CHAPTER 6

Anatomy of Flowering Plants

6.1 The Tissues

1. Phloem in gymnosperms lacks
(a) both sieve tubes and companion cells
(b) albuminous cells and sieve cells
(c) sieve tubes only (d) companion cells only. *(NEET 2019)*

2. Regeneration of damaged growing grass following grazing is largely due to
(a) lateral meristem (b) apical meristem
(c) intercalary meristem (d) secondary meristem. *(Odisha NEET 2019)*

3. Tracheids differ from other tracheary elements in
(a) having Casparian strips
(b) being imperforate (c) lacking nucleus
(d) being lignified. *(2014)*

4. Meristematic tissue responsible for increase in girth of tree trunk is
(a) intercalary meristem (b) lateral meristem
(c) phellogen (d) apical meristem. *(Karnataka NEET 2013)*

5. Gymnosperms are also called soft wood spermatophytes because they lack
(a) cambium (b) phloem fibres
(c) thick-walled tracheids (d) xylem fibres. *(2012)*

6. Companion cells are closely associated with
(a) sieve elements (b) vessel elements
(c) trichomes (d) guard cells. *(2012)*

7. Function of companion cells is
(a) providing energy to sieve elements for active transport
(b) providing water to phloem
(c) loading of sucrose into sieve elements by passive transport
(d) loading of sucrose into sieve elements. *(Mains 2011)*

8. Which one of the following is not a lateral meristem?
(a) Intrafascicular cambium
(b) Interfascicular cambium
(c) Phellogen (d) Intercalary meristem *(2010)*

9. The chief water conducting elements of xylem in gymnosperms are
(a) vessels (b) fibres
(c) transfusion tissue (d) tracheids. *(2010)*

10. Transport of food material in higher plants takes place through
(a) companion cells (b) transfusion tissue
(c) tracheids (d) sieve elements. *(Mains 2010)*

11. The length of different internodes in a culm of sugarcane is variable because of
(a) size of leaf lamina at the node below each internode
(b) intercalary meristem (c) shoot apical meristem
(d) position of axillary buds. *(2008)*

12. A common structural feature of vessel elements and sieve tube elements is
(a) enucleate condition (b) thick secondary walls
(c) pores on lateral walls (d) presence of P-protein. *(2006)*

13. The apical meristem of the root is present
(a) only in radicals (b) only in tap roots
(c) only in adventitious roots
(d) in all the roots. *(2003)*

14. Chlorenchyma is known to develop in the
(a) cytoplasm of *Chlorella*
(b) mycelium of a green mould such as *Aspergillus*
(c) spore capsule of a moss
(d) pollen tube of *Pinus*. *(2003)*

15. The cells of the quiescent centre are characterised by
(a) having dense cytoplasm and prominent nuclei
(b) having light cytoplasm and small nuclei
(c) dividing regularly to add to the corpus
(d) dividing regularly to add to tunica. *(2003)*

16. Which of the following statements is true?
(a) Vessels are multicellular with wide lumen.
(b) Tracheids are multicellular with narrow lumen.
(c) Vessels are unicellular with narrow lumen.
(d) Tracheids are unicellular with wide lumen. *(2002)*

17. Axillary bud and terminal bud derived from the activity of
(a) lateral meristem (b) intercalary meristem
(c) apical meristem (d) parenchyma. *(2002)*

18. Vessels are found in
(a) all angiosperms and some gymnosperm
(b) most of angiosperms and few gymnosperms
(c) all angiosperms, all gymnosperms and some pteridophyta
(d) all pteridophyta. *(2002)*

19. At maturity, which of the following is non-nucleated?
(a) Palisade cell (b) Cortical cell
(c) Sieve cell (d) Companion cell *(1997)*

20. Which of the following is not true about 'sclereids'?
(a) These are groups of living cells.
(b) These are found in nut shells, guava pulp, pear.
(c) These are also called stone cells.
(d) These are form of sclerenchyma with fibres. *(1996)*

21. Which of the following plant cells will show totipotency?
(a) Sieve tubes (b) Xylem vessels
(c) Meristem (d) Cork cells *(1993)*

22. Bordered pits are found in
(a) sieve cells (b) vessel wall
(c) companion cells (d) sieve tube wall. *(1993)*

23. An organised and differentiated cellular structure having cytoplasm but no nucleus is
(a) vessels (b) xylem parenchyma
(c) sieve tubes (d) tracheids. *(1991)*

24. Angular collenchyma occurs in
(a) *Cucurbita* (b) *Helianthus*
(c) *Althaea* (d) *Salvia*. *(1991)*

25. Collenchyma occurs in
(a) herbaceous climbers (b) woody climbers
(c) climbing stems (d) water plants. *(1990)*

26. Collenchyma occurs in the stem and petioles of
(a) xerophytes (b) monocots
(c) dicot herbs (d) hydrophytes. *(1990)*

27. Cork cambium and vascular cambium are
(a) parts of secondary xylem and phloem
(b) parts of pericycle (c) lateral meristem
(d) apical meristem. *(1990)*

28. Sieve tubes are suited for translocation of food because they possess
(a) bordered pits (b) no end walls
(c) broader lumen and perforated cross walls
(d) no protoplasm. *(1989)*

29. Death of protoplasm is a pre-requisite for a vital function like
(a) transport of sap (b) transport of food
(c) absorption of water (d) gaseous exchange. *(1989)*

