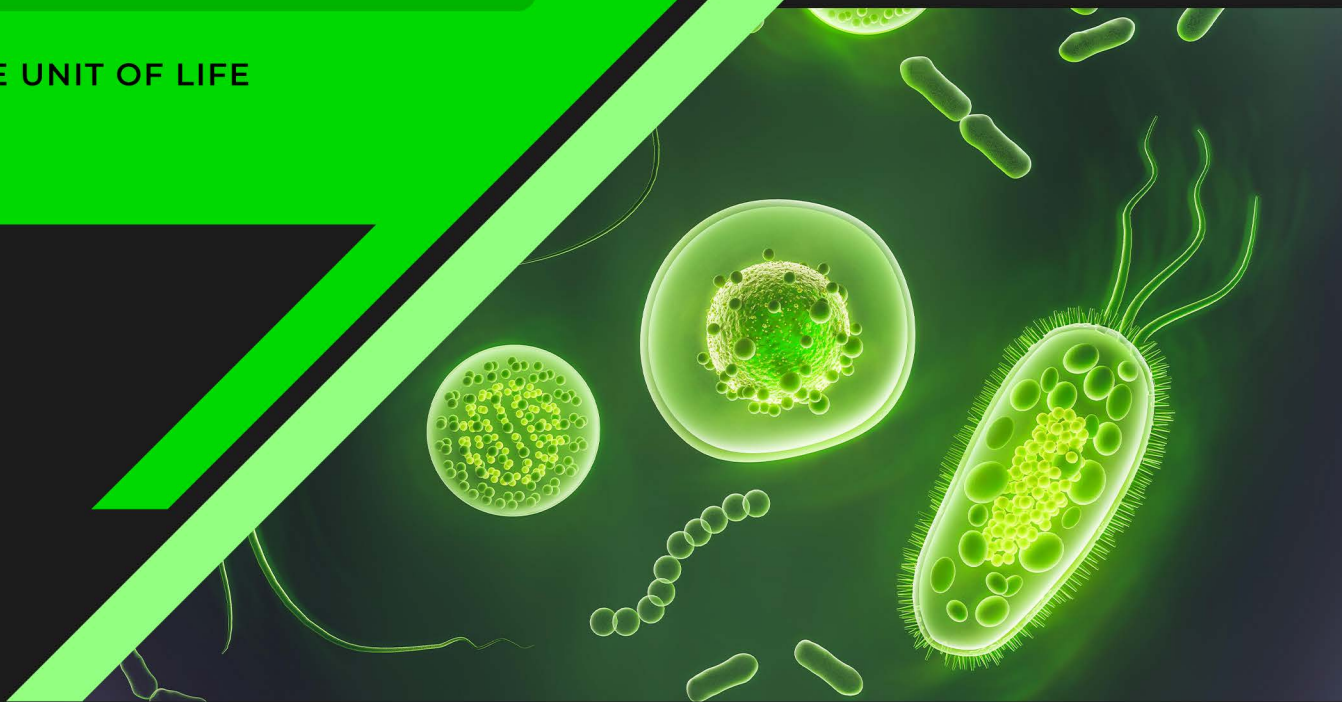


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BIOLOGY

CLASS XI + XII

CELL : THE UNIT OF LIFE



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Cell: The Unit of Life

INTRODUCTION

- The cell is a fundamental structural and functional unit of living organisms, just as the atom is the fundamental unit in chemical structures.
- Living organisms are distinct in form, structure, behaviour, heredity, and development. Its uniqueness is due to its specific organization at the molecular, cellular, and higher levels. Life is only expressed through cells, and it is autonomous having all genetic information. Thus, physiology and function of an organism is governed by the sum total of activities and interactions of its constituent cells.

WHAT IS A CELL?

- All living organisms are made up of basic unit structure called cell. An organism consists of one or more cells. Accordingly, there are two types of organisms: (i) Unicellular organisms, e.g., amoeba, diatoms, etc. (ii) Multicellular organisms, e.g., plants, animals, etc.
- Unicellular organisms are capable of independent existence and performing the essential functions of life. Anything less than a complete structure of a cell does not ensure independent living. Hence, cell is the fundamental structural and functional unit of all living organisms.
- **Robert Hooke** (in 1665) studied and discovered the cell from a thin slice of cork, but that was the “dead cell.” It had a honey comb structure with a number of compartments, which were named cell(L. *cella* – compartments). The term “cell” was coined by him. He published his findings in the form of book *Micrographia*.
- **Anton von Leeuwenhoek** was the first person who observed few living cells capable of moving, such as bacteria, protozoa, spermatozoa, and red blood corpuscles under his own-designed microscope.
- **Robert Brown** discovered the nucleus of a cell. The invention of the microscope and its improvement leading to the electron microscope revealed all the structural details of the cell.

CELL THEORY

- In 1838, **Matthias Schleiden**, a German botanist, examined a large number of plants and observed that all plants are composed of different kinds of cells that form the tissues of the plant.
- In 1839, **Theodore Schwann**, a German Zoologist, studied different types of animal cells and reported that cells had a thin outer layer, which is today known as the “plasma membrane.” He also concluded, based on his studies on plant tissues, that the presence of cell wall is a unique character of the plant cells. Schwann proposed the hypothesis that the bodies of animals and plants are composed of cells and products of cells.
- Schleiden and Schwann together formulated the cell theory. This theory, however, did not explain as to how new cells were formed.
- **Rudolf Virchow** (1855) first explained that cells divide, and new cells are formed from preexisting cells (*omnis cellula-e cellula*). He modified the hypothesis of Schleiden and Schwann to give the cell theory a final shape. Cell theory, as understood today, is:
 - (i) All living organisms are composed of cells and products of cells.
 - (ii) All cells arise from preexisting cells.

CONCEPT BOOSTER

Objections to the Cell Theory

- Independent metabolic machinery is absent in viruses. Viruses also do not obey theory of cell lineage of *omnis cellula-e cellula*.
- Nucleus is absent in prokaryotes; instead of this, nucleoid or genophore is present.
- There are living cells that do not possess nuclei, e.g., mammalian erythrocytes, sieve tube cells.

AN OVERVIEW OF CELL

- A typical plant cell (e.g., onion cell) has a distinct cell wall, forming its outer boundary followed by the cell membrane within it.
- The animal cells (e.g., human cheek cell) on the other hand, have an outer membrane as the delimiting structure of the cell. Thus, animal cell lacks cell wall as its outer boundary.
- In all the cells, a semi-fluid matrix called cytoplasm occupies the volume of the cell, which is limited by the plasma membrane. It is the main site of all the cellular reactions and activities occurring to keep the cell in its 'living state'.
- A dense membrane bound structure, called the nucleus, is present inside the cell.
- Nucleus contains chromosomes which further contain the genetic material, DNA.
- Cells that have membrane-bound nuclei are called **eukaryotic**, whereas cells that lack a membrane-bound nucleus are **prokaryotic**.
- In both prokaryotic and eukaryotic cells, a semifluid matrix called cytoplasm occupies the volume of the cell.
- The cytoplasm is the main arena of cellular activities in both the plant and animal cells. Various chemical reactions occur in it to keep the cell in the "living state."
- The eukaryotic cells have other membrane-bound organelles like the endoplasmic reticulum (ER), Golgi complex, lysosomes, mitochondria, microbodies. The prokaryotic cells lack such membrane-bound organelles.
- Ribosomes are non-membrane bound organelles found in all cells—both eukaryotic as well as prokaryotic cell. Within the cell, ribosomes are found not only in the cytoplasm but also within the two organelles—chloroplasts (in plants) and mitochondria and on rough ER.

3.	Ribosomes are 70S, lie free in cytoplasm or joined to cell membrane.	Ribosomes are 80S, lie free or bound to ER. and nuclear envelope. 70S ribosomes are also present.
4.	Nuclear material is not enclosed by nuclear envelope and lies directly in cytoplasm. It is called nucleoid.	Nuclear material is enclosed by nuclear envelope to form a nucleus distinct from cytoplasm.
5.	There is no nucleolus.	One or more nucleoli occurs within the nucleus.
6.	DNA is circular and without a protein coat.	Nuclear DNA is linear with a protein coat, extranuclear DNA is circular and naked.
7.	DNA occurs in the cytoplasm only.	DNA occurs in the nucleus as well as in mitochondria and chloroplasts.
8.	Occurs in bacteria, blue-green algae, mycoplasmas, rickettsiae and spirochaetes, etc.	Occurs in algae other than blue-green algae, protists, fungi, plants and animals.

- Cells differ greatly in size, shape and activities. For example, mycoplasmas, the smallest cells, are only 0.3 μm in length, while bacteria could be 3–5 μm .
- Egg of an ostrich is the largest isolated single cell.
- Human red blood cells are about 7.0 μm in diameter and their nerve cells are some of the longest cells.

TABLE: Differences between prokaryotic cell and eukaryotic cell

S. No.	Prokaryotic Cell	Eukaryotic Cell
1.	Cytoplasm lacks organelles (endoplasmic reticulum, mitochondria, Golgi apparatus, centrosome, microfilaments, microtubules, intermediate fibres microbodies), except ribosomes.	Cytoplasm contains organelles, viz, endoplasmic reticulum, mitochondria, Golgi apparatus, lysosomes, centrosome, microfilaments, microtubules, intermediate fibres microbodies besides ribosomes.
2.	A prokaryotic cell is a single membrane system	A eukaryotic cell is double membrane system.

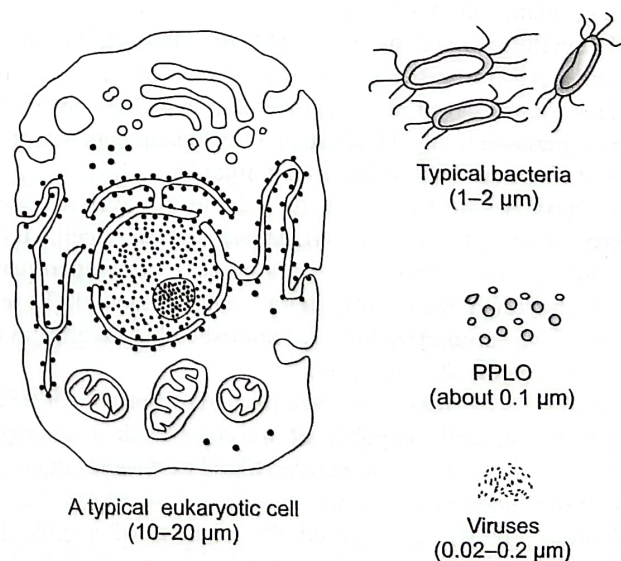


Diagram showing comparison of eukaryotic cell with other organisms

- Cells also vary greatly in their shape, i.e., they may be disc-like, polygonal, columnar, cuboid, thread like, or even irregular in shape, which varies with the function they perform.

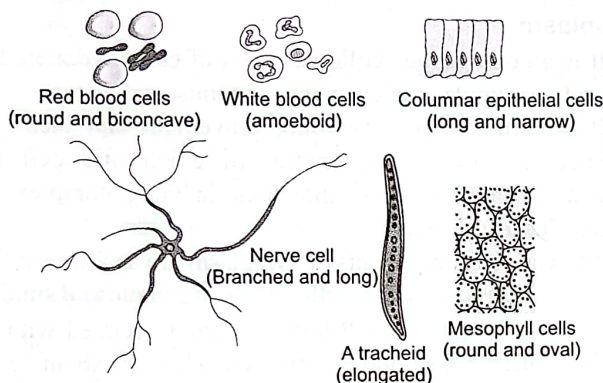


Diagram showing different shapes of the cells

Concept Application Exercise 1

- Some organisms are composed of a single cell and are called "A" organisms while other organisms are composed of many cells are called "B" organisms. (Fill in the blanks)
- Complete the analogy.
Matthias Schleiden : German botanist :: Theodore Schwann: _____
- Who proposed the "Cell theory"?
(1) Schleiden and Schwann
(2) Watson and Crick
(3) Mendel and Morgan
(4) Robert Hooke
- The main difference between plant and animal cell is:
(1) Animal cells lack cell wall
(2) Plant cell has no cell wall
(3) Animal cell has a rigid cell wall
(4) Plant cells lack cell membrane
- Arrange the following cells in descending order of their sizes.
(I) Mycoplasma (II) Ostrich egg
(III) Human RBC (IV) Bacteria
(1) (I), (II), (III), (IV)
(2) (I), (IV), (III), (II).
(3) (II), (III), (IV), (I)
(4) (IV), (III), (II), (I)
- Anything less than a complete structure of a cell does not ensure independent living.
True ☐ False ☐

PROKARYOTIC CELLS

- The prokaryotic cells are represented by bacteria, blue-green algae, mycoplasma or PPLO (pleuropneumonia-like organism), spirochete, and rickettsiae.
- Generally, prokaryotic cells are supposed to be far smaller than the eukaryotic cells.
- The prokaryotic cells, however, multiply more rapidly as compared to most of the eukaryotic cells.
- The prokaryotic cells have remarkable amount of variation in shape and size. There are four basic shapes of bacteria: **bacillus** (rod like), **coccus** (spherical), **vibrio** (comma shaped), and **spirillum** (spiral).
- The organisation of the prokaryotic cell is fundamentally similar even though prokaryotes exhibit a wide variety of shapes and functions.
- All prokaryotes have a cell wall surrounding the cell membrane except in mycoplasma.
- The fluid matrix filling the cell is the cytoplasm.
- There is no well-defined nucleus. The genetic material is basically naked, not enveloped by a nuclear membrane.
- In addition to the genomic DNA (the single chromosome/circular DNA), many bacteria have small circular DNA outside the genomic DNA. These smaller DNA are called plasmids.
- The plasmid DNA confers certain unique phenotypic characters to such bacteria. One such character is resistance to antibiotics. Plasmid DNA is used to monitor bacterial transformation with foreign DNA.
- Nuclear membrane is found in eukaryotes. No organelles, like the ones in eukaryotes, are found in prokaryotic cells except for ribosomes.
- Prokaryotes have something unique in the form of inclusions. A specialised differentiated form of cell membrane called mesosome is the characteristic of prokaryotes. They are essentially infoldings of cell membrane.

Cell Envelope and Its Modifications

- Most prokaryotic cells, particularly the bacterial cells, have a chemically complex cell envelope.
- The cell envelope consists of a tightly bound three-layered structure, i.e., the outermost **glycocalyx** followed by the **cell wall** and the **plasma membrane**.
- Although each layer of the envelope performs distinct functions, they act together as a single protective unit.

Glycocalyx

- It is the outermost layer comprising a coating of mucus or polysaccharides macromolecules, which protects the cells and also helps in adhesion.
- This layer differs in thickness and chemical composition in different bacteria.
- Some have a loose sheath called **slime layer**, which protects the cell from loss of water and nutrients.

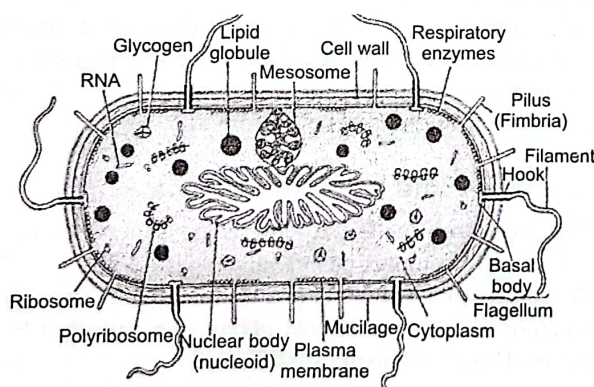
- Others may have a thick and tough covering known as **capsule**.
- The capsule and slime layer are made up of polysaccharides but may sometimes contain proteins also.
- The capsule is responsible for giving gummy and sticky character to the cell. It allows bacterium to hide from host's immune system.

Cell Wall

- It is present outside the cell membrane and is a rigid structure.
- All prokaryotes have a cell wall surrounding the cell membrane, except in mycoplasma.
- It determines the shape of the cell and provides a strong structural support to prevent the bacterium from bursting or collapsing.
- This layer is rigid due to a special macromolecule called **peptidoglycan** (murein or mucopeptide).
- A number of antibiotics (e.g., penicillin) inhibits cross-linking of peptidoglycan strands. Therefore, cells undergo lysis in the presence of these antibiotics.
- **Gram staining** (developed by Christian Gram) is a special technique, which is used to classify bacteria into two groups, viz. Gram-positive and Gram-negative bacteria. Those bacteria that take up the Gram stain are Gram positive and the others that do not are called Gram negative bacteria.

Plasma Membrane

- It is selectively permeable in nature and interacts with the outside world. This membrane is similar structurally to that of the eukaryotes.



Cell structure under electron microscope

- The cell membrane gets invaginated and folded to form structure called **mesosome**. These extensions are in the form of vesicles, tubules, and lamellae.
- They help in the cell wall formation, DNA replication, and distribution to daughter cells.
- They also help in respiration, secretion process, and to increase the surface area of the plasma membrane and enzymatic content.
- Mesosome is found in Gram-positive bacteria.

- In some photosynthetic prokaryotes like cyanobacteria and purple bacteria, there are other membranous extensions into the cytoplasm called **chromatophores**, which contain pigments.

Cytoplasm

- It is a homogenous colloidal mass of carbohydrates, fats, proteins, lipids, nucleic acids, minerals, and water.
- It does not show streaming movement and lacks sap vacuoles. Typical organelles of eukaryotic cell like endoplasmic reticulum, mitochondria, Golgi complex, and plastids are absent.
- The various components of cytoplasm are as follows:
 - (i) Ribosomes (organelle within organelle and smallest cell organelle):** Ribosomes are associated with the plasma membrane of the cell. They are about 15 nm by 20 nm in size and are made of two subunits - 50S and 30S units which when present together form 70S prokaryotic ribosomes. Ribosomes are the site of protein synthesis. Cytoplasmic ribosomes synthesize proteins, which remain within cells, but the ribosomes on the plasma membrane make proteins that are transported out. Several ribosomes may attach to a single mRNA and form a chain called polyribosomes or polysome. The ribosomes of a polysome translate the mRNA into proteins.
 - (ii) Inclusion bodies:** Reserve material in prokaryotic cells are stored in the cytoplasm in the form of inclusion bodies. These are not bound by any membrane system and lie free in the cytoplasm, e.g., phosphate granules, cyanophycan granules and glycogen granules. Gas vacuoles are found in blue green and purple and green photosynthetic bacteria.

Flagella

- Bacterial cells may be motile or nonmotile. If motile, they have thin, filamentous extensions from their cell wall called flagella. Bacteria show a range in the number and arrangement of flagella.
- Bacterial flagellum is composed of three parts—**filament**, **hook**, and **basal body**. The filament is the longest portion and extends from the cell surface to the outside.

Pili

- These are elongated, tubular, filamentous appendages projecting from the walls of some Gram-negative bacteria. These are thinner and shorter than the flagella. They are 1–4 in number.
- They are made up of specific proteins called pilin.
- Pili help in the attachment of the bacterial cells during conjugation.

Fimbriae

- They are small, bristle-like fibers, which develop from the surface of bacterial cells. They are quite numerous (300–400 cell). In some bacteria, they are known to help attach the bacteria to rocks in streams and also to the host tissues.

Concept Application Exercise 2

- The prokaryotic cells are represented by
 - (1) Bacteria, fungi, blue-green algae, mycoplasma and PPLO
 - (2) Bacteria, blue-green algae, mycoplasma but not PPLO
 - (3) Bacteria, blue-green algae, mycoplasma and PPLO
 - (4) Bacteria, cyanobacteria, protozoans and PPLO
- The four basic shapes of bacteria are __, __, __ and __. (Fill in the blanks)
- Give the full form of PPLO.
- The structures that help some bacteria to attach to rocks in streams and also to the host tissues are
 - (1) Pili and fimbriae
 - (2) Flagella and fimbriae
 - (3) Flagella and pili
 - (4) Pili, fimbriae and flagella
- In addition to the genomic DNA, many bacteria have large circular RNA outside the genomic DNA, called plasmids.
True ☐ False ☐
- Which of the following is not an inclusion body found in prokaryotes?
 - (1) Phosphate granules
 - (2) Cyanophycean granules
 - (3) Glycogen granules
 - (4) Starch granules

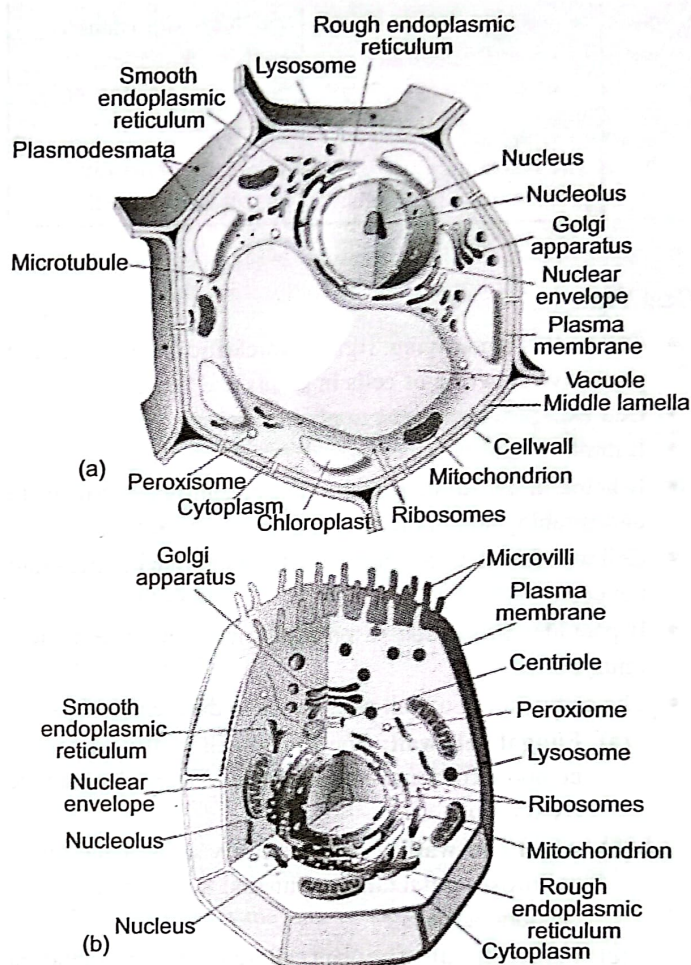


Diagram showing: (a) Plant cell, (b) Animal cell

EUKARYOTIC CELL

- The eukaryotes include all the protists, plants, animals, and fungi.
- In eukaryotic cells, there is an extensive compartmentalization of cytoplasm through the presence of membrane-bound cell organelles such as mitochondrion, lysosomes, dictyosomes, chloroplasts, endoplasmic reticulum, etc., which perform different functions.
- Eukaryotic cells possess an organized nucleus with a nuclear envelope.
- In addition, eukaryotic cells have a variety of complex locomotory and cytoskeletal structures. Their genetic material is organized into chromosomes.
- All eukaryotic cells are not identical. Plant and animal cells are different, as the former possess cell walls, plastids, and a large central vacuole, which are absent in animal cells.
- On the other hand, animal cells have centrioles, which are absent in almost all plant cells.

