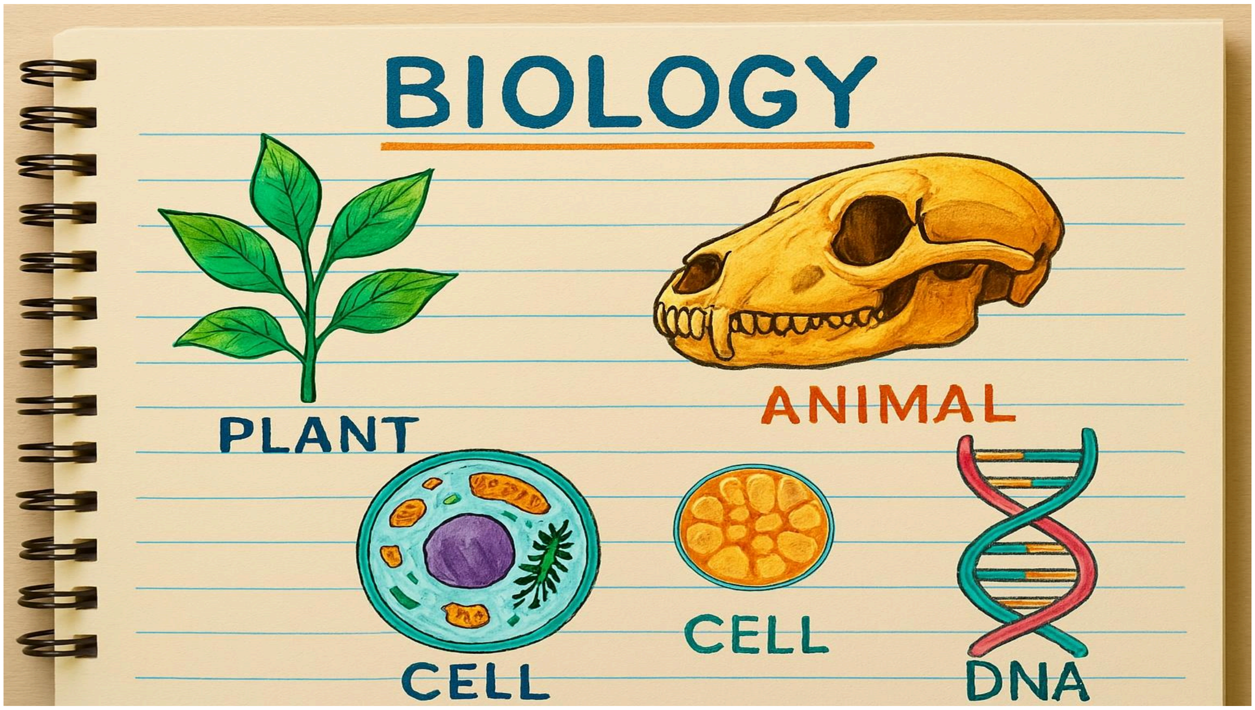


Class: 11th

Subject: Biology

Chapter 3: Cells and Subcellular Organelles

❖ Important MCQs:

1. Cells are considered the basic unit of life because:

(a) They can only perform one function

(b) They make up all living organisms✅

(c) They are only present in multicellular organisms

(d) They do not show any properties of life

2. In unicellular organisms like amoebas, a single cell:

(a) Performs only reproduction

(b) Performs all functions necessary for life✅

(c) Cannot move

(d) Cannot obtain nutrients

3. Which of the following is NOT one of the seven basic properties of life?

(a) Movement

(b) Respiration

(c) Photosynthesis✅

(d) Excretion

4. Cells generate energy through which process?

(a) Photosynthesis

(b) Respiration✅

(c) Excretion

(d) Homeostasis

5. Which of the following examples shows movement at the cellular level?

(a) Nutrient absorption in root cells

(b) Flagellar movement of sperm cells✅

(c) DNA replication

(d) Cellular respiration

6. How do cells maintain homeostasis?

(a) By producing gametes only

(b) By regulating the movement of substances across membranes✅

(c) By moving organelles randomly

(d) By breaking down glucose only

7. Which type of cell division produces identical daughter cells for growth and repair?

(a) Meiosis

(b) Binary fission

(c) Mitosis✅

(d) Budding

8. Which process allows cells to obtain nutrients from their environment to produce energy and build cellular structures?

(a) Excretion

(b) Nutrition✅

(c) Movement

(d) Reproduction

9. Waste products are removed from cells through:

(a) Respiration only

(b) Diffusion and active transport✅

(c) Photosynthesis

(d) Growth

10. Meiosis is important because it:

(a) Produces identical daughter cells

(b) Produces gametes for sexual reproduction✅

(c) Generates ATP

(d) Helps in nutrient absorption

11. Who first observed cells in cork slices under a microscope?

(a) Anton van Leeuwenhoek

(b) Robert Hooke✅

(c) Rudolf Virchow

(d) Matthias Schleiden

12. What term did Robert Hooke use to describe the compartments he observed in cork?

(a) Animalcules

(b) Cellulae✅

(c) Nucleus

(d) Protoplasm

13. Who observed living cells in pond water using a better microscope?

(a) Robert Hooke

(b) Anton van Leeuwenhoek✅

(c) Theodor Schwann

(d) Jean Baptiste de Lamarck

14. Who discovered the nucleus in a cell?

(a) Rudolf Virchow

(b) Robert Brown✅

(c) Louis Pasteur

(d) Matthias Schleiden

15. Matthias Schleiden concluded that:

(a) All animals are made of cells

(b) All plants are made of cells✅

(c) Cells come from pre-existing cells

(d) Cells are not the basic units of life

16. Theodor Schwann concluded that:

(a) Only plants are composed of cells

(b) Only animals are composed of cells✅

(c) Viruses are made of cells

(d) Cells cannot divide

17. Rudolf Virchow is known for the principle that:

(a) All cells are made of protoplasm

(b) All cells come from pre-existing cells✅

(c) Cells can originate spontaneously

(d) Nucleus is optional in a cell

18. Louis Pasteur contributed to cell theory by:

(a) Discovering the nucleus

(b) Providing experimental proof that cells arise from pre-existing cells✅

(c) Observing cork under microscope

(d) Naming the compartments as cellulae

19. Which of the following is NOT a core point of cell theory?

(a) All living organisms are composed of one or more cells

(b) Cells are the basic units of structure and function in organisms

(c) All cells are capable of independent life outside an organism✅

(d) Cells arise only from pre-existing cells

20. Which technique helps validate that cells arise from pre-existing cells?

(a) DNA sequencing

(b) Live-cell imaging✅

(c) Electron microscopy

(d) Photosynthesis

21. Why are viruses considered exceptions to cell theory?

(a) They are made of multiple cells

(b) They are not made of cells and require a host to replicate✅

(c) They have their own nucleus

(d) They can perform all life processes independently

22. Which organelles challenge the traditional cell theory because they have their own DNA?

(a) Ribosomes

(b) Golgi apparatus

(c) Mitochondria and chloroplasts✅

(d) Lysosomes

23. Some fungi and algae have multinucleated structures. This challenges cell theory because:

(a) They lack DNA

(b) Multiple nuclei exist within shared cytoplasm, blurring single-cell boundaries✅

(c) They cannot reproduce

(d) They perform no metabolism

24. Muscle cells (myocytes) challenge cell theory because:

(a) They lack cytoplasm

(b) They fuse to form multinucleated fibres✅

(c) They cannot produce energy

(d) They do not grow

25. Cell theory states that cells are the basic units of:

(a) Only structure

(b) Only function

(c) Both structure and function✅

(d) None of the above

26. Which scientist observed cells in both plants and animals under a microscope before cell theory was formulated?

(a) Anton van Leeuwenhoek

(b) Jean Baptiste de Lamarck✅

(c) Rudolf Virchow

(d) Theodor Schwann

27. Which of the following experimental methods provides tangible evidence of cells as structural units?

(a) Light and electron microscopy✅

(b) Gel electrophoresis

(c) Centrifugation

(d) Chromatography

28. DNA sequencing contributes to cell theory by:

(a) Showing cells are made of RNA only

(b) Revealing common genetic material and metabolic pathways✅

(c) Observing cell shape

(d) Tracking nutrient absorption

29. Live-cell imaging and tissue engineering validate cell theory by demonstrating:

(a) Cellular growth, differentiation, and reproduction✅

(b) Protein synthesis only

(c) Cell death only

(d) Movement of organelles only

30. Which of the following is considered at the border of living and non-living entities?

(a) Mitochondria

(b) Viruses✅

(c) Chloroplasts

(d) Ribosomes

31. Who is credited with concluding that all plants are made of cells?

(a) Theodor Schwann

(b) Matthias Schleiden✅

(c) Rudolf Virchow

(d) Robert Brown

32. Which scientist observed living cells in pond water and called them "animalcules"?

(a) Robert Hooke

(b) Anton van Leeuwenhoek✅

(c) Jean Baptiste de Lamarck

(d) Rudolf Virchow

33. The term “cellulae” was first used by:

(a) Matthias Schleiden

(b) Robert Hooke✅

(c) Theodor Schwann

(d) Robert Brown

34. Which of the following is a key experimental proof that cells arise from pre-existing cells?

(a) Observation of cork slices

(b) Louis Pasteur’s experiments✅

(c) Discovery of mitochondria

(d) Identification of chlorophyll

35. Which eukaryotic organelles have their own DNA and can replicate independently?

(a) Ribosomes and lysosomes

(b) Mitochondria and chloroplasts✅

(c) Golgi apparatus and nucleus

(d) Endoplasmic reticulum and vacuoles

36. Why are viruses considered exceptions to cell theory?

(a) They can perform all cellular functions independently

(b) They are not composed of cells and require a host to replicate✅

(c) They can divide by mitosis

(d) They are multinucleated

37. Rudolf Virchow is known for which principle in cell theory?

(a) Cells are the basic units of life

(b) All cells come from pre-existing cells✅

(c) All plants are made of cells

(d) Cells can arise spontaneously

38. Which scientist discovered the nucleus in 1831?

(a) Matthias Schleiden

(b) Robert Brown✅

(c) Anton van Leeuwenhoek

(d) Jean Baptiste de Lamarck

39. Some fungi and algae challenge traditional cell theory because:

(a) They are made of viruses

(b) They have multiple nuclei in a shared cytoplasm✅

(c) They cannot reproduce

(d) They lack DNA

40. Muscle cells (myocytes) challenge the concept of a single cell because:

(a) They cannot generate ATP

(b) They fuse to form multinucleated fibres✅

(c) They do not have a nucleus

(d) They cannot move

41. Microscopy is the technique of:

(a) Using lenses and light or electron beams to study very small objects✅

(b) Observing objects visible to the naked eye

(c) Measuring large distances

(d) Recording sound waves

42. In a light microscope, how many lenses are used to form an enlarged image?

(a) One

(b) Two✅

(c) Three

(d) Four

43. The maximum magnification of a light microscope is approximately:

(a) 150X

(b) 1500X✅

(c) 15,000X

(d) 250,000X

44. The resolving power of a light microscope is:

(a) 0.2 millimetre

(b) 0.2 micrometre✅

(c) 0.2 nanometre

(d) 2 micrometre

45. Why is staining required in light microscopy?

(a) To increase magnification

(b) To make transparent cell components visible✅

(c) To preserve living cells

(d) To reduce electron scattering

46. Which type of microscope uses a beam of electrons instead of light?

(a) Light microscope

(b) Electron microscope✅

(c) Simple microscope

(d) Compound lens

47. Which electron microscope is used to study the internal structure of cells?

(a) Scanning Electron Microscope (SEM)

(b) Transmission Electron Microscope (TEM)✅

(c) Light microscope

(d) Fluorescence microscope

48. What is the maximum magnification of a TEM?

(a) 25,000X

(b) 100,000X

(c) 250,000X✅

(d) 1,500X

49. Which electron microscope is used to study the surface details of cells?

(a) Transmission Electron Microscope (TEM)

