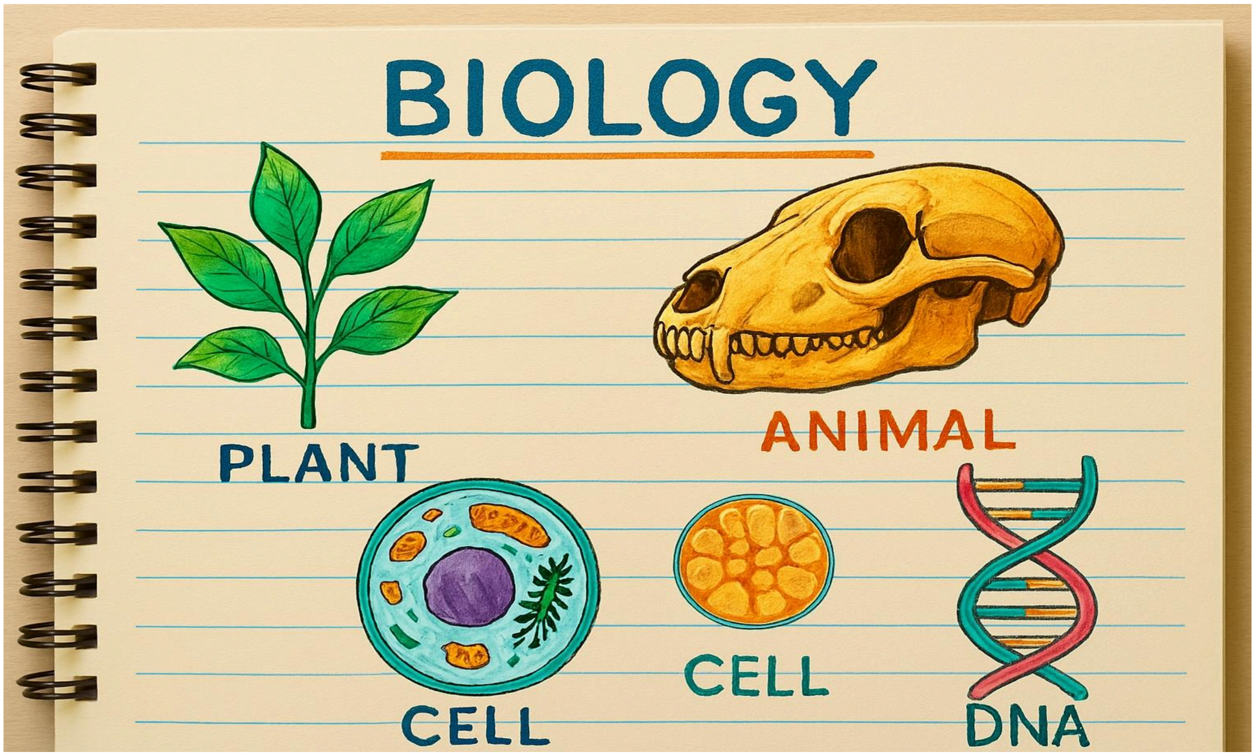


Class: 9th

Subject: Biology

Chapter 8: PLANT PHYSIOLOGY

❖ Important MCQs:

1. Which macronutrient is a structural component of chlorophyll and directly involved in photosynthesis?

(a) Calcium

(b) Magnesium ✅

(c) Potassium

(d) Sulfur

2. Deficiency of which nutrient results in leaf loss and stunted growth due to reduced protein synthesis?

(a) Nitrogen ✅

(b) Potassium

(c) Calcium

(d) Phosphorus

3. Which nutrient is a part of ATP and promotes root growth and flowering?

(a) Potassium

(b) Nitrogen

(c) Phosphorus ✅

(d) Calcium

4. Dark patches on plant leaves indicate deficiency of:

(a) Nitrogen

(b) Potassium ✅

(c) Calcium

(d) Magnesium

5. Which macronutrient helps in maintaining stability of the cell wall and development of seeds?

(a) Calcium ✅

(b) Potassium

(c) Magnesium

(d) Nitrogen

6. Which element is essential for chlorophyll synthesis and also acts as a cofactor for enzymes involved in energy transfer?