TABLE: Differences between animal cell and plant cell

S. No.	Animal Cell	Plant Cell
1.	Cell wall is absent in all animal cells. Cells are covered by a thin flexible living cell membrane.	Cells are covered by thick rigid, cellulosic cell wall in addition to cell membrane
2.	Animal cell have centrioles and centrosome in their cytoplasm	Centrioles and centrosome are absent in plant cells.
3.	Chloroplasts are absent and other plastids are generally absent.	Chloroplasts and other plastids are present in plant cells.
4.	Small sized few food vacuoles and contractile vacuoles may be present in cytoplasm.	Vacuoles are large in size and more in number. It has a large central sap vacuole. Food vacuoles and contractile vacuoles are absent.

5.	In animal cells, nucleus is generally centrally located in the cytoplasm.	The large sap vacuole pushes the nucleus to peripheral position in cytoplasm.
6.	The lysosomes are present in animal cells.	These are generally absent in plant cells.

Cell Wall

- Cell wall is a nonliving, rigid, semielastic, supportive, and protective covering of cells in plants and fungi.
- Cell wall provides shape to plant cells.
- It imparts rigidity to cells.
- It helps in cell-to-cell interaction and provides barrier to undesirable macromolecules.
- Cell wall functions as a barrier to the entry of pathogens into the cells.
- It provides protection to protoplasm against mechanical injury.
- The composition of cell wall varies in different groups.

(a) **Fungal cell wall:** The fungal cell wall is generally composed of chitin—a polymer of *N*-acetylglucosamine (NAG) units.

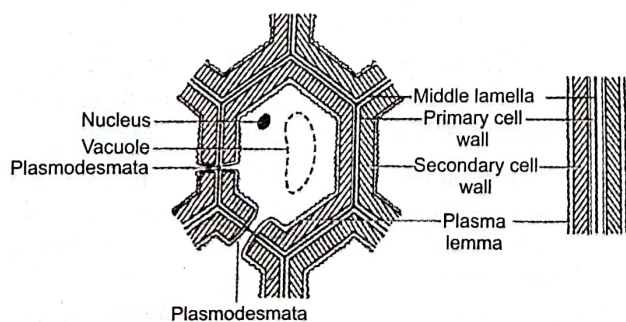
(b) **Algal cell wall:** The algal cell wall is made up of cellulose, galactans, mannans, and minerals like calcium carbonate.

(c) **Plant cell wall:** The plant cell wall is chiefly composed of the insoluble polysaccharides (cellulose, certain other compounds, such as hemicellulose, pectin, and proteins are also present in the cell wall).

- The different layers of cell wall are as follows:

(i) **Middle lamella:** It is thin, amorphous, intercellular matrix between two adjacent plant cells that functions as a cementing layer between them. It is considered to be the outermost layer of wall. It consists mainly of calcium pectates.

(ii) **Primary cell wall:** It is the first formed wall of cell, present inner to middle lamella in young cells. It gradually diminishes as the cell grows.



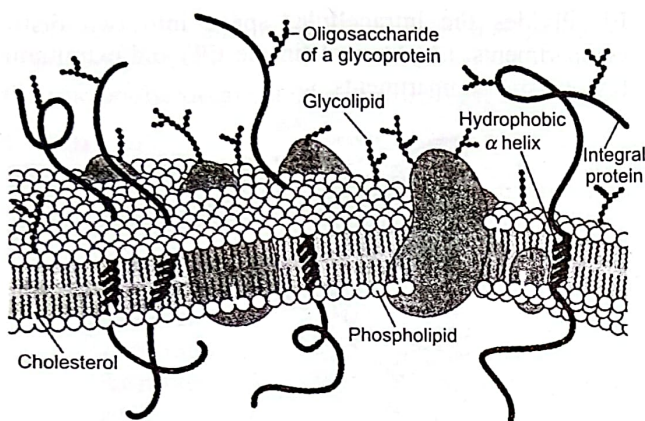
Arrangement of various layers of cell wall in a mature plant cell

(iii) **Secondary cell wall:** It is the thick layer, formed inner to primary wall in mature cells.

- The cytoplasmic connections between two adjacent plant cells are called plasmodesmata.
- Plasmodesmata are characteristic of multicellular plants, and they maintain continuity of cytoplasm between adjacent cells. Endoplasmic reticulum plays a role in origin of plasmodesmata.
- ER tubules (desmotubules) help to maintain continuity of cytoplasm.

Cell Membrane

- All the living cells are covered by a thin, delicate, elastic, selectively permeable, and living boundary, which is called cell membrane or plasmalemma or biomembrane, or plasma membrane.
- The detailed structure of the membrane was studied only after the invention of electron microscope in the 1950s.
- Meanwhile, chemical studies on the cell membrane enabled the scientists to deduce the possible structure of the plasma membrane.
- On the basis of these studies, scientists found that the cell membrane is composed of lipids that are arranged in a bilayer. These lipids are arranged within the membrane with the polar head towards the outer sides and the hydrophobic (nonpolar) tails towards the inner sides. The polar ends (head) interact with water and are called hydrophilic. This ensures that the nonpolar tail of saturated hydrocarbons or hydrophobic tail is protected from the aqueous environment.
- Later, biochemical investigation clearly revealed that the cell membranes also possess protein and carbohydrate. The ratio of protein and lipid varies considerably in different cell types. In human beings, the membrane of the erythrocyte (RBC) has approximately 52% protein (Arginine, Lysine rich) and 40% lipids (phospholipid, cholesterol, glycolipids).
- Depending on the ease of extraction, membrane proteins can be classified as integral and peripheral.
- **Peripheral proteins** lie on the surface of membrane while the **integral proteins** are partially or totally buried in the membrane.
- An improved model of the structure of cell membrane was proposed by Singer and Nicolson (1972) widely accepted as **fluid mosaic model**. According to this, the quasi-fluid nature of lipid enables lateral movement of proteins within the overall bilayer. This ability to move within the membrane is measured as its fluidity.
- The fluid nature of the membrane is important from the point of view of functions like cell growth, formation of intercellular junctions, secretion, endocytosis, cell division, cell movement (in *Amoeba* formation of pseudopodia), etc.
- Plasma membrane allows the transport of the molecules across it. The membrane is selectively permeable to some molecules present on either side of it.



Fluid "mosaic" model of the structure of plasma membrane
(Peripheral proteins are not shown)

- The passage of substances across cell membranes occurs by various methods such as passive transport and active transport.

(i) **Passive transport:** Many molecules can move across the membrane without any requirement of energy, and this is called the passive transport. Neutral solutes may move across the membrane by the process of simple diffusion along the concentration gradient, i.e., from higher concentration to the lower.

Water may also move across the plasma membrane from higher to lower concentration. The movement of water by diffusion through membrane is called **osmosis**. As the polar molecules cannot pass through the nonpolar lipid bilayer, they require a carrier protein of the membrane to facilitate their transport across the membrane.

(ii) **Active transport:** It is an uphill movement of materials across the membrane where the solute particles move against their concentration gradient, i.e., from their lower to higher concentration. Such a transport requires energy, which is obtained from ATP. Thus, it is an energy-dependent process. For example- $\text{Na}^+ - \text{K}^+$ pump in animals.

CONCEPT BOOSTER

Bulk Transport

A. **Endocytosis:** It involves intake of materials in the form of carrier vesicles formed by invagination of small regions of plasma membrane. Endocytosis is of two types, i.e., **pinocytosis** and **phagocytosis** as explained below:

(a) **Pinocytosis:** It is also called **cell drinking process**, as fluid materials having high molecular weight such as proteins, amino acids, fats, insulin, lipoproteins, etc., in the form of globules of fluid enter the cytoplasm by invagination of plasma membrane.

(b) **Phagocytosis:** It is bulk intake of large-sized solid particles by the cell using the plasma membrane. It is also called **cell eating process**. It occurs in all protozoans and in special cells of metazoans such as leucocytes of blood, the reticular cells of spleen, etc.

B. **Exocytosis:** It is a process of exuding the secretory products or undigested waste products to outside of the cell cytoplasm through plasma membrane. This process is also called **cell vomiting or ephagy**.

Concept Application Exercise 3

- The best material for the study of structure of cell membrane is:
 - RBC of human
 - RBC of frog
 - Kidney cell
 - Muscle cell
- Biochemical investigation reveals that the cell membrane is composed of:
 - Proteins only
 - Lipids + Proteins only
 - Carbohydrates + Lipids + Proteins
 - Carbohydrates + Lipids only
- The internal layer joining the primary walls of the two adjacent cells is known as _____. (Fill in the blank)
- Neutral solutes may move across the membrane by the process of _____ along the concentration gradient.
 - Simple diffusion
 - Facilitated diffusion
 - $\text{Na}^+ - \text{K}^+$ transport
 - Active transport of sugars and amino acids
- Why tail of lipids in the membrane are towards inner part?
 - The nonpolar tail of saturated hydrocarbon is protected from the aqueous environment.
 - The tail is polar hydrocarbon and so is protected from aqueous environment.
 - The tail is hydrophilic, so it tends to be located in the aqueous inner side of membrane.
 - The tail is nonpolar hydrocarbon and so is protected within an aqueous environment.
- The cytoplasm of neighbouring cells are connected by (chiasmata/plasmodesmata). (Tick the correct word)
- The innermost portion of a mature plant cell wall is the:
 - Primary cell wall
 - Plasma membrane
 - Secondary cell wall
 - Plasmodesmata
- Cell wall is absent in
 - Gametes
 - Amoeba
 - Mycoplasma
 - All of these

9. Choose the odd one out w.r.t the extensions of plasma membrane into the cell.

Vesicles, Tubules, Capsule, Lamellae

10. The ratio of proteins and lipids is same in all cell membranes.

True ☐ False ☐

ENDOMEMBRANE SYSTEM

- While each of the membranous organelles is distinct in terms of its structure and function, many of these are considered together as an endomembrane system because their functions are coordinated.
- The endomembrane system includes **endoplasmic reticulum (ER)**, **Golgi complex**, **lysosomes**, and **vacuoles**.
- Since the functions of the mitochondria, chloroplast, and peroxisomes are not coordinated with the above components; these are not considered as part of the endomembrane system.

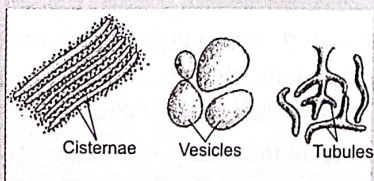
Endoplasmic Reticulum

- Electron microscopic studies of eukaryotic cells reveal the presence of a network of reticulum of tiny tubular structures scattered in the cytoplasm that is called the endoplasmic reticulum (ER).
- It occurs in all eukaryotic cells except erythrocytes (RBCs) of mammals and all prokaryotes.

CONCEPT BOOSTER

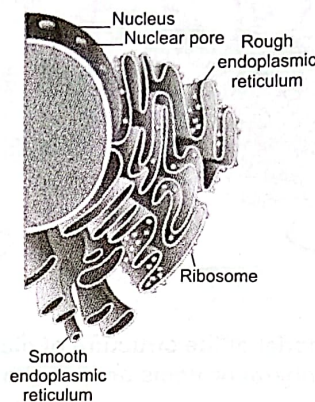
Components of endoplasmic reticulum

- Cisternae:** The cisternae are long, flattened, parallel, sac-like, interconnected structures. These are found in cells that are actively involved in protein synthesis. The cisternae usually occur in those cells that have synthetic roles.
- Tubules:** The tubules are branched or unbranched structures forming the reticular system along with the cisternae and vesicles. They are free of ribosomes and are common in cells involved in lipid and sterol synthesis.
- Vesicles:** The vesicles are oval, membrane-bound vacuolar structures. They are also free of ribosomes.



Various components of the endoplasmic reticulum

- ER divides the intracellular space into two distinct compartments, i.e., luminal (inside ER) and extraluminal (cytoplasm) compartments.



Endoplasmic reticulum

Types of Endoplasmic Reticulum

- Smooth Endoplasmic Reticulum (SER):** Smooth endoplasmic reticulum (SER) has smooth surface membranes, because the membranes are free from ribosomes.
 - It is more abundant near the plasma membrane.
 - It consists of mainly tubules and vesicles.
 - The muscle cells are also rich in smooth type of endoplasmic reticulum, which is known as sarcoplasmic reticulum.
 - It is found in adipose cells, intestinal cells, adrenal cortical cells, etc.
 - In animal cells lipid-like steroidal hormones are synthesised in SER.
 - The SER is the major site for the synthesis of lipid.
- Rough endoplasmic reticulum (RER):** Rough endoplasmic reticulum has rough surface membranes because the membranes contain ribosomes.
 - RER is made of mainly cisternae and a few tubules.
 - They are extensive and are continuous with the outer membrane of the nucleus. RER are more numerous in protein-secretory cells such as fibroblasts, cells of pancreas, liver cells, etc.
 - Ribosomes are the site of protein synthesis, and, thus, RER are present in the cells that are actively involved in the protein synthesis and secretion.
 - It provides precursors of enzymes for the formation of lysosomes in Golgi complex.
 - RER without ribosomes becomes SER.

Golgi Complex

- Golgi apparatus was first observed by Camillo Golgi in 1898. He described it as a densely stained reticular structures present near the nucleus of the cell. Therefore, these were given the name Golgi bodies, after his name.
- It is present in eukaryotic cells, except in mature sieve tubes of plants, mature RBCs of mammals, sperm cells

of bryophytes and pteridophytes, etc. It is also absent in prokaryotic cells.

- Structurally, Golgi complex consists of following parts.

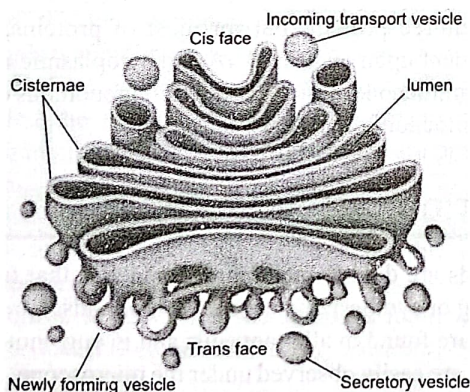
(i) **Cisternae**

- These are flat, disc-shaped sac-like structures stacked on one another. There are usually 4–8 cisternae present in a stack.
- Their size may range from 0.5 μm to 1.0 μm in diameter.
- The Golgi cisternae are concentrically arranged near the nucleus with distinct convex *cis* or the forming face and concave *trans* or the maturing face. The *cis* and the *trans* faces of the organelles are entirely different, but interconnected.

(ii) **Tubules:** These are branched and irregular tube-like structures associated with cisternae.

(iii) **Vesicles:** These are large, rounded sacs present at the edges of cisternae in clusters. Vesicles are filled with secretory materials.

(iv) **Golgian vacuoles:** These are large, spherical vacuoles produced at maturing face. These are filled with some granular or amorphous substances. Some of them function as lysosomes.



Golgi complex

- The golgi apparatus principally performs the functions of processing, packaging, and transportation of materials, to be delivered either to the intracellular targets or secreted outside the cell.
- The material to be secreted moves from ER to the golgi apparatus in the form of transitional vesicles. These vesicles then fuse with the *cis* face of the golgi apparatus and move towards the maturing face. This explains, why the golgi apparatus remains in close association with the endoplasmic reticulum.
- A number of proteins synthesized by ribosomes on the endoplasmic reticulum are modified in the cisternae of the golgi apparatus before they are released from its *trans* face.
- Golgi apparatus is the important site of formation of glycoproteins and glycolipids.

Lysosome

- These are membrane-bound (covered by **single unit membrane**) vesicular structures formed by the process of packaging in the golgi apparatus.
- With the exception of mammalian RBC, they were reported from all cells.
- Lysosomes are formed by joint activity of ER and Golgi complex.
- The isolated lysosomal vesicles have been found to be very rich in almost all types of hydrolytic enzymes (hydrolases: lipases, proteases, carbohydrases) optimally active at the acidic pH (pH = 5). About 50 different type of digestive enzymes termed as acid hydrolases are present. These enzymes are capable of digesting carbohydrates, proteins, lipids, and nucleic acids.
- Lysosomes are highly polymorphic cell organelles. Because, during functioning, lysosomes have different morphological and physiological states.

Vacuoles

- The vacuole is the membrane-bound space found in the cytoplasm. It contains water, sap, excretory products, and other materials not useful for the cell. These are also called sap vacuoles.
- The vacuole is bound by a single, semipermeable membrane called **tonoplast**. In plant cells, the vacuoles can occupy up to 90% of the volume of the cell.
- In plants, the tonoplast facilitates the transport of a number of ions and other materials against concentration gradients into the vacuole, hence their concentration is significantly higher in the vacuole than in the cytoplasm.

Types of Vacuoles

- Contractile vacuole:** In *Amoeba*, it helps in excretion and osmoregulation.
- Food vacuoles:** In many cells, as in protists, food vacuoles are formed by engulfing the food particles.
- Gas vacuoles:** These are membrane-less vacuoles found in prokaryotes to provide buoyancy.

Concept Application Exercise 4

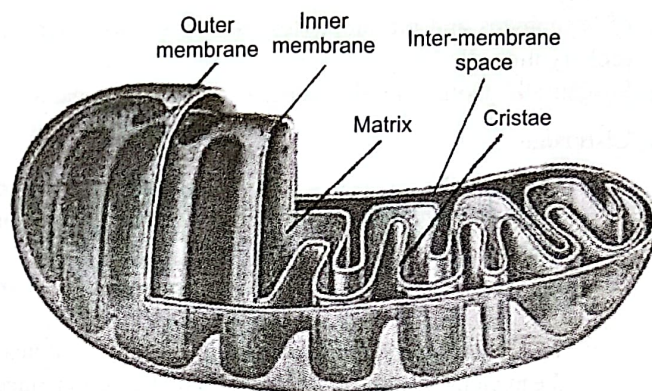
- The function like delivery of packaged materials either to the intracellular targets or secreted outside the cell is principally performed by:
 - (1) Lysosomes
 - (2) Golgi body
 - (3) Vacuole
 - (4) ER
- ER, GB, lysosome, and vacuoles are components of endomembranous system because:
 - (1) Their structures are distinct
 - (2) Their functions are distinct
 - (3) Their functions are coordinated
 - (4) All of these

3. The SER is the major site for synthesis of:
 - (1) Lipids
 - (2) Proteins
 - (3) Lipid, steroidal hormones, and glycogen metabolism
 - (4) Protein and lipids
4. The important site of synthesis of glycoprotein and glycolipid is _____. (Fill in the blank)
5. The transfer vesicle from RER fuse with which region of Golgi complex?

(1) Cis	(2) Medial
(3) Trans	(4) Protein arms
6. The organelles whose major function is storage of hydrolytic enzymes lysosomes:
 True ☐ False ☐
7. Tonoplast is a:
 - (1) Covering layer of Golgi complex
 - (2) Covering layer of vacuoles
 - (3) Covering layer of microbodies
 - (4) Nonliving cytoplasmic content

MITOCHONDRIA (SINGULAR: MITOCHONDRION)

- **Kolliker** in 1850 first observed mitochondria as cytoplasmic granules in striped muscles of insects. **Benda** in 1897 coined the term mitochondria.
- The number of mitochondria per cell varies, depending upon the physiological activity of the cells. Higher is the metabolic activity of a cell, higher is the number of mitochondria in it, e.g., in germinating seeds.
- Mitochondria, unless specifically stained, are not easily visible under the microscope. Thus, they are stained by a vital stain Janus green so that it can be observed.
- In terms of shape and size, considerable degree of variability is observed. Typically, it is sausage shaped or cylindrical having a diameter of 0.2–1.0 μm (average 0.5 μm) and length of 1.0–4.1 μm .
- Each mitochondrion is bounded by two-unit membranes – the **outer and inner membrane**, separated by perimitochondrial space.
- The outer and the inner membrane divide the mitochondrial lumen distinctly into two aqueous compartments, i.e., the outer compartment and the inner compartment.
- The inner compartment is filled with a dense homogeneous substance called the **matrix**.
- The outer membrane, which forms the continuous boundary of the organelle, is permeable because of the presence of integral proteins called **porins**.
- The inner membrane, on the other hand is selectively permeable and forms a number of infoldings called **cristae** (singular - crista) facing the matrix. Cristae help in increasing the surface area.



Structure of mitochondrion (Longitudinal section)

- The two membranes have their own specific enzymes associated with the mitochondrial function.
- Mitochondria are cell organelles of aerobic eukaryotes that take part in oxidative phosphorylation and Krebs' cycle of aerobic respiration. They produce cellular energy in the form of ATP, hence they are called '**power houses**' of the cell.
- The matrix also possesses single circular DNA molecule with high G-C ratio, a few RNA molecules, ribosomes (70S) and some components required for the synthesis of proteins. Thus, a mitochondrion can form some of the required proteins but for most of proteins, these are dependent upon nuclear DNA and cytoplasmic ribosomes, so the mitochondria are called semi-autonomous organelles.
- The mitochondria divide by fission.