30. Organisation of stem apex into corpus and tunica is determined mainly by
(a) planes of cell division
(b) regions of meristematic activity
(c) rate of cell growth
(d) rate of shoot tip growth. *(1988)*

31. Which meristem helps in increasing girth?
(a) Lateral meristem (b) Intercalary meristem
(c) Primary meristem (d) Apical meristem *(1988)*

32. Tunica corpus theory is connected with
(a) root apex (b) root cap
(c) shoot apex (d) secondary growth. *(1988)*

6.2 The Tissue System

33. Stomata in grass leaf are
(a) dumb-bell shaped (b) kidney-shaped
(c) rectangular (d) barrel-shaped. *(NEET 2018)*

34. Specialised epidermal cells surrounding the guard cells are called
(a) bulliform cells (b) lenticels
(c) complementary cells (d) subsidiary cells. *(NEET-I 2016)*

35. Vascular bundles in monocotyledons are considered closed because
(a) there are no vessels with perforations
(b) xylem is surrounded all around by phloem
(c) a bundle sheath surrounds each bundle
(d) cambium is absent. *(2015 Cancelled)*

36. Which of the following statements is not true for stomatal apparatus?
(a) Guard cells invariably possess chloroplasts and mitochondria.
(b) Guard cells are always surrounded by subsidiary cells.
(c) Stomata are involved in gaseous exchange.
(d) Inner wall of guard cells are thick. *(Karnataka NEET 2013)*

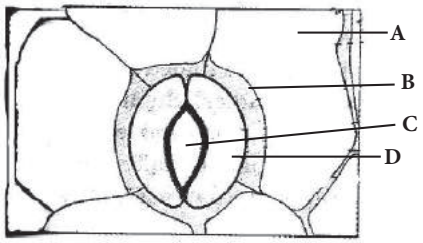
37. Closed vascular bundles lack
(a) ground tissue (b) conjunctive tissue
(c) cambium (d) pith. *(2012)*

38. Ground tissue includes
(a) all tissues external to endodermis
(b) all tissues except epidermis and vascular bundles
(c) epidermis and cortex
(d) all tissues internal to endodermis. *(2011)*

39. Some vascular bundles are described as open because these
(a) are surrounded by pericycle but no endodermis
(b) are capable of producing secondary xylem and phloem

(c) possess conjunctive tissue between xylem and phloem
(d) are not surrounded by pericycle. *(Mains 2011)*

40. Given below is the diagram of a stomatal apparatus. In which of the following all the four parts labelled as A, B, C and D are correctly identified?



	A	B	C	D
(a)	Subsidiary cell	Epidermal cell	Guard cell	Stomatal aperture
(b)	Guard cell	Stomatal aperture	Subsidiary cell	Epidermal cell
(c)	Epidermal cell	Guard cell	Stomatal aperture	Subsidiary cell
(d)	Epidermal cell	Subsidiary cell	Stomatal aperture	Guard cell

(Mains 2010)

41. In barley stem vascular bundles are
(a) closed and scattered (b) open and in a ring
(c) closed and radial (d) open and scattered. *(2009)*

42. A bicollateral vascular bundle is characterised by
(a) phloem being sandwiched between xylem
(b) transverse splitting of vascular bundle
(c) longitudinal splitting of vascular bundle
(d) xylem being sandwiched between phloem. *(1992)*

6.3 Anatomy of Dicotyledonous and Monocotyledonous Plants

43. The transverse section of a plant shows following anatomical features :
(i) Large number of scattered vascular bundles surrounded by bundle sheath
(ii) Large conspicuous parenchymatous ground tissue
(iii) vascular bundles conjoint and closed
(iv) phloem parenchyma absent
Identify the category of plant and its part.
(a) Monocotyledonous stem
(b) Monocotyledonous root
(c) Dicotyledonous stem
(d) Dicotyledonous root *(NEET 2020)*

44. Grass leaves curl inwards during very dry weather. Select the most appropriate reason from the following.
(a) Tyloses in vessels (b) Closure of stomata
(c) Flaccidity of bulliform cells
(d) Shrinkage of air spaces in spongy mesophyll *(NEET 2019)*

45. In the dicot root the vascular cambium originates from
(a) tissue located below the phloem bundles and a portion of pericycle tissue above protoxylem
(b) cortical region
(c) parenchyma between endodermis and pericycle
(d) intrafascicular and interfascicular tissue in a ring. *(Odisha NEET 2019)*

46. Casparian strips occur in
(a) epidermis (b) pericycle
(c) cortex (d) endodermis. *(NEET 2018)*

47. Root hair develop from the region of
(a) elongation (b) root cap
(c) meristematic activity
(d) maturation. *(NEET 2017)*

48. Cortex is the region found between
(a) epidermis and stele
(b) pericycle and endodermis
(c) endodermis and pith
(d) endodermis and vascular bundle. *(NEET-II 2016)*

49. A major characteristic of monocot root is the presence of
(a) vasculature without cambium
(b) cambium sandwiched between phloem and xylem along the radius
(c) open vascular bundles
(d) scattered vascular bundles. *(2015 Cancelled)*

50. You are given a fairly old piece of dicot stem and a dicot root. Which of the following anatomical structures will you use to distinguish between the two?
(a) Secondary xylem (b) Secondary phloem
(c) Protoxylem (d) Cortical cells *(2014)*

51. Water containing cavities in vascular bundles are found in
(a) sunflower (b) maize
(c) *Cycas* (d) *Pinus.* *(2012)*

52. As compared to a dicot root, a monocot root has
(a) more abundant secondary xylem
(b) many xylem bundles
(c) inconspicuous annual rings
(d) relatively thicker periderm. *(Mains 2012)*