(a) Iron ✅

(b) Zinc

(c) Copper

(d) Boron

7. Premature falling of leaves and delayed maturity occur due to deficiency of:

(a) Zinc

(b) Iron

(c) Manganese ✅

(d) Copper

8. Which micronutrient is necessary for nitrogen fixation and reduction?

(a) Zinc

(b) Copper

(c) Molybdenum ✅

(d) Chlorine

9. Stunted growth and poor root development in plants indicate deficiency of:

(a) Zinc ✅

(b) Copper

(c) Iron

(d) Chlorine

10. Which micronutrient plays a role in lignin synthesis and provides strength to cell walls?

(a) Copper ✅

(b) Boron

(c) Zinc

(d) Iron

11. Chlorine mainly helps plants in:

(a) Chlorophyll breakdown

(b) Stomatal regulation and osmotic adjustment ✅

(c) Protein synthesis

(d) Seed germination

12. Which element forms the basic structure of organic compounds in plants?

(a) Carbon ✅

(b) Iron

(c) Potassium

(d) Zinc

13. Plants mainly obtain carbon for organic molecules from:

(a) Soil minerals

(b) Carbon dioxide in air ✅

(c) Water in soil

(d) Sunlight

14. Which nutrient deficiency causes yellowing between veins of leaves (interveinal chlorosis)?

(a) Iron ✅

(b) Nitrogen

(c) Potassium

(d) Calcium

15. Which nutrient improves the plant's ability to carry out photosynthesis and helps in nitrate uptake?

(a) Potassium ✅

(b) Sulfur

(c) Calcium

(d) Magnesium

16. If a plant shows delayed flowering and wrinkled leaves, the most probable deficiency is:

(a) Nitrogen

(b) Phosphorus ✅

(c) Magnesium

(d) Sulfur

17. Sulfur deficiency in plants results in:

(a) Dark green leaves

(b) Light coloured plants ✅

(c) Large stems

(d) Rapid growth

18. Which group of nutrients is required in relatively larger amounts by plants?

(a) Micronutrients

(b) Macronutrients ✅

(c) Vitamins

(d) Pigments

19. Which of the following is NOT a micronutrient?

(a) Iron

(b) Copper

(c) Calcium ✅

(d) Zinc

20. Insectivorous plants capture insects mainly to obtain:

(a) Carbon

(b) Nitrogen ✅

(c) Oxygen

(d) Hydrogen

21. Which insectivorous plant has leaves modified into a pitcher-like structure?

(a) Sundew

(b) Venus fly trap

(c) Pitcher plant ✅

(d) Cactus

22. The rapid closing of leaf lobes to trap insects is characteristic of:

(a) Pitcher plant

(b) Venus fly trap ✅

(c) Sundew

(d) Fern

23. Sundew plants trap insects using:

(a) Sticky dew-like secretions on tentacles ✅

(b) Hinged leaves

(c) Hollow sacs

(d) Sharp thorns

24. Enzymes released by leaves of insectivorous plants mainly help in:

(a) Photosynthesis

(b) Digestion of insects ✅

(c) Absorption of water

(d) Transport of minerals

25. Insectivorous plants are considered autotrophs because they:

(a) Depend only on insects for food

(b) Perform photosynthesis to make food ✅

(c) Absorb nutrients only from soil

(d) Cannot synthesize organic compounds

26. Stomata are mainly responsible for:

(a) Transport of food

(b) Gaseous exchange in plants ✅

(c) Water absorption

(d) Mineral transport

27. Stomata are usually found in:

(a) Roots only

(b) Leaves and some stems ✅

(c) Flowers only

(d) Fruits only

28. Which specialized cells control the opening and closing of stomata?

(a) Epidermal cells

(b) Palisade cells

(c) Guard cells ✅

(d) Xylem cells

29. Guard cells differ from other epidermal cells because they contain:

(a) Vacuoles only

(b) Chloroplasts ✅

(c) Lignin

(d) Suberin

30. Stomata open during daytime mainly to allow entry of:

(a) Oxygen

(b) Nitrogen

(c) Carbon dioxide ✅

(d) Hydrogen

31. At night, stomata usually close mainly to:

(a) Increase photosynthesis

(b) Reduce water loss through transpiration ✅

(c) Increase oxygen intake

(d) Increase mineral absorption

32. During night, plants continue the process of:

(a) Photosynthesis

(b) Transpiration

(c) Respiration ✅

(d) Germination

33. According to the starch-sugar hypothesis, stomata open during the day because:

(a) Starch converts into sugar in guard cells

(b) Sugar concentration increases in guard cells ✅

(c) Oxygen concentration increases

(d) Water evaporates rapidly

34. Increase in sugar concentration in guard cells causes:

(a) Increase in water potential

(b) Decrease in water potential ✅

(c) No change in osmotic pressure

(d) Decrease in photosynthesis

35. When water enters guard cells by osmosis, the cells become:

(a) Flaccid

(b) Turgid ✅

(c) Dead

(d) Shrinked

36. According to the potassium ion influx theory, stomatal opening occurs due to:

(a) Entry of potassium ions into guard cells ✅

(b) Entry of calcium ions

(c) Loss of potassium ions

(d) Increase in starch

37. The influx of potassium ions into guard cells results in:

(a) Increase in osmotic potential

(b) Decrease in osmotic potential ✅

(c) Decrease in water absorption

(d) Closure of stomata

38. Blue light promotes stomatal opening mainly by:

(a) Increasing respiration

(b) Enhancing potassium ion uptake in guard cells ✅

(c) Increasing starch formation

(d) Blocking water movement

39. Carbon dioxide entering the leaf first diffuses through:

(a) Xylem

(b) Phloem

(c) Stomata ✅

(d) Cuticle

40. Inside the leaf, carbon dioxide moves through spongy mesophyll and finally reaches:

(a) Epidermal cells

(b) Palisade mesophyll cells ✅

(c) Xylem vessels

(d) Guard cells

41. Which tissue provides support to herbaceous plants and parts of larger plants?

(a) Collenchyma

(b) Parenchyma ✅

(c) Sclerenchyma

(d) Xylem

42. The rigidity of parenchyma cells is mainly due to:

(a) Lignin deposition

(b) Turgor pressure ✅

(c) Cellulose in secondary walls

(d) Thick cuticle

43. The membrane surrounding the vacuole in plant cells is called:

(a) Plasma membrane

(b) Tonoplast ✅

(c) Cell wall

(d) Endoplasmic reticulum

44. Collenchyma cells are typically found:

(a) Deep inside xylem

(b) Beneath epidermis of young stems and leaf stalks ✅

(c) Only in seed coats

(d) In mature woody stems

45. Collenchyma cells provide support primarily to:

(a) Mature woody stems

(b) Young parts of plants where secondary growth has not occurred ✅

(c) Roots only

(d) Flower petals only

46. Collenchyma cells are unique because:

(a) They have thickened secondary walls

(b) They have primary walls thickened at corners due to extra cellulose ✅

(c) They are lignified

(d) They are non-living

47. Sclerenchyma cells are mostly:

(a) Living

(b) Non-living ✅

(c) Only found in leaves

(d) Photosynthetic

48. Which organic compound makes sclerenchyma walls strong and rigid?

(a) Cellulose

(b) Lignin ✅

(c) Starch

(d) Protein

49. Sclerenchyma fibers (tracheids) are mainly found:

(a) In seed coats

(b) As compact bundles inside xylem or as bundle caps ✅

(c) In palisade mesophyll

(d) In guard cells

50. Sclereids differ from fibers in that they:

(a) Are elongated

(b) Are smaller in size and found in seed coats and nut shells ✅

(c) Conduct water

(d) Have thin primary walls

51. Water potential (Ψw) is defined as:

(a) The concentration of solute only

(b) The kinetic energy of water molecules in a system ✅

(c) Pressure exerted by the cell wall

(d) Only osmotic potential

52. The symbol commonly used for water potential is:

(a) Φ

(b) Ψ ✅

(c) π

(d) Ω

53. In plant cells, water potential is determined by:

(a) Solute potential only

(b) Pressure potential only

(c) Solute potential and pressure potential ✅

(d) Cell wall thickness

54. Pure water has a water potential of:

(a) Negative

(b) Zero ✅

(c) Positive

(d) Variable

55. Water moves from one region to another because:

(a) Higher solute concentration to lower solute concentration

(b) Higher water potential to lower water potential ✅

(c) Lower water potential to higher water potential

(d) Random motion only

56. Osmosis can be defined as:

(a) Movement of solutes from high to low concentration

(b) Movement of water molecules from higher to lower water potential through a partially permeable membrane ✅

(c) Movement of water molecules against pressure

(d) Movement of gases in leaves

57. Solute potential (Ψs) is:

(a) Always positive

(b) Always negative ✅

(c) Zero in all solutions

(d) Independent of solute concentration

58. The more solute molecules present in a solution, the:

(a) Higher (less negative) is Ψs

(b) Lower (more negative) is Ψs ✅

(c) Ψs remains constant

(d) Ψp increases

59. Pressure potential (Ψp) arises due to:

(a) Osmotic movement only

(b) Turgor pressure inside the cell ✅

(c) Solute concentration

(d) Atmospheric pressure only

60. Total water potential (Ψw) of a plant cell is calculated by:

(a) $\Psi w = \Psi s - \Psi p$

(b) $\Psi w = \Psi s + \Psi p$ ✅

(c) $\Psi w = \Psi p - \Psi s$

(d) $\Psi w = \Psi s \times \Psi p$

61. Most water and mineral absorption in roots occurs through:

(a) Root cortex

(b) Root hairs ✅

(c) Xylem vessels

(d) Endodermis

62. Water moves from soil into root epidermal cells by:

(a) Active transport only

(b) Passive transport only

(c) Both active and passive transport ✅

(d) Diffusion of gases

63. Which root pathway involves water movement through cell walls but becomes blocked at the endodermis?

(a) Symplast

(b) Apoplast ✅

(c) Vacuolar

(d) Xylem parenchyma

64. In the symplast pathway, water moves:

(a) Through plasmodesmata connecting protoplasts ✅

(b) Through vacuoles only

(c) Only through cell walls

(d) Randomly through soil pores

65. Movement through the vacuolar pathway is:

(a) Major contributor to water transport

(b) Negligible compared to apoplast and symplast ✅

(c) Responsible for transpiration

(d) Only for mineral transport

66. Xylem tissue provides:

(a) Only water transport

(b) Structural support and water transport ✅

(c) Only sugar transport

(d) Photosynthesis

67. Tracheids differ from vessels in that they:

(a) Are short and broad

(b) Are elongated and tapered with thick lignified walls ✅

(c) Are living at maturity

(d) Conduct sugars only

68. The bordered pits in tracheids allow:

(a) Lateral movement of water between tracheids ✅

(b) Transport of sugars

(c) Photosynthesis

(d) Storage of minerals

69. Xylem vessels are arranged:

(a) Randomly in the stem

(b) In a linear fashion forming continuous channels ✅

(c) Only in roots

(d) Only in leaves

70. Perforation plates are found in:

(a) Tracheids

(b) Xylem vessels ✅

(c) Xylem fibres

(d) Phloem sieve tubes

71. Xylem fibres are:

(a) Living at maturity

(b) Dead cells providing structural support ✅

(c) Involved in sugar transport

(d) Photosynthetic

72. Xylem parenchyma cells function to:

(a) Conduct water only

(b) Retain water and nutrients, aid lateral transport, and help in regeneration ✅