PLASTIDS

- Plastids are double-membrane organelles that take part in storing or synthesizing organic compounds.
- They are found in all plant cells and in euglenoides.
- These are easily observed under the microscope, as they are large.
- Based on the type of pigments present, plastids can be classified into—leucoplast, chromoplast, and chloroplast.

(i) Leucoplast

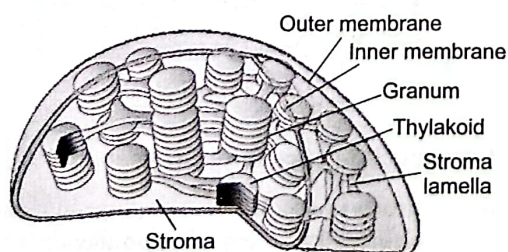
- These are colorless plastids with stored nutrients occurring in nongreen plant cells.
- They may be of various shapes—rounded, oval, cylindrical, and filamentous.
- Photosynthetic pigments are absent in them. These are
 - (i) **Amyloplast** are starch-storing leucoplast. It contains simple or compound starch grain. For example, tuber of potato, grain of rice, grain of wheat.
 - (ii) **Elaioplast** are fat-storing leucoplasts.
 - (iii) **Aleuroplasts** are protein-storing plastids. Protein is in amorphous, crystalloid, e.g., aleurone layer in maize grain, endosperm cells of castor.

(II) Chromoplast

- These are nonphotosynthetic colored plastid that synthesizes and stores carotenoid pigments. These, therefore, appear orange, red, or yellow.
- These are formed either from leucoplast or chloroplast.
- Change of color from green to reddish during the ripening of tomato and chili is due to transformation of chloroplasts to chromoplasts.
- They provide color to many flowers for attracting pollinating insects.

(III) Chloroplast

- Chloroplast is a double membrane bound organelle, containing **chlorophyll** and carotenoid pigments which are responsible for trapping light energy essential for photosynthesis.
- Majority of the chloroplasts of the green plants are found in the mesophyll cells of the leaves.
- These are lens-shaped, oval, spherical, discoid or even ribbon-like organelles having variable length (5-10 μ m) and width (2-4 μ m).
- Their number varies from 1 per cell of the *Chlamydomonas*, a green alga to 20-40 per cell in the mesophyll.
- Out of the two membranes of chloroplast, the inner chloroplast membrane is relatively less permeable. The space limited by the inner membrane of the chloroplast is called the **stroma**. A number of organised flattened membranous sacs called the **thylakoids**, are present in the stroma.
- Thylakoids are arranged in stacks like the piles of coins called **grana** (singular: granum) or the intergranal thylakoids.
- In addition, there are flat membranous tubules called the **stroma lamellae** connecting the thylakoids of the different grana.
- The membrane of the thylakoids encloses a space called a lumen.
- Chlorophyll pigments are present in the thylakoids.



Sectional view of chloroplast

- Like mitochondria chloroplasts are also semiautonomous cell organelles. They are capable of self-duplication. For duplication, they have small, double stranded circular DNA, ribosomes, and different types of RNAs, i.e., mRNA, tRNA, rRNA for protein synthesis. The stroma of the

chloroplast contains enzymes required for the synthesis of carbohydrates and proteins.

- The ribosomes of the chloroplasts are smaller (70S) than the cytoplasmic ribosomes (80S).

Concept Application Exercise 5

1. The inner compartment of mitochondria is called _____.
(Fill in the blank)
2. Which membrane of chloroplast is more permeable ?
3. The ribosomes of the chloroplasts are
 - (1) Larger (100S) than the cytoplasmic ribosomes (80S)
 - (2) Smaller (70S) than the cytoplasmic ribosomes (80S)
 - (3) Smaller (80S) than the cytoplasmic ribosomes (70S)
 - (4) Larger (80S) than the cytoplasmic ribosomes (70S)
4. Mitochondria is typically _____ shaped.
(Fill in the blank)
5. In chloroplast, chlorophyll is present in:
 - (1) Thylakoid
 - (2) Stroma
 - (3) Outer membrane
 - (4) Inner membrane of envelope
6. The stroma lamellae connect the thylakoid of different grana.
True ☐ False ☐
7. Colour giving pigments are present in _____ type of plastids. (Fill in the blank)
8. Arrangement of thylakoids like piles of coin is known as (grana/stroma). (Tick the correct word)

RIBOSOMES

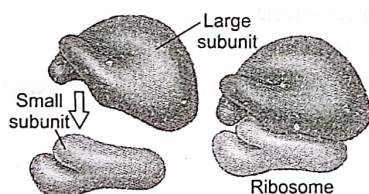
- Ribosomes are the granular structures first observed under the electron microscope as dense particles by George Palade (1953).
- They are composed of ribonucleic acid (RNA) and proteins and are not surrounded by any membrane.
- Except mammalian RBC, all living cells have ribosomes (both prokaryotes and eukaryotes).
- Ribosomes are smallest cell organelles (150 \times 250 Å). Ribosomes are organelle without membranes. Ribosomes are also called as "Organelle within an organelle".
- The ribosomes are composed of two subunits. One ribosomal subunit is large in size and has a dome-like shape, while the other ribosomal subunit is smaller in size and occurs above the larger subunit and forms a cap-like structure.
- The two ribosomal subunits remain united with each other due to a specific concentration of the Mg^{2+} ions.
- Ribosomes are of two types—70S and 80S, where 'S' (Svedberg's unit) represents the sedimentation coefficient that indirectly measures the density and size of the ribosomes.

- The ribosomes of prokaryotes are 70S, whereas the eukaryotic ribosomes are 80S. In mitochondria and chloroplast, ribosomes are 70S.

TABLE: Different ribosomes with their subunits

Ribosomes	Subunits
Eukaryotic (80S)	Large (60S)
	Small (40S)
Prokaryotic (70S)	Large (50S)
	Small (30S)

- Ribosomes are sites of protein synthesis. The free ribosomes synthesize nonsecretory proteins, whereas ER-bound ribosomes synthesize secretory proteins. Free ribosomes synthesize structural and enzymatic proteins for use inside the cell. The attached ribosomes synthesize proteins for transport. Thus, these organelles are also known as protein factories."



Structure of Ribosome

CYTOSKELETON

- An elaborate network of filamentous, proteinaceous structures consisting of microtubules, microfilaments and intermediate filaments present in the cytoplasm is collectively referred to as the **cytoskeleton**.
- The cytoskeleton in a cell is involved in many functions such as mechanical support, motility, maintenance of the shape of the cell.

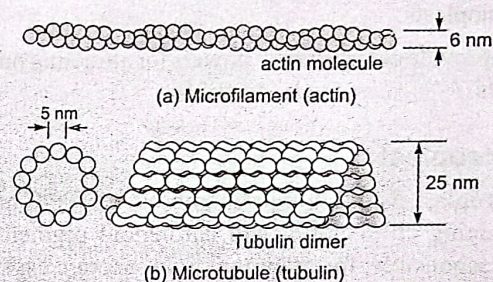
CONCEPT BOOSTER

Microtubules

- The microtubules are found in the cytoplasmic matrix of all eukaryotic cells. Prokaryotic cells lack microtubules.
- They are unbranched, hollow, noncontractile tubules of indefinite length—25 nm in thickness with 15 nm core.
- They are formed of 13 helically arranged protofilaments of α - and β -tubulin protein.
- Microtubules are basic structures of spindle apparatus, centrioles, basal bodies, cilia, and flagella and are responsible for cell motility and maintenance of shape.

Microfilaments

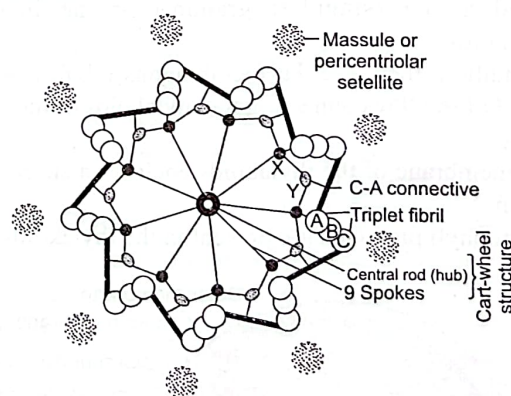
- They are found in eukaryotic cells. They are cylindrical, solid contractile rods or filaments of actin protein with a diameter of 6–10 nm.
- Microfilaments conform hexagonal bundles, take part in cytoplasmic streaming, membrane undulations, cleavage, contraction of muscles, movement of microvilli to absorb food and endocytosis.



Structure of microfilament and microtubule

CENTROSOME AND CENTRIOLES

- Centrosome (zone of exclusion is present) is an organelle usually containing two cylindrical structures called centrioles that are surrounded by a cloud of amorphous pericentriolar material called **centrosphere** or **kinoplasm**. These two centrioles—called **diplosome**—are localized in the centrosome at right angles to each other.
- The centrioles are found in almost all eukaryotic cells like animal cells, fungi, and algae, but are not found in higher plant cells.



Ultrastructure of centriole as seen in T.S.

- Both the centrioles in a centrosome lie perpendicular to each other in which each has an organisation like the cartwheel.
- They are made up of nine evenly spaced peripheral fibrils of tubulin protein. Each of the peripheral fibril is a triplet. The adjacent triplets are also linked together by proteinaceous linkers.
- The central part of the proximal region of the centriole is also proteinaceous and called the **hub**, which is connected

with tubules of the peripheral triplets by radial spokes made of protein.

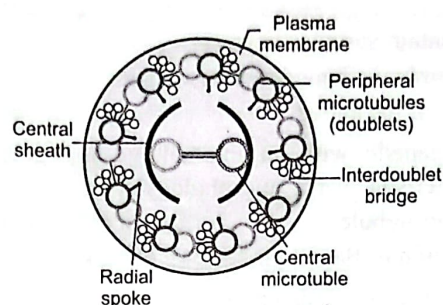
- The centrioles form the basal body of cilia or flagella, and spindle fibres that give rise to spindle apparatus during cell division in animal cells.

CILIA AND FLAGELLA

- Cilia (singular: cilium) and flagella (singular: flagellum) are hair-like outgrowths of the cell membrane.
- Cilia are small structures that work like oars, causing the movement of either the cell or the surrounding fluid.
- Flagella are comparatively longer and responsible for cell movement.
- The prokaryotic bacteria also possess flagella, but these are structurally different from that of the eukaryotic flagella.
- The electron microscopic study of a cilium or the flagellum show that they are covered with plasma membrane. Their core called the **axoneme**, possesses a number of microtubules running parallel to the long axis.
- The axoneme usually has nine doublets of radially arranged peripheral microtubules, and a pair of centrally located microtubules. Such an arrangement of axonemal microtubules is referred to as the 9+2 array.
- The central tubules are connected by bridges and is also enclosed by a central sheath, which is connected to one of the tubules of each peripheral doublets by a radial spoke. Thus, there are nine radial spokes.
- The peripheral doublets are also interconnected by linkers.
- Both the cilium and flagellum emerge from centriole-like structure called the basal bodies and both are vibratile and push the fluid medium to one side.

TABLE: Differences between Cilia and Flagella

S. no.	Cilia	Flagella
1.	A cell bears large number of cilia (30–14,000).	A cell bears few flagella (1–4).
2.	The length is 2–10 μm (smaller in size).	The length is 100–150 μm (longer in size).
3.	There is a coordination in beating of different cilia of the same cell.	Flagella show independent beating.
4.	Cilia perform sweeping or rowing action.	Flagella perform undulatory action.
5.	Besides locomotion, cilia can perform function of circulation, aeration, protection, feeding, etc.	Flagella take part in locomotion only.



Diagrammatic representation of internal structure of cilia/flagella

MICROBODIES

- They are small cell organelles bound by single membrane. It contains various enzymes that are associated with oxidation reactions other than respiration. They are of three different types:

(i) Peroxisomes

- They are microbodies that contain enzymes for peroxide biosynthesis.
- They are found in both plant and animal cells, in close association with endoplasmic reticulum, mitochondria, and chloroplasts. They are absent in prokaryotes.
- In animal cells peroxisomes are concerned with peroxide (H_2O_2) metabolism.
- In plants, peroxisomes occur in cells of green tissues and are concerned with photorespiration (glycolate pathway).

(ii) Spherosomes

- Spherosomes occur only in plant cells. They are major site of lipid storage and synthesis in plants.
- They also have lysosome-like activity, so they are also termed as plant lysosomes.

(iii) Glyoxysomes

- Glyoxysomes occurs only in plants, especially in fatty seeds (castor seed, ground nut seed, etc.), guard cells of stomata, and unripe fruits.
- Glyoxysomes are considered as a highly specialized peroxisomes. Glyoxylate acid cycle takes place in glyoxysomes. This cycle converts fats into carbohydrates.

Concept Application Exercise 6

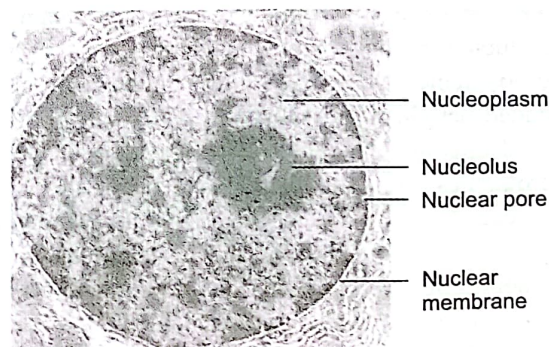
1. The central part of centriole is called the (hub/spokes), which is connected with radial (hub/spokes).
(Tick the correct words)
2. Which of the following statement is correct about microbodies?
(1) Present in both plant and animal cells

- (2) Contain various enzymes
 - (3) Membrane bound minute vesicles
 - (4) All of the above
3. An organelle with an internal cross-section showing characteristic "9 + 2" morphology is the:
- (1) Microtubule (2) Microfilament
 - (3) Cilium or flagellum (4) Cytoskeleton
4. Ribosomes are made up of:
- (1) DNA and protein (2) DNA alone
 - (3) RNA and protein (4) RNA and DNA
5. 70S type of ribosome shows two units whose sedimentation constants are:
- (1) 40S and 30S (2) 50S and 20S
 - (3) 50S and 30S (4) 60S and 20S
6. The electron microscopic study of a eukaryotic cilium shows that they are covered with plasma membrane.
True ☐ False ☐
7. Which cellular structure organisation is like the cartwheel?
8. A network of filamentous proteinaceous structures present in the cytoplasm is called _____.
(Fill in the blank)

NUCLEUS

- Nucleus as a cell organelle was first described by Robert Brown, as early as 1831. Later, the material of the nucleus stained by the basic dyes (Acetocarmine) was given the name **chromatin** by Fleming. It is the largest cell organelle in the cell.
- The interphase nucleus (nucleus of a cell when it is not dividing) has highly extended and elaborate nucleoprotein fibres called **chromatin**, nuclear matrix and one or more spherical bodies called **nucleoli** (sing.: **nucleolus**).
- Electron microscopy has revealed that the nucleus is bounded by a double-membrane—the **outer membrane** and **inner membrane**, structure forming a nuclear envelope.
- These two parallel membranes are separated by a space called **perinuclear space** (10 to 50 nm), which forms a barrier between the materials present inside the nucleus and that of the cytoplasm.
- The outer membrane communicates with the endoplasmic reticulum at several points and ribosomes are attached on the outer surface of the membrane.
- Many openings or apertures called **nuclear pores** perforate the nuclear membrane. The average diameter of nuclear pore is about 300–1000 Å.
- The nuclear pores are the passages through which movement of RNA and protein molecules takes place in both directions between the nucleus and the cytoplasm, e.g., RNA, ribosomes, proteins.

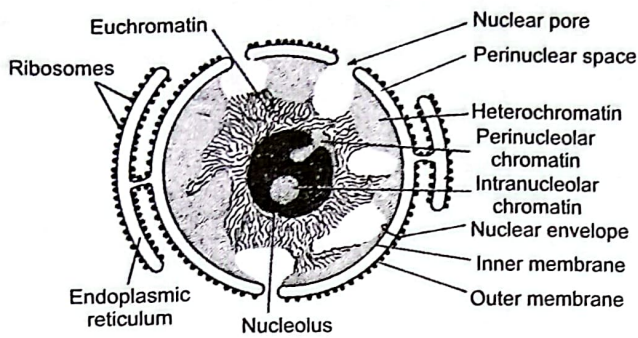
- Normally, there is only one nucleus per cell, variations in the number of nuclei are also frequently observed.
- The organism that has more than one nucleus per cell is known as coenocytic organism e.g., fungi (*Rhizopus*, *Penicillium*), algae (*Vaucheria*, *Chara*), protozoa (*Paramecium*), etc.
- Some mature cells even lack nucleus, e.g., erythrocytes of many mammals and sieve tube cells of vascular plants.
- The nuclear matrix or the nucleoplasm contains nucleolus and chromatin.
- The nucleoli are spherical structures present in the nucleoplasm.
- The content of nucleolus is continuous with the rest of the nucleoplasm as it is not a membrane bound structure. It is a site for active ribosomal RNA synthesis.
- Larger and more numerous nucleoli are present in cells actively carrying out protein synthesis.
- Chromatin contains DNA and some basic proteins called histones, some non-histone proteins and also RNA.



Structure of nucleus

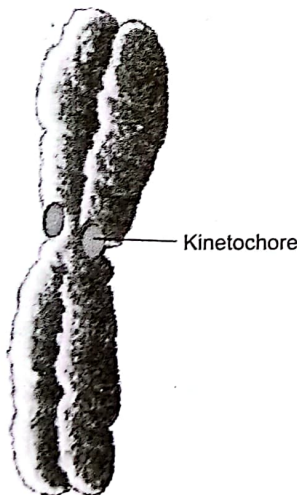
TABLE: Differences between cytoplasm and nucleoplasm

S. No.	Cytoplasm	Nucleoplasm
1.	It is a part of protoplasm excluding the nucleus.	It is present inside the nucleus.
2.	Cytoplasm consists of cytosol, cytoplasmic organelles.	Nucleoplasm is equivalent to cytosol of cytoplasm.
3.	Cytoplasm is covered on the outside by a single membrane called plasmalemma.	Nucleoplasm is covered on the outside by a double-membrane covering called nuclear envelope or nucleolemma.
4.	Cytoplasm shows cyclosis or streaming movement.	Cyclosis is absent.
5.	It contains raw materials for synthesis of all types of chemicals.	Nucleoplasm contains raw materials for synthesis of RNA, DNA, and ribosome subunits.



Electron microscopic structure of nucleus

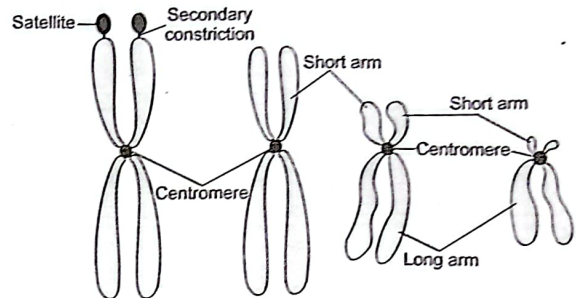
- During different stages of cell division, cells show structured chromosomes in place of the nucleus.
- A single human cell has approximately two-metre-long thread of DNA distributed among its forty six (twenty three pairs) chromosomes.
- Every chromosome (visible only in dividing cells) essentially has a **primary constriction** or the **centromere** on the sides of which disc shaped structures called kinetochores are present. Centromere holds two chromatids of a chromosome.



Chromosome with kinetochore

- With the change in the phase of the cell division, the shape of the chromosome also changes.
- The shape of chromosomes depends upon the position of the centromere, and it can be better observed during the anaphase stage of the cell division.
- The shapes of the chromosome are as follows:
 - (i) **Metacentric:** The position of the centromere is central, i.e., the length of the chromatids is of equal size and the chromosome is V shaped.
 - (ii) **Submetacentric:** The position of the centromere is slightly away from the center, i.e., the length of one of the chromatids is of smaller size and the chromosome is L shaped.
 - (iii) **Acrocentric:** When centromere is situated near the end of the chromosome to form J-shaped structure.

- (iv) **Telocentric:** The position of the centromere at one end of the chromosome, i.e., the length of one of the chromatids is very short and the chromosome is I shaped (rod shaped).



Types of chromosomes based on the position of centromere

- **Secondary constriction** are the regions that contain genes coded for the rRNA. These regions are responsible for the formation of the nucleolus. If nucleolus is attached with the chromosomes, such chromosomes are regarded as the nucleolar organizing chromosomes.
- Sometimes a few chromosomes have non-staining secondary constrictions at a constant location. This gives the appearance of a small fragment called the **satellite**. Chromosomes attached with satellite body are called as the SAT chromosomes (Sine Acido Thyminonucleinico, which means "without thymonucleic acid"), because it didn't stain with the Feulgen reaction.

Concept Application Exercise 7

1. Give the name of two mature eukaryotic cells that lack nucleus.
2. One very short arm and one very long arm is found in _____ chromosome.

(1) Submetacentric	(2) Metacentric
(3) Acrocentric	(4) Telocentric
3. The function of nucleolus is the synthesis of:

(1) DNA	(2) m-RNA
(3) r-RNA	(4) t-RNA
4. Chromatin consists of:

(1) DNA only
(2) DNA + Histones
(3) DNA + RNA + Histones + Nonhistones
(4) Ribonucleoproteins only
5. The spherical structure present in the nucleoplasm is _____. (Fill in the blank)
6. Nucleus controls the activities of organelles and play a major role in heredity.

True ☐False ☐

REVISION MAP

① An Overview of Cell

- Cells that have membrane-bound nuclei are called **eukaryotic** whereas cells that lack a membrane-bound nucleus are **prokaryotic**.
- The **cytoplasm** is the **main arena** of cellular activities in both the plant and animal cells.
- Besides the nucleus, the eukaryotic cells have other membrane bound distinct structures called organelles like the endoplasmic reticulum (ER), the golgi complex, lysosomes, mitochondria, microbodies and vacuoles.
- The prokaryotic cells lack such membrane bound organelles.
- Ribosomes are non-membrane bound organelles found in all cells both eukaryotic as well as prokaryotic.
- Animal cells contain another non-membrane bound organelle called **centrosome** which helps in cell division.
- The largest isolated single cell is the egg of an ostrich.
- Among multicellular organisms, human red blood cells are about 7.0 µm in diameter.