(b) Scanning Electron Microscope (SEM)✅

(c) Light microscope

(d) Phase contrast microscope

50. Why can't electron microscopes be used to view living cells?

(a) Because their magnification is too low

(b) Because specimen preparation methods kill the cells✅

(c) Because they cannot focus electrons

(d) Because they only show transparent images

51. Which of the following are prokaryotic cells?

(a) Yeast

(b) Euglena

(c) Bacteria✅

(d) Plant cells

52. Which of the following is a unicellular eukaryote?

(a) Bacteria

(b) Yeast✅

(c) Plant

(d) Cyanobacteria

53. The primary cell wall of plants is mainly composed of:

(a) Chitin

(b) Cellulose, hemicellulose, and pectin✅

(c) Lignin only

(d) Peptidoglycan

54. The gelatinous layer that holds primary walls of neighbouring plant cells is called:

(a) Secondary wall

(b) Middle lamella✅

(c) Protoplast

(d) Plasma membrane

55. Secondary cell walls are more rigid than primary walls because they contain:

(a) Pectin

(b) Lignin✅

(c) Proteins only

(d) Glycoproteins

56. Small channels connecting the cytoplasm of neighbouring plant cells are called:

(a) Plasmodesmata✅

(b) Gap junctions

(c) Microtubules

(d) Endoplasmic reticulum

57. The cell wall of fungi is composed of:

(a) Cellulose

(b) Chitin✅

(c) Peptidoglycan

(d) Pectin

58. Peptidoglycan is found in the cell walls of:

(a) Bacteria✅

(b) Plants

(c) Fungi

(d) Archaebacteria

59. Which polysaccharide is absent in the cell wall of archaebacteria?

(a) Peptidoglycan✅

(b) Proteins

(c) Polysaccharides

(d) Glycoproteins

60. The plasma membrane is described by which model?

(a) Lock-and-key model

(b) Fluid mosaic model✅

(c) Central dogma

(d) Endosymbiotic model

61. Which part of a phospholipid is hydrophilic?

(a) Tail region

(b) Phosphate head✅

(c) C-H chains

(d) Lipid bilayer

62. In the plasma membrane, the hydrophobic lipid tails are oriented:

(a) Outwards toward cytoplasm

(b) Inwards toward each other✅

(c) Randomly in all directions

(d) Attached to proteins

63. Cholesterol molecules in the eukaryotic plasma membrane:

(a) Decrease membrane fluidity

(b) Keep membrane fluid at low temperatures✅

(c) Form channels for transport

(d) Act as receptors

64. Proteins that float within the lipid bilayer of plasma membrane are involved in:

(a) Structural support only

(b) Selective transport, attachment, signaling, and enzymatic activity✅

(c) Storing lipids

(d) Cell wall formation

65. A protein with attached sugar in the plasma membrane is called:

(a) Glycolipid

(b) Glycoprotein✅

(c) Phospholipid

(d) Cholesterol

66. Glycocalyx is composed of:

(a) Only phospholipids

(b) Glycoproteins and glycolipids✅

(c) Proteins only

(d) Carbohydrates only

67. Small molecules like oxygen, carbon dioxide, and water:

(a) Cannot pass through plasma membrane

(b) Pass freely across the plasma membrane✅

(c) Are actively transported

(d) Require vesicles

68. Which technique is used to study the detailed structure of the lipid bilayer and associated proteins?

(a) Scanning Electron Microscopy

(b) Transmission Electron Microscopy (TEM)✅

(c) Confocal Microscopy

(d) Atomic Force Microscopy

69. Confocal Microscopy is primarily used to:

(a) Examine surface topology

(b) Create sharp, detailed images using laser scanning and fluorescence✅

(c) Determine atomic structure of membrane proteins

(d) Analyze lipids by mass spectrometry

70. The cytoplasm of a eukaryotic cell is located:

(a) Inside the nucleus

(b) Between the plasma membrane and nuclear envelope✅

(c) Outside the cell

(d) Only around organelles

71. Cytosol is:

(a) The semi-viscous, aqueous substance of cytoplasm✅

(b) The rigid layer around cell

(c) Another name for plasma membrane

(d) Only the organelles of the cell

72. Cytoplasm provides space for:

(a) Cell wall formation

(b) Proper functioning of organelles and metabolic reactions✅

(c) DNA replication only

(d) Passive transport only

73. Which organelles are generally enclosed by a membrane?

(a) Ribosomes only

(b) Most organelles except ribosomes✅

(c) Cytosol

(d) Cell wall

74. The cytoplasm is the site of which metabolic reaction?

(a) Glycolysis✅

(b) Photosynthesis

(c) Transcription

(d) Translation only

75. Which plasma membrane proteins function as receptors?

(a) Proteins binding messenger molecules and transmitting signals✅

(b) Proteins forming lipid bilayer

(c) Proteins storing carbohydrates

(d) Proteins forming cell wall

76. Which plasma membrane component acts as cell identification marks?

(a) Phospholipid tails

(b) Glycocalyx✅

(c) Cytoskeleton

(d) Cholesterol

77. Large molecules such as amino acids and sugars:

(a) Pass freely across the plasma membrane

(b) Are carefully regulated✅

(c) Cannot enter the cell at all

(d) Only exit the cell

78. Atomic Force Microscopy is used to:

(a) Study lipid mobility

(b) Provide topographical images of the cell membrane at high resolution✅

(c) Examine surface topology

(d) Visualize fluorescent molecules

79. Lipidomics involves:

(a) Studying the protein composition of membranes

(b) Comprehensive analysis of lipids using techniques like mass spectrometry✅

(c) Imaging the cell surface

(d) Tracking DNA sequences

80. Fluorescence Recovery After Photobleaching (FRAP) is used to study:

(a) Cytoskeleton only

(b) Mobility and dynamics of membrane proteins and lipids✅

(c) Nuclear division

(d) Cell wall composition

81. The nucleus in eukaryotic cells serves as:

(a) Energy-producing centre

(b) Information processing and administrative centre✅

(c) Protein storage only

(d) Lipid synthesis centre

82. The semifluid matrix inside the nucleus is called:

(a) Cytoplasm

(b) Nucleoplasm✅

(c) Chromatin

(d) Ribosome

83. Most nuclear material consists of:

(a) Ribosomes

(b) Chromatin✅

(c) Mitochondria

(d) Golgi apparatus

84. The nuclear envelope is composed of:

(a) Single-layered membrane

(b) Double-layered membrane✅

(c) Protein only

(d) Lipid only

85. The space between the two layers of nuclear envelope is called:

(a) Nucleolus

(b) Perinuclear space✅

(c) Chromatin

(d) Cytosol

86. The nuclear envelope has tiny holes called:

(a) Plasmodesmata

(b) Nuclear pores✅

(c) Ribosomes

(d) Endoplasmic reticulum

87. Nuclear pores are made of:

(a) Lipid bilayer

(b) Nuclear pore complex✅

(c) Chromatin only

(d) Nucleolus

88. The nucleolus primarily functions to:

(a) Store DNA

(b) Manufacture subunits of ribosomes✅

(c) Produce mitochondria

(d) Organize chromatin

89. The DNA regions that form nucleoli are called:

(a) Centromeres

(b) Nucleolus Organizer Regions (NORs)✅

(c) Telomeres

(d) Ribosomes

90. Chromatin is composed of:

(a) RNA and lipids

(b) DNA and proteins✅

(c) Only DNA

(d) Only histones

91. The bead-like structures in chromatin are called:

(a) Centromeres

(b) Nucleosomes✅

(c) Chromatids

(d) Nuclear pores

92. In a nucleosome, DNA wraps around:

(a) Ribosomes

(b) Histone proteins✅

(c) RNA molecules

(d) Phospholipids

93. During interphase, chromatin is:

(a) Condensed into chromosomes

(b) Dispersed as tangled fibres throughout nucleus✅

(c) Absent

(d) Found only in cytoplasm

94. When a cell begins to divide, chromatin compresses into:

(a) Nucleolus

(b) Chromosomes✅

(c) Ribosomes

(d) Centrosomes

95. Each chromosome consists of:

(a) Centromere only

(b) Arms called chromatids and a centromere✅

(c) Nucleolus only

(d) Nuclear pores

96. The number of chromosomes in human diploid cells is:

(a) 23

(b) 46✅

(c) 92

(d) 2

97. Chromosome number is:

(a) Directly proportional to organism's complexity

(b) Species-specific✅

(c) The same in all organisms

(d) Always more than 100

98. The nucleolus contains:

(a) Only ribosomal proteins

(b) Granular and fibrillar components, rRNA, and proteins✅

(c) Only DNA

(d) Only nuclear envelope

99. Granules in nucleolus consist of:

(a) DNA

(b) Ribosomal subunits already formed✅

(c) RNA only

(d) Lipids

100. Fibrils in nucleolus are composed of:

(a) Ribosomal subunits

(b) rRNA molecules and associated proteins✅

(c) DNA only

(d) Histones only

101. The endoplasmic reticulum (ER) is a network of:

(a) DNA and RNA

(b) Flattened sacs and branching tubules✅

(c) Ribosomes only

(d) Cell wall components

102. The sacs and tubules of ER are called:

(a) Cisternae✅

(b) Chromatin

(c) Nucleoli

(d) Vesicles

103. The cisternae of ER are interconnected and contain:

(a) Cytosol only

(b) A large cisternal space✅

(c) Ribosomes only

(d) DNA

104. The ER is connected to:

(a) Golgi apparatus

(b) Double-layered nuclear envelope✅

(c) Plasma membrane only

(d) Ribosomes

105. Rough ER (RER) is primarily involved in:

(a) Lipid synthesis

(b) Protein production and processing✅

(c) Calcium storage

(d) Detoxification only

106. The rough appearance of RER is due to:

(a) Phospholipids

(b) Ribosomes attached on its surface✅

(c) Cholesterol

(d) Smooth tubules

107. Smooth ER (SER) lacks:

(a) Tubules

(b) Ribosomes✅

(c) Membrane

(d) Proteins

108. The main functions of SER include:

(a) Protein synthesis only

(b) Lipid production, carbohydrate metabolism, and detoxification✅

(c) Ribosome assembly

(d) Chromatin organization

109. In muscle cells, SER plays a role in:

(a) Protein folding

(b) Calcium storage and release for muscle contraction✅

(c) DNA replication

(d) Ribosome production

110. Ribosomes are composed of approximately:

(a) 100% protein

(b) 100% rRNA

(c) 60% rRNA and 40% protein✅

(d) 50% rRNA and 50% DNA

111. Ribosomes are:

(a) Membrane-bound organelles

(b) Non-membrane-bound granular structures✅

(c) Found only in eukaryotes

(d) Only in the nucleus

112. In eukaryotic cells, ribosomes are mainly found:

(a) Attached to SER

(b) Attached to RER and some freely in cytoplasm✅

(c) Only in the nucleolus

(d) In the plasma membrane

113. In prokaryotic cells, ribosomes are:

(a) Membrane-bound

(b) Scattered freely in cytoplasm✅

(c) Attached to ER

(d) Found in nucleus

114. Ribosomes serve as:

(a) Lipid production machinery

(b) Protein production machinery✅

(c) DNA replication machinery

(d) Calcium storage

115. Ribosomes are most abundant in cells that are active in:

(a) Lipid synthesis

(b) Protein synthesis✅

(c) Calcium metabolism

(d) Detoxification

116. Ribosome subunits in eukaryotes are produced and assembled in:

(a) Cytoplasm

(b) Nucleolus✅

(c) Golgi apparatus

(d) SER

117. The two subunits of a eukaryotic ribosome are:

(a) 30S and 50S

(b) 40S and 60S✅

(c) 50S and 60S

(d) 20S and 40S

118. Complete eukaryotic ribosome has a Svedberg value of:

(a) 70S

(b) 80S✅

(c) 60S

(d) 50S

119. Complete prokaryotic ribosome has a Svedberg value of:

(a) 70S✅

(b) 80S

(c) 60S

(d) 50S

120. The subunits of prokaryotic ribosomes are:

(a) 30S and 50S✅

(b) 40S and 60S

(c) 20S and 50S

(d) 35S and 55S

121. Messenger RNA (mRNA) in protein synthesis:

(a) Brings amino acids

(b) Provides instructions from DNA✅

(c) Forms ribosome subunits

(d) Acts as enzyme

122. Transfer RNA (tRNA) in protein synthesis:

(a) Carries instructions from DNA

(b) Brings amino acids to ribosome✅

(c) Forms DNA

(d) Synthesizes lipids

123. During protein synthesis, ribosome releases:

(a) DNA

(b) Lipids

(c) Completed chain of amino acids✅

(d) Carbohydrates

124. When protein synthesis is not occurring, ribosomal subunits are:

(a) Combined permanently

(b) Separated✅

(c) Attached to SER only

(d) Dissolved in nucleoplasm

125. Rough ER adds _______ to proteins during processing.

(a) Lipids

(b) Sugars✅

(c) Amino acids only

(d) DNA

126. Mitochondria are often called:

(a) Protein factories

(b) Power generators of the cell✅

(c) Storage organelles

(d) Lipid producers

127. The outer membrane of mitochondria:

(a) Forms cristae

(b) Is smooth and acts as a sieve✅

(c) Contains F-1 particles only

(d) Is highly convoluted

128. The inner membrane of mitochondria forms:

(a) Ribosomes

(b) Cristae✅

(c) Nucleoli

(d) Golgi stacks

129. Knob-like extensions on cristae, known as F-1 particles, are:

(a) ATP-synthase enzymes✅

(b) Ribosomes

(c) Chlorophyll pigments

(d) DNA strands

130. Mitochondria differ from most other organelles because they:

(a) Lack membranes

(b) Contain their own circular DNA, RNA, and 70S ribosomes✅

(c) Cannot replicate independently

(d) Do not participate in respiration

131. Mitochondria are the sites of:

(a) Photosynthesis

(b) Cellular respiration✅

(c) Protein synthesis only

(d) Lipid storage

132. Enzymes for Krebs cycle are located in:

(a) Intermembrane space

(b) Matrix of mitochondria✅

(c) Cristae only

(d) Outer membrane

133. Electron transport chain proteins are located in:

(a) Outer membrane

(b) Inner membrane✅

(c) Matrix only

(d) Cytoplasm

134. Chloroplasts are specialized organelles for:

(a) Cellular respiration

(b) Photosynthesis✅

(c) Protein synthesis

(d) Lipid metabolism

135. Chloroplasts contain pigments:

(a) Carotene only

(b) Chlorophyll a and b✅

(c) Hemoglobin

(d) Melanin

136. The fluid inside chloroplasts is called:

(a) Stroma✅

(b) Matrix

(c) Cytosol

(d) Thylakoid

137. Disk-shaped compartments inside chloroplasts are called:

(a) Grana

(b) Lamellae

(c) Thylakoids✅

(d) Cristae

138. Stacks of thylakoids in a chloroplast are called:

(a) Thylakoids

(b) Grana✅

(c) Lamellae

(d) Cristae

139. Lamellae in chloroplasts:

(a) Contain chlorophyll

(b) Connect two grana✅

(c) Store DNA

(d) Are ATP-synthase enzymes

140. Chloroplasts are similar to mitochondria in that they:

(a) Lack DNA

(b) Reproduce independently of the cell✅

(c) Do not participate in energy transformation

(d) Contain only RNA

141. Golgi apparatus is composed of:

(a) Flattened sacs called cisternae✅

(b) Tubular mitochondria

(c) Ribosomal granules

(d) Thylakoids

142. The 'cis' face of Golgi apparatus:

(a) Faces the plasma membrane

(b) Faces the endoplasmic reticulum✅

(c) Releases secretions

(d) Produces lysosomes only

143. The 'trans' face of Golgi apparatus:

(a) Receives vesicles from ER

(b) Directs processed molecules to their final destination✅

(c) Is connected to nuclear envelope

(d) Synthesizes ribosomes

144. Golgi apparatus modifies proteins and lipids into:

(a) DNA and RNA

(b) Glycoproteins and glycolipids✅

(c) ATP and NADH

(d) Peptidoglycans

145. Products exported from Golgi apparatus are called:

(a) Enzymes

(b) Secretions✅

(c) Lysosomes

(d) Ribosomes

146. Lysosomes are bounded by:

(a) Double membrane

(b) Single membrane✅

(c) No membrane

(d) Lipid bilayer with pores

147. Lysosomes contain approximately:

(a) 10 hydrolytic enzymes

(b) 20 digestive enzymes

(c) 40 hydrolytic enzymes✅

(d) 100 ribosomes

148. Lysosomes perform autophagy, which means:

(a) Transporting molecules

(b) Digesting cellular materials that are no longer useful✅

(c) Synthesizing proteins

(d) Replicating DNA

149. In Tay-Sachs disease, lysosomes lack:

(a) Glycogen-digesting enzyme

(b) Lipid-digesting enzyme✅

(c) Protein-synthesizing enzyme

(d) RNA polymerase

150. Selective cell death in development, such as tail removal in tadpoles, is carried out by:

(a) Ribosomes

(b) Golgi apparatus

(c) Lysosomal enzymes✅

(d) Mitochondria

151. Peroxisomes were discovered by:

(a) Christian de Duve✅

(b) Robert Hooke

(c) Matthias Schleiden

(d) Louis Pasteur

152. Peroxisomes mainly function to:

(a) Synthesize proteins

(b) Remove toxic substances by oxidation✅

(c) Store water

(d) Produce chlorophyll

153. The enzyme catalase in peroxisomes breaks down hydrogen peroxide into:

(a) Oxygen and glucose

(b) Water and oxygen✅

(c) Carbon dioxide and water

(d) Hydrogen and oxygen

154. Zellweger syndrome is caused by:

(a) Absence or reduced number of lysosomes

(b) Absence or reduced number of peroxisomes✅

(c) Defective mitochondria

(d) Defective ribosomes

155. Glyoxysomes are found in:

(a) Animal cells

(b) Fungal cells

(c) Plant cells✅

(d) Bacterial cells

156. Glyoxysomes in plant seeds convert:

(a) Carbohydrates into lipids

(b) Lipids into carbohydrates✅

(c) Proteins into lipids

(d) Nucleic acids into proteins

157. In mature plant cells, a single large vacuole develops by:

(a) Fission of chloroplasts

(b) Fusion of smaller vacuoles✅

(c) Absorption of cytoplasm

(d) Division of nucleus

158. The membrane surrounding a plant vacuole is called:

(a) Plasma membrane

(b) Tonoplast✅

(c) Lysosomal membrane

(d) Endoplasmic reticulum

159. Centrioles are absent in:

(a) Animal cells

(b) Plant cells✅

(c) Protists

(d) Ciliated cells

160. Each centriole in a pair is positioned at:

(a) 45 degrees angle

(b) Right angle✅

(c) Parallel to each other

(d) Random orientation

161. Microfilaments of the cytoskeleton are made of:

(a) Tubulin

(b) Actin✅

(c) Keratin

(d) Myosin

162. Microtubules are composed of:

(a) Alpha-tubulin and beta-tubulin✅

(b) Actin and myosin

(c) Keratin and vimentin

(d) Dynein only

163. Intermediate filaments are primarily found in:

(a) All prokaryotes

(b) Higher animals✅

(c) Plants only

(d) Fungi only

164. Cilia and flagella have a core called:

(a) Axoneme✅

(b) Tonoplast

(c) Microfilament

(d) Centrosome

165. The structural arrangement of eukaryotic cilia and flagella is:

(a) 9 + 2 microtubule arrangement✅

(b) 9 + 1

(c) 2 + 9

(d) 7 + 2

166. Basal body of a cilium is actually:

(a) Mitochondrion

(b) Centriole✅

(c) Ribosome

(d) Golgi vesicle

167. Prokaryotic flagella are made of:

(a) Tubulin

(b) Dynein

(c) Actin

(d) Flagellin✅

168. In humans, cilia are commonly found in:

(a) Liver cells

(b) Lining of trachea✅

(c) Blood cells

(d) Muscle cells

169. Functions of vacuoles in plant cells include all except:

(a) Storage✅

(b) Structural support

(c) Waste disposal

(d) Protein synthesis

170. High turgor pressure in plant cells is maintained by:

(a) Golgi apparatus

(b) Central vacuole✅

(c) Nucleus

(d) Mitochondria

171. Prokaryotic cells are found in:

(a) Animals

(b) Plants

(c) Bacteria and Archaea✅

(d) Fungi

172. Eukaryotic cells differ from prokaryotic cells because they:

(a) Lack DNA

(b) Lack ribosomes

(c) Have a nucleus and membrane-bound organelles✅

(d) Are smaller in size

173. The region in a prokaryotic cell where DNA is located is called:

(a) Nucleolus

(b) Nucleoid✅

(c) Nucleus

(d) Centrosome

174. Prokaryotic cells lack all of the following except:

(a) Mitochondria

(b) Ribosomes✅

(c) Endoplasmic reticulum

(d) Golgi apparatus

175. The size range of most prokaryotic cells is:

(a) 20–80 µm

(b) 2–8 µm✅

(c) 0.2–0.8 mm

(d) 10–50 µm

176. Ribosomes of prokaryotic cells have Svedberg value of:

(a) 80S (40S + 60S)

(b) 70S (30S + 50S)✅

(c) 90S (40S + 50S)

(d) 60S (30S + 30S)

177. The prokaryotic cell wall is composed of:

(a) Cellulose

(b) Chitin

(c) Peptidoglycan✅

(d) Pectin

178. Prokaryotic flagella are made of:

(a) Tubulin

(b) Actin

(c) Flagellin✅

(d) Dynein

179. Prokaryotic cells divide by:

(a) Mitosis

(b) Meiosis

(c) Binary fission✅

(d) Budding

180. Pili in prokaryotic cells function mainly for:

(a) Photosynthesis

(b) Attachment to surfaces✅

(c) Protein synthesis

(d) Cellular respiration

181. Cell signalling is defined as:

(a) Movement of cells

(b) Ability of cells to respond to stimuli from their environment✅

(c) Division of cells

(d) Protein synthesis

182. The first step in cell signalling is:

(a) Signal Transduction

(b) Cellular Response

(c) Signal Reception✅

(d) Gene Expression

183. A signal molecule that binds to a receptor is called:

(a) Enzyme

(b) Ligand✅

(c) Hormone

(d) Second messenger

184. Receptors for water-soluble ligands are usually located:

(a) Inside the nucleus

(b) On plasma membrane✅

(c) In mitochondria

(d) On ribosomes

185. Small molecules like cAMP, calcium ions, and IP3 act as:

(a) First messengers

(b) Receptors

(c) Second messengers✅

(d) Ligands

186. Signal transduction often leads to:

(a) Protein degradation

(b) Cellular response like changes in gene expression✅

(c) Immediate cell death

(d) Formation of lysosomes

187. Protein/peptide signalling molecules cannot pass through plasma membrane because they are:

(a) Lipophilic

(b) Hydrophilic / Water-soluble✅

(c) Small molecules

(d) Nonpolar

188. Steroid hormones differ from protein ligands because they:

(a) Cannot enter the cell

(b) Diffuse through plasma membrane✅

(c) Do not bind receptors

(d) Act as second messengers

189. Once a steroid hormone binds its intracellular receptor, it forms:

(a) Second messenger

(b) Receptor-ligand complex

(c) Active receptor-hormone complex✅

(d) Ribosome

190. The receptor-hormone complex inside the nucleus regulates:

(a) ATP production

(b) Transcription of target genes✅

(c) Protein degradation

(d) Ribosome synthesis

191. Cell signalling can lead to:

(a) Changes in cellular metabolism✅

(b) Movement of lysosomes only

(c) Formation of pili

(d) None of the above

192. A conformational change in the receptor protein occurs during:

(a) Signal Reception✅

(b) Protein synthesis

(c) Cell division

(d) Signal termination

193. The term "second messenger" refers to:

(a) Ligand outside the cell

(b) Small intracellular molecule transmitting signal from receptor✅

(c) DNA molecule

(d) RNA molecule

194. Apoptosis triggered by cell signalling is also called:

(a) Uncontrolled cell division

(b) Programmed cell death✅

(c) Necrosis

(d) Mitosis

195. Steroid hormone signalling differs from peptide signalling because it:

(a) Uses plasma membrane receptors only

(b) Can directly regulate gene transcription inside the nucleus✅

(c) Requires second messengers

(d) Cannot affect gene expression

196. The movement of molecules across plasma membrane without energy is called:

(a) Active transport

(b) Passive transport✅

(c) Endocytosis

(d) Exocytosis

197. Which of the following is a type of passive transport?

(a) Osmosis✅

(b) Sodium-potassium pump

(c) Phagocytosis

(d) Pinocytosis

198. Diffusion is defined as:

(a) Movement of molecules from low to high concentration

(b) Movement of molecules along concentration gradient without energy✅

(c) Transport requiring ATP

(d) Transport of water only

199. Facilitated diffusion differs from simple diffusion because:

(a) It requires energy

(b) It uses transport proteins✅

(c) It moves molecules against concentration gradient

(d) It only occurs in plant cells

200. Which proteins form hydrophilic channels in plasma membrane for specific ions?

(a) Carrier proteins

(b) Channel proteins✅

(c) Ribosomal proteins

(d) Enzymes

201. Aquaporins are responsible for:

(a) Facilitating the rapid transport of water molecules✅

(b) Transport of glucose

(c) Moving ions against gradient

(d) Forming lysosomes

202. Carrier proteins in facilitated diffusion:

(a) Bind and transport specific molecules✅

(b) Create pores in membrane

(c) Pump molecules against gradient

(d) Store ATP

203. Osmosis is the movement of:

(a) Solutes from high to low concentration

(b) Water molecules from higher to lower concentration✅

(c) Ions using carrier proteins

(d) Proteins through channels

204. In osmosis, water moves from:

(a) Hypertonic to hypotonic solution

(b) Hypotonic to hypertonic solution✅

(c) Equal solute concentrations

(d) Random directions

205. Selectively permeable membranes:

(a) Allow all molecules to pass

(b) Allow water but restrict many solutes✅

(c) Only allow solutes

(d) Prevent osmosis

206. Active transport differs from passive transport because it:

(a) Requires no energy

(b) Moves molecules against concentration gradient✅

(c) Occurs only in plant cells

(d) Moves water only

207. Sodium-potassium pump is an example of:

(a) Passive transport

(b) Active transport✅

(c) Osmosis

(d) Facilitated diffusion

208. In a resting nerve cell, sodium-potassium pump maintains:

(a) Equal Na^+ and K^+ inside and outside

(b) Higher K^+ and lower Na^+ inside✅

(c) Higher Na^+ and lower K^+ inside

(d) Only Na^+ concentration

209. Active transport through carrier proteins uses:

(a) Diffusion

(b) ATP energy✅

(c) Water potential

(d) Osmosis

210. The primary function of membrane transport mechanisms is:

(a) Maintaining homeostasis✅

(b) Cell division

(c) Ribosome production

(d) Chlorophyll synthesis

211. Endocytosis is a process in which:

(a) Materials are exported out of the cell

(b) Bulky materials are brought into the cell✅

(c) ATP is produced

(d) Water moves across membrane

212. In endocytosis, a portion of the plasma membrane:

(a) Fuses with Golgi

(b) Invaginates to form a vesicle✅

(c) Breaks into fragments

(d) Forms lysosomes

213. Phagocytosis is a type of endocytosis where the cell takes in:

(a) Water

(b) Liquids in droplets

(c) Solid material✅

(d) Gases

214. Pinocytosis differs from phagocytosis because it:

(a) Takes in liquids✅

(b) Takes in solids

(c) Expels materials

(d) Requires no vesicles

215. In exocytosis, materials are:

(a) Brought into the cell

(b) Exported out of the cell✅

(c) Diffused passively

(d) Transported through nuclear pores

216. The vesicle in exocytosis fuses with:

(a) Mitochondria

(b) Endoplasmic reticulum

(c) Plasma membrane✅

(d) Nucleus

217. Stem cells are unique because they:

(a) Can divide but not differentiate

(b) Can develop into many different cell types✅

(c) Cannot renew themselves

(d) Are only found in embryos

218. Totipotent stem cells can differentiate into:

(a) Almost any cell

(b) All possible cell types✅

(c) A few cell types

(d) Only one cell type

219. Which stem cells are pluripotent?

(a) Zygote cells

(b) Early embryonic cells✅

(c) Adult muscle stem cells

(d) Adult lymphoid stem cells

220. Multipotent stem cells can differentiate into:

(a) Any cell type

(b) Only their own type

(c) A closely related family of cells✅

(d) All cell types in body

221. Oligopotent stem cells:

(a) Can become only one cell type

(b) Can differentiate into a few cell types✅

(c) Can become all cell types

(d) Are artificially produced only

222. Unipotent stem cells:

(a) Can produce all cell types

(b) Can produce only one cell type✅

(c) Cannot renew themselves

(d) Are always embryonic

223. Stem cells are used in regenerative medicine to:

(a) Produce energy

(b) Repair or replace damaged tissues✅

(c) Transport molecules

(d) Form cell membranes

224. Stem cells help in drug testing because:

(a) They produce ATP

(b) They allow creation of human disease models✅

(c) They form lysosomes

(d) They generate ions

225. Personalized medicine with stem cells reduces:

(a) Need for ATP

(b) Risk of immune rejection✅

(c) Vesicle formation

(d) Photosynthesis

226. Embryonic stem cells (ESCs) are derived from:

(a) Bone marrow

(b) Inner cell mass of blastocysts✅

(c) Adult skin cells

(d) Nucleus of somatic cells

227. ESCs are pluripotent, which means they:

(a) Can produce only one cell type

(b) Can differentiate into nearly all cell types✅

(c) Cannot renew themselves

(d) Are only found in adult tissue

228. Adult stem cells (ASCs) are mostly:

(a) Totipotent

(b) Multipotent✅

(c) Pluripotent

(d) Unipotent

229. ASCs are preferred over ESCs because they:

(a) Have higher differentiation potential

(b) Involve less ethical controversy✅

(c) Are easier to create in lab

(d) Can become any cell type

230. Induced pluripotent stem cells (iPSCs) are generated by:

(a) Extracting from embryos

(b) Reprogramming adult somatic cells✅

(c) Bone marrow only

(d) Multiplying totipotent cells

231. iPSCs are similar to ESCs because:

(a) They are totipotent

(b) They are pluripotent✅

(c) They are unipotent

(d) They cannot differentiate

232. Advantage of iPSCs over ESCs is:

(a) Can be generated from patient's own cells✅

(b) Always totipotent

(c) Do not divide

(d) Cannot be used in therapy

233. Disadvantages of iPSCs include:

(a) Risk of tumor formation✅

(b) Ethical controversies

(c) Cannot differentiate

(d) Do not produce energy

234. iPSCs avoid ethical issues of ESCs because:

(a) Do not require human embryos✅

(b) Cannot divide

(c) Are unipotent

(d) Always form tumors

235. Stem cells in spinal cord injury treatment aim to:

(a) Destroy damaged tissue

(b) Replace damaged nerve cells✅

(c) Form lysosomes

(d) Remove calcium

236. Stem cells in diabetes treatment aim to:

(a) Produce insulin-producing cells✅

(b) Remove glucose

(c) Form red blood cells

(d) Produce glucagon only

237. Teratoma formation is a risk with:

(a) ASCs

(b) ESCs

(c) iPSCs✅

(d) Totipotent zygote cells

238. Phagocytosis can be described as:

(a) Cell drinking

(b) Cell eating✅

(c) Passive transport

(d) Exocytosis

239. Pinocytosis can be described as:

(a) Cell eating

(b) Cell drinking✅

(c) Protein transport

(d) ATP production

240. Endocytosis and exocytosis are both forms of:

(a) Passive transport

(b) Active transport✅

(c) Diffusion only

(d) Osmosis

📘 Exercise Mcqs:

Section 1: Multiple Choice Questions

1. Which one of the following eukaryotic cell structures does not contain DNA?

(a) Nucleus

(b) Mitochondrion

(c) Endoplasmic reticulum✅

(d) Chloroplast

2. Which of the following is not an accurate description of a chromosome?

(a) It is a coloured body localized in the nucleus

(b) It is a protein and nucleic acid complex

(c) It is the cellular structure that contains the genetic material

(d) In eukaryotes, it is composed of many DNA molecules attached end to end✅

3. A centriole is an organelle that is:

(a) Present in the centre of a cell's cytoplasm

(b) Composed of microtubules and important for organizing the spindle fibres✅

(c) Surrounded by a membrane

(d) Part of a chromosome

4. The rough endoplasmic reticulum is:

(a) An intracellular double-membrane system to which ribosomes are attached✅

(b) An intracellular membrane that is studded with microtubular structures

(c) A membranous structure found within mitochondria

(d) Only found in prokaryotic cells

5. In the nucleus of eukaryotic cells, the genetic material is organized into linear structures called:

(a) Centrioles

(b) Histones

(c) Chromosomes✅

(d) Plasmids

6. Which of the following statements does not apply to the nuclear envelope?

(a) It is a double membrane

(b) It is continuous with the endoplasmic reticulum

(c) It has pores through which material enters and leaves

(d) It has infoldings to form cristae✅

7. Lysosomes are formed by budding from:

(a) Smooth endoplasmic reticulum

(b) Golgi apparatus✅

(c) Rough endoplasmic reticulum

(d) Nucleus

8. All peroxisomes carry out this function:

(a) Break down fats and amino acids into smaller molecules for energy

(b) Digest macromolecules using hydrolytic enzymes they contain✅

(c) Synthesize membrane components

(d) Control the flow of ions into and out of the cell

9. How would the absence of peroxisomes affect the cell?

(a) The cell would be unable to carry out oxidative phosphorylation

(b) The cell would accumulate hydrogen peroxide causing oxidative stress and damage✅

(c) The cell would have impaired protein synthesis

(d) The cell would fail to produce lipids

10. Which of the following does not apply to chloroplasts?

(a) They contain chlorophyll

(b) They contain thylakoids

(c) They synthesize ATP

(d) Their inner membrane is folded into cristae✅

11. What is the correct sequence of membrane compartments for a secretory protein?

(a) SER ⟶ Golgi apparatus ⟶ RER ⟶ Cell membrane

(b) Cell membrane ⟶ Golgi apparatus ⟶ RER ⟶ SER

(c) RER ⟶ Golgi ⟶ Cell membrane ⟶ SER

(d) RER ⟶ SER ⟶ Golgi apparatus ⟶ Cell membrane✅

12. How does facilitated diffusion differ from active transport?

(a) Facilitated diffusion requires energy

(b) Facilitated diffusion does not require energy, active transport does✅

(c) Both processes require energy

(d) Both processes do not require energy

Section 2: Short Questions

1. Compare the resolution and magnification of light microscope and electron microscope.

Answer:

Resolution: Light microscope – 200 nm, Electron microscope – 0.2 nm (Electron microscope is more precise).

Magnification: Light microscope – up to 1500×, Electron microscope – up to 1,000,000× (Electron microscope magnifies more).

2. State the cell theory. How can we validate it? What are the exceptions to sell theory?

Answer:

Cell theory:

- All living organisms are made of cells.
- Cell is the basic unit of life.
- All cells come from pre-existing cells.

Validation: Observing cells under microscope and studying cell division.

Exceptions: Viruses (acellular), mitochondria and chloroplasts (have their own DNA), skeletal muscle fibers (multi-nucleated), giant algae (single-celled but large).

3. The table below compares the process of diffusion, facilitated diffusion and active transport. Fill in the blank cells, using the words "YES" or "NO".

Answer:

Description	**Simple Diffusion**	**Facilitated Diffusion**
Is ATP required?	No	No

Are carrier proteins involved?	No	Yes
Is direction of transport always from higher to lower concentrati on?	Yes	Yes

Quick Explanation:

- Simple Diffusion → Molecules move freely from high concentration to low concentration, without ATP or carrier proteins.
- Facilitated Diffusion → Molecules still move high → low, but they need carrier proteins. No ATP is required.
- Active Transport → Molecules move against the concentration gradient (low → high). This requires both ATP energy and carrier proteins.

4. Categorize the organelles as (i) single membrane bounded, (ii) double membrane bounded, and (iii) lacking any membrane.

Answer:

Single membrane bounded organelles:

- Lysosomes, peroxisomes, vacuoles, Golgi apparatus, endoplasmic reticulum – these organelles are surrounded by a single lipid layer and perform functions like storage, transport, or digestion.

Double membrane bounded organelles:

- Nucleus, mitochondria, chloroplasts – these organelles have two lipid layers, providing protection and compartmentalization.

Lacking any membrane:

- Ribosomes, centrioles, cytoskeleton, cilia, flagella – these structures are not surrounded by membranes but are essential for protein synthesis, structural support, and movement.

5. State two functions of the proteins in the plasma membrane.

Answer:

Transport: Proteins help in the movement of molecules such as glucose, ions, and water into or out of the cell (via carrier or channel proteins).

Signal reception and recognition: Proteins detect signals, bind hormones, and help cells communicate with each other.

6. State two features that mitochondria have in common with prokaryotes.

Answer:

Own DNA: Mitochondria contain circular DNA, similar to prokaryotes.

Own ribosomes and independent replication: Mitochondria have 70S ribosomes and can replicate independently of the cell.

7. Three ways in which prokaryotic cells differ from eukaryotic cells:

Answer:

Nucleus: Prokaryotic cells do not have a true nucleus; their DNA is free in a region called the nucleoid. Eukaryotic cells have a well-defined, membrane-bound nucleus.

Organelles: Prokaryotic cells lack membrane-bound organelles like mitochondria, endoplasmic reticulum, Golgi apparatus, chloroplasts, and lysosomes. Eukaryotic cells have all these organelles.

Size and Complexity: Prokaryotic cells are small (2–8 µm) and simple in structure. Eukaryotic cells are larger (10–100 µm) and more complex.

8. Structures and molecules that can cross the nuclear envelope:

Answer:

- Small molecules such as ions, nucleotides, and water can freely pass through nuclear pores.
- Large molecules like proteins (e.g., histones, enzymes) enter the nucleus through active transport via nuclear pores.
- RNA and ribosomal subunits leave the nucleus through nuclear pores to participate in protein synthesis in the cytoplasm.

9. Differences between the following pairs:

Answer:

a. Exocytosis vs Endocytosis

- **Exocytosis:** Cell exports large materials using vesicles that fuse with the plasma membrane. Example: secretion of hormones.
- **Endocytosis:** Cell imports large materials by forming a vesicle from plasma membrane. Example: white blood cell engulfing bacteria.

b. Phagocytosis vs Pinocytosis

- **Phagocytosis:** Cell takes in solids (e.g., bacteria, debris).
- **Pinocytosis:** Cell takes in liquids in the form of small droplets.

c. Peroxisomes vs Glyoxysomes

- **Peroxisomes:** Found in almost all eukaryotic cells; detoxify harmful substances, break down fatty acids, and convert hydrogen peroxide into water and oxygen.
- **Glyoxysomes:** Found only in plant cells, especially in seeds; convert stored fats into carbohydrates to provide energy during germination.

10. What are the main functions of lysosomes?

Answer:

Lysosomes are the digestive system of the cell. They contain hydrolytic enzymes that break down worn-out organelles, cellular waste, and foreign particles like bacteria.

- They perform autophagy, recycling cellular components.

- Lysosomes are involved in cell death (apoptosis) when cells need to be removed.
- In some specialized cells (like white blood cells), they digest pathogens.

11. Describe the role of the Golgi body in forming lysosomes.

Answer:

The Golgi apparatus processes and packages enzymes made by the rough endoplasmic reticulum (RER).

- It encloses these enzymes in vesicles, forming lysosomes.
- These lysosomes are then ready to digest materials or worn-out organelles in the cell.

12. What are histones? Where are these found in eukaryotic cells?

Answer:

- Histones are small proteins around which DNA wraps to form chromatin.
- They help in structuring and organizing DNA, making it compact and manageable inside the nucleus.

Location: Histones are found in the nucleus of eukaryotic cells.

13. What do you mean by "stem cell"? What are the main usages of stem cells?

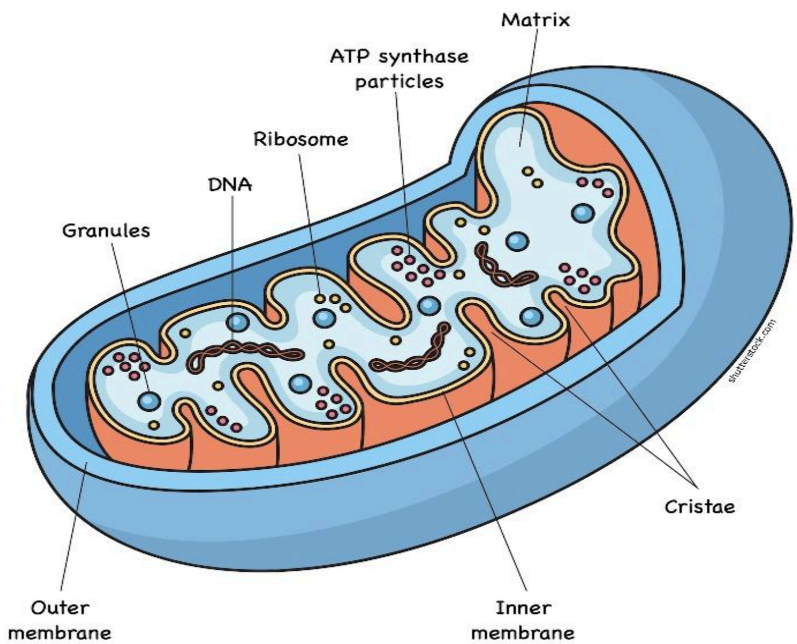
Answer:

Stem cells are undifferentiated cells that can divide and develop into different specialized cell types.

Usages of stem cells:

- **Regenerative medicine:** Repair or replace damaged tissues (e.g., heart, spinal cord, pancreas).
- **Drug testing:** Test effects of drugs on specific cell types without using humans or animals.
- **Personalized medicine:** Stem cells from a patient reduce the risk of immune rejection.

14. The following diagram shows the structure of a mitochondrion. Name structures A to G.



Structures of the Mitochondrion

A – Outer membrane

- The smooth boundary that encloses the organelle.

B – Inner membrane

- The folded membrane inside, forming cristae.

C – Cristae

- The inward folds of the inner membrane that increase surface area for ATP production.

D – Matrix

- The fluid-filled central space containing enzymes, mitochondrial DNA, and ribosomes.

E – Intermembrane space

- The narrow region between the outer and inner membranes.

F – Mitochondrial DNA

- Circular DNA found in the matrix, responsible for coding some mitochondrial proteins.

G – Ribosomes

- Small structures in the matrix that synthesize proteins.

Section 3: Long Questions

🌟 **Q1: Write details of the structure and the chemical composition of cell walls of eukaryotes and prokaryotes.**

❖ **Answer:**

The cell wall is a rigid or semi-rigid layer that surrounds the plasma membrane of cells. It provides structural support, protection, and shape to the cell. Cell walls are present in prokaryotic cells (like bacteria) and many eukaryotic cells (such as plants, fungi, and algae), but they differ in their chemical composition and structure depending on the organism.

1. Prokaryotic Cell Wall

Structure: Prokaryotic cell walls are usually rigid and strong to protect against mechanical stress and osmotic pressure. They are located outside the plasma membrane. Some bacteria also have a capsule or slime layer outside the wall for extra protection.

Chemical Composition: The main component is peptidoglycan, a polymer made of sugar chains (N-acetylglucosamine and N-acetylmuramic acid) linked by short amino acid chains.

Types:

- **Gram-positive bacteria:** Thick peptidoglycan layer.
- **Gram-negative bacteria:** Thin peptidoglycan layer and an additional outer membrane.

Functions: Maintains shape, protects against bursting in hypotonic solutions, and provides a barrier against harmful chemicals.

2. Plant Cell Wall

Structure: Plant cell walls are multi-layered.

- **Primary wall:** Flexible, thin, allows growth.
- **Secondary wall:** Rigid, contains lignin for strength.
- **Middle lamella:** Rich in pectin, glues adjacent cells together.

Chemical Composition: Mainly cellulose, with hemicellulose, pectin, and proteins.

Functions: Provides rigidity, structural support, protection, and helps maintain turgor pressure.

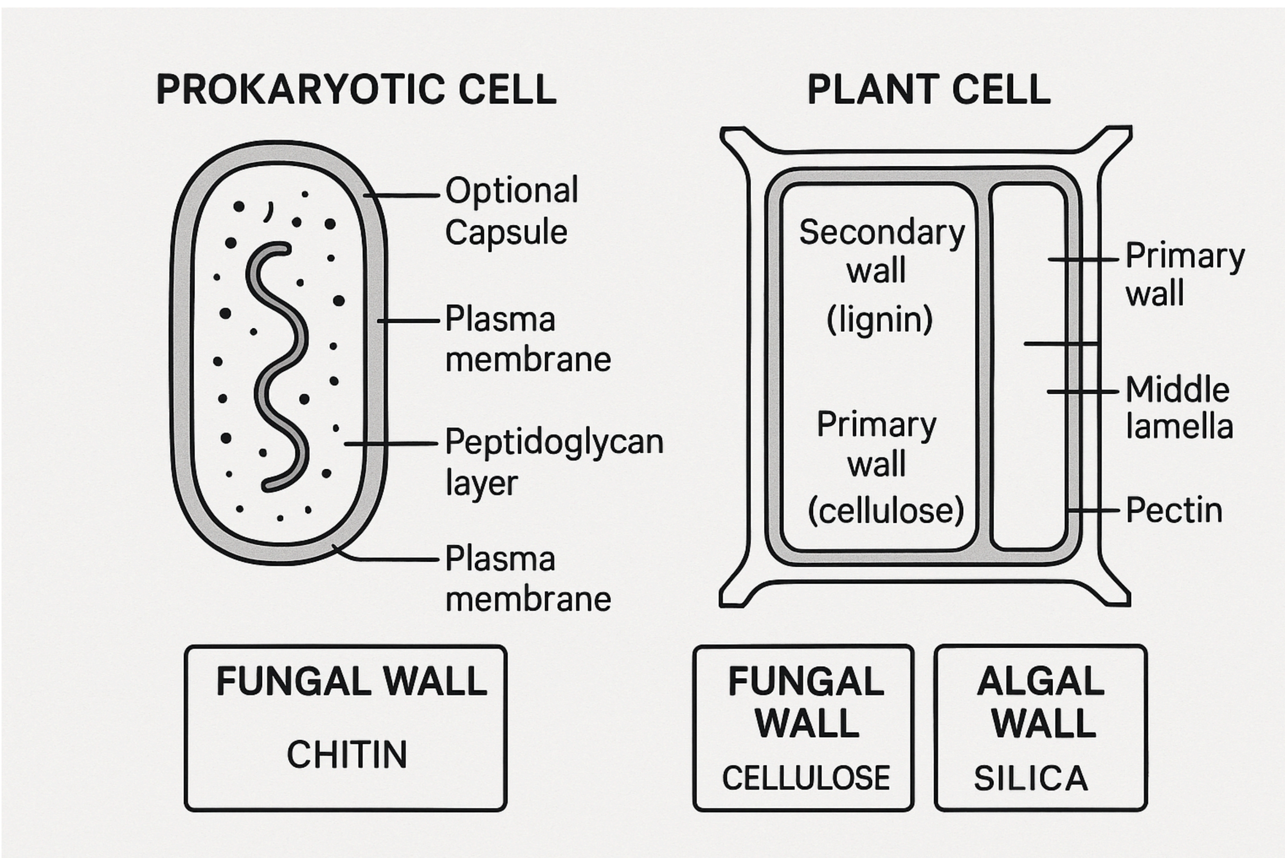
3. Fungal Cell Wall

- **Structure:** Thick and rigid, surrounding the plasma membrane.
- **Chemical Composition:** Mainly chitin, a polymer of N-acetylglucosamine, along with glucans and proteins.
- **Functions:** Protects against environmental stress, maintains shape, and prevents bursting.