53. Palisade parenchyma is absent in leaves of
(a) mustard (b) soybean
(c) gram (d) *Sorghum.* *(2009)*

54. The annular and spirally thickened conducting elements generally develop in the protoxylem when the root or stem is
(a) elongating (b) widening
(c) differentiating (d) maturing. *(2009)*

55. Anatomically fairly old dicotyledonous root is distinguished from the dicotyledonous stem by

(a) absence of secondary phloem
(b) presence of cortex
(c) position of protoxylem
(d) absence of secondary xylem. *(2009)*

56. Passage cells are thin walled cells found in
(a) phloem elements that serve as entry points for substance for transport to other plant parts
(b) testa of seeds to enable emergence of growing embryonic axis during seed germination
(c) central region of style through which the pollen tube grows towards the ovary
(d) endodermis of roots facilitating rapid transport of water from cortex to pericycle. *(2007)*

57. In a woody dicotyledonous tree, which of the following parts will mainly consist of primary tissues?
(a) All parts (b) Stem and root
(c) Flowers, fruits and leaves
(d) Shoot tips and root tips *(2005)*

58. Four radial vascular bundle are found in
(a) dicot root (b) monocot root
(c) dicot stem (d) monocot stem. *(2002)*

59. What happens in plants during vascularisation?
(a) Differentiation of procambium, formation of primary phloem followed by formation of primary xylem
(b) Differentiation of procambium followed by the formation of primary phloem and xylem simultaneously
(c) Formation of procambium, primary phloem and xylem simultaneously
(d) Differentiation of procambium followed by the formation of secondary xylem *(2000)*

60. Casparian strips are found in
(a) epidermis (b) hypodermis
(c) periderm (d) endodermis. *(1999)*

61. Casparian strip occurs in a
(a) endodermis (b) exodermis
(c) pericycle (d) epidermis. *(1994)*

62. A plant bears fruit, has a column of vascular tissue and a tap root system. This plant is a
(a) angiosperm and dicot
(b) gymnosperm and dicot
(c) angiosperm and monocot
(d) gymnosperm and monocot. *(1994)*

63. Where do the Casparian bands occur?
(a) Epidermis (b) Endodermis
(c) Pericycle (d) Phloem *(1994, 1990)*

64. A narrow layer of thin walled cells found between phloem/bark and wood of a dicot is
(a) cork cambium (b) vascular cambium
(c) endodermis (d) pericycle. *(1993)*

65. What is true about a monocot leaf?
(a) Reticulate venation
(b) Absence of bulliform cells from epidermis
(c) Mesophyll not differentiated into palisade and spongy tissues
(d) Well differentiated mesophyll *(1992, 1990)*

66. Pericycle of roots produces
(a) mechanical support (b) lateral roots
(c) vascular bundles (d) adventitious buds. *(1990)*

67. Monocot leaves possess
(a) intercalary meristem (b) lateral meristem
(c) apical meristem (d) mass meristem. *(1990)*

68. Pith and cortex do not differentiate in
(a) monocot stem (b) dicot stem
(c) monocot root (d) dicot root. *(1988)*

6.4 Secondary Growth

69. Identify the incorrect statement.
(a) Heartwood does not conduct water but gives mechanical support.
(b) Sapwood is involved in conduction of water and minerals from root to leaf.
(c) Sapwood is the innermost secondary xylem and is lighter in colour.
(d) Due to deposition of tannins, resins, oils, etc., heartwood is dark in colour. *(NEET 2020)*

70. Which of the statements given below is not true about formation of annual rings in trees?
(a) Annual rings are not prominent in trees of temperate region.
(b) Annual ring is a combination of spring wood and autumn wood produced in a year.
(c) Differential activity of cambium causes light and dark bands of tissue-early and late wood respectively.
(d) Activity of cambium depends upon variation in climate. *(NEET 2019)*

71. Secondary xylem and phloem in dicot stem are produced by
(a) apical meristems (b) vascular cambium
(c) phellogen (d) axillary meristems. *(NEET 2018)*

72. Plants having little or no secondary growth are
(a) grasses
(b) deciduous angiosperms
(c) conifers (d) cycads. *(NEET 2018)*

73. The vascular cambium normally gives rise to
(a) primary phloem (b) secondary xylem
(c) periderm (d) phelloderm. *(NEET 2017)*

74. Which of the following is made up of dead cells?
(a) Collenchyma (b) Phellem
(c) Phloem (d) Xylem parenchyma *(NEET 2017)*

75. Identify the wrong statement in context of heartwood.
(a) It is highly durable.
(b) It conducts water and minerals efficiently.
(c) It comprises dead elements with highly lignified walls.
(d) Organic compounds are deposited in it.
(NEET 2017)

76. The balloon-shaped structures called tyloses
(a) originate in the lumen of vessels
(b) characterise the sapwood
(c) are extensions of xylem parenchyma cells into vessels
(d) are linked to the ascent of sap through xylem vessels. *(NEET-II 2016)*

77. Read the different components from (i) to (iv) in the list given below and tell the correct order of the components with reference to their arrangement from outer side to inner side in a woody dicot stem.
(i) Secondary cortex (ii) Wood
(iii) Secondary phloem (iv) Phellem
The correct order is
(a) (iv), (i), (iii), (ii) (b) (iv), (iii), (i), (ii)
(c) (iii), (iv), (ii), (i) (d) (i), (ii), (iv), (iii).
(2015)