② Prokaryotic Cells

- All prokaryotes have a cell wall surrounding the cell membrane (except *Mycoplasma*).
- In addition to genomic DNA, many bacteria have small circular DNA outside the genomic DNA called plasmids.
- The prokaryotic cells are represented by **bacteria**, **blue-green algae**, **mycoplasma** and **PPLO** (Pleuro Pneumonia Like Organisms) and belongs to Kingdom Monera.
- The plasmid DNA confers certain unique phenotypic characters to such bacteria. One such character is resistance to antibiotics. This plasmid DNA is used to monitor bacterial transformation with foreign DNA.
- No organelles, like the ones in eukaryotes, are found in prokaryotic cells except for ribosomes.

Cell envelope and its modifications

- The cell wall determines the shape of the cell and provides a strong structural support to prevent the bacterium from bursting or collapsing.
- A special membranous structure is the **mesosome** which is formed by the extensions of plasma membrane into the cell of prokaryotes.
- Mesosomes help in cell wall formation, DNA replication and distribution to daughter cells. They also help in respiration, secretion processes, to increase the surface area of the plasma membrane and enzymatic content.
- In some prokaryotes like **cyanobacteria**, there are other membranous extensions into the cytoplasm called chromatophores which contain pigments.
- Chromatophore takes part in photosynthesis.
- Most prokaryotic cells have cell envelope, which is tightly bound three layered structure.
- Glycocalyx may be a loose sheath called slime layer or thick and tough called capsule.

Surface Structure

- Bacterial cells may be motile or non-motile.
- If motile, they have thin filamentous extensions from their cell wall called flagella.
- Bacterial flagellum is composed of three parts—filament, hook and basal body.
- Besides flagella, **Pili** and **Fimbriae** are also surface structures of the bacteria but do not play a role in motility.
- Bacteria on the basis of the differences in the cell envelope can be Gram positive or Gram negative.

Ribosomes

- They are about **15 nm by 20 nm** in size and are made of two subunits—50S & 30S units which when present together form 70S prokaryotic ribosomes
- Ribosomes are the site of protein synthesis.
- Several ribosomes may attach to a single mRNA and form a chain called polyribosome or polysome.

Inclusion Bodies

- Inclusion bodies are not bounded by any membrane system and lie free in the cytoplasm, e.g., phosphate granules, cyanophycean granules and glycogen granules.
- **Gas vacuoles** are found in **blue green** and **purple** and **green** photosynthetic bacteria.

③ Eukaryotic Cells

In eukaryotic cells, there is an **extensive compartmentalisation** of cytoplasm through the presence of membrane-bound organelles.

Cell Wall

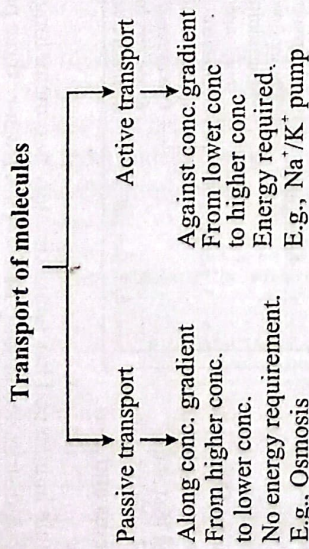
- Algae have cell wall, made of cellulose, galactans, mannans and minerals like calcium carbonate, while in other plants it consists of cellulose, hemicellulose, pectins and proteins.
- The **middle lamella** is a layer mainly of **calcium pectate** which holds or glues the different neighbouring cells together.

Cell Membrane

- The major lipids are phospholipids that are arranged in a bilayer. Also, the lipids are arranged within the membrane with the polar head towards the outer sides and the hydrophobic tails towards the inner part.
- This ensures that the non-polar tail of saturated hydrocarbons is protected from the aqueous environment. In addition to phospholipids, membrane also contains cholesterol. The lipid component of the membrane mainly consists of phosphoglycerides.
- The ratio of protein and lipid varies considerably in different cell types.
- In human beings, the membrane of the **erythrocyte** has approximately **52 per cent proteins** and **40 per cent lipids**.

④ Fluid-Mosaic Model

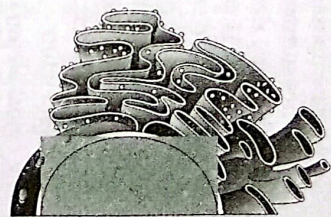
- According to this, the **quasi-fluid nature of lipid** enables lateral movement of proteins within the overall bilayer. This ability to move within the membrane is measured as its fluidity.



⑤ Endomembrane System

Endoplasmic Reticulum (ER)

- The ER often shows ribosomes attached to their outer surface.
- The endoplasmic reticulum bearing ribosomes on their surface is called **rough endoplasmic reticulum (RER)**.
- RER is frequently observed in the cells actively involved in protein synthesis and secretion.
- In the absence of ribosomes, they appear smooth and are called **smooth endoplasmic reticulum (SER)**.
- The smooth endoplasmic reticulum is the major site for synthesis of lipid and steroids.
- In animal cells, **lipid-like steroidal hormones** are synthesised in SER.



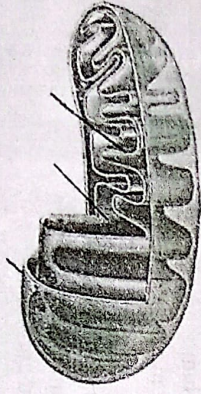
Endoplasmic Reticulum



Golgi Apparatus

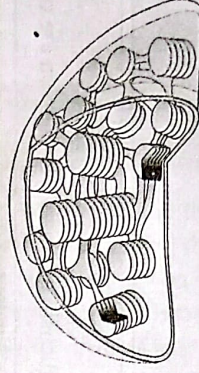
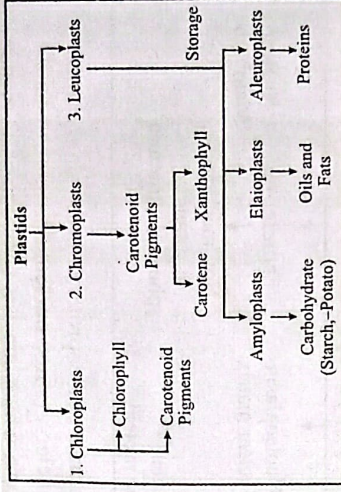
⑥ Mitochondria

- Each mitochondrion is a double membrane-bound structure with the outer membrane and the inner membrane dividing its lumen distinctly into two aqueous compartments, i.e., the outer compartment and the inner compartment.
- The inner membrane forms a number of infoldings called the **cristae** (sing.: crista) towards the matrix.
- The cristae increase the surface area.
- Mitochondria are the sites of aerobic respiration or **Kreb's cycle**.
- They produce cellular energy in the form of ATP, hence they are called '**power houses**' of the cell.
- The matrix also possesses single circular DNA molecule, a few RNA molecules, ribosomes (70S) and the components required for the synthesis of proteins.



⑦ Plastids

- In the chromoplasts, fat soluble carotenoid pigments like carotene, xanthophylls and others are present.
- The leucoplasts are the **colourless plastids** of varied shapes and sizes with stored nutrients.
- The chloroplasts contain chlorophyll and carotenoid pigments which are responsible for trapping light energy essential for photosynthesis.
- Like mitochondria, the chloroplasts are also double membrane bound. Of the two, the inner chloroplast membrane is relatively less permeable.
- Thylakoids are arranged in stacks like the piles of coins called **grana** (singular: granum) or the **intergranal thylakoids**.
- The ribosomes of the chloroplasts are smaller (70S) than the cytoplasmic ribosomes (80S).



Golgi Apparatus

- The golgi apparatus principally performs the function of **packaging materials**.
- The Golgi complex plays a major role in post-translational modification of proteins and glycosylation of lipids.
- Golgi apparatus is the important site of the formation of **glycoproteins** and **glycolipids** by glycogen.

Lysosomes

- These are membrane bound vesicular structures formed by the process of packaging in the golgi apparatus.
- The isolated lysosomal vesicles have been found to be very rich in almost all types of **hydrolytic enzymes** (hydrolases—lipases, proteases, carbohydrases) optimally active at the acidic pH.

Vacuoles

- The vacuole is the membrane-bound space found in the cytoplasm. The vacuole is bound by a single membrane called **tonoplast**.

⑧ Ribosomes

- They are composed of **ribonucleic acid (RNA)** and **proteins**, and are not surrounded by any membrane.
- The eukaryotic ribosomes are 80S while the prokaryotic ribosomes are 70S. Here 'S' stands for the **Svedberg unit** or **sedimentation coefficient**.
- Two subunits of 70S ribosome are 50S (larger subunit) & 30S (smaller subunit) and 80S ribosome are 60 S (larger subunit) & 40S (smaller subunit).

⑨ Cytoskeleton

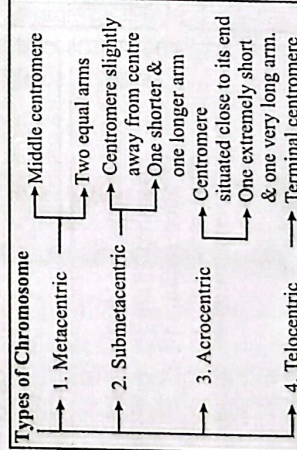
- The cytoskeleton in a cell are involved in many functions such as mechanical support, motility, maintenance of the shape of the cell.

⑩ Centrosome and Centrioles

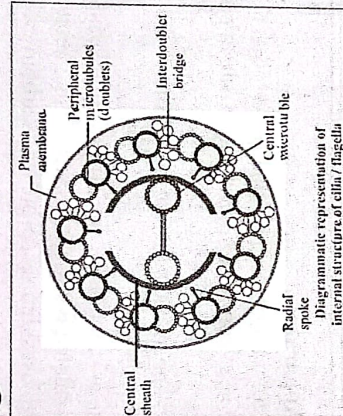
- Centrosome is surrounded by amorphous pericentriolar materials.
- The central part of the centriole is also proteinaceous and called the hub, which is connected with tubules of the peripheral triplets by radial spokes made of protein.
- The centrioles form the basal body of cilia or flagella, and spindle fibres that give rise to spindle apparatus) during cell division in animal cells.

⑬ Chromosomes

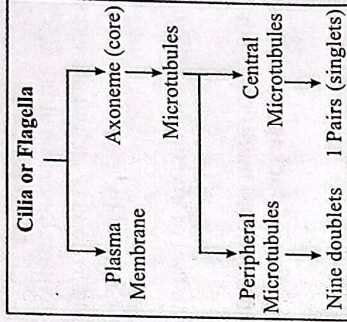
- **Nucleolus** is a site for active **ribosomal RNA (r-RNA)** synthesis.
- Chromatin contains **DNA** and some basic proteins called histones, some **non-histone proteins** and also **RNA**.
- A single human cell has approximately two metre long thread of DNA distributed among its forty six (twenty three pairs) chromosomes.
- Every chromosome essentially has a primary constriction or the centromere on the sides of which **disc-shaped** structures called kinetochores are present.



⑪ Cilia and Flagella

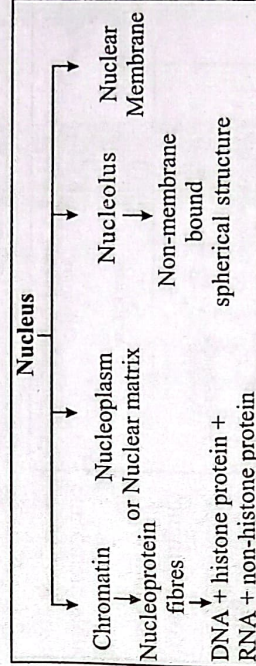


- The axoneme usually has nine pairs of doublets of radially arranged peripheral microtubules, and a pair of centrally located microtubules.
- Such an arrangement of axonemal microtubules is referred to as the 9+2 array.



⑫ Nucleus

- For the staining of chromosomes, carmine/ acetocarmine, basic fuchsin and methylene green are used.
- Erythrocytes of many mammals and sieve tube cells of vascular plants lack nucleus. These cells are enucleated or anucleated.
- A common characteristic feature of a plant sieve tube cell and most of mammalian erythrocytes in the absence of nucleus.
- The interphase nucleus (nucleus of a cell when it is not dividing) has highly extended and elaborate nucleoprotein fibres called chromatin, nuclear matrix and one or more spherical bodies called nucleoli (sing.: nucleolus).
- Electron microscopy has revealed that the nuclear envelope, which consists of two parallel membranes with a space between (10 to 50 nm) called the perinuclear space, forms a barrier between the materials present inside the nucleus and that of the cytoplasm.
- The outer membrane usually remains continuous with the endoplasmic reticulum and also bears ribosomes on it.
- Nuclear envelope is a derivative of rough endoplasmic reticulum.
- At a number of places, the nuclear envelope is interrupted by minute pores, which are formed by the fusion of its two membranes.
- These nuclear pores are the passages through which the movement of RNA and protein molecules takes place in both directions between the nucleus and the cytoplasm.
- The nuclear matrix or the nucleoplasm contains nucleolus and chromatin.
- The nucleoli are spherical structures present in the nucleoplasm.



NCERT Based

TOPICWISE QUESTIONS

Introduction, Cell Theory

1. Who proposed the theory that "cells arise only from the preexisting cells"?
(1) Mohl (2) Virchow
(3) Haeckel (4) Brown
2. Unicellular organisms are:
(1) Not capable of independent existence because they cannot perform all the essential functions of life.
(2) Not capable of independent existence, but they can perform all the essential vital functions.
(3) Are capable of independent existence and perform all the essential vital functions.
(4) Are capable to lead independent existence, but they perform some vital functions.
3. Which of the following is membrane less?
(1) Ribosomes (2) Nucleolus
(3) Centriole (4) All of the above
4. Nucleus was discovered by
(1) Anton Von Leeuwenhoek
(2) Robert Brown
(3) Robert Hooke
(4) Robert Frost
5. Who first saw and described a live cell?
(1) Anton Von Leeuwenhoek
(2) Robert Hooke
(3) Rudolf Virchow
(4) Schleiden and Schwann
6. Read the following statements and choose the correct option.
(1) Cell is the fundamental structural and functional unit of all living organisms except mycoplasma.
(2) Anything less than a complete structure of a cell does not ensure independent living.
(3) Only multicellular organisms are composed of cells.
(4) All of the above
7. Read the following statements and choose the correct option.
(1) The cell in all living organisms is the basic unit of life.
(2) The invention of the microscope and its improvement leading to the electron microscope revealed all the structural details of the cell.
(3) Humans are composed of many cells and are called multicellular organisms.
(4) All statements are correct
8. Who modified the hypothesis of Schleiden and Schwann to give the cell theory a final shape?
(1) Anton Von Leeuwenhoek
(2) Robert Brown
(3) Rudolf Virchow
(4) Hugo Von Mohl
9. Who examined a large number of plants and observed that all plants are composed of different kinds of cells which form the tissues of the plant?
(1) Theophrastus (2) Schwann
(3) Matthias Schleiden (4) Schleiden and Schwann
10. Read the following statements and choose the incorrect option
(1) In both the plant and animal cells, various chemical reactions occur in cytoplasm to keep the cell in the 'living state'.
(2) Cells that lack a membrane bound nucleus are prokaryotic.
(3) The onion cell is a typical plant cell.
(4) None of the above
11. In both prokaryotic and eukaryotic cells, the volume of the cell is occupied by
(1) A semi-fluid matrix (2) Cytoplasm
(3) Inclusion body (4) Both (1) and (2)
12. Schwann (1839), a British zoologist, studied different types of animal cells and reported that cells had a thin outer layer which is today known as the
(1) Plasma membrane (2) Cell membrane
(3) Plasmalemma (4) All of the above
13. Matthias Schleiden was a
(1) British zoologist (2) German botanist
(3) British geneticist (4) Microbiologist

Cell Wall

14. Plant cells differ from animal cells in having:
(1) Cell membrane, plastid, and cell wall
(2) Cell wall, plastid and centriole
(3) Cell wall, plastid, and mitochondria
(4) Large vacuole, plastid, and cell wall
15. Middle lamella is made mainly of:
(1) Cellulose (2) Suberin
(3) Calcium pectate (4) Lignin
16. A cell without cell wall would also lack:
(1) Mitochondria (2) Chloroplast
(3) ER (4) Biomembrane

17. Middle lamellae:
 (1) Mainly consists of calcium pectate.
 (2) Holds different neighboring cells together.
 (3) Is formed as cell plate during cytokinesis.
 (4) All the above
18. The innermost portion of a mature plant cell wall is the:
 (1) Primary cell wall (2) Plasma membrane
 (3) Secondary cell wall (4) Plasmodesmata
19. Choose the false statement.
 (1) The primary cell wall of young cell is capable of growth.
 (2) Growth of primary cell wall diminishes, as the cell matures.
 (3) Algal cell wall does not have cellulose.
 (4) Secondary cell wall is positioned between the primary cell wall and cell membrane.
20. Cell wall of algae is made of
 (1) Cellulose, galactans, mannans and minerals like calcium carbonate
 (2) Only cellulose
 (3) Peptidoglycan, galactans, mannans and minerals like calcium carbonate
 (4) Cellulose, hemicellulose, pectins, chitin and proteins
21. Plasmodesmata are
 (1) Connections between cytoplasm of neighbouring cells
 (2) Membranes connecting the nucleus with endoplasmic reticulum
 (3) Connections between plasma membrane and cell wall
 (4) Outermost membrane of plant cell
22. Read the following statements and choose the incorrect option.
 (1) Cell wall is a non-living rigid structure.
 (2) The cell wall of a young plant cell i.e., the primary wall is capable of growth.
 (3) Secondary wall gradually diminishes as the cell matures.
 (4) The secondary wall is formed on the inner (towards membrane) side of the cell.
23. Cell wall is present in all except
 (1) Plant cells
 (2) Fungal cells
 (3) Animal cells
 (4) Algal cells
24. "One of the most important functions of the plasma membrane is the transport of molecules." Which of the following is correct with respect to this statement?
 (1) Polar molecules can pass easily through the lipid bilayer.
 (2) The membrane does not support passive transport.
 (3) Neutral solutes require a carrier protein of membrane for transport.
 (4) The membrane is selectively permeable to some molecules present on either side of it.
25. Which of the following structure is not found in animal cell?
 (1) Microbodies (2) Chromatin
 (3) Plasmodesmata (4) Microfilaments
26. Which of the following layer is present nearest to plasma membrane in plant cell?
 (1) Secondary wall (2) Middle lamella
 (3) Primary wall (4) Tonoplast
27. Human RBC membrane is composed of:
 (1) 40% proteins and 60% lipids
 (2) 50% proteins and 50% lipids
 (3) 70% proteins and 30% lipids
 (4) 52% proteins and 40% lipids
28. The most abundant lipid in the cell membrane is
 (1) Cutin
 (2) Cholesterol
 (3) Steroid
 (4) Phospholipid/phosphoglycerides
29. Lipids are arranged within the membrane with:
 (1) Polar heads towards innerside and the hydrophobic tails towards outside
 (2) Both heads and tails towards innerside
 (3) Both heads and tails towards outside
 (4) Heads towards outside and tail towards inside
30. The molecules in a membrane that limit its permeability are the:
 (1) Carbohydrates (2) Phospholipids
 (3) Proteins (4) Water
31. An improved model of cell membrane, a widely accepted model is the:
 (1) Sandwich model
 (2) Fluid mosaic model
 (3) Danielli and Davson's model
 (4) Robertson's model
32. Which of the following statements is not true about the cell membrane?
 (1) It is present in both plant and animal cells.
 (2) Lipid is present in it as bilayer.
 (3) Proteins may be peripheral or integral in it.
 (4) Carbohydrates are never found in it.
33. The fluid mosaic model explains:
 (1) Only structural aspects of cell membrane.
 (2) Only functional aspects of cell membrane.
 (3) Both structural and functional aspects of cell membrane.
 (4) Only fluidity of membrane.