(c) Produce lignin

(d) Absorb CO_2

73. The primary driving force for upward water movement in plants is:

(a) Root pressure

(b) Transpiration ✅

(c) Osmotic gradient

(d) Cohesion only

74. Adhesion in xylem ensures that:

(a) Water molecules stick to each other

(b) Water molecules stick to xylem walls preventing break in water column ✅

(c) Transpiration stops

(d) Root hairs swell

75. Cohesion in xylem is due to:

(a) Hydrogen bonding between water molecules ✅

(b) Adhesion to xylem walls

(c) Root pressure

(d) Capillary action

76. Tension in the TACT mechanism is generated by:

(a) Evaporation of water from leaf surface ✅

(b) Osmotic potential in roots

(c) Sugar loading in phloem

(d) Capillary action only

77. The TACT model of water transport stands for:

(a) Transport, Allocation, Cohesion, Turgor

(b) Transpiration, Adhesion, Cohesion, Tension ✅

(c) Translocation, Absorption, Capillarity, Transport

(d) Turgor, Adhesion, Cellulose, Transport

78. Which property of water helps maintain a continuous column from roots to leaves?

(a) Cohesion ✅

(b) Adhesion

(c) Osmotic potential

(d) Root pressure

79. The negative pressure created in leaves during transpiration helps to:

(a) Pull water upward through xylem ✅

(b) Push water down to roots

(c) Transport sugars in phloem

(d) Absorb minerals from soil

80. The efficiency of water transport through xylem increases with:

(a) High humidity only

(b) Steep water potential gradient ✅

(c) Thick cuticle

(d) Low leaf surface area

81. Phloem is responsible for transporting:

(a) Water and minerals

(b) Organic nutrients like sugars ✅

(c) Oxygen and CO_2

(d) Hormones only

82. Sieve tube elements are:

(a) Dead at maturity

(b) Living cells without nuclei ✅

(c) Photosynthetic

(d) Lignified

83. Companion cells function to:

(a) Conduct water

(b) Provide ATP and proteins to sieve tube elements ✅

(c) Store lignin

(d) Prevent transpiration

84. Plasmodesmata between sieve tube elements and companion cells allow:

(a) Water transport only

(b) Communication and transport of solutes ✅

(c) Movement of minerals from soil

(d) Only sugar storage

85. Phloem parenchyma stores:

(a) Water and minerals

(b) Sugars, resins, latex, and mucilage ✅

(c) Lignin only

(d) Proteins only

86. The primary mechanism for sugar transport in phloem is explained by:

(a) Diffusion

(b) Pressure-flow theory ✅

(c) Capillarity

(d) Root pressure

87. According to the pressure-flow theory, sucrose moves from:

(a) Sink to source

(b) Source to sink ✅

(c) Root to leaf only

(d) Leaf to soil

88. Water enters the sieve tubes at the source end due to:

(a) Transpiration pull

(b) Osmosis caused by higher sucrose concentration ✅

(c) Cohesion only

(d) Active pumping of water

89. At the sink end, sugar is unloaded actively while water follows:

(a) By active transport

(b) By osmosis ✅

(c) By transpiration

(d) By diffusion only

90. The difference in water potential between source and sink causes:

(a) Water to move from sink to source

(b) Water and dissolved sucrose to flow from source to sink ✅

(c) Only sugar to flow

(d) Only water to evaporate

91. Growth in plants is best described as:

(a) Temporary increase in mass

(b) Permanent increase in size ✅

(c) Change in color

(d) Increase in photosynthesis

92. In higher plants, growth is limited to:

(a) Entire plant body

(b) Growing points or meristems ✅

(c) Leaves only

(d) Roots only

93. Apical meristems are located at:

(a) Bases of internodes

(b) Tips of roots and shoots ✅

(c) Peripheral regions of stems

(d) Cork cambium

94. Function of apical meristems is:

(a) Increase in thickness of stems

(b) Primary growth and elongation of roots and shoots ✅

(c) Production of cork cells

(d) Lignin deposition in cell walls

95. Intercalary meristems are mainly found:

(a) At root tips

(b) At the base of internodes in grasses ✅

(c) Along the vascular cambium

(d) In cork cambium

96. Lateral meristems are responsible for:

(a) Primary growth

(b) Secondary growth and increase in girth ✅

(c) Photosynthesis

(d) Leaf formation

97. Vascular cambium produces:

(a) Secondary phloem outward and secondary xylem inward ✅

(b) Only secondary xylem

(c) Only cork

(d) Primary phloem

98. Cork cambium produces:

(a) Secondary xylem

(b) Cork cells replacing epidermis ✅

(c) Phloem parenchyma

(d) Xylem fibres

99. Primary growth is associated with which of the following zones?

(a) Zone of cell division, zone of cell elongation, zone of cell differentiation ✅

(b) Vascular cambium and cork cambium

(c) Root hair zone only

(d) Sieve tube formation zone

100. In the zone of cell division, cells are:

(a) Vacuolated and large

(b) Non-vacuolated and small with central nuclei ✅

(c) Fully differentiated

(d) Lignified

101. Cell elongation in primary growth occurs due to:

(a) Photosynthesis

(b) Water uptake and plasticity of cell wall ✅

(c) Lateral meristem activity

(d) Cork deposition

102. Cell differentiation is characterized by:

(a) Continuous cell division

(b) Cells attaining final size and specialization ✅

(c) Water uptake

(d) Formation of annual rings

103. Secondary growth leads to:

(a) Increase in length of plant

(b) Increase in thickness or girth of stems and roots ✅

(c) Leaf expansion

(d) Root hair elongation

104. Outer cells produced by vascular cambium develop into:

(a) Secondary xylem

(b) Secondary phloem ✅

(c) Cork cells

(d) Sieve tubes

105. Inner cells produced by vascular cambium develop into:

(a) Secondary xylem ✅

(b) Secondary phloem

(c) Cork

(d) Companion cells

106. Annual rings are formed due to:

(a) Seasonal activity of vascular cambium ✅

(b) Apical meristem growth

(c) Leaf senescence

(d) Phloem transport

107. Spring wood differs from autumn wood in that:

(a) Spring wood has narrower xylem vessels

(b) Spring wood has wider xylem vessels and lighter color ✅

(c) Autumn wood has lighter vessels

(d) No difference

108. Dendrochronology studies:

(a) Leaf growth patterns

(b) Tree rings to determine age and past climate ✅

(c) Soil moisture

(d) Root length

109. Herbaceous plants generally show:

(a) Only secondary growth

(b) Primary growth with little or no secondary growth ✅

(c) Secondary growth with bark formation

(d) Annual rings

110. The abrupt transition from autumn to spring wood in the following year allows scientists to:

(a) Measure plant height

(b) Distinguish growth periods and study climate changes ✅

(c) Determine leaf count

(d) Study water potential

111. Which of the following is a major plant growth regulator responsible for promoting cell enlargement and apical dominance?

(a) Gibberellin

(b) Cytokinin

(c) Auxin ✅

(d) Abscisic acid

112. Low concentrations of auxins in roots:

(a) Inhibit root growth

(b) Promote root growth ✅

(c) Cause leaf senescence

(d) Induce abscission

113. One of the functions of gibberellins is:

(a) Inhibit bolting in rosette plants

(b) Promote bolting and elongation in rosette plants ✅

(c) Close stomata during water stress

(d) Inhibit lateral bud growth

114. Cytokinins are mainly synthesized in:

(a) Mature leaves and stems

(b) Roots, young fruits, and seeds ✅

(c) Shoot apex

(d) Cork cambium

115. The primary function of cytokinins is:

(a) Promote abscission

(b) Promote cytokinesis during cell division ✅

(c) Inhibit lateral bud growth

(d) Induce leaf senescence

116. Abscisic acid is most involved in:

(a) Promoting stem growth

(b) Inducing bud and seed dormancy ✅

(c) Stimulating cell division

(d) Promoting fruit growth

117. Which plant hormone promotes closing of stomata under water stress?

(a) Auxin

(b) Cytokinin

(c) Abscisic acid ✅

(d) Gibberellin

118. Ethylene primarily functions to:

(a) Promote root and stem elongation

(b) Promote fruit ripening and break bud dormancy ✅

(c) Delay leaf senescence

(d) Stimulate DNA replication

119. Which of the following hormones can delay leaf senescence?

(a) Auxin, Gibberellin, Cytokinin ✅

(b) Ethylene and Abscisic acid

(c) Gibberellin and Ethylene

(d) Only Auxin

120. Parthenocarpy (development of fruit without fertilization) can be induced by:

(a) Abscisic acid

(b) Auxins and Gibberellins ✅

(c) Cytokinins only

(d) Ethylene

121. Osmoregulation in plants primarily helps to:

(a) Increase photosynthesis

(b) Maintain water and solute balance under varying environmental conditions ✅

(c) Promote flowering

(d) Enhance secondary growth

122. A plant cell placed in a hypertonic solution will:

(a) Swell due to water intake

(b) Remain unchanged

(c) Shrink due to water loss (plasmolysis) ✅

(d) Divide rapidly

123. Which of the following solutions has solute concentration equal to the intracellular environment of a cell?

(a) Hypotonic

(b) Hypertonic

(c) Isotonic ✅

(d) Saline

124. Freshwater hydrophytes survive in hypotonic conditions by:

(a) Excreting excess salts through salt glands

(b) Expelling excess water through hydathodes and vacuoles ✅

(c) Closing stomata to prevent water loss

(d) Folding leaves to reduce water intake

125. Marine hydrophytes maintain water balance in hypertonic conditions by:

(a) Producing abscisic acid

(b) Synthesizing organic solutes like proline and glycine betaine ✅

(c) Shedding leaves

(d) Increasing stomatal opening

126. Xerophytes are adapted to dry conditions mainly by:

(a) Having thin, broad leaves

(b) Having waxy coatings, succulence, and leaf modifications ✅

(c) Having extensive hydathodes

(d) Excreting salts

127. Which of the following is a succulent plant adapted to store water in its tissues?

(a) Rose

(b) Blue agave ✅

(c) Lotus

(d) Sea arrowgrass

128. Halophytes survive in saline soils by:

(a) Developing deep roots only

(b) Succulent leaves and sometimes stems, with modifications like spines ✅

(c) Closing stomata permanently

(d) Producing more xylem tissue

129. Mesophytes do not require special adaptations because:

(a) They live in extremely dry conditions

(b) They live in moderate environments with balanced water and salt availability ✅