78. Lenticels are involved in
(a) food transport (b) photosynthesis
(c) transpiration (d) gaseous exchange.
(NEET 2013)

79. Age of a tree can be estimated by
(a) number of annual rings
(b) diameter of its heartwood
(c) its height and girth (d) biomass. *(NEET 2013)*

80. Interfascicular cambium develops from the cells of
(a) endodermis (b) pericycle
(c) medullary rays (d) xylem parenchyma.
(NEET 2013)

81. The common bottle cork is a product of
(a) dermatogen (b) phellogen
(c) xylem (d) vascular cambium.
(2012)

82. The cork cambium, cork and secondary cortex are collectively called
(a) phelloderm (b) phellogen
(c) periderm (d) phellem. *(2011)*

83. Heartwood differs from sapwood in
(a) presence of rays and fibres
(b) absence of vessels and parenchyma
(c) having dead and non-conducting elements
(d) being susceptible to pests and pathogens.
(2010)

84. Vascular tissues in flowering plants develop from
(a) periblem (b) dermatogen
(c) phellogen (d) plerome. *(2008)*

85. For a critical study of secondary growth in plants, which one of the following pairs is suitable?
(a) Teak and pine (b) Deodar and fern
(c) Wheat and maiden hair fern
(d) Sugarcane and sunflower *(2007)*

86. Diffuse porous woods are characteristic of plants growing in
(a) alpine region (b) cold winter regions
(c) temperature climate (d) tropics. *(2003)*

87. Which of the following meristems is responsible for extrastelar secondary growth in dicotyledonous stem?
(a) Interfascicular cambium
(b) Intercalary meristem
(c) Phellogen
(d) Intrafascicular cambium *(1998)*

88. The periderm includes
(a) secondary phloem (b) cork
(c) cambium (d) all of these. *(1998)*

89. As a tree grows older, which of the following increases more rapidly in thickness?
(a) Heart wood (b) Sapwood
(c) Phloem (d) Cortex *(1994)*

90. Periderm is produced by
(a) vascular cambium (b) fascicular cambium
(c) phellogen
(d) intrafascicular cambium. *(1993)*

91. Which exposed wood will decay faster?
(a) Sapwood (b) Softwood
(c) Wood with lot of fibres
(d) Heartwood *(1993)*

92. Abnormal/anomalous secondary growth occurs in
(a) *Dracaena* (b) ginger
(c) wheat (d) sunflower. *(1993)*

93. Vascular cambium produces
(a) primary xylem and primary phloem
(b) secondary xylem and secondary phloem
(c) primary xylem and secondary phloem
(d) secondary xylem and primary phloem.
(1992, 1990)

94. Out of diffuse porous and ring porous woods, which is correct?
(a) Ring porous wood carries more water for short period.
(b) Diffuse porous wood carries more water.
(c) Ring porous wood carries more water when need is higher.
(d) Diffuse porous wood is less specialised but conducts water rapidly throughout. *(1989)*

95. Cork is formed from
(a) cork cambium (phellogen)
(b) vascular cambium (c) phloem
(d) xylem. *(1988)*

ANSWER KEY

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

Hints & Explanations

1. (a) : In gymnosperms phloem is without companion cells and sieve tubes.

2. (c)

3. (b) : Tracheids are elongated, dead cells with hard lignified walls, wide lumens and narrow walls with spiral, annular, reticulate, scalariform and pitted thickening but without perforated end walls of septa. That is, they have intact end walls unlike vessels. Vessels are long cylindrical tube like structures made of many cells, called vessel members, each with lignified walls and a large central cavity. Vessel members are interconnected through perforation in their common walls.

4. (b) : Lateral meristems are the meristems which are present along the lateral sides of stem and roots. They divide only in radial direction. Intrastelar or vascular cambium ring formed by intra-fascicular (also called fascicular) and inter-fascicular cambium; and cork cambium (phellogen) are examples of this type of meristem. These meristems are responsible for increase in girth of stem and roots.

5. (d)

6. (a) : Companion cell is a type of cell found within the phloem of flowering plants. Each companion cell is usually closely associated with a sieve element. They remain connected with sieve cells by plasmodesmata. They help in loading of phloem sieve cells with sugars through active transport.

7. (d) : Companion cells move sugar and amino acids into and out of the sieve elements. In "source" tissue such as leaf companion cells use transmembrane proteins to take up sugar and amino acids by active transport. Movement of sugars in the phloem begins at the source, where sugars are loaded (actively transported) into a sieve tube. Loading sets up a water potential gradient that facilitates movement of sugar.

8. (d) : Meristem is classified on the basis of position in plant bodies into lateral meristem, apical meristem and intercalary meristem. Lateral meristem is present on the lateral sides, *e.g.*, vascular cambium (fascicular and interfascicular cambium) and cork cambium (phellogen).

9. (d) : The chief water conducting elements of xylem in gymnosperms are tracheids. These are elongated cells with tapering ends and are dead because of deposition of lignin. These show scalariform, annular, reticulate or bordered pitted thickening. These are the only water conducting xylem elements in both gymnosperms and pteridophytes. Generally vessels are absent in gymnosperms with exceptions like *Gnetum*, *Welwitschia*, *Ephedra*.

10. (d)

11. (b) : Internode is the part of a plant stem, that occurs between two adjacent nodes. Intercalary meristem is internodal in position and is found in the stem of grasses and other monocotyledonous plants. In early stages the internode is wholly or partially meristematic but later on some of its parts become matured more rapidly than the rest so a definite continuous sequence of development is maintained *i.e.*, mature tissue left behind whereas new ones grow which later shows variable length.

