07

Cell : The Unit of Life

Quick Revision

- Cell is the fundamental, structural and functional unit of all living organisms. The term 'Cell' was coined by **Robert Hooke** in the year 1665.
- A living cell was first seen and described by **Antonie van Leeuwenhoek**. The nucleus was discovered by **Robert Brown**.

Cell Theory

- Cell theory was proposed by **Schleiden** and **Schwann** in 1838.
- This theory was modified by **Rudolf Virchow** (1855) to explain the formation of new cells. The cell theory can be summarised as
  - All living organisms are made up of one or more cells.
  - The cell is the basic structural and functional unit of life.
  - All cells arise from pre-existing cells (*Omnis cellula-e-cellula*).

Size and Shape of Cell

- The cells exhibit high variation in size, lifespan and cellular activities, e.g. mycoplasmas (**smallest cell**) or PPLOs (Pleuro-Pneumonia Like Organisms) is only 0.3 µm in length and bacterial cells are approximately 3-5 µm in size.
- An ostrich egg, which is known to be the largest isolated single cell measures about 170 × 135 mm. Human Red Blood Cells (RBCs) are about 7 µm in diameter and the nerve cell of human being is the **longest cell** having a length of 90-100 cm.
- The cells also vary in their shapes and may be polygonal, disc-like, amoeboid, thread-like, cuboid or irregular. The shape of the cell is may varies with the function they performs.

Types of Cells

- On the basis of organisation, complexity and variety, all cells can be grouped into two types, i.e. prokaryotic and eukaryotic cells.

Prokaryotic Cells

- These are represented by bacteria, blue-green algae, mycoplasma, etc.
- All prokaryotic cells are bound by a plasma membrane enclosing a gel or fluid-like cytoplasm. Except mycoplasma, all prokaryotic cells have a cell wall.
- These lack a well-defined nucleus. The genetic material, i.e DNA is naked and circular, not enveloped by a nuclear membrane. Many prokaryotic cells possess extrachromosomal small circular DNA called **plasmids**. It confers unique phenotype to the cell.
- Cell envelope is chemically complex and the manner in which it responds to Gram staining procedure, classified bacteria as **Gram positive** and **Gram negative** bacteria. The cell envelope of former take up the stain, while that of later does not take up the stain.
- Cell envelope consist of three tightly bound layers,
  - **Glycocalyx** Present either as slime layer or as capsule in different bacteria.

- **Cell wall** Made up of peptidoglycan provides structural support and integrity to the bacterial cell.
- **Plasma membrane** Selectively permeable in nature.

- **Mesosomes** are the membranous structures which are formed by the extensions of plasma membrane as vesicles, tubules and lamellae. These are involved in cell wall formation, DNA replication, respiration, secretion, increase in surface area, etc.
- **Chromatophores** are pigment containing membranous extensions present in cyanobacteria.
- **Flagella** are thin filamentous extensions, arising from the cell wall of a bacterial cell. A flagellum in a prokaryotic cell is composed of three parts–filament (longest portion), hook and basal body.
- **Pili** are proteinaceous, elongated and tubular structures found on the surface of bacterial cell.
- **Fimbriae** are small, bristle-like fibres, which help the bacteria to attach to the substratum or host tissue. Both pili and fimbriae do not play role in the motility of bacteria.
- Prokaryotes contain **70 S ribosomes** [50 S + 30 S] in the cytoplasm and these are the site of protein synthesis.
- **Polysome** or **Polyribosomes** are formed by the association of several ribosomes to a single *m*RNA.
- **Inclusion bodies**, e.g. phosphates granules, glycogen granules, gas vacuoles, etc., found in the cytoplasm of prokaryotic cells store reserve food material. These are not bound by any membrane system.

Eukaryotic Cells

- It includes protists, plants, animals and fungi.
- These possess membrane bound organelles, including an organised nucleus bound by a double-layered nuclear envelope. The nucleus contains genetic material organised into chromosomes.
- All eukaryotic cells are not identical. Plant cells and animal cells differ significantly due to the presence or absence of certain organelles.
- The difference between plant and animal cells can be tabulated as

Structure/ Organelles	Plant Cell	Animal Cell
Cell wall	Present	Absent
Plastids	Present	Absent
Centrioles	Absent	Present
Vacuoles	Present as a large central vacuole	Either very small or Absent

- An eukaryotic cell is composed of various cell components as cell membrane, cell wall (only in plants), mitochondria, chloroplast, Golgi bodies, ribosomes, centrioles (only in animals), etc.

Cell Membrane

- Every living cell is covered by a thin, elastic, transparent, semi-permeable and regenerative membrane called **cell membrane** also called **plasma membrane** or **plasmalemma**.
- In 1950s, with the advancement of electron microscope the detailed structure of the membrane was studied. Most of the initial studies on cell membrane structure, i.e. especially on the human **Red Blood Cells** (RBCs), enabled the scientists to deduce the possible structure of plasma membrane.
- Studies on human RBCs concluded that the cell membrane is composed of lipid which forms a bilayer with protein molecules embedded in it at different places.
  - **Lipids** Majorly cholesterol and phospholipids are arranged in a bilayer with polar hydrophilic heads facing outwards and non-polar, hydrophobic tails facing inwards the cell.
  - **Proteins** These include, peripheral proteins and integral proteins. The former lies on the surface, while the latter are partially or totally embedded in the membrane.
- **Fluid mosaic model** is the most accepted model of the cell membrane structure. It was proposed by **Singer** and **Nicolson** in 1972. They proposed that the **quasi-fluid** nature of lipids in plasma membrane allow the lateral movement to proteins within the overall bilayer. It also contributes to cell growth,

division, secretion, endocytosis and formation of plasmodesmata.

- The selectively permeable plasma membrane allow the movement of various substances across it through different mechanisms which have been tabulated below

Mode of Transport	Characteristics/ Type of Molecules
Passive transport • **Simple diffusion** • **Osmosis** • **Carrier proteins**	• Does not require energy while transporting molecules along the concentration gradient. • Neutral solutes are transported along the concentration gradient. • Movement of water along the concentration gradient. • Transport of polar molecules is facilitated.
• **Active transport** (Na^+/K^+ pump)	• Molecules are transported against the concentration gradient by utilising ATP.

Cell Wall

- It is the outer covering of plasma membrane in plants and fungi. It is differentiated into
  - **Middle lamella** composed of calcium pectate which keep the different neighbouring cells intact.
  - **Primary wall** capable of growth and thus, found in young plant cells.
  - **Secondary wall** formed on the inner side of the mature cell.
- Occasionally, a tertiary cell wall may also be present.
- Algal cell wall contains galactans, mannans, cellulose and minerals, while plant cell wall contains cellulose, hemicellulose, pectins and proteins. Fungal cell wall consists mainly of chitin.

Endomembrane System

- It consists of four membranous organelles whose functions are coordinated. These include ER, Golgi complex, lysosomes and vacuoles.
- The structural and functional details of the organelles of the endomembrane system are tabulated below

Organelles	Structure	Functions
Endoplasmic Reticulum (ER)	• Network of tubular structures. • **Rough ER** possess ribosomes on surface, continuous with nuclear membrane. • **Smooth ER** does not possess ribosomes.	• RER involved in protein synthesis and secretion. • SER involved in synthesis of lipids.
Golgi apparatus	• Flat, disc-shaped, parallely stacked **cisternae**, possess *cis* (forming) and *trans* (maturation) faces.	• Packaging and secretion. • Formation of glycoproteins and glycolipids.
Lysosomes (Suicidal bags)	• Single membrane bound vesicular structures containing hydrolytic enzymes. • Exhibit polymorphism and occur as primary lysosomes (contain inactive enzymes), secondary lysosomes (digestive vacuoles), residual bodies and autophagic vacuoles.	• Digestion of proteins, lipids, nucleic acids and carbohydrates.
Vacuoles	• Single membrane (tonoplast) bound sacs in cytoplasm which contain water, sap, excretory products, etc. • Food vacuole is formed by fusion of phagosome and lysosome.	• Osmoregul-ati on and excretion by contractile vacuole in *Amoeba.* • Food vacuole engulf food particles, as in protists.

