XI
15

PLANT GROWTH AND DEVELOPMENT

SYLLABUS

Seed germination; Phases of Plant growth and plant growth rate; Conditions of growth;
Differentiation, dedifferentiation and redifferentiation; Sequence of developmental process in a plant cell; Growth regulators-auxin,gibberellin, cytokinin, ethylene, ABA; Seed dormancy; Vernalisation; Photoperiodism

KEY CONCEPTS

INTRODUCTION

* Growth is a characteristic feature of all living organisms.
* Growth is a vital process which brings about permanent and irreversible change in any plant or its part. Growth in plants means increase in shape, size, weight and volume of a plant or plant part. Growth leads to increase in fresh weight, dry weight, length, area, volume and cell number.
* Growth is diffused in animals but growth in plants is localised & irregular.(Nail in plant stem, occupies same height till several years of growth).
* Almost all the plants face a period of suspended growth.
* If the suspension of growth is due to exogenously controlled factors (environmental factors) then it is called **quiescence.**
* When the suspension of growth is due to the endogenously controlled factors (hormonal, genetic) then it is termed as **dormancy.**
* In dormancy, an organism reduces its metabolic state to a minimum level to survive unfavourable conditions.
* Development is the sum of two processes: growth and differentiation.
* The development of a mature plant from a zygote (fertilised egg) follow a precise and highly ordered succession of events.
* During this process a complex body organisation is formed that produces roots, leaves, branches, flowers, fruits, and seeds, and eventually they die.

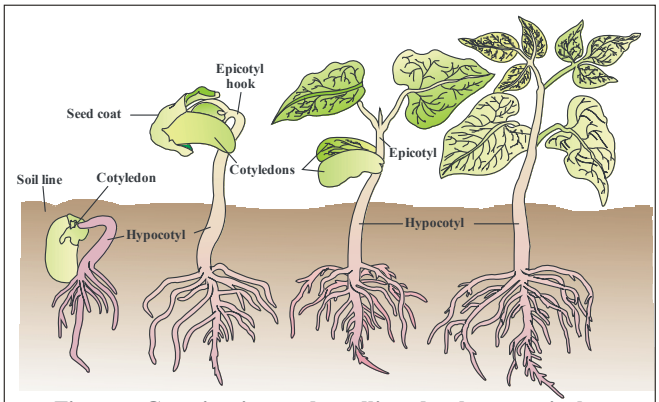


Figure : Germination and seedling development in bean

PHASES OF GROWTH

(i) **Phase of cell division or cell formation :** Number of cells is increases by cell division.

(ii) **Phase of cell enlargement or cell elongation:** Size of cells increased due to vacuolization & TP (Turgor pressure). New cell wall formation.

(iii) **Cell maturation or differentiation phase :** (Also called as Morphogenetic, Organogenic phase) Development or qualitative change is important feature of this phase.

REGIONS OF GROWTH

* In unicellular plants there is overall growth and not confined to any specific region but in multicellular plants growth is restricted to specific regions having meristematic cells.
* On the basis of their position in the plant body (higher plants) meristems are divided into three main categories.

(i) **Apical meristems :** These meristems are found at shoot and root apex. As a result of activity of these meristems plant increases in length. In angiosperms and gymnosperms there is a group of meristematic cells but in bryophytes and pteridophytes there is a single tetrahedral cell found at the shoot apex.

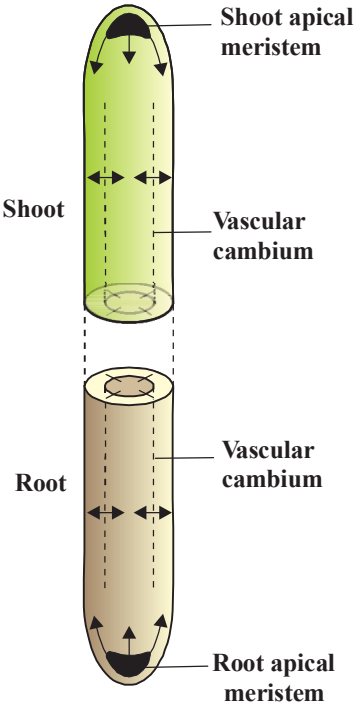


Figure : Diagrammatic representation of locations of root apical meristem, shoot aplical meristem and vascular cambium. Arrows exhibit the direction of growth of cells and organ.

