7 Plant Growth and Development

7.0 : Introduction :

Q.1. Define growth.

Ans: Growth may be defined as a vital process which brings about irreversible increase in any organism or its parts with respect to its size, form, weight and volume.

Q.2. Do non-living objects also show growth? How?

Ans: Yes, non-living objects also show growth and it is extrinsic as it takes place by the addition of similar materials from outside.

Q.3. What is the difference between the growth of non-living objects and living organisms?

Ans: In non-living objects, growth is extrinsic due to addition of similar material from outside. While in living organisms, growth is intrinsic due to addition of cellular material from inside.

Q.4. How does growth take place in unicellular organisms?

Ans: In unicellular organisms, growth involves increase in size and numbers. Cell division leads to reproduction and thus, raises the number of organisms (population). Hence, growth takes place in unicellular organisms.

7.1 : Seed dormancy :

Q.5. Define seed dormancy and give its causes.

Ans: Inability of viable seeds to germinate even under suitable environmental conditions is known as seed dormancy.

Causes of seed dormancy:

Hard seed coat, seed coat impermeable to water and gases, presence of immature 'embryo, sensitivity to light and presence of germination inhibitors.

Q.6. Which are the methods to break seed dormancy?

Ans: Methods to break seed dormancy are:

i. **Scariflcatlon:**
   It is softening of seed coat using sand paper or knives or chemicals like alcohol or acid.

ii. **Stratification:**
   It involves layering of seeds in specific medium and then exposing them to warm stratification at 15°C to 20°C which is followed by cold stratification at O°C to 10°C.

iii. **Removal of germination inhibitors:**
   This includes washing the seeds thoroughly.

iv. **Hormonal treatment:**
   Hormones such as gibberellins or auxins can be used.

7.2 : Seed germination :

Q.7. Explain different types of seed germination with suitable examples.

Ans: Seed Germination:

The process by which dormant embryo of the seed resumes metabolic activities and grows to produce a seedling is called seed germination.

It is the first step in plant growth and occurs when the dormancy period is either over or broken under favourable conditions.

Types of germination:

Three types of seed germination are given below:

Epigeal Germination (epi = above, geo = soil):

i. Cotyledons come above the soil surface.
ii. Hypocotyl shows faster and active growth and thus, elongates considerably.
iii. Epicotyl shows slow growth and remains short during germination.
iv. Radicle comes out first and grows into the soil to form primary root.
v. Plumule comes up above soil to form primary shoot.
vi. Cotyledons become flat and green, they function as embryonic leaves till the development of foliage leaves.
e.g. Tamarind, Cucumber, Cotton, Castor, Papaya, Onion.

Hypogeal germination (hypo = below, geo = soil):

i. The cotyledons remain below soil surface.
ii. Hypocotyl shows slow growth and thus remain short.
iii. Epicotyl shows faster and active growth and thus elongates considerably to push the plumule above soil surface.
iv. Radicle comes out first and grows into the soil to form primary root.
v. Plumule comes up above soil and forms young shoot. e.g. Pea, Gram, Groundnut, Mango, Maize, Jowar,

Vivipary germination:

i. When the seeds germinate within the fruit before the dispersal of fruits from parent plant, it is called viviparous germination.
ii. It is found in mangrove plants like Rhizophora. In such plants, the seed dormancy is absent.
iii. During this type of germination, the hypocotyl elongates and pushes the radicle out of the seed and fruit.
iv. The hypocotyl grows more vigorously and becomes club-like.
v. The young seedling comes out of the fruit showing the long hypocotyl and radicle.
vi. When the seedling gains weight, it gets detached from the fruit, and falls down vertically like a dart.
vii. Now, the radicle penetrates into the mud and grows continuously to form a plant.
e.g. Rhizophora, Sonneratia, etc.

Q.8. Why seed germination in castor is described as epigeal?

Ans: In castor seed, cotyledons are raised above the soil due to the elongation of the hypocotyl during germination, it is called epigeal germination.

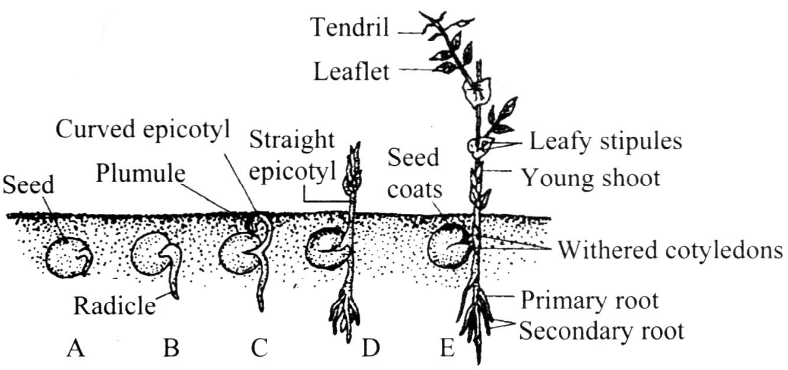
Q.9. Where is food material stored during seed germination? ,

Ans: During seed germination, the food is stored either in cotyledons or endosperm.

Q.10. Draw neat and labelled diagram of the following:

i. Hypogeal germination.

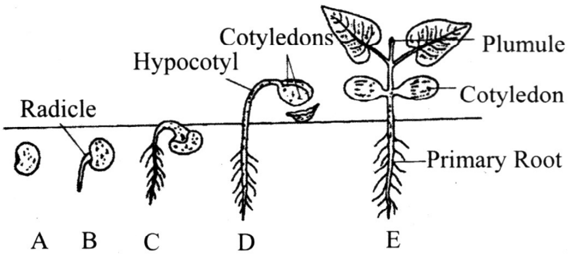
Ans:



Hypogeal germination

ii. **Epigeal germination.**

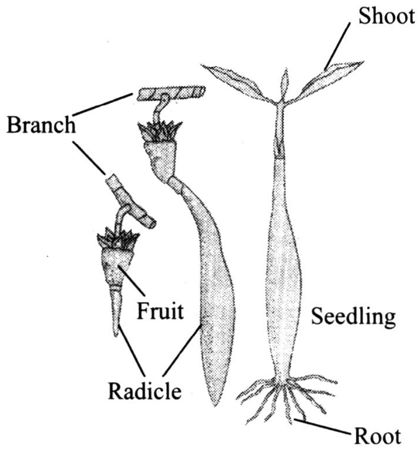
Ans:



Epigeal germination

iii. **Viviparous germination.**

Ans:



Viviparous germination

Q.11. Enlist the changes taking place during germination.