Mitochondria

- These are enveloped by double membrane filled with dense, homogenous matrix. The inner membrane folds into the **matrix** to form **cristae** (bear F_1-particles or oxysomes).
- Mitochondria are cylindrical bodies with an average diameter of 0.2-1 μ and are ordinarily 3-10 μ in length.
- These possess single circular DNA, 70 S ribosomes and RNA. Mitochondria divide by fission.
- These are the site of aerobic respiration and produce energy in the form of ATP.

Plastids

- These are found in all plant cells and in euglenoids. Based on the type of pigments which are responsible for trapping light energy essential for photosynthesis.
  - **Chloroplasts** which contain chlorophyll and carotenoid pigments, which are responsible for trapping light energy essential for photosynthesis.
  - **Chromoplasts** which contain fat soluble carotenoid pigments like carotene and xanthophyll.
  - **Leucoplasts** are the colourless plastids which store nutrients. These include
    - **Amyloplasts** store carbohydrates (starch).
    - **Elaioplasts** store oil and fats.
    - **Aleuroplasts** store proteins.
- **Chloroplasts** are found abundantly in the mesophyll cells of the leaves of most photosynthesising plants.
- These are double membrane bound organelles containing small double-stranded circular DNA and 70 S ribosomes.
- The sectional view of chloroplast shows that the inner membrane encloses stroma which contain flat membranous sacs called **thylakoids**.
- The latter are arranged in piles to form **grana** and these are connected by **stroma lamellae**. These two unit membranes are separated by **periplastidial** or **intermembrane space.**

Ribosomes

- These are the granular structures first observed under the electron microscope as dense particle by **George Palade** (1953).
- These are composed of Ribonucleic Acid (RNA) and proteins and are not surrounded by any membrane.
- Eukaryotic ribosomes are 80 S, while prokaryotic ribosomes are 70 S. Here, 'S' stands for sedimentation coefficient.
- Both 70 S and 80 S ribosomes are composed of two subunits.

Cytoskeleton

- Network of interconnected proteinaceous microtubules, microfilaments and intermediate filaments present in the cytoplasm is collectively referred to as the cytoskeleton.
- It maintains the shape of the cell, provides mechanical support, etc.

Cilia and Flagella

- These are hair-like outgrowths of cell membrane which is responsible for cell movement.
- Their core called **axoneme** is composed of microtubules exhibiting 9 + 2 arrangement. The nine peripheral tubules are doublets and are joined by nine **radial spokes**. The two central microtubules are bound by a central sheath.
- Both cilia and flagella emerges from the basal body which is a centriole-like structure.

Centrosome and Centrioles

- **Centrosome** contains two perpendicularly arranged cylindrical structures called **centrioles**.
- Centrioles are made up of nine peripheral fibrils of tubulin protein and a central proteinaceous core called **hub**.
- The peripheral tubules are triplets and each peripheral tubule is connected to hub through radial spokes made up of protein.
- Centriole form basal body of cilia and flagella.
- It also forms spindle fibres during cell division in animal cells.

Nucleus

- It is a structure bound by a nuclear envelope of double unit membrane. It consists of
  - **Chromatin** Flemming described it as nucleoprotein fibres formed when the nucleus of the cell is not dividing, i.e. during interphase.
  - Chromatin consists of DNA, basic proteins called **histones**, **non-histone proteins** and **RNA**.
  - **Nuclear envelope** surrounds the nucleus and bears numerous small nuclear pores that allow movement of RNA and protein between nucleus and cytoplasm. The space between its two parallel membrane is called **perinuclear space**.
  - **Nucleolus** is found in the nuclear matrix or **nucleoplasm**. It is not bound by a membrane and acts as the site for active *r*RNA synthesis. It was discovered by **Fontana** in 1774.
- Chromatin material condenses to form **chromosomes** in the nucleus during cell division.
- Each chromosome posseses two chromatids which remain attached to the centromere or primary constriction. The latter posseses a disc-shaped structure called **kinetochore** on its surface.
- Based on the position of centromere, chromosomes are **metacentric** (middle centromere), **sub-metacentric** (centromere slightly away from middle), **acrocentric** (centromere near the end) and **telocentric** (terminal centromere).
- Few chromosomes possess secondary constrictions called **satellite** at constant locations.

Functions

Nucleus performs the following functions

- It stores information that controls cellular functions.
- It controls the synthesis of structural proteins.
- It also stores the genetic information for development reproduction and behaviour.
- It also induces genetic variations.

Microbodies

- Many membrane bound minute vesicles called microbodies containing various enzymes are present in both plant and animal cells.
- A few examples are **peroxisomes** in both plant cell and animal cell and **glyoxysomes** in plant cell only.

Objective Questions

Multiple Choice Questions

1. The branch of biology dealing with structure, function and reproduction of cell is

(a) cytology (b) anatomy
(c) histology (d) cell biology

2. Name the scientist, who saw a live cell first time.

(a) Robert Brown
(b) Antonie van Leeuwenhoek
(c) Robert White
(d) Schleiden

3. Robert Hooke used the term cell in the year

(a) 1664 (b) 1665 (c) 1666 (d) 1667

4. Robert Hooke developed a microscope using which he studied the internal structure of

(a) cork cells (b) onion peel cells
(c) human cheek cells (d) blood cells

5. Identify the correct statements.

I. Division of labour is a result of differentiation occurring in the different types of tissues, organs and organ systems.
II. A new cell always develops by the division of pre-existing cells.
III. Cells are totipotent.
IV. Cell is the smallest unit, capable of independent existence and performing the essential functions of life.

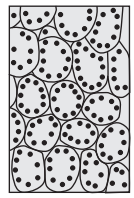
Choose the correct option.
(a) I, II and III (b) I, III and IV
(c) II, III and IV (d) I, II, III and IV

6. Cell theory was formulated by
(a) Schleiden and Schwann
(b) Rudolf Virchow
(c) Robert Brown
(d) Robert Hooke

7. *'Omnis cellula-e-cellula* (all cells arise from pre-existing cells). Who gave this concept and modified the cell theory?
(a) Schleiden and Schwann (b) Virchow
(c) Robert Brown (d) Leeuwenhoek

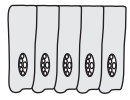
8. The cell theory, jointly given by Schleiden and Schwann did not explain
(a) all living organisms are composed of cells and their products
(b) cell is the structural and functional unit of living organisms
(c) formation of new cells
(d) None of the above

9. Which of the following represents the incorrect pair?

(a)  = Mesophyll cells
(Round and oval)

(b)  = Red blood cells
(Round and biconcave)

(c)  = Platelets
(Amoeboid)

(d)  = Columnar epithelial cells
(Long and narrow)

10. Which of the following represents prokaryotic cells?
(a) PPLO
(b) Mycoplasma
(c) Bacteria
(d) All of the above

11. The genetic material of prokaryotic cell
(a) possess small circular DNA called plasmids
(b) is not enveloped by nuclear membrane
(c) composed of a single circular DNA molecule
(d) All of the above

12. The cell envelope of bacteria is composed of
(a) outermost cell wall followed by glycocalyx and plasma membrane
(b) plasma membrane and cell wall
(c) outermost glycocalyx followed by cell wall and plasma membrane
(d) plasma membrane

