRNA
(d) Have no role in protein synthesis
[NCERT Exemplar]

Ans. *(d) Have no role in protein synthesis*

Explanation: Ribosomes are the site for protein synthesis thus option (d) is not true. Rest of the options are characteristic of ribosomes and are true statements.

3. Out of the given options, which cell organelle is present in cell-cytoplasm, mitochondria, RER and plastids?

(a) Lysosome **(b) Ribosome**
(c) Centriole **(d) Golgi Body [Diksha]**

Ans. *(b) Ribosome*

Explanation: It has been mentioned that ribosomes are present on the surface of rough endoplasmic reticulum and 70S ribosomes are found in the matrix of mitochondria. Also, there are cytoplasmic ribosomes of 80S as well and they are also found in the chloroplasts.

4. Choose the incorrect pair.

(a) Elaioplasts - store oils
(b) Amyloplasts - store carbohydrates
(c) Elaioplasts - store starch
(d) Aleuroplasts - store proteins

Ans. *(c) Elaioplasts - store starch*

Explanation: Elaioplasts stores fat and oils not starch. Starch is stored by amyloplasts.

5. What type of pigment are present in chromoplast?

(a) Carotenoid pigments
(b) Xanthophylls
(c) Carotene
(d) All of the above

Ans. *(d) All of the above*

Explanation: Based on the type of pigments plastids can be classified into chloroplasts, chromoplasts and leucoplasts.

In the chromoplasts, fat soluble carotenoid pigments like carotene, xanthophylls and others are present. This gives a yellow, orange or red colour to the plant parts. The leucoplasts are colourless plastids of varied shapes and sizes with stored nutrients.

6. Statement A: A plant cell does not swell up or burst if placed in a hypertonic solution.

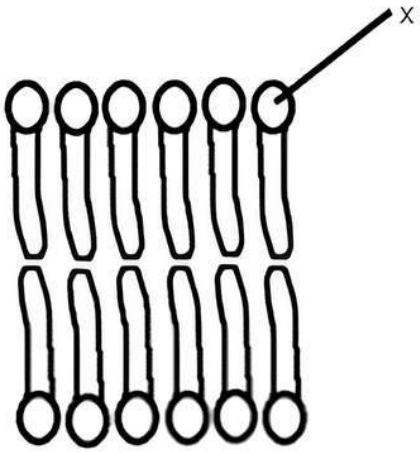
Statement B: Rigid cell wall does not let the plant cell expand.

(a) Both A and B are correct.
(b) Both A and B are incorrect.
(c) Only A is correct.
(d) Only B is correct.

Ans. *(b) Only B is correct.*

Explanation: A plant cell will absorb water in a hypoosmotic condition and become turgid. The turgor pressure of a cell is equal to and opposite to the wall pressure while the plasma membrane is still intact. A stiff cell wall encloses each plant cell. When a plant cell is submerged in a hypotonic solution, it begins to inflate and absorb water by osmosis, but the cell wall stops it from bursting. The plant cell is said to have hardened and swelled, or become turgid. As the pressure inside the cell increases, it eventually reaches the same level as the pressure outside. The turgor pressure, also known as liquid or hydrostatic pressure, limits further net water intake.

7. Identify the component marked as 'X' of the cell membrane.



(a) Hydrophilic phosphate head
(b) Hydrophobic phosphate tail
(c) Hydrophilic lipid tail
(d) Hydrophobic lipid head

Ans. *(a) Hydrophilic phosphate head*

Explanation: The cell membrane is a phospholipid bilayer in which the polar and hydrophilic phosphate head groups face outwards, while the non-polar and hydrophilic lipid tails face each other.

8. Statement A: A eukaryotic cell has no membrane-bound organelles in its cytoplasm.

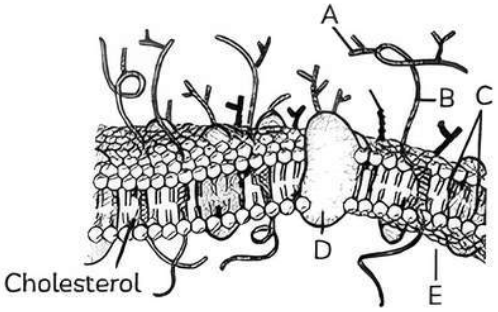
Statement B: Intracellular compartmentalisation keeps the various chemical reactions occurring in the cell isolated from one another.