(ii) **Intercalary meristems :** These meristems are found above the nodes. As a result of the activity of these meristems increase in length takes place. e.g., *Bambusa*.

(iii) **Lateral meristems :** These meristems are made up of cells which divide in radial direction only. They form laterally placed new cells towards the centre and periphery.

In dicotyledonous plants and gymnosperms, the lateral meristems, vascular cambium and cork-cambium appear later in life. These are the meristems that cause the increase in the girth of the organs in which they are active. This is known as secondary growth of the plant.

PHASES OF GROWTH

* The period of growth is generally divided into three phases, namely, meristematic, elongation and maturation.

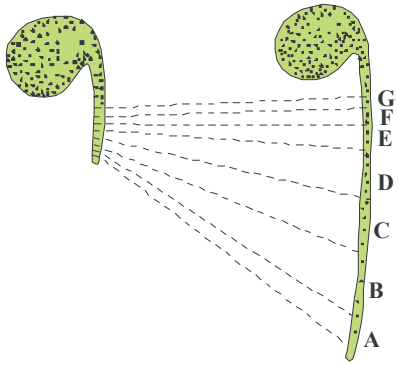


Figure : Detection of zones of elongation by the parallel line technique. Zones A, B, C, D immediately behind the apex have elongated most.

* At the root tips, the constantly dividing cells, both at the root apex and the shoot apex, represent the meristematic phase of growth.
* The cells in this region are rich in protoplasm, possess large conspicuous nuclei. Their cell walls are primary in nature, thin and cellulosic with abundant plasmodesmatal connections.
* The cells proximal (just next, away from the tip) to the meristematic zone represent the phase of elongation.
* Increased vacuolation, cell enlargement and new cell wall deposition are the characteristics of the cells in this phase.

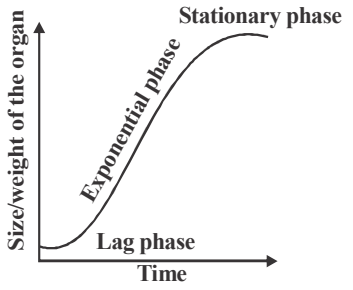
* Further away from the apex, i.e., more proximal to the phase of elongation, lies the portion of axis which is undergoing the phase of maturation.
* The cells of this zone, attain their maximal size in terms of wall thickening and protoplasmic modifications.

GROWTH RATE

It can be defined as the increased growth in plants per unit time.

(a) **Arithmetic growth :** From dividing cell into two new cells formed (by mitotic division) out of them one daughter cell continues to divide while other differentiate and mature (stop dividing) .
Ex. Root & Shoot elongation at constant rate.
It is mathematically expressed as $L_t = L_0 + rt$
where L_t - length at time 't'
L_0 - length at time 'zero'
r - growth rate/elongation per unit time.
It's curve is Linear.

(b) **Geometric / Exponential Growth :** From dividing cell (by mitotic division) both daughter cells retains the ability to divide and continue to do so.
Ex : All cells, -Tissue, Organs, Developing seed, Germinating seed, Seasonal activities etc.
It is mathematically represented as $W_1 = W_0 e^{rt}$
Where, W_1 = final size (Weight, height, number etc.)
W_0 = initial size at the beginning of period.
r = growth rate, e = base of natural logarithms.
It's **curve sigmoid.**



The following phases of growth are recognized.

(i) **Lag phase :** In lag period the growth is slow. It represents formative or cell division phase.

(ii) **Log phase :** Also called as exponential phase. During this phase growth is maximum & most rapid. It represents cell elongation phase.

(iii) **Steady or stationary phase :** It represents cell maturation phase.