13. Choose the incorrect pair.
(a) Gram-positive bacteria–Take up the Gram stain
(b) Cell wall–Prevents bacterium from collapsing
(c) Capsule–Thick and tough glycocalyx
(d) Pili– Locomotory structure in bacteria

14. What is true about mesosomes?
(a) Help in cell wall formation
(b) Help in cellular respiration
(c) Help in DNA replication
(d) All of the above

15. Mesosomes are the infoldings of cell membrane, which
I. are in the form of vesicles tubules and lamellae.
II. increase the surface area of plasma membrane.
III. are present in both prokaryotic and eukaryotic cells.
Which of the following option is most appropriate?
(a) II and III (b) I and II
(c) I and III (d) I, II and III

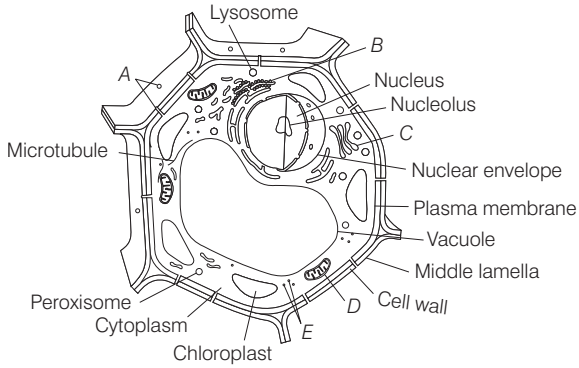
16. The longest portion in a bacterial flagellum is
(a) hook (b) basal body
(c) filament (d) pili

17. Which one of the following is not an inclusion body found in prokaryotes?
(a) Cyanophycean granule
(b) Glycogen granule
(c) Polysome
(d) Phosphate granule

18. What is the function of polysome?
(a) Active protein synthesis
(b) Formation of multiple copies of same polypeptide
(c) Both (a) and (b)
(d) None of the above

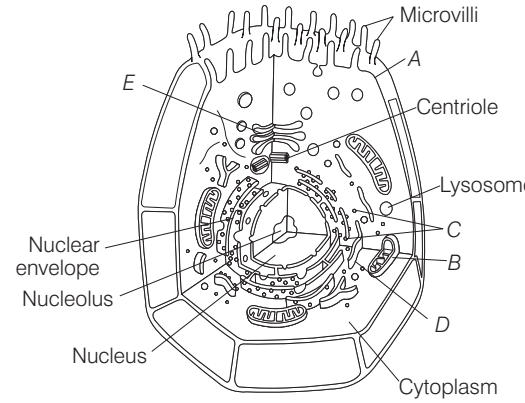
19. Which of the following features is common to prokaryotes and many eukaryotes?
(a) Cell wall is present
(b) Chromosomes are present
(c) Subcellular organelles are present
(d) Nuclear membrane is present

20. The following diagram shows some of the missing structures in a plant cell (*A-E*). Identify the structures.



(a) *A*-Plasmodesmata, *B*-Rough endoplasmic reticulum, *C*-Golgi apparatus, *D*-Mitochondrion, *E*-Ribosomes
(b) *A*-Desmosome, *B*-Rough endoplasmic reticulum, *C*-Golgi apparatus, *D*-Mitochondrion, *E*-Ribosomes
(c) *A*-Plasmodesmata, *B*-Smooth endoplasmic reticulum, *C*-Golgi apparatus, *D*-Mitochondrion, *E*-Ribosomes
(d) *A*-Tight junction, *B*-Rough endoplasmic reticulum, *C*-Golgi apparatus, *D*-Mitochondrion, *E*-Ribosomes

21. The following diagram shows some of the missing structures in an animal cell (*A-E*). Identify the structures.



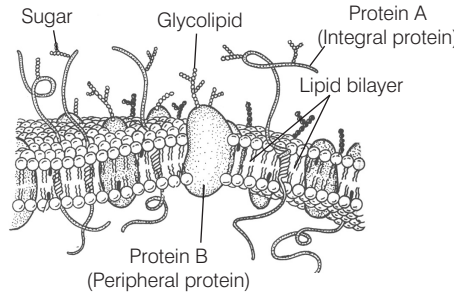
(a) *A*-Plasma membrane, *B*-Rough endoplasmic reticulum, *C*-Ribosomes, *D*-Mitochondrion, *E*-Golgi apparatus
(b) *A*-Plasma membrane, *B*-Mitochondrion, *C*-Ribosomes, *D*-Rough endoplamic reticulum, *E*-Golgi apparatus
(c) *A*-Plasma membrane, *B*-Mitochondria, *C*-Ribosomes, *D*-Smooth endoplasmic reticulum, *E*-Golgi apparatus
(d) *A*-Plasma membrane, *B*-Mitochondria, *C*-Golgi apparatus, *D*-Smooth endoplasmic reticulum, *E*-Ribosomes

22. Which one of the following differentiates plant cells from animal cells?
(a) Large vacuole, plastid and cell wall
(b) Cell wall, plastid and centriole
(c) Cell wall, plastid and mitochondria
(d) Cell membrane, plastid and cell wall

23. Most abundant lipid in cell membrane is
(a) phospholipid (b) starch
(c) oil (d) sulpholipid

24. Each phospholipid molecule in a cell membrane consists of one polar head and two non-polar tails.
(a) True (b) False
(c) Cannot say (d) Partially true or false

25. A student made a pictorial representation of a eukaryotic cell membrane and labelled the components as follows.



The student has made errors while labelling the components of membrane. Which of the following statements hold true regarding the error?
I. Protein A should be labelled as *trans*-membrane protein only and not as integral protein.
II. The polarity of the protein A should be reversed because the cytosolic phase always shows reducing environment.
III. Glycolipid should be labelled as glycoprotein.
IV. Protein B should be labelled as integral membrane protein and not as peripheral glycoprotein.
(a) I and II (b) III and IV
(c) II and III (d) I and IV

26. The fluid mosaic model explains
(a) Only structural aspects of cell membrane
(b) Only functional aspects of cell membrane
(c) Both structural and functional aspects of cell membrane
(d) Only fluidity of membrane

27. Cell membrane is …… to ions.
(a) permeable (b) differentially permeable
(c) semipermeable (d) impermeable

28. Na^+/K^+ pump represents
(a) active transport
(b) passive transport
(c) osmosis
(d) simple diffusion

29. The main difference between active and passive transport across cell membrane is
(a) passive transport is non-selective whereas active transport is selective
(b) passive transport requires a concentration gradient across a biological membrane whereas active transport requires energy to move solutes
(c) passive transport is confined to anionic carrier proteins whereas active transport is confined to cationic channel proteins
(d) active transport occurs more rapidly than passive transport

30. Which of the following statements depict the function of cell wall?
I. Provides shape to the cell.
II. Protects the cell from mechanical damage and infection.
III. Helps in cell to cell interaction.
IV. Provides barrier to undesirable macromolecules.
V. Imbibes water.
Codes
(a) Only V (b) Only IV
(c) II, IV and V (d) I, II, III, IV and V

31. Cell wall consists of
(a) lignin, hemicellulose, protein and lipid
(b) hemicellulose, cellulose, tubulin and lignin
(c) lignin, hemicellulose, pectin and lipid
(d) lignin, hemicellulose, pectin and cellulose

32. The innermost portion of a mature plant cell wall possesses
(a) primary cell wall (b) plasma membrane
(c) secondary cell wall (d) plasmodesmata

33. The layer of cell wall common to two adjacent cell walls in plants is called
(a) middle lamella (b) middle layer
(c) common lamella (d) common layer

34. Middle lamella of plant cell is made up of
(a) calcium oxalate (b) calcium carbonate
(c) calcium silicate (d) calcium pectate