(c) They have succulent tissues

(d) They can excrete salts actively

130. An example of a halophyte is:

(a) Lotus

(b) Sea arrowgrass ✅

(c) Tomato

(d) Blue agave

131. Thermoregulation in plants primarily helps to:

(a) Maintain optimum water content

(b) Maintain metabolic efficiency by protecting enzymes under temperature extremes ✅

(c) Promote flowering

(d) Increase transpiration rate

132. Heat-shock proteins in plants are synthesized to:

(a) Store energy for high temperature

(b) Prevent denaturation of enzymes and proteins under heat stress ✅

(c) Increase stomatal closure

(d) Promote secondary growth

133. Cold stress affects plant cell membranes by:

(a) Increasing cytoplasmic water content

(b) Locking lipids into crystalline structures, affecting solute transport ✅

(c) Promoting lateral growth

(d) Enhancing transpiration

134. Plants adapt to low temperatures by:

(a) Increasing saturated fatty acids in membranes

(b) Increasing unsaturated fatty acids to maintain membrane fluidity ✅

(c) Closing stomata permanently

(d) Producing gibberellins

135. Supercooling in plants occurs when:

(a) Ice crystals form inside protoplasm

(b) Cytosol remains liquid while ice forms in cell walls ✅

(c) Stomata open to reduce freezing

(d) Plant increases heat-shock protein synthesis

136. Phototropism is defined as:

(a) Growth movement in response to gravity

(b) Growth movement in response to light ✅

(c) Movement in response to chemicals

(d) Movement due to touch stimulus

137. Positive phototropism is observed in:

(a) Roots

(b) Shoot tips

(c) Both roots and shoots ✅

(d) None

138. Geotropism refers to:

(a) Movement in response to chemicals

(b) Movement in response to touch

(c) Growth movement in response to gravity ✅

(d) Movement in response to light

139. Roots display ___________ geotropism while shoots display ___________ geotropism.

(a) Negative, positive

(b) Positive, negative ✅

(c) Positive, positive

(d) Negative, negative

140. Thigmotropism is commonly seen in:

(a) Pine trees

(b) Climbing vines and tendrils ✅

(c) Desert plants

(d) Hydrophytes

141. Photoperiodism in plants refers to:

(a) Response to temperature changes

(b) Response to light and dark periods (day length) ✅

(c) Response to water availability

(d) Response to soil nutrients

142. Who first studied the effect of photoperiodism in 1920?

(a) Darwin and Wallace

(b) Garner and Allard ✅

(c) Mendel and Watson

(d) Hooke and Huxley

143. Tobacco plant naturally flowers under:

(a) Long days in summer

(b) Short days in autumn ✅

(c) Long nights in spring

(d) Continuous light

144. Short-day plants are actually:

(a) Long-day plants

(b) Long-night plants ✅

(c) Day-neutral plants

(d) Photoperiod-insensitive plants

145. Flowering in long-day plants can be induced in short days if:

(a) Night is uninterrupted

(b) Light interrupts the long night ✅

(c) Soil temperature is increased

(d) Watering is increased

146. The phytochrome system in plants includes which two forms?

(a) P600 and P700

(b) P660 and P730 ✅

(c) P500 and P650

(d) Pr and Pg

147. In nature, conversion of P660 to P730 occurs during:

(a) Nighttime

(b) Daylight ✅

(c) Winter

(d) Darkness

148. The florigen hormone is:

(a) Produced in roots and moves to leaves

(b) Produced in leaves and moves to floral buds via phloem ✅

(c) Produced in stem and remains there

(d) Produced in flowers to promote seed growth

149. Red light has the following effect on short-day and long-day plants:

(a) Promotes flowering in short-day plants only

(b) Inhibits flowering in short-day plants but promotes in long-day plants ✅

(c) Inhibits flowering in both

(d) Promotes flowering in both

150. Vernalisation refers to:

(a) Flowering induced by photoperiod

(b) Flowering induced by low temperature ✅

(c) Flowering induced by drought

(d) Flowering induced by high light intensity

151. The low-temperature stimulus for vernalisation is received by:

(a) Leaves

(b) Shoot apex of mature stem or embryo of seed ✅

(c) Roots

(d) Flowers

152. Temperature around ______ is most effective for vernalisation.

(a) 0°C

(b) 4°C ✅

(c) 10°C

(d) 20°C

153. The hormone responsible for vernalisation is called:

(a) Auxin

(b) Gibberellin

(c) Vernalin ✅

(d) Cytokinin

154. Vernalisation helps plants by:

(a) Increasing leaf growth

(b) Synchronising flowering with favourable season ✅

(c) Increasing stem thickness

(d) Promoting root branching

155. Biennial and perennial plants may require vernalisation to:

(a) Increase seed size

(b) Stimulate flowering ✅

(c) Increase photosynthesis

(d) Enhance transpiration

156. Photoperiodism and vernalisation together ensure:

(a) Continuous vegetative growth

(b) Synchronous reproduction and cross-pollination ✅

(c) Early leaf senescence

(d) Rapid fruit ripening

157. Interruption of the dark period in short-day plants:

(a) Promotes flowering

(b) Prevents flowering ✅

(c) Has no effect

(d) Increases leaf growth

158. Day-neutral plants:

(a) Flower only in long days

(b) Flower only in short days

(c) Flower irrespective of day length ✅

(d) Flower only under continuous light

159. Phytochrome P730 accumulates during:

(a) Night ✅

(b) Day

(c) Winter

(d) Continuous darkness

160. The critical factor for flowering in short-day plants is:

(a) Length of day

(b) Length of night ✅

(c) Temperature alone

(d) Water availability

📘 EXERCISE

SECTION 1: MULTIPLE CHOICE QUESTIONS

1. Process by which water evaporates from surface of leaf primarily through stomata:

(a) Transpiration ✅

(b) Guttation

(c) Imbibition

(d) Cohesion

2. Through which structure does most of transpiration occur?

(a) Root hairs

(b) Phloem

(c) Xylem

(d) Stomata ✅

3. The TACT theory primarily explains:

(a) The movement of nutrients in plants

(b) The transport of water in plants ✅

(c) The absorption of minerals

(d) The process of photosynthesis

4. Which of the following is not a function of xylem?

(a) Transport of water

(b) Transport of minerals

(c) Transport of food ✅

(d) Mechanical support

5. Which of the following has a perforated cell wall?

(a) Vessel ✅

(b) Fibre

(c) Tracheid

(d) Sclereid

6. Exposure to low temperature stimulates the process of flowering in biennial or perennial plants:

(a) Dormancy

(b) Photoperiodism

(c) Vernalization ✅

(d) All of these

7. Plants that are adapted to survive in dry conditions:

(a) Xerophytes ✅

(b) Hydrophytes

(c) Mesophytes

(d) Halophytes

8. When sugar content in a cell increases and solute concentration increases, what happens to water potential?

(a) Raises

(b) Drops ✅

(c) Unchanged

(d) None of these

9. In higher plants, transport of food materials occurs through:

(a) Companion cells

(b) Sieve tubes ✅

(c) Vessel elements

(d) Tracheids

10. The plant hormone which inhibits stem and root growth is:

(a) Auxin

(b) Ethylene ✅

(c) Cytokinin

(d) Gibberellin

11. The leaves of some hydrophytes float on the surface of water. In such leaves, stomata are found in:

(a) Lower epidermis

(b) Upper epidermis ✅

(c) Sides of leaf

(d) Deep depressions in leaf

12. Mesophytes are adapted to survive in:

(a) Moderate environments ✅

(b) Dry conditions

(c) Water environments

(d) Salty environments

SECTION 2: SHORT QUESTIONS

1. Differentiate between macronutrients and micronutrients

Answer:

Macronutrients – Elements required in large amounts for plant growth, such as Nitrogen (N), Phosphorus (P), and Potassium (K).