Cell Membrane

34. Integral cell membrane proteins:
- (1) Are completely embedded in lipid layers
 - (2) Are partially embedded in lipid layers
 - (3) Show lateral but not vertical movements within bilayer of lipid
 - (4) All of the above
35. Fluid nature of membrane is able to explain:
- (1) Secretion and permeation of various substances across membrane
 - (2) Formation of intercellular junctions
 - (3) Cell growth and cell division
 - (4) All of the above
36. Plasma membrane is:
- (1) Semipermeable for a short duration
 - (2) Permeable
 - (3) Selective/differentially permeable
 - (4) Impermeable
37. Neutral solutes may move across the membrane by a process of simple _____, _____ concentration gradients (from higher to lower concentration).
- (1) Method, against
 - (2) Transport, along
 - (3) Diffusion, along
 - (4) Active transport, against
38. What would you expect to happen, if you removed the cell wall from a plant cell and placed it into a hypotonic water?
- (1) The cell show lysis
 - (2) The cell would shrink
 - (3) The cell would burst
 - (4) Nothing would happen

Endomembrane System

39. The cell organelle responsible for concentration of secretory substance is:
- (1) Endoplasmic reticulum
 - (2) Ribosome
 - (3) Nucleolus
 - (4) Golgi body
40. Lipid-like steroidal hormones in animal cells are synthesized in:
- (1) Centrosome
 - (2) SER
 - (3) RER
 - (4) Golgi apparatus
41. The endoplasmic reticulum is involved in the:
- (1) Replication of DNA
 - (2) Protein synthesis and secretion
 - (3) Breakdown of newly synthesized RNA
 - (4) Identification of foreign material
42. Which of the following cell organelles were discovered after the introduction of electron microscope?
- (1) Mitochondria
 - (2) Endoplasmic Reticulum
 - (3) Ribosomes
 - (4) Both (2) and (3)
43. Endoplasmic reticulum is called RER, when it has _____ on its surface.
- (1) Elementary particles
 - (2) Ribosomes
 - (3) Oxyosome
 - (4) Quantasomes
44. How many of the following features are associated with the endomembrane system?
- Synthesis of steroidal hormones, digestion of food, storage of waste, storage of proteins, synthesis of ATP, formation of glycolipid.
- (1) Four
 - (2) Three
 - (3) One
 - (4) Two
45. The membrane of the ER are continuous with the membrane of:
- (1) Nucleus
 - (2) Golgi body
 - (3) Membrane of mitochondria
 - (4) Membrane of plastid
46. A cell, which is very active in the synthesis and secretion of proteins, would be expected to have:
- (1) Equal amount of RER and SER
 - (2) More SER than RER
 - (3) More RER than SER
 - (4) More Golgi body and no RER
47. "The cytoplasm of animal and plant cells is transversed by a network of tiny tubular membranous system that divides the intracellular space into two compartments—luminal and extraluminal compartment."
- The above statement is attributed to:
- (1) ER
 - (2) Golgi body
 - (3) Plasma membrane
 - (4) Nuclear membrane
48. Which of the following cell organelles are named after the name of discoverer?
- (1) ER
 - (2) DNA
 - (3) Golgi body
 - (4) ATP
49. A. Both the faces are similar.
 B. Varied number of cisternae are present in a Golgi body.
 C. The cis and trans face are interconnected.
 D. Golgi body shows polarity—cis/proximal/forming/concave face near nucleus and distal/convex/trans/maturation face.
 E. Golgi cisternae are concentrically arranged near the nucleus.
- Which of the above statements about Golgi body is/are false?
- (1) Only E
 - (2) Only D
 - (3) Only D and E
 - (4) Only A

50. Which of the following is the correct sequence/route of the secretory product?
- (1) ER → Vesicles → *cis* region of GB → *trans* region of GB → Vesicle → Plasma membrane
 - (2) RER → GB → Lysosome → Nuclear membrane → Plasma membrane
 - (3) ER → Vesicles → *trans* region of GB → *cis* region of GB → Vesicles → Plasma membrane
 - (4) Lysosome → ER → GB → Vesicles → Cell membrane
51. Which of the following enzymes is absent in lysosome?
- (1) Lipases
 - (2) Carbohydrase
 - (3) Polymerases
 - (4) Proteases
52. Which of the following is correct for the origin of lysosome?
- (1) ER → GB → Lysosome
 - (2) GB → ER → Lysosome
 - (3) Nucleus → GB → Lysosome
 - (4) Mitochondria → ER → GB → Lysosome
53. Of the following structures of a plant cell, the one that most often has the greatest volume is the:
- (1) Vacuole
 - (2) Lysosome
 - (3) Glyoxysome
 - (4) Ribosome
54. I. In plant cells, it can occupy up to 90% of cellular volume.
 II. Its content forms cell sap.
 III. It contains water, sap, excretory product, and other unwanted materials.
 IV. It is bound by a single membrane called tonoplast.
- The above features are attributed to:
- (1) Lysosome
 - (2) Vacuole
 - (3) Peroxisome
 - (4) Food vacuole
55. In endoplasmic reticulum, the following process takes place:
- (1) Lipid synthesis
 - (2) Channeling of biosynthetic processes
 - (3) Steroid synthesis
 - (4) All of the above
56. Which one of the following pairs is correctly matched?
- (1) Microsomes: Participate in the process of photosynthesis
 - (2) Lysosomes: Involved in synthesizing amino acids
 - (3) Endoplasmic reticulum: Plays role in the formation of a new nuclear membrane during cell division
 - (4) Centrosomes: Provide enzymes required in the digestive process
57. Which one is correct?
- (1) In *Amoeba*, contractile vacuole is important for excretion and osmoregulation.
 - (2) In many cells, as in protists, food vacuoles are formed by engulfing the food particles.
 - (3) Both (1) and (2).
 - (4) Vacuole is always large sized in all cells of plant.
58. Which of the following parts of a cell is nonliving?
- (1) Centriole
 - (2) Vacuole
 - (3) Ribosomes
 - (4) Mitochondria
59. The endomembrane system includes
- (1) Endoplasmic reticulum (ER), Golgi complex, mitochondria and vacuoles
 - (2) Endoplasmic reticulum (ER), Golgi complex, lysosomes and vacuoles
 - (3) Ribosomes, Golgi complex, lysosomes and vacuoles
 - (4) Endoplasmic reticulum (ER), Golgi complex, mitochondria and plastids
60. Match the columns and choose the correct option.
- | Column I | Column II |
|--------------------------|------------------------|
| 1. Endoplasmic reticulum | a. Reticular structure |
| 2. Golgi apparatus | b. Tubular structure |
| 3. Lysosomes | c. Vesicular structure |
- (1) 1 - a, 2 - b, 3 - c
 - (2) 1 - b, 2 - a, 3 - c
 - (3) 1 - b, 2 - c, 3 - a
 - (4) 1 - a, 2 - c, 3 - b
61. Read the following statements and choose the incorrect option.
- (1) Varied number of cisternae are present in a Golgi complex.
 - (2) The vacuole contains water, sap, excretory products and other materials useful for the cell.
 - (3) In the absence of ribosomes, ER appear smooth and are called smooth endoplasmic reticulum (SER).
 - (4) The endoplasmic reticulum (ER) is scattered in the cytoplasm.
62. Fill in the blanks:
- ER divides the ... (a) ... space into two distinct compartments, i.e., luminal ... (b) ... and extra luminal ... (c) ... compartments.
- (1) a - Extracellular, b - Inside ER, c - Cytoplasm
 - (2) a - Intracellular, b - Outside ER, c - Nucleus
 - (3) a - Extracellular, b - Outside ER, c - Nucleus
 - (4) a - Intracellular, b - Inside ER, c - Cytoplasm

Mitochondria and Plastids

63. The DNA is located in the _____ of _____.
- (1) Cristae, mitochondria
 - (2) Matrix, mitochondria
 - (3) Intermembrane space, mitochondria
 - (4) Grana, chloroplast
64. Which of the following is the correct pair?
- (1) DNA synthesis — Ribosomes
 - (2) Protein synthesis — Smooth ER
 - (3) Aerobic respiration — Mitochondria
 - (4) Suicidal sacs — Chloroplast

65. Read the following statements.
 A: Mitochondria help in generation of adenosine triphosphate.
 B: The outer mitochondrial membrane folds into several cristae.
 (1) Only B is incorrect.
 (2) Both A and B are correct.
 (3) Only A is incorrect.
 (4) Both A and B are incorrect.
66. Choose the correct statements.
 I. Mitochondria and chloroplast transfer energy.
 II. Mitochondrion is a powerhouse of cell, as it produces most of the cellular ATP.
 III. Mitochondria and chloroplast are found in all eukaryotic cells.
 IV. Mitochondria are the sites of anaerobic respiration.
 V. The matrix of mitochondria possesses a single, linear DNA, many RNA molecules, 80S ribosomes.
 (1) IV and V (2) I and II
 (3) II, IV and V (4) III and V
67. Which statement about chloroplasts is false?
 (1) They are organelles with a double membrane.
 (2) They contain their own genetic information and ribosomes.
 (3) They are found in all eukaryotic and prokaryotic cells.
 (4) The thylakoid membranes within the chloroplast contain chlorophyll.
68. I. Amyloplasts
 II. Elaioplasts
 III. Aleuroplast
 The above types of plastids are included under:
 (1) Leucoplasts (colorless plastid)
 (2) Chromoplasts (nongreen color plastid)
 (3) Chloroplast (green plastid)
 (5) None
69. Which of these is mismatched?
 (1) Amyloplasts—Store protein granules
 (2) Elaioplasts—Store oils or fats
 (3) Chloroplasts—Contain chlorophyll pigments
 (4) Chromoplasts—Contain colored pigments other than chlorophyll
70. Extranuclear genes are found in:
 (1) Lysosome and chloroplast
 (2) GB and ER
 (3) Nucleus and mitochondria
 (4) Mitochondria and chloroplast
71. Plastids are found in
 (1) Some plant cells and all euglenoids
 (2) All plant cells and in euglenoids
 (3) All plant cells and protists
 (4) Some plant cells and all protists
72. The sites of aerobic respiration are
 (1) Chloroplasts (2) Oxysomes
 (3) Mitochondria (4) Peroxisomes
73. The ribosomes of the chloroplasts are
 (1) Larger (100S) than the cytoplasmic ribosomes (80S)
 (2) Smaller (70S) than the cytoplasmic ribosomes (80S)
 (3) Smaller (80S) than the cytoplasmic ribosomes (70S)
 (4) Larger (80S) than the cytoplasmic ribosomes (70S)
74. Plastids can be classified into chloroplasts, chromoplasts and leucoplasts based on the
 (1) Shape of plastids (2) Size of plastids
 (3) Type of stored food (4) Type of pigments
75. Which of the following type of plastid does not contain stored food material?
 (1) Chromoplasts and amyloplasts
 (2) Amyloplasts and aleuroplasts
 (3) Amyloplasts and elaioplasts
 (4) Aleuroplasts and elaioplasts
76. Read the following statements and choose the correct option.
 (1) Stroma lamellae connects the thylakoids of different grana.
 (2) Thylakoids are present in the stroma.
 (3) Chloroplasts are lens-shaped, oval, spherical, discoid or even ribbon-like organelles.
 (4) All of the above

Cytoskeletal Structure, Centriole, Cilia, and Flagella

77. The cytoskeleton is a proteinaceous network of fibers in the cytoplasm involved in:
 (1) Motility
 (2) Maintenance of cell shape
 (3) Mechanical support
 (4) All the above
78. The number of membranes that surround centrioles structure is:
 (1) 3 (2) 0
 (3) 1 (4) 2
79. I. Cilium and flagellum are covered with plasma membrane.
 II. Cilium/flagellum contains an outer ring of nine doublet microtubules surrounding two singlet microtubules.
 III. Flagella are comparatively longer and responsible for cell movement.
 IV. Cilia are smaller, which work like oars, causing the movement of either the cells or surrounding fluid.
 Which of the above statement is correct?
 (1) I, II (2) I, III
 (3) I, IV (4) All the above

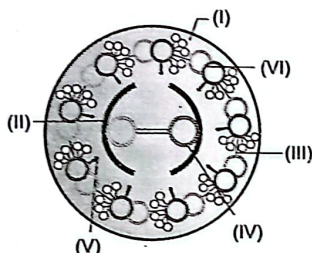
80. The core of cilium or flagellum, composed of microtubules and their associated proteins is called:

- (1) Actin (2) Axoneme
(3) Microfilament (4) Tubulin

81. Choose the correct statement about cilia and flagella.

- (1) They are hair-like outgrowths of the cell membrane.
(2) Eukaryotic flagella are not structurally different from prokaryotic flagella.
(3) They originate from basal bodies (centriole-like structure).
(4) Both (1) and (3) are correct.

82. Choose the correct labeling for the given diagram.

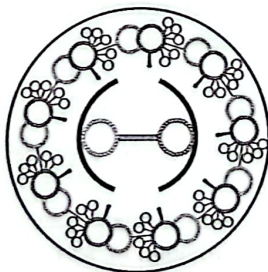


- (1) I – Central sheath
III – Intertriplet bridge
(2) II – Plasma membrane
IV – Central microtubule
(3) V – Radial spoke
IV – Incomplete microfilament
(4) II – Central sheath
III – Interdoublet bridge

83. Which of the following feature is not associated with centrosome?

- (1) Pericentriolar material
(2) Two cylindrical structures
(3) Two centriole
(4) Lipid bilayer covering

84. Choose the correct statement with respect to the following diagram.



- (1) Section of flagella showing different parts seen in eukaryotes and prokaryotes.
(2) It shows the cartwheel organization, with 9 + 0 microtubular arrangement.
(3) They form structures that cause movement of either the cell or the surrounding fluid.

(4) It forms structure that is not covered by any membrane.

85. Select the correct statement.

- (1) Centrioles form the basal body of cilia and flagella.
(2) Secondary constrictions on the chromosomes do not have a constant location.
(3) Microbodies are present in plant cells only.
(4) Nucleoli are less in number in cells undergoing protein synthesis.

86. How many parts are there in bacterial flagellum, and amongst these, which is the longest portion, respectively?

- (1) Two, hook (2) Two, filament
(3) Three, filament (4) Three, hook

87. Which of the following sequence is correct?

- (1) Basal body → Cilium/flagellum → Centriole
(2) Cilium/flagellum → Basal body → Centriole
(3) Centriole → Basal body → Cilium/flagellum
(4) Basal body → Centriole → Flagellum/cilium

Ribosome

88. Select the odd one out with respect to ribosomes.

- (1) Synthesized inside the nucleus in eukaryotes.
(2) Composed of DNA and proteins.
(3) Not surrounded by any membrane.
(4) Prokaryotic ribosomes are 70S.

89. Ribosomes are found in all except:

- (1) Bacteria
(2) Mitochondria and chloroplast
(3) RER
(4) GB

90. Which of the following pairs is correct?

- (1) Svedberg unit — Biomembranes
(2) Polyribosomes — RNA
(3) Mitochondria — Suicidal sacs
(4) Cisternae — Chloroplast

91. Which one is considered as organelle within organelle?

- (1) Chloroplast (2) Nucleus
(3) Mitochondria (4) Ribosome

92. Ribosomes are the granular structures first observed under the electron microscope as dense particles in the year

- (1) 1853 (2) 1898
(3) 1953 (4) 1998

93. Which of the following is not true about ribosomes?

- (1) The eukaryotic ribosomes are 80S while the prokaryotic ribosomes are 70S
(2) Each ribosome has two subunits, a larger and a smaller subunit
(3) The two subunits of 80S ribosomes are 50S and 30S
(4) All of the above are true

Nucleus

94. The chief role of nucleolus in a nucleus is:
- Organization of chromosome
 - DNA replication
 - Biosynthesis of ribosomes
 - Chromatid separation
95. The eukaryotic cell structure, which controls the activities of organelles and also plays a major role in heredity is:
- Nucleoli
 - Nucleus
 - Nucleoid
 - Mitochondria
96. Interphase nucleus possesses:
- Condensed chromatin, nucleolus, nuclear matrix, centrioles
 - Elaborate nucleoprotein fibers, sub-spherical nucleoli, stroma
 - Extended nucleoprotein fiber, nucleolus, nuclear matrix
 - Condensed chromatin, subspherical nucleoli, matrix
97. In a cell that is not dividing, the chromosomes are visible as a tangle of fine threads called:
- Microtubules
 - Chromatin
 - Microfilaments
 - Nucleotin
98. Which of the following are used to define the karyotype of a species?
- The number of chromosomes
 - The chromosome length
 - The positions of the centromeres
- Code:**
- I, II and III are correct
 - Only I and II are correct
 - Only II and III are correct
 - Only I and III are correct
99. A chromosome having subterminal centromere is called:
- Telocentric
 - Acrocentric
 - Metacentric
 - Submetacentric
100. Basic structure of chromatin is composed of:
- Nonhistone proteins wrapped around DNA
 - Histone proteins wrapped around DNA
 - RNA wrapped around histones
 - DNA wrapped around histones
101. The structure of nuclear membrane facilitates:
- Synapsis of homologous chromosomes at meiosis
 - Nucleocytoplasmic exchange of materials
 - Anaphasic separation of daughter chromosomes
 - Organization of spindles

102. Identify the correct match between types of chromosomes and their descriptions.

Chromosomes	Position of Centromere
A. Metacentric	1. At the tip
B. Submetacentric	2. Almost near the tip
C. Acrocentric	3. At the middle
D. Telocentric	4. Slightly away from the middle

- A-1, B-3, C-2, D-4
 - A-4, B-3, C-2, D-1
 - A-3, B-4, C-2, D-1
 - A-4, B-3, C-1, D-2
103. Nuclear DNA exists as a complex of proteins called _____ that condenses into _____ during _____.
- Chromatids, chromosomes, cell division.
 - Chromosomes, chromatin, interphase.
 - Chromatin, chromosome, interphase
 - Chromatin, chromosome, cell division
104. The nuclear pores are the passage for the movement of certain materials between the nucleus and cytoplasm in both the direction. Which one is correct about materials in their respective direction?
- mRNA out of the nucleus
 - Ribosomal components out of the nucleus
 - Proteins, enzymes into the nucleus
 - All the above
105. Part of chromosome after secondary constriction is called:
- Chromomere
 - Telomere
 - Satellite
 - Primary constriction
106. Chromosome with one shorter arm and one longer arm, having centromere slightly away from middle is:
- Acrocentric
 - Metacentric
 - Submetacentric
 - Telocentric
107. The content of nucleolus is continuous with the rest of the nucleoplasm because
- It is not surrounded by any membrane
 - It is traversed by plasmodesmata
 - Nuclear pore is present in nucleolus
 - All of the above
108. Fill in the blanks:
- Sometimes a few chromosomes have ...(a)... secondary constrictions at a ...(b)... location. This gives the appearance of ...(c)... fragment called the satellite.
- a - Non-staining, b - Variable, c - A small
 - a - Staining, b - Constant, c - A large
 - a - Staining, b - Variable, c - A large
 - a - Non-staining, b - Constant, c - A small
109. The nuclear pores are the passages through which
- Movement of RNA molecules takes place from the nucleus to the cytoplasm



- (2) Movement of protein molecules takes place in both directions between the nucleus and the cytoplasm
 - (3) Movement of RNA and protein molecules takes place from the nucleus to the cytoplasm
 - (4) Movement of RNA and protein molecules takes place in both directions between the nucleus and the cytoplasm
- 110.** The nuclear matrix or the nucleoplasm contains
- (1) Nucleolus
 - (2) Chromatin
 - (3) Both nucleolus and chromatin
 - (4) Nuclear envelop

NCERT Based

MIXED CONCEPT QUESTIONS

1. Which one of the following pairs is not correctly matched?
- (1) Cristae: The "Shelves" formed by the folding of the inner membrane of the mitochondrion
 - (2) Plasmodesmata: The membrane surrounding the vacuole in plants
 - (3) Grana: Membrane-bound discs in chloroplasts that contain chlorophylls and carotenoids
 - (4) Middle lamella: Layer between adjacent cell walls in plants derived from cell plate

2. Match the following columns and choose the correct option.

Column I	Column II
1. Cell theory	a. Rudolf Virchow
2. Fluid mosaic model	b. Schleiden and Schwann
3. Cells arise from pre-existing cells	c. Schwann
4. Bodies of animals and plants are composed of cells and products of cells	d. Schleiden
	e. Singer and Nicolson

- (1) 1 - d, 2 - e, 3 - b, 4 - c
- (2) 1 - b, 2 - e, 3 - a, 4 - a
- (3) 1 - e, 2 - d, 3 - a, 4 - d
- (4) 1 - b, 2 - e, 3 - a, 4 - c

3. Read the following statements and choose the correct option.

- Stroma is the site of dark reactions.
- The plasma membrane is selectively permeable and facilitates transport of several molecules.
- All the cell organelles perform different but specific functions.
- Nucleus does not only control the activities of organelles but also plays a major role in heredity.
- Mitochondria help in oxidative phosphorylation and generation of adenosine triphosphate.

- (1) All statements are correct
- (2) Only statements i, ii, and iv are correct
- (3) Only statements ii, iii and v are correct
- (4) Only statements ii, iv and v are correct

4. Inclusion bodies:

- (1) Are bound by a unit membrane
- (2) Store reserve material in eukaryotic cells
- (3) Can be glycogen granules
- (4) Are living structures

5. A characteristic feature common to both a plant sieve tube cell and a mammalian erythrocyte is

- (1) Absence of mitochondria
- (2) Absence of nucleus
- (3) Presence of cell wall
- (4) Presence of haemoglobin

6. Protein synthesis in an animal cell takes place:

- (1) Only in the cytoplasm
- (2) In the cytoplasm as well as in mitochondria
- (3) In the nucleolus as well as in the cytoplasm
- (4) Only on ribose attached to nucleus

7. Read the following statements.

- The Golgi body is a membranous organelle composed of flattened sacs.
- Endoplasmic reticulum contains tubules or cisternae.
- In all cells, centrioles also form spindle apparatus during cell division.
- Nucleus contains nucleoli and chromatin network.

How many statements are correct?

- (1) Four
- (2) One
- (3) Two
- (4) Three

8. Match the following cellular organelles with their functions.

Column I	Column II
A. Rough endoplasmic reticulum	1. Makes ATP
B. Mitochondria	2. Contain lipases
C. Golgi complex	3. Synthesizes proteins to be used inside the cell
D. Ribosomes	4. Synthesizes proteins to be used outside the cell
E. Lysosomes	5. 80S and 70S

- (1) A-2, B-1, C-5, D-3, E-4
- (2) A-3, B-1, C-2, D-4, E-5
- (3) A-4, B-1, C-3, D-5, E-2
- (4) A-5, B-4, C-3, D-1, E-2

9. Read the following statements.

- Lipids are arranged in a bilayer with polar heads towards inner side.
- Both chloroplasts and mitochondria contain DNA.
- Vacuole in a plant cell is membrane-bound and contains storage protein and lipids.
- Neutral solutes require a carrier protein of the membrane to facilitate their transport across the membrane.

- E. The secretions of cells are packed in Golgi body and are transported from the cell.