Ans: Changes taking place during germination are as follows:

i. The seeds absorb water from the soil through micropyle and swell.
ii. The rate of respiration increases.
iii. Hydrolytic enzymes present in seeds become active and convert complex food material stored in endosperms or cotyledons into simple units that are easily utilized by growing embryo.
iv. Cell division starts in growing parts of embryo such as radicle and plumule.
v. Radicle comes out of the seed coat and grows towards the soil forming root system.
vi. Due to expansion of embryo, the seed coat ruptures and the plumule develops into shoot system.

Q.12. Distinguish between hypogeal and epigeal germination.

Ans:

No.	Epigeal germination	Hypogeal germination
i.	The cotyledons come out of the soil.	The cotyledons remain in the soil.
ii.	The cotyledons are brought out of the soil by the elongation of the hypocotyl.	The hypocotyl do not elongate. The epicotyl grows and takes the plumule above the soil.
iii.	While coming out, hypocotyl develops curvature.	Epicotyl develops curvature.
iv.	The plumule remains enclosed and protected by cotyledons, still it comes out of the soil.	The plumule comes out of the seed inside the soil.
v.	The cotyledons become flat, green leaf like.	Cotyledons remain enclosed within the seed.
vi.	e.g. Tamarind, Castor, Cucumber, etc.	e.g. Gram, Pea, Maize, etc.

7.3 : Characteristics of growth

Q.13. Give the important characteristics of growth.

Ans: Characteristics of growth:

i. Growth is the permanent increase in size, shape, volume and dry weight.

ii. Growth brings permanent and irreversible changes.

iii. In living organisms, growth is intrinsic (internal) as compared to non-living objects where extrinsic (external) growth is observed.

iv. Growth occurs by cell division and cell elongation followed by cell maturation to form different types of tissues.

v. Plants show an indefinite growth due to the activity of meristematic tissue (tissue which is restricted to some parts or regions of plant like stem, root and branches).

vi. Whereas other parts like leaves, flowers and fruits show limited growth.

vii. In higher plants, growth is not uniform. It is localised due to the specific location of meristematic tissue in the plant body. Meristematic cells are isodiametric, thin walled and consists of a prominent large nucleus and dense cytoplasm. They Eosses capacity to divide and produce new cells.

7.4 : Phases of growth :

Q.14. Mention the phases of growth.

Ans: There are three phases of growth namely - phase of cell division, phase of cell enlargement and phase of cell maturation and differentiation.

Q.15. Describe the phases of growth. Add a note on GPG.

Ans: The meristematic cells divide and give rise to new cells. Every new cell has to undergo the following three phases during the process of growth:

i. Phase of cell division or cell formation or formative phase:

It is the first phase of growth.
In this phase, the meristematic cells undergo mitosis and produce new cells.
These new cells are thin-walled with prominent nucleus and dense cytoplasm.
Vacuoles are absent.
Addition of new cells results in slight increase in size of organs.

ii. Phase of cell enlargement or Elongation phase:

This is the second phase of growth.
The daughter cells formed during elongation phase increase in size and volume.
Generally, the cells get elongated so there is increase in the length of root and stem.
Cell enlargement takes place due to synthesis of more protoplasm and large quantity of solutes.
There is considerable increase in size and weight of an organ or plant.

iii. Phase of cell maturation and differentiation or Maturation phase:

It is the last phase of growth.
The elongated cells undergo maturation and differentiation to obtain permanent size.
The cells get differentiated to form parenchyma, xylem, phloem and sclerenchyma.
Structural and physiological differentiation enables the cells to perform particular function.

Grand period of growth (GPG):

The term "Grand Period of Growth" is given by a German physiologist 'Sachs' (1873).
Grand Period of Growth is the time interval from the formative phase to maturation phase.
Grand Period of Growth is observed in all cells, organs or organisms undergoing growth, thus it is of universal occurrence.
The rate of growth is slow during formative phase.
It becomes maximum in elongation phase and then during the maturation phase, the rate becomes slow and steady till it stops.

The total time required for the completion of three phases of growth is called the "Grand Period of Growth".

Q.16. What is Grand period of growth?

Ans: The time interval from the formative phase to maturation phase is called the 'Grand period of growth.'

Q.17. Define differentiation.

Ans: Differentiation:

The cells derived from root apical and shoot apical meristems and cambium differentiate and mature to perform specific functions. This act leading to maturation is termed as differentiation.

Q.18. What is dedifferentiation and redifferentiation?

OR

Define dedifferentiation and redifferentiation.

Ans: Dedifferentiation:

Parenchymatous cells may regain the capacity to divide and redivide and this is called dedifferentiation.

Redifferentiation:

Interfascicular cambium or cork cambium is formed by dedifferentiation. Secondary growth takes place and the cells get differentiated again, this is called redifferentiation.

Q.19. Which are the factors affecting growth?

Ans: Factors affecting growth:

i. **Water:** It is essential for cell elongation, enzymatic activity and other metabolic processes.
ii. **Nutrients:** These are required for synthesis of protoplasm.
iii. **Oxygen:** It is a key factor in energy metabolism.
iv. **Temperature:** Optimum temperature range is required for normal growth.

Q.20. Explain different phases of growth with the help of growth curve.

OR

Sketch, label and describe the standard growth curve.

OR

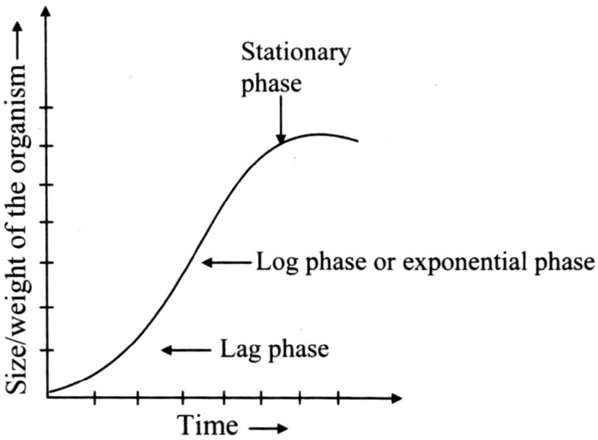
Describe briefly sigmoid growth curve.

Ans: Growth curve:

Growth curve is a graphic representation of the rate of growth plotted against time.

It is always'S' shaped or sigmoid.

Each growth curve consists of 3 phases, viz. lag phase, log phase, stationary phase.



Growth Curve

i. **Lag phase or Initial growth phase:**
In this phase, the rate of growth is slow.
Many preparatory changes take place in the cells during this phase.
This phase corresponds to the formative phase where the cell division takes place and new cells are formed.
This phase requires more time for a little growth.

ii. **Log phase or Exponential phase:**
In this phase, the growth is rapid.
The maximum rate of growth is achieved during this phase.
It corresponds to the phase of cell elongation.

iii. **Steady phase or Stationary phase:**

In this phase, the growth rate slows down.
During this phase, cell-differentiation is almost complete.
There is no addition of new cells and the growth remains steady.

