Plant Growth and Development

OBJECTIVE TYPE QUESTIONS

Multiple Choice Questions (MCQs)

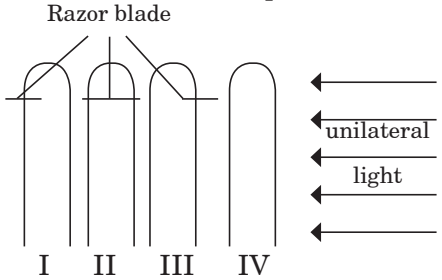
1. Differentiation of shoot is controlled by
(a) high gibberellin : cytokinin ratio
(b) high auxin : cytokinin ratio
(c) high cytokinin : auxin ratio
(d) high gibberellin : auxin ratio.

2. Match column I with column II and select the correct option.

	Column I (Discovery)		**Column II (Name of scientists)**
A.	Foolish seedling disease of rice	I.	R. Gane
B.	Crystallised the kinetin	II.	F.W. Went
C.	Release of ethylene gas	III.	Skoog and Miller
D.	Bioassay of auxin	IV.	E. Kurosawa

(a) A — III, B — IV, C – I, D – II
(b) A — IV, B — III, C – II, D – I
(c) A — IV, B — III, C – I, D – II
(d) A — IV, B — I, C – III, D – II

3. The following diagram shows four coleoptiles set up at the start of an experiment.



Which two coleoptiles will bend towards the light source?
(a) I and II (b) I and IV
(c) II and III (d) III and IV

4. Which one of the following statements regarding auxin is correct?
(a) IAA and IBA are natural but NAA, 2, 4-D and 2, 4, 5-T are synthetic auxins.
(b) IAA and NAA are natural but IBA, 2, 4, 5-T and 2, 4-D are synthetic auxin.
(c) NAA and 2, 4, 5-T are natural but IAA, IBA and 2, 4-D are synthetic auxins.
(d) IAA, NAA, IBA, 2, 4-D and 2, 4, 5-T are synthetic auxins.

5. Read the given statements and select the correct option.
Statement 1 : Cytokinins are anti senescent.
Statement 2 : Effect of cytokinins is antagonists to ethylene.
(a) Both statement 1 and statement 2 are true and statement 2 is the correct explanation of statement 1.
(b) Both statement 1 and statement 2 are true but statement 2 is not the correct explanation of statement 1.
(c) Statement 1 is true and statement 2 is false.
(d) Both statement 1 and statement 2 are false.

6. Which one is the test for gibberellin?
(a) Bolting in Cabbage
(b) Morphogenesis in tobacco callus
(c) Rapid division in carrot cells
(d) None of these

7. Bud dormancy is induced by
(a) IAA (b) GA
(c) ABA (d) ethylene.

8. The hormone which promotes rapid internode or petiole elongation in deep water rice plants, also
(a) initiates germination in peanut seeds and sprouting of potato tubers
(b) breaks seed and bud dormancy
(c) inhibits seed germination
(d) both (a) and (b).

9. During mid-1960s, three independent researchers reported the purification and chemical characterisation of three different kinds of inhibitors; inhibitor—B, abscission II and dormin. Later all the three were proved to be chemically identical. It was named
(a) indole acetic acid (b) indole butyric acid
(c) naphthalene acetic acid
(d) abscisic acid.

10. Which one of the PGRs would you use if you are asked to
A. Overcoming senescence
B. 'Bolt' a rosette plant
C. Induce immediate stomatal closure in leaves
(a) A—cytokinin, B—GA, C—ABA
(b) A— ABA, B—GA, C—auxin
(c) A—auxin, B—ethylene, C—GA
(d) A—cytokinin, B—ethylene, C—ABA

11. What would be expected to happen if you forget to add cytokinin to the culture medium?
(a) There will be no differentiation of root.
(b) There will be no differentiation of shoot.
(c) A callus will not be produced.
(d) Nothing would happen.

12. Growth substance that stimulates nodule formation in leguminous plants is
(a) NAA (b) IAA
(c) IBA (d) ABA.

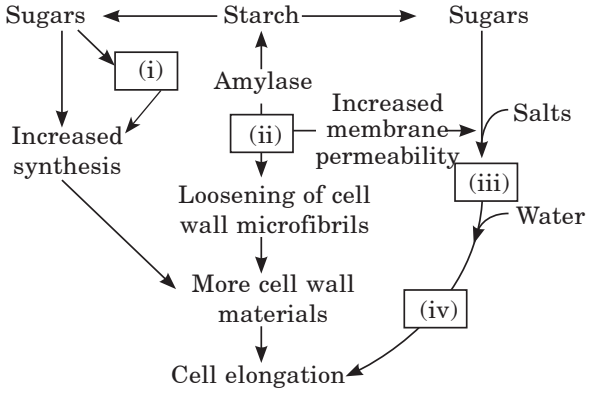
13. Phytohormone A causes apical dominance while phytohormone B overcomes the same. Select the option that correctly identifies A and B.

	A	**B**
(a)	Auxin	Cytokinin
(b)	Cytokinin	Auxin
(c)	Gibberellin	Cytokinin
(d)	Auxin	Gibberellin

14. Removal of auxin source demonstrates that leaf abscission is _____by auxin, and apical dominance is _____by auxin.
(a) promoted, promoted
(b) inhibited, inhibited
(c) promoted, inhibited
(d) inhibited, promoted

15. Which of the following is incorrect?
(a) ABA induce parthenocarpic development in rose.
(b) Ethylene has musculinising effects in plants.
(c) Human urine is also natural source of auxin.
(d) Gibberellin promotes growth of intact stems.

16. Refer to the given flowchart regarding action of IAA in cell elongation.



	(i)	**(ii)**	**(iii)**	**(iv)**
(a)	Increased respiration	IAA	Greater osmotic pressure	Endosmosis
(b)	Decreased respiration	NAA	Lower osmotic pressure	Exosmosis
(c)	Increased respiration	IAA	Lower osmotic pressure	Exosmosis
(d)	Decreased respiration	IAA	Lower osmotic pressure	Endosmosis

17. Refer the functions of the growth hormones given below.
I. Cell division
II. Cell enlargement
III. Promotes seed dormancy
IV. Promotes stomatal closure
V. Flowering
VI. Stoppage of cambium activity
Identify the functions of growth promoters from the above list.
(a) I and IV only (b) I, II and III only
(c) I, II and V only (d) IV and VI only

18. Which one of the following phytohormones is produced under water deficient condition and plays an important role in the tolerance response of plants to drought?
(a) Abscisic acid (b) Cytokinin
(c) Ethylene (d) Gibberellin

19. Artificial application of auxins like IAA, IBA and NAA to unpollinated pistils can form
(a) fruits with much flesh
(b) larger fruits
(c) sweet fruits
(d) seedless fruits.