(a) Both A and B are correct.
(b) Both A and B are incorrect.
(c) Only A is correct.
(d) Only B is correct.

Ans. *(b) Only B is correct.*

Explanation: Many membrane-bound organelles can be found in the cytoplasm of eukaryotic cells. The different chemical reactions taking place within the cell are kept apart from one another by this intracellular compartmentalisation.

9. The diagram represents plasma membrane.



Match the components marked as A, B, C, D and E in the diagram below from the list (I) to (VII).

(I) Sugar (II) Protein
(III) Lipid bilayer (IV) Integral protein
(V) Cytoplasm (VI) Cell wall
(VII) External protein

Codes:

(a) A – (I), B – (II), C – (III), D – (IV), E – (V)
(b) A – (II), B – (I), C – (III), D – (IV), E – (V)
(c) A – (I), B – (II), C – (III), D – (IV), E – (VI)
(d) A – (I), B – (II), C – (III), D – (VII), E – (V)

Ans. *(a) A – (I), B – (II), C – (III), D – (IV), E – (V)*

Explanation: In the diagram, the components marked as A, B, C, D and E are (I) sugar, (II) protein, (III) lipid bilayer, (IV) integral proteins, and (V) cytoplasm respectively. The cell membrane is a two-dimensional liquid in which phospholipid and protein molecules diffuse easily.

10. Match the List–I with List–II.

List-I	List-II
(A) Metacentric	(i) Centromere situated close to the chromosome end forming one extremely short and one very long arms.
(B) Acrocentric	(ii) Centromere at the end terminal chromosome.
(C) Sub-metacentric	(iii) Centromere in the middle forming two equal arms of chromosomes.
(D) Telocentric	(iv) Centromere slightly away from the middle of chromosome forming one shorter arm and one longer arm.

Choose the correct answer from the options given below:

(a) A – (i), B – (iii), C – (ii), D – (iv)
(b) A – (ii), B – (iii), C – (iv), D – (i)
(c) A – (i), B – (ii), C – (iii), D – (iv)
(d) A – (iii), B – (i), C – (iv), D – (ii)

Ans. *(d) A – (iii), B – (i), C – (iv), D – (ii)*

Explanation: Metacentric chromosome—Centromere in the middle of chromosome.

Telocentric chromosome—Centromere at the terminal end of chromosome.

Acrocentric chromosome—Centromere slightly away from the middle of chromosome.

Sub-metacentric chromosome—Centromere at the end terminal chromosome.

11. Ribosomes are very important cell organelles and they are also called Palade granules.

Read the following statements, and choose the ones which are true for eukaryotic ribosomes.

(I) They are 80S ribosomes.

(II) They have a 50S and a 30S subunits.

(III) They are 70S ribosomes.

(IV) They have a 60S and a 40S subunits.

Codes:

(a) Only (I) **(b) (I) and (II)**

(c) (I) and (IV) **(d) (II) and (III)**

Ans. *(c) (I) and (IV)*

Explanation: The eukaryotic ribosomes are 80S and their two subunits are 60S and 40S.

Related Theory

Ribosomes do not possess a membrane and eukaryotic ribosomes are 80S while prokaryotic ribosomes are 70S. Every ribosome has two subunits (larger and smaller). The two subunits of 80S ribosomes are 60S and 40S and the two subunits of 70S ribosomes are 50S and 30S.

12. Which of the following is a function of the cell wall?

(a) Cell-to-cell interaction

(b) Synthesis of glycolipids

(c) Producing cellular energy

(d) Packaging of materials

Ans. *(a) Cell-to-cell interaction*

Explanation: The cell wall has many functions like protection from damage and infection, providing shape to cells, and also helping in cell-to-cell interaction. Other options are incorrect as synthesis of glycolipids and packaging of materials are the functions performed by golgi apparatus. Mitochondria produce cellular energy in the form of ATP.

Caution

Students usually don't know that the cell wall has many functions and they include cell-to-cell communication, forming a barrier against unwanted macromolecules, giving the cell structure, and protecting it from damage and infection.

13. Ribosomes that function as a micro-machine for protein synthesis were discovered by which scientist?

(a) Karl von Baer **(b) Robert Brown**

(c) Robert Hooke **(d) George Palade**

Ans. *(d) George Palade*

Explanation: George Palade discovered ribosomes that looked like dense particles under the electron microscope.