Q.21. What is sigmoid growth curve?

Ans: When the rate of growth is plotted against time, a 'S' - shaped curve is obtained which is called 'Sigmoid growth curve'.

Q.22. Why is growth curve always'S' shaped in plants?

Ans: i. In plants, the growth is initially slow but becomes rapid afterwards.
ii. Finally, the growth slows down to a steady state.
iii. For this reason, the growth curve is always'S' shaped.

Q.23. In which phase does maximum growth take place?

Ans: Maximum growth takes place in log phase.

Q.24. Define growth rate.

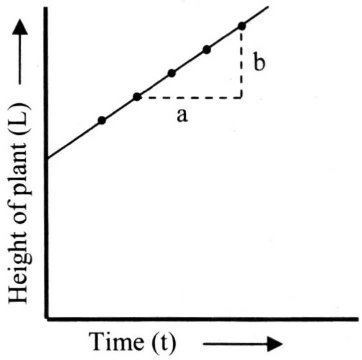
Ans: Increase in growth, per unit time is called growth rate.

Q.25. Explain arithmetic and geometrical growth.

Ans: In an organism, cell division occurs to produce new cells. These new cells are produced either by arithmetic or geometric way.

i. Arithmetic growth:

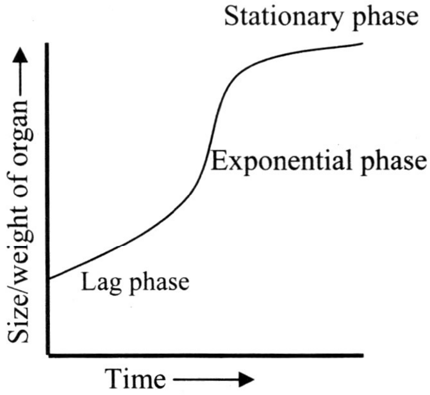
In arithmetic growth, only one daughter cell continues to divide and other goes for differentiation and maturation.
In root, elongation takes place by arithmetic growth.
It shows constant linear growth and can be represented as follows:
$L_1 = L_0 + r_1$
L_1 = Length at time 't'
L_o = Length at time 'zero'
r = growth rate/elongation per time unit.



Constant linear growth

ii. Geometrical growth:

It shows three different phases - lag, log and stationary phase.
Initial growth is slow. It rapidly increases till it reaches the stationary phase ..
At stationary phase, all the progeny cells retain the ability of cell division.
Geometrical growth can be expressed as follows:
$W_1 = W_o e^{rt}$
W_1 = Final size (weight, height, number, etc)
W_0 = Initial size at the beginning.
r = growth rate
t = time of growth
e = base of natural logarithms



Sigmoid growth

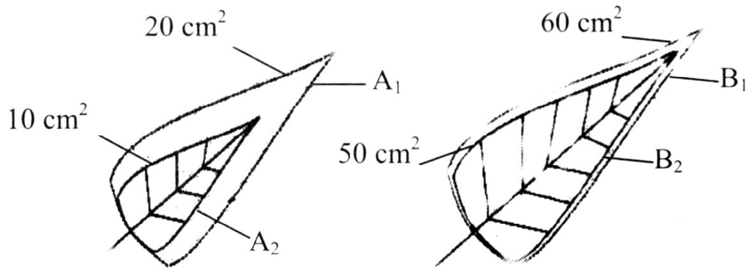
Q.26. Define absolute growth rate and relative growth rate.

Ans: i. Absolute growth rate:

Measurement and comparison of total growth per unit time is called absolute growth rate.

ii. Relative growth rate:

Growth of the given living system per unit time expressed on a common basis is called relative growth rate.



Comparison of absolute and relative growth

In the given figure, the leaves 'A' and 'B' having different sizes show increase in their area by 10 cm^2, Both of them show absolute increase in the area in the given unit time. However, leaf' A' shows more relative growth.

Q.27. Define development and state the factors influencing the development.

OR

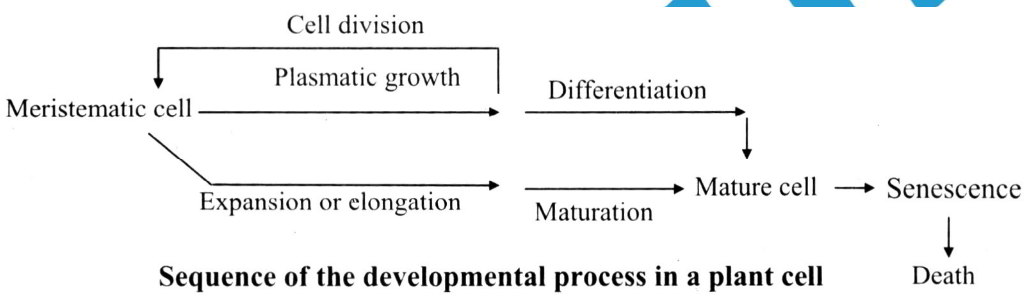
Define Development.

Ans: Development is the sum total of growth and differentiation.

Development is influenced by both intrinsic (genetic and hormonal) factors and extrinsic (light, temperature, water, oxygen, nutrients) factors.

Q.28. Draw a diagram to represent the sequence of the developmental process in a plant cell.

Ans:



Sequence of the developmental process in a plant cell

7.5 : Plant growth regulators (Plant growth hormones or phytohormones) :

Q.29. What are Phytohormones?

Ans: Phytohormones are the organic compounds produced by the plants which promote, inhibit or control the growth or influence other physiological functions.

Q.30. What are the characteristics of plant growth regulators.

Ans: Characteristics of plant growth regulators:

i. They are essential organic compounds other than nutrients.
ii. They are required in very small quantities.
iii. They are generally synthesized at the root, shoot and leaf apices.
iv. The plant growth regulators are transported from their origin to other parts to bring about their effect.
v. Production of growth regulators is under genetic control.
vi. Environmental factors are also essential for their synthesis.
vii. Different aspects of growth can be regulated or controlled by a single growth regulator.

Q.31. What are the types of plant growth regulators?

Ans: The types of plant growth regulators are:

i. Auxin ii. Gibberellins iii. Cytokinins
iv. Ethylene v. Abscissic acid

Q.32. What are auxins? Where are they synthesized? Name the precursor of auxin.

Ans: i. Auxins are a group of organic compounds produced naturally by plants. They influence various aspects of growth, especially cell elongation.

ii. Synthesis of auxins take place continuously in the shoot apices, root apices and leaves.

iii. Precursor of auxin is tryptophan.