35. The cell wall and middle lamellae are transversed by
(a) plasmodesmata (b) primary wall
(c) cytoplasm (d) cortex

36. The main organelle involved in modification and routing of newly synthesised proteins to their destination is
(a) mitochondria (b) endoplasmic reticulum
(c) lysosome (d) chloroplast

37. Given below are the various structural modifications of ER and their characteristics.
I. Cisternae – Arranged parallel to each other to form lamellae
II. Tubules – Usually associated with ribosomes
III. Vesicles – Round isolated sacs, free of ribosomes
Choose the option containing incorrectly matched pair/s.
(a) Only I (b) II and III
(c) Only II (d) I and III

38. Site of protein synthesis on endoplasmic reticulum is called
(a) ribosome (b) cristae
(c) tubules (d) vesicles and tubules

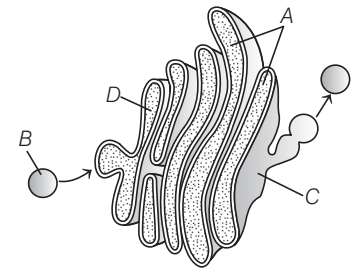
39. Smooth endoplasmic reticulum acts as a major site for the synthesis of
(a) lipids and steroids (b) proteins
(c) ribosomes (d) DNA

40. Which one of the following events does not occur in rough endoplasmic reticulum?
(a) Cleavage of signal peptide
(b) Protein glycosylation
(c) Protein folding
(d) Phospholipid synthesis

41. Consider the following statements.
I. RER plays a major role in glycogenesis.
II. Sarcoplasmic reticulum of striated muscles is a modified form of SER.
III. SER plays a major role in the synthesis of steroid hormones.
IV. ER is one of the organelle of endomembrane system.
Choose the option containing incorrect statements.
(a) I and II (b) II, III and IV
(c) Only I (d) Only III

42. The scientist, who first observed densely stained reticular structures near the nucleus is
(a) Robert Hooke (b) Robert Brown
(c) Strasburger (d) Camillo Golgi

43. Which one of the following is the correct labelling of given structures of Golgi apparatus?



(a) *A*–Cisternae, *B*–Vesicle, *C*–*Cis* face, *D*–*Trans* face
(b) *A*–Cisternae, *B*–Vesicle, *C*–*Trans* face, *D*–*Cis* face
(c) *A*–Tubules, *B*–Vesicle, *C*–*Trans* face, *D*–*Cis* face
(d) *A*–Vesicle, *B*–Cisternae, *C*–*Cis* face, *D*–*Trans* face

44. Which one of the following organelles is located near the nucleus and contains a collection of flattened membrane bound cisternae?
(a) Nucleolus (b) Mitochondrion
(c) Centriole (d) Golgi apparatus

45. Golgi bodies aries from endoplasmic reticulum.
(a) True
(b) False
(c) Cannot say
(d) Partially true or false

46. Important site for the formation of glycoprotein and glycolipid is
(a) lysosomes (b) Golgi apparatus
(c) vacuoles (d) plastids

47. Match the following columns and select the correct option from the codes given below.

	Column I		Column II
A.	Smooth endoplasmic reticulum	1.	Protein synthesis
B.	Rough endoplasmic reticulum	2.	Lipid synthesis
C.	Golgi complex	3.	Glycosylation
D.	Centriole	4.	Spindle formation

Codes

	A	B	C	D
(a)	2	1	3	4
(b)	3	1	2	4
(c)	4	2	1	3
(d)	1	2	3	4

48. Which one of the following cell organelles is enclosed by a single membrane?
(a) Chloroplasts (b) Lysosomes
(c) Nuclei (d) Mitochondria

49. Match the following columns.

	Column I (Cell organelles)		Column II (Functions)
A.	Golgi apparatus	1.	Synthesis of protein
B.	Lysosomes	2.	Trap waste and excretory products
C.	Vacuoles	3.	Packaging and secretion
D.	Ribosomes	4.	Digesting biomolecules

Codes

	A	B	C	D
(a)	3	4	2	1
(b)	4	3	1	2
(c)	3	2	4	1
(d)	1	2	4	3

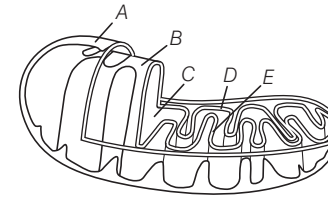
50. Which of the following pairs of organelles does not contain DNA?
(a) Chloroplast and vacuoles
(b) Lysosomes and vacuoles
(c) Nuclear envelope and mitochondria
(d) Mitochondria and lysosomes

51. Vacuole in a plant cell
(a) is membrane bound and contains storage proteins and lipids
(b) is membrane bound and contains water and excretory substances
(c) lacks membrane and contains air
(d) lacks membrane and contains water and excretory substances

52. The osmotic expansion of a cell kept in water is chiefly regulated by lysosomes.
(a) True
(b) False
(c) Cannot say
(d) Partially true or false

53. Function of contractile vacuole is
(a) excretion (b) elimination
(c) osmoregulation (d) gaseous exchange

54. Go through the sectional view of a mitochondrion showing the different parts and identify the structures *A* to *E*.



(a) *A*-Outer membrane, *B*-Inner membrane, *C*-Matrix, *D*-Inter membrane space, *E*-Crista
(b) *A*-Outer membrane, *B*-Inner membrane, *C*-Inter membrane space, *D*-Matrix, *E*-Crista

(c) *A*–Outer membrane, *B*–Inner membrane, *C*–Matrix, *D*–Crista, *E*–Inter membrane space
(d) *A*–Outer membrane, *B*–Inner membrane, *C*–Crista, *D*–Matrix, *E*–Inter membrane space

55. The cristae in mitochondria is important because
(a) increases surface area
(b) decreases surface area
(c) have fluid in it
(d) None of the above

56. Consider the following statements and choose the option containing the correct statements.
I. The endomembrane system includes plasma membrane, ER, Golgi complex, lysosomes and vacuoles.
II. ER helps in the transport of substances, synthesis of proteins, lipoproteins and glycogen.
III. Ribosomes are involved in protein synthesis.
IV. Mitochondria helps in oxidative phosphorylation and generation of ATP.
(a) I, II, III and IV (b) Only I
(c) Only II (d) Only III

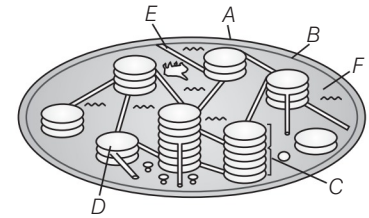
57. Mitochondria are semiautonomous as they possess
(a) DNA
(b) DNA + RNA
(c) DNA + RNA + Ribosomes
(d) Protein

58. Choose the incorrect pair.
(a) Chloroplast — Traps light energy
(b) Chromoplast — Imparts colours to the plant
(c) Leucoplast — Stores nutrients
(d) None of the above

59. Chromoplasts have fat soluble pigments called
(a) chlorophyll (b) carotenoid
(c) chloroplast (d) Both (a) and (b)

60. Analyse the following pairs and identify the correct option given below.
I. Chromoplasts – Contain pigments other than chlorophyll
II. Leucoplasts – Devoid of any pigments
III. Amyloplasts – Store proteins
IV. Aleuroplasts – Store oils and fats
V. Elaioplasts – Store carbohydrates
Codes
(a) II and III (b) III and IV
(c) IV and V (d) I and II