20. Which of the given statements is not true according to Cholodny-Went model?
(a) Acceleration of growth on shaded side accompanies retardation of growth on the irradiated side.
(b) Illumination from one side causes transport of auxin towards the shaded side.
(c) Auxin differential accounts for the growth differential observed in plants.
(d) Auxin movement is polar, being basipetal in both stem and root.

21. Which of the following are not the uses of ABA?
(a) Stoppage of cambial activity
(b) Antitranspirant
(c) Apical dominance
(d) Dormancy

22. To get a carpet like grass, lawns are mowed regularly, this is done to
(a) remove the shoot apical meristem
(b) remove the axillary buds
(c) accelerate the growth of terminal bud
(d) both (b) and (c).

23. Which of the following hormones induces early transition from juvenile to adult phases in conifers?
(a) Cytokinins (b) GA
(c) ABA (d) IAA

24. Ethylene is not directly applied in the field as a gas due to its high diffusion rate. Which compound is used to overcome this limitation?
(a) Ethephon (b) Agent orange
(c) Benzaldehyde (d) 2,4,5-T

25. Which hormone plays important role in phototropism?
(a) Gibberellin (b) Auxins
(c) Ethylene (d) Cytokinin

26. Pick out the false statements.
I. Naphthalene acetic acid increases the number of dwarf shoots as well as the number of fruits.
II. Gibberellic acid (GA_3) was isolated in pure form by Cross *et al* (1961).
III. Most of gibberellic acids occur in plants and fungi.
IV. Excised radish cotyledon expansion test, developed by Letham, is used for bioassay of ethylene.
(a) II and III (b) II and IV
(c) I, II and III (d) II, III and IV

27. 6- furfuryl amino purine, 2-4 dichlorophenoxy acetic acid and indole acetic acids are respectively examples of
(a) kinetin, natural auxin and synthetic auxin
(b) kinetin, synthetic auxin and natural auxin
(c) kinetin, gibberellin and natural auxin
(d) natural auxin, synthetic auxin and kinetin.

28. Consider the following statements regarding phytohormones.
I. The genetically male plants of *Cannabis* can be induced to promote female flowers in response to ethylene.
II. Auxins and gibberellins control xylem differentiation.
III. IBA reduces sweetening of fruits.
IV. Auxins delays abcission of older leaves and fruits.
The incorrect statements are
(a) I, II and III (b) I, III and IV
(c) II and IV (d) I and IV.

29. Which of the following is the correct difference between auxin and gibberellin?
(a) Gibberelin promotes rooting while auxin has no such role.
(b) Auxin has feminising effect whereas gibberellin has masculinising effect in some plants.
(c) Auxin mobilises food reserve during seed germination whereas gibberellin has no such effect.
(d) Natural auxin promotes flowering in long day plants whereas natural gibberellin has no such effect.

30. Which of the following acids is a derivative of terpenes?
(a) Indole acetic acid
(b) Naphthalene acetic acid
(c) Abscisic acid
(d) Gibberellic acid

31. In 1926, the Japanese biologist Eiichi Kurosawa showed that the bakanae ("foolish seedling") disease of rice was caused by a substance produced by the fungus *Gibberella fujikuroi*. The substance was named gibberellin and was shown to cause elongation of stem tissues. Which of the following statements about gibberellin is false?

(a) Pea plants carrying the dwarf mutation would be expected to have higher levels of gibberellin in their stems than normal plants.

(b) If gibberellin is applied to the stems of dwarf pea plants, the stems elongate so that plant reach normal height.

(c) Dwarf pea plants have a mutation in the gibberellin biosynthetic pathway.

(d) Normal pea plants respond to gibberellin by growing even taller.

32. Read the given statements and identify the PGRs X, Y and Z.

(i) X induces accumulation of salts inside the cells.

(ii) Y promotes rapid elongation of leaf bases and internodes in deep water rice plants.

(iii) Application of Z to leaves shall reduce transpiration.

(a) X-Auxin, Y-Cytokinin, Z-Ethylene

(b) X-Cytokinin, Y-Ethylene, Z-ABA

(c) X-Auxin, Y-Cytokinin, Z-ABA

(d) X-Cytokinin, Y-ABA, Z-Ethylene

33. Match column I with column II. (There can be more than one match for column I).

	Column I	**Column II**
A.	Antiauxin	(i) Zeatin
B.	Synthetic auxin	(ii) NAA
C.	Natural Cytokinin	(iii) MCPA
		(iv) PCIB
		(v) TIBA

(a) A-(iv, v), B-(ii, iii), C-(i)

(b) A-(iii, v), B-(iv), C-(i)

(c) A-(v, iv), B-(ii, i), C-(i, iii)

(d) A-(v, iii), B-(v, iv), C-(i)

34. Consider the following statements about phytohormones and identify them as true or false.

A. Natural auxin promotes flowering in plants which require vernalisation.

B. Ethylene decreases sensitivity to gravity.

C. Like gibberellins, abscisic acid promotes amylase formation during seed germination.

D. Young fruit thinning done by ethylene in walnut allow better growth of remaining fruits.

E. Gibberellins have no role in apical dominance.

Choose the correct option.

	A	**B**	**C**	**D**	**E**
(a)	F	T	F	F	T
(b)	F	T	F	T	F
(c)	T	T	F	T	T
(d)	F	T	F	T	T

35. A young dicot seedling (*e.g.*, soybean) is laid horizontally on a surface and is subjected to gravity stimulus. The shoot bends in upward direction and the root bends in downward direction. Which out of the following is the possible reason for this movement?

(a) Redistribution of auxins throughout the seedlings is responsible for the stimulatory unequal growth in shoots and roots.