Q.33. Write a note on Avena Curvature test.

Ans: F.W. Went (1928), in his experiment isolated auxin from coleoptile tip of oat (Avena sativa) plant in the form of Indole - 3 - Acetic Acid (IAA).

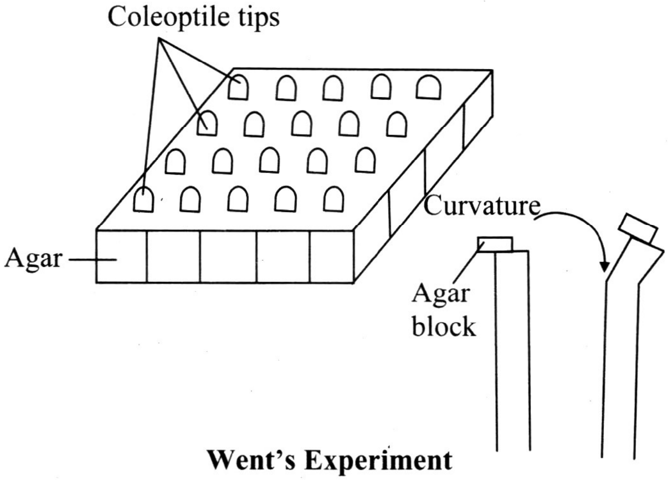
When he cut off the tips of the Avena coleoptiles and placed them on small thin agar blocks for a certain period of time, he found that agar blocks were placed asymmetrically on cut coleoptile stumps.

He noticed that all the coleoptile showed typical curvature even indark.

He concluded that some substances from cut coleoptile tip were diffused into the agar blocks which cause growth and curvature in other coleoptile stump.

He also developed a method for determining the amount of this growth substance.

This method is famous by the name of "Avena Curvature Test".



Went's Experiment

Q.34. Give the physiological effects (applications) of Auxins.

OR

Give applications of auxins.

Ans: Role (applications) of auxins:

i. Auxins play an important role in initiation and promotion of cell division.

ii. Auxins are widely used in tissue culture technique because they help in callus formation.

iii. Auxins help in the formation of adventitious roots from cuttings when applied In lower concentrations. In tissue culture also, auxins are used for root initiation.

iv. Auxins play an important role in apical dominance, i.e. suppression of growth of lateral buds by apical buds.

v. Higher concentration of auxin promote growth of stem.

vi. Auxin prevents abscission by preventing the action of hydrolytic enzymes in abscission layer.

vii. Auxins are used in production of parthenocarpic fruits in plants like orange, apple, tomato and grapes.

viii. Auxin (2, 4 - D) is used to eliminate dicotyledonous weed from a mono cot crop field.

Q.35. Which auxin is used as weedicide?

Ans: 2,4-D is used as a weedicide.

Q.36. Describe the properties of Auxin.

OR

Write an account of "Auxins" as growth regulator.

Ans: Properties of auxins:

i. Auxins are weak organic acids produced naturally by plants and are capable of promoting cell elongation during the growth of stem and roots.
ii. Auxins are not catalysts as they are used up in growth process.
iii. Auxins are produced in shoot tips, root tips, young leaf primordia,. etc.
iv. They migrate to the elongation region from their synthesizing region.
v. Auxins are inactivated by light.
vi. Auxins are translocated in polar manner, i.e. from morphological apex to base.
vii. In stems, the translocation of auxin takes place in downward direction, while in roots, it is in upward direction.
viii. Auxins may be natural or synthetic.
ix. Example of natural auxins are Indole-3-acetic acid (IAA) and its derivatives; whereas synthetic auxins are NAA, 2,4 - D, 2, 4, 5 - T, etc.
x. Lower concentration of Auxin promotes growth of roots and axillary bud, whereas higher concentration is required for stem growth.

Additional Information :

Q.37. Give the full forms of given auxins: IAA; NAA; 2,4 - D; 2, 4, 5 - T

Ans: Full forms of some Auxins are as follows:

IAA = Indole - 3 acetic acid
NAA = Napthalene acetic acid
2, 4 - D = 2, 4 - Dichlorophenoxyacetic acid
2, 4, 5 - T = 2, 4, 5 - Trichlorophenoxy acetic acid.

Q.38. Why "art of pruning" is practiced by gardners?

Ans: In "art of pruning", apical bud, i.e. the stem tip is cut off, then the auxin production is stopped and lateral buds become active which results in rapid growth of plants. It gives a bushy appearance to the plant. That is why it is practiced by gardners.

Q.39. Write a note on Apical Dominance.

Ans: i. The presence of apical bud inhibits the growth of lateral buds, this is called apical dominance.
ii. It is believed that the apical dominance is controlled by an auxin which is synthesized in the apical bud.
iii. Auxin migrates from apical bud to lateral buds. Higher concentration of auxin ill apical bud suppresses the growth of lateral or axillary buds.
iv. When apical bud is removed, lateral buds grow and form branches.
v. By removing apical bud, more branches can be produced in plants.

Q.40. What are gibberellins? Write the source of gibberellin. Name the precursor of gibberellin.

Ans: i. Gibberellins are a group of plant hormones exhibiting pronounced effect in shoot system.
ii. They are abundantly found in young expanding organs such as growing shoot tips, leaves, buds, seeds.
iii. Precursor of gibberellin is Acetyl Co-A.
iv. The transport of gibberellin is non-polar, i.e. in all directions.

Q.41. Enlist the applications of gibberellins.

OR

Write the role of gibberellins.

Ans: Role (applications) of Gibberellins:

i. Gibberellins are known to induce elongation of the cells in stem. By the application of gibberellins, genetically dwarf varieties of plants grow to normal size.
ii. Gibberellins are more effective in inducing parthenocarpy than auxins in plants like pear and apple.
iii. Gibberellins playa vital role in breaking the dormancy of buds. .

iv. Gibberellins are used to increase the commercial value of leafy vegetables by causing leaf expansion.
v. Spray of gibberellins brings about increase in size of fruits.
vi. Gibberellin treatment induces flowering in long day plants under short day conditions.
vii. Seed dormancy due to low temperature and light requirement for germination can be broken by gibberellin treatment.
viii. Gibberellins are used to promote seed germination in monocotyledons. It induces synthesis of amylase enzyme which converts insoluble starch into soluble sugar and make it available to embryo as food during seed germination.

Q.42. Who discovered gibberellins and how?

Ans: Kurosawa (1928) discovered gibberellins in rice plants infected by a fungus Gibberella fujikuroi, which causes the 'bakane' or 'foolish seedling disease' in plants.