Incorrect statements are:

- (1) Only A and D (2) Only A, C and D
(3) Only A, C and E (4) Only B and E
10. Which of the statement is not true for ribosomes?
(1) Made of two subunits
(2) May attach to mRNA
(3) Form polysome
(4) Have no role in protein synthesis
11. Match the following columns and choose the correct option.
- | Column I | Column II |
|---------------|--|
| 1. Mesosomes | a. Vacuole |
| 2. Cisternae | b. Leucoplast |
| 3. Tonoplast | c. Disc-shaped sacs in Golgi apparatus |
| 4. Amyloplast | d. Respiration |
| 5. Cristae | e. Mitochondria |
- (1) 1 - d, 2 - c, 3 - b, 4 - a, 5 - e
(2) 1 - d, 2 - c, 3 - a, 4 - b, 5 - e
(3) 1 - c, 2 - e, 3 - a, 4 - b, 5 - d
(4) 1 - d, 2 - e, 3 - a, 4 - b, 5 - c
12. Find out the correct match with regard to stored food.
(I) Aleuroplasts—Proteins
(II) Elaioplasts—Fats and Oils
(III) RER—Glycogen
(IV) Amyloplasts—Starch
(1) I and II only (2) I, II, III, and IV
(3) I, II, and IV (4) I, III, and IV
13. Select the incorrect match.
(1) Cristae—Increase the surface area
(2) Amyloplast—Store starch
(3) Inner nuclear membrane—Bears ribosomes
(4) Kinetochore—Attachment site for spindle fibers
14. Read the following statements and choose the incorrect option.
(1) Besides flagella, pili and fimbriae are also surface structures of the bacteria.
(2) Pili and flagella do not play a role in motility.
(3) Chromatophores are membranous extensions into the cytoplasm.
(4) Bacteria show a range in the number and arrangement of flagella.
15. Which among the following is not a eukaryotic cell?
(1) *Anabaena* (2) *Agaricus*
(3) *Euglena* (4) *Spirogyra*

16. In which of the following features bacterial cells, plant cells, and animal cells show similarity?

- (1) Cytoskeleton (2) Glycocalyx
(3) 70 S ribosomes (4) Flagella organization

17. $\text{Na}^+ - \text{K}^+$ exchange pump involves:

- (1) Diffusion (2) Osmosis
(3) Deplasmolysis (4) Active transport

18. Match the following columns and choose the correct option.

Column I	Column II
1. Endoplasmic reticulum	a. Contain various enzymes
2. Elaioplasts	b. Contain tubules
3. Microbodies	c. Present in stroma
4. Thylakoid	d. Store oils or fats

- (1) 1 - a, 2 - d, 3 - c, 4 - b
(2) 1 - b, 2 - d, 3 - a, 4 - c
(3) 1 - b, 2 - d, 3 - c, 4 - a
(4) 1 - d, 2 - b, 3 - a, 4 - c

19. Choose the correct statement.

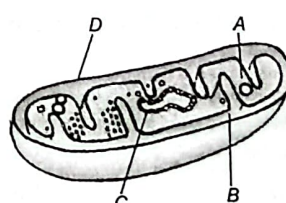
- (1) Mitochondria and chloroplast are energy transducers.
(2) The functions of mitochondria, chloroplast, and peroxisome are not coordinated with ER, GB, lysosome, and vacuoles, so they are not a part of the endomembranous system.
(3) Internal compartmentalization causes the division of labor within eukaryotic cells that greatly increases overall cellular function.
(4) All the above.

20. Read the following statements and choose the incorrect option.

- (1) Prokaryotic cells are generally smaller and multiply more rapidly than the eukaryotic cells.
(2) Bacteria can be classified into two groups on the basis of the differences in the cell envelopes and the manner in which they respond to the staining procedure developed by Gram.
(3) Although each layer of the cell envelope performs distinct function, they act together as a single protective unit.
(4) None of the above

21. Match List I and List II and select the correct answer using the code given below the lists.

List I	List II
1. Microtubules	Structural components of cilia
2. Centrioles	Store hydrolytic enzymes
3. Peroxisomes	Store oil protein and starch in plants

- (1) 1, 2 and 3 are correct.
 (2) 1 and 2 are correct, 3 is false.
 (3) 1 is correct, 2 and 3 are false.
 (4) 1 and 3 are correct, 2 is false.
22. Of the following organelles, which group is involved in manufacturing substances needed by cell?
 (1) Lysosome, vacuole, ribosome
 (2) Vacuole, RER, SER
 (3) Ribosome, RER, SER
 (4) RER, lysosome, vacuole
23. A, B, and C are three membrane-bound cell organelles. Organelle C is formed from A, whereas B transfers some complex organic substances to A, for modification and packaging. Apart from this cell organelle, B also possess another organelle upon it, other than A and C. Identify A, B, and C, respectively.
 (1) Lysosomes—Golgi complex—RER
 (2) Golgi complex—Lysosomes—RER
 (3) RER—Golgi complex—Lysosomes
 (4) Golgi complex—RER—Lysosomes
24. "A" is a cell organelle that is present in another cell organelle.
 "B" is a cell organelle that contains "A" on its surface.
 "C" is a cell organelle that contains "A" in it.
 Then "A," "B," and "C," respectively, are:
 (1) Ribosomes, Golgi complex, mitochondria
 (2) Ribosomes, mitochondria, lysosomes
 (3) Mitochondria, ribosomes, chloroplast
 (4) Ribosomes, endoplasmic reticulum, chloroplast
25. Different cells have different sizes. Arrange the following cells in ascending order of their sizes and select the correct option.
 (i) Mycoplasma (ii) Ostrich eggs
 (iii) Human RBCs (iv) Bacteria
 (1) (i), (iv), (iii), (ii)
 (2) (i), (iii), (iv), (ii)
 (3) (ii), (i), (iii), (iv)
 (4) (iii), (ii), (i), (iv)
26. Read the following statement and choose the incorrect option.
 (1) Chemical studies on the cell membrane, especially in human red blood cells (RBCs), enabled the scientists to deduce the possible structure of plasma membrane.
 (2) The ratio of protein and lipid varies considerably in different cell types.
 (3) The cell membrane is completely permeable to some molecules present on either side of it.
 (4) In addition to phospholipids, cell membrane also contains cholesterol.
27. Match List I and List II, and select the correct answer using the code given below the list:
- | List I | List II |
|---------------|---|
| a. Lysosome | 1. Bacteria without cell walls |
| b. Mycoplasma | 2. Flattened sacs in a chloroplast |
| c. Thylakoid | 3. A vesicle in which hydrolytic enzymes are stored |
- Code:
 a b c
 (1) 3 1 2
 (2) 2 1 3
 (3) 2 3 1
 (4) 1 3 2
28. Match the following and pick the correct options given.
- | Cell organelle | Function |
|--------------------------|---------------------------------------|
| a. Endoplasmic reticulum | (i) Take part in cellular respiration |
| b. Free ribosome | (ii) Take part in glycosylation |
| c. Mitochondrion | (iii) Synthesize lipids |
| d. Golgi body | (iv) Synthesize nonsecretory proteins |
- (1) a-(iii), b-(iv), c-(i), d-(ii)
 (2) a-(i), b-(ii), c-(iv), d-(iii)
 (3) a-(iii), b-(ii), c-(i), d-(iv)
 (4) a-(ii), b-(i), c-(iii), d-(iv)
29. The figure below is the structure of a mitochondrion with labeled parts A, B, C, and D. Select the part correctly matched with its function.
- 
- (1) Part C: Cristae (possess single, circular DNA molecule and ribosomes)
 (2) Part B: Inner membrane (forms infoldings called cristae)
 (3) Part D: Outer membrane (gives rise to inner membrane by splitting)
 (4) Part A: Matrix (major site for ETS)
30. The characteristic feature common to both prokaryotes and many of the eukaryotic organisms is
 (1) Presence of chromatin material
 (2) Presence of cell wall present
 (3) Presence of membrane-bound subcellular organelles
 (4) Presence of nuclear membrane

31. Function(s) of the cell wall is/are
- Provide shape of the cell and protects the cell from the mechanical damage and infection.
 - Helps in cell-to-cell interaction.
 - Provides barrier to undesirable macromolecules.

Choose the correct option:

- (1) I only (2) II and III
(3) I and III (4) I, II and III
32. Match the following columns and choose the correct option.

Column I	Column II
1. Non-membrane bound	a. Centrosome
2. Single membrane bound	b. Plastids
3. Double membrane bound	c. Endoplasmic reticulum

- (1) 1 - b, 2 - c, 3 - a
(2) 1 - c, 2 - a, 3 - b
(3) 1 - a, 2 - c, 3 - b
(4) 1 - a, 2 - b, 3 - c
33. Which of the following is incorrect about vacuole?
- In protists, food vacuoles are formed by engulfing the food particles.
 - The vacuole is the membrane-bound space found in the cytoplasm.
 - In plants, the tonoplast facilitates the transport of a number of ions and other materials against concentration gradients into the vacuole.
 - The concentration of ions and other materials is significantly higher in the cytoplasm than in the vacuole.

34. Match the following columns and choose the correct option.

Column I	Column II
1. Ribosomes	a. Robert Brown
2. Term cell	b. Anton Von Leeuwenhoek
3. First saw and described a live cell	c. Flemming
4. Nucleus	d. George Palade
5. Chromatin	e. Robert Hooke

- (1) 1 - d, 2 - a, 3 - b, 4 - e, 5 - c
(2) 1 - d, 2 - e, 3 - b, 4 - c, 5 - a
(3) 1 - b, 2 - d, 3 - c, 4 - e, 5 - a
(4) 1 - d, 2 - e, 3 - b, 4 - a, 5 - c
35. The fluid mosaic model of plasma membrane was proposed by
- Singer and Nicolson
 - Camillo Golgi

- (3) Robert Brown
(4) Schleiden and Schwann

36. Which of the following statements is true for a secretory cell?

- Golgi apparatus is absent.
- Rough endoplasmic reticulum (RER) is easily observed in the cell.
- Only smooth endoplasmic reticulum (SER) is present.
- Secretory granules are formed in nucleus.

37. Read the following statements and choose the correct option.

- Lysosomes consist of many flat, disc-shaped sacs.
 - The endoplasmic reticulum bearing ribosomes on their surface is called rough endoplasmic reticulum (SER).
 - Golgi bodies are found near the nucleus.
 - The Golgi cisternae are stacked parallel to each other.
- All statements are correct
 - Only statements I and II are incorrect
 - Statements I, III and IV are incorrect
 - All statements are incorrect

38. Read the following statements and choose the correct option.

- The Golgi cisternae are concentrically arranged near the nucleus with distinct concave *cis* or the forming face and convex *trans* or the maturing face.
- The Golgi cisternae are concentrically arranged near the nucleus with distinct convex *cis* or the maturing face and concave *trans* or the forming face.
- The Golgi apparatus principally performs the function of packaging materials, to be delivered either to the intracellular targets or secreted outside the cell.
- Number of proteins synthesised by ribosomes on the endoplasmic reticulum are modified in the cisternae of the Golgi apparatus before they are released from its *cis* face.

39. Match List I with II and select the correct answer using the codes given below the lists.

List I	List II
(A) Golgi complex	(i) Storage
(B) Mitochondria	(ii) Photosynthesis
(C) Vacuoles	(iii) Transport
(D) Grana	(iv) Secretion
	(v) Respiration

- | | | | | |
|-----|-------|-------|-------|------|
| | A | B | C | D |
| (1) | (iv) | (v) | (i) | (ii) |
| (2) | (iii) | (iv) | (ii) | (i) |
| (3) | (iv) | (v) | (iii) | (ii) |
| (4) | (iv) | (iii) | (i) | (ii) |

40. Select the correct statement for a secretory cell.
- (1) Secretory granules are formed in nucleus.
 - (2) Rough Endoplasmic reticulum (RER) is easily observed in the cell.
 - (3) Only Smooth endoplasmic reticulum (SER) is present.
 - (4) Golgi apparatus is absent.

41. Match list I with list II and select the correct answer.

List I	List II
(A) Nucleolus	(1) Photorespiration
(B) Peroxisomes	(2) Glyoxylate metabolism
(C) Glyoxysomes	(3) Transport of macromolecules
(D) Plasmodesmata	(4) Ribosome synthesis

A	B	C	D
(1) 4	1	3	2
(2) 1	2	4	3
(3) 4	1	2	3
(4) 1	2	3	4

42. Read the following statements.
- (A) Protein storage cell organelles are amembranous.
 (B) Plastids are found in all photosynthetic organisms.

Which of the above statement(s) is/are incorrect?

- (1) A only
- (2) B only
- (3) Both A and B
- (4) Neither A nor B

43. Which of the following is the common purpose for the mesosomes in a bacterial cell, cristae in a mitochondrion, and grana in a chloroplast?
- (1) Oxidation of food
 - (2) ATP synthesis by photophosphorylation
 - (3) Increase the surface area
 - (4) Utilization of O_2 for ATP synthesis

44. Some cellular structures bounded by single or double membranes, whereas some other are without a membrane. Match the organelle in List I with the nature of membrane in List II and select the correct answer using the codes given below.

List I	List II
(A) Mitochondria	(1) Without membrane
(B) Lysosomes	(2) Single membrane
(C) Ribosomes	(3) Double membrane
(D) Nucleus	(4) Double membrane with pores

A	B	C	D
(1) 1	2	3	4
(2) 3	1	4	2
(3) 3	2	1	4
(4) 2	3	4	1

45. Tonoplast refers to
- (1) Inner membrane of chloroplast
 - (2) Outer membrane of mitochondria
 - (3) Cell membrane of a plant cell
 - (4) Membrane of the vacuoles in plant cells

46. The arrangement of microtubules regarding the structure of cilia/flagella are
- (1) $9 + 1$
 - (2) $9 + 0$
 - (3) $9 + 2$
 - (4) $11 + 0$

47. Choose the incorrect statement.
- (1) Centriole is a nonmembrane-bound cell organelle found in animal cells only.
 - (2) Ribosome is the nonmembrane-bound cell organelle found in all types of living cells.
 - (3) Centrioles are the only the membranous cell organelles present in animal cells.
 - (4) Ribosomes and inclusion bodies are non-membranous cell organelles found in prokaryotes.

48. Which of the following is not a correct match?
- (1) Contractile vacuole of *Amoeba* – Excretion
 - (2) Lysosomal enzymes – Optimally active at acidic pH
 - (3) Smooth ER – Synthesis of steroidal hormones
 - (4) Centrioles – Non-membranous organelles found in all eukaryotic cells

49. Identify the correct ones with regard to Golgi apparatus.
- (I) Convex side is called *cis* or forming face.
 - (II) Concave side is called *trans* or maturing face.
 - (III) Cisternae of Golgi body modify proteins.
 - (IV) Materials enters through transface and are released through *cis* face.
- (1) I - II - III
 - (2) II - III - IV
 - (3) I - II - IV
 - (4) I - III - IV

50. Which of the following statement is not true for an eukaryotic cell?
- (1) Membrane bound organelles are present.
 - (2) It has 80S type of ribosome present in the cytoplasm.
 - (3) Cell wall is made up of peptidoglycans.
 - (4) Mitochondria contain circular DNA.

51. Match the following columns and choose the correct option.

Column I	Column II
1. Plasmodesmata	a. Stroma
2. Centriole	b. Connect the cytoplasm of neighbouring cells
3. Chloroplasts	c. Infoldings in mitochondria
4. Cristae	d. Basal body of cilia or flagella

- (1) 1 - b, 2 - d, 3 - a, 4 - c
- (2) 1 - b, 2 - c, 3 - d, 4 - a
- (3) 1 - c, 2 - d, 3 - a, 4 - d
- (4) 1 - d, 2 - b, 3 - a, 4 - c

52. Match the following columns and choose the correct option.

Column I	Column II
1. Microtubules	a. Active ribosomal RNA synthesis
2. Centrosome	b. Cytoskeleton
3. Nucleolus	c. Holds two chromatids
4. Centromere	d. Basal body

- (1) 1 – b, 2 – d, 3 – a, 4 – c
 (2) 1 – d, 2 – b, 3 – c, 4 – a
 (3) 1 – b, 2 – d, 3 – c, 4 – a
 (4) 1 – d, 2 – b, 3 – a, 4 – c

53. Read the following statements and choose the incorrect option about mitochondria.

- (1) The two membranes have their own specific enzymes associated with the mitochondrial function.
 (2) The cisternae increase the surface area in the mitochondria.
 (3) The number of mitochondria per cell is variable depending on the physiological activity of the cells.
 (4) They produce cellular energy in the form of ATP.

54. Which of the following produces and modifies polysaccharides that will be secreted?

- (1) Lysosome (2) Vacuole
 (3) Mitochondrion (4) Golgi apparatus

55. Select the incorrect statements for plasma membrane.

- (1) It is present in both plant and animal cells.
 (2) Lipid is present as bilayer in it.
 (3) Carbohydrates are never found in it.
 (4) Proteins are present integrated as well as loosely associated with the lipid bilayer.

56. Golgi complex is absent in _____.

- (1) Sperms of bryophytes
 (2) Sieve tubes of plants
 (3) Matured RBCs of mammals
 (4) All of these

57. Study the following pairs.

- (A) Starch storage—Amyloplast
 (B) Detoxification of H_2O_2 —Lysosomes
 (C) Oxidation of food—Mitochondria
 (D) Synthesis of steroidal hormones—SER
 (E) Digestion of glycoproteins—Golgi complex

Out of these:

- (1) A, C, and D are wrong
 (2) A, B, and D are correct
 (3) Except D, all are correct
 (4) B and E are wrong

58. Correct statement regarding mitochondria and chloroplast.

- (I) ATP synthesis is seen in both.

(II) Outer membrane has more surface in both.

(III) Circular naked DNA, RNA, and 70S ribosomes are seen in both.

(IV) Oxidative phosphorylation occurs in both.

- (1) I and II (2) II and III
 (3) I and III (4) I and IV

59. Choose the correct statement among the following.

- (1) Components of cytoskeleton are useful during anaphase.
 (2) Cytoskeleton filaments are made up of cellulose and hemicellulose.
 (3) Cilia and flagella emerge from centriole-like structures called as axoneme.
 (4) Cilia and flagella are outgrowths of nuclear wall.

60. Plastids can be differentiated from mitochondria on the basis of certain features. Identify the correct feature with respect to this.

- (1) Presence of two layers of membrane
 (2) Presence of thylakoids
 (3) Presence of ribosome
 (4) Presence of DNA

61. Lysosomes are the reservoirs (store houses) of:

- (1) Hydrolytic enzymes
 (2) Secretory glycoproteins
 (3) RNA and protein
 (4) Fats (or sugars or ATP)

62. Chlorophyll in chloroplasts is located in:

- (1) Grana (2) Thylakoids
 (3) Stroma (4) Both (1) and (3)

63. Which of the following does not contain DNA?

- (1) Mitochondrion (2) Chloroplast
 (3) Peroxisome (4) Nucleus

64. Endoplasmic reticulum is in continuation with:

- (1) Golgi body (2) Nuclear wall
 (3) Mitochondria (4) Cell wall

65. Which of the following is not a function of cytoskeleton in a cell?

- (1) Intracellular transport
 (2) Cell motility
 (3) Maintenance of cell shape and structure
 (4) Support of the organelle

66. Read the following statements and choose the incorrect option.

- (1) The inner chloroplast membrane is relatively less permeable.
 (2) Mitochondria (sing.: mitochondrion), unless specifically stained, are not easily visible under the microscope.
 (3) Cristae are formed towards the matrix in mitochondria.
 (4) The inner membrane of mitochondria forms the continuous limiting boundary of the organelle.

67. Match the following columns and choose the correct option.

Column I	Column II
1. Nucleus	a. Respiration
2. Lysosome	b. Hydrolases
3. Mitochondria	c. RNA
4. Chloroplast	d. Double membrane bound

- (1) 1 - d, 2 - b, 3 - a, 4 - c
 (2) 1 - c, 2 - b, 3 - d, 4 - c
 (3) 1 - d, 2 - b, 3 - c, 4 - d
 (4) All of the above
68. The thylakoids are present in the stroma
- Single circular DNA molecule, a few RNA molecules, ribosomes (80S) and the components required for the synthesis of lipids
 - Single circular DNA molecule, a few RNA molecules, ribosomes (70S) and the components required for the synthesis of proteins
 - Double circular DNA molecule, many RNA molecules, ribosomes (80S) and the components required for the synthesis of proteins
 - Single circular DNA molecule, a few RNA molecules, ribosomes (70S) and the components required for the synthesis of lipids
69. Read the following statements.
- Of the two membranes of chloroplast, the outer membrane is relatively less permeable.
 - Thylakoids are arranged in stacks like piles of coins called granum or intergranal thylakoids.
 - The stroma of chloroplast contains enzymes required for the synthesis of carbohydrates and proteins.
- Choose the correct statements:
- I only
 - II and III
 - I and II
 - I, II and III
70. Read the following statements and find out the correct statements.
- Mitochondrion is typically sausage shaped or cylindrical
 - The inner compartment of the mitochondrion is called stroma and of chloroplast is called matrix
 - Mitochondria and bacteria both divide by fission
 - Chromoplasts have fat insoluble carotenoid pigments like carotene and xanthophylls
 - Plastids are found in all plant cells and euglenoids
- b, c, e
 - a, b, d
 - c, d, e
 - a, c, e
71. Read the following statements and choose the incorrect option.
- Each ribosome has two subunits, a larger and a smaller subunit.
 - Only 80S ribosomes are composed of two subunits.

- Cilia (sing.: cilium) and flagella (sing.: flagellum) are hair-like outgrowths of the cell membrane.
- The prokaryotic bacteria possess flagella which are structurally different from that of the eukaryotic flagella.

72. Read the following statements and choose the correct option.

- Cilia are large structures which work like oars, causing the cell movement.
- Flagella are comparatively longer and responsible for movement of either the cell or the surrounding fluid.
- The axoneme usually has nine triplets of radially arranged peripheral microtubules, and a pair of centrally located microtubules.
- Axoneme possesses a number of microtubules running parallel to the long axis.