4. Algal Cell Wall

- **Structure:** Similar to plants, but can vary widely. Some algae have silica or calcium carbonate in their walls.
- **Chemical Composition:** Mostly cellulose, sometimes with alginates, carrageenan, or silica.
- **Functions:** Provides rigidity and protection, especially in aquatic environments.

Diagram:



✦ **Summary:**

Prokaryotes: Cell wall made of peptidoglycan, provides strength and shape, protects from osmotic stress.

Plants: Made of cellulose, hemicellulose, pectin, multi-layered for support and turgor maintenance.

Fungi: Made of chitin, protects and supports the cell.

Algae: Made of cellulose and other polysaccharides, provides protection in water.

🌟 **Q2: Explain the chemical composition and the functions of plasma membrane.**

❖ **Answer:**

The plasma membrane is a thin, flexible layer that surrounds every cell, separating its internal contents from the external environment. It is semi-permeable, which means it allows some substances to pass while restricting others. It plays a key role in maintaining homeostasis and communication between the cell and its environment.

1. Chemical Composition of Plasma Membrane

The plasma membrane is mainly composed of lipids, proteins, and carbohydrates:

a. Lipids

- **Phospholipids:** Form the bilayer, with hydrophilic heads facing outside and inside, and hydrophobic tails in the middle.
- **Cholesterol:** Maintains fluidity and stability of the membrane.

b. Proteins

- **Integral (intrinsic) proteins:** Span the membrane and function in transport, channels, and receptors.

- **Peripheral (extrinsic) proteins:** Attach to the inner or outer surface and help in cell signaling and structure.

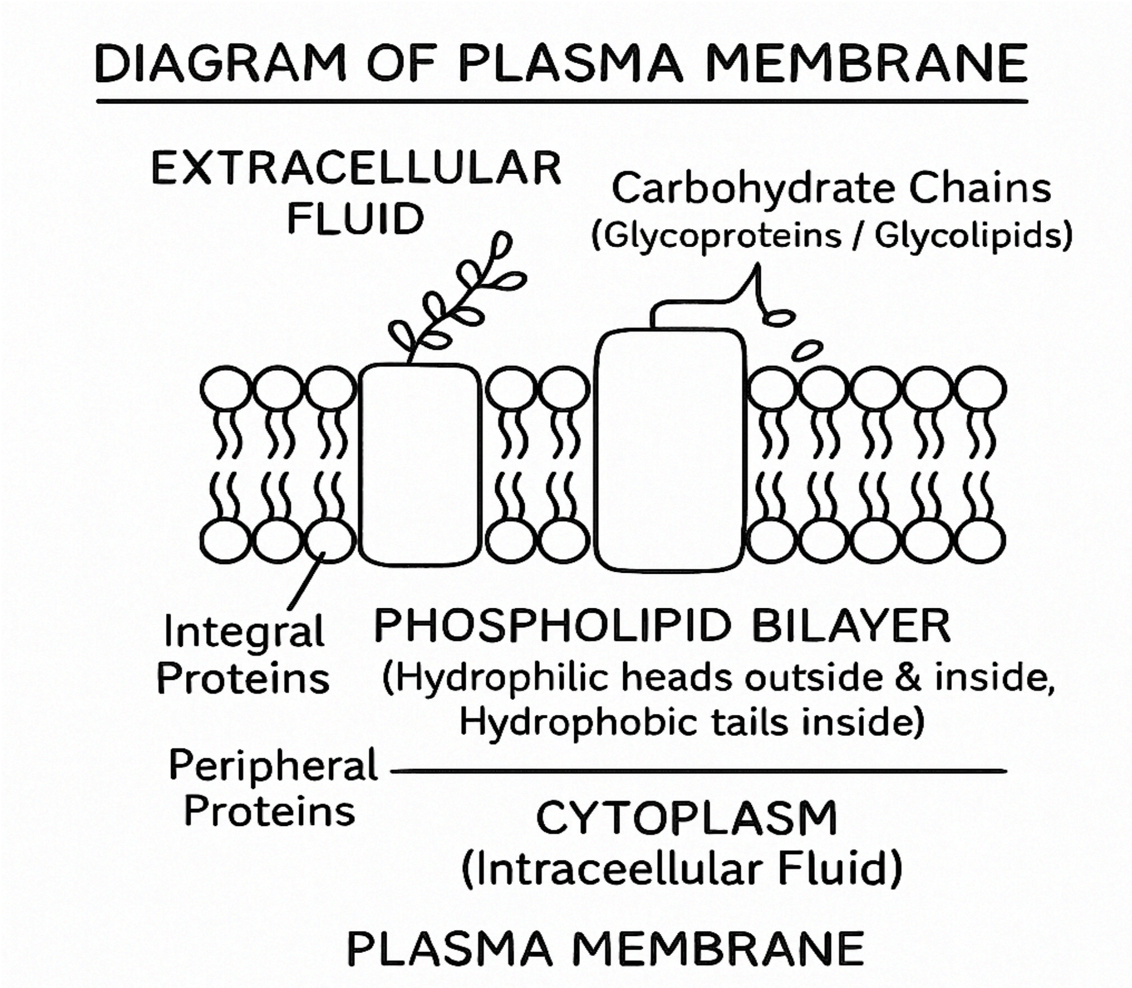
c. Carbohydrates

- Found on glycoproteins and glycolipids, forming the glycocalyx.
- Functions in cell recognition, adhesion, and signaling.

2. Functions of Plasma Membrane

1. **Selective Barrier:** Controls entry and exit of molecules, maintaining internal environment.
2. **Transport:** Helps in diffusion, osmosis, and active transport of nutrients, ions, and waste.
3. **Communication:** Receptors on membrane detect signals from other cells or environment.
4. **Support and Shape:** Provides structural support to the cell and anchors cytoskeleton.
5. **Protection:** Protects the cell from mechanical stress and harmful substances.

Diagram:



✦ **Summary:**

- The plasma membrane is made of lipids, proteins, and carbohydrates.
- It functions in selective transport, communication, protection, support, and signaling.
- Its fluid-mosaic structure allows it to be flexible and dynamic, adapting to the needs of the cell.

🌟 **Q3: Identify the role of glycolipids and glycoproteins as the cell surface markers.**

❖ **Answer**

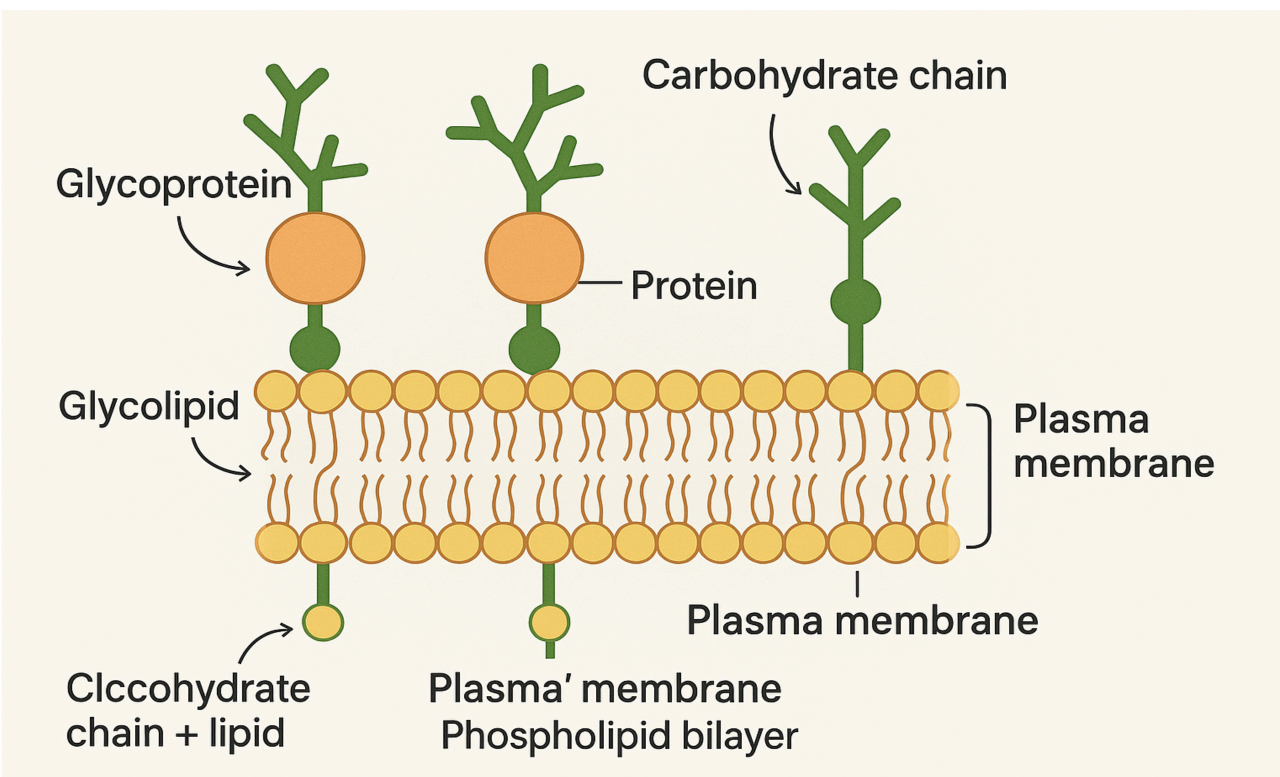
- Glycolipids and glycoproteins are important molecules found on the outer surface of the plasma membrane. They have carbohydrates attached to lipids or proteins, which project outside the cell. These molecules act as cell surface markers that help the cell to communicate, recognize, and interact with its environment.

- **Glycoproteins:** Proteins with carbohydrate chains. They are involved in cell recognition, immune response, and signaling. For example, glycoproteins help white blood cells identify foreign cells and trigger an immune response.
- **Glycolipids:** Lipids with carbohydrate chains. They provide structural stability, cell adhesion, and recognition. Glycolipids are especially important in nerve cells for maintaining tissue structure and signaling between cells.

Key roles of glycolipids and glycoproteins:

- **Cell recognition:** Enable cells to identify each other, e.g., distinguishing self from foreign cells.
- **Cell communication:** Help in signaling between cells.
- **Immune response:** Activate immune cells against pathogens.
- **Cell adhesion:** Assist in the formation of tissues by binding cells together.

Diagram:



✦ **Summary:**

Glycoproteins and glycolipids act as "ID cards" of the cell, allowing it to interact, communicate, and protect itself. They are essential for immune defense, tissue formation, and proper cellular signaling.

🌟 **Q4: Explain the structure, chemical composition, and function of ribosomes.**

❖ **Answer:**

Ribosomes are tiny, granular structures found in all living cells. They are the sites of protein synthesis and can either be free in the cytoplasm or attached to the rough endoplasmic reticulum in eukaryotic cells. In prokaryotic cells, ribosomes are always free in the cytoplasm.

Structure:

1. Ribosomes are not bound by a membrane.
2. They are composed of two subunits: a small subunit and a large subunit.
3. In eukaryotes, the ribosome is 80S, with 40S small subunit and 60S large subunit.
4. In prokaryotes, the ribosome is 70S, with 30S small subunit and 50S large subunit.
5. The subunits are produced and assembled in the nucleolus in eukaryotic cells.

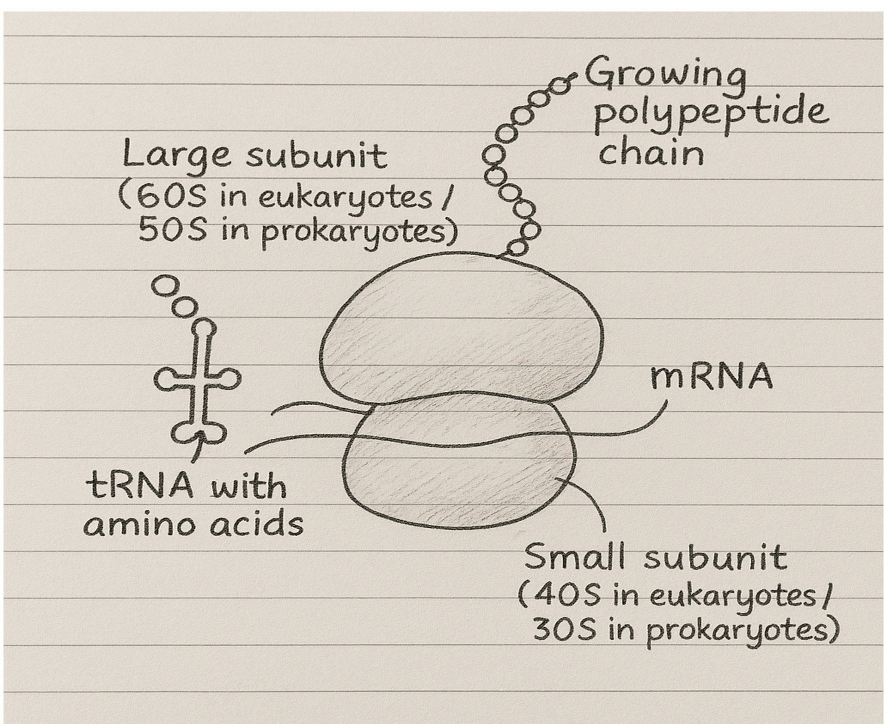
Chemical Composition:

- Ribosomes are made of 60% ribosomal RNA (rRNA) and 40% protein.
- The rRNA provides the structural framework, while proteins help in ribosome function.

Function:

- **Protein synthesis:** Ribosomes read the instructions from messenger RNA (mRNA) and link amino acids brought by transfer RNA (tRNA) to form proteins.
- **Supporting cell activity:** Cells active in protein synthesis, like pancreas and brain cells, contain thousands to millions of ribosomes.
- **Assembly:** Ribosomes assemble amino acids into polypeptide chains, which fold into functional proteins.

Diagram:



✦ **Summary:**

Ribosomes are universal protein factories of the cell, composed of rRNA and proteins, and exist in two subunits. They are essential for cell growth, repair, and overall metabolic activity.