Assertion-Reason (A-R)

Given below are two statements labelled as Assertion (A) and Reason (R). Select the most appropriate answer from the options given below:

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true and R is not the correct explanation of A.

(c) A is true but R is false.

(d) A is false but R is true.

14. Assertion (A): Lysosomal vesicles are found to be rich in many types of hydrolytic enzymes.

Reason (R): Lysosomes help in digesting proteins, lipids, and nucleic acids.

Ans. *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: Lysosomes have many hydrolytic enzymes like lipases, proteases, and nucleases. These enzymes can be used to digest lipids, proteins, and nucleic acid, respectively.

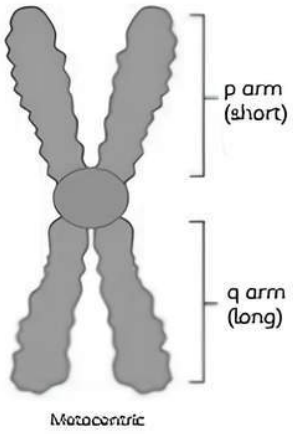
15. Assertion (A): The nucleolus is a membrane-bound structure and its content is continuous with the nucleoplasm.

Reason (R): The nucleolus is a site of active ribosomal RNA synthesis.

Ans. *(d) A is false but R is true.*

Explanation: Since the content of the nucleolus is continuous with the rest of the nucleoplasm, it is not a membrane-bound structure and so the assertion (A) is not correct. Reason (R) correctly states that the nucleolus is a site of ribosomal RNA synthesis.

16. A metacentric bisatellited microchromosome was detected in all metaphases from an amniotic culture performed because of maternal age. A wide-ranging survey of the literature failed to disclose any consistent anomaly associated with such a marker, but did reveal that the clinical picture of patients manifesting it could range from complete normality through mental retardation to a variety of deformities.



Metacentric

Assertion (A): The metacentric chromosomes have two equal chromosomal arms.

Reason (R): In metacentric chromosomes, the centromere holds the two chromatids in the middle of the chromosome.

Ans. *(a) Both A and R are true and R is the correct explanation of A.*

Explanation: It is true that metacentric chromosomes have two equal arms as the centromere is present in the middle of the chromosome.

CASE BASED Questions (CBQs)

[**4** & **5** marks]

Read the following passages and answer the questions that follow:

17. *Tarun studied about mitochondria in a magazine which he bought from a local shop. He concluded the following points about it. The number of mitochondria is variable in each cell depending on their physiological activity and they are not visible under the microscope unless stained specifically. Their shape and size are also variable but typically, they are sausage-shaped or cylindrical having a length of 1.0-4.1 μm and a diameter of 0.2-1.0 μm.*

(A) Which statement is incorrect about the mitochondria?

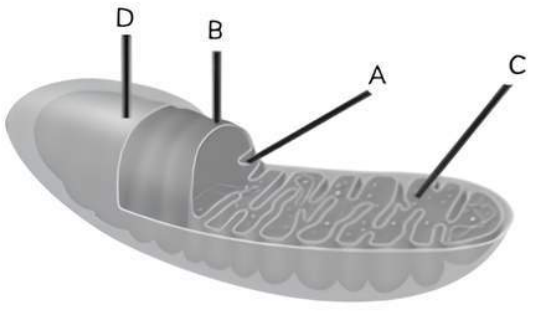
(a) They are the site for aerobic respiration.

(b) They have 80S ribosomes.

(c) They divide by fission.

(d) They produce cellular energy.

(B) Identify the parts of the mitochondrion correctly.



(a) A-Matrix, B-Inner membrane, C-Cristae, D-Outer membrane

(b) A-Matrix, B-Outer membrane, C-Inner membrane, D-Cristae

(c) A-Cristæ, B-Inner membrane, C-Matrix, D-Outer membrane

(d) A-Cristæ, B-Outer membrane, C-Inner membrane, D-Matrix

(C) Each cell organelle has a particular function, what is the function of the mitochondria?

(a) Digestion

(b) Packaging

(c) Respiration

(d) Protein synthesis

(D) The mitochondria are also known as:

(a) cell's gatekeeper

(b) cell's powerhouse

(c) cell's garbage man

(d) nucleus's assistant

(E) How do the mitochondria divide?