(b) Redistribution of cytokinins throughout the seedlings is responsible for the stimulatory unequal growth in roots and shoots.

(c) Redistribution of auxins in roots and cytokinins in shoots is responsible for stimulatory unequal growth.

(d) Redistribution of auxins in shoots and cytokininis in roots is responsible for stimulatory unequal growth.

36. Match the following columns and select the correct option.

	Column I	**Column II**
A.	Human urine	(i) Cytokinin
B.	*Gibberella fujikuroi*	(ii) Auxin
C.	Herring sperm DNA	(iii) Ethylene
D.	Ripening of fruit	(iv) ABA
E.	Aging leaves of plants	(v) GA

(a) A - (ii), B - (iii), C - (iv), D - (v), E - (i)

(b) A - (ii), B - (v), C - (i), D - (iii), E - (iv)

(c) A - (i), B - (ii), C - (iii), D - (iv), E - (v)

(d) A - (v), B - (iv), C - (iii), D - (ii), E - (i)

37. Refer the functions of the growth hormones given below.

I. Cell division
II. Cell enlargement
III. Pattern formation
IV. Tropic growth
V. Flowering
VI. Fruiting
VII. Seed germination
VIII. Response to wound
IX. Response to stresses of biotic and abiotic origin

Identify the functions of growth promoters and growth inhibitors from the above.

	Functions of growth promoters	**Functions of growth inhibitors**
(a)	I, II, VII, IX	III, IV, V, VI, VII
(b)	VIII, IX	I, II, III, IV, V, VI, VII
(c)	I, II, III, IV, V, VI, VII	VIII, IX
(d)	I, II, III, IV, V, VI, VII, IX	VIII

38. Read the following statement (i-iv) regarding "ethephon" and answer the question which follows them.

(i) Ethephon is sprayed in aqueous solution and is readily absorbed and transported within the plant.
(ii) It hastens fruit ripening in tomatoes and apples.
(iii) It can be used to induce fruit thinning in cotton, cherry and walnut.
(iv) It is used to promote female sex expression in cucumber and increase yield.

How many of the above statement (s) is/are correct?

(a) One
(b) Two
(c) Three
(d) All of these

39. Which plant hormone overcome the natural dormancy of buds, tubers, and seeds and allow them to grow?

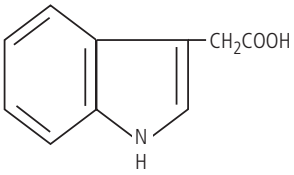
(a) Auxin
(b) Ethylene
(c) ABA
(d) Gibberellin

40. Which of the following plant hormone is not a growth inhibitor?

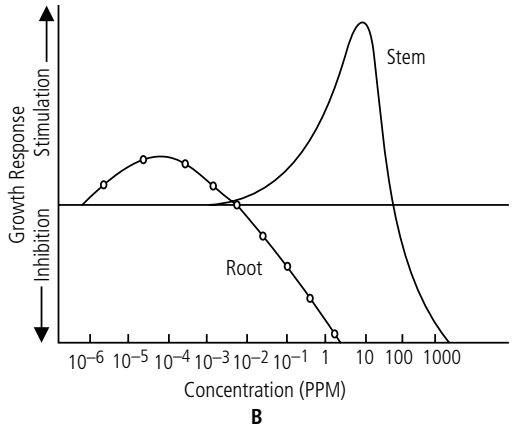
(a) IAA
(b) Dormin
(c) ABA
(d) Ethylene

Case Based MCQs

Case I : Refer to the given structure of a hormone (A) whose various concentration effect is shown in the graph B and answer the questions from 41 to 45 given below.



A



B

41. The given structure A represents

(a) NAA
(b) GA
(c) IAA
(d) ABA

42. Which of the following is correct regarding action of A from the given graph B?

(a) A helps in elongation of both root and shoot but the optimum concentration for the two is different.
(b) A acts as growth inhibitor at higher concentration.
(c) Movement of A is basipetal in root but acropetal in the stem.
(d) Both (a) and (b)

43. High concentration of A is present in

(a) flower
(b) stem apex
(c) node
(d) petiole.

44. Which of the following effects of A or plants is the basis for their commercial application in tissue culture?

(a) Callus formation
(b) Curvature of stem
(c) Induction of root formation in stem cuttings
(d) Induction of shoot formation

45. Artifical application of A to unpollinated pistils can form
(a) fruits with much flesh
(b) seedless fruits
(c) larger fruits
(d) sweet fruits

Case II : Read the following passage and answer questions from 46 to 50 given below.

X are acidic growth hormones which causes cell elongation of intact plants in general and increase internodal length of genetically dwarfed plants whereas Y are basic growth hormones that promotes cell division either alone or in conjunction with other hormone.

46. What could be the X and Y?
(a) X-Auxin, Y-Abscisic acid
(b) X-Gibberellins, Y-Cytokinins
(c) X-Gibberellins, Y-Auxin
(d) X-Ethylene, Y-Cytokinin

47. Which hormone causes cell elongation other than X?
(a) Auxin (b) Cytokinin
(c) Ethylene (d) Both (a) and (b)

48. Plant growth hormone that promotes femaleness in flowers is/are
(a) X only
(b) Y only
(c) both X and Y
(d) neither X nor Y.

49. Select the correct statement regarding Y.
(a) Y help in phloem transport.
(b) Y increase the yield of malt from barely grains.
(c) Y promotes apical dominance.
(d) Y hastens the senescence of leaves and flowers.

50. The precursor for the synthesis of X is
(a) indole 3 acetic acid
(b) phenyl urea
(c) mevalonic acid
(d) methionine.

Assertion & Reasoning Based MCQs

For question numbers 51-57, two statements are given-one labelled Assertion and the other labelled Reason. Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

51. Assertion : Axillary buds in actively growing herbaceous plants generally remain dormant.
Reason : This is due to apical dominance which is under the influence of auxins.

52. Assertion : Cytokinins increases shelf life of fruits and vegetables.
Reason : Cytokinins induce cell division.

53. Assertion : Plant growth regulators (PGRs) are very important for plant growth and development.
Reason : Auxins do not induce flowering in gymnosperms.

54. Assertion : Abscisic acid is known as dormin.
Reason : Abscisic acid is employed for breaking of seed and bud dormancy.