61. Identify *A* to *F* in the sectional view of a chloroplast showing the different parts.

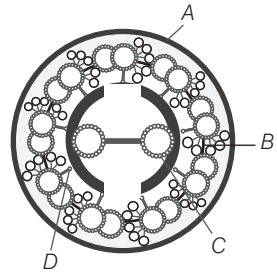


(a) *A*–Inner membrane, *B*–Granum, *C*–Outer membrane, *D*–Stroma lamella, *E*–Stroma, *F*–Thylakoid
(b) *A*–Outer membrane, *B*–Inner membrane, *C*–Granum, *D*–Thylakoid, *E*–Stroma lamella, *F*–Stroma
(c) *A*–Thylakoid, *B*–Outer membrane, *C*–Stroma, *D*–Stroma lamella, *E*–Granum, *F*–Inner membrane
(d) *A*–Outer membrane, *B*–Stroma, *C*–Inner membrane, *D*–Granum, *E*–Thylakoid, *F*–Stroma lamella

62. Who discovered ribosomes as dense particles under the electron microscope?
(a) George Palade (b) Kolliker
(c) Boveri (d) Strasburger

63. The solid linear cytoskeletal elements having a diameter of 6 nm and made up of a single type of monomer are known as
(a) microtubules (b) microfilaments
(c) intermediate filaments (d) lamins

64. Identify *A* to *D* in the diagrammatic representation of internal structure of cilia.



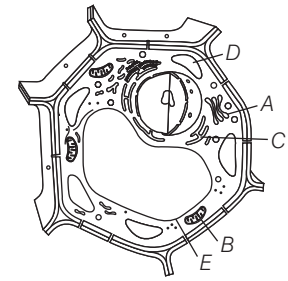
(a) *A*–Interdoublet bridge, *B*–Central microtubule, *C*–Plasma membrane, *D*–Radial spoke
(b) *A*–Plasma membrane, *B*–Central microtubule, *C*–Interdoublet bridge, *D*–Radial spoke
(c) *A*–Plasma membrane, *B*–Interdoublet bridge, *C*–Central microtubule, *D*–Radial spoke
(d) *A*–Plasma membrane, *B*–Interdoublet bridge, *C*–Radial spoke, *D*–Central microtubule

65. What is common between a eukaryotic and prokaryotic flagella?
(a) Same structure
(b) Both are used for locomotion
(c) Composed of same proteins
(d) Both are extension of cell membrane

66. The central part of the proximal region of the centriole is
(a) spokes (b) hub
(c) centrosome (d) axonema

67. Which one of the following cellular parts is correctly described?
(a) Centrioles – Sites for active RNA synthesis
(b) Lysosomes – Optimally active at a pH of about 8.5
(c) Thylakoids – Flattened membranous sacs forming the grana of chloroplasts
(d) Ribosomes – Those on chloroplasts are larger (80S) while those in the cytoplasm are smaller (70S)

68. The diagram of the ultrastructure of a plant cell is given below. Identify the functions of the organelles labelled as *A, B, C, D* and *E* in the diagram.



(a) *A*– Intracellular transport, *B*–Site of oxidative phosphorylation, *C*–Principle director of macromolecular traffic, *D*–Site of photophosphorylation, *E*–Storage of cell sap
(b) *A*–Principle director of macromolecular traffic, *B*–Site of oxidative phosphorylation, *C*–Intracellular transport, *D*–Site of photophosphorylation, *E*–Storage of cell sap
(c) *A*–Site of photophosphorylation, *B*–Storage of cell sap, *C*–Intracellular transport, *D*–Site of oxidative phosphorylation, *E*–Principle director of macromolecular traffic
(d) *A*–Storage of cell sap, *B*–Site of oxidative phosphorylation, *C*–Principle director of macromolecular traffic, *D*–Site of photophosphorylation, *E*–Intracellular transport

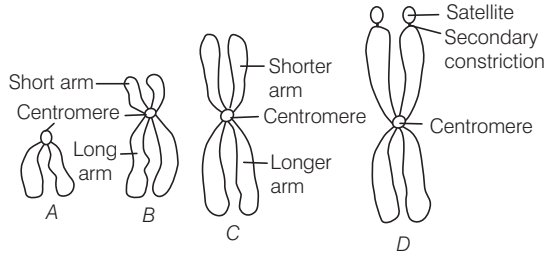
69. Nucleus is stained by a ..... .
(a) acidic dye (b) basic dye
(c) neutral dye (d) iodine

70. Within the nucleus, DNA is organised along with proteins into material called
(a) nuclear lamina (b) chromosome
(c) chromatin (d) chromatid

71. The nuclear pores in the nuclear membrane allows the passage of
(a) proteins, enzymes into the nucleus
(b) ribosomal components out of the nucleus
(c) *m*RNA out of the nucleus
(d) All of the above

72. Choose the incorrect pair.
(a) Histones — Basic proteins
(b) Centromere — Primary constriction
(c) Kinetochore — Disc-shaped structure
(d) None of the above

73. In the given diagram of types of chromosomes, identify *A-D*.



(a) *A*–Telocentric chromosome, *B*–Acrocentric chromosome, *C*–Submetacentric chromosome, *D*–Metacentric chromosome
(b) *A*–Acrocentric chromosome, *B*–Telocentric chromosome, *C*–Metacentric chromosome, *D*–Submetacentric chromosome
(c) *A*–Submetacentric chromosome, *B*–Metacentric chromosome, *C*–Telocentric chromosome, *D*–Acrocentric chromosome
(d) *A*–Metacentric chromosome, *B*–Submetacentric chromosome, *C*–Acrocentric chromosome, *D*–Telocentric chromosome

Assertion-Reasoning MCQs

Direction *(Q. Nos. 74-85) Each of these questions contains two statements Assertion (A) and Reason (R). Each of these questions also has four alternative choices, any one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.*

(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true, but R is not the correct explanation of A
(c) A is true, but R is false
(d) A is false, but R is true

74 **Assertion** (A) Smaller cells are usually metabolically active cells.
Reason (R) Smaller cells have higher nucleocytoplasmic ratio and higher surface volume ratio.

75. **Assertion** (A) Cell is an open system.
Reason (R) Cell receives a number of materials including energy containing nutrients from outside and also release metabolic wastes into its surroundings.

76. **Assertion** (A) Every cell behaves as a compartment.
Reason (R) Cells are partially covered over by a membrane.

77. **Assertion** (A) A cell is a closed compartment.
Reason (R) Plasma membrane of a cell is selectively permeable.

78. **Assertion** (A) The cisternae in Golgi complex have *cis* face and *trans* face.
Reason (R) The *cis* face is also called forming face and *trans* face is also called maturing face.

79. **Assertion** (A) Peroxisomes are involved in photorespiration of the plant cells and help in lipid metabolism in animal cells.
Reason (R) These are the cell garbage disposal system.

80. **Assertion** (A) In prokaryotes, mitochondria are absent.
Reason (R) In prokaryotes, mesosomes are present which help in respiration.

81. **Assertion** (A) Mitochondria and chloroplast are semiautonomous organelles.
Reason (R) These are formed by the division of pre-existing organelles as well as they contain DNA, but lack protein synthesising machinery.

82. **Assertion** (A) Mitochondria and chloroplast have their own genome.
Reason (R) ER and Golgi body are the cell organelles which have their own DNA.

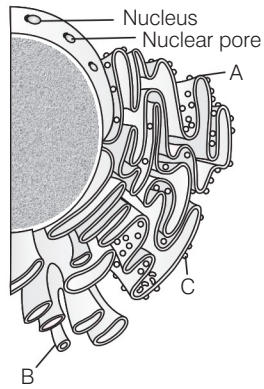
83. **Assertion** (A) Mitochondria are common to both plant and animal cells.
Reason (R) The number of mitochondria in a cell does not correspond to the function of the cell.

84. **Assertion** (A) Chloroplast is a cell organelle.
Reason (R) An organelle is a distinct part of cell which has a particular structure and function.

