CHAPTER 15

Plant Growth and Development

15.1 Growth

1. The process of growth is maximum during
(a) log phase (b) lag phase
(c) senescence (d) dormancy.
(NEET 2020)

2. Typical growth curve in plants is
(a) stair-steps shaped
(b) parabolic
(c) sigmoid
(d) linear. *(2015 Cancelled)*

15.3 Development

3. Senescence as an active developmental cellular process in the growth and functioning of a flowering plant, is indicated in
(a) annual plants
(b) floral parts
(c) vessels and tracheid differentiation
(d) leaf abscission. *(2008)*

15.4 Plant Growth Regulators

4. Name the plant growth regulator which upon spraying on sugarcane crop, increases the length of stem, thus increasing the yield of sugarcane crop.
(a) Cytokinin (b) Gibberellin
(c) Ethylene (d) Abscisic acid
(NEET 2020)

5. Which of the following is not an inhibitory substance governing seed dormancy?
(a) Gibberellic acid (b) Abscisic acid
(c) Phenolic acid (d) Para-ascorbic acid
(NEET 2020)

6. It takes very long time for pineapple plants to produce flowers. Which combination of hormones can be applied to artificially induce flowering in pineapple plants throughout the year to increase yield?
(a) Cytokinin and Abscisic acid
(b) Auxin and Ethylene
(c) Gibberellin and Cytokinin
(d) Gibberellin and Abscisic acid *(NEET 2019)*

7. Fruit and leaf drop at early stages can be prevented by the application of
(a) ethylene (b) auxins
(c) gibberellic acid (d) cytokinins.
(NEET 2017)

8. You are given a tissue with its potential for differentiation in an artificial culture. Which of the following pairs of hormones would you add to the medium to secure shoots as well as roots?
(a) IAA and gibberellin
(b) Auxin and cytokinin
(c) Auxin and abscisic acid
(d) Gibberellin and abscisic acid *(NEET-II 2016)*

9. The *Avena* curvature is used for bioassay of
(a) IAA (b) ethylene
(c) ABA (d) GA_3. *(NEET-I 2016)*

10. Auxin can be bioassayed by
(a) potometer
(b) lettuce hypocotyl elongation
(c) *Avena* coleoptile curvature
(d) hydroponics. *(2015)*

11. What causes a green plant exposed to the light, on only one side, to bend towards the source of light as it grows?
(a) Light stimulates plant cells on the lighted side to grow faster.
(b) Auxin accumulates on the shaded side, stimulating greater cell elongation there.
(c) Green plants need light to perform photosynthesis.
(d) Green plants seek light because they are phototropic. *(2015 Cancelled)*

12. Dr. F. Went noted that if coleoptile tips were removed and placed on agar for one hour, the agar would produce a bending when placed on one side of freshly-cut coleoptile stumps. Of what significance is this experiment?

(a) It made possible the isolation and exact identification of auxin.
(b) It is the basis for quantitative determination of small amounts of growth-promoting substances.
(c) It supports the hypothesis that IAA is auxin.
(d) It demonstrated polar movement of auxins. *(2014)*

13. Which one of the following growth regulators is known as 'stress hormone'?
(a) Abscisic acid (b) Ethylene
(c) GA_3 (d) Indole acetic acid
(2014)

14. During seed germination, its stored food is mobilized by
(a) ABA (b) gibberellin
(c) ethylene (d) cytokinin.
(NEET 2013)

15. The pineapple which under natural condition is difficult to blossom has been made to produce fruits throughout the year by application of
(a) NAA, 2, 4-D (b) Phenyl acetic acid
(c) Cytokinin (d) IAA, IBA.
(Karnataka NEET 2013)

16. Through their effects on plant growth regulators, what do the temperature and light control in the plants?
(a) Apical dominance
(b) Flowering
(c) Closure of stomata
(d) Fruit elongation *(Mains 2012)*

17. Which one of the following generally acts as an antagonist to gibberellins?
(a) Zeatin (b) Ethylene
(c) ABA (d) IAA *(Mains 2012)*

18. Phototropic curvature is the result of uneven distribution of
(a) gibberellin (b) phytochrome
(c) cytokinins (d) auxin. *(2010)*

19. One of the commonly used plant growth hormone in tea plantations is
(a) ethylene (b) abscisic acid
(c) zeatin (d) indole-3-acetic acid.
(Mains 2010)

20. Root development is promoted by
(a) abscisic acid (b) auxin
(c) gibberellin (d) ethylene.
(Mains 2010)

21. One of the synthetic auxin is
(a) IAA (b) GA
(c) IBA (d) NAA. *(2009)*

22. Which one of the following acids is a derivative of carotenoids?
(a) Indole-3-acetic acid
(b) Gibberellic acid
(c) Abscisic acid
(d) Indole butyric acid *(2009)*

23. Which one of the following pairs, is not correctly matched?
(a) Gibberellic acid - Leaf fall
(b) Cytokinin - Cell division
(c) IAA - Cell wall elongation
(d) Abscissic acid - Stomatal closure *(2007)*

24. Parthenocarpic tomato fruits can be produced by
(a) treating the plants with phenylmercuric acetate
(b) removing androecium of flowers before pollen grains are released
(c) treating the plants with low concentrations of gibberellic acid and auxins
(d) raising the plants from vernalized seeds. *(2006)*

25. How does pruning help in making the hedge dense?
(a) It releases wound hormones.
(b) It induces the differentiation of new shoots from the rootstock.
(c) It frees axillary buds from apical dominance.
(d) The apical shoot grows faster after pruning.
(2006)