55. Assertion : Genetically male plants of *Cannabis* can be induced to produce female flowers in the presence of gibberellin.
Reason : Gibberellin has masculinising effect in some plants.

56. Assertion : TIBA acts as antiauxin by blocking the transport of auxin.
Reason : Bound auxin cannot be extracted easily except with the help of organic solvents.

57. Assertion : ABA promotes rooting in stem cuttings of *Poinsettia*.
Reason : ABA promotes growth by cell division.

SUBJECTIVE TYPE QUESTIONS

Very Short Answer Type Questions (VSA)

1. Name a plant growth regulator that is often inhibitory in function but also promotes certain functions.

2. Which hormone is used to increase sugar production in sugarcanes?

3. Why are cytokinins named so?

4. A farmer cultivating *Cannabis* wants to increase the number of male flowers in his field comprising predominantly female *Cannabis* plants. Which hormone would you suggest him to use?

5. Why are apples usually wrapped in wax before being sold to market?

6. What is Richmond-Lang effect?

7. Name the universal natural auxin.

8. What is bioassay? Name any two bioassays for auxins.

9. Why an overripe fruit affects rest of the fruits kept in the basket?

10. A farmer grows cucumber plants in his field. He wants to increase the number of female flowers in them. Which plant growth regulator can be applied to achieve this?

Short Answer Type Questions (SA-I)

11. The rice seedlings infected with fungus *Gibberella fujikuroi* are called foolish seedlings. What was the reason behind it?

12. (a) What is the site of synthesis of auxin in plants?
(b) How is it transported in plant body?

13. Name synthetic auxin hormone used as weedicide. Give two more commercial applications of same.

14. Identify the hormone on the basis of their specific characteristic.
(a) Gaseous in nature
(b) Responsible for phototropism
(c) Induces femaleness in flowers of cucumber
(d) Kills weeds (dicots)
(e) Induces flowering in long day plants.

15. What functions of ethylene contribute towards improved growth and increase in number of fruits?

16. Mention one antagonistic function for each of the given pair of hormones.
(a) Gibberellin - Auxin
(b) Cytokinin - Abcisic acid
(c) Auxin - Cytokinin

17. What would be expected to happen if :
(a) GA_3 is applied to rice seedlings
(b) dividing cells stop differentiating
(c) a rotten fruit gets mixed with unripe fruits
(d) you forget to add cytokinin to the culture medium.

18. Plant growth substances (PGS) have innumerable practical applications. Name the PGS you should use to
(a) Increase yield of sugarcane.
(b) Promote lateral shoot growth.
(c) Cause sprouting of potato tuber.
(d) Inhibit seed germination.

19. In botanical gardens and tea gardens, gardeners trim the plants regularly so that they remain bushy. Does this practice have any scientific explanation?

20. Which one of the plant growth regulators would you use if you are asked to
(a) induce rooting in a twig
(b) quickly ripen a fruit
(c) delay leaf senescence
(d) induce growth in axillary buds
(e) 'bolt' a rosette plant
(f) induce immediate stomatal closure in leaves.

Short Answer Type Questions (SA-II)

21. Auxins are growth hormones capable of promoting cell elongation. They have been used in horticulture to promote growth, flowering and rooting. Write a line to explain the meaning of the following terms related to auxins.

(a) Auxin precursors

(b) Antiauxins

(c) Synthetic auxins

22. These phytohormones were first discovered in Japan when rice plants suffered from bakane (the foolish seedling disease) caused by a fungus *Gibberella fujikuroi*.

(a) Name and give two functions of this phytohormone.

(b) Which property of this phytohormone caused foolish seedling disease in rice?

23. (a) Gibberellins are plants hormones with a large number of physiological functions. Some of these gibberellins are used commercially to improve production in agriculture. Mention its commercial applications.

(b) Where are gibberellins synthesised in plants and how do they get transported?

24. Why is ABA known as 'stress hormone'? Mention any two functions of this hormone. How are they antagonistic to gibberellins?

25. List five main groups of natural, plant growth regulators. Write a note on discovery, physiological functions and agricultural/ horticultural applications of any one of them.

26. The role of ethylene and abscisic acid is both positive and negative. Justify the statement.

27. While experimentation, why do you think it is difficult to assign any affect seen to any single hormone?

28. How are gibberellins useful in agriculture to improve productivity. Give any three points in support of your answer.

29. Name the categories of plant hormones concerned with each of the following and describe one other function of each of the three categories of plant hormones

(i) Inhibition of seed germination

(ii) Promote flowering

(iii) Cell division-promoting activity.

30. Suggest some ways in which inhibitors might be important to plant survival.

31. Name a plant hormone that can never act alone. List any three activities of this hormone in conjunction with auxins.

32. What is bolting? How can it be artificially induced?

33. Give one bioassay for gibberellins.

Long Answer Type Questions (LA)

34. What are plant growth regulators? Name any for different chemical nature of them with one example of each.

35. Mention the factors which prove that phytohormones act synergistically or antagonistically.

36. Which hormone prevents senescence? Write its different functions and uses.

37. Write a brief account of abscisic acid and explain how it is antagonistic to most of the other plant growth regulators.

ANSWERS

OBJECTIVE TYPE QUESTIONS

1. (c) : Following the work of Skoog and Miller, it is now well established that the auxin-cytokinin ratio used in culture media determines the degree of shoot or root formation in tissue culture. A high ratio of cytokinin to auxin favours shoot production whereas a high auxin to cytokinin ratio favours root production. Intermediate levels of both hormones enhance callus formation.

2. (c)

3. (d) : Auxin concentration increases in shaded area, *i.e.*, auxins are collected in the opposite side of light. Increased concentration of auxin is stimulatory for shoot growth and

for this reason, shaded side shows more growth than lighted side. Hence, bending of shoot takes place towards light.

4. (a)

5. (b) : When cytokinins are added directly to the abscission layer, senescence of the zone is retarded. They delay the degradation of protein and chlorophyll of the plant parts and hence delay senescence. They are antagonistic to ethylene which accelerates senescence.

6. (a) : Gibberellins induce sub apical meristem to develop faster which causes elongation of reduced stem or bolting in case of rosette plants, *e.g.*, henbane, cabbage.