Q.43. What are cytokinins? Write the source of cytokinins. ame the precursor of cytokinin.

Ans: i. Cytokinins are the group of plant growth hormones which increase the rate of cell division by accelerating cytokinesis.
ii. Skoog and Miller (1955) discovered substances which stimulate cell division while working on tissue culture in tobacco.
iii. They have also isolated a compound from the autoclaved herring (a silvery-fish) sperm DNA.
iv. This compound was named as 'Kinetin'.
v. Cytokinins occur abundantly in the tissues where there is rapid cell division. Cytokinin rich parts are roots, developing fruits and embryos.
vi. In mature plants, they are frequently synthesized in roots and subsequently move to shoots through the xylem.
vii. Precursor of cytokinin is Purine nitrogen base (adenine).

Q.44. Write a note on role of cytokinins.

Ans: Physiological effects/practical applications/role of Cytokinins:

i. Cytokinins play an important role in cell division when combined with auxin. It can induce cell division even in permanent cells.
ii. A balanced combination of cytokinin and auxin is useful for inducing organogenesis. In presence of more auxins than cytokinins, root formation (rhizogenesis) takes place. In presence of less auxins than cytokinins, shoot formation (Caulogenesis) takes place.
iii. Cytokinins initiate the formation of chloroplasts in the presence of light.
iv. Cytokinins delay senescence by preventing degradation of metabolites or by promoting the synthesis of metabolites.
v. Cytokinins stimulate the growth of lateral buds and reduce the apical dominance.
vi. Cytokinins help in the formation of interfascicular cambium during secondary growth of plants.

Q.45. What is senescence?

Ans: The period between complete maturity and final death of an organ or organisms is called senescence.

Q.46. What is Richmond-Lang effect?

Ans: Due to cytokinins, there is delaying of senescence by preventing the degradation of metabolites or by promoting their synthesis. It is called Richmond-Lang effect.

Q.47. What is ethylene? Write the source of ethylene. Name the precursor of ethylene.

Ans: i. Ethylene is the only naturally occuring gaseous plant growth regulator.
ii. Ethylene is a colourless, unsaturated hydrocarbon gas, which is lipid soluble and lighter than air.
iii. The hormone is effective in ripening of fruits, hence commonly called ripening hormone.
iv. Ethylene is produced by roots, leaves, flowers, fruits and seeds. Shoot apex of seedling and ripening fruits are the major sites of ethylene formation.
v. Precursor of ethylene is methionine.

vi. Application of auxins promote ethylene production, so it is also called secondary hormone.
vii. Increased CO_2 concentration has inhibiting effect on ethylene.

Q.48. Enlist the applications of ethylene.
Ans: Applications (Physiological effects) of Ethylene:

i. Ethylene plays an important role in breaking the dormancy of seeds and buds. It also overcomes dormancy of potato tubers.
ii. Ethylene promotes senescence besides abscission of organs like leaves and flowers.
iii. Ethylene inhibits the elongation of stem and roots in dicots.
iv. Ethylene plays an important role in commercial ripening of fruits. Thus plays a significant role in post - harvest technology.

Q.49. How does ethylene playa significant role in post harvest technology?
Ans: Ethylene is widely used for commercial ripening of fruits.
The green and unripe fruits are picked up from the field and transported to the desired destination in CO_2 rich medium, which prevents ripening.
After that, CO_2 rich medium is removed which leads to ethylene formation. This results in ripening of fruits.

Q.50. Which hormone is called stress hormone?
Ans: Abscissic acid is called stress hormone.

Q.51. Why ABA is called stress hormone?
OR
Why is abscissic acid also known as stress hormone?
Ans: i. ABA is a naturally occuring growth inhibiting hormone which plays an important role in abscission and dormancy.
ii. It is produced in stem, mature leaves, fruits and seeds.
iii. It is produced in adverse climatic conditions and hence, also called stress hormone.

Q.52. Which hormone is also known as anti-gibberellin? Why?
Ans: Abscissic acid (ABA) is also known as anti-gibberellin because it inhibits the growth which is gibberellin stimulated.

Q.53. Write the physiological effects of ABA over plants.
OR
Explain the role of abscissic acid as a stress hormone.
Ans: Physiological effects of abscissic acid:

i. Abscissic acid is called stress hormone because it is produced during drought and unfavourable climatic conditions.
ii. During drought and other adverse conditions, ABA is formed in leaves, it brings about the closing of stomata to reduce the rate of transpiration. Thus, abscissic acid acts as antitranspirant.
iii. ABA promotes senescence in leaves by causing loss of chlorophyll and decreasing rate of photosynthesis. ABA also inhibits the synthesis of RNA and proteins.
iv. Abscissic acid enables the seeds to withstand under the conditions of water stress.

Q.54. Which one of the plant growth regulators would you use, if you are asked to.
i. Induce rooting in a twig.
ii. Quickly ripen a fruit.
iii. Delay leaf senescence.
iv. Induce growth in axillary buds.
v. Induce immediate stomatal closure in leaves.
Ans: i. Auxin ii. Ethylene iii. Cytokinins· iv. Cytokinins v. ABA

Q.55. What would be expected to happen if,

- **i. GA_3 is applied to rice seedlings.**
- **ii. Dividing cells stop differentiating.**
- **iii. A rotten fruit gets mixed with unripe fruits.**
- **iv. You forget to add cytokinin to the culture medium.**

Ans: i. Rice seedlings will elongate rapidly.

ii. If dividing cells stop differentiating then, it leads to formation of mass cells, which is known as callus.

iii. Due to ripening activity of rotten fruit, ethylene will be produced and unripe fruits will ripe quickly.

iv. In absence of cytokinins, in culture medium, callus will not develop shoot buds.

7.6 : Photoperiodism :

Q.56. Who had first used the term photoperiodism?

Ans: The term 'photoperiodism' was first used by the American plant breeders Gamer and Allard (1920) in a variety of tobacco 'Maryland mammoth '.

Q.57.What is photoperiodism? Explain how the plants are classified on the basis of photoperiods required.

Ans: Photoperiodism:

The response of plants to the relative length of light and dark periods with reference to initiation of flowering is called photoperiodism.

Classification of plants on the basis of photoperiodic responses:

On the basis of their photoperiodic response, plants have been classified into the following three groups:

a. Short Day Plants (SDP):

i. These plants show flowering only when they are exposed to light for a duration shorter than their critical photoperiod.

ii. A typical short day plant requires 10^{-11} hours of light period.

iii. The dark period (night period) should be uninterrupted even by a flash of light.

iv. Therefore, these plants are also called long night plants.

e.g. Chrysanthemum, Cosmos, soyabean, Bryophyllum, Dahlia, Sorghum, Xanthium, etc.

b. Long Day Plants (LDP):

i. These plants show flowering only when they are exposed to light for a period longer than their critical photoperiod.

ii. These plants generally need shorter night periods for flowering, hence called short night plants.

iii. In these plants, there is no effect on flowering even if the dark period is interrupted.