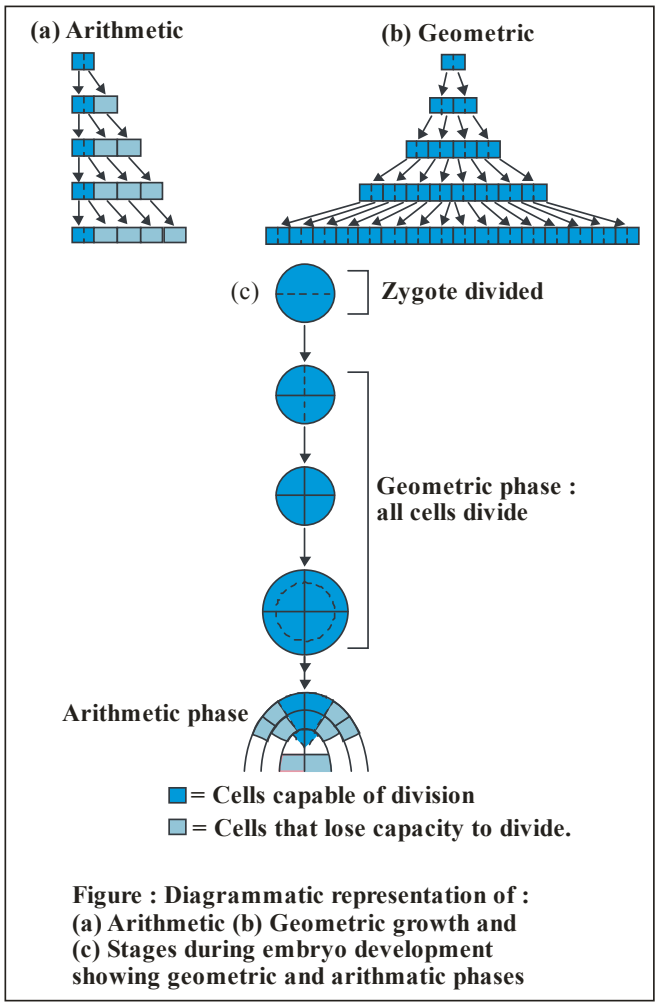


Figure : Diagrammatic representation of : (a) Arithmetic (b) Geometric growth and (c) Stages during embryo development showing geometric and arithmatic phases

(c) **Absolute and Relative growth rates :**

(i) **Absolute growth rate :** Total growth occurs in unit time in plant or plant -parts.

(ii) **Relative growth rate :** Total growth occurs in unit time in comparison to initial parameter in plant or plant parts. Relative growth rate is generally high in young developing plant parts.
For example, in figure shown for leaves A and B absolute growth rate is same but high relative growth rate in A (In leave A growth rate is 100% and in B it is 10%).

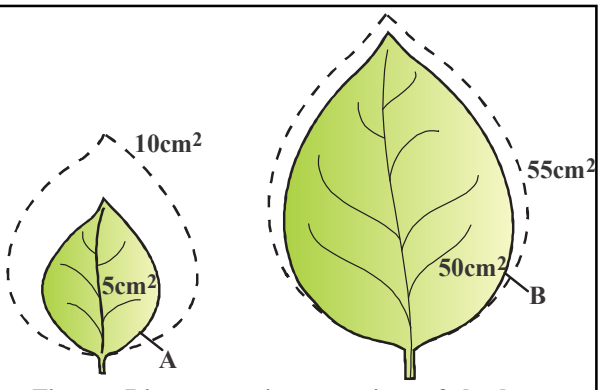


Figure : Diagrammatic comparison of absolute and relative growth rates.

FACTORS AFFECTING PLANT GROWTH

(i) **Light :** Light involved in photosynthesis and determine the direction of shoot and root growth. Light controlled morphogenesis of plant is called **photomorphogenesis.**
Light is not essential during the initial stage of growth or seed germination. In absence of light plant exhibit etiolation.

(ii) **Temperature :** Optimum temp. for growth is 20-35°C. Temp. above 45°C damages the protoplasm and growth is retarted.
Effect of low temperature on flowering is called vernalization.

(iii) **Water :** Water maintains the turgidity of cell, which is essential for growth. (TP is important for growth) in order to cell to grow ψ_ω must not be allowed to reach zero. Water is essential for the enzyme activity in protoplasm.

(iv) **Oxygen :** It helps in releasing metabolic energy essential for growth activities.

(v) **Mineral nutrients :** Nutrients (macro and micro essential elements) are required by plants for the synthesis of protoplasm and act as source of energy.

CHARACTERISTICS OF PLANT GROWTH

* **Differentiation :** Cells derived from active meristem tissue become mature to perform specific function.
* **Development :** Sum of morphogenesis and differentiation activities in livings is called as development.
* **Dedifferentiation:** In plants the living differentiated cell which lost the capacity of cell division, regain the capacity of cell division under certain conditions called dedifferentiation.
Ex. Formation of meristems intrafescicular cambium & cork from differentiated parenchyma cells.
* **Redifferentiation :** The regain of differentiation by losing the capacity of cell division for performing specific function by a dedifferentiatied cells.
* **Determinate/Limited Growth :** Growth activities in some plants limited for specific period of time or season called as determinate/limited growth. **Ex.** Annuals & Biannuals.