7. (c) : ABA induces dormancy of buds towards the approach of winter. Seed dormancy is also caused by ABA. Dormancy allows seeds to tolerate desiccation and extremes of temperature better.

8. (d) : The hormone (ethylene) which promotes rapid internode or petiole elongation in deep water rice plants, also initiates germination in peanut seeds and sprouting of potato tubers and breaks seed and bud dormancy.

9. (d) : During mid-1960s, three independent researchers reported the purification and chemical characterisation of three different kinds of inhibitors; inhibitor—B, abscission II and dormin. Later all the three were proved to be chemically identical. It was named abscisic acid.

10. (a) : (A) Overcoming senescence—Cytokinin

(B) 'Bolt' a rosette plant—GA

(C) Induce immediate stomatal closure in leaves—ABA

11. (b) : In tissue culture, differentiation of callus occurs in the presence of both auxin and cytokinin, cytokinin is responsible for shoot development.

12. (b) : Growth substance that stimulates nodule formation in leguminous plants is IAA.

13. (a) : Presence of cytokinin in an area causes preferential movement of nutrients towards it. When applied to lateral buds, they help in their growth despite the presence of apical bud. They thus act antagonistically to auxin which promotes apical dominance. Therefore, cytokinin can overcome apical dominance, caused by auxins.

14. (d) : Shedding of mature leaves from the stem or ripe fruits from the stem is called abscission. Generally a layer of tissue is formed at the base of the organ. This layer of tissue is called abscission zone. Abscission zone does not occur when the concentration of auxin is high, particularly when the gradient of auxin is steep *i.e.*, more auxin on distal side and less auxin on proximal side. The abscission zone formation occurs rapidly when the auxin gradient becomes slight or neutral. Moreover, the plant hormone ethylene is found to promote the abscission. Thus, a high concentration of auxin prevents the formation of abscission layer and the phenomenon is controlled by the concentrations of auxin and ethylene. Apical dominance is promoted by auxin.

15. (b) : Like auxin and cytokinins, ethylene has a feminising effect on sex expression in plants.

16. (a)

17. (c) : Plant Growth Hormones (PGRs) or phytohormones are the organic substances which are synthesised in minute quantities in one part of the plant body and transported to another part where they influence specific physiological processes (Went and Thimann, 1937). PGRs are broadly divided into two groups—plant growth promoters and plant growth inhibitors. Plant growth promoters perform growth promoting activities like cell division, cell enlargement, pattern formation, tropic growth, flowering, fruiting and seed formation. They are three in number *viz.*, auxins, gibberellins and cytokinins. Plant growth inhibitors have important functions in inducing plant responses to wounding, biotic and abiotic stresses, dormancy and abscission.

18. (a) : Abscisic acid is also called stress hormone because the production of hormone is stimulated by drought, water logging and other adverse environmental conditions.

19. (d) : NAA and 2, 4-D are often employed for inducing flowering in litchi and pineapple. Application of auxins (*e.g.*, IAA, IBA) and conjugate auxins (*e.g.*, IBA-alanine) to unpollinated pistils make them develop into seedless fruits (or parthenocarps) which carry a better market price than the normal fruits having seeds.

20. (d) : Auxin passes from shoot tip to the region of elongation. Auxin movement is polar. It is basipetal in stem but acropetal in root. Auxin helps in the elongation of both roots and shoots. However the optimum concentration for the two is quite different. It is 10 ppm for stem 0.0001 ppm for the root.

21. (c) **22. (d)**

23. (b) : In conifers, gibberellins GA_4 and GA_7 have been found to cause quicker early growth so that maturity is reached early. It is useful for obtaining quicker yield of economically important seeds.

24. (a) : Ethephon, 2-chloroethyl phosphonic acid is a liquid from which ethylene gas is released gradually.

25. (b) : Auxin is synthesised in shoot apices, leaf primordial and developing seeds. The role of auxin was clear after the experiments done on phototropism.

26. (b) : Gibberellic acid (GA_3) was isolated in pure form by Brian *et al.*, in 1955. Excised radish cotyledon expansion test, developed by Letham is used for bioassay of cytokinin.

27. (b) : The first cytokinin was discovered from degraded autoclaved herring sperm DNA by Miller, it is called kinetin (6-furfurylamino-purine). Auxins like IAA and indole butyric acid (IBA) have been isolated from plants. NAA (naphthalene acetic acid) and 2, 4-D (2, D-dichlorophenoxyacetic) are synthetic auxins.

28. (b) : Degree of cambial activity is directly proportional to auxin concentration, it controls xylem differentiation. Auxin delays abscission of young leaves and fruits but promotes abscission of mature or older leaves and fruits.

29. (b) : Auxin promotes root formation while gibberellin has no such role. Auxin does not mobilised food reserve during seed germination while gibberellin mobilises food reserve during seed germination by inducing formation of hydrolytic enzymes. Natural auxin has no effect in induction of flowering in long day plants whereas gibberellin promotes flowering in long day plants.

30. (d) : Indole acetic acids and naphthalene acetic acids are auxins which are indole compounds, ABA are derivatives of carotenoids and fatty acids. Gibberellic acid is a pentacyclic diterpene acid (terpene derivative).

31. (a) : Mutated pea plant cannot have higher level of gibberellins as it must have long internodal portion in the presence of gibberellins.

32. (b) **33. (a)**

34. (d) : Gibberellins promotes flowering in long day plants and plants requiring vernalisation. Gibberellin promotes amylase formation during seed germination while abscisic acid act antagonistically to gibberellin.

35. (a) : Auxins play a paramount role in the various tropic movements shown by plants such as phototropism and gravitropism. Phototropism is the movement in response to light. The shoot tip is responsible for the directional movement in response to sunlight, as tip is the area where auxins are synthesised. The part of the shoot tip which receives direct sunlight will have the least amount of auxin. More auxin present on the shaded side promotes more cell division and elongation, causing the plant to bend towards sunlight. Gravitropism is the movement in response to gravity. Roots bend downwards in response to gravity due to the regulated transport of auxins called as polar auxin transport.

36. (b) **37. (c)** **38. (d)**

39. (d) : Gibberellins overcome the natural dormancy of buds, tubers, seeds etc., and allow them to grow.