12. (a) : Xylem vessels are hollow, elongated cells with open ends and pitted walls. Cells walls are lignified. At maturity nucleus is absent in vessels. Sieve tube members are long, slender, tube-like cells joined end to end, to form long tubular channels – the sieve tubes. Sieve tube members possess specialized sieve areas on the end walls called sieve plate. Young sieve tube members have abundant cytoplasm but there is no nucleus. The nucleus disintegrates during their development.

13. (d) : Parts of typical root : root cap, meristematic growing region, zone of elongation, root hair zone, zone of meristematic cells.

Apical meristem is terminal in position and responsible for terminal growth of the plant. Apical meristem is present at all root tips and shoot tips.

14. (c) : Chlorenchyma or assimilatory parenchyma are parenchymatous cells that possess abundant chloroplasts in them. They are capable of photosynthesis. A spore capsule of moss can perform photosynthesis because of the presence of chlorenchyma cells in them.

15. (b) : In the apices of some roots, there is a central region of cells which normally does not divide. This central inactive region was called quiescent centre by Clowes. The cells of this region have lesser amount of RNA and DNA so they have small nuclei. These cells also have a lower rate of protein synthesis. Mitochondria and endoplasmic reticulum are less developed. The cells of the quiescent centre are usually inactive. However, if already existing meristematic cells are injured or become inactive due to any other reason, the cells of quiescent centre become active.

16. (a) : Xylem is the principal water conducting tissue of the plant. It consists of four types of cells-tracheids, vessels, xylem fibres and xylem parenchyma. The tracheids and vessels together are known as tracheary elements. Tracheids are characteristic of all vascular plant. Tracheids originate from single cells. These are single elongated cells with tapering ends. The end walls are without perforations. Their length varies from 1 to 3 mm. Tracheids are devoid of protoplast, hence dead; fairly large cavity of these cells is without any contents. The wall of tracheids is moderately thick and usually lignified.

17. (c) : Apical meristems are situated at the tips of the root and shoot. They take part in initial growth. Plants elongate and increase in height as a result of divisions in this meristem. Promeristem and primary meristem (root and shoot apices) are included in this type of meristem.

18. (b) : Vessels are found in the wood of almost all the angiosperms except certain primitive members of the order Ranales (vesseless dicots), *e.g.*, *Trochodendron*, *Tetracentron, Drimys, Pseudowintera,* etc. Vessels also occur in some pteridophytes, such as *Selaginella* and in the members of order Gnetales of gymnosperms (*e.g.*, *Genetum*, *Ephedra* and *Welwitschia*).

19. (c) : In pteridophytes and gymnosperms, sieve tubes are not arranged in linear rows and hence called sieve cells. Sieve tube elements are the conducting elements of phloem. These are arranged end to end in linear rows with sieve plate between two sieve tube elements. In the sieve plate, there are present sieve pores. Sieve tube elements are living and have thin cellulosic walls in young cells but they become thick walled and are without nuclei at maturity.

20. (a) : Sclereids are a type of sclerenchyma cells. They are short or irregular, their walls are very thick, irrergular and the lumen is very narrow. These are dead cells and do not perform any metabolic functions. They show different types of lignin depositions and also have pits.

21. (c) : Meristems show the totipotency whereas xylem vessels and cork cells are dead cells while sieve tube cells do not possess nuclei.

22. (b) : Bordered pits are found in vessel wall. In bordered pits, the thickening material over arches the pit cavity in such a way that a pit chamber opens to the interior by a pit aperture.

23. (c) : An organised and differentiated cellular structure having cytoplasm but no nucleus are sieve tubes. The sieve tubes are living cells. Their walls are thicker than surrounding parenchyma cells. Sometimes they have a special, shining nacreous thickening. Cytoplasm occurs in the form of thin lining enclosing a big central vacuole.

24. (a) : Angular collenchyma occurs in, *Cucurbita*. It has thickening at the angles and there are no intercellular spaces. It is generally found in leaf petioles.

25. (c) : Collenchyma occurs in climbing stems. Collenchyma occurs in the stem and petioles of dicot herbs. Due to deposition of pectin, it has high water retaining capacity. Since pectin appears at the angles, it becomes a spongy tissues. The collenchyma is a mechanical tissue which gives tensile strength to the plant.

26. (c) : *Refer to answer 25.*

27. (c) : Cork cambium and vascular cambium are lateral meristems. Both are responsible for the secondary growth of stem. They also increase the girth of stem.

28. (c) : Sieve tubes are suited for translocation of food because they possess broader lumen and perforated cross walls. Sieve tubes are elongated tubular conducting channels of phloem. The end wall possess many small pores and have thin cellulosic wall.

29. (a) : Death of protoplasm is a pre-requisite for a vital function like transport of sap. Xylem is a dead tissue (except xylem parenchyma) and do not have protoplasm, xylem performs the function of transport of water or sap inside the plant from roots to leaves.

30. (a) : The tunica corpus concept was given by Schmidt (1924) which was based on plane of divisions of cells. According to this concept there are two portions in shoot apex-tunica and corpus. The tunica shows only anticlinical divisions and thus it is responsible for surface growth. The corpus shows divisions in all plane and thus responsible for volume growth.