26. Cell elongation in internodal regions of the green plants takes place due to
(a) indole acetic acid (b) cytokinins
(c) gibberellins (d) ethylene. *(2004)*

27. Coconut milk factor is
(a) an auxin (b) a gibberellin
(c) abscisic acid (d) cytokinin. *(2003)*

28. Plants deficient of element zinc, show its effect on the biosynthesis of plant growth hormone
(a) auxin (b) cytokinin
(c) ethylene (d) abscisic acid. *(2003)*

29. Differentiation of shoot is controlled by
(a) high auxin : cytokinin ratio
(b) high cytokinin : auxin ratio
(c) high gibberellin : auxin ration
(d) high gibberellin : cytokinin ratio. *(2003)*

30. Dwarfness can be controlled by treating the plant with
(a) cytokinin (b) gibberellic acid
(c) auxin (d) anti-gibberellin.
(2002, 1992)

31. Which of the following prevents the fall of fruits?
(a) GA_3 (b) NAA
(c) Ethylene (d) Zeatin *(2001)*

32. Hormone responsible for senescence is
(a) ABA (b) auxin
(c) GA (d) cytokinin. *(2001)*

33. Which hormone breaks dormancy of potato tuber?
(a) Gibberellin (b) IAA
(c) ABA (d) Zeatin *(2001)*

34. If the apical bud has been removed then we observe
(a) more lateral branches
(b) more axillary buds
(c) plant growth stops
(d) flowering stops. *(2000)*

35. Which hormone is responsible for fruit ripening?
(a) Ethylene (b) Auxin
(c) Ethyl chloride (d) Cytokinin *(2000)*

36. ABA is involved in
(a) shoot elongation
(b) increased cell division
(c) dormancy of seeds
(d) root elongation. *(1999)*

37. A plant hormone used for inducing morphogenesis in plant tissue culture is
(a) cytokinins (b) ethylene
(c) abscisic acid (d) gibberellins. *(1998)*

38. Which combination of gases is suitable for fruit ripening?
(a) 80% CH_4 and 20% CO_2
(b) 80% CO_2 and 20% O_2
(c) 80% C_2H_4 and 20% CO_2
(d) 80% CO_2 and 20% CH_2 *(1998)*

39. Which one among the following chemicals is used for causing defoliation of forest trees?
(a) Malic hydrazide (b) 2, 4-D
(c) Amo-1618 (d) Phosphon D *(1998)*

40. Gibberellic acid induces flowering
(a) in short day plants under long day conditions
(b) in day-neutral plants under dark conditions
(c) in some gymnospermic plants only
(d) in long day plants under short day conditions. *(1997)*

41. The movement of auxin is largely
(a) centripetal (b) basipetal
(c) acropetal (d) both (a) and (c). *(1994)*

42. If the growing plant is decapitated, then
(a) its growth stops
(b) leaves become yellow and fall down
(c) axillary buds are inactivated
(d) axillary buds are activated. *(1994)*

43. Removal of apical bud results in
(a) formation of new apical bud
(b) elongation of main stem
(c) death of plant
(d) formation of lateral branching. *(1993)*

44. The regulator which retards ageing/senescence of plant parts is
(a) cytokinin (b) auxin
(c) gibberellin (d) abscisic acid. *(1993)*

45. The hormone produced during adverse environmental conditions is
(a) benzyl aminopurine
(b) bichlorophenoxy acetic acid
(c) ethylene
(d) abscisic acid. *(1993)*

46. Klinostat is employed in the study of
(a) osmosis
(b) growth movements
(c) photosynthesis
(d) respiration. *(1993)*

47. Which is produced during water stress that brings stomatal closure?
(a) Ethylene
(b) Abscisic acid
(c) Ferulic acid
(d) Coumarin *(1993)*

48. Bananas can be prevented from over-ripening by
(a) maintaining them at room temperature
(b) refrigeration
(c) dipping in ascorbic acid solution
(d) storing in a freezer. *(1992)*

49. Apical dominance is caused by
(a) abscisic acid in lateral bud
(b) cytokinin in leaf tip
(c) gibberellin in lateral buds
(d) auxin in shoot tip. *(1992)*

50. Cytokinins
(a) promote abscission
(b) influence water movement
(c) help retain chlorophyll
(d) inhibit protoplasmic streaming. *(1992)*

51. Which is employed for artificial ripening of banana fruits?
(a) Auxin (b) Coumarin
(c) Ethylene (d) Cytokinin *(1992)*

52. Abscisic acid causes
(a) stomatal closure (b) stem elongation
(c) leaf expansion (d) root elongation. *(1991)*

53. The hormone responsible for apical dominance is
(a) IAA (b) GA
(c) ABA (d) Florigen. *(1991)*

54. Hormone primarily connected with cell division is
(a) IAA (b) NAA
(c) cytokinin/zeatin (d) gibberellic acid.
(1991, 1988)

55. Highest auxin concentration occurs
(a) in growing tips
(b) in leaves
(c) at base of plant organs
(d) in xylem and phloem. *(1990)*

56. Phytohormones are
(a) chemical regulating flowering
(b) chemical regulating secondary growth
(c) hormones regulating growth from seed to adulthood
(d) regulators synthesised by plants and influencing physiological processes. *(1990)*

57. Abscisic acid controls
(a) cell division
(b) leaf fall and dormancy
(c) shoot elongation
(d) cell elongation and wall formation. *(1990)*