40. (a) : IAA is a growth promoting hormone. The higher amount of IAA promotes the root initiation in plants but dormin or ABA and ethylene hormone acts as a growth inhibitor.

41. (c) : The given structure A is of hormone auxin (Indole 3-acetic acid)

42. (d) : From the graph, following points can be concluded about auxin –

(i) It helps in the elongation of both root and shoot but the optimum concentration for the two is different. For stem growth, optimum concentration is 10 ppm while for root growth it is 0.0001 ppm.

(ii) At higher concentration, it acts as growth inhibitor.

(c) Auxin movement is polar. It is basipetal in stem but acropetal in the root.

43. (b) : High concentration of auxin is present in apical part of plant such as stem apex.

44. (c) : Auxin such as IAA stimulate the root formation in stem cuttings and used in commercial application of tissue culture.

45. (b) : Auxin induce parthenocarpy so, artifical application of IAA to unpollinated pistils can form seedless fruits.

46. (b) : X-Gibberllins, Y-Cytokinins

47. (d)

48. (b) : Cytokinins promote femaleness in flowers like auxins and ethylene whereas gibberellins promote the formation of male flowers on genetically female plants *e.g.*, *Cannabis*.

49. (b)

50. (c) : Gibberellins are synthesised in the apical shoot buds, root tips and developing seeds. The precursors for their synthesis is mevalonic acid (derived from acetyl coenzyme A).

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

52. (b) : Application of cytokinins to marketed vegetables can keep them fresh for several days. Shelf life of cut shoots and flowers is prolonged by employing the hormone cytokinin. The reason is that the cytokinin increases retention of chlorophyll and delayed senescence in leaves.

Cytokinin as the name suggests, is essential for cell division or cytokinesis. It promotes cell division along with auxin by controlling the activity of cyclin dependent kinases.

53. (b) : Plant growth regulators (PGRs) are small, simple molecules of diverse chemical composition, which in low concentration regulate growth, differentiation and development by promoting or inhibiting the same. One type of plant growth regulators are plant hormones or phytohormones. Auxins are the phytohormones. They do not induce flowering in gymnosperms.

54. (c)

55. (d) : In the presence of gibberellin, genetically female plants of *Cannabis* can be induced to produce male flowers on them as this hormone promote the formation of male flowers in some plants.

56. (b) **57. (c)**

SUBJECTIVE TYPE QUESTIONS

1. Ethylene

2. Gibberellin is used to increase sugar production in sugarcane.

3. Cytokinins are named so, because they promote cell division.

4. Gibberellin

5. To prevent ripening of fruits due to release of ethylene.

6. The delay in senescence of leaves and other parts by mobilisation of nutrients is called Richmond-Lang effect.

7. Universal natural auxin is IAA -Indole 3-Acetic acid.

8. Quantitative estimation of biologically active substances by measurement of their activity on living organisms or their part is called bioassay. *Avena* curvature test and root growth inhibition test are the bioassays for examining auxin activity.

9. An overripened fruit releases the gaseous hormone ethylene. This when released into the surrounding environment initiates ripening of other fruits in the basket. Soon, all the them get over-ripened.

10. Ethylene, is a plant growth regulator that has a feminising effect on sex expression. Ethylene promotes formation of female flowers in monoecious plants like cucumber.

11. The rice seedlings infected with fungus *Gibberella fujikuroi* are called foolish seedlings because infected plants grow excessively taller than rest of the non-infected rice plants in the field, fall over and become unharvestable.

12. (a) Auxin is synthesised in shoot apices and leaf primordia.

(b) It is transported by shoot tip to region of elongation. Its movement in plants body is polar, *i.e.*, basipetal in stem and acropetal in root.

13. 2, 4-D is a synthetic auxin used as weedicide. Its two other commercial uses are:

(i) to induce flowering in litchi and pineapples

(ii) to prevent preharvest fruit drop of orange and apple.

14. (a) Ethylene (b) Auxin
(c) Ethylene (d) Auxin
(e) Gibberellin

15. (i) Ethylene is used in thinning of excess flowers and young fruits, which helps in improved growth of remaining fruits.

(ii) It stimulates flowering in certain group of plants and help in synchronising fruit set.

(iii) It has a feminising effect on certain plants, hence number of female flowers increases. Thus, fruit formation is enhanced in plants.

16. (a) Gibberellin induces formation of male flowers (masculinity) while auxin induces production of female flowers (feminism) in plants.

(b) Cytokinins prevent senescence and induces stomatal opening but abscisic acid induces senescence and brings about closure of stomata.

(c) Auxin causes apical dominance while it is overcome by cytokinin.

17. (a) The coleoptile will elongate rapidly, as GA_3 helps in cell growth.

(b) The development of callus (mass of undifferentiated cells) will take place.

(c) The unripe fruits will ripe quickly because of the increased rate of respiration due to emission of ethylene from rotten fruit.

(d) Cell division will retard and shoot will not initiate from the callus.

18. (a) Gibberellin increase yield of sugarcane.

(b) Cytokinin promote lateral shoot growth.

(c) Ethylene causes sprouting of potato tuber.

(d) Abscisic acid inhibit seed germination.

19. The phenomenon of regularly trimming the plants resulting in bushy growth is based on apical dominance, *i.e.*, apical bud does not allow the nearby lateral buds to grow (by releasing auxins). When the apical bud is removed, the lateral buds sprout. This produces dense bushy growth. The phenomenon is widely used in tea plucking and hedge making.

20. (a) Auxins like IBA, NAA.

(b) Ethylene (c) Cytokinins
(d) Cytokinins (e) Gibberellins
(f) Abscisic acid (ABA)

21. (a) Auxin precursors : These are the raw materials used in synthesis of auxin. *e.g.,* tryptophan is precursor for indole-3-acetic acid (IAA).

(b) Anti-auxins : These are the compounds which inhibit the action of auxin. *e.g.,* TIBA (2, 3, 5 triiodobenzoic acid) acts as anti-auxin by blocking the transport of auxin.

(c) Synthetic auxin : Auxins which are manufactured synthetically and do not occur naturally in plants. *e.g.*, 2, 4-D, NAA etc.