(a) Fission **(b) Budding**

(c) Fragmentation **(d) Parthenogenesis**

Ans. (A) *(b) They have 80S ribosomes.*

Explanation: As mitochondria have 70S ribosomes, option (b) is incorrect as it states that mitochondria have 80S ribosomes. Rest all other statements are correct for mitochondria.

(B) *(a) A-Matrix, B-Inner membrane, C-Cristae, D-Outer membrane*

(C) *(c) Respiration*

Explanation: The mitochondria are the site of aerobic respiration and they produce cellular energy, so only option (c) is the correct one. Mitochondria do not help with digestion, packaging or protein synthesis. Lysosomes help in digestion as they contain a variety of hydrolytic enzymes. Golgi bodies help in packaging.

They are also known as the packaging and dispatching units of a cell. Ribosomes help in protein synthesis.

(D) *(b) cell's powerhouse*

Explanation: Mitochondria are known as the powerhouse of the cell because it helps in the production of energy in the form of ATP. It is responsible for powering most cellular processes in living organisms.

(E) *(a) Fission*

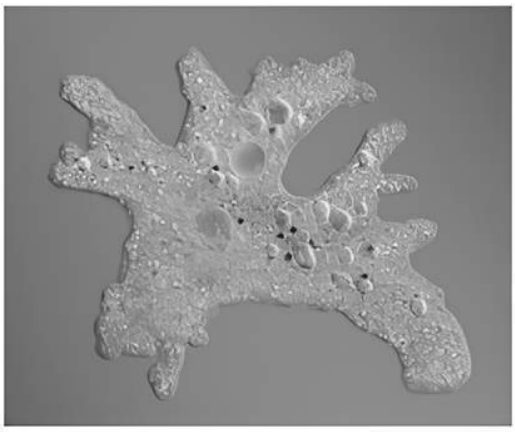
Explanation: Mitochondria divide by fission and that makes option (a) correct. The rest of the options are not correct for mitochondria.

18. *There is a contractile vacuole for excretion in Amoeba, and food vacuoles are created by the intake of food particles in numerous cells, such as protists. Vacuoles have a single membrane called tonoplast and take up 90% of the volume in plant cells.*

(A) Describe the functions of vacuoles.

(B) Name a secondary metabolite stored in plant vacuoles.

(C) The vacuole occupies a lot of space in the plant cell and is an essential organelle. What does it contain?



Ans. (A) The functions of vacuoles vary greatly according to the type of cells in which they are present. The main functions of vacuoles are:

(1) Maintains the internal hydrostatic pressure or turgor within the cell.

(2) Containing water in plant cells

(3) Maintaining an acidic internal pH.

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

(B) Tannins are secondary metabolites stored in plant vacuoles.

(C) The vacuole can have water, sap, excretory products, and several other materials that are not used by the cell.

VERY SHORT ANSWER Type Questions (VSA)

[1 mark]

19. Give the location of chloroplasts in green plants.

Ans. The chloroplasts are found in the mesophyll cells of leaves.

20. The middle lamella which functions as a cementing substance in adjacent cells is made up of which substance?

Ans. The middle lamella is mainly made up of calcium pectate.

21. What is the percentage of proteins and lipids in the human RBCs?

Ans. The erythrocytes have approximately 40 per cent lipids and 52 per cent proteins.

22. What is the significance of vacuole in a plant cell?

Ans. Vacuoles are important for excretion, food storage, and also for cell protection.

SHORT ANSWER Type-I Questions (SA-I)

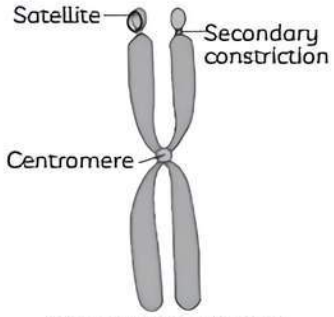
[2 marks]

23. Discuss briefly the role of nucleolus in the cells actively involved in protein synthesis.

Ans. Ribosomes are involved in protein synthesis and nucleolus helps in active ribosomal RNA synthesis and so a larger number of nucleoli are present in those cells that are carrying out protein synthesis.

24. Draw a well-labelled diagram of a chromosome which shows satellite and secondary constriction. Also write the type of chromosome. **[Diksha]**

Ans.



Chromosome showing satellite region

The chromosome shown is a metacentric chromosome.