58. Phototropic and geotropic movements are linked to
(a) gibberellins (b) enzymes
(c) auxin (d) cytokinins. *(1990)*

59. Which of the following movement is not related to auxin level?
(a) Bending of shoot towards light
(b) Movement of root towards soil
(c) Nyctinastic leaf movements
(d) Movement of sunflower head tracking the sun
(1990)

60. Leaf fall can be prevented with the help of
(a) abscisic acid (b) auxins
(c) florigen (d) cytokinins. *(1989)*

61. Mowing grass lawn facilitates better maintenance because
(a) wounding stimulates regeneration
(b) removal of apical dominance and stimulation of intercalary meristem
(c) removal of apical dominance
(d) removal of apical dominance and promotion of lateral meristem. *(1989)*

62. Cut or excised leaves remain green for long if induced to root or dipped in
(a) gibberellins (b) cytokinins
(c) auxins (d) ethylene. *(1988)*

63. Gibberellins promote
(a) seed germination (b) seed dormancy
(c) leaf fall (d) root elongation.
(1988)

15.5 Photoperiodism

64. What is the site of perception of photoperiod necessary for induction of flowering in plants?
(a) Leaves (b) Lateral buds
(c) Pulvinus (d) Shoot apex
(NEET 2019)

65. Phytochrome is a
(a) flavoprotein (b) glycoprotein
(c) lipoprotein (d) chromoprotein.
(NEET-II 2016)

66. Study the four statements (A-D) given below and select the two correct ones out of them.
A. Definition of biological species was given by Ernst Mayr.
B. Photoperiod does not affect reproduction in plants.
C. Binomial nomenclature system was given by R.H. Whittaker.
D. In unicellular organisms, reproduction is synonymous with growth.
The two correct statements are
(a) B and C (b) C and D
(c) A and D (d) A and B.
(NEET-II 2016)

67. Photoperiodism was first characterised in
(a) tobacco (b) potato
(c) tomato (d) cotton. *(2010)*

68. Importance of day length in flowering of plants was first shown in
(a) cotton (b) *Petunia*
(c) *Lemna* (d) tobacco. *(2008)*

69. The wavelength of light absorbed by P_r form of phytochrome is
(a) 680 nm (b) 720 nm
(c) 620 nm (d) 640 nm. *(2007)*

70. One set of the plant was grown at 12 hours day and 12 hours night period cycles and it flowered while in the other set night phase was interrupted by flash of light and it did not produce flower. Under which one of the following categories will you place this plant?
(a) Long day (b) Darkness neutral
(c) Day neutral (d) Short day *(2004)*

71. Which pigment absorbs the red and far-red light?
(a) Cytochrome (b) Phytochrome
(c) Carotenoids (d) Chlorophyll *(2002)*

72. Which plant is LDP?
(a) Tobacco (b) *Glycine max*
(c) *Mirabilis jalapa* (d) Spinach *(2001)*

73. Proteinaceous pigment which controls the activities concerned with light is
(a) phytochrome (b) chlorophyll
(c) anthocyanin (d) carotenoids. *(2001)*

74. The response of different organisms to the environmental rhythms of light and darkness is called
(a) vernalization (b) photoperiodism
(c) phototaxis (d) phototropism. *(1998)*

75. Phytochrome becomes active in
(a) red light (b) green light
(c) blue light (d) none of these. *(1998)*

76. A pigment which absorbs red and far-red light is
(a) cytochrome (b) xanthophyll
(c) phytochrome (d) carotene. *(1997)*

77. What will be the effect on phytochrome in a plant subjected to continuous red light?
(a) Phytochrome synthesis will increase
(b) Level of phytochrome will decrease
(c) Phytochrome will be destroyed
(d) First (b) then (a) *(1997)*

78. If a tree flowers thrice in a year (Oct, Jan and July) in Northern India, it is said to be
(a) photo and thermo-insensitive
(b) photo and thermo-sensitive
(c) photosensitive but thermo-insensitive
(d) thermosensitive but photo-insensitive. *(1997)*

79. In short day plants, flowering is induced by
(a) photoperiod less than 12 hours
(b) photoperiod below a critical length and uninterrupted long night
(c) long night
(d) short photoperiod and interrupted long night. *(1992)*

80. A chemical believed to be involved in flowering is
(a) gibberellin (b) kinetin
(c) florigen (d) IBA. *(1991)*

81. Which one increases in the absence of light?
(a) Uptake of minerals
(b) Uptake of water
(c) Elongation of internodes
(d) Ascent of sap *(1989)*

82. Phytochrome is involved in
(a) phototropism (b) photorespiration
(c) photoperiodism (d) geotropism. *(1988)*

15.6 Vernalisation

83. Vernalisation stimulates flowering in
(a) zamikand (b) turmeric
(c) carrot (d) ginger. *(Mains 2012)*

84. Treatment of seeds at low temperature under moist conditions to break its dormancy is called
(a) stratification (b) scarification
(c) vernalization (d) chelation. *(2006)*

85. Flowering dependent on cold treatment is
(a) cryotherapy (b) cryogenics
(c) cryoscopy (d) vernalisation. *(1992)*

86. Which of the following hormones can replace vernalisation?
(a) Auxin (b) Cytokinin
(c) Gibberellins (d) Ethylene *(1989)*

15.7 Seed Dormancy

87. An enzyme that can stimulate germination of barley seeds is
(a) invertase (b) α-amylase
(c) lipase (d) protease. *(2006)*

88. Seed dormancy is due to the
(a) ethylene (b) abscisic acid
(c) IAA (d) starch. *(2002)*

89. By which action a seed coat becomes permeable to water?
(a) Scarification (b) Stratification
(c) Vernalization (d) All of these *(2000)*

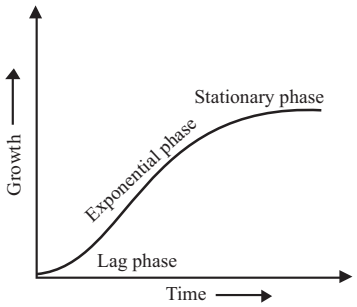
ANSWER KEY

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

Hints & Explanations

1. (a) : In most systems, the initial growth is slow *i.e.*, lag phase, and it increases rapidly thereafter – at an exponential rate *i.e.*, log or exponential phase.

2. (c) : Geometric growth cannot be sustained for long in natural condition. Limited nutrient availability slows down the growth. It leads to a stationary phase or even a decline. Plotting the growth against time, gives a typical sigmoid or S-curve. Sigmoid curve of growth is typical of most organisms in their natural environment including plants. An idealised sigmoid growth curve is shown below:



3. (c) : Senescence is the process of ageing which is caused by cellular breakdown, increased metabolic failure, increased entropy, etc. It occurs in the period between reproductive maturity and death. Cell division followed by cell enlargement and differentiation, precede the actual separation. Senescence of cell in distal region lead to lignification of cell wall. Tylose formation in tracheary element and callose deposition in sieve elements which occur in advance of abscission (*i.e.* senescence) finally, lead to actual separation. Thus, vessels and tracheid (trachery elements) differentiation indicates senescence.

4. (b) : Spraying sugarcane crop with gibberellins increases the length of the stem and increasing the yield by as much as 20 tonnes per acre.

5. (a) : Gibberellic acid involved in growth promoting activities, such as cell division, cell enlargement, pattern formation, tropic growth, flowering, fruiting and seed formation and is called plant growth promoters. It breaks seed dormancy which is antagonistic to abscisic acid.

6. (b) : Synthetic auxins like NAA and 2, 4-D are often employed for inducing flowering in pineapple. Ethylene also stimulates flowering in pineapple and related plants. Hence, both auxin and ethylene can be applied artificially to induce flowering in pineapple plants throughout the year to increase yield.

7. (b) : In low concentrations, auxins such as 2, 4-D(2,4- Dichlorophenoxy acetic acid) is useful in preventing pre-harvest fruit drop and leaf drop.

8. (b) : Cytokinin and auxin are two plant hormones that are supplied to the tissue culture medium in definite proportions. They bring about cell division and differentiation of callus. A low auxin to cytokinin ratio promotes shoot formation whereas a high auxin to cytokinin ratio promotes rooting of callus.

9. (a) : *Avena* curvature test is a test based on the experiments of Went (1928) which can measure auxin upto 300 mg/litre. Indole 3-acetic acid (IAA) is a universal natural auxin and *Avena* curvature test serves as an accurate bioassay for this plant hormone.

10. (c) : Auxin bioassay is a quantitative test as it measures concentration of auxin to produce the effect and the amount of the effect. *Avena* curvature is based upon experiments of Went (1928). 10° curvature is produced by auxin concentration of 150 mg/litre at 25°C and 90% relative humidity. The test can measure auxin upto 300 mg/litre. Auxin from a shoot tip or any other plant organ is allowed to diffuse in a standard size agar block (generally $2 \times 2 \times 1$ mm). Auxin can also be dissolved directly in agar. 15– 30 mm long oat coleoptile grown in dark is held vertically over water. 1 mm tip of coleoptile is removed without injuring the primary leaf. After 3 hours a second decapitation is carried out for a distance of 4 mm. Primary leaf is now pulled loose and agar block supported against it at the tip of decapitated coleoptile. After 90–110 minutes, the coleoptile is found to have bent. The curvature is measured. It can also be photographed and the curvature known from shadow graph.

11. (b) : Auxins induce cell elongation. In a differentially illuminated plant, they accumulate in the shaded part, causing elongation of the cells in the shaded part. This unequal elongation on two sides causes the plant to curve or bend towards the light source, *i.e.*, phototropic curvature.

12. (a)

13. (a) : Abscisic acid prepares plants to cope with stress conditions like drought, etc. by inducing stomatal closure and other reactions. Hence, it is named stress hormone.

14. (b) : Gibberellins are plant growth substances chemically related to terpenes and occurring naturally in plants and fungi. They promote elongation of stems, *e.g.*, bolting in cabbage plants and the mobilization of food reserves in germinating seeds. They are influential in inducing flowering and fruit development.

15. (a) : NAA (α-Naphthalene acetic acid) and 2,4 D (2, 4 dichlorophenoxy acetic acid) are synthetic auxins. In pineapple, application of auxin promotes flowering

and thus pineapple which under natural conditions is difficult to blossom has been made to produce fruits throughout the year by application of synthetic auxins such as NAA and 2, 4, D.

16. (b) : Light and temperature may affect flowering in plants in various ways. The effect of photoperiods or daily duration of light hours (and dark periods) on flowering is called photoperiodism. For example, in short day plants flowering occurs when day length is below critical period, *e.g.*, dahlia, rice, etc. In long day plants, flowering occurs when day length is above critical period, *e.g.*, spinach, lettuce, etc. In short-long day plants, short photoperiod is required for floral initiation and long photoperiod is required for blossoming and *vice-versa* for long-short day plants. Hence, flowering in certain plants not only depends on a combination of light and dark exposures but also on their relative durations. Similarly, there are plants for which flowering is either quantitatively or qualitatively dependent on exposure to low temperature. This phenomenon is termed as vernalisation. It prevents precocious reproductive development late in the growing season and enables the plant to have sufficient time to reach maturity. Thus, many plants require a warm-cold-warm sequence to complete their annual cycle.

17. (c) : Abscisic acid or ABA is an antagonist to gibberellins. The given table tabulated the antagonistic effect of ABA and gibberellic acid :

S. No.	Abscisic acid	Gibberellic acid
(i)	It inhibits growth.	It promotes growth.
(ii)	It promotes the dormancy of seeds, buds and tubers.	It overcomes the natural dormancy of seeds, tubers, etc.
(iii)	It inhibits the synthesis of RNA and proteins.	It promotes the synthesis of RNA and proteins.
(iv)	It causes abscission of flowers and fruits.	It promotes development of fruits.
(v)	It promotes leaf senescence.	It prevents leaf senescence.
(vi)	It promotes stomatal closure.	It promotes stomatal opening.
(vii)	It prevents amylase activity.	It promotes amylase activity during seed germination.

18. (d) : Phototropic curvature is the result of uneven distribution of auxin. Charles Darwin and his son Francis Darwin observed that the coleoptiles of canary grass responded to unilateral illmination by growing towards the light source (phototropism). After a series of experiments, it was concluded that the tip of coleoptile contains auxin that caused the bending of the entire coleoptile in relation to the direction of light.

19. (d) : Indole-3-acetic acid (auxin) is a phytohormone which is generally produced by the growing apices of the stems and roots, from where they migrate to the regions of their action. It is observed that the growing apical bud inhibits the growth of the lateral (axillary) bud (apical dominance). Since apical meristem is the site of auxin synthesis, it is the physiological effect of the auxin which results in the phenomenon of apical dominance. When shoot tip is removed it usually results in the growth of lateral buds. This phenomenon is widely applied in tea plantations and hedge-making because as in tea plantation and industries, the apical bud is plucked for tea processing which results in more lateral buds thus enhancing plantation and further industrial purposes.

20. (d) : Ethylene promotes root growth and root hair formation. In low concentration, ethylene is used for initiation of roots and also of lateral roots.

21. (c, d) : Many auxins have been synthesized which have similar properties with natural auxin and some examples of synthetic auxins are indole-3-butyric acid (IBA), naphthalene acetic acid (NAA), 2,4-dichloro-phenoxy acetic acid (2,4-D), 2,4,5-trichloro-phenoxyacetic acid (2,4,5 -T).

22. (c) : Biosynthesis of abscisic acid (ABA) in most plants occur indirectly by degradation of certain carotenoids present in chloroplasts or other plastids. The biosynthetic pathway follow mevalonic acid pathway for their synthesis. The sites of synthesis are fruits, tissues, leaves, roots and seeds.

23. (a) : Gibberellic acid is a simple weakly acidic plant growth hormone which promotes cell elongation of both leaves and stems in general and internodal length of genetically dwarf plants in particular. It is in general a growth promoting hormone and does not inhibit growth. So, leaf abscission is not associated with gibberellic acid but with abscisic acid.

24. (c) : Development of fruits without fertilization is called parthenocarpy and such fruits are called parthenocarpic fruits. Parthenocarpic fruits are seedless. A flower is emasculated and auxins are applied to the stigma of the flower, it forms a parthenocarpic fruit. For parthenocarpy induction by auxins, these should be applied after anthesis (first opening of flower) and by gibberellins, these should be applied earlier, *i.e.*, at anthesis.

25. (c) : Prunning is the process of cutting shoot tips to promote lateral growth of branches. Removal of shoot tips involves removal of apical buds. In the shoot tips auxins are produced. Auxins are growth promoting phytohormones. They cause apical dominance by

promoting the growth of apical buds and suppressing the growth of axillary buds. So when the auxins produced in the shoot tips are removed by decapitation it results in lateral growth and plants thus show bushy appearance. This is because of a relatively high concentration of auxin in the apical bud than in the lateral buds.

26. (c) : Gibberellins play a role in the elongation of internodes in 'rosette' plants. Before reproductive stage there is too much elongation of internodes but there is less leaf formation. An elongated internode without leaves in called a "bolt" like structure and the process is called "bolting". Flowering takes place after bolting. Gibberellins induce cell division and cell elongation, when bolting takes place.

27. (d) : Many experiments were done to sustain the proliferation of normal stem tissues in culture. The growth of culture was most dramatic when the liquid endosperm of coconut, also known as coconut milk, was added to the culture medium. This finding indicated that coconut milk contains a substance or substances that stimulate mature cells to enter and remain in the cell division cycle. Eventually coconut milk was shown to contain the cytokinin zeatin, but this finding was not obtained until several years after the discovery of the cytokinins. The first cytokinin to be discovered was the synthetic analog kinetin.

28. (a) : Zinc is available to the plants for absorption in the divalent form. It occurs in the form of minerals as hornblende, magnetite, biotite, etc., from where it is released by weathering. It is involved in the synthesis of Indole-acetic acid in plants. It is an activator in the enzyme tryptophan synthetase. Tryptophan is the precursor of Indole-acetic acid.

29. (b) : The major physiological function of cytokinin is to enhance cell division. In tissue culture the undifferentiated mass of cells formed in the culture tubes is called callus. The callus may remain in the undifferentiated condition or differentiation may take place in this. If it is differentiated, then root and shoot may be formed.

Skoog and Miller had reported that cytokinins induce shoot formation and auxins induce root formation.

30. (b) : Gibberellins helps in the reversal of dwarfism in many genetically dwarf plants. External supply of gibberellic acid causes rapid elongation, *e.g.*, rosette plants of sugarbeet when treated with GA_3 undergo marked longitudinal growth of axis.

31. (b) : α-Naphthalene acetic acid (NAA) is a synthetic or exogenous auxin. It prevents the formation of abscission layer, which is a layer of dead cells in the petiole and pedicel that causes fall of leaf or fruit. NAA prevents formation of this layer and so it prevents fall of leaf or fruit.

32. (a) : Abscisic acid is a growth inhibiting phytohormone. It induces senescence in leaves by promoting the degradation of chlorophyll and proteins.

33. (a): Gibberellin is the hormone that breaks seed/bud dormancy. The tubers of potato reproduce vegetatively to give rise to new plants. So the dormancy of these tubers can be overcome by applying gibberellins.

34. (a) : Apical dominance is the phenomenon by which presence of apical bud does not allow the nearby lateral buds to grow. When apical bud is removed, the lateral buds sprout.

35. (a) : Ethylene is largely a growth inhibiting phytohormone but is also involved in some growth promotion activities. It has been established that ethylene is a fruit ripening hormone. Ethylene stimulates all the biochemical changes which take place at the time of fruit ripening.

36. (c)

37. (a) : Cytokinins are growth promoting phytohomones. Cytokinin plays an important role in organ formation (morphogenesis) with auxin. Different auxin/cytokinin ratio decides the development of root/shoot ratio. The major physiological function of cytokinin is to enhance cell division. If cytokinin to auxin ratio is low, then root formation takes place but if the ratio of cytokinin to auxin is high, then, there is formation of meristematic cells in the callus.

38. (c) : In most of the plants, there is a sharp rise in respiration rate near the end of the development of fruit, which sets in progress those changes, which are involved in ripening of fruit. The ripening on demand can be induced in these fruits by exposing them to normal air containing about 1 ppm of ethylene. Suitable combination of gases in atmosphere for fruit ripening is 80% ethylene (C_2H_4) and 20% CO_2.

39. (b) : Defoliation is the process of leaves falling off a plant naturally or by inducing using strong chemicals. 2, 4–D (2, 4 dichloro phenoxy acetic acid) is an auxin hormone. It over stimulates the growth activities of the root cells due to which roots get destroyed and thus plants finally destroyed. 2, 4-D is used as defoliant for broad leaves dicots.

40. (d) : Gibberellins are growth promoting phytohormones. Some plant species flower only if the light period exceeds a critical length and others flower only if this period is shorter than some critical length. Gibberellins promote flowering in long-day plant during non-inductive periods.

41. (b) : Auxin is a growth promoting phytohormone. It moves mainly from the apical to the basal end (basipetally). This type of unidirectional transport is termed polar transport. Auxin is the only plant growth

hormone known to be transported polarly. Recently it has been recognized that a significant amount of auxin transport also occur acropetally (from basal end to the apical end) in the root.

42. (d) : Decapitating a growing plant means removing shoot apex of the plant. Auxin, a growth promoting phytohormone present in apex inhibits the growth of axillary buds so that only the apex continues to grow. When the apex containing auxin is removed or decapitation is done, then axillary or lateral buds show their growth, this is because the apical dominance is removed. This practice of removal of apical dominance is applied in tea gardens, hedges, rose gardens, etc.

43. (d) : *Refer to answer 42.*

44. (a) : Richmond and Lang, 1967 observed that degradation of protein and chlorophyll was delayed in the detached leaves, if there was cytokinin in the medium. The senescence in the detached leaves was controlled by cytokinin first by keeping the stomata open thus allowing more CO_2 to enter. This suppresses the action of ethylene which promotes senescence.

45. (d) : Abscisic acid is a hormone which is produced during adverse environmental conditions. It also causes the closure of stomata under conditions of water stress and also under high concentration of CO_2 in the guard cells. ABA plays an important role in plants during water stress and drought conditions. The concentration of ABA increases in the leaves of plants facing such stresses, hence it is called as a stress hormone.

46. (b) : Klinostat is used to study growth movements. Klinostat comprises a disc with pot which are rotated by an axial rod with the help of a motor. Auxin get uniformly distributed on all sides and hence the stem grows horizontally forward.

47. (b) : Abscisic acid is produced during water stress that brings stomatal closure. Abscisic acid is a stress hormone and it is produced during water scarcity, when the transpiration rate exceeds absorption, the plant faces water stress condition. As a result, incipient wilting occurs. Under water stress condition ABA increases which induces stomatal closure.

48. (c) : In artificial ripening of banana, uncontrolled application of ethylene gas may cause over ripening of banana. It can be prevented from over-ripening by dipping in ascorbic acid solution.

49. (d) **50. (c)**

51. (c) : Ethylene is a hormone which is used for ripening of fruit. In case of unripe banana, it can be made to ripe before proper time if they are kept in ethylene atmosphere. Uncontrolled application of this gas may spoil the fruits. Ethylene is produced in mature but unripe fruits and then it initiates a chain of reactions that finally lead to ripening.

52. (a) : Abscisic acid is a hormone produced during adverse environmental condition. It also causes the closure of stomata under conditions of water stress and also under high concentration of CO_2 in the guard cells. Abscisic acid inhibits the K^+ uptake by guard cells and promotes the leakage of malic acid. It results in reduction of osmotically active solutes so that the guard cells become flaccid and stomata get closed.

53. (a)

54. (c) : Cytokinin has a very specific effect on cell division (cytokinesis), hence the name cytokinin. They contain kinetin and related compound generally called kinins. Chemically, cytokinins are degradation product of adenine, ATP, NAD and NADP. Cytokinins are essential for cytokinesis though chromosome doubling can occur in their absence. Cytokinins bring about division even in permanent cells.

55. (a) : Auxins are well known to promote elongation of stem and coleoptile. However when exogenous auxin is given to intact plants this is not observed because the required amount of auxin is already present in plants. When the apex of shoot is removed, then the exogenous application of auxin promotes growth, this clearly indicates that growing apex, having meristematic cells, is the site where endogenous auxins are present in sufficient amount, once the apex is removed the source of auxin is also removed.

56. (d) : Growth hormones or phytohormones are defined as organic substances which are synthesized in minute quantities in one part of the plant body and transported to another part where they influence specific physiological processes. Phytohormones are chemical substances which are synthesized by plants and are naturally occurring.

57. (b) : Before a leaf fall, a special zone of cells is formed at the base of the pedicel or petiole. This zone is called abscission zone. It is delimited by a protection layer on the stem side and a separation layer on the organ side. The leaf is ultimately separated and phenomenon is called abscission. ABA is also a growth inhibitor. It regulates the dormancy of seeds and buds perhaps by inhibiting the growth process. The ABA level decreases in the whole seed as their dormancy is broken.

58. (c) : Auxin regulates some of the important plant growth movements like photoropism and geotropism. Phototropism means growth of plants in response to light and geotropism means growth of plants towards gravity.

59. (c) : Nyctinastic leaf movement is not related to auxin level. It is a movement of leaves of many species from nearly horizontal leaves during the day and nearly vertical at night. This movement is controlled by biological clock, while the bending of shoot towards

light, movement of root towards soil and movement of sunflower head tracking the sun are the conditions related to auxins.

60. (d)

61. (b) : Mowing grass lawn facilitates better maintenance because of removal of apical dominance and stimulation of intercalary meristem.

62. (b) : Cytokinins are plant growth hormones which are basic in nature. Cytokinins induce formation of new leaves, chloroplasts in leaves, which in turn keeps the leaves green for a longer duration of time. Cytokinins applied to marketed vegetables can keep them fresh for several days. Shelf life of cut shoots and flowers is prolonged by employing the hormones.

63. (a) : Gibberellins promote seed germination. Gibberellins are weakly acidic growth hormones having ring structure and cause cell elongation of intact plants in general and increased internodal length of genetically dwarfed plants. Gibberellins are synthesized in the apical shoot buds, root tips and developing seeds. During seed germination, especially of cereals gibberellin stimulates the production of some messenger RNAs and then hydrolytic enzymes like amylases, lipases, proteases. The enzymes solubilize the reserve food of the seed.

64. (a) : Shoot apices modify themselves into flower apices prior to flowering, but they themselves cannot perceive photoperiods. Leaves are the site of perception of light/dark photoperiods. It has been hypothesised that leaves contain a hormonal substance responsible for flowering, which migrates from leaves to shoot apices for inducing flowering only when plants are exposed to necessary inductive photoperiods.

65. (d) : Phytochrome is a chromoprotein *i.e.*, plant pigment that can detect the presence or absence of light and is involved in regulating many processes that are linked to day length (photoperiod), such as seed germination and initiation of flowering. It consists of a light detecting portion, called a chromophore, linked to a small protein and exists in two inter-convertible forms with different physical properties.

66. (c) : Photoperiod affects flowering and reproduction in plants. Binomial nomenclature system was given by Carolus Linnaeus.

67. (a) : Photoperiodism is the response to duration and timings of light and dark period. It was first studied by W.W. Garner and H.A. Allard (1920) in tobacco. They observed that Maryland Mammoth variety of tobacco could be made to flower in summer by reducing the light hours with artificial darkening.

68. (d) : The effect of photoperiods or daily duration of light hours (and dark periods) on the growth and development of plants, especially flowering, is called photoperiodism. *Also refer to answer 67.*

69. (a) : Phytochrome is the photoreceptor pigment that controls flowering. It has two forms : P_r and P_{fr}. P_r is bluish phytochrome and it absorbs light at 660 to 680 nm of wavelength. P_{fr} is (far red) yellowish green phytochrome and absorbs light at 730 nm of wavelength.

70. (d) : Plants require a day length or light period for flowering, this light period is called photoperiod. Short day plants (SDP's) flower in photoperiods less than critical day length, *e.g.*, *Nicotiana tabacum*, *Glycine max* (Soybean) and *Xanthium strumarium*. Further these plants require long uninterrupted dark period and hence are called long night plants. Long day plants (LDP's) flower in photoperiod more than critical day length, *e.g.*, *Hyocyamus niger* (Henbane), radish, *Beta*, spinach, *Plantago*, etc. Day neutral plants flower in any photoperiod, *e.g.*, tomato, maize, cucumber, etc.

71. (b) : Phytochrome has a light absorbing or light detecting portion (the chromophore) attached to small protein of about 1,24,000 daltons. Phytochrome occurs in 2 forms, *i.e.*, P_R and P_{FR} (*i.e.*, red light and far red light absorbing forms) and these 2 forms are interconvertible. Cytochromes are electron transferring proteins. They contain iron porphyrin or copper porphyrin as prosthetic groups. Chlorophyll is the fundamental green pigment of photosynthesis. It is localised in the chloroplasts. Carotenoids are lipid compounds and they are yellow, orange, purple, etc. in colour. These are found in higher plants red algae, green algae, fungi and photosynthetic bacteria.

72. (d) : *Refer to answer 70.*

73. (a) : Phytochrome is a plant pigment that can detect the presence or absence of light and is involved in regulating many processes that are linked to day length (photoperiod), such as seed germination and initiation of flowering. It consists of a light-detecting portion, called a chromophore, linked to a small protein and exists in two interconvertible forms with different physical properties, particularly in the ability to bind to membranes.

74. (b) : Photoperiodism is the response of plants to relative length of light and darkness.

75. (a) : Phytochromes are photoreceptors present in plants which are used to detect light. They are sensitive to light in red and far-red region of visible spectrum. Phytochrome occurs in 2 forms, *i.e.*, P_r and P_{fr} (*i.e.*, red light and far red light absorbing forms) and these 2 forms are interconvertible.

$$P_r \underset{\text{Far red light}}{\overset{\text{Red light}}{\rightleftharpoons}} P_{fr}$$

P_r is activated by red light and P_{fr} is activated by far-red light. So, Phytochrome becomes active in red light.
It is involved in the perception of photoperiodic stimuli controlling flowering and other morpho-genetic phenomenon in plants.

76. (c) : *Refer to answer 75.*

77. (d) : When continous red light is given the level of P_r decreases as most of it is converted to P_{fr} form. When the concentration of P_r reaches below a critical value, it starts synthesis of more phytochromes in the P_r form so that there is an equilibrium between synthesis and destruction of P_r form.

78. (a) : In Northern India, during October, January and July variation in light intensity, duration and temperature is observed. Since tree can flower in these months in a year, it is said to be photo and thermo-insensitive.

79. (b) : In short day plant, no flowering takes place if the dark period is less than the critical day length. The flowering is inhibited if weak intensity of light is given during the dark period. If the dark period is interrupted mid way by even a single flash of light, no flowering takes place. If this flash is given in the beginning or near the end of the dark phase, they produce flowers.

80. (c) : Chailakhyan in 1937 gave the view that flower hormone namely florigen is synthesized in the leaves under favourable photoperiodic conditions. This hormone is transmitted to the growing point where the flowering occurs.

81. (c) : Stem elongation takes place in the absence of light due to etiolation. But uptake of minerals, uptake of water and ascent of sap all this processes are related to photosynthesis which takes place only in the presence of light.

82. (c) : *Refer to answer 69.*

83. (c) : Carrot is a biennial plant that requires stimulus of low temperature for flowering. It remains vegetative during the warm season and bears flowers and fruits only during winter. It can be made to flower in one growing season by providing low temperature treatment to young plants or seedlings which is referred to as vernalization. Hence, vernalization stimulates flowering in carrot.

84. (c) : Vernalization is the method of promoting flowering by exposing young plants to cold treatment, *e.g.*, winter varieties of wheat, barley, oats and rye are given artificial cold treatment and planted in spring in areas of very harsh winters such as Soviet Union to promote flowering in them. In most cereals optimum temperature for vernalization is 4°C. Receptive organ to chilling is the apical meristem. Chelation is the process by which certain micronutrients are treated to keep them readily available to a plant once they are introduced into the soil. Stratification is a process by which seeds are pretreated to simulated winter conditions so that germination may occur. The degradation of the seed coat is called scarification. This process permits water to pass through the sead coat so that embryo can begin metabolism.

85. (d) : In several plants, particularly biennials and perennials, light does not seem to be the only factor controlling the process of flowering. Temperature, particularly the low temperature treatment induce flowering. Vernalisation means ability of low temperature to convert winter cereal into spring cereal as a result of satisfaction of their low temperature requirement.

86. (c) : Gibberellin is a hormone that replaces vernalisation.

87. (b) : The process by which the dormant embryo of seed resumes active growth and forms a seedling is known as germination. The initial step in germination process is the uptake of water and rehydration of the seed tissues by the process of imbibition. The first visible sign of germination is the emergence of the radicle from the seed. But this event is preceded by a series of biochemical reactions. Imbibition of water causes the embryo within seed to produce α- and β-amylases. These enzymes hydrolyze the starch stored in endosperm into glucose which is necessary for use both as a respiratory substrate and as a source of carbon skeletons of the molecules needed for growth.

88. (b) : Viable seeds of some plants are unable to germinate even after getting all the necessary conditions. This inability of viable seeds to germinate even under favourable conditions, is called dormancy of seeds. This is considered to be due to some barriers or blocks inside the seeds. Some common causes of seed dormancy are :

(i) Mechanically hard seed coat, which does not allow proper growth of embryo inside it, *e.g., Brassica campestris.*

(ii) Presence of impermeable (impervious) seed coat to H_2O, *e.g.* many seeds of legumes.

(iii) Presence of impermeable seed coat to oxygen, *e.g. Xanthium* (cocklebur).

(iv) Presence of germination inhibitors like ABA (abscisic acid) and phenolics, etc., in seed coat or fruit pulp, *e.g.*, in tomoto, inhibitor is present in fruit pulp.

Seed coats may contain relatively high concentrations of growth inhibitors that can suppress germination of the embryo. Abscisic acid (ABA) is a common germination inhibitor present in the seed coats. Repeated washing and heavy rainfall removes such substances from the seed coat.

89. (a) : Scarification means the application of those methods by which the hard seed coat is ruptured or softened so that it becomes permeable to water, gases and the embryo can expand. There are two methods of scarification as mechanical scarification and chemical scarification. This helps in overcoming seed dormancy.

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