22. (a) The phytohormone is identified as gibberllin. Gibberellins are weakly acidic growth hormones having gibbane ring structure which cause cell elongation of intact plants in general and increased internodal length of genetically dwarf plants in particular. Two functions of gibberellins are as follows:

(i) Bolting : Gibberellin induce subapical meristem to develop faster. This causes elongation of reduced stem or bolting in case of rosette plants.

(ii) Seed germination : During seed germination, especially of cereals, gibberellins stimulate the production of some messenger RNAs and hydrolytic enzymes like amylases, lipases, ribonucleases and proteases, which solubilise the reserve food of the seed. This food is then transferred to embryo axis for its growth.

(b) Gibberellins help in cell growth of stem, leaves and other aerial parts. Therefore, they increase the size of stem, leaves, flowers and fruits. This property of gibberellin leads to abnormal increase in stem length of rice plants causing foolish seedling disease or bakane disease.

23. (a) The commercial uses of gibberellin are -

(i) Application of gibberellins increases the number and size of several fruits, ***e.g.***, grape, tomato. Size and shape of apple fruits is also enhanced by application of GA_4 and GA_7 mixture.

(ii) Seedless pomaceous fruits can be produced by application of gibberellins to unpollinated flowers, ***i.e.***, induce parthenocarpy.

(iii) Gibberellins (*e.g.*, GA_3) increases the yield of malt from barley grains.

(iv) Gibberellins can be employed for breaking seed and bud dormancy. They induce germination of positively photoblastic seeds of tobacco and lettuce in complete darkness.

(v) GA_7 delays senescence so that fruit can be left on the tree for longer period. Ripening of *Citrus* fruits can also be delayed with the help of gibberellins which is useful in storing the fruits.

(vi) Gibberellins can be used in inducing offseason flowering in many long day plants as well as requiring vernalisation.

(vii) Spraying of sugarcane crop with gibberellins increases length of stem and yield of sugar to as much as 20 tonnes/ acre.

(b) Gibberellins are synthesised in apical shoot buds or young leaves, root tips and developing seeds. They are transported through simple diffusion as well as through conducting channels.

24. A fairly high concentration of abscisic acid (ABA) is found in leaves of plants growing under stress conditions, such as drought, flooding, injury, mineral deficiency, etc. It is accompanied by loss of turgor and closure of stomata. When such plants are transferred to normal conditions, they regain normal turgor and ABA concentration decreases. Since the synthesis of ABA is accelerated under stress condition and the same is destroyed or inactivated when stress is relieved, it is also known as stress hormone.

The two functions of ABA are

(i) Induces seed and bud dormancy and

(ii) Promotes abscission of flowers and fruits.

Abscisic acid and gibberellins are antagonistic in following respects.

	Abscisic Acid	Gibberellic Acid/Cytokinin
(i)	It inhibits growth.	It promotes growth.
(ii)	It promotes dormancy of seeds, buds and tubers	It overcomes the natural dormancy of seeds, bulbs, tubers, etc. and allow them to germinate.
(iii)	It promotes flowering in some short day plants	It promotes flowering in some long day plants.
(iv)	It promotes stomatal closure.	It helps in stomatal opening.
(v)	It prevents amylase activity.	It promotes amylase activity during germination of cereal grains.
(vi)	It causes abscision of flowers and fruits.	It promotes development of fruits.
(vii)	It promotes leaf senescence.	It prevents leaf senescence.

25. Five main groups of natural, plant growth regulators are auxins, gibberellins, ethylene, cytokinins and ABA.

Auxins

(i) Discovery – Auxins was first isolated from human urine. They are generally produced by the growing apices of the stems and roots. Auxins like IAA and IBA have been isolated from plants. NAA (Naphthalene Acetic acid) and 2, 4-D (2, 4-dichlorophenoxyacetic) are synthetic auxins.

(ii) Physiological functions – They help to initiate rooting in stem cuttings, an application widely used for plant propagation. Auxins promote flowering, ***i.e.***, in pineapples. They help to prevent fruit and leaf drop at early stages but promote the abscission of older mature leaves and fruits.

(iii) Agricultural/horticultural applications – Auxins also induce parthenocary, ***e.g.***, in tomatoes. They are widely used herbicides 2, 4-D, and are used to kill dicotyledonous seeds. They do not effect mature monocotyledonous plants, instead is used to prepare seed-free lawns by gardeners. It also controls xylem different and helps in cell division.

26. The role of ethylene and abscisic acid is both positive and negative. Ethylene is a simple gaseous PGR. As a negative effect, it is synthesised in large amount by tissues undergoing senescence and ripening. It also promotes senescence and abscission of plant organs expecially of leaves and flowers.

As a positive effects, ethylene breaks seed and bud dormancy, initiates germination in peanut seeds, sprouting of potato tubers. It promotes internode/petiole elongation in deep water rice plants. It helps leaves/inner parts of the shoot to remain above water.

27. As all the hormones are synergistic to each other in their functions. Thus, during experimentation, we can not judge whether, a particular effect is produce by a single hormone or many. For example

(i) Auxins help to initiate rooting in stem cuttings, (an application widely used for plant propagation.) Cytokinins also show the similar function of root formation. Auxins promote flowering, e.g., in pineapples. They also induce parthenocarpy, e.g., in tomatoes.

(ii) Both gibberellins and ethylene are synergistic to auxin in initiating flowering and for synchronising fruit set in pineapples.

(iii) Cytokinins and gibberellins help overcome the apical dominance and delay the process of leaf senescence.

(iv) On the other hand, ethylene promotes senescence and abscission of plant organs especially of leaves and flowers. This shown that all hormones are synergistic to each other in their mode of action in plants.

28. Gibberellins are useful in agriculture in the following ways

(i) Application of gibberellins increase the length of the stem and increase the yield of sugar in sugarcane.

(ii) Gibberellins delay senescence and the fruits can be left on the trees for longer duration, so as to increase the market period.

(iii) It can cause fruit like apple to elongate and improve in shape.

29. (i) Abscisic acid, signals closure of stomata to prevent water loss during water stress.

(ii) Auxins, controls cell division and xylem differentiation.

(iii) Cytokinin, helps in the growth of lateral buds and overcome apical dominance.

30. Inhibitors are important to the survival of higher plants in temperature zones. These plants become dormant during harsh winter period or when conditions are not capable of supporting an active plant. Seeds often will not begin to germinate until they have been exposed to cold and then brought to moderate temperature. The breaking of dormancy and the beginning of growth depend on the release from inhibition of vigorous metabolic activity.