DEVELOPMENT

Development is a term that includes all changes that an organism goes through during its life cycle from germination of the seed to senescence.

* Plants follow different pathways in response to environment or phases of life to form different kinds of structures. This ability is called **plasticity**, e.g., heterophylly in cotton, coriander and larkspur. In such plants, the leaves of the juvenile plant are different in shape from those in mature plants.

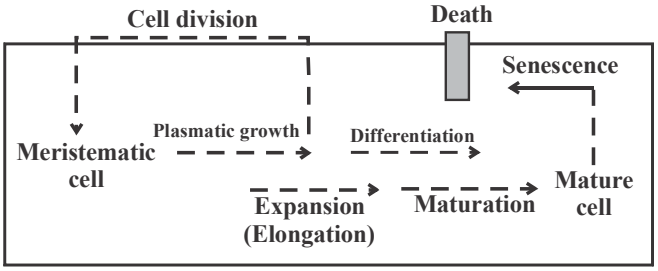


Figure : Sequence of the development process in a plant cell

* On the other hand, difference in shapes of leaves produced in air and those produced in water in buttercup also represent the heterophyllous development due to environment (Figure). This phenomenon of **heterophylly** is an example of plasticity

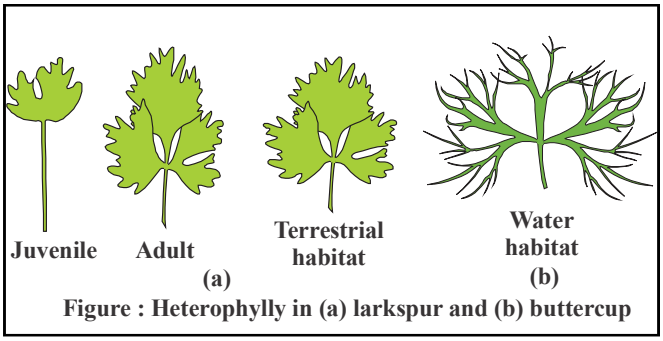


Figure : Heterophylly in (a) larkspur and (b) buttercup

* Development is considered as the sum of growth and differentiation.
* Development in plants (i.e., both growth and differentiation) is under the control of intrinsic and extrinsic factors. The former includes both intracellular (genetic) or intercellular factors (chemicals such as plant growth regulators) while the latter includes light, temperature, water, oxygen, nutrition, etc.

PLANT GROWTH REGULATORS

* The plant growth regulators (PGRs) are small, simple molecules of diverse chemical composition.
* The PGRs can be broadly divided into two groups based on their functions in a living plant body.

(i) One group of PGRs are involved in growth promoting activities, such as cell division, cell enlargement, pattern formation, tropic growth, flowering, fruiting and seed formation. These are also called **plant growth promoters**, e.g., auxins, gibberellins and cytokinins.

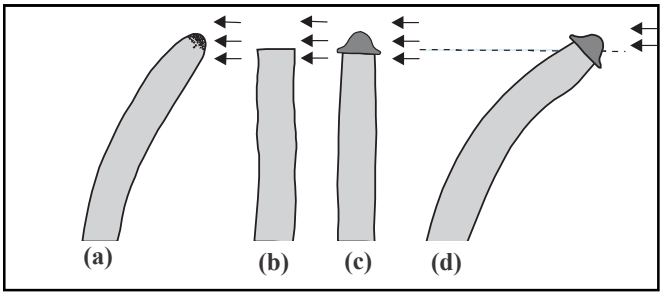
(ii) The PGRs of the other group play an important role in plant responses to wounds and stresses of biotic and abiotic origin. They are also involved in various growth inhibiting activities such as dormancy and abscission. The PGR abscisic acid belongs to this group.

* The gaseous PGR, ethylene, could fit either of the groups, but it is largely an inhibitor of growth activities.

The Discovery of Plant Growth Regulators:

(i) The discovery of each of the five major groups of PGRs have been accidental. Charles Darwin and his son Francis Darwin when observing the coleoptiles of canary grass reported that it respond to unilateral illumination by growing towards the light source (phototropism).

