Plant Growth and Development

CHAPTER 15

EXAM DRILL

ANSWERS

1. **(c) :** Auxins are well known to promote elongation of stem and coleoptile. However, when exogenous auxin is given to intact plants this is not observed as the required amount of auxin is already present in plants.

When the apex of shoot is removed, then the exogenous applications 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.

2. **(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.

OR

(b) : Cytokinins induce accumulation of salts inside the cells. Ethylene promotes rapid elongation of leaf bases and internodes in deep water rice plants. As a result, leaves remain above water. Application of minute quantity of abscisic acid to leaves shall reduce transpiration to a great extent through partial closure of stomata. It conserves water and reduces the requirement of irrigation.

3. **(d) :** Spraying juvenile conifers with gibberellins hastens their maturity period, thus leading to early seed production. Auxin controls xylem differentiation. Abscisic acid (ABA) increases the tolerance of plants to various kinds of stresses therefore, is also known as stress hormone.

4. **(d)** : Ethylene is a simple gaseous plant hormone which is produced in large amounts by senescing organs and ripening fruits. It promotes abscission and senescence, fruit ripening, horizontal growth of seedlings, bud opening and seed germination but do not overcome apical dominance. Cytokinins help to overcome apical dominance.

OR

(d) : Auxins have been used extensively in agricultural and horticultural practices. They help to initiate rooting in stem cuttings, promote flowering in pineapples. They prevent fruit and leaf drop at early stages but promote the abscission of older mature leaves and fruits. Auxins also induce parthenocarpy, *e.g.*, in tomatoes. They are widely used as herbicides. Auxins also control xylem differentiation and help in cell division. They prevent growth of lateral buds and ensure apical dominance. Bolting is induced by gibberellins which induce sub apical meristem to develop faster. This causes elongation of reduced stem or bolting in case of rosette plants.

5. **(b)**

6. Stimulation in the internodal growth just before reproduction and flowering is called bolting.

Some plants require specific long day periods or specific cold requirement to bolt and flower. Bolting can be induced artificially by the treatment of gibberellins.

7. Tryptophan is the precursor for the synthesis of the natural auxin, indole-acetic acid (IAA).

8. The pineapple which under natural conditions is difficult to blossom has been made to produce fruits throughout the year by the application of NAA, 2, 4-D. NAA and 2, 4-D are the synthetic auxins. They enhance the size of carpel and hence earlier fruit formation.

9. Temperature, light, water soil nutrients and plant growth regulators control the growth.

10. Carrot root phloem assay is the bioassay of cytokinins.

11. Dwarf pea and barley endosperm test are the two bioassays for gibberellin.

12. **(a)**

13. **(b) :** Auxin delays abscission of young leaves and fruits. Its effect is through nonformation of abscission zone below a leaf or fruit. Abscission zone cuts off nutrients and water supply. However, auxin promotes the abscission of mature or older leaves and fruits.

14. **(b) :** Ethylene is a simple gaseous PGR. The most widely used compound as source of ethylene is ethephon. Ethephon in an aqueous solution is readily absorbed and `transported within the plant and releases ethylene slowly. Ethephon hastens fruit ripening in tomatoes and apples and accelerates abscission in flowers and fruits (thinning of cotton, cherry,

walnut). It promotes female flowers in cucumbers thereby increasing the yield.

15. (i) (d)

(ii) (b) : Phototropic movements in plants are controlled by auxins. Stem bends towards the source of light due to unequal growth induced by auxins. Auxins accumulate on the darker side causing cell elongation thereby leading to curvature or bending of stem on account of more growth on shaded side.

(iii) (a)

(iv) (a) : The given experiment represents phototropic curvature which is the result of uneven distribution of auxin.

(v) (b) : Hormone X is auxin. The high concentration of this hormone is present in stem apex.

16. (i) (b)

(ii) (c) : The ability to change under the influence of internal or external stimuli is called plasticity. The intrinsic plasticity is found in juvenile stages of many plants *e.g.*, cotton, coriander, Larkspur, ivy etc.

Environmental plasticity is best seen in emergent hydrophytes like buttercup (*Ranunculus flagellaris*).

(iii) (d) : The plants such as cotton, coriander and larkspur exhibit intrinsic plasticity or heterophylly as the leaves of juvenile plants are quite different in shape from those of mature plants.