25. Why does the Golgi apparatus remain in close association with the endoplasmic reticulum?

Ans. Golgi apparatus performs the function of packaging materials and delivering them. Now the materials that are to be packaged by them are released from the ER or endoplasmic reticulum in the form of vesicles. They fuse with the *cis* face of the Golgi apparatus and move towards the maturing face and that is why they remain in close association with the ER.

26. Cilia and flagella play an important in cell functioning. How?

Ans. Cilia work like oars and they are small structures that cause the movement of the cell or the surrounding fluid.

Flagella are longer than the cilia and their primary function is cell movement.

Related Theory

Movement is the major function of cilia and flagella. Many microscopic unicellular and multicellular species use them to travel from one location to another. Many of these species live in aquatic environments and are driven along by the beating of their cilia or the whip-like movement of their flagella.

27. Endoplasmic Reticulum is of two types. Differentiate between these two.

Ans. The two types are:

(1) Rough Endoplasmic Reticulum (REP)

(2) Smooth Endoplasmic Reticulum (SEP)

Rough Endoplasmic Reticulum (RER)	Smooth Endoplasmic Reticulum (SER)
Endoplasmic reticulum with ribosomes on their surface appear rough and they are called the rough endoplasmic reticulum.	Endoplasmic reticulum that does not have ribosomes on their surface appear smooth and they are called smooth endoplasmic reticulum.
They are continuous with the outer nuclear membrane and are found in cells actively involved in protein synthesis and secretion.	It is the site of lipid synthesis and in animal cells, lipid-like steroidal hormones are produced in the SER.

28. What do you understand by the endomembrane system of cells?

Name any two cell organelles which are not considered as part of the endomembrane system. [Diksha]

Ans. Functions of many membranous cell organelles of the cell are coordinated to each other. These cell organelles are considered together as an endomembrane system of cells. This system includes ER, Golgi complex, lysosomes and vacuoles.

Mitochondria, chloroplast, etc., are not considered as part of the endomembrane system.

29. Differentiate between the electron microscopic structure of cilia/flagella and centriole. [Delhi Gov. QB 2022]

Ans.

Flagella/Chilia	Centriole
Possess (9 + 2) pattern of axoneme.	Possess (9 + 2) pattern.
Each tubule is a doublet.	Each tubule is a triplet.

SHORT ANSWER Type-II Questions (SA-II)

[3 marks]

30. A student is given two samples 'X' and 'Y'. Sample 'X' contain ER and nucleus. It belongs to eukaryotic cells, where sample 'Y' belongs to Prokaryote cells. Explain why the sample having ER and nucleus belonged to eukaryotic cells and not prokaryotic cells.

Ans. The samples belong to eukaryotic cells because an eukaryotic cell is a type of cell which has enclosed membrane-bound organelles and a nucleus. and both the mitochondria and chloroplast are membrane bound organelles.

Whereas prokaryotic cells are morphologically the most primitive cells and they don't have a membrane-bound nucleus and organelles. Prokaryotic cells are generally smaller in size and multiply more rapidly than the eukaryotic cells.

31. How are chromosomes classified based on the position of centromere?

Ans. Firstly, there are metacentric chromosomes with a middle centromere that form two equal chromosomal arms. Secondly, there are sub-metacentric chromosomes where the centromere is slightly shifted from the middle forming one longer arm and one shorter arm. Thirdly, there are acrocentric chromosomes that have centromeres near the end forming one very short arm and another very long arm. Finally, in telocentric chromosomes, centromere is terminal and situated on one end.

32. Briefly describe the ultrastructure of the Golgi apparatus.

Ans. The Golgi has flat, disc-shaped sacs called cisternae that are stacked parallel to each other. The cisternae can be variable in number and they are concentrically arranged near the nucleus. Close to the nucleus, Golgi have a convex *cis* or forming face and on moving further there is the *trans* or maturing face. The forming and maturing faces or the *cis* and *trans* faces are different but interconnected.

33. A cell can have both cell membrane and cell wall. Differentiate between a cell membrane and cell wall.

Ans.

Cell membrane	Cell wall
It is a living structure and is made up of lipids and proteins.	It is a non-living structure made up of cellulose, galatians, or mannans.
It is found in animal cells like the erythrocytes of human beings.	It is the outer covering of the plasma membrane and can be found in plant cells or fungal cells.
It is important for cellular growth, forming intercellular junctions, secretion, cell division, etc.	It helps in cell-to-cell interaction and protects the cell from mechanical damage and infection.
This membrane is selectively permeable and thus, helps in the transport of only certain molecules.	The cell wall is freely permeable to most molecules.