After a series of experiments, it was concluded that the tip of coleoptile was the site of transmittable influence that caused the bending of the entire coleoptile. Auxin was isolated by FW Went from tips of coleoptiles of oat seedlings.



Experiment used to demonstrate that tip of the coleoptile is the source of auxin. Arrows indicate direction of light.

(ii) The 'bakane' (foolish seedling) disease of rice seedlings, was caused by a fungal pathogen Gibberella fujikuroi. E. Kurosawa reported the appearance of symptoms of the disease in uninfected rice seedlings when they were treated with sterile filtrates of the fungus. The active substances were later identified as gibberellic acid.

(iii) F. Skoog and his co-workers observed that from the internodal segments of tobacco stems the callus (a mass of undifferentiated cells) proliferated only if, in addition to auxins the nutrients medium was supplemented with one of the following: extracts of vascular tissues, yeast extract, coconut milk or DNA. Skoog and Miller, later identified and crystallised the cytokinesis promoting active substance that they termed kinetin.

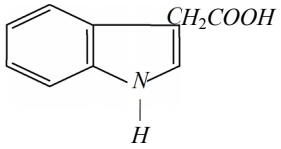
(iv) During mid-1960s, three independent researches reported the purification and chemical characterisation of three different kinds of inhibitors: inhibitor-B, abscission II and dormin. Later all the three were proved to be chemically identical. It was named abscisic acid (ABA).

(v) Cousins confirmed the release of a volatile substance from ripened oranges that hastened the ripening of stored unripened bananas. Later this volatile substance was identified as ethylene, a gaseous PGR.

Physiological Effects of Plant Growth Regulators:

(i) Auxins :

* Auxins (from Greek 'auxein' : to grow) was first isolated from human urine.
* The term 'auxin' is applied to the indole-3-acetic acid (IAA), and to other natural and synthetic compounds having certain growth regulating properties.



Indole acetic acid (IAA)

* They are generally produced by the growing apices of the stems and roots, from where they migrate to the regions of their action.
* Auxins like IAA and indole butyric acid (IBA) have been isolated from plants.
* NAA (naphthalene acetic acid) and 2, 4-D (2, 4-dichlorophenoxyacetic) are synthetic auxins. All these auxins have been used extensively in agricultural and horticultural practices.
* They help to initiate rooting in stem cuttings, an application widely used for plant propagation.
* Auxins promote flowering e.g. in pineapples.
* They help to prevent fruit and leaf drop at early stages but promote the abscission of older mature leaves and fruits.
* In most higher plants, the growing apical bud inhibits the growth of the lateral (axillary) buds, a phenomenon called **apical dominance**. Removal of shoot tips (**decapitation**) usually results in the growth of lateral buds.
* It is widely applied in tea plantations, hedge-making.
* Auxins also induce parthenocarpy, e.g., in tomatoes.
* They are widely used as herbicides. 2, 4-D, widely used to kill dicotyledonous weeds, does not affect mature monocotyledonous plants. It is used to prepare weed-free lawns by gardeners.
* Auxin also controls xylem differentiation and helps in cell division.

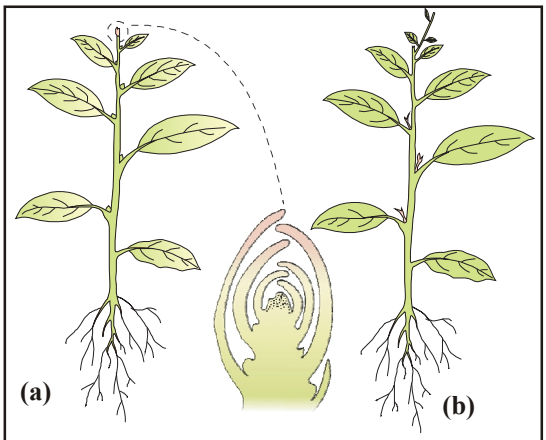
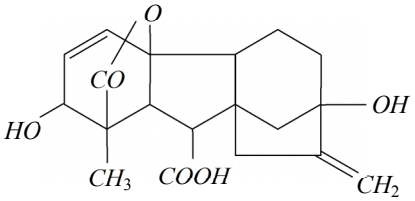


Figure : Apical dominance in plants :
(a) A plant with apical bud intact
(b) A plant with apical bud removed
Note the growth of lateral buds into branches after decapitation.