(iv) (d)

(v) (a) : The leaves of the juvenile plant are different in shape from those in mature plant is caused by intrinsic factor such as hormones or growth regulators.

17. Plant growth regulators (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 normally induce dormancy and abscision they have however, an important function in including plant responses to wounding, biotic and abiotic stresses. Abscisic acid is known plant growth inhibitor. Ethylene is largely plant growth inhibitor but is also involved in some growth promotion activities.

OR

(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.

18. (a) Auxins change the sex ratio in some plants. The flowers of some plants like cucumber and gourd are unisexual. These plants produce a large number of male flowers, but only a few female flowers. Auxin promotes femaleness in these plants.

(b) The phenomenon in which ovary changes into fruit without fertilisation is called parthenocarpy. Application of auxins and conjugate auxins to unpollinated pistils make them develop into seedless fruits or parthenocarps which carry a better market price than the normal fruits having seeds.

19. Ethylene helps in regulating many physiological processes in plants and is known to be the most widely used PGR in agricultural field. Ethephon is the most widely used compound as a source of ethylene. This tends to absorb readily in an aqueous solution and is transported within the plant. This slowly releases ethylene.

(i) Ethephon is known to control fruit ripening (in tomatoes and apples).

(ii) It also helps in accelerating abscission in flowers and fruits (causes thining of fruits like cotton, cherry, walnut, etc.).

(iii) Helps in promoting female flowers, enhances the yield of the fruits, *e.g.*, cucumber.

20. (i) In unicellular organisms, growth means an increase in the population size.

(ii) Growth in plants involves (i) Cell division, (ii) Cell enlargement and (iii) Cell differentiation

(iii) Cell divisions occur in the meristems, found in the shoot apex (where growth in length is achieved), vascular cambium and cork cambium (where growth in thickness is achieved).

(iv) When rate of growth is plotted in terms of length, size, area, volume or weight, growth curve is obtained.

(v) The rate of growth is represented against definite period of time.

(vi) S-shaped or sigmoid growth curve is exhibited by numerous annual plants.

(vii) The period during which the growth shows increase is called grand period of growth.

(viii) The rate of plant growth is slow in the initial stages (lag phase), increases rapidly thereafter (exponential phase) and again slows down due to limitation of nutrients (stationary phase).

(ix) Growth in plant is measured in terms of an increase in size / volume, or area of an organ in a unit time.

21. Auxins and cytokinins together cause cell division in callus during tissue culture process. More auxin and less cytokinin causes root initation whereas less auxin and more cytokinin causes shoot formation. This is an example of synergistic action. Auxin inhibits growth of lateral buds whereas cytokinins promote it. This is an example of antagonistic action of the two hormone in plants

22. The role of ethylene is both positive and negative. Ethylene is a simple gaseous Plant Growth Regulator (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 especially of leaves and flowers.

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

OR

Abscisic acid is a mildly acidic dextrorotatory *cis* sesquiterpene growth hormone which functions as a general growth inhibitor by counteracting other hormones or reactions mediated by them.

It was originally discovered for its role in regulating abscission and bud dormancy.

23. Physiological roles and functions of gibberellins are as follows :

(i) Expansion of leaves : Gibberellin induces the increase in diameter as well as surface area of leaf blade.

(ii) Synthesis of hydrolytic enzymes : Gibberellin increases the synthesis and activity of hydrolytic enzymes which in turn hydrolyse the cell wall polysaccharides and help in cell elongation.

(iii) Seed and bud dormancy : Gibberellin breaks dormancy in buds and seeds of various plants. In these cases they act as germination promoter and prevent the activities of abscisic acid.

(iv) Senescence : Gibberellins prevent senescence of immuture plant parts by preventing the activities of abscisic acid and ethylene.

(v) Adventitious root formation : In some plants it helps in adventitious root formation.

(vi) α-amylase activity : Gibberellin's are synthesized within the tissues of the germinating embryo. It is then transported to the aleurone layer. It is the proteinaceous part for nourishment of the embryo.

(vii) Parthenocarpy : Gibberellin induces seedless fruit formation in some plant species.