31. (a) : The meristem that helps in increasing girth is lateral meristem. The lateral meristem is responsible for lateral growth of the plant *i.e.*, growth in thickness *e.g.*, cambium and cork cambium. It divides only periclinally or radially and is responsible for increase in girth or diameter.

32. (c) : The tunica corpus concept was given by Schmidt (1924) which was based on plane of divisions of cells. According to this concept there are two portions in shoot apex-tunica and corpus. The tunica shows only

anticlinical divisions and thus it is responsible for surface growth. The corpus shows divisions in all plane and thus responsible for volume growth.

33. (a) : Grass being a monocot, has dumb-bell shaped guard cells. Guard cells are generally bean shaped or kidney-shaped in dicots.

34. (d) : The leaf and stem epidermis of plant is covered with pores called stomata. Each stomata is surrounded by a pair of specialised epidermal cells known as guard cells which are in some cases further surrounded by another category of less modified epidermal cells known as subsidiary cells which provide support to the guard cells.

35. (d)

36. (b) : The epidermal surface of the leaf exhibits 1,000 to 60,000 minute openings called stomata. The stomata are bordered by two specialised epidermal cells - the guard cells which in some cases are accompanied by subsidiary cells. The walls of guard cells are unevenly thickened. Each guard cell has thick, inelastic inner wall and thin, elastic outer wall. Stomatal aperture is present in between the guard cells. Guard cells are not always surrounded by accessory cells or subsidiary cells.

37. (c) : Vascular bundle consists of complex tissues, the phloem and xylem. In dicots, between xylem and phloem, cambium is present which helps in secondary growth. This type of vascular bundle is called open. While in monocots cambium is absent, so these are called closed vascular bundles.

38. (b) : Ground tissue can be defined as all the tissues except epidermis and vascular bundles. Ground tissue constitutes the interior of organs except vascular system. It consists of simple tissues such as parenchyma, collenchyma and sclerenchyma.

39. (b) : In dicot stem, cambium is present between xylem and phloem, such vascular bundles are called open. Cambium constitutes meristematic cells which produce secondary xylem and phloem.

40. (d) : A – Epidermal cell B – Subsidiary cell
C – Stomatal aperture D – Guard cell

41. (a) : Barley is a monocotyledonous plant. The vascular bundle of stem is conjoint,collateral,exarch and closed (because cambium is absent). It is also scattered throughout the ground tissue.

42. (d) : A bicollateral vascular bundle is characterised by xylem being sandwiched between phloem. Here there are two cambium rings *e.g.*, *Cucurbita*.

43. (a)

44. (c) : In grasses, certain adaxial epidermal cells along the veins modify themselves into large, empty, colourless cells. These are called bulliform cells. When the bulliform cells in the leaves have absorbed water and are turgid, the leaf surface is exposed. When they are flaccid due to water stress, they make the leaves curl inwards to minimise water loss.

45. (a)

46. (d) : Casparian strip is a band of thickening present on the radial and tangential walls of the endodermis. It is made up of both suberin and lignin.

47. (d) : Root hair are lateral tubular outgrowths that develop from the outer cells of zone of maturation or root hair zone.

48. (a)

49. (a) : In monocot root, a large number of vascular bundles are arranged in the form of a ring around the central pith. Vascular bundles are closed because there is no cambium present between the xylem and phloem.

50. (c) : In stems, the protoxylem lies towards the centre (pith) and the metaxylem lies towards the periphery. This type of primary xylem is called endarch. In root, the protoxylem lies towards periphery and metaxylem lies towards the centre, such arrangement is called exarch.

51. (b)

52. (b) : In monocot root, secondary growth is absent and vascular cylinder is in the form of several alternate and radial xylem and phloem bundles. The vascular bundles are arranged in the form of ring around central pith. Their number in maize ranges between 20 – 30 whereas in *Pandanus* and palms, they may be upto 100. Because of the presence of numerous xylem bundles and exarch condition, xylem of monocot root is polyarch. On the other hand, in dicot root, xylem and phloem are equal in number (2 – 6) and alternately arranged *i.e.*, they lie on different radii hence called radial bundles. According to number of ray (equivalent to number of xylem or phloem bundles) the roots may be diarch, triarch, tetrarch, pentarch or hexarch.

53. (d) : Palisade parenchyma is absent in leaves of *Sorghum*. It is a monocot plant where the parenchyma tissues of the leaves are not differentiated into palisade and spongy.

54. (c) : The protoxylem differentiates in the parts of the primary body that have not completed their growth and differentiation. In fact in the shoot, the protoxylem matures among actively elongating tissues and is, therefore subjected to stresses. In the root, the protoxylem elements persist longer because here they mature beyond the region of maximum growth. In this differentiation annular and spiral thickening take place.

55. (c) : In dicot root the protoxylem is located near the periphery of the vascular cylinder, the metaxylem farther inward. In roots xylem is exarch or centripetal. In dicot stem the protoxylem is located near the centre of vascular bundle and metaxylem is located near the periphery *i.e.,* the xylem is endarch or centrifugal.

56. (d) : Endodermis is a single layered structure which separates cortex from stele. There are both thick walled and thin walled cells in the endodermis. The thin walled cells are known as passage cells or transfusion cells which

are opposite the protoxylem groups. These cells help in rapid transport of water from cortex to pericycle.

57. (d) : Primary tissues are those meristematic tissues that are derived directly from embryonal tissues, *e.g.*, shoot apex and root apex.