🌟 **Q5: Explain the structure and functions of Golgi complex.**

❖ **Answer:**

The Golgi complex, also called Golgi apparatus, is an organelle made of 5–8 flattened, membrane-bound sacs called cisternae stacked over each other. It is located near the nucleus and works as the shipping and processing center of the cell. Proteins and lipids from the endoplasmic reticulum (ER) reach the Golgi complex at the cis face, are modified, packaged into vesicles, and transported out through the trans face to their destination. It also forms lysosomes and produces polysaccharides in plant cells.

Structure of Golgi Complex:

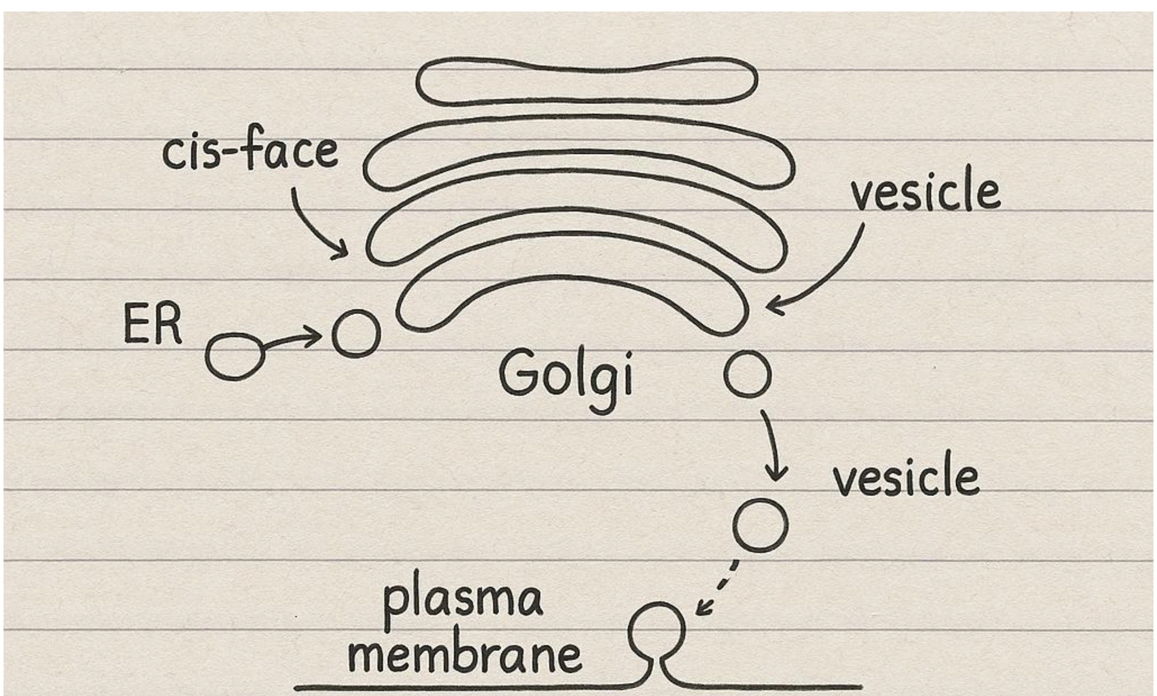
1. **Cisternae:** Flattened, membrane-bound sacs that are stacked. They carry out the main processing of molecules.
2. **Cis face:** The receiving side, faces the ER; vesicles from ER fuse here.
3. **Trans face:** The shipping side, faces the plasma membrane; modified molecules exit here in vesicles.
4. **Vesicles:** Small membrane-bound sacs that transport molecules to and from the Golgi and other cell parts.

Explanation: The Golgi complex acts like a post office, modifying proteins and lipids, labeling them for delivery, and sending them to the correct location inside or outside the cell. In plants, it also produces cell wall polysaccharides.

Functions of Golgi Complex:

1. **Protein and lipid modification:** Adds sugars, phosphates, and other molecules to proteins and lipids.
2. **Packaging and transport:** Sorts molecules into vesicles for delivery inside or outside the cell.
3. **Lysosome formation:** Produces lysosomes with hydrolytic enzymes.
4. **Polysaccharide synthesis:** In plant cells, it makes structural polysaccharides like pectin.

Diagram:



✦ **Summary:**

The Golgi complex is a central organelle in eukaryotic cells responsible for modifying, packaging, and shipping proteins and lipids, forming lysosomes, and producing plant polysaccharides. Its cisternae and vesicles make it efficient in molecular transport.

🌟 **Q6: Describe the structure, chemical composition, and function of a chromosome.**

❖ **Answer:**

A chromosome is a thread-like structure found in the nucleus of eukaryotic cells, carrying the genetic material (DNA). It is composed of DNA and associated proteins, mainly histones, which help in packaging and organizing the DNA into a compact form. During cell division, chromosomes condense and become visible under a microscope. Each chromosome has a centromere, which divides it into two arms (short 'p' arm and long 'q' arm) and may contain telomeres at the ends for stability. Chromosomes store and transmit hereditary information from one generation to the next.

Structure of Chromosome:

1. **DNA double helix:** The primary molecule carrying genetic instructions.
2. **Histone proteins:** Positively charged proteins around which DNA wraps to form nucleosomes.
3. **Chromatin:** The combination of DNA and protein; exists as euchromatin (less condensed, active) and heterochromatin (condensed, inactive).

4. **Centromere:** The constricted region connecting two arms; plays a role in segregation during cell division.
5. **Telomeres:** Protective caps at the ends of chromosomes preventing DNA degradation.

Chemical Composition:

- **DNA (≈50%):** Nucleotides containing phosphate, sugar (deoxyribose), and nitrogenous bases (A, T, G, C).
- **Proteins (≈50%):** Mainly histones (H1, H2A, H2B, H3, H4) and some non-histone proteins.

Functions of Chromosomes:

1. **Genetic information storage:** Chromosomes carry genes that determine traits.
2. **Transmission of hereditary traits:** Ensure genetic continuity during cell division.
3. **Gene regulation:** Chromatin structure helps control gene expression.
4. **Protection:** Telomeres protect chromosome ends from damage.

✦ Summary:

Chromosomes are DNA-protein complexes that store and transmit genetic information. Their compact structure, aided by histones, ensures efficient packaging, protection, and correct segregation during cell division.

🌟 Q7: Discuss nuclear envelope and nuclear pore complex in detail.

❖ Answer:

The nuclear envelope is a double-membrane structure that surrounds the nucleus in eukaryotic cells, separating it from the cytoplasm. The outer membrane is continuous with the rough endoplasmic reticulum, while the inner membrane supports the nuclear lamina, providing structural stability. The nuclear envelope contains nuclear pores, which are large protein complexes that regulate the transport of molecules in and out of the nucleus, such as RNA and proteins. These pores maintain selective exchange and communication between the nucleus and cytoplasm.

Structure of Nuclear Envelope:

1. **Outer membrane:** Continuous with rough ER; may have ribosomes attached.
2. **Inner membrane:** Lines the nucleoplasm and anchors the nuclear lamina.
3. **Perinuclear space:** The space between the inner and outer membranes (~20–40 nm).
4. **Nuclear pores:** Spanning both membranes; control bidirectional transport.

Nuclear Pore Complex (NPC):

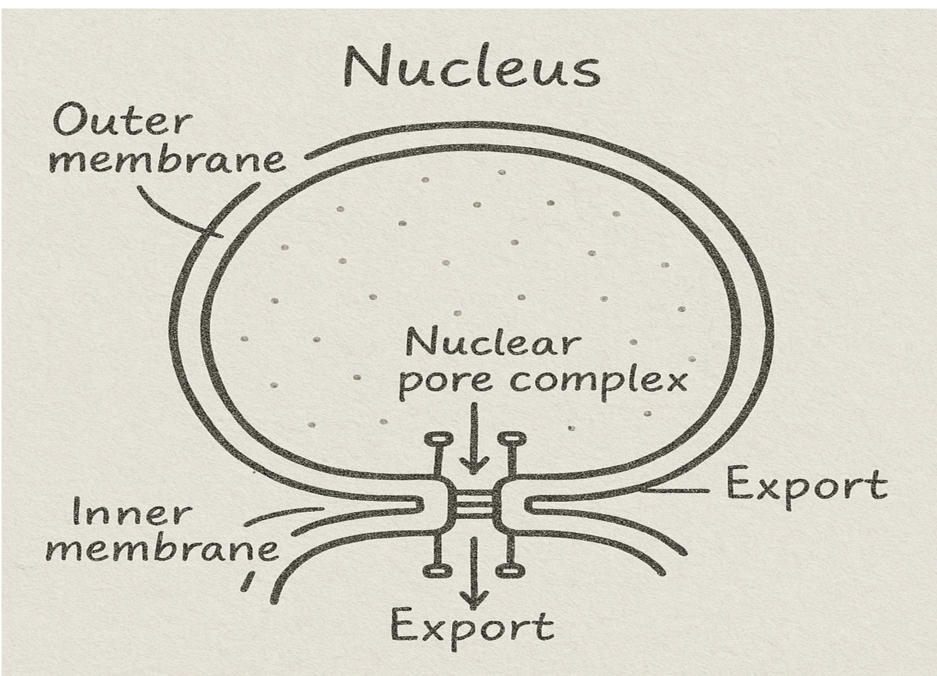
- A large protein assembly embedded in the nuclear envelope.
- Composed of multiple nucleoporins forming a central channel.
- **Allows selective transport of molecules:**
  - **Into nucleus:** Proteins with nuclear localization signals (NLS).
  - **Out of nucleus:** mRNA, rRNA, tRNA, and ribosomal subunits.

- Maintains nuclear-cytoplasmic compartmentalization.
- **Size**: ~100 nm diameter; central channel ~9 nm for passive diffusion.

Functions:

1. **Protection:** Separates nuclear content from cytoplasm.
2. **Transport:** Regulates import and export of proteins, RNAs, and ribonucleoproteins.
3. **Communication:** Connects nucleus to cytoplasmic signaling pathways.
4. **Structural support:** Inner membrane and nuclear lamina provide rigidity.

Diagram:



✦ **Summary:**

The nuclear envelope protects and organizes the nucleus, while the nuclear pore complex acts as a gatekeeper, controlling the selective transport of molecules between the nucleus and cytoplasm. Both structures are essential for nuclear function, gene expression, and cellular regulation.

🌟 **Q8: Explain how Golgi apparatus is involved in making cell secretions.**

❖ **Answer:**

The Golgi apparatus is a stack of flattened, membrane-bound sacs called cisternae, located near the nucleus. It receives proteins and lipids from the endoplasmic reticulum (ER) via transport vesicles at the cis-face. Inside the Golgi, these molecules are modified by enzymes (e.g., addition of sugars to form glycoproteins and glycolipids). The processed products are then packaged into secretory vesicles that bud from the trans-face of the Golgi. These vesicles are directed to the plasma membrane, where they fuse and release their contents outside the cell as cell secretions.

Steps of Golgi in Cell Secretion:

1. **Receiving molecules:** Vesicles from the ER fuse with the cis-face of the Golgi.
2. **Modification:** Proteins and lipids are modified by Golgi enzymes (glycosylation, phosphorylation).
3. **Sorting and packaging:** Modified molecules are sorted and packaged into secretory vesicles.
4. **Transport:** Vesicles move through cytoplasm towards the plasma membrane.
5. **Secretion:** Vesicles fuse with the plasma membrane and release contents outside the cell.

Functions in Secretion:

1. Produces enzymes, hormones, and mucous for export.
2. Generates glycoproteins and glycolipids for the plasma membrane.
3. In plant cells, produces pectin and polysaccharides for cell wall formation.

✦ **Summary:**

The Golgi apparatus acts as the cell's processing and shipping center, modifying, sorting, and packaging molecules received from the ER into secretory vesicles, which then release them outside the cell. This process is essential for hormone release, enzyme secretion, and building cell structures.

🌟 Q9: Describe the structure and functions of smooth and rough endoplasmic reticulum.

❖ Answer:

The Endoplasmic Reticulum (ER) is a network of flattened sacs and tubules (cisternae) that spreads throughout the cytoplasm, connecting with the nuclear envelope. There are two types:

1. Rough ER (RER): Its surface is studded with ribosomes, giving a rough appearance. RER synthesizes proteins, modifies them (e.g., glycosylation), and transports them to the Golgi apparatus for further processing.

2. Smooth ER (SER): Lacks ribosomes, appears smooth, and is involved in lipid synthesis, carbohydrate metabolism, detoxification, and calcium storage in muscle cells.

Functions of RER:

- Protein synthesis for secretion or membrane insertion.
- Adds sugars or other chemicals to proteins (modification).
- Transports proteins to Golgi apparatus.

Functions of SER:

- Lipid and steroid hormone synthesis.
- Detoxification of drugs and poisons in liver cells.
- Stores and regulates calcium ions in muscle cells.
- Assists in carbohydrate metabolism.

✦ Summary:

The ER is a cellular manufacturing and transport system. Rough ER specializes in protein synthesis and modification, while Smooth ER handles lipid production, detoxification, and calcium storage. Together, they support cell growth, metabolism, and secretion.

🌟 **Q10: Describe the structure and functions of smooth and rough endoplasmic reticulum.**

❖ **Answer:**

The endoplasmic reticulum (ER) is a network of flattened sacs and branching tubules that extends throughout the cytoplasm of eukaryotic cells. It connects with the nuclear envelope, forming a pathway between the nucleus and cytoplasm. There are two types of ER: Rough ER (RER) and Smooth ER (SER).

Rough Endoplasmic Reticulum (RER):

- RER has ribosomes attached to its surface, giving it a rough appearance under a microscope. It mainly functions in protein synthesis and processing. The RER modifies proteins by adding sugars or other chemical groups and then transports them to the Golgi apparatus for further processing or export.

Smooth Endoplasmic Reticulum (SER):

- SER lacks ribosomes, appearing smooth. It is involved in lipid synthesis, detoxification of drugs and poisons, carbohydrate metabolism, and calcium storage, which is especially important in muscle cells for contraction.

✦ **Summary:**

RER is mainly for protein production and processing, while SER is responsible for lipid synthesis, detoxification, and calcium regulation. Together, they maintain cellular function and communication with the nucleus.