OR

Different physiological roles of cytokinin are as follows :

(i) Cytokinesis : The action of cytokinin is specific in mitosis. Thus specificity of cytokinin in the induction of cytokinesis is well established.

(ii) Morphogenesis : Cytokinin is essential for morphogenesis in tissue culture. Formation of shoots and adventitious roots by the callus is called organogenesis. A proper ratio of cytokinin (as well as other hormones) is chosen for the development of an entire plant from a callus.

(iii) Delaying senescence : Cytokinin content of a leaf is decreased when a mature leaf is removed from a plant. Immediately senescence occurs in that particular leaf. But the application of kinetin retards senescence. Richmond and Lang (1957) noted this effect for the first time in *Xanthium.* It is popularly known as 'Richmond and Lang effect'.

(iv) Breaking of dormancy : Cytokinin breaks dormancy and promotes germination in some seeds.

(v) Promotion of axillary bud development : Cytokinins promote the growth of axillary bud and suppress the growth of apical bud.

(vi) Chloroplast development and chlorophyll synthesis : Cytokinin enhances the development of chloroplast from etioplasts or pre-platids, especially by promoting grana formation. It also increases the rate of chlorophyll synthesis, probably by formation of one or more proteins to which chlorophylls bind and become stabilised.

24. Physiological roles of auxin are as follows :

(i) Cell enlargement and elongation : Auxin induces cell enlargement by :

(a) increase in osmotic content of the cell
(b) increase in cell membrane permeability to water
(c) reduction in wall pressure
(d) synthesis of wall material
(e) increase in respiration
(f) synthesis of specific RNA and proteins which results in increase in cell wall plasticity

(ii) Growth and cell elongation : The most profound effect of IAA is cell elongation. The concentration of IAA at which stimulation of growth takes place vary along with the type of the tissues. As for example, higher concentration of IAA is needed for the growth of stem but the same concentration inhibits growth in roots and buds.

Another hormonal compound ethylene thwarts the action of IAA. Inhibition of growth in presence of high IAA concentration takes place due to ethylene production. The stimulatory effect of IAA on growth is masked by the ethylene activation.

(iii) Cell division and tissue differentiation : IAA stimulates cambial activity. As a result the rate of cell division increases rapidly in a particular part of the plant. In the shoot apical meristem differentiation of vascular tissues are regulated by appropriate IAA concentration.

(a) Auxin initiates and enhances cell division by inducing meristematic activity and cambial cell activity.

(b) Auxin induces early differentiation of xylem and phloem in tissue culture experiments.

Auxin + 2% sucrose – Xylem-differentiation

Auxin + 3% sucrose – Xylem and phloem differentiation

Auxin + 4% sucrose – Phloem differentiation

(c) In tissue culture growth of callus requires the presence of auxin, *e.g.*, 2, 4-D.

(iv) Adventitious root formation : IAA stimulates adventitious root formation in stem, leaf and root cuttings. As a result commercial IAA (synthetic auxin) is used by horticulturist and floriculturist for formation of roots. Higher concentration of auxins are needed to induce adventitious root formation but the same concentration inhibits root elongation.

Again the development of prop root system in horizontally spreading branches of *Ficus* is under the control of IAA. Stilt roots of *Pandanus*, *Zea*, *Saccharum*, etc, are produced by the activity of auxins.

(v) Phototropism : Stem tips move towards the source of light. It is referred to as phototropism. IAA regulates phototropism and light plays the key role. Growth curvature of the stem is due to unequal distribution of IAA in the organ. However, IAA activates in low light intensity. In the high light intensity (also in presence of riboflavin, xanthophylls, etc.) IAA is photoxidised to 3-methyl-2-auxindole and loses its activity.

(vi) Geotropism : Previously it was thought that auxin and ethylene together cause geotropism. Recent investigations have put forward the view that ABA produced within the root cap is responsible for geotropism. IAA may have some role in the geotropic responses.

(vii) Senescence and abscission : Ethylene promotes the synthesis of certain cell wall degrading enzymes, *e.g.*, cellulase, pectinase, etc. These enzymes are responsible for the formation of abscission layer but IAA reverses the effect of ethylene. Thus IAA retards senescence and abscission. Developing fruits, maturing seeds etc., synthesize large amount of IAA which prevents the premature senescence of these plant parts.

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