58. (a) : The vascular tissue of the root is characterised by radial arrangement of vascular bundles *i.e.*, xylem and phloem occur in separate patches on alternate radii. The number of xylem and phloem groups vary from two to six. But tetrarch condition (four vascular bundles) is more common. Monocot root generally has more than six vascular bundles (polyarch). Vascular bundles in dicot stems are conjoint, collateral or bicollateral, endarch and open. They are arranged in a ring.
In monocot stems the vascular bundles are conjoint, collateral, endarch and closed. They are scattered in the ground tissue.

59. (b) : In plants during vascularisation, differentiation of procambium occurs followed by the formation of primary phloem and xylem simultaneously.

60. (d) : Endodermis is single layered structure which separates cortex from stele. The cells of endodermis are barrel-shaped without intercellular spaces, living and containing starch. The radial and tangential walls of endodermal cells possess thickenings of lignin, suberin and cutin in the form of strips or bands, which are known as casparian bands or Casparian strips.

61. (a) : *Refer to answer 60.*

62. (a) : In angiosperms, seeds are produced inside the ripened ovary called fruit. However in gymnosperms the seeds are not produced inside a fruit. In angiosperms vascular tissue includes both tracheids and vessels and in gymnosperms the vascular tissue contains only tracheids and not vessels. Tap root is the primary root that develops from the radicle. It forms lateral branches which are further branched to form tertiary roots. These are generally found in dicotyledons. In monocotyledons, primary root is short lived, tap root is absent and adventitious roots are found.

63. (b) : *Refer to answer 60.*

64. (b) : A narrow layer of thin walled cells found between phloem/bark and wood of dicot is vascular cambium. Vascular cambium present inside a vascular bundle is called as intrafascicular cambium or fascicular cambium. The vascular cambium is a meristematic tissue.

65. (c) : In monocot leaf, mesophyll cells are not differentiated into palisade and spongy tissues. But there is well differentiated mesophyll cells in dicot stem. Also in the upper epidermis, there are some large cells found in groups which are called bulliform cells. The venation pattern in monocot is parallel.

66. (b) : Pericycle of root produces lateral roots. Endodermis is followed by pericycle. Usually it is a continuous layer but in some monocots it is interrupted by xylem and phloem. It is the site of origin of lateral roots and cork cambium. The root branches are, therefore described as endogenous in origin.

67. (a) : Monocot leaves possess intercalary meristem. Intercalary meristem are responsible for localised growth. Perhaps they have been separated or detached from the mother meristem *e.g.*, meristem present at the base of leaves in many monocots, in the internode of grasses, at the top of peduncles of *Plantago* and *Taraxacum,*etc.

68. (a) : Pith and cortex do not differentiate in monocot stem. Since numerous vascular bundles lie scattered, the ground tissue system in a monocot stem is distinguishable into hypodermis and ground parenchyma.

69. (c) : Sapwood is the peripheral or outermost region of the secondary xylem and lighter in colour.

70. (a) : The activity of cambium is under the control of many physiological and environmental factors. In temperate regions, the climatic conditions are not uniform throughout the year. In the spring season, cambium is very active and produces a large number of xylary elements having vessels with wider cavities. The wood formed during this season is called spring wood or early wood. In winter, the cambium is less active and forms fewer xylary elements that have narrow vessels and this wood is called autumn wood or late wood. The spring wood is lighter in colour and has a lower density whereas the autumn wood is darker and has a higher density. The two kinds of woods that appear as alternate concentric rings, constitute an annual ring.

71. (b) : Vascular cambium is a type of lateral meristem that produces secondary tissues (xylem and phloem) during secondary growth. It is produced by two types of meristem: intrafascicular cambium (primary meristem occurring as strip in vascular bundles) and interfascicular cambium (secondary meristem which develops from permanent cells of medullary rays which occur at the level of intrafascicular strips). The cells of vascular cambium are of two types : fusiform initials which produce secondary xylem towards outside and secondary phloem towards inner side and ray initials which give rise to vascular rays.

72. (a) : Monocots (*e.g.*, grasses) lack secondary growth, as they lack lateral meristem *viz.* vascular cambium and cork cambium. In case of conifers (*e.g.*, *Pinus*) and cycads (*e.g.*, *Cycas*) vascular tissues are arranged into vascular bundles just like angiosperms, they are open so secondary growth is common.

73. (b) : Cells of vascular cambium divide periclinally both on the outer and inner sides to form secondary permanent tissues, *i.e.,* secondary xylem and secondary phloem.

74. (b) : The phellem or cork consists of dead and compactly arranged rectangular cells that possess suberised cell wall.

75. (b) : Heartwood is the non-functional part of secondary xylem, hence, it does not conduct water and minerals.

76. (c) : Tyloses are balloon-like extensions of parenchyma cells that protrude into the lumen of a neighbouring xylem vessel or tracheid through a pit in the cell wall. Tyloses form most commonly in older woody tissue, possibly in response to injury, they may eventually block the vessels and thus prevent the spread of fungi and other pathogens within the plant. Tyloses may become filled with tannins, gums, pigments, etc., giving heartwood its dark colour, and their walls can remain thin or become lignified.

77. (a) : In a woody dicot stem, phellem (cork) forms the outermost layer followed by phellogen and then secondary cortex (phelloderm). Secondary phloem forms a narrow circle on the outer side of vascular cambium whereas secondary xylem occurs on the inner side of vascular cambium.

78. (d) : Lenticels are lens shaped openings formed in bark due to secondary growth. They permit gaseous exchange in woody trees. They also contribute to transpiration but in minute amounts because the suberised complementary cells present beneath the pore prevent excessive water loss.