🌟 **Q11: Explain the role of lysosomes and peroxisomes in regulating the amounts of cellular contents.**

❖ **Answer:**

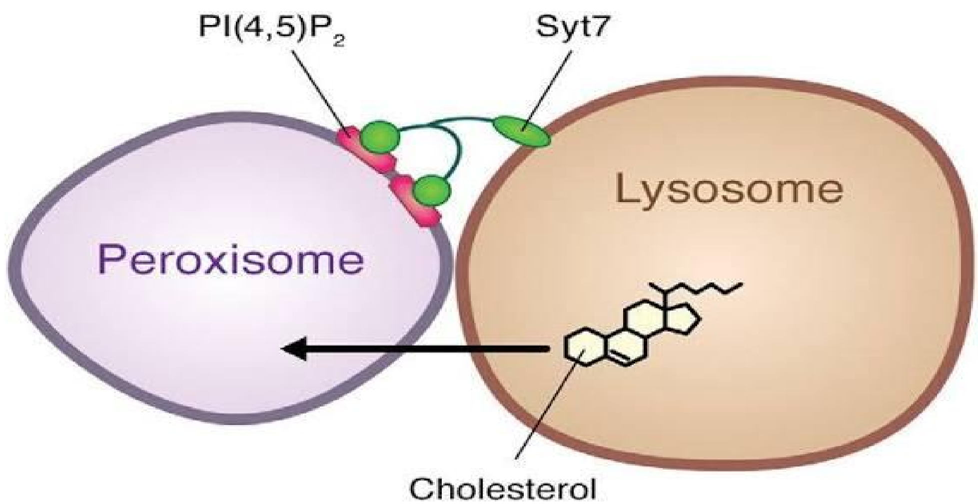
Lysosomes are membrane-bound organelles containing hydrolytic enzymes that digest cellular waste, worn-out organelles, and foreign particles. They perform autophagy, recycling the cell's own materials and regulating the amounts of cellular contents. Lysosomes also play a role in selective cell death during development, such as when tadpole tails disappear as a frog develops.

Peroxisomes are single-membrane organelles containing oxidative enzymes, including catalase. They break down toxic substances, such as hydrogen peroxide, and metabolize lipids. By controlling toxic molecules and breaking down excess substances, peroxisomes help maintain cellular balance and protect the cell from damage.

✦ **Summary:**

- **Lysosomes:** Digest and recycle cellular materials, regulate cellular content, and eliminate harmful organelles.
- **Peroxisomes:** Detoxify harmful substances, metabolize lipids, and maintain chemical balance inside the cell.

Diagram:



🌟 **Q11: Describe the structures of the three fibres that make the cytoskeleton.**

❖ **Answer:**

The cytoskeleton is a dynamic network of protein fibres that provides structural support, shape, and movement to eukaryotic cells. It also helps in intracellular transport, organelle positioning, and cell division. The cytoskeleton consists of three main types of fibres:

1. Microfilaments (Actin Filaments)

- **Structure:** Thin, flexible rods about 7 nm in diameter, made of actin protein.
- **Function:** Maintain cell shape, support cell surface projections, assist in cell motility, and enable cytokinesis during cell division. Microfilaments also interact with myosin for muscle contraction.

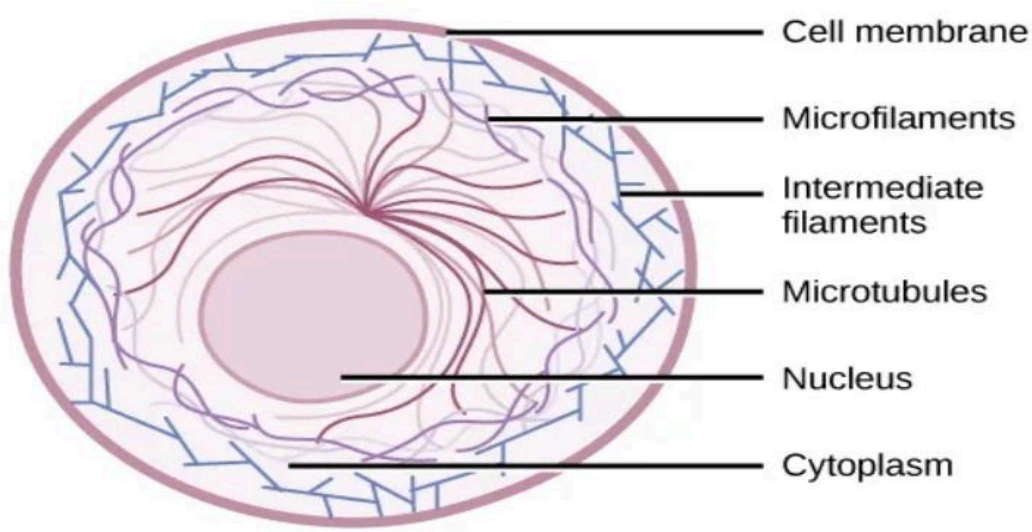
2. Microtubules

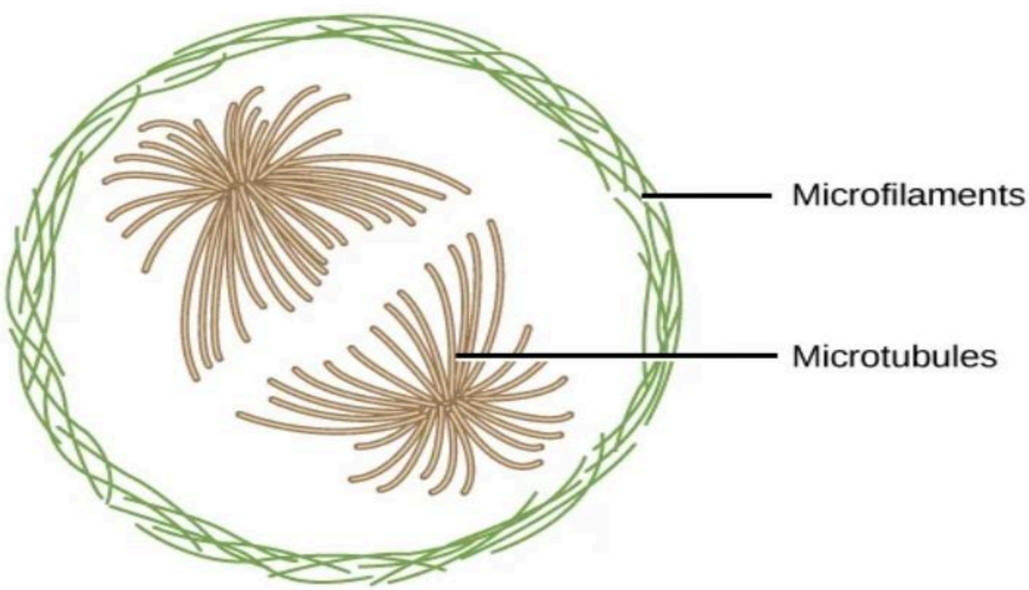
- **Structure:** Hollow cylinders about 25 nm in diameter, made of α-tubulin and β-tubulin subunits.
- **Function:** Provide a scaffold for cell shape, act as tracks for intracellular transport of organelles and vesicles, form spindle fibres during mitosis, and are major components of cilia and flagella.

3. Intermediate Filaments

- **Structure:** Rope-like fibres 8–12 nm in diameter, composed of various proteins such as vimentin, keratin, or lamin.
- **Function:** Provide mechanical strength, maintain cell shape, and anchor organelles like the nucleus. They are less dynamic than microfilaments and microtubules.

Diagram:





✦ **Summary:**

The cytoskeleton is crucial for maintaining cell integrity, enabling movement, guiding intracellular transport, and facilitating cell division. Each fibre type contributes in a specialized way: microfilaments for shape and motility, microtubules for transport and organelle organization, and intermediate filaments for mechanical strength.

🌟 **Q12: Describe the formation and functions of lysosomes.**

❖ **Answer:**

Lysosomes are spherical organelles bounded by a single membrane and are known as the digestive compartments of the cell. They are found in most eukaryotic cells, especially in animal cells.

Formation of Lysosomes:

1. Lysosomal enzymes are first synthesized in the rough endoplasmic reticulum (RER).
2. These enzymes are then transported to the Golgi apparatus, where they are modified and packaged into small vesicles.
3. These vesicles bud off from the Golgi apparatus to become primary lysosomes, containing digestive enzymes.
4. Primary lysosomes may fuse with vacuoles or vesicles containing materials to be digested, forming secondary lysosomes.

Functions of Lysosomes:

1. **Intracellular digestion:** Break down food particles, macromolecules, and foreign substances like bacteria and viruses.
2. **Autophagy:** Digest worn-out or damaged organelles and recycle their components.
3. **Defense:** Destroy pathogens ingested by white blood cells.
4. **Cell death:** Involved in programmed cell death (apoptosis) by releasing enzymes that break down cellular contents.
5. **Storage disease prevention:** Maintain cellular balance by preventing accumulation of waste materials.

✦ **Summary:**

Lysosomes are essential for cellular digestion, recycling, defense, and regulated cell death. They are formed from the RER and Golgi apparatus and contain hydrolytic enzymes that function in a controlled environment.

🌟 **Q13: Compare mitochondria and chloroplasts as the organelles that are involved in cellular energetics.**

❖ **Answer:**

Mitochondria and chloroplasts are double-membrane organelles that produce energy for the cell, but they differ in structure, function, and energy source.

Mitochondria:

Mitochondria are found in almost all eukaryotic cells. They have a smooth outer membrane and a highly folded inner membrane called cristae, which increases surface area. The internal matrix contains enzymes, DNA, RNA, and 70S ribosomes. Mitochondria are the site of cellular respiration, converting glucose and oxygen into ATP, the chemical energy currency of the cell. Their energy source is nutrients like glucose and fatty acids.

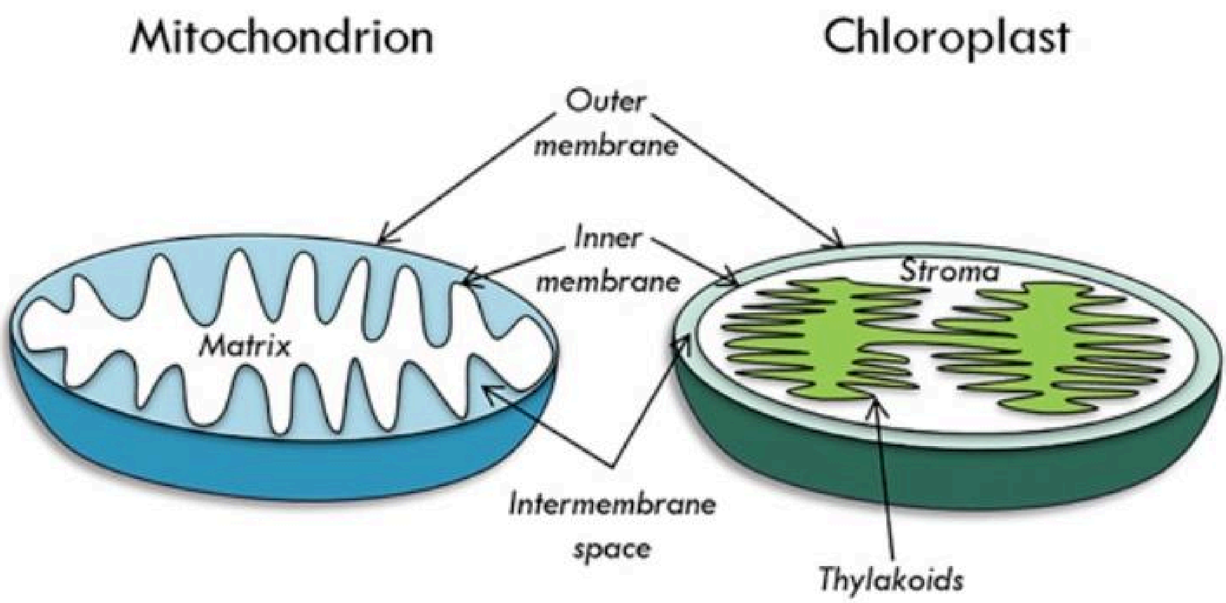
Chloroplasts:

Chloroplasts are found in plant cells and some algae. They have a double membrane surrounding a stroma, which contains DNA, RNA, and 70S ribosomes. Inside, thylakoids are stacked into grana, and pigments like chlorophyll a and b are embedded. Chloroplasts carry out photosynthesis, capturing light energy to produce glucose. Their energy source is sunlight.

Key Differences:

Mitochondria release energy stored in nutrients as ATP, whereas chloroplasts capture light energy to synthesize glucose. Both organelles have their own DNA and ribosomes and can reproduce independently within the cell.

Diagram:



✦ **Summary:**

Both organelles are essential for energy conversion: mitochondria produce ATP for cellular activities, and chloroplasts produce glucose for energy storage and biosynthesis.

🌟 **Q14: Describe the basic structure of a mitochondrion, from outside inward.**

❖ **Answer:**

A mitochondrion is a rod-shaped organelle often called the "powerhouse of the cell" because it generates energy in the form of ATP (adenosine triphosphate). Its structure is specialized to carry out cellular respiration efficiently. From outside inward, the mitochondrion is organized as follows:

1. Outer Membrane:

- This is a smooth, semi-permeable membrane that surrounds the mitochondrion.
- It allows small molecules and ions to pass freely but blocks larger molecules, acting as a protective barrier.

2. Intermembrane Space:

- The narrow region between the outer and inner membranes.
- It plays a critical role in storing protons (H^+ ions) during the electron transport chain, which is essential for ATP production.