Micronutrients – Elements required in very small amounts but essential for enzyme activities and metabolism, such as Iron (Fe), Zinc (Zn), and Manganese (Mn).

2. What is water potential?

Answer:

Water Potential (Ψ) – The potential energy of water in a system that determines the movement of water. Water moves from regions of higher water potential to regions of lower water potential.

3. What are the main three pathways for the movement of water between plant cells?

Answer:

Apoplast Pathway – Water moves through cell walls and intercellular spaces without crossing cell membranes.

Symplast Pathway – Water moves through the cytoplasm of connected cells via plasmodesmata.

Vacuolar Pathway – Water moves through vacuoles and cell membranes, passing from one vacuole to another.

4. Differentiate between hypertonic and hypotonic solution

Answer:

Hypertonic Solution – Has a higher solute concentration outside the cell than inside; water moves out of the cell causing shrinkage (plasmolysis).

Hypotonic Solution – Has a lower solute concentration outside the cell than inside; water enters the cell causing it to swell.

5. What are halophytes?

Answer:

Halophytes – Plants adapted to grow in saline soils or environments with high salt concentration. They may have succulent leaves or stems and specialized adaptations to tolerate salinity.

Examples: Sea arrowgrass, Sea lavender.

6. Differentiate between long day plants and short day plants

Answer:

Long Day Plants (LDPs) – Plants that require longer daylight periods than a critical duration to initiate flowering. Flowering is promoted when days are long.

Short Day Plants (SDPs) – Plants that require shorter daylight periods than a critical duration to initiate flowering. Flowering is promoted when nights are long (or days are short).

7. Write down the phases of plant growth

Answer:

Cell Division – Cells of apical meristems divide actively, increasing the number of cells. This occurs in the zone of cell division at the tips of roots and shoots.

Cell Elongation – Newly formed cells increase in size by water uptake. Occurs in the zone of cell elongation; cells become vacuolated and enlarge.

Cell Differentiation – Cells attain their final size and shape, develop specific structures, and perform specialized functions. This occurs in the zone of cell differentiation.

8. Differentiate between Vernalin and Florigen

Answer:

Vernalin – Hormone produced in response to low temperature (vernalisation); induces flowering in biennial and perennial plants.

Florigen – Hormone produced in leaves in response to photoperiod; moves to floral buds to induce flowering.

9. Differentiate between Thigmotropism and Geotropism

Answer:

Thigmotropism – Growth movement of plants in response to touch. Example: Tendrils of climbing plants coil around a support.

Geotropism – Growth movement of plants in response to gravity. Roots show positive geotropism (grow downward), shoots show negative geotropism (grow upward).

10. How intercalary meristem is different from apical meristem

Answer:

Intercalary Meristem – Found at the base of internodes in grasses and some plants. It is temporary and responsible for the growth of leaves and elongation of stems.

Apical Meristem – Found at the tips of roots and shoots. It is permanent and responsible for the primary growth (increase in length) of the plant.

SECTION 3: LONG QUESTIONS

🌟 **Q1: Describe Osmoregulation in Hydrophytes and Halophytes**

Osmoregulation:

Osmoregulation is the process by which plants maintain a stable internal water and solute balance despite variations in the external environment. It helps plants survive in different habitats such as aquatic, dry, and saline areas.

A. Osmoregulation in Hydrophytes (Aquatic Plants)

Hydrophytes are plants that live in water, either in freshwater or marine environments. Osmoregulation in hydrophytes depends on the type of water environment:

1. Freshwater Hydrophytes:

- Freshwater has low solute concentration (hypotonic environment) compared to plant cells.
- Water continuously enters plant cells by osmosis, which may cause swelling.
- To prevent overhydration, these plants use special structures like vacuoles and hydathodes to expel excess water.
- They actively absorb essential ions like potassium (K^+) and calcium (Ca^{2+}) to maintain osmotic balance.
- **Leaf adaptations:** Thin or absent cuticles and reduced roots to allow direct water absorption.
- **Examples**: Water lily, Lotus, Tape grass.

2. Marine (Saline) Hydrophytes:

- Marine environments are hypertonic, so water tends to leave plant cells.
- These plants excrete excess salts through specialized salt glands.
- They synthesize organic solutes like proline, glycine betaine, and sugars to retain water.
- Thick cuticles reduce water loss.
- Such adaptations are called halophytic traits for salinity tolerance.
- **Examples:** Seaweeds, Mangroves.

B. Osmoregulation in Halophytes (Salt-Tolerant Plants)

Halophytes grow in saline soils or salty water environments where salt concentration is high. These plants have evolved special mechanisms to survive in high salinity:

1. Water Retention:

- Halophytes often have succulent leaves and sometimes succulent stems to store water.

2. Salt Management:

- Excess salts are either sequestered in vacuoles to prevent toxicity or excreted through salt glands.

3. Structural Adaptations:

- Some halophytes modify leaves into spines to reduce transpiration.
- Thick cuticles reduce water loss from leaves.

Examples:

Sea arrowgrass, Sea lavender.

✦ **Summary:**

- **Osmoregulation** ensures water and solute balance in plants despite external conditions.
- **Hydrophytes** adapt to freshwater by expelling excess water and to marine environments by excreting salts and synthesizing organic solutes.
- **Halophytes** survive in saline soils by storing water in succulent organs, managing salts through vacuoles or glands, and reducing water loss via structural adaptations.
- These mechanisms enable plants to maintain cell turgor, prevent plasmolysis or overhydration, and survive in extreme habitats.

Key Concept: Osmoregulation is vital for plant survival in aquatic (hypotonic or hypertonic) and saline environments, using both physiological and structural adaptations.

🌟 Q2: Describe the Physiological Adaptation of Plants to Extreme Conditions. How do Plants Adjust their Cell Membrane Composition and Protein Structures to Survive High and Low Temperatures?

❖ **Answer:**

Plants are exposed to extreme environmental temperatures, both high and low, which can disrupt their metabolic processes. High temperatures may denature proteins and enzymes, while low temperatures can solidify membranes and cause ice crystal formation inside cells. To survive these stresses, plants exhibit physiological adaptations that modify their cell structures and biochemical processes.

1. Adaptations to High Temperature (Heat Stress)

Problem:

- High temperature can denature enzymes and other proteins, impairing essential metabolic reactions.
- Excess heat can also increase water loss through transpiration, causing dehydration.

Adaptation Mechanisms:

1. Evaporative Cooling:

- Plants release water through stomata, which cools leaf surfaces.

- This helps reduce internal temperature and protects cellular machinery.

2. Heat-Shock Proteins (HSPs):

- Plants synthesize special proteins called heat-shock proteins under heat stress.
- HSPs bind to other proteins, preventing them from unfolding or aggregating, thus stabilizing enzymes and cellular structures.

3. Membrane Stability:

- Some plants adjust the lipid composition of cell membranes to maintain integrity at high temperatures.
- Saturated and unsaturated lipid balance helps prevent excessive fluidity or leakage.

2. Adaptations to Low Temperature (Cold Stress)

Problem:

- Low temperature reduces membrane fluidity, making membranes rigid.
- Ice formation inside cells can rupture membranes and organelles, causing cell death.

Adaptation Mechanisms:

1. Adjustment of Membrane Composition:

- Plants increase the proportion of unsaturated fatty acids in membranes.

- Unsaturated lipids maintain flexibility and prevent solidification of membranes, allowing normal transport of solutes.

2. Supercooling of Cytoplasm:

- Plants accumulate solutes such as sugars and proteins in the cytoplasm.
- This lowers the freezing point of cell sap, preventing intracellular ice formation.