73. Read the following statements and find out the correct statements.

- Prokaryotic and eukaryotic flagella are structurally similar.
 - Cilia work like oars and comparatively smaller than flagella.
 - The core of cilium or flagellum is called axoneme.
 - Central tubules are connected by interdoublet bridges and is enclosed by central sheath.
 - Central sheath is connected to one of the tubules of each peripheral doublets by a radial spoke. There are nine radial spokes.
 - Peripheral doublets are also interconnected by linkers.
- b, d, e, f
 - c, d, e
 - a, b, c
 - b, c, e, f

74. Read the following statements and choose the correct option.

- Spindle fibres give rise to spindle apparatus during cell division in animal cells.
 - Centrioles are made up of nine evenly spaced peripheral fibrils of tubulin protein.
 - Radial spokes are made of protein.
 - The adjacent triplets are linked.
- All statements are correct
 - Only statements i, ii and iv are correct
 - Only statements i and iii are correct
 - Only statements ii and iv are correct

75. Match the following columns and choose the correct option.

Column I	Column II
1. Endoplasmic reticulum	a. Granular structures
2. Cell wall	b. Formation of intercellular junctions
3. Cell membrane	c. Lipid synthesis
4. Ribosomes	d. Protects the cell from mechanical damage and infection



- (1) 1 - c, 2 - d, 3 - b, 4 - a
- (2) 1 - a, 2 - d, 3 - b, 4 - c
- (3) 1 - c, 2 - b, 3 - d, 4 - a
- (4) 1 - a, 2 - b, 3 - d, 4 - c

76. Read the following statements.

- i. Microbodies are present only in plant cells.
- ii. All organisms are made of cells or aggregates of cells.
- iii. The green coloured plastids are chloroplasts, which contain chlorophyll, whereas the other coloured plastids are chromoplasts, which may contain water soluble pigments like carotene and xanthophyll.
- iv. Glycocalyx in the form of loose sheath is called capsule.

How many statements are correct?

- (1) Two
- (2) Three
- (3) One
- (4) Four

77. Read the following statements.

- I. Inclusion bodies are not bound by any membrane.
- II. Pili and fimbriae do not play any role in motility.
- III. Nuclear pores act as passage for proteins and RNA molecules in both directions between nucleus and cytoplasm.
- IV. Centrosome and centromere form the basal body of cilia and flagella that facilitate locomotion.
- V. Lysosomes are non-membrane structures containing enzymes for digestion of all types of macromolecules.

How many statements are correct?

- (1) One
- (2) Three
- (3) Four
- (4) Five

78. Read the following statements.

- i. Mesosome is formed by the extensions of plasma membrane into the cell wall.
 - ii. In human beings, the membrane of the erythrocyte has approximately 40 per cent protein and 52 per cent lipids.
 - iii. In plant cells, the primary wall is capable of growth.
 - iv. The outer membrane of mitochondria is smooth and inner one folds into several cisternae.
- (1) All statements are correct
 - (2) Only statements i, ii and iv are incorrect
 - (3) Only statements ii and iv are correct
 - (4) All statements are incorrect

79. Read the following statements.

- i. The sub-metacentric chromosome has middle centromere forming two equal arms of the chromosome.
- ii. Chromatophores are found in some protists.
- iii. Cell membrane prevent the bacterium from bursting or collapsing.
- iv. The chloroplasts are generally much larger than mitochondria.

- v. Based on the presence or absence of a membrane bound nucleus and other organelles, cells and hence organisms can be named as unicellular or multicellular.

How many statements are incorrect?

- (1) Three
- (2) Two
- (3) Four
- (4) One

80. Read the following statement.

- I. Cytoskeleton is an elaborate network of filamentous proteinaceous structures which is involved in support of the cell.
- II. The number of chloroplasts varies from 1 per cell of the *Chlamydomonas*, a brown alga to 20-40 per cell in the mesophyll.
- III. The intermembrane space of mitochondria is filled with a dense homogeneous substance called the matrix.
- IV. Lipases, proteases, carbohydrases, and nucleases are active at pH less than 7.
- V. Plasmodesmata holds or glues the different neighbouring cells together.

Incorrect statements are:

- (1) Only II, III and V
- (2) Only III
- (3) Only I, II and IV
- (4) Only III, IV and V

81. Read the following statements and choose the correct option.

- i. Schwann proposed the hypothesis that the bodies of animals and plants are composed of cells and products of cells.
 - ii. The presence of cell wall is a unique character of the plant cells.
 - iii. Besides the nucleus, the prokaryotic cells have other membrane bound distinct structures called organelles.
 - iv. The cells of the human cheek have an outer membrane as the delimiting structure of the cell.
- (1) All statements are correct
 - (2) All statements are correct except iv
 - (3) All statements are correct except ii and iv
 - (4) All statements are correct except iii

82. Today the cell theory is understood as

- I. All living organisms are composed of cells and products of cells.
- II. Only multicellular organisms are composed of cells and products of cells.
- III. Only unicellular organisms are composed of cells.
- IV. Only plant and animal cells arise from pre-existing cells.
- V. All cells arise from pre-existing cells.

The correct statements are:

- (1) I and IV
- (2) I and V
- (3) II and V
- (4) III and IV

83. Match the following columns and choose the correct option.

Column I	Column II
1. Bacillus	a. Spiral
2. Vibrio	b. Rod like
3. Spirillum	c. Spherical
4. Coccus	d. Comma shaped

- (1) 1 - b, 2 - a, 3 - d, 4 - c
 (2) 1 - c, 2 - a, 3 - d, 4 - b
 (3) 1 - c, 2 - d, 3 - a, 4 - b
 (4) 1 - b, 2 - d, 3 - a, 4 - c
84. Read the following statements and choose the correct option.
- Glycocalyx differs in composition and thickness among different bacteria.
 - In prokaryotes, the genetic material is basically naked, not enveloped by a nuclear membrane.
 - In onion peel and human cheek cells, nucleus is not surrounded by nuclear envelope.

- iv. Prokaryotic cells may vary greatly in shape and size.

Correct statements is/are:

- (1) Only iii
 (2) Only i, ii and iii
 (3) Only i, ii and iv
 (4) All statements are correct

85. Match the following columns and choose the correct option.

Column I	Column II
1. Slime layer	a. Lamellae
2. Capsule	b. Basal body
3. Mesosomes	c. Thick and tough
4. Flagella	d. Loose sheath

- (1) 1 - d, 2 - c, 3 - a, 4 - b
 (2) 1 - c, 2 - d, 3 - a, 4 - b
 (3) 1 - d, 2 - c, 3 - b, 4 - a
 (4) 1 - c, 2 - d, 3 - b, 4 - a

ASSERTION REASON/STATEMENT BASED QUESTIONS

INSTRUCTION FOR QUESTIONS 1–10

IN EACH OF THE FOLLOWING QUESTION, A STATEMENT OF ASSERTION IS FOLLOWED BY A CORRESPONDING STATEMENT OF REASON. MARK THE CORRECT ANSWER AS PER THE INSTRUCTIONS GIVEN BELOW.

- (1) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
- (2) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
- (3) If Assertion is true but Reason is false.
- (4) If both Assertion and Reason are false.

1. Assertion: Chromatin contain RNA, DNA and histone proteins but non-histone proteins are absent.

Reason: Every chromosome essentially has a kinetochore on the sides of which centromeres are present.

2. Assertion: Sub-metacentric chromosome has one shorter and one longer arm.

Reason: Interphase nucleus has a loose and distinct network of fibres called chromatin.

3. Assertion: Cell is the fundamental structural and functional unit of all living organisms.

Reason: Anything less than a complete structure of a cell does not ensure independent living.

4. Assertion: Pili and fimbriae are known to help the bacteria to become motile in streams.

Reason: Unlike flagella, pili and fimbriae are surface structures of bacteria.

5. Assertion: In eukaryotic cells, there is an extensive compartmentalisation of cytoplasm.

Reason: Eukaryotic cells have membrane bound organelles.

6. Assertion: Fluid mosaic model was proposed by Singer and Nicholson.

Reason: The “mosaic” is the intricate composite of proteins and lipids of the membrane.

7. Assertion: $\text{Na}^+ - \text{K}^+$ ATPase is an important membrane-associated enzyme.

Reason: It helps in ion transfer across the membrane.

8. Assertion: In the chromoplasts, fat soluble carotenoid pigments like carotene, xanthophylls and others are present.

Reason: This gives the part of the plant a yellow, orange or red colour.

9. Assertion: One of the most important functions of the plasma membrane is the transport of the molecules across it.

Reason: The membrane is selectively permeable to some molecules present on either side of it.

10. Assertion: In plants, the tonoplast facilitates the transport of a number of ions and other materials against concentration gradients into the vacuole.

Reason: Their concentration is significantly higher in the vacuole than in the cytoplasm.

INSTRUCTION FOR QUESTIONS 11–20

IN THE FOLLOWING QUESTIONS, STATEMENT I IS FOLLOWED BY STATEMENT II. EACH QUESTION HAS THE FOLLOWING FOUR CHOICES OUT OF WHICH ONLY ONE IS CORRECT.

- (1) Both statement I and statement II are true
- (2) Both statement I and statement II are false
- (3) Statement I is true, and statement II is false
- (4) Statement I is false, and statement II is true

11. Statement I: In the cell membrane, the non-polar tail of saturated hydrocarbons is protected from the aqueous environment.

Statement II: The lipids are arranged within the membrane with the polar head towards the outer sides and the hydrophobic tail towards the inner part.

12. Statement I: Chloroplasts, mitochondria and peroxisomes are not considered as a part of the endomembrane system.

Statement II: Functions of chloroplasts, mitochondria and peroxisomes are not coordinated with ER, Golgi complex, lysosomes and vacuoles

13. Statement I: The nuclear pores are the passages through which movement of RNA and protein molecules takes place in both directions between the cytoplasm and nucleoplasm.

Statement II: Nuclear pores are formed by the fusion of two membranes of nucleus.

14. Statement I: Perinuclear space in nucleus is a site for active ribosomal RNA synthesis.

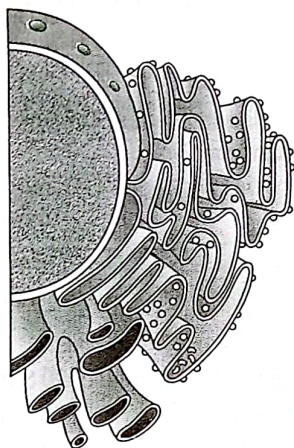
Statement II: Nuclear matrix or nucleoplasm contains one or more cylindrical structures called nucleolus.

15. **Statement I:** A number of proteins synthesized by rough endoplasmic reticulum are modified in the cisternae of Golgi bodies.
Statement II: Rough endoplasmic reticulum is the only cell organelle in a eukaryotic cell that synthesizes proteins.
16. **Statement I:** Eukaryotic cells have the ability to adopt a variety of shapes and carry out directed movements.
Statement II: There are three principal types of protein filaments—microfilaments, microtubules, and intermediate filaments which constitute the cytoskeleton.
17. **Statement I:** Cell wall is not found in animal cell.
Statement II: They are covered by cell membrane.
18. **Statement I:** Cristae are the infoldings of outer membrane of mitochondria.
Statement II: They help in increasing surface area.
19. **Statement I:** Genetic material in prokaryotic cells is always a single-stranded, circular, naked DNA.
Statement II: DNA in bacterial cells is not associated with histones and is not bound by nuclear membrane.
20. **Statement I:** The outer mitochondrial membrane forms the continuous limiting boundary of the organelle.
Statement II: Mitochondria helps in electron transport and generation of lipids.

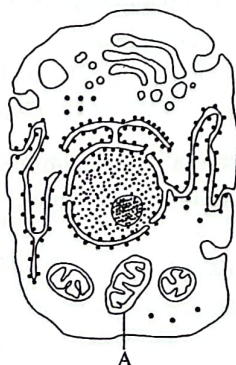
PREVIOUS YEARS' QUESTIONS

1. Algal cell wall is made up of (2010)
 - (1) Cellulose, hemicellulose and pectins
 - (2) Cellulose and galactans
 - (3) Mannans and Minerals (CaCO_3)
 - (4) Both (2) and (3)
2. Which is correct? (2010)
 - (1) Oil storage—Rhodoplast
 - (2) Protein storage—Amyloplast
 - (3) Starch storage—Aleuroplast
 - (4) Fat storage—Elaioplast
3. The size of mitochondrion in plant cell is (2010)
 - (1) 3.0–4.0 μm long
 - (2) 2–4 μm long
 - (3) 1–4 μm long
 - (4) 0.01–1.0 μm long
4. An elaborate network of filamentous proteinaceous structures which helps in the maintenance of cell shape is called (2010)
 - (1) Plasmalemma
 - (2) Cytoskeleton
 - (3) Endoplasmic reticulum
 - (4) Thylakoids
5. The plasma membrane consists of (2010)
 - (1) Proteins embedded in a phospholipid bilayer
 - (2) Protein embedded in a polymer of glucose molecules
 - (3) Proteins embedded in a carbohydrate bilayer
 - (4) Phospholipids embedded in a protein bilayer
6. Which one of the following structures between two adjacent cells in an effective transport pathway? (2010)
 - (1) Plastoquinones
 - (2) Endoplasmic reticulum
 - (3) Plasmalemma
 - (4) Plasmodesmata
7. The main arena of various activities of a cell is (2010)
 - (1) Mitochondrion
 - (2) Cytoplasm
 - (3) Nucleus
 - (4) Plasma membrane
8. Important site for formation of glycoproteins and glycolipids is (2011)
 - (1) Lysosome
 - (2) Plastid
 - (3) Golgi apparatus
 - (4) Vacuole
9. Which is not a part of endomembrane system? (2011)
 - (1) Golgi body
 - (2) Vacuole
 - (3) Peroxisome
 - (4) Lysosome
10. Cell theory was propounded by (2011)
 - (1) A botanist
 - (2) A zoologist
 - (3) Both a botanist and a zoologist
 - (4) A psychologist
11. Which one does not differ in *E.coli* and *Chlamydomonas*? (2012)
 - (1) Ribosome
 - (2) Cell wall
 - (3) Cell membrane
 - (4) Chromosomal organisation
12. What is true of ribosome? (2012)
 - (1) Prokaryotic ribosomes are 80S
 - (2) Composed of RNA and proteins
 - (3) Found only in eukaryotic cells
 - (4) They are self-splicing introns of some RNAs
13. Which one is an organelle within an organelle? (2012)
 - (1) ER
 - (2) Mesosome
 - (3) Peroxisome
 - (4) Ribosome
14. Which cellular part is correctly described? (2012)
 - (1) Thylakoids—Flattened membranous sacs forming grana
 - (2) Centrioles—Sites for active RNA synthesis
 - (3) Ribosomes—Those in chloroplasts are larger (80 S) while those in cytoplasm are smaller (70 S)
 - (4) Lysosomes—Optimally active at 8.5 pH
15. Detailed structure of the membrane was studied after the advent of electron microscope in (2012)
 - (1) 1930s
 - (2) 1950s
 - (3) 1970s
 - (4) 1990s
16. A chromosome with centromere nearer to one end forming shorter and longer arms is (2012)
 - (1) Metacentric
 - (2) Submetacentric
 - (3) Acrocentric
 - (4) Telocentric
17. Colour of flower petals is due to (2012)
 - (1) Xanthophyll
 - (2) Carotenes
 - (3) Anthocyanin
 - (4) Phycoerythrin
18. A living cell can be best studied by means of (2012)
 - (1) Dark field microscope
 - (2) Electron microscope
 - (3) Phase-contrast microscope
 - (4) Compound microscope
19. Nuclear membrane is absent in (2012)
 - (1) Plantae
 - (2) Protista
 - (3) Monera/*Nostoc*
 - (4) Fungi
20. The term 'glycocalyx' is used for (2013)
 - (1) A layer present between cell wall and membrane of bacteria
 - (2) Cell wall of bacteria
 - (3) Bacterial cell glyco-engineered to possess N-glycosylated proteins
 - (4) A layer surrounding the cell wall of bacteria

21. Why is a capsule advantageous to a bacterium? (2013)
- (1) It protects the bacterium from desiccation
 - (2) It provides means of locomotion
 - (3) It allows bacterium to "hide" from host's immune system.
 - (4) It allows the bacterium to attach to the surface.
22. Which one of the following organelle in the figure correctly matches with its functions? (2013)



- (1) Golgi apparatus, formation of glycolipids
 - (2) Rough endoplasmic reticulum, protein synthesis
 - (3) Rough endoplasmic reticulum, formation of glycoproteins
 - (4) Golgi apparatus, protein synthesis
23. The Golgi complex plays a major role (2013)
- (1) As energy transferring organelles
 - (2) In post-translational modification of proteins and glycosylation of lipids
 - (3) In trapping the light and transforming it into chemical energy
 - (4) In digesting proteins and carbohydrates
24. A major site for synthesis of lipids is (2013)
- (1) Symplast
 - (2) Nucleoplasm
 - (3) RER
 - (4) SER
25. Select the alternative giving correct identification and function of the organelle 'A' in the diagram. (2013)



- (1) Mitochondria—Produce cellular energy in the form of ATP
 - (2) Golgi body—Provides packaging material
 - (3) Lysosomes—Secretes hydrolytic enzymes
 - (4) Endoplasmic reticulum—Synthesis of lipids
26. Which of the following types of plastids does not contain stored food material? (2013)
- (1) Chromoplasts
 - (2) Elaioplasts
 - (3) Aleuroplasts
 - (4) Amyloplasts
27. The fluid mosaic model of cell membrane was given by (2013)
- (1) S.S. Singer and J.L. Nicolson
 - (2) S.J. Singer and H.L. Nicolson
 - (3) S.J. Singer and G.L. Nicolson
 - (4) S.S. Singer and G.L. Nicolson
28. According to the modern concept of cellular membranes the structure of the cell membrane is as follows: (2013)
- (1) There is a continuous lipid bilayer with interspersed proteins on the outside as well as some on the inside
 - (2) There is a continuous lipid bilayer with continuous protein layer on the inside
 - (3) There is a continuous lipid bilayer with continuous protein layer on the outside
 - (4) Both (1) and (3)
29. Electron microscope was invented by (2014)
- (1) Schleiden
 - (2) Zigmond
 - (3) Knoll and Ruska
 - (4) Schwann
30. Smallest living organism is (2014)
- (1) Virus
 - (2) Bacteria
 - (3) Mycoplasma
 - (4) Fungi
31. Smallest cell organelle discovered by Palade (1953) is (2014)
- (1) Lysosome
 - (2) Ribosome
 - (3) Sphaerosome
 - (4) Dictyosome
32. Which of the following is correct about centriole? (2014)
- (1) It is found in all eukaryotes
 - (2) It is microfilamentous
 - (3) It is important for mitosis
 - (4) It is made up of solid protein rod
33. Which of the following is found in middle lamella? (2014)
- (1) Calcium carbonate
 - (2) Calcium pectate
 - (3) Calcium oxalate
 - (4) Calcium phosphate
34. Which of the following is devoid of deoxyribonucleic acid? (2014)
- (1) Nucleus and chloroplast
 - (2) Mitochondria and chloroplast
 - (3) Lysosome and dictyosome
 - (4) Nucleus and mitochondria

35. Cytoskeleton of cell is made of (2014)
 (1) Protein (2) Lipid
 (3) Carbohydrate (4) Nucleic acid
36. Which of the following is wrong? (2014)
 (1) Elaioplast—Fat and oil
 (2) Aleuroplast—Fatty acid
 (3) Amyloplast—Starch
 (4) Chromoplast—Carotene
37. r-RNA is synthesised in (2014)
 (1) Nucleolus (2) Mitochondrion
 (3) Chloroplast (4) Golgi body
38. Which structure perform the function of mitochondria in bacteria? (2014)
 (1) Mesosomes (2) Nucleoid
 (3) Ribosomes (4) Cell wall
39. The motile bacteria are able to move by (2014)
 (1) Pili (2) Fimbriae
 (3) Flagella (4) Cilia
40. The solid linear cytoskeletal elements having a diameter of 6 nm and made up of a single type of monomer are known as (2014)
 (1) Lamins
 (2) Microtubules
 (3) Microfilaments
 (4) Intermediate filaments
41. The main arena of cellular activity in both plant and animal cell is (2014)
 (1) Nucleus (2) Cytoplasm
 (3) Endomembrane system (4) Vacuole
42. Match the following and select the correct answer. (2014)
- | | |
|-----------------|------------------------------------|
| (a) Centriole | (i) Infoldings in mitochondria |
| (b) Chlorophyll | (ii) Thylakoids |
| (c) Cristae | (iii) Nucleic acids |
| (d) Ribozymes | (iv) Basal body, cilia or flagella |
- (1) a—iv, b—iii, c—i, d—ii
 (2) a—iv, b—ii, c—i, d—iii
 (3) a—i, b—ii, c—iv, d—iii
 (4) a—i, b—iii, c—ii, d—iv
43. Prokaryotic flagella is made up of which of the following protein? (2014)
 (1) Tubulin (2) Flagellin
 (3) Pilin (4) Dynein
44. Tonoplast is the surrounding membrane of (2014)
 (1) Nucleolus (2) Nucleus
 (3) Vacuole (4) Chloroplast
45. Which option is correct about lysosomes? (2014)
 (1) Called power house of the cell
 (2) Contain hydrolases which active at the acidic pH
 (3) Formation of glycoprotein and glycolipid
 (4) All of the above
46. A particular species of bacteria multiplies in such a way that it becomes double in one minute. If a single bacterium is put in a cup, which is filled in 60 minutes. The cup will be half filled in (2015)
 (1) 29 minutes (2) 30 minutes
 (3) 31 minutes (4) 59 minutes
47. The smallest measuring unit in Cell Biology is (2015)
 (1) Micrometer (2) Nanometer
 (3) Angstrom (4) Dalton
48. Which of the following subcellular components is likely to be absent in plant root? (2015)
 (1) Mitochondria (2) Chloroplasts
 (3) Leucoplast (4) Ribosomes
49. A major site for synthesis of lipids is (2015)
 (1) SER (2) Symplast
 (3) Neucloplasm (4) RER
50. Molecular weight of 50 S subunit of 70 S ribosome is (2015)
 (1) 1.8×10^6 Dalton (2) 1.5×10^6 Dalton
 (3) 2.2×10^6 Dalton (4) 2.5×10^6 Dalton
51. Which of the following is not surrounded by a membrane? (2015)
 (1) Vacuole (2) Lysosome
 (3) Microbodies (4) Nucleolus
52. In a chloroplast, DNA and ribosomes are present in its (2015)
 (1) Stroma (2) Lumen of thylakoids
 (3) Grana (4) Stroma lamellae
53. The correct match the name of the cell-organelle and its function is (2015)
 (1) Smooth endoplasmic reticulum—synthesis of lipids
 (2) Golgi apparatus—synthesis of proteins
 (3) Mitochondrion—produce cellular energy in the form of ADP
 (4) Lysosomes—protein synthesis
54. An elaborate network of filamentous proteinaceous structures present in the cytoplasm which helps maintain the cell shape is referred to as (2015)
 (1) Thylakoid (2) Endoplasmic reticulum
 (3) Plasmalemma (4) Cytoskeleton
55. Based on the position of the centromere, identify the type of chromosome shown in the figure. (2015)