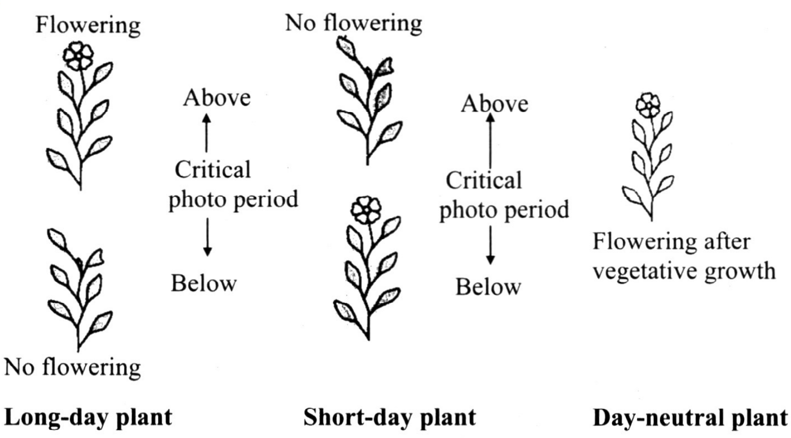
e.g. Lettuce, beet, poppy, spinach, wheat, radish, mentha, etc.

c. Day Neutral Plants (DNP):

i. The plants in which flowering is unaffected by the duration of light are called day neutral plants.

ii. The day neutral plants are also known as photoneutral plants or intermediate plants.

e.g. Shoe-flower, sunflower, tomato, four o'clock plant, cucumber, rose, etc.



SDP, LDP and DNP

Q.58. What are photo neutral plants?

Ans: The plants in which flowering is not affected by length of the day, are known as photo neutral plants.

Q.59. What is critical photoperiod?

Ans: The duration of light required to induce flowering in a plant is called critical photoperiod.

Q.60. Distinguish between long day plants and short day plants.

Ans:

No.	Long day plants	Short day plants
i.	These plants show flowering only when they are exposed to light for a period longer than their critical photoperiod.	These plants show flowering only when they are exposed to light for a duration shorter than their critical photoperiod.
ii.	Long day plants require a short night period for flowering. Therefore, also called short night plants.	Short day plants require a long uninterrupted night period for flowering. Hence, they are also called long night plants.
iii.	e.g. Spinach, wheat, radish, beet, lettuce, mentha, poppy, etc.	e.g. *Cosmos, Dahlia, Chrysanthemum*, Marigold, etc.

Q.61."Both a short day, plant and a long day plant can produce flower simultaneously in a given place". Comment.

Ans: Flowering in plants depends not only on combination of light and dark exposures, but also on their relative durations. Both short day plant and long day plant will produce flowers, simultaneously at a given place only when they are exposed to required photoperiods by natural or artificial means.

Q.62. Would a defoliated plant respond to photoperiodic cycle? Why?

Ans: Photoperiodic response is perceived by leaves, a defoliated plant will not respond to photoperiodic cycle.

Q.63. Write the mechanism of photoperiodism.

OR

Describe the physiology of flowering.

Ans: Mechanism of photoperiodism:

i. It has been suggested that a substance responsible for flowering is synthesized in plants, when exposed to proper photoperiod.
ii. Cajlachjan (1935) demonstrated the existence of such a flower forming hormone and named it as florigen.
iii. It is believed that florigen is synthesized in leaves when a plant is exposed to its correct photoperiod.
iv. From the leaves, the florigen gets transported to apical meristem through phloem.
v. A plant which is not exposed to proper photoperiod can flower when it is grafted to another plant that has already received suitable photoperiod.
vi. It indicates that florigen is synthesized in treated plant and transported to grafted plant.

7.7 : Photomorphogenesis :

Q.64. Which responses in plants can be induced by light?

Ans: In plants, light induces phototropism, photomorphogenesis, chloroplast differentiation and various other responses like flowering and germination.

Q.65. What is the difference between skotomorphogenesis and photomorphogenesis?

Ans: Plants in response to light stimulus exhibit different growth habits in dark and light. In dark, plants have elongated stems, undifferentiated chloroplasts and unexpanded leaves. This is known as skotomorphogenesis. This phenomenon is also known as etiolation. In presence of light, plants show inhibition of stem elongation, differentiation of chloroplasts and accumulation of chlorophyll and expansion of leaves. This is known as photomorphogenesis.

Q.66. Write a short note on phytochrome.

Ans: i. Phytochrome is a protein containing a covalently attached chromophore.

ii. Phytochrome exists in two interconvertible forms with different absorption spectra.

iii. Pfr absorbs far red and is generally the biologically active form.

iv. Pr absorbs red and gets converted to Pfr.

v. While absorption offar red converts Pfr to Pr.

7.8 : Vernalization :

Q.67. What is vernalization?

Ans: The cold treatment or chilling treatment of germinating seeds or seedlings to promote early flowering in plants is called vernalization or yarovisation.

Q.68. How was vernalization first noticed?

Ans: i. Vernalization was first noticed by Klippart in 1857.

ii. He found that the winter variety of wheat (which are sown in winter and flowers in summer) can be converted to. spring variety of wheat (which is sown in spring and flowers in summer).

iii. Klippart observed that this process of conversion can be done if the germinating seeds were kept at near freezing temperature (0° – 5°C).

iv. T.D. Lysertko (1928), a Russian geneticist first termed the process as vernalization.

Q.69. Write an account of vernalization.

Ans: Vernalization:

The cold treatment or chilling treatment of germinating seeds or seedlings to promote early flowering in plants is called vernalization or the method of inducing early flowering in plants by pretreatment of their seeds at very low temperature is called vernalization.

Mechanism of vernalization:

i. The method of vernalization was developed in Russia by Lysenko (1928).

ii. It was suggested by Melchers (1939) that vernalization initiates a stimulus for the formation of a hormone called vernal in.

iii. Thus, when vernalization treatment is given to seeds or seedlings at low temperature (O°C - 5°C), it induces flowering.

iv. Vernalization reduces vegetative period and induces an early flowering.

v. Althoughl it is believed that vernalin induces early flowering in plants, its existence is hypothetical and it is yet to be isolated.

vi. Plant physiologists believe that vernalization alone is not enough to induce flowering in. plants. It should be followed by the exposure of plant to its required photoperiod.