85. **Assertion** (A) The chromoplasts contain fat soluble carotenoid pigments.
Reason (R) These pigments provide colour to plant parts other than green.

Case Based MCQs

86. Observe the diagram given below and answer the questions that follow



(i) Identify the labels *A*, *B* and *C* shown in the above diagram.

	A	*B*	*C*
(a)	Ribosomes	SER	RER
(b)	RER	SER	Ribosomes
(c)	SER	Ribosomes	RER
(d)	RER	Ribosomes	SER

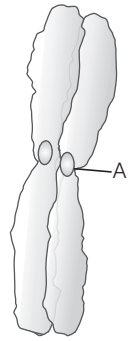
(ii) The label 'C' in the given diagram is the site of
(a) respiration (b) photosynthesis
(c) protein synthesis (d) fat synthesis

(iii) Difference between rough and smooth endoplasmic reticulum is that
(a) rough ER has ribosomes
(b) smooth ER has ribosomes
(c) smooth ER takes part in protein synthesis
(d) Both has F_1 particles

(iv) Ribosomes are
I. Non-membrane bound.
II. Absent in plastids and mitochondria.
III. Present in the cytoplasm and RER.
Choose the correct option.
(a) Only II (b) I and II
(c) I, II and III (d) I and III

(v) Which of the following statements are true about endoplasmic reticulum?
I. Smooth Endoplasmic Reticulum (SER) makes lipids.
II. It is also called the control centre of the cell.
III. It processes carbohydrates.
IV. It modifies chemicals that are toxic to the cell.
Choose the correct option
(a) I, II and III (b) I, III and IV
(c) I and IV (d) All of these

87. Observe the diagram shown below and answer the following questions.



(i) Identify the label A in the above diagram.
(a) Chromatin fibre (b) nuclear pore
(c) Kinetochore (d) None of these

(ii) Choose the correct pair.
(a) Histones – Basic proteins
(b) Centromere – Secondary constriction
(c) Kinetochore – Kidney-shaped structure
(d) None of the above

(iii) For the study of structure of nucleus, the best cell is
(a) cell in the interphase
(b) cell in the late prophase
(c) cell in the divisional phase
(d) cell in the meiotic phase

(iv) Which of the following table refers correctly to the chromosome?

	Numbers of Centromere	Numbers of Kinetochore	Numbers of Arm
(a)	2	1	4
(b)	1	2	4
(c)	2	2	4
(d)	1	2	2

(v) Which of the following stains is not used for staining chromosomes?
(a) Basic fuschsin
(b) Safranin
(c) Methylene blue
(d) Carmine

88. Direction *Read the following and answer the questions that follow*

Lysosomes are speciallised cell organelles present in the cytoplasm. These are common in animal cells, but also found in plant cells. It is surrounded by a single unit membrane, which encloses a dense stroma and a large vacuole, which contains about 50 hydrolytic enzymes. These enzymes can digest most of the biological substances. Lysosomes exist in four forms, such as primary lysosomes, secondary lysosomes, residual bodies and autophagosomes.

(i) Which of the following sequence is correct regarding origin of lysosomes?
(a) Endoplasmic reticulum → Golgi bodies → Lysosomes
(b) Golgi bodies → Endoplasmic reticulum → Lysosomes
(c) Nucleus → Golgi bodies → Lysosomes
(d) Mitochondria → Endoplasmic reticulum → Golgi bodies → Lysosomes

(ii) Lysosomes have acidic environment inside their vesicles due to
(a) production of carboxylate ions inside it
(b) production of phosphate ions inside it
(c) high pH compared to outside
(d) None of the above

(iii) Lysosomes are involved in
(a) digestion
(b) formation of polypeptides
(c) packaging
(d) None of the above

(iv) Which of the following statements is not correct?
(a) Lysosomes have numerous hydrolytic enzymes
(b) The hydrolytic enzymes of lysosomes are active under acidic pH
(c) Lysosomes are membrane bound structures
(d) Lysosomes are formed by the process of packaging in the endoplasmic reticulum

(v) Which one of the following cell organelles exhibits polymorphism?
(a) Chloroplasts (b) Lysosomes
(c) Nuclei (d) Mitochondria

89. Direction *Read the following and answer the questions that follow*

Chloroplast, structure within the cells of plants and green algae that is the site of photosynthesis, the process by which light energy is converted to chemical energy, resulting in the production of oxygen and energy-rich organic compounds. Photosynthetic cyanobacteria are free-living close relatives of chloroplasts, endosymbiotic theory posits that chloroplasts and mitochondria (energy-producing organelles in eukaryotic cells) are descended from such organisms.

(i) The stack of thylakoid found inside plastids is
(a) thylakoid (b) granum
(c) stroma (d) oxysomes

(ii) Stroma in the chloroplasts of higher plant contains
(a) light dependent reaction enzymes
(b) ribosomes
(c) chlorophyll
(d) light independent reaction enzymes

(iii) What is common between chloroplasts, chromoplasts and leucoplasts?
(a) Presence of pigments
(b) Possession of thylakoids and grana
(c) Storage of starch, proteins and lipids
(d) Ability to multiply by a fission-like process

(iv) Chlorophyll in chloroplast is located in
(a) grana
(b) pyrenoid
(c) stroma
(d) Both (a) and (c)

(v) Which is incorrect with reference to chloroplast?
(a) Presence in algae and plants
(b) Releases O_2
(c) Occurs only in cells with aerobic respiration
(d) None of the above

ANSWERS

Multiple Choice Questions

1. (d)	2. (b)	3. (b)	4. (a)	5. (d)	6. (a)	7. (b)	8. (c)	9. (c)	10. (d)
11. (d)	12. (c)	13. (d)	14. (d)	15. (b)	16. (c)	17. (c)	18. (c)	19. (a)	20. (a)
21. (c)	22. (a)	23. (a)	24. (a)	25. (b)	26. (c)	27. (b)	28. (a)	29. (b)	30. (d)
31. (d)	32. (c)	33. (a)	34. (d)	35. (a)	36. (b)	37. (c)	38. (a)	39. (a)	40. (d)
41. (c)	42. (d)	43. (b)	44. (d)	45. (a)	46. (b)	47. (a)	48. (b)	49. (a)	50. (b)
51. (b)	52. (b)	53. (c)	54. (a)	55. (a)	56. (a)	57. (c)	58. (d)	59. (b)	60. (d)
61. (b)	62. (a)	63. (b)	64. (c)	65. (b)	66. (b)	67. (c)	68. (b)	69. (b)	70. (c)
71. (d)	72. (d)	73. (a)							

Assertion-Reasoning MCQs

74. (a)	75. (a)	76. (c)	77. (b)	78. (b)	79. (c)	80. (b)	81. (c)	82. (c)	83. (c)
84. (a)	85. (b)								

Case Based MCQs

86. (i) *(b),* (ii) *(c),* (iii) *(a),* (iv) *(d),* (v) *(b)*
87. (i) *(c),* (ii) *(a),* (iii) *(a),* (iv) *(b),* (v) *(b)*
88. (i) *(a),* (ii) *(d),* (iii) *(a),* (iv) *(d),* (v) *(b)*
89. (i) *(b),* (ii) *(d),* (iii) *(d),* (iv) *(a),* (v) *(c)*

EXPLANATIONS

1. (d) Cell biology is the branch of biology which deals with cell structure, function and its reproduction.

3. (b) In the year 1665, Robert Hooke discovered hollow cavities in a thin piece of bottle cork under very light microscope. The term cell had been given to these cavities by him.

6. (a) Cell theory was formulated by Schleiden and Schwann in the year 1839 based on their studies on plant and animal cells and their products.