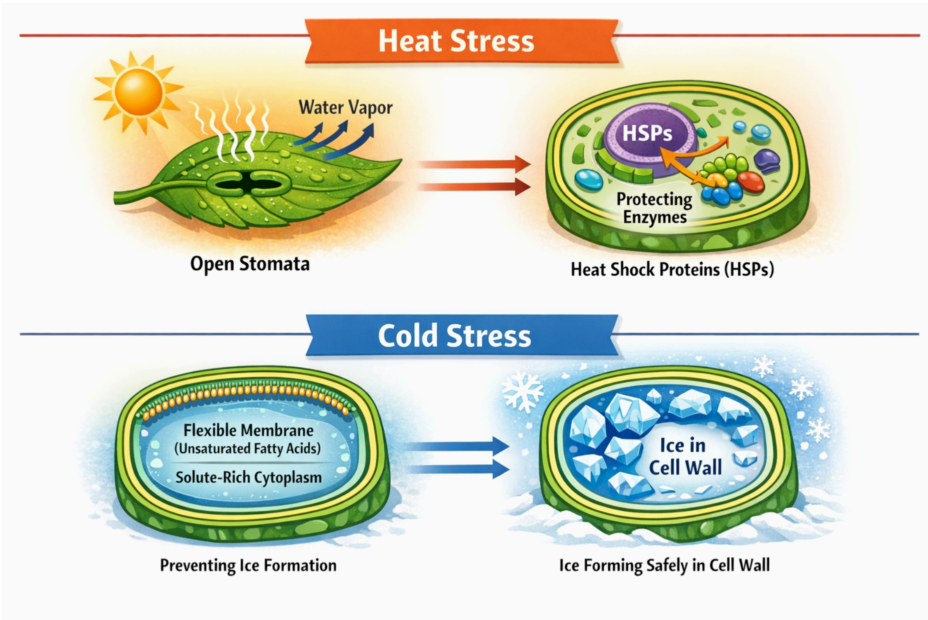
3. Cold-Responsive Proteins:

- Proteins that stabilize membranes and enzymes are produced during gradual cooling.
- These proteins prevent damage to organelles and maintain metabolic activity in cold conditions.

4. Ice Formation in Safe Areas:

- Ice is allowed to form in cell walls or intercellular spaces where it does not harm the cell.
- This protects the cytoplasm and organelles from freezing damage.

Diagram:



✦ **Summary:**

Plants survive extreme temperatures through specific physiological strategies:

- **High Temperature:** Evaporative cooling, heat-shock proteins, and membrane stabilization protect cells from heat-induced damage.
- **Low Temperature:** Increased unsaturated fatty acids, accumulation of solutes for supercooling, cold-responsive proteins, and controlled ice formation protect cells from freezing and maintain cellular function.

Overall: These adaptations ensure that plants maintain metabolic activity, structural integrity, and survival under both heat and cold stress.

🌟 Q3: What is the role of meristem in the growth of plants?

❖ **Answer:**

Meristems are regions of actively dividing cells in plants. These cells are undifferentiated, small, and capable of continuous cell division, which allows plants to grow throughout their life. Growth in plants occurs only in regions where meristematic tissues are present.

1. Types of Meristems and Their Role in Growth

1. Apical Meristems

- **Location:** Tips of roots and shoots.
- **Function:** Responsible for primary growth, which increases the length of the plant.
- **Example:** Growth of roots into soil and elongation of shoots.

2. Intercalary Meristems

- **Location:** Base of internodes, especially in grasses and monocots.
- **Function:** Helps in regrowth of leaves and stems after grazing or cutting.
- **Example:** Grass blades regrowing after mowing.

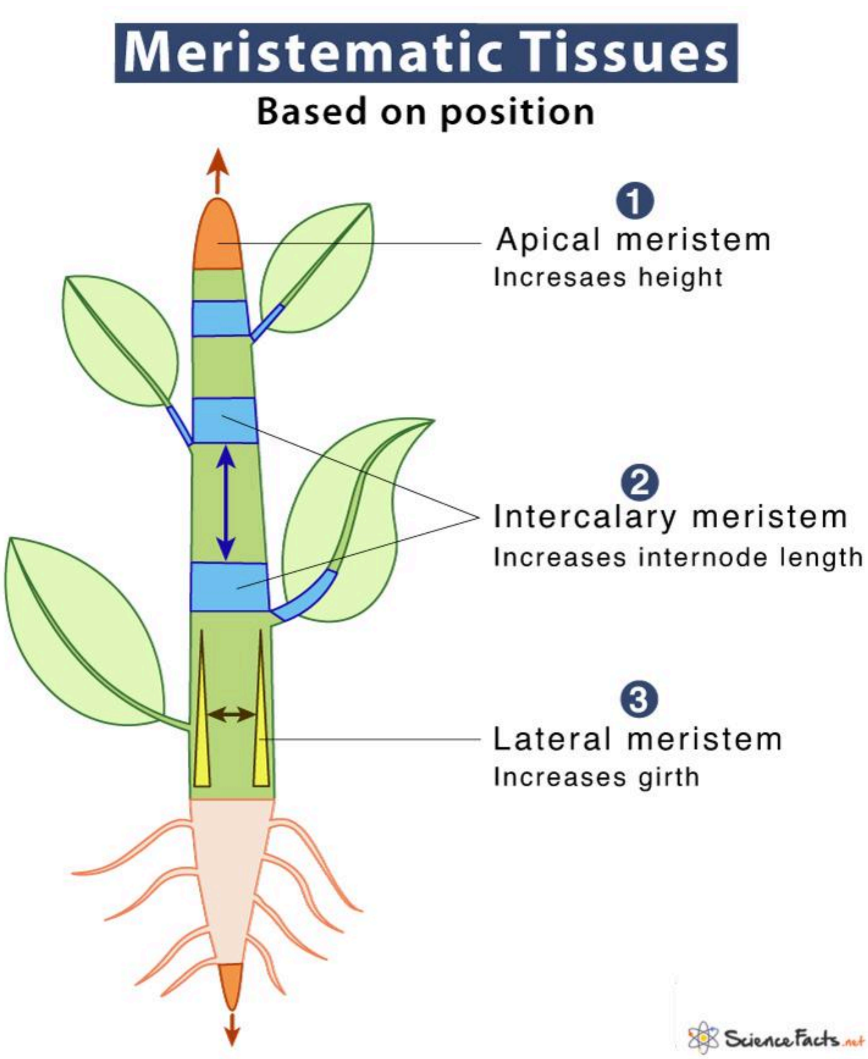
3. Lateral Meristems

- **Location:** Cylindrical regions along stems and roots (vascular cambium and cork cambium).
- **Function:** Responsible for secondary growth, which increases the thickness or girth of stems and roots.
- **Example:** Formation of woody stems and bark in trees.

3. Mechanism of Growth

- Meristematic cells divide continuously to produce new cells.
- New cells then elongate and differentiate into specialized cells such as xylem, phloem, parenchyma, and epidermal cells.
- This process ensures the extension, thickening, and development of plant organs.

Diagram:



✦ **Summary:**

Meristems are essential for plant growth, as they:

- Produce new cells for lengthening (apical meristem),
- Enable regrowth and repair (intercalary meristem),
- Increase thickness and support (lateral meristem).
- Without meristems, plants would not grow, regenerate, or form woody tissues.

🌟 **Q4: Describe the mechanism of opening and closing of stomata.**

❖ **Answer:**

Stomata are tiny pores present on the epidermis of leaves and stems, mainly responsible for gas exchange and transpiration. Each stoma is surrounded by two guard cells, which regulate its opening and closing. The movement of stomata depends on the turgor pressure of guard cells.