Q.70. Explain the site for vernalization.

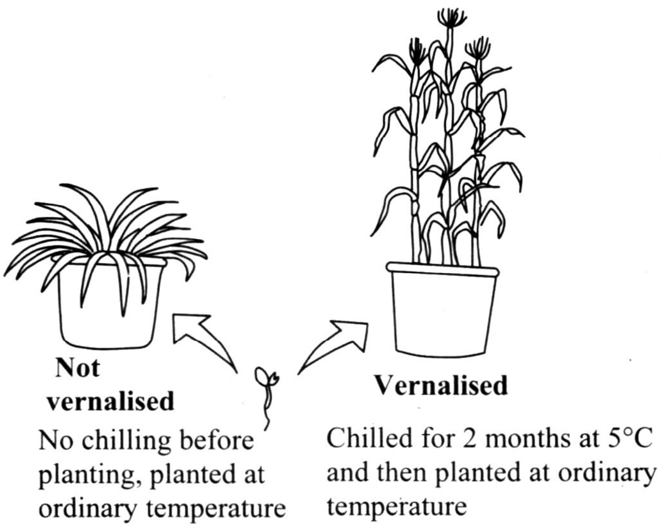
Ans: Site for Vernalization:

i. The site for vernalization in biennials and perennials is the growing point, i.e. shoot apex.

ii. In annuals, vernalization takes place at seed stage.

iii. In seeds, embryo receives vernalization stimulus.

iv. Seeds are soaked in water and given



Vernalization (Petkus rye)

cold treatment at O°C-soC.

v. These seeds are dried and stored.

vi. Age at which plant can be vernalized varies from species to species.

Q.71. What are the various conditions involved in vernalization?

Ans: Conditions for vernalization:

i. Vernalization treatment:
Vernalization treatment is applied to' the seeds or seedlings or to 10 day old plants (in some cases only).

ii. Temperature:
Suitable temperature range for vernalization is oo-S°c.

iii. Duration of treatment:
Duration varies ranging from few days to weeks in different species.

iv. Stimulus for vernalization:
Stimulus occurs in the growing points, r.e. shoot apex (biennials and perennials), embryo (water soaked seeds).

v. Devernalization:
Devernalization is the reversal effect of vernalization, which is done by high temperature treatment.

vi. Vernalin:
Vernal in is a horrnone which induces flowering and is initiated by vernalization. This was suggested by Melchers (1939).

Q.72. Explain the process of Vernalization.

Ans: Process of vernalization:

i. The seeds are allowed to germinate for sometime.

ii. Then, cold treatment is given to semi-germinated seeds keeping them at 0°-5°C.

iii. The period of cold treatment varies from few days to many weeks from species to species.

iv. The seedlings are allowed to dry for sometime after the cold treatment and then sown.

v. They should not be sown immediately after the cold treatment and drying period should not be very long.

Q.73. Which condition is responsible for devernalization?

Ans: High temperature of about 35°C is responsible for devernalization.

Q.74. What do you understand by photoperiodism and vernalization? Describe their significance.

Ans: Photoperiodism:

The response of plants to the relative length of light and dark periods with reference to initiation of flowering is called photoperiodism.

Significance of photoperiodism:

i. Photoperiodism is of great practical importance in hybridisation or breeding experiments.

ii. Plants can be made to flower in any part of the year by providing artificial light or darkness.

iii. It is also useful to keep some plants in vegetative growth to obtain higher yield of tubers, rhizomes, etc.

Vernalization:

The cold treatment or chilling treatment of germinating seeds or seedlings to promote early flowering in plants is called vernalization.

Significance of vernalization:

i. Vernalization increases the cold resistance of plants.

ii. It reduces vegetative period of development and induces early flowering.

iii. It increases resistance against fungal diseases.

iv. Winter varieties of plants can be converted into spring varieties by vernalization, also it converts biennial variety to annuals.

v. It increases the crop production.

Additional Theory Questions :

Q.1. Define seed germination. Refer Q.7.
Q.2. Write short notes on epigeal germination and viviparous germination. Refer Q.7.
Q.3. Describe hypogeal seed germination. Refer Q.7. and Q.1O.(i): For Diagram
QA. Write a note on Grand period of growth. Refer Q.15.
Q.5. Write a note on formative phase. Refer Q.15.(i)
Q.6. Sketch and label a typical growth curve. Refer Q.20.
Q.7. What are gibberellins? Enlist the applications of gibberellins. Refer Q.40 and 41.
Q.8 Give an account of the ripening hormone. Refer Q.47 and Q.48.
Q.9. Define SDP and LDP. Give one example of each Refer Q.57(a) and (b)

Quick Review :

Seed germination

- Hypogeal germination e.g. Gram, groundnut, pea, mango
- Epigeal germination e.g. Castor, Tamarind
- Viviparous germination e.g. *Rhizophora, Sonneratia*

Phases of growth

- Phase of cell division or Formative phase → Meristematic cells undergo mitosis to produce new daughter cells.
- Phase of cell enlargement or Elongation → Enlargement of daughter cells.
- Phase of Maturation and differentiation or Maturation phase → Elongated cells undergo maturation and differentiation to gain permanent size.

Growth hormones

- Auxins → Promotes cell elongation.
- Gibberellins → Promotes elongation of cells in stem and induces development of parthenocarpic fruits.
- Cytokinins → Stimulates cell division.
- Ethylene → Promotes ripening of fruits.
- Abscissic acid → Stress hormone and growth inhibitor.

- **Scientists and their contribution :**

No.	Scientist	Contribution	Year
i.	F.W. Went	Performed Avena-curvature test to prove the presence of auxin.	1928
ii.	Kurosawa	Discovered gibberellins in rice plants infected by a fungus.	1928
iii.	Skoog and Miller	Discovered the growth regulator cytokinin.	1955
iv.	Garner and Allard	Discovered photoperiodism in a variety of tobacco, *Maryland mammoth*.	1920
v.	Cajlachjan	Demonstrated the existence of flowering hormone named florigen.	1935
vi.	T.D. Lysenko	Termed cold treatment for flowering as vernalization.	1928
vii.	Sachs	Gave the term 'Grand period of growth'.	1873
viii.	Yabuta and Sumiki	Isolated disease causing substance in crystalline form and named it gibberellin.	1938
ix.	Gane	Reported that ethylene synthesized by plants promotes ripening of fruits.	1934

Multipal Choice Question's

1. The growth of plants differ from that of animals in being
a) localized b) diffused
c) temporary d) permanent

2. Growth in non living objects is
a) extrinsic b) intrinsic
c) localized d) rapid

3. Causes of seed dormancy are
a) hard seed coat
b) immature embryo
c) seed weight
d) both a) and b)

4. The first step towards plant growth is
a) dormancy b) germination
c) vernalization d) photoperiodism

5. During seed germination, when cotyledons remain below the ground, then it is called"
a) hypogeal germination
b) epigeal germination
c) viviparous germination
d) oviparous germination