7. (b) Rudolf Virchow modified the cell theory and gave the theory '*Omnis cellula-e-cellula*' which means that new cells are formed by the division of the pre-existing cell. This is called theory of cell lineage or common ancestry.

8. (c) The cell theory given by Schleiden and Schwann did not explain the formation of new cells.

9. (c) Out of the given pairs, option (c) is incorrectly matched. It can be corrected as

Amoeboid-shaped, nucleus containing cells are WBCs not platelets.

Rest of the options contain correctly matched pairs.

10. (d) The prokaryotic cells are represented by bacteria, blue-green algae, mycoplasma and PPLO. All these cells contain naked DNA and lack well-defined nucleus.

12. (c) The cell envelope of bacteria consists of a tightly bound three-layered structure *viz*., outermost glycocalyx, followed by cell wall and plasma membrane. All these layers act as a single protective unit.

13. (d) The pair in option (d) is incorrect. It can be corrected as

Pili are not involved in locomotion. Actually, pili are longer, fewer in number and thicker tubular outgrowths, which develop in response to F^+ or fertility factor in Gram-negative bacteria. These help in sexual reproduction in bacteria.

Rest of the options contain correctly matched pairs.

15. (b) Statements I and II are correct, but III is incorrect about mesosomes. It can be corrected as

Mesosomes are present in prokaryotes and not in eukaryotes. Mesosomes help in cell respiration and the same function is carried out by mitochondria in eukaryotic cells.

16. (c) Filament is the longest portion in a bacterial flagellum. It constitutes of three parts, i.e. filament, hook and basal body. Bacteria show a wide range in the number and arrangement of flagella.

19. (a) Cell wall is present in both prokaryotes and eukaryotes. In prokaryotic cells, cell wall is composed of peptidoglycans comprising polysaccharides linked to amino acids, where strengthening material is murein. In eukaryotes, cell wall is composed of polysaccharides. The main strengthening material is chitin in most fungi and cellulose in others (animal cells lack cell wall).

22. (a) Plant and animal cells are different as plant cells possess cell wall, plastids and a large vacuole, which are absent in animal cells. On the other hand, animal cells have centrioles, which are absent in almost all plant cells.

23. (a) Phospholipids are predominant or most abundant lipids in the cell membrane. They are amphipathic, i.e. they are structurally asymmetric with polar hydrophilic and non-polar hydrophobic groups (i.e. phosphate group as head and one or more fatty acids as tail, respectively).

24. (a) Each phospholipid molecule in a cell membrane consists of one polar head and two non-polar tails.

25. (b) Statements III and IV hold true regarding the error made by student, while labelling different components of plasma membrane. The correct information regarding the statements is as follows

- Glycolipids are found directly attached to lipid bilayer whereas carbohydrate moiety attached to the membrane proteins is glycoprotein.
- Protein B is embedded in the plasma membrane and therefore, it should be labelled as integral protein. Peripheral proteins are present on the surface of lipid bilayer.

27. (b) Cell membrane is any membrane that is found in a living cell, especially the plasma membrane, which forms the cell boundary and is semipermeable for water and selectively or differentially permeable for certain solutes or ions.

28. (a) Na^+ / K^+ pump represents active transport. This is because sodium and potassium ions are transported across the membrane against their concentration gradient, i.e. from lower to the higher concentration with the help of ATPase complex, which utilises ATP.

29. (b) The main difference between active and passive transport across the cell membrane is that passive transport requires a concentration gradient across the biological membrane to facilitate movements of molecules.

Whereas during active transport, the movement of molecules occurs from the region of high concentration to low concentration, i.e. the molecules move against the concentration gradient by using ATP (energy).

31. (d) Cell wall consists of lignin, hemicellulose, pectin and cellulose. Plant cell wall is made up of cellulose, hemicellulose, lignin and pectin. Fungal cell wall is made up of chitin.

32. (c) The innermost portion of a mature plant cell wall possesses secondary cell wall. The cell wall of a young plant cell is the primary cell wall which is capable of growth. It gradually diminishes as the cell matures and the secondary cell wall is formed on the inner (towards membrane) side of the cell.

33. (a) The cell wall comprises of four layers, the middle lamella, the primary wall, the secondary wall and tertiary wall.

Primary wall is laid down on both sides of middle lamella. Thus, the middle lamella will act as the common layer between adjacent cell walls.

34. (d) Middle lamella of plant cell is made up of calcium and magnesium pectate.

35. (a) Plasmodesmata are the microscopic channels which transverse the cell wall and middle lamellae and connect the cytoplasm of two neighbouring cells.

36. (b) Endoplasmic reticulum is involved in the modification and routing of newly synthesised proteins to their destination. Rough endoplasmic reticulum possesses ribosomes on its surface and serves as the site of protein synthesis and modification.

37. (c) Only statement II in option (c) is incorrectly matched pair and can be corrected as

Tubules are 50-100Å in diameter and they do not have ribosomes at their surface.

Rest other statements are correctly representing the structural modifications of ER and their characteristics.

40. (d) Phospholipid synthesis does not occur in Rough Endoplasmic Reticulum (RER). It occurs inside Smooth Endoplasmic Reticulum (SER). A signal peptide is a short peptide present at the N-terminus of the newly synthesised proteins. It targets them to the Endoplasmic Reticulum and is then cleaved off. RER synthesises proteins. It bears enzymes for modifying polypeptides synthesised by attached ribosomes, e.g. glycosylation.

41. (c) Only statement I in option (c) is incorrect and can be corrected as

Glycogenesis is carried out in SER and it is the major site of glycogen and glucose metabolism.

Rest statements are correct.

45. (a) The Golgi apparatus are pinched off from the tubules of the cisternae of ER. They are of two types

(i) Smooth or secretory vesicles, which have a smooth surface and contain secretions of the cell.

(ii) Coated vesicles, that have rough surface and elaborate membrane proteins. They carry materials to or from the cisternae.

46. (b) Golgi apparatus is involved in the glycosylation of proteins and lipids, so as to form glycoproteins and glycolipids. It is also involved in protein trafficking. It packages materials and delivers them to various cell targets.

48. (b) Lysosomes are enclosed by a single membrane. These store hydrolysing enzymes to digest proteins, lipids, etc. Mitochondria, chloroplast and nuclei are all double membrane bound organelles.

50. (b) Lysosomes and vacuoles do not contain DNA. Lysosomes are single membrane bound small vesicles which contain hydrolytic enzymes.

Vacuoles are large membranous sacs found in the cytoplasm. These contain substances that are not essentially useful for the cell like water, sap, excretory products and other materials.

51. (b) Vacuole in a plant cell is membrane bound and contains water and excretory substance. It is a space within the cytoplasm of living cell that is filled with air, water or other liquid, cell sap or food particles. In plant cells, there is usually one large vacuole bounded by a single-layered membrane (tonoplast or vacuole membrane) and animal cells usually have several small vacuoles.

52. (b) The osmotic expansion of a cell kept in water is chiefly regulated by vacuoles. The vacuoles usually possess high solute concentration. During osmosis, the water moves from the region of high concentration of solvent to that of lower concentration. Thus, the water enters into the vacuole and the cell expands.

53. (c) Contractile vacuoles are membrane bound organelles in many protozoans. In flagellated algae, there are two anterior contractile vacuoles. They contract rhythmically and expel the contents outside through a process called osmoregulation.

57. (c) Mitochondria is considered semiautonomons because it has its own DNA which can replicate independently. All three types of RNAs are also present in mitochondrial matrix, e.g. *m*RNA, *t*RNA and *r*RNA. Mitochondrial matrix also possesses its own ribosomes (55 S to 70 S in nature).

59. (b) Chromoplasts have fat soluble pigments called carotenoids. They protect the chlorophyll molecule from oxidation in the presence of light.