(ii) Gibberellins

* Gibberellins are promotery PGR.
* There are more than 100 gibberellins reported from widely different organisms such as fungi and higher plants. They are denoted as GA_1, GA_2, GA_3 and so on.
* Gibberellic acid (GA_3) was one of the first gibberellins to be discovered.
* All GAs are acidic.



Gibberellic acid

* Their ability to cause an increase in length of axis is used to increase the length of grapes stalks.
* Gibberellins, cause fruits like apple to elongate and improve its shape.
* They also delay senescence. Thus, the fruits can be left on the tree longer so as to extend the market period.
* GA_3 is used to speed up the malting process in brewing industry.
* Sugarcane stores carbohydrate as sugar in their stems. Spraying sugarcane crop with gibberellins increases the length of the stem, thus increasing the yield by as much as 20 tonnes per acre.

* Spraying juvenile conifers with GAs hastens the maturity period, thus leading to early seed production.
* Gibberellins also promotes bolting (internode elongation just prior to flowering) in beet, cabbages and many plants with rosette habit.

(iii) Cytokinins :

* Cytokinins have specific effects on cytokinesis, and were discovered as kinetin (a modified form of adenine, a purine) from the autoclaved herring sperm DNA. Kinetin does not occur naturally in plants.
* Search for natural substances with cytokinin-like activities led to the isolation of zeatin from corn-kernels and coconut milk.
* Since the discovery of zeatin, several naturally occurring cytokinins, and some synthetic compounds with cell division promoting activity, have been identified.
* Natural cytokinins are synthesised in regions where rapid cell division occurs, for example, root apices, developing shoot buds, young fruits etc.
* It helps to produce new leaves, chloroplasts in leaves, lateral shoot growth and adventitious shoot formation.
* Cytokinins help overcome the apical dominance.
* They promote nutrient mobilisation which helps in the delay of leaf senescence.

(iv) Ethylene :

* Ethylene is a simple gaseous PGR.
* It is synthesised in large amounts by tissues undergoing senescence and ripening fruits.
* Influences of ethylene on plants include horizontal growth of seedlings, swelling of the axis and apical hook formation in dicot seedlings.
* Ethylene promotes senescence and abscission of plant organs especially of leaves and flowers.
* Ethylene is highly effective in fruit ripening. It enhances the respiration rate during ripening of the fruits. This rise in rate of respiration is called **respiratory climactic**.
* Ethylene breaks seed and bud dormancy, initiates germination in peanut seeds, sprouting of potato tubers.
* Ethylene promotes rapid internode/petiole elongation in deep water rice plants.
* It helps leaves/upper parts of the shoot to remain above water.
* Ethylene also promotes root growth and root hair formation, thus helping the plants to increase their absorption surface.
* Ethylene is used to initiate flowering and for synchronising fruit-set in pineapples.
* It also induces flowering in mango. Since ethylene regulates so many physiological processes, it is one of the most widely used PGR in agriculture.
* 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.

(v) Abscisic acid :

* Abscisic acid (ABA) was discovered for its role in regulating abscission and dormancy.
* It acts as a general plant growth inhibitor and an inhibitor of plant metabolism.
* ABA inhibits seed germination.
* ABA stimulates the closure of stomata in the epidermis and increases the tolerance of plants to various kinds of stresses. Therefore, it is also called the **stress hormone.**
* ABA plays an important role in seed development, maturation and dormancy.
* By inducing dormancy, ABA helps seeds to withstand desiccation and other factors unfavourable for growth.
* In most situations, ABA acts as an antagonist to GAs.

PHOTOPERIODISM

* The relative length of day & night is called as photoperiod.
* The response of plants to the photoperiod, expressed in the form of flowering is called as photoperiodism.

* "Effect of requirement of relative length of day (photoperiod) & night (dark phase) on flowering of plants is called as photoperiodism".

(i) SDP (Short day plants) :

* These plants flower on exposure to photoperiod equal or shorter than their critical day length.
* They need a continuous (uninterrupted) dark period of flowering. Thus SDP also called as LNP (Long night plants).
* In SDP the dark period is critical and must be continuous. If this dark period is interrupted even with a brief exposure of red light, the SDP will not flower.
* Ex. of SDP : Tobacoo, Soyabean, Viola, Xanthium (Cocklebur), Chrysanthemum, Canabis, Coleus, Chenopodium, Musturd, Dahlia, Sugarcane, Straberry, Cosmos, Rice etc.

(