79. (a) : Two bands of secondary xylem *i.e.*, autumn wood and spring wood are produced in one year. These two bands make an annual ring. The age of plant can be determined by counting the annual rings. It is called dendrochronology.

80. (c) : In dicot stems, the cells of cambium present between primary xylem and primary phloem is the intrasfascicular cambium. The cells of medullary rays, adjoining these intrafascicular cambium become meristematic and form the interfascicular cambium. Thus, a continuous ring of cambium is formed.

81. (b) : Cork cambium or phellogen is a type of cambium arising within the outer layer of the stems of woody plants, usually as a complete ring surrounding the inner tissues. The cells of the cork cambium divide to produce an outer corky tissue (cork or phellem) and an inner secondary cortex (phelloderm). The common bottle cork produced from *Quercus suber* is a product of phellogen.

82. (c) : In hypodermis or outer cortical cells, a layer becomes meristematic which is known as cork cambium or phellogen. This phellogen also cuts off cells both on its outer side and inner side. The cells cut off on outer side are phellem or cork cells and cells cut off on inner side are phelloderm or secondary cortex. Phellem, phellogen and phelloderm collectively constitute periderm. The function of periderm is protective (because at maturity epidermis ruptures and hence the function is performed by periderm).

83. (c) : In old trees, the greater part of secondary xylem is dark brown due to deposition of organic compounds like tannins, resins, oils, gums, aromatic substances and essential oils in the central or innermost layers of the stem. These substances make it hard, durable and resistant to the attacks of microorganisms and insects. This region comprises dead elements with highly lignified walls and is called heartwood. The heartwood does not conduct water but it gives mechanical support to the stem. The peripheral region of the secondary xylem, is lighter in colour and is known as the sapwood. It is involved in the conduction of water and minerals from root to leaf.

84. (d) : Dermatogen is the region or histogen of single layer of outermost cells formed from the apical meristem. Dermatogen gives rise to epidermis of stem and other aerial parts. Periblem is the middle histogen which forms the cortex of stem and roots. Plerome is the central histogen which forms stele or part of stem and root inner to endodermis. Part of plerome that forms vascular tissues is called procambium. The pericycle layer converts into a secondary meristem called cork cambium or phellogen which divides to form secondary cortex or phelloderm.

85. (a) : Secondary growth is observed in dicots and gymnosperms. It is not observed in pteridophytes and rarely observed in monocots. Secondary growth results in increase in girth or diameter of the stem by formation of secondary tissue by the activity of lateral meristem. So for study of secondary growth, teak (angiosperm) and pine (gymnosperm) are best suited.

86. (d) : In most of the gymnosperms, like conifers and cycads, vessels are absent and the wood is made entirely of tracheids. Such wood is known as nonporous.
In angiosperms, on the other hand, the wood consists of both tracheids and vessels. The wide vessels appear as pores between otherwise small sized tracheary elements. Such a wood is known as porous. In porous wood, if vessels have essentially equal diameters and are uniformly distributed throughout the ring, the wood is known as diffuse porous. It is characteristic of plants growing in tropics.

87. (c) : Extrastelar secondary growth means growth in the cortical region, external to stele.
For extrastelar secondary growth the cork cambium or phellogen develops in the region outside the vascular tissue. This gives rise to cork or phellem and secondary cortex or phelloderm. All the three layers (*i.e*, cork, cork cambium and secondary cortex) together constitute periderm. Fascicular and interfascicular cambuim occurs in the stelar regions.

88. (b) : *Refer to answer 82.*

89. (a) : Heartwood or duramen is the dark coloured wood near the centre of the axis formed after many years of secondary growth of stem. A small outer region, however, remains light coloured. It is known as sap wood or alburnum. The heartwood is formed due to changes in the elements of the secondary xylem. As secondary growth proceeds most of the older elements of secondary xylem lose water and become filled with organic compounds such as oils, gums, resins, tannins, aromatic and colouring materials. The wood becomes dark coloured due to accumulation of these substances and is also termed as duramen. The sap wood is the light coloured region of the secondary xylem. Cells of this region are functionally active. The elements of the secondary xylem added by cambial activity are those of sap wood. But gradually most of these elements get transformed into heart wood. Thus the amount of heart wood increases as the tree grows older. The amount of sap wood, however, remains almost constant.

90. (c) : Periderm is produced by phellogen. The phellogen forms phellem on the outer face and phelloderm on the inner. The three layers *i.e.*, phellem, phellogen and phelloderm jointly constitute the periderm.

91. (a) : Sapwood will decay faster. Sap wood is less durable because it is susceptible to attack by pathogen and insects.

92. (a) : Monocot trees such as palms grow in thickness by primary thickening of meristem situated at the base of the leaf. Plants like *Dracaena* show secondary growth by a special cambium. It develops in the form of strips just outside the vascular region. This cambial strips produce secondary vascular bundles which are amphivasal in *Dracaena*.

93. (b) : Vascular cambium produces secondary xylem and secondary phloem. It is developed from the procambium which is an embryonic tissue, hence it is primary in origin. It is secondary in function because it forms the secondary tissues like secondary xylem, secondary phloem and secondary medullary rays. The cambium is a radially one cell thick zone of meristematic cells.

94. (c) : Ring porous wood carries more water when need is higher. Ring porous wood provides better translocation when requirement of plant is more. Hence, it is very advanced than diffuse porous wood.

95. (a) : *Refer to answer 81.*

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