1. Mechanism of Stomatal Opening

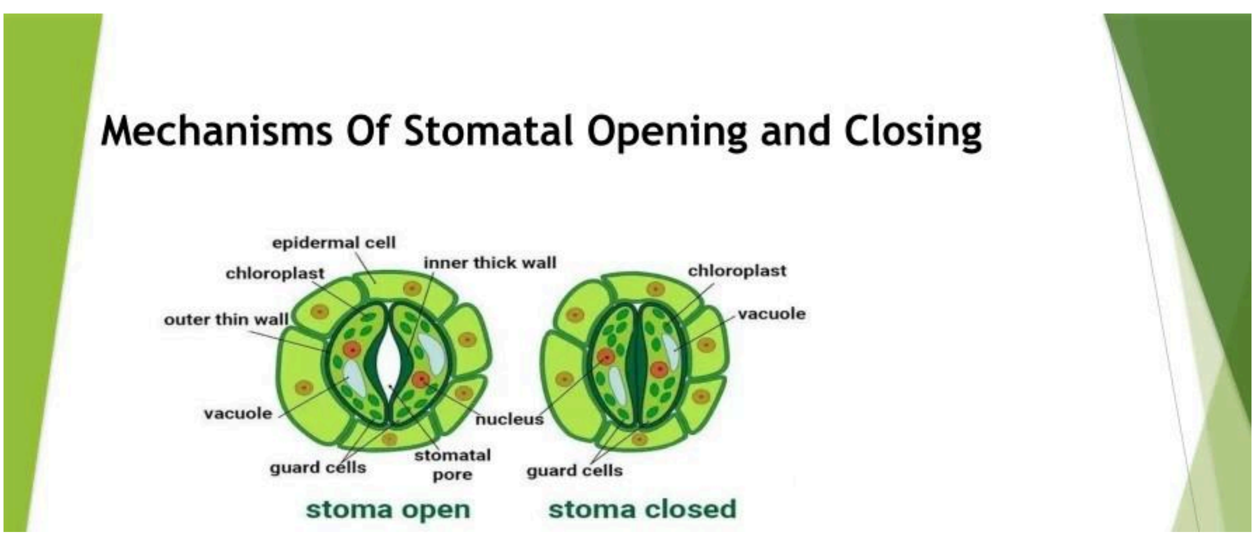
- **Trigger:** Light, low CO_2 concentration, and circadian rhythm stimulate stomata to open.
- **Potassium Ion Uptake:** Guard cells actively take up K^+ ions from surrounding epidermal cells.
- **Water Movement:** The increase in K^+ lowers the water potential inside guard cells, causing water to enter by osmosis.
- **Turgor Pressure:** As water enters, the guard cells become turgid.

- **Opening of Stoma:** Turgid guard cells bend outwards, due to their unequal wall thickness (thicker inner walls, thinner outer walls), creating an open pore.
- **Result:** Stomata are open, allowing CO_2 to enter for photosynthesis and O_2 and water vapor to exit.

2. Mechanism of Stomatal Closing

- **Trigger:** Darkness, high CO_2 concentration, water stress (drought) trigger closure.
- **Potassium Ion Release:** Guard cells release K^+ ions into surrounding cells.
- **Water Loss:** Water moves out of guard cells by osmosis, causing a decrease in turgor pressure.
- **Flaccid Guard Cells:** Guard cells become flaccid.
- **Closing of Stoma:** Flaccid guard cells collapse inward, closing the pore.
- **Result:** Stomata are closed, preventing water loss and conserving moisture during stress conditions.

Diagram:



✦ **Summary:**

- Stomatal opening occurs due to turgid guard cells; closing occurs due to flaccid guard cells.
- Ion movement (K^+ and Cl^-) and osmosis of water are key factors.
- Stomatal movements regulate gas exchange and transpiration, helping plants adapt to environmental conditions.

🌟 **Q5: Explain the concept of photoperiodism and its influence on plant flowering. How do short-day, long-day, and day-neutral plants differ in their flowering responses, and what role does phytochrome play in this process?**

❖ **Answer:**

Photoperiodism is the response of plants to the relative lengths of day and night, allowing them to adapt their flowering time to seasonal changes. It ensures that flowering occurs at the most favorable time for reproduction.

The phenomenon was first studied by Garner and Allard (1920) in tobacco plants, where flowering could be induced artificially by controlling day length.

✦ Types of Flowering Responses

1. Short-Day Plants (SDPs):

- Flower when the night period is longer than a critical length.
- True SDPs are actually long-night plants, meaning the uninterrupted dark period is crucial.
- **Example:** Tobacco, Chrysanthemum.

2. Long-Day Plants (LDPs):

- Flower when the night period is shorter than a critical length.
- They can flower in shorter nights even if the day is long.
- **Example:** Spinach, Barley.

3. Day-Neutral Plants (DNPs):

- Flower independently of day length.
- Their flowering is controlled by factors other than photoperiod.
- **Example:** Tomato, Cucumber.

✦ Role of Phytochrome

Phytochrome is a photoreceptor protein in plants that exists in two forms:

1. **P660 (Pr form):** Absorbs red light (660 nm); inactive form.
2. **P730 (Pfr form):** Absorbs far-red light (730 nm); active form.

Mechanism:

- During daylight, P660 absorbs red light and is converted to P730.
- During darkness, P730 slowly converts back to P660.
- Plants use the ratio of P730 to P660 to measure the length of the night, which triggers flowering.

Effect on Flowering:

- **In SDPs,** long nights allow P730 to accumulate sufficiently to promote flowering.

- **In LDPs,** short nights prevent the accumulation of P730 inactivating inhibitors, allowing flowering.
- Phytochrome acts as a biological clock, helping plants detect day length and regulate flowering hormones like florigen.

✦ **Summary:**

- Photoperiodism enables plants to synchronize flowering with favorable seasons.
- Short-day plants flower in long nights; long-day plants flower in short nights; day-neutral plants are unaffected by day length.
- Phytochrome is the photoreceptor controlling the perception of light and dark periods.
- Activation of florigen hormone in leaves, influenced by phytochrome, stimulates floral bud formation.

✦ INQUISITIVE QUESTIONS

🌟 Q1: Can you explain the hypothesis regarding the opening and closing of stomata?

❖ **Answer:**

Stomata are tiny pores on the surface of leaves that regulate gas exchange (CO_2 intake and O_2 release) and transpiration (water loss). The opening and closing of stomata is controlled by guard cells, which respond to environmental and physiological signals.

1. Hypothesis of Stomatal Movement

The current and widely accepted hypothesis is based on turgor changes in guard cells:

1. Stomatal Opening

- Guard cells take up potassium ions (K^+) from surrounding epidermal cells.
- This increases the osmotic pressure inside guard cells.
- Water enters the guard cells by osmosis, increasing their turgor pressure.
- The guard cells swell and curve outward, because their inner walls are thicker and less flexible.
- The pore between the guard cells opens, allowing gas exchange and transpiration.

2. Stomatal Closing

- Guard cells lose potassium ions (K^+) to the surrounding cells.
- Osmotic pressure inside the guard cells decreases.
- Water moves out of the guard cells, reducing turgor pressure.
- The guard cells become flaccid and collapse toward each other.
- The stomatal pore closes, reducing water loss.

3. Factors Affecting Stomatal Movement

- **Light:** Blue light triggers stomatal opening.
- **CO_2 concentration:** Low CO_2 in leaf promotes opening; high CO_2 promotes closing.
- **Water availability:** Water stress leads to stomatal closure.
- **Plant hormones:** Abscisic acid (ABA) signals stomata to close during drought.

✦ **Summary:**

- The turgor pressure hypothesis explains stomatal movement as a result of osmotic changes in guard cells.
- Opening occurs due to water influx into guard cells; closing occurs due to water efflux.
- Environmental factors and hormones fine-tune this process to balance photosynthesis and water conservation.

🌟 **Q2: What mechanisms enable carnivorous plants to supplement their nutrient uptake despite being autotrophs?**

❖ **Answer:**

Carnivorous plants are autotrophs, meaning they can produce their own food through photosynthesis. However, they often grow in nutrient-poor soils, especially lacking nitrogen and phosphorus, which are essential for growth. To overcome this deficiency, carnivorous plants have developed special mechanisms to trap and digest insects or other small organisms to supplement their nutrient uptake.

1. Mechanisms of Nutrient Supplementation

1. Trap Structures

Carnivorous plants have evolved specialized structures to capture prey:

- **Pitfall traps:** Formed by modified leaves that create a deep cavity filled with digestive fluids. **Example:** Nepenthes (Pitcher plant).
- **Snap traps:** Rapidly closing leaves that capture insects when triggered. **Example:** Dionaea muscipula (Venus flytrap).
- **Sticky traps:** Leaves covered with mucilage that trap insects. **Example:** Drosera (Sundew).

- **Suction traps:** Bladder-like structures that suck in small aquatic organisms. **Example:** Utricularia (Bladderwort).

2. Digestive Enzymes

- Once the prey is trapped, carnivorous plants secrete enzymes like proteases, phosphatases, and nucleases.
- These enzymes break down proteins, nucleic acids, and other organic compounds into simpler molecules such as amino acids, phosphate ions, and ammonium ions.