60. (d) I and II are correctly matched pairs.

Plastid are mainly of two types

- Coloured, including chromoplasts pigments other than chlorophyll and green pigment containing chlorophyll.
- Leucoplasts, which store reserve food material, these are devoid of any pigment.

Rest others are incorrectly matched pairs and can be corrected as

Leucoplasts may be carbohydrate storing amyloplast, fat storing elaioplast or protein storing aleuroplast.

62. (a) George Palade (1953) was the first to discover ribosomes. He observed ribosomes under the electron microscope as dense granular structures consisting of RNA and proteins.

65. (b) The common feature between eukaryotic and prokaryotic flagella is that both are used in locomotion. Eukaryotic flagellum has two parts, i.e. basal body and shaft, while prokaryotic flagellum consists of three parts, i.e. basal body, hook and filament. Prokaryotic and eukaryotic flagella are made up of flagellin and tubulin proteins, respectively.

67. (c) Option (c) is correctly described cellular part and rest options are incorrect.

Incorrect options can be corrected as

- Centrioles serve as basal bodies for cilia and flagella. They are concerned with spindle formation during cell division.
- Lysosomes are membrane bound organelles containing many hydrolytic enzymes, which are optimally active at acidic pH (near pH 5).
- Cytoplasmic ribosomes are 80S type whereas those in chloroplasts are 70 S type.

68. (b) *A*–Golgi body, is said to be 'the principle director of macromolecular traffic in cell'. It chemically modify and transport the materials received by it.

B–Mitochondria, the inner membrane of this organelle contains oxysomes or F_1 particles. Oxysomes are composed of ATPase enzymes and is concerned with oxidative photophosphorylation.

C–Endoplasmic reticulum, helps in intracellular transport.

D–The chloroplast is associated with photophosphorylation.

E–The large central vacuole contains cell sap and serves as storage of materials and provides mechanical support.

69. (b) Due to the presence of basic histone proteins, nucleus is stained by the basic dyes.

70. (c) Chromatin consists of proteins (principally histones), DNA and small amounts of RNA.

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

Metabolically active cells are usually smaller as such cells have a higher nucleocytoplasmic ratio and higher surface volume ratio.

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

An open system is the one, which is separated from its surroundings by a boundary that allows the transfer of materials and energy across it. Cell is an open system because it receives a number of materials including energy containing nutrients from outside. It liberates energy as heat and excretes metabolic wastes from inside.

76. (c) A is true, but R is false and it can be corrected as

Every cell behaves as a compartment because it is completely enclosed by a membrane known as plasma membrane or plasmalemma.

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

Cell is a closed compartment, usually surrounded by a single or double-layered membrane. Plasma membrane of a cell is selectively permeable that allows only selective substances to enter the cell.

78. (b) Both A and R are true, but R is not the correct explanation of A.
Golgi complex consists of a stack of cisternae, which are curved to give definite polarity to the Golgi apparatus.

The convex side (forming/*cis* face) receives vesicles from endoplasmic reticulum. The concave side (maturing/*trans* face) buds off vesicles as secretion.

79. (c) A is true, but R is false and it can be corrected as

Peroxisomes are found in photosynthetic cells and perform photorespiration. They also take part in lipid metabolism. Lysosomes are the cell garbage disposal system.

80. (b) Both A and R are true, but R is not true correct explanation of A.

Mitochondria are absent in prokaryotes. Mesosomes are characteristic, circular to villiform shaped specialisation of cell membrane of bacteria that develop as ingrowths from the plasma membrane.

It contains respiratory enzymes and is, therefore often called chondroid. It is believed to be equal to mitochondrion of eukaryotes. However, respiratory enzymes are also present over the plasma membrane in prokaryotic cell.

81. (c) A is true, but R is false and it can be corrected as

Mitochondria and chloroplasts are semiautonomous cell organelles, which contain their own DNA and protein synthesising machinery. These arise from pre-existing organelles and their functions are partially controlled by nucleus of the cells and partially by themselves (semiautonomous).

82. (c) A is true, but R is false and it can be corrected as

Chloroplasts and mitochondria are endosymbionts in eukaryotic cells, having their own DNA. ER and Golgi bodies do not contain their own DNA.

83. (c) A is true, but R is false. It can be corrected as

The number of mitochondria per cell varies from species to species and from cell to cell depending on the functional site of the cell.

84. (a) Both A and R are true and R is the correct explanation of A.
A cell organelle is a distinct part of a cell which also has a particular structure and function. Since, chloroplast possesses a specific membrane bound structure and plays an important role in photosynthesis, it is said to be a cell organelle.

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

Chromoplasts are yellow or reddish in colour because of the presence of fat soluble carotenoid pigments. In some plants chlorophylls is absent and hence, the carotenoid pigments provide a colour to plant parts other than green, e.g. orange colour of carrot roots, etc.

86. (ii) (c) Ribosomes are the site of protein synthesis (secretory proteins, integral membrane proteins, lysosomal proteins).

These are involved in the process of translating messenger RNA (*m*RNA) into protein.

(iii) (a) On rough endoplasmic reticulum, the ribosomes are attached to the surface by ribophorin-I and ribophorin-II. Ribosomes are altogether absent on smooth ER.

(iv) (d) Statements I and III are correct and II is incorrect and can be corrected as

Ribosomes are present in mitochondria and chloroplast (plastids). Both of these organelles contain 70S ribosomes.

(v) (b) Statements I, III and IV are correct, while II is incorrect. It can be corrected as

Endoplasmic reticulum is not the control centre of the cell. Nucleus controls all the activites occurring within the cell and is hence called as the control centre of a cell.

87. (iii) (a) During interphase, the nucleus contains loose and indistinct network of nucleoprotein fibres called chromatin. Thus, it is the best phase to study the structure of nucleus.

88. (ii) (d) To maintain their internal acidic or low pH, lysosomes must actively concentrate H^+ ions (protons). This is accomplished by a proton pump in the lysosomal membrane, which actively transports protons into the lysosome from the cytosol.
This pumping requires expenditure of energy in the form of ATP hydrolysis, since it maintains approximately a hundred fold higher H^+ concentration inside the lysosome.

Thus, option (d) is correct.

(iv) (d) Statement in option (d) is not correct and can be corrected as

Lysosomes are formed by the fusion of vesicles from the Golgi complex with endosomes. These bud off from *trans* face of Golgi bodies. Precursors of lysosomal enzymes are synthesised by RER and then send to Golgi bodies for further processing.

Rest statements are correct regarding lysosomes.

89. (i) (b) Chloroplasts consist of stroma and lamella enclosed in double membrane. The lamellar system within the stroma forms flattened sac-like lamella called thylakoids. These thylakoids are stacked in some places to form grana.

(ii) (d) Stroma in the chloroplasts of higher plants contains light independent reaction enzymes. Within the stroma are stacks of thylakoids, the suborganelles, which are the site of photosynthesis.

(iii) (d) Plastids (i.e. chloroplasts, chromoplasts and leucoplasts) are semiautonomous cell organelles which are surrounded by double membrane envelop and are found only in plants cells and some unicellular organisms like *Euglena*.

Plastids have the ability to multiply by a fission-like process because these organelles contain their own genetic material and protein synthesising machinery, i.e. DNA, RNA and ribosomes.

(iv) (a) In chloroplast, grana possess green photosynthetic pigment called chlorophyll. There are different types of chlorophyll among which chlorophyll-*a* is the most abundant.

(v) (c) Statement (c) is incorrect about chloroplasts and can be corrected as

They are not associated with any type of respiration, i.e. aerobic and anaerobic and can be found in any type of photosynthesising cell.

Rest other statements are correct with reference to chloroplasts.