56. Which of the following are not membrane-bound? (2015)
 (1) Ribosomes (2) Lysosomes
 (3) Mesosomes (4) Vacuoles

57. Which of the following structures is not found in a prokaryotic cell? (2015)
 (1) Ribosome (2) Mesosome
 (3) Plasma membrane (4) Nuclear envelope

58. Balbiani rings are sites of (2015)
 (1) Nucleotide synthesis
 (2) Polysaccharide synthesis
 (3) RNA and protein synthesis
 (4) Lipid synthesis

59. Match the columns and identify the correct option (2015)

Column I	Column II
a. Thylakoids	i. Disc-shaped sacs in Golgi apparatus
b. Cristae	ii. Condensed structure of DNA
c. Cisternae	iii. Flat membranous sacs in stroma
d. Chromatin	iv. Infoldings in mitochondria

- (1) a—(iii), b—(iv), c—(i), d—(ii)
 (2) a—(iii), b—(i), c—(iv), d—(ii)
 (3) a—(iii), b—(iv), c—(ii), d—(i)
 (4) a—(iv), b—(iii), c—(i), d—(ii)
60. The structures that help some bacteria to attach to rocks and/or host tissues are (2015)
 (1) Fimbriae (2) Mesosomes
 (3) Holdfast (4) Rhizoids
61. Chromatophores take part in (2015)
 (1) Growth (2) Movement
 (3) Respiration (4) Photosynthesis
62. Cellular organelles with membranes are (2015)
 (1) Chromosomes, ribosomes and endoplasmic reticulum
 (2) Endoplasmic reticulum, ribosomes and nuclei
 (3) Lysosomes, Golgi apparatus and mitochondria
 (4) Nuclei, ribosomes and mitochondria
63. Which one of the following is not an inclusion body found in prokaryotes? (2015)
 (1) Glycogen granule (2) Polysome
 (3) Phosphate granule (4) Cyanophycean granule
64. The chromosomes in which centromere is situated close to one end are (2015)
 (1) Telocentric (2) Sub-metacentric
 (3) Metacentric (4) Acrocentric
65. Select the correct matching in the following pairs: (2015)
 (1) Rough ER—Synthesis of glycogen
 (2) Rough ER—Oxidation of fatty acids

- (3) Smooth ER—Oxidation of phospholipids
 (4) Smooth ER—Synthesis of lipids

66. The structures that are formed by stacking of organized flattened membranous sacs in the chloroplasts are (2015)
 (1) Stroma lamellae (2) Stroma
 (3) Cristae (4) Grana

67. Cytochromes are found in (2015)
 (1) Cristae of mitochondria
 (2) Lysosomes
 (3) Matrix of mitochondria
 (4) Outer wall of mitochondria

68. DNA is not present in (2015)
 (1) Nucleus (2) Mitochondria
 (3) Chloroplast (4) Ribosomes

69. Nuclear envelope is a derivative of (2015)
 (1) Microtubules
 (2) Rough endoplasmic reticulum
 (3) Smooth endoplasmic reticulum
 (4) Membrane of Golgi complex

70. Which of the following nitrogenous base is double ringed (2016 Phase-I)

- (1) Guanine (2) Thymine
 (3) Uracil (4) Cytosine

71. Respiratory enzymes occur in bacterium in (2016 Phase-I)

- (1) Plasma membrane
 (2) Mitochondria
 (3) Golgi apparatus
 (4) Endoplasmic reticulum

72. Mitochondria and chloroplast are (2016 Phase-I)
 (a) semi-autonomous organelles
 (b) formed by division of pre-existing organelles and they contain DNA but lack protein synthesizing machinery

Which one of the following options is correct:

- (1) Both (a) and (b) are correct
 (2) (b) is true but (a) is false
 (3) (a) is true but (b) is false
 (4) Both (a) and (b) are false

73. Microtubules are the constituents of (2016 Phase-I)
 (1) Cilia, flagella and peroxisomes
 (2) Spindle fibres, centrioles and cilia
 (3) Centrioles, spindle fibres and chromatin
 (4) Centrosome, nucleosome and centrioles

74. Which one of the following cell organelles is enclosed by a single membrane (2016 Phase-I)
 (1) Mitochondria (2) Chloroplasts
 (3) Lysosomes (4) Nuclei

75. Water soluble pigments found in plant cell vacuoles are (2016 Phase-I)
 (1) Xanthophylls (2) Chlorophylls
 (3) Carotenoids (4) Anthocyanins
76. A cell organelle containing hydrolytic enzymes is (2016 Phase-II)
 (1) Ribosome (2) Mesosome
 (3) Lysosome (4) Microsome
77. During cell growth, DNA synthesis takes place in (2016 Phase-II)
 (1) G₂ phase (2) M phase
 (3) S phase (4) G₁ phase
78. Oxidative phosphorylation is (2016 Phase-II)
 (1) Addition of phosphate group to ATP
 (2) Formation of ATP by energy released from electrons removed during substrate oxidation
 (3) Formation of ATP by transfer of phosphate group from a substrate to ADP
 (4) Oxidation of phosphate group in ATP
79. Adult human RBCs are enucleate. Which of the following statement(s) is/are most appropriate explanation for this feature? (2017)
 (a) They do not need to reproduce.
 (b) They are somatic cells.
 (c) They do not metabolize.
 (d) All their internal space is available for oxygen transport.
- Options:**
 (1) Only a (2) a, c and d
 (3) b and c (4) Only d
80. Which of the following cell organelles is responsible for extracting energy from carbohydrates to form ATP? (2017)
 (1) Ribosome (2) Chloroplast
 (3) Mitochondrion (4) Lysosome
81. Which of the following is true for nucleolus? (2018)
 (1) Larger nucleoli are present in dividing cells.
 (2) It is a membrane-bound structure.
 (3) It takes part in spindle formation.
 (4) It is a site for active ribosomal RNA synthesis.
82. The Golgi complex participates in (2018)
 (1) Fatty acid breakdown
 (2) Formation of secretory vesicles
 (3) Respiration in bacteria
 (4) Activation of amino acid
83. Which of the following events does not occur in rough endoplasmic reticulum? (2018)
 (1) Protein folding
 (2) Protein glycosylation
 (3) Cleavage of signal peptide
 (4) Phospholipid synthesis
84. Many ribosomes may associate with a single mRNA to form multiple copies of a polypeptide simultaneously. Such strings of ribosomes are termed as (2018)
 (1) Polysome (2) Polyhedral bodies
 (3) Plastidome (4) Nucleosome
85. Select the incorrect match. (2018)
 (1) Lampbrush chromosomes—Diplotene bivalents
 (2) Allosomes—Sex chromosomes
 (3) Submetacentric chromosomes—L-shaped chromosomes
 (4) Polytene chromosomes—Oocytes of amphibians
86. Which of the following pair of organelles does not contain DNA? (2019)
 (1) Chloroplast and vacuoles
 (2) Lysosomes and vacuoles
 (3) Nuclear envelope and mitochondria
 (4) Mitochondria and lysosomes
87. Which of the following statements is **not** correct? (2019)
 (1) The hydrolytic enzymes of lysosomes are active under the acidic pH.
 (2) Lysosomes are membrane bound structure.
 (3) Lysosomes are formed by the process of packaging in the endoplasmic reticulum.
 (4) Lysosomes have numerous hydrolytic enzymes.
88. The shorter and longer arms of a submetacentric chromosome are referred to as (2019)
 (1) p-arm and q-arm respectively
 (2) q-arm and p-arm respectively
 (3) m-arm and n-arm respectively
 (4) s-arm and l-arm respectively
89. The concept of "*Omnis cellula-e-cellula*" regarding cell division was first proposed by (2019)
 (1) Theodore Schwann (2) Schleiden
 (3) Aristotle (4) Rudolf Virchow
90. Which of the following statements regarding mitochondria is incorrect? (2019)
 (1) Enzymes of electrons transport are embedded in outer membrane.
 (2) Inner membrane is convoluted with infoldings.
 (3) Mitochondrial matrix contains single circular DNA molecule and ribosomes.
 (4) Outer membrane is permeable to monomers of carbohydrates, fats and proteins.
91. Which is the important site of formation of glycoproteins and glycolipids in eukaryotic cells? (2020 Phase-1)
 (1) Endoplasmic reticulum
 (2) Peroxisomes
 (3) Golgi bodies
 (4) Polysomes
92. Which of the following statements about inclusion bodies is incorrect? (2020 Phase-1)
 (1) They are not bound by any membrane.

- (2) These are involved in ingestion of food particles.
 (3) They lie free in the cytoplasm.
 (4) These represent reserve material in cytoplasm.
93. Inclusion bodies of blue-green, purple and green photosynthetic bacteria are (2020 Phase-2)
 (1) Microtubules (2) Contractile vacuoles
 (3) Gas vacuoles (4) Centrioles
94. The biosynthesis of ribosomal RNA occurs in (2020 Phase-2)
 (1) Nucleolus (2) Ribosomes
 (3) Golgi apparatus (4) Microbodies
95. Match the following columns and select the correct option. (2020 Phase-2)

Column I	Column II
(a) Smooth endoplasmic reticulum	(i) Protein synthesis
(b) Rough endoplasmic reticulum	(ii) Lipid synthesis
(c) Golgi complex	(iii) Glycosylation
(d) Centriole	(iv) Spindle formation

- (1) (a)-(i), (b)-(ii), (c)-(iii), (d)-(iv)
 (2) (a)-(ii), (b)-(i), (c)-(iii), (d)-(iv)
 (3) (a)-(iii), (b)-(i), (c)-(ii), (d)-(iv)
 (4) (a)-(iv), (b)-(ii), (c)-(i), (d)-(iii)
96. The size of Pleuropneumonia-like organism (PPLO) is (2020 Phase-2)
 (1) 0.1 μm (2) 0.02 μm
 (3) 1–2 μm (4) 10–20 μm
97. When the centromere is situated in the middle of two equal arms of chromosomes, the chromosome is referred as (2021)
 (1) Metacentric (2) Telocentric
 (3) Sub-metacentric (4) Acrocentric
98. Match List I with List II. (2021)

List I	List II
(a) Cristae	(i) Primary constriction in chromosome
(b) Thylakoids	(ii) Disc-shaped sacs in Golgi apparatus
(c) Centromere	(iii) Infolding in mitochondria
(d) Cisternae	(iv) Flattened membranous sacs in stroma of plastids

Choose the correct answer from the options given below.

- (1) (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i)
 (2) (a)-(i), (b)-(iv), (c)-(iii), (d)-(ii)
 (3) (a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)
 (4) (a)-(ii), (b)-(iii), (c)-(iv), (d)-(i)

99. Which of the following is an incorrect statement? (2021)
 (1) Mature sieve tube elements possess a conspicuous nucleus and usual cytoplasmic organelles.
 (2) Microbodies are present in both plant and animal cells.
 (3) The perinuclear space forms a barrier between the materials present inside the nucleus and that of the cytoplasm.
 (4) Nuclear pores act as passages for proteins and RNA molecules in both directions between nucleus and cytoplasm.
100. The organelles that are included in the endomembrane system are (2021)
 (1) Endoplasmic reticulum, Mitochondria, Ribosomes and Lysosomes
 (2) Endoplasmic reticulum, Golgi complex, Lysosomes and Vacuoles
 (3) Golgi complex, Mitochondria, Ribosomes and Lysosomes
 (4) Golgi complex, Endoplasmic reticulum, Mitochondria and Lysosomes
101. Match List I with List II. (2022)

List I	List II
(a) Metacentric chromosome	(i) Centromere situated close to the end forming one extremely short and one very long arm
(b) Acrocentric chromosome	(ii) Centromere at the terminal end
(c) Submetacentric chromosomes	(iii) Centromere in the middle forming two equal arms of chromosomes
(d) Telocentric chromosome	(iv) Centromere slightly away from the middle forming one shorter arm and one longer arm

Choose the correct answer from the options given below:

- (1) (a)-(ii), (b)-(iii), (c)-(iv), (d)-(i)
 (2) (a)-(i), (b)-(ii), (c)-(iii), (d)-(iv)
 (3) (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)
 (4) (a)-(i), (b)-(iii), (c)-(ii), (d)-(iv)

102. Given below are two statements: (2022)

Statement I: Mycoplasma can pass through less than 1 micron filter size.

Statement II: Mycoplasma are bacteria with cell wall.

In the light of the above statements, choose the correct answer from the options given below:

- (1) Statement I is correct, but Statement II is incorrect.
 (2) Statement I is incorrect, but Statement II is correct.
 (3) Both Statement I and Statement II are correct.
 (4) Both Statement I and Statement II are incorrect.

103. Which of the following statements with respect to endoplasmic reticulum is incorrect? (2022)

- (1) In prokaryotes, only RER are present.
- (2) SER are the sites for lipid synthesis.
- (3) RER has ribosomes attached to ER.
- (4) SER is devoid of ribosomes.

104. Movement and accumulation of ions across a membrane against their concentration gradient can be explained by (2023)

- (1) Facilitated Diffusion
- (2) Passive Transport
- (3) Active Transport
- (4) Osmosis

105. How many different proteins does the ribosome consist of? (2023)

- (1) 60
- (2) 40
- (3) 20
- (4) 80

106. Which of the following are NOT considered as the part of endomembrane system? (2023)

- A. Mitochondria
- B. Endoplasmic Reticulum
- C. Chloroplasts
- D. Golgi complex
- E. Peroxisomes

Choose the most appropriate answer from the options given below:

- (1) A, C and E only
- (2) A and D only
- (3) A, D and E only
- (4) B and D only

107. Which of the following functions is carried out by cytoskeleton in a cell? (2023)

- (1) Protein synthesis
- (2) Motility
- (3) Transportation
- (4) Nuclear division

108. Match List I with List II.

	List I		List II
A.	Nucleolus	I.	Site of formation of glycolipid
B.	Centriole	II.	Organization like the cartwheel

C.	Leucoplasts	III.	Site for active ribosomal RNA synthesis
D.	Golgi apparatus	IV.	For storing nutrients

Choose the correct answer from the options given below:

- (1) A-III, B-IV, C-II, D-I
- (2) A-I, B-II, C-III, D-IV
- (3) A-III, B-II, C-IV, D-I
- (4) A-II, B-III, C-I, D-IV

(2024)

109. The DNA present in chloroplast is

- (1) Linear, single-stranded
- (2) Circular, single-stranded
- (3) Linear, double-stranded
- (4) Circular, double-stranded

(2024)

110. Match List I with List II:

	List I		List II
A.	Axoneme	I.	Centriole
B.	Cartwheel pattern	II.	Cilia and flagella
C.	Crista	III.	Chromosome
D.	Satellite	IV.	Mitochondria

Choose the correct answer from the options given below:

- (1) A-II, B-IV, C-I, D-III
- (2) A-II, B-I, C-IV, D-III
- (3) A-IV, B-III, C-II, D-I
- (4) A-IV, B-II, C-III, D-I

(2024)

111. Given below are two statements:

Statement I: Mitochondria and chloroplasts are both double membrane-bound organelles.

Statement II: Inner membrane of mitochondria is relatively less permeable, as compared to chloroplast.

In the light of the above statements, choose the correct answer from the options given below:

- (1) Statement I is true, but Statement II is false.
- (2) Statement I is false, but Statement II is true.
- (3) Both Statement I and Statement II are true.
- (4) Both Statement I and Statement II are false.

(2024)

ANSWER KEYS

Concept Application Exercise 1

1. A - unicellular, B - multicellular
5. (3) 6. True

2. British zoologist

3. (1)

4. (1)

Concept Application Exercise 2

1. (3) 2. Bacillus (rod like), coccus (spherical), vibrio (comma shaped) and spirillum (spiral)
3. PPLO (Pleuro Pneumonia Like Organisms) 4. (1) 5. False
6. (4)

Concept Application Exercise 3

1. Middle lamella 2. (3) 3. (2) 4. (1) 5. (1)
6. Plasmodesmata 7. (3) 8. (4) 9. Capsule 10. False

Concept Application Exercise 4

1. (2) 2. (3) 3. (3) 4. Golgi body 5. (1)
6. True 7. (2)

Concept Application Exercise 5

1. Matrix 2. Outer membrane 3. (2) 4. Sausage/cylindrical 5. (1)
6. True 7. Chromoplast 8. Grana

Concept Application Exercise 6

1. Hub; spokes 2. (4) 3. (3) 4. (3) 5. (3)
6. True 7. Centriole 8. Cytoskeleton

Concept Application Exercise 7

1. (i) RBC (Erythrocytes) of many mammals (ii) Sieve tube cells 2. (3) 3. (3)
4. (3) 5. Nucleolus 6. True

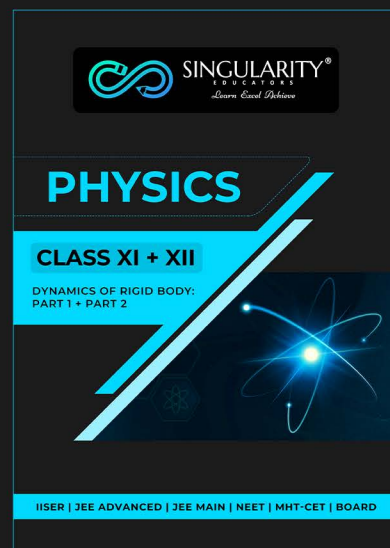
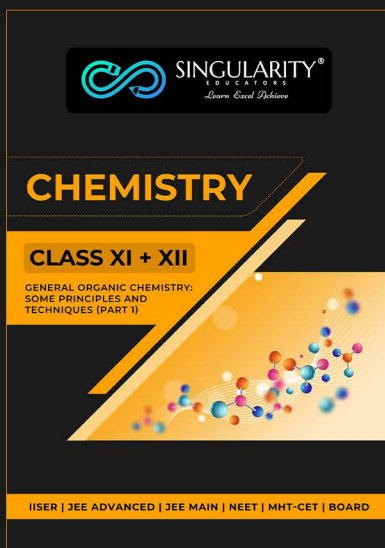
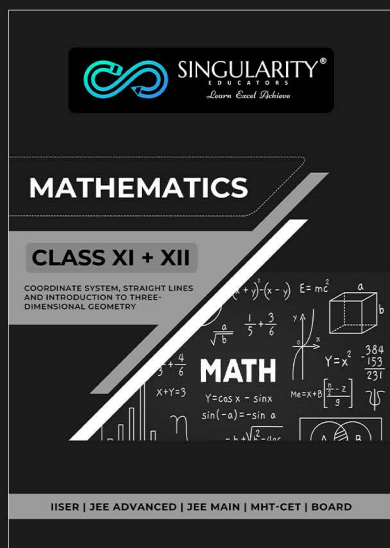
TOPICWISE QUESTIONS

1.	(2)	2.	(3)	3.	(4)	4.	(2)	5.	(1)	6.	(2)	7.	(4)	8.	(3)	9.	(3)	10.	(3)
11.	(4)	12.	(4)	13.	(2)	14.	(4)	15.	(3)	16.	(2)	17.	(4)	18.	(3)	19.	(3)	20.	(1)
21.	(1)	22.	(3)	23.	(3)	24.	(4)	25.	(3)	26.	(1)	27.	(4)	28.	(4)	29.	(4)	30.	(2)
31.	(2)	32.	(4)	33.	(3)	34.	(4)	35.	(4)	36.	(3)	37.	(3)	38.	(3)	39.	(4)	40.	(2)
41.	(2)	42.	(4)	43.	(2)	44.	(1)	45.	(1)	46.	(3)	47.	(1)	48.	(3)	49.	(4)	50.	(1)
51.	(3)	52.	(1)	53.	(1)	54.	(2)	55.	(4)	56.	(3)	57.	(3)	58.	(2)	59.	(2)	60.	(2)
61.	(2)	62.	(4)	63.	(2)	64.	(3)	65.	(1)	66.	(2)	67.	(3)	68.	(1)	69.	(1)	70.	(4)
71.	(2)	72.	(3)	73.	(2)	74.	(4)	75.	(1)	76.	(4)	77.	(4)	78.	(2)	79.	(4)	80.	(2)
81.	(4)	82.	(4)	83.	(4)	84.	(3)	85.	(1)	86.	(3)	87.	(3)	88.	(2)	89.	(4)	90.	(2)
91.	(4)	92.	(3)	93.	(3)	94.	(3)	95.	(2)	96.	(3)	97.	(2)	98.	(1)	99.	(2)	100.	(2)
101.	(2)	102.	(3)	103.	(4)	104.	(4)	105.	(3)	106.	(3)	107.	(1)	108.	(4)	109.	(4)	110.	(3)

[illegible]

1.	(4)	2.	(3)	3.	(1)	4.	(4)	5.	(1)	6.	(2)	7.	(1)	8.	(2)	9.	(2)	10.	(1)
11.	(1)	12.	(1)	13.	(1)	14.	(2)	15.	(3)	16.	(1)	17.	(1)	18.	(4)	19.	(2)	20.	(3)

[illegible]



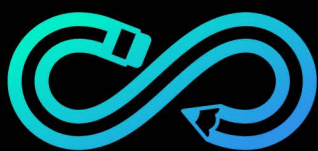
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