3. Absorption of Nutrients

- The breakdown products are absorbed through specialized cells in the trap surface.
- These nutrients supplement nitrogen, phosphorus, and other minerals, which are often deficient in their natural habitats.

2. Examples of Carnivorous Plants and Their Mechanisms

- **Venus flytrap:** Snap trap, secretes digestive enzymes.
- **Pitcher plant:** Pitfall trap, collects rainwater and enzymes for digestion.
- **Sundew:** Sticky tentacles, enzymes dissolve prey.
- **Bladderwort:** Suction trap, captures small aquatic prey.

✦ **Summary:**

- Carnivorous plants remain autotrophic, producing energy via photosynthesis.
- They supplement nutrient uptake by capturing prey using specialized traps.

- Digestion of prey by enzymes provides essential nitrogen, phosphorus, and minerals.
- This adaptation allows them to thrive in nutrient-poor environments, where most other plants struggle.

🌟 Q3: How can you say that parenchyma and sclerenchyma provide support to plants?

✦ Answer:

1. Parenchyma and Plant Support

- Parenchyma is a simple, living tissue found throughout the plant in leaves, stems, roots, and fruits.
- **Structure:** Cells are generally thin-walled, isodiametric, and loosely packed with intercellular spaces.

Support Role:

- Parenchyma cells turgid with water act like hydraulic skeletons, helping the plant maintain its shape and rigidity.
- In soft, non-woody parts of plants (herbaceous stems), turgor pressure in parenchyma cells provides mechanical support.
- They also fill spaces between other tissues, giving the plant structural integrity.

2. Sclerenchyma and Plant Support

- Sclerenchyma is a hard, lignified tissue composed of dead cells at maturity.
- **Structure:** Cells have thick secondary walls containing lignin, which makes them rigid and strong.

Support Role:

- Provides mechanical strength to stems, roots, and leaves, especially in woody plants.
- **Fibres:** Long, slender sclerenchyma cells that reinforce vascular bundles, making stems strong.
- **Sclereids:** Short, irregular cells that support fruits, seeds, and hard tissues, e.g., nutshells and pear flesh.

3. Comparison of Support Roles

- **Parenchyma:** Supports via turgor pressure; provides flexibility to herbaceous plants.
- **Sclerenchyma:** Supports via rigidity and lignification; provides strength and hardness to woody plants.
- **Together**, these tissues ensure that plants maintain upright growth and resist mechanical stresses like wind or gravity.

✦ Summary:

- **Parenchyma:** Living, thin-walled cells; support through turgidity.
- **Sclerenchyma:** Dead, lignified cells; support through rigidity and strength.

Both tissues are essential for structural integrity, allowing plants to grow upright and withstand environmental forces.

🌟 Q4: How do the annual rings depict climatic variability?

❖ Answer:

1. Concept of Annual Rings

- Annual rings are concentric rings visible in the cross-section of woody stems and roots.
- They are formed due to the seasonal activity of the vascular cambium, which produces secondary xylem each year.

Each annual ring consists of two types of wood:

1. **Spring wood (early wood):** Light-colored, with wide vessels, formed during favorable growth conditions in spring.
2. **Autumn wood (late wood):** Dark-colored, with narrow vessels, formed during less favorable growth conditions in autumn.

2. Annual Rings and Climatic Variability

The width and density of the rings indicate the climatic conditions during each year:

- **Wide rings:** Indicate favorable conditions, such as adequate water, moderate temperature, and longer growing season.
- **Narrow rings:** Indicate stressful conditions, such as drought, low temperature, or short growing season.

By studying the pattern of rings over several years, scientists can reconstruct past climate conditions, including rainfall, temperature, and periods of stress.

3. Scientific Relevance

This study of tree rings is called dendrochronology.

It helps in:

- Understanding long-term climate variability.
- Dating historical environmental events like droughts and floods.
- Studying ecological changes in a region over time.

✦ **Summary:**

- Annual rings are formed annually due to seasonal cambium activity.
- Spring wood forms under favorable conditions, autumn wood under less favorable conditions.
- The width and density of rings reflect climatic variability, making annual rings a reliable record of past environmental conditions.

🌟 **Q5: How does Pressure Flow Theory explain the movement of sugars through a plant?**

❖ **Answer:**

1. Concept of Pressure Flow Theory

- Pressure Flow Theory, also called the Mass Flow Hypothesis, explains the movement of sugars (mainly sucrose) in the phloem from source (leaves) to sink (storage organs or growing tissues).
- Proposed by Ernst Munch in 1930, this theory is widely accepted for translocation in plants.

2. Steps in Sugar Movement

1. Sugar Production at Source

- Glucose formed during photosynthesis in mesophyll cells is converted into sucrose (a non-reducing sugar) if it is in excess.

2. Active Loading into Phloem

- Sucrose is actively transported from mesophyll cells into companion cells, and then diffuses into sieve tube elements through plasmodesmata.
- This creates a high sugar concentration in the sieve tubes at the source.

3. Water Entry by Osmosis

- Due to high sucrose concentration, water moves from xylem into sieve tubes by osmosis.
- This increases turgor pressure at the source end of the phloem.

4. Flow from Source to Sink

- Sugar solution moves along the pressure gradient from the high-pressure source to the low-pressure sink.
- This movement is bulk flow, carrying sucrose dissolved in water.

5. Sugar Unloading at Sink

- At the sink (e.g., roots, fruits, storage organs), sugars are actively or passively removed from sieve tubes.
- Water follows by osmosis, lowering the pressure at the sink end.

3. Key Features

- The movement is from high-pressure to low-pressure areas.

- It requires energy for active loading and unloading of sucrose.
- Phloem transport is bidirectional, depending on the location of sources and sinks.

✦ **Summary:**

- Pressure Flow Theory explains sugar transport as a pressure-driven bulk flow.
- High sucrose at source → water enters → high pressure → flow towards sink → sucrose removed → water exits → low pressure.
- This mechanism efficiently moves sugars from leaves to growing or storage tissues in the plant.

🌟 **Q6: What strategies would you adopt to induce flowering in a plant?**

❖ **Answer:**

Flowering in plants is influenced by environmental cues and internal physiological signals. To induce flowering, one must manipulate these factors based on the type of plant and its flowering requirements.

1. Manipulation of Photoperiod (Day Length)

Plants are classified based on their response to day length:

- **Short-Day Plants (Long-Night Plants):** Require longer nights to flower (e.g., tobacco, chrysanthemum).
- **Long-Day Plants (Short-Night Plants):** Require shorter nights to flower (e.g., spinach, radish).
- **Day-Neutral Plants:** Flowering is independent of day length (e.g., tomato, cucumber).

Strategies:

- For short-day plants, extend the dark period using opaque covers or grow in naturally long-night conditions.
- For long-day plants, interrupt the long night with artificial light to simulate a shorter night.
- Day-neutral plants flower without day-length manipulation.

2. Vernalisation (Low-Temperature Treatment)

- Some plants require exposure to low temperature to induce flowering.
- This treatment is applied to the shoot apex of mature stems or embryos of seeds.
- Temperature around 4°C for a few days to months stimulates production of vernalin hormone, which promotes flowering.

Examples: biennial plants like carrot, cabbage, and beetroot.

3. Hormonal Treatment

Flowering can be induced or accelerated by applying plant growth regulators:

- **Gibberellins (GA):** Promote flowering in long-day plants and rosette plants.
- **Auxins & Cytokinins:** Enhance bud formation and flower initiation in some plants.
- **Florigen:** A naturally produced flowering hormone that moves from leaves to buds to trigger flowering.

4. Use of Artificial Light (Phytochrome Manipulation)

- Phytochrome proteins in plants exist in two forms: P660 and P730, which help plants measure the length of night.
- By controlling red and far-red light exposure, the P660 ↔ P730 balance can be manipulated, which regulates flowering in short-day and long-day plants.

✦ **Summary:**

- Flowering can be induced by controlling day length, temperature, hormones, and light quality.
- Short-day plants require long nights, long-day plants require short nights, and day-neutral plants are unaffected by photoperiod.
- Vernalisation involves low-temperature treatment to stimulate flowering.
- Hormones like gibberellins and florigen play a key role in promoting flower initiation.
- Understanding these factors allows controlled flowering, which is valuable in agriculture, horticulture, and plant breeding.