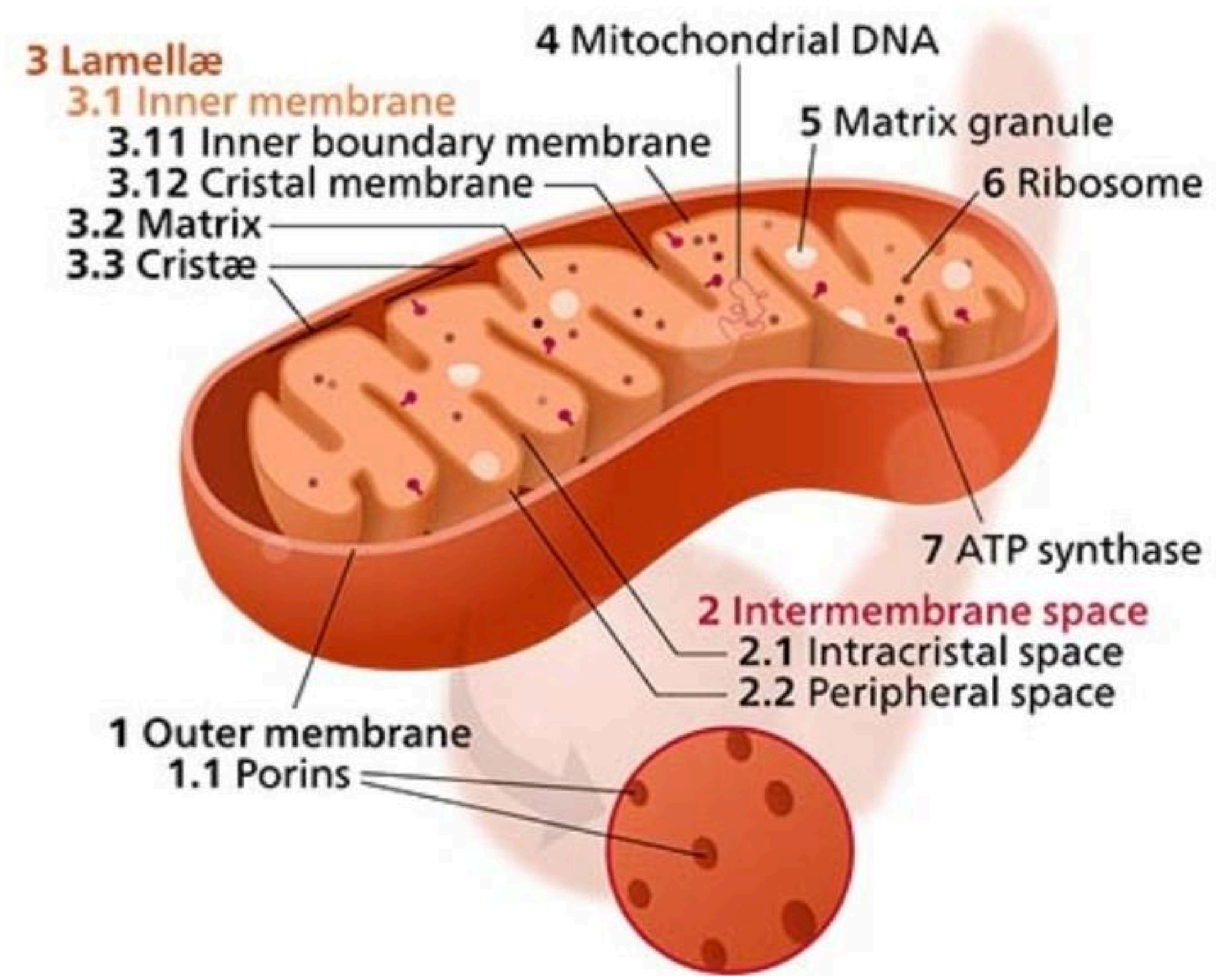
3. Inner Membrane:

- Highly folded into structures called cristae, which increase surface area, allowing more space for energy-producing enzymes.
- Contains electron transport chain proteins and ATP synthase, the enzyme that produces ATP.
- These folds ensure maximum efficiency of oxidative phosphorylation.

4. Matrix:

- The innermost part of the mitochondrion, enclosed by the inner membrane.
- Contains mitochondrial DNA, ribosomes, and enzymes that are responsible for the Krebs cycle and other metabolic reactions.
- The matrix provides the environment for chemical reactions that generate high-energy molecules.

Diagram:



✦ **Summary:**

The mitochondrion's structure is perfectly designed to produce energy: the outer membrane controls entry, the inner membrane and cristae increase enzyme surface area, and the matrix provides the necessary machinery for metabolic reactions. Together, these layers allow the cell to efficiently convert nutrients into ATP.

🌟 **Q15: Describe the pathway of protein signal and steroid signal from outside of a cell to inside.**

❖ **Answer:**

Cells communicate with their environment through cell signalling, which allows them to respond to external signals such as hormones or proteins. The pathways differ depending on whether the signal is water-soluble (protein/peptide) or lipid-soluble (steroid).

1. Protein/Peptide Signal Pathway (Water-soluble signals)

1. Signal Reception:

- The protein or peptide signal (ligand) cannot cross the plasma membrane because it is hydrophilic.
- It binds to a specific receptor protein on the cell surface (plasma membrane).

2. Signal Transduction:

- Binding triggers a conformational change in the receptor.
- This activates an intracellular signalling cascade, often involving second messengers like cyclic AMP (cAMP), calcium ions, or IP3.
- The cascade amplifies the signal, passing it to various target molecules inside the cell.

3. Cellular Response:

- The signal often leads to changes in gene expression or enzyme activity, affecting cell growth, division, metabolism, or apoptosis.

2. Steroid Signal Pathway (Lipid-soluble signals)

1. Signal Reception:

- Steroid hormones are lipophilic, so they can diffuse directly through the plasma membrane into the cytoplasm.
- Inside the cell, they bind to specific intracellular receptors in the cytoplasm or nucleus.

2. Receptor-Hormone Complex Formation:

- The steroid-receptor binding forms an active complex.
- If the receptor was in the cytoplasm, the complex moves into the nucleus.

3. Cellular Response:

- Inside the nucleus, the complex binds to specific DNA sequences in target genes.
- This regulates gene transcription, increasing or decreasing the production of specific proteins, which then bring about the cell's response.

✦ **Summary:**

- Protein signals act via membrane-bound receptors and second messengers to change cell activity.
- Steroid signals pass through the membrane, bind intracellular receptors, and directly affect gene transcription.
- Both pathways allow the cell to detect and respond to external stimuli, but the mechanism differs based on the chemical nature of the signal.

🌟 **Q16: Categorize and explain different types of stem cells.**

❖ **Answer:**

Stem cells are unique cells that can divide and differentiate into specialized cell types. They play a key role in growth, repair, and regenerative medicine. Stem cells are classified based on differentiation potential and origin.

1. Classification by Differentiation Potential

1. Totipotent Stem Cells

- Can differentiate into all possible cell types, including embryonic and extra-embryonic tissues (placenta).
- **Example:** Zygote and cells from the first few divisions of a fertilized egg.

2. Pluripotent Stem Cells

- Can turn into almost any cell type in the body but cannot form extra-embryonic tissues.
- **Example:** Cells from the early embryo (inner cell mass of blastocyst).

3. Multipotent Stem Cells

- Can differentiate into a closely related family of cells.
- **Example:** Hematopoietic stem cells → red blood cells, white blood cells, or platelets.

4. Oligopotent Stem Cells

- Can differentiate into a few different cell types.
- **Example:** Adult lymphoid or myeloid stem cells.

5. Unipotent Stem Cells

- Can produce only one cell type, but retain the ability to self-renew.
- **Example:** Adult muscle stem cells.

2. Classification by Origin

1. Embryonic Stem Cells (ESCs)

- Derived from inner cell mass of blastocysts.
- Pluripotent with high differentiation potential.
- **Advantages:** Versatile for research and therapy.
- **Disadvantages:** Ethical concerns, risk of teratoma formation, immune rejection.

2. Adult Stem Cells (ASCs)

- Found in bone marrow, fat, blood, and other tissues.
- Multipotent, can differentiate into a limited range of cell types.
- **Advantages:** Less ethical controversy, reduced risk of immune rejection.
- **Disadvantages:** Limited differentiation potential, difficult to isolate and culture.

3. Induced Pluripotent Stem Cells (iPSCs)

- Generated by reprogramming adult somatic cells using transcription factors.
- Pluripotent, similar to ESCs.
- **Advantages:** Avoids ethical issues, can be patient-specific to reduce immune rejection.
- **Disadvantages:** Risk of genetic changes, tumor formation, and difficulty in ensuring proper differentiation.

✦ **Summary:**

- Stem cells are classified by potential (totipotent ⟶ unipotent) and origin (embryonic, adult, induced pluripotent).

- They are important for regeneration, disease treatment, drug testing, and personalized medicine.
- Choice of stem cell depends on ethical considerations, differentiation potential, and clinical application.

🌟 Q17: What are the advantages and disadvantages of using induced Pluripotent Stem Cells (iPSCs)?

❖ **Answer:**

Induced Pluripotent Stem Cells (iPSCs) are adult somatic cells that are reprogrammed in the lab to become pluripotent, meaning they can develop into almost any cell type in the body.

Advantages of iPSCs

1. No Ethical Concerns

- iPSCs do not require destruction of embryos, unlike embryonic stem cells.

2. Patient-Specific Therapy

- Can be generated from a patient's own cells, reducing the risk of immune rejection during transplantation.

3. Versatility

- Pluripotent like embryonic stem cells, so they can be used for regeneration, tissue repair, and disease modeling.

4. Drug Testing and Research

- iPSCs allow scientists to create cell models of diseases, improving drug testing without relying on animals.

Disadvantages of iPSCs

1. Genetic and Epigenetic Changes

- Reprogramming can introduce mutations or changes that may affect cell function.

2. Risk of Tumor Formation

- iPSCs may form teratomas (tumors containing multiple tissue types) if not fully differentiated.

3. Complex Differentiation Process

- It is challenging to guide iPSCs to mature, fully functional cell types for clinical use.

4. Time and Cost

- Reprogramming and culturing iPSCs is expensive and time-consuming.

✦ Summary:

iPSCs are a powerful tool for regenerative medicine and research because they are pluripotent and patient-specific, avoiding ethical issues. However, their genetic instability, tumor risk, and complex differentiation are significant challenges.

INQUISITIVE QUESTIONS:

🌟 **Q1: If a researcher observes that a certain cell type has an exceptionally large Golgi apparatus, what can be inferred about the function of this cell?**

❖ **Answer:**

A large Golgi apparatus indicates that the cell is highly active in modifying, packaging, and secreting proteins or lipids. The Golgi apparatus acts as the cell's "shipping and processing center," so its size often reflects the secretory activity of the cell.

Inference about the cell function:

1. The cell likely produces and secretes large amounts of proteins, such as enzymes, hormones, or antibodies.
2. It may be involved in exporting complex molecules to other cells or to the extracellular matrix.
3. Cells with a large Golgi apparatus are often glandular or secretory cells, such as:
    - Pancreatic cells (secreting digestive enzymes)
    - Plasma cells (secreting antibodies)
    - Goblet cells (secreting mucus)

✦ **Summary:**

The large Golgi apparatus reflects high secretory function, meaning the cell is specialized in producing, processing, and exporting proteins or other molecules efficiently.

🌟 Q2: If a signalling molecule is lipid-soluble, like a steroid hormone, what is the most likely mechanism for its action within the target cell?

❖ Answer:

Lipid-soluble signalling molecules, such as steroid hormones, can diffuse directly through the plasma membrane because they are lipophilic. Once inside the cell, they bind to specific intracellular receptors located in the cytoplasm or nucleus. This forms a hormone-receptor complex, which then moves into the nucleus (if not already there) and binds to specific DNA sequences. This binding regulates gene transcription, leading to increased or decreased synthesis of target proteins, which produce the cellular response.

Key Steps:

- Diffusion through the plasma membrane.
- Binding to intracellular receptor (cytoplasm or nucleus).
- Formation of hormone-receptor complex.
- Binding to DNA at target genes.
- Regulation of gene expression ⟶ production of specific proteins ⟶ cellular response.

✦ Summary:

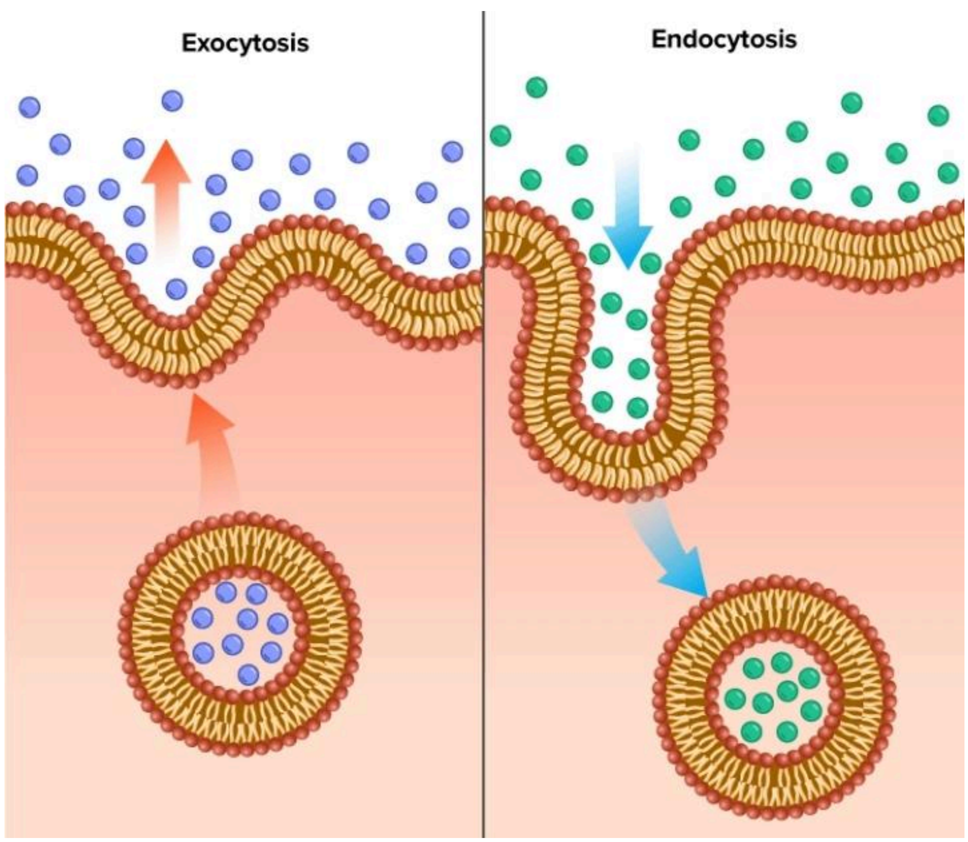
Lipid-soluble signals bypass the cell membrane receptors and act directly on the nucleus, altering gene expression and protein synthesis to produce the target cell's response.

🌟 Q3: Why do we categorize endocytosis and exocytosis in active transport?

❖ **Answer:**

Endocytosis and exocytosis are considered active transport processes because they require energy (usually ATP) to move materials against concentration gradients or to transport large/bulky substances that cannot pass through the plasma membrane by diffusion or protein channels.

Diagram:



- **Endocytosis:** The plasma membrane engulfs materials (solids in phagocytosis or liquids in pinocytosis) and forms a vesicle to bring them into the cell. Energy is needed to reorganize the membrane and move vesicles inside.
- **Exocytosis:** Vesicles containing proteins, hormones, or waste fuse with the plasma membrane to release their contents outside the cell. Energy is required to transport vesicles and fuse membranes.

✦ **Summary:**

Both processes use cellular energy to move materials in bulk, either into or out of the cell, which is why they fall under active transport.

🌟 **Q4: Justify why the membrane may be described as fluid.**

❖ **Answer:**

The plasma membrane is described as fluid because its lipid and protein components are not rigidly fixed. The phospholipid bilayer allows lipids and some proteins to move laterally within the layer, giving the membrane flexibility and enabling it to change shape. This fluidity is essential for processes such as endocytosis, exocytosis, cell signaling, and membrane repair.

- Phospholipids are constantly shifting, which allows proteins to float and diffuse in the membrane.
- Cholesterol in animal membranes helps maintain fluidity by preventing lipids from packing too tightly.

✦ **Summary:**

The fluid nature of the membrane ensures that it is flexible, dynamic, and able to respond to changes, which is why it is called a fluid mosaic model.

Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further exploration of the subject. The content has been carefully selected to support effective learning and inspire students to engage with the topic more deeply.

Author: Muhammad Asghar

Purpose: To contribute to education by offering insightful, valuable content that enhances learning and understanding.