6. Which of the following seeds is hypogeal?
a) Rhizophora b) Castor
c) Tamarind d) Pea

7. When cotyledons are above the ground, germination is
a) epigeal b) hypogeal
c) vivipary d) ovipary

8. The correct sequence of different phases of growth is
a) Elongation, Formative, Maturation
b) Formative, Elongation, Maturation
c) Differentiation, Elongation, Maturation
d) Maturation, Formative, Elongation

9. In cell enlargement phase, cells elongate due to
a) endosmosis b) imbibition
c) diffusion d) plasmolysis

10. The phase in which rate of growth is slow is
a) lag phase
b) log phase
c) exponential phase
d) senescence phase

11. When growth rate is plotted against time, the curve obtained is
a) sigmoid b) S - shaped
c) both a) and b) d) J - shaped

12. The phase where growth reaches its maximum value is
a) log phase b) lag phase
c) exponential phase d) both a) and c)

13. Stationary phase is also called
a) lag phase b) log phase
c) exponential phase d) steady phase

14. Which of the following instrument is used to measure the rate of growth?
a) Mamometer b) Auxamometer
c) Potometer d) Anemometer

15. The substances synthesized at the tip of the stem

and control growth elsewhere are
a) auxins b) vitamins
c) enzymes d) florigen

16. The true natural auxin of higher plants is
a) Indole-3-acetic acid
b) Indole-3-acetaldehyde
c) Indole-3-pyruvic acid
d) Indole-3-nitric acid

17. To promote the growth of lateral branches of a plant
a) auxin is applied to the apical bud
b) auxin is applied to the decapitated shoot tip
c) axillary buds are removed
d) apical bud is removed

18. The auxin used to destroy broad leaf dicots is
a) IAA b) IBA
c) 2, 4-D d) 2,4,5-T

19. Which of the following is not a function of auxin?
a) root initiation
b) flower initiation
c) fruit ripening
d) prevention of premature fruit drop

20. Synthetic auxins are
a) NAA b) 2,4-D
c) 2,4,5-T d) all of these

21. Transport of gibberellins in plants is
a) polar b) non-polar
c) apex to base d) base to apex

22. Gibberellin is obtained from
a) Gibberella fujikuroi
b) Coconut milk
c) Spirogyra
d) Gibberella chrysogenum

23. Gibberellin was first isolated by
a) Kurosawa
b) Yabuta and Sumiki
c) Suzuki
d) Yelstin

24. The fungus Gibberellin attacked _____ plant.
a) Wheat b) Rice
c) Lemon grass d) Tulip

25. Internodal elongation is stimulated by
a) auxins b) gibberellins
c) cytokinins d) ABA

26. The elongation of stem by gibberellins is due to
a) elongation of internode
b) rapid cell division
c) both a) and b)
d) elongation of node

27. Which of the following is used for the production of large seedless grapes?
a) auxin b) cytokinin
c) ethylene d) gibberellin

28. Which of the following physiological effects is caused in plants by gibberellic acid?
a) shortening of genetically tall plants
b) elongation of genetically dwarf plants
c) rooting in stem cuttings
d) yellowing of young leaves

29. Cytokinins are the derivatives of
a) acids b) phenols
c) purines d) glycosides

30. Coconut milk is rich in
a) auxins b) cytokinin
c) ethylene d) GA

31. The effect of cytokinin in retarding ageing is called
a) caulogenesis
b) karyokinesis
c) organogenesis
d) Richmond Lang effect

32. Most common role of cytokinin in plant is
a) cell enlargement
b) cell division
c) elongation of internodes
d) apical dominance

33. The only plant hormone in gaseous state is
a) cytokinin b) auxin
c) GA d) ethylene

34. The fruit ripening hormone is
a) ethylene b) auxm
c) cytokinin d) morphin

35. Precursor of ethylene is
a) methionine b) kinetin
c) adenine d) cytokinin

36. Ethylene is not effective for
a) fruit ripening
b) breaking seed dormancy
c) inhibiting stem elongation
d) preventing senescence

37. The commonly called "Stress hormone" of plants is
a) Auxin b) Gibberellin
c) Abscissic acid d) Cytokinin

38. Abscissic acid is useful in
a) stomatal closure b) leaf expansion
c) root elongation d) stem elongation

39. A physiological response to the duration of light and darkness is a
a) daily phase cycle b) circadian rhythm
c) biological clock d) photoperiodism

40. Photoperiodism is associated with the synthesis of
a) vernalin b) colchicine
c) abscissic d) florigen

41. Which tobacco variety was observed first for photoperiodism?
a) Nicotiana tobaccum
b) Maryland mammoth
c) Phaseolus mungo
d) Allium cepa

42. Which of the following is short day plant?
a) Chrysanthemum b) Spinach
c) Opium d) Wheat

43. Xanthium is
a) SDP
b) LDP
c) DNP
d) not a flowering plant

44. A long-day plant, flowers only if exposed to a light period
a) more than its critical day length
b) less than its critical day length
c) equal to its critical day length
d) slightly less than its critical day length

45. Which of the following is a long day plant?
a) Radish b) Cosmos
c) Dahlia d) Marigold

46. Which ofthe following is a day neutral plant?
a) Shoe-flower b) Chrysanthemum
c) Beet d) Spinach

47. The term 'vernalization' was given by
a) Gamer b) Allard
c) Lysenko d) Sachs

48. The site of vernalization in biennials and perennials is
a) seed stage b) root apex
c) shoot apex d) node

49. In vernalization, the cold stimulus is perceived by
a) axillary bud b) floral bud
c) leaves d) apical bud

50. Most appropriate temperature for vernalization ranges between
a) 0 °C to –4°C b) –5°C to –7°C
c) 5°C to 10°C d) 0°c to 5°c

Answer Keys

1. a)	2. a)	3. d)	4. b)	5. a)	6. d)	7. a)	8. b)	9. a)	10. a)
11. c)	12. d)	13. d)	14. b)	15. a)	16. a)	17. d)	18. c)	19. c)	20. d)
21. b)	22. a)	23. b)	24. b)	25. b)	26. c)	27. d)	28. b)	29. c)	30. b)
31. d)	32. b)	33. d)	34. a)	35. a)	36. d)	37. c)	38. a)	39. d)	40. d)
41. b)	42. a)	43. a)	44. a)	45. a)	46. a)	47. c)	48. c)	49. d)	50. d)