(Any three)

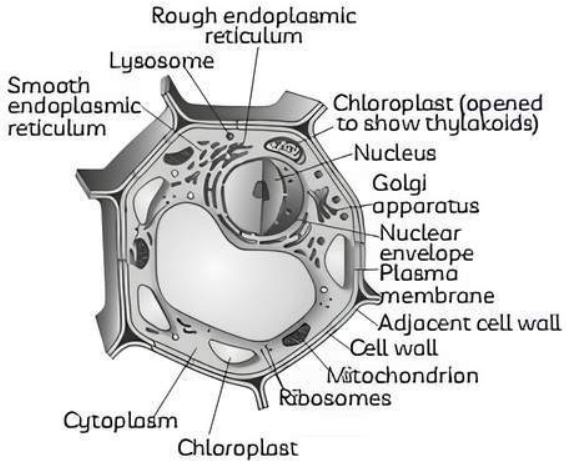
LONG ANSWER Type Questions (LA)

[**4** & **5** marks]

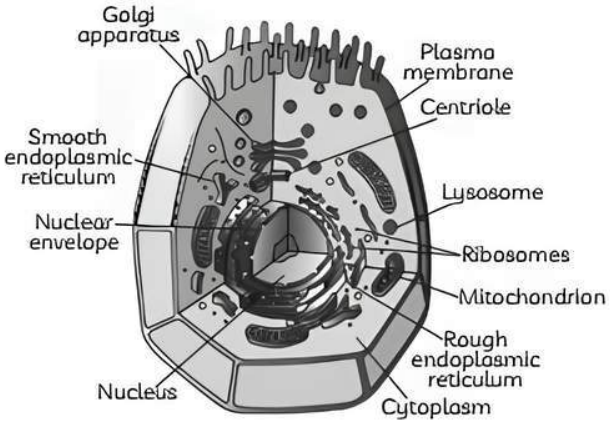
34. Differentiate between the Plant cell and Animal cell. Also, draw the diagram of each one of them.

Ans. The differences between plant cell and animal cell are listed below:

Characteristics	Plant Cell	Animal Cell
Cell Wall	A plant cell is surrounded by a rigid cell wall.	An animal cell does not have a cell wall.
Vacuole	Presence of a large vacuole is seen in plant cells.	There are very small vacuoles as compared to plant cells are seen in animal cells.
Mitochondria	Present but fewer in number.	Present and are numerous.
Plastids	Plant cells have plastids.	Animal cells do not have plastids.
Centrosomes	Centrosomes are absent in plant cells.	Animal cells have centrosomes.
Cilia	Plant cells do not have cilia.	Animal cells have cilia.
Lysosomes	Lysosomes are very rare in plant cells.	Animal cells have lysosomes.



Plant cell



Animal cell

35. Make a quick list of the components found within the inner chloroplast membrane.

Ans. (1) The space-bound by the inner membrane is called stroma and the stroma has many flattened membranous sacs called thylakoids.

(2) When thylakoids are organised in stacks like piles of coins, they are called grana (intergranular thylakoids) and additionally, there can be flat, membranous tubules that connect thylakoids of different grana.

(3) The thylakoids enclose a space called a lumen and chlorophyll pigments are present in the thylakoids.

(4) The stroma contains enzymes for the synthesis of carbohydrates and proteins and it also has double-stranded circular DNA and ribosome (70S) molecules.

(5) Ribosomes are 70S and they are smaller than the ribosomes found in the cytoplasm that are 80S.

36. Centrosome and Centrioles are two structural components of a cell. Describe the structural organisation.

Ans. The centrosome is an organelle with two cylindrical structures called centrioles that are surrounded by pericentriolar material.

The centrosome's centrioles are organised in a cartwheel pattern, and both centrioles are perpendicular to each other.

They are made up of nine tubulin protein peripheral fibrils, each of which is made up of three triplets.

The adjacent triplets are interconnected, and radial spikes composed of protein connect the central part of the proximal region of the centriole to the tubules of the peripheral triplets.

Hub refers to the centre proteinaceous portion.

During cell division in animal cells, centrioles give rise to the spindle apparatus and serve as the foundation for cilia, flagella, and spindle fibres.