31. Cytokinins can never act alone. The three activities of cytokinins in conjunction with auxins :

(a) Morphogenesis : Both auxin and cytokinin should be proportionate in order to allow shoot and root development. If both these PGRS are present in roughly equal concentrations, callus or undifferentiated tissue will be formed. If auxin is higher than cytokinin, then roots will form while if cytokinin is higher than auxin, shoots will form. Thus, auxin and cytokinin have antagonistic effects. This phenomenon is called morphogenesis and is applied to produce a large number of plants by a technique called micropropagation.

(b) Apical dominance : Cytokinins have also known to antagonize auxins in apical dominance. It has been found that if the internal levels of cytokinins in the plant body are high, they promote growth of axillary buds, thereby reducing or overcoming apical dominance.

(c) Cell division : Cytokinins have a direct role in regulating progression through the cell cycle and promote cell division in tissue culture provided auxins are present. Cell division in callus also requires both the hormones.

32. It is a process of rapid stem elongation, generally in rosette plants and usually precedes flowering. In general, environmental factors such as photoperiod and/or low temperature trigger bolting in these plants. Exogenous application of gibberellins has been found to induce bolting and flowering in these plants in the absence of required environmental conditions.

33. Some seeds of dwarf seedlings of garden pea (*Pisum sativum*) were germinated. Once their coleoptile was formed, a solution rich in GA was administered to some seedlings, while other seedlings were kept under control. After some days, it was found that in the dwarf plants kept under control, reduced internode elongation was exhibited which is characteristic of the dwarf growth habit, whereas for those plants treated with solution containing gibberellin, the stem was elongated due to elongation of the internodes. It was also found that when gibberellin was applied to the dwarf mutant of pea (or rice or bean etc.), it restores a normal tall phenotype; however, gibberellin has no appreciable effect on the genetically normal plant.

34. Plant growth regulators are small, simple molecules secreted in minute quantities, that influence various physiological functions in plants. They are of diverse chemical composition.

(i) Indole compounds [such as-indole-3-acetic acid (IAA)]

(ii) Adenine derivatives [such as kinetin, 6-furfuryl amino purnie]

(iii) Derivatives of carotenoids [such as abscisic acid (ABA)]

(iv) Terpenes [such as gibberellic acids]

35. The factors which prove the phytohormones act synergistically or antagonistically are

(i) Cell division is promoted by both auxins and cytokinins acting synergistically.

(ii) Auxin and cytokinins interact to control morphogenetic differentiation of shoot and root. When auxin is in excess, roots differentiate on the callus, while excess of cytokinins promote bud formation.

(iii) Auxins and cytokinins acts antagonistically in controlling apical dominance. Auxins causes apical dominance, while cytokinins overcome same.

(iv) Senescence is prevented by auxins and cytokinins, while it is stimulated by abscisic acid and ethylene.

(v) The activity of cambium and fruit growth seem to be promoted by auxins, gibberellins and cytokinins, the same is inhibited by abscisic acid.

(vi) The dormancy of seeds and buds is mostly due to abscisic acid, the same is broken by gibberellins.

(vii) Cytokinins cause opening of stomata, while abscisic results in their closure.

36. Cytokinins cause delay in senescence of intact plant parts. The various functions of cytokinins are as follows :

(i) They promote cell division in tissue culture provide auxins are present. They have a direct role in regulating progression through the cell cycle. Both auxin and cytokinin should be proportionate in order to allow shoot and root development.

(ii) If the internal leaves or cytokinins in the plant body are high, they promote growth of axillary buds, thereby reducing or over coming apical dominance. If cytokinins are applied to axillary buds, lateral shoot growth is promoted.

(iii) They also aid in formation of new leaves, chloroplast development, formation of lateral and adventitious shoots, etc.

(iv) Cytokinins have been found to cause a delay in sentence in mature leaves probably by directing nutrient mobilization and retention by stimulating metabolic activities.

(v) They promote femaleness in plants like auxins and ethylene and help in induction of parthenocarpy.

Uses of cytokinins :

(i) In tissue culture, to form new plant varieties by morphogenesis.

(ii) To prolong the shelf-lives of vegetables such as cabbage, lettuce, etc.

(iii) Keep cut flowers fresh.

(iv) To help the plant develop resistance to certain pathogens and extreme temperature variations.

37. Abscisic acid serves to increase plant tolerance to several stresses, such as drought, waterlogging, etc., hence, it is also known as stress hormone. It is also called as dormin because it induces dormancy in buds, underground stems and seeds. It is synthesized in mesophyll cells, guard cells and vascular tissue mainly from mevalonic acid or xanthophyll. It is highly mobile and rapidly moves out of the leaves to other parts of the plant body, specially sink tissues through diffusion, as well as through xylem and phloem transport. Abscisic acid has been found to have effects mainly on seed germination, dormancy and stomatal closure. It acts antagonistically with gibberellins, auxins and cytokinins (e.g., seed germination, seed or bud dormancy, ripening of fruits, senescence, transpiration) and keeps them in check, thus controlling growth.

Functions of abscisic acid :

(i) ABA plays an important role in embryo maturation and seed germination, controlling the growth of embryo at maturation stage, causing accumulation of nutrients in the endosperm and increasing the capacity of tolerance to desiccation.

(ii) It prevents precocious germination or vivipary and promotes dormancy.

(iii) It plays an important role in stomatal closure due to water stress and gets accumulated in water-stressed or wilted leaves.

(iv) It inhibits the development of lateral or secondary roots that are promoted by auxin.

(v) It is found to promote flowering in some short day plants.

(vi) It is found to induce parthenocarpy in some plants, such as rose.

(vii) It promotes leaf senescence by preventing the synthesis of protein and RNA in the leaves.

(viii) It promotes the abscission of fruits and flowers.

Uses of abscisic acid :

(i) ABA is used as an antitranspirant as it reduces transpiration to a great extent through stomatal closure when applied to leaves.

(ii) It is used in short day plants such as black current, strawberry to induce flowering even during unfavorable photoperiods.

(iii) It is used to prolong dormancy in buds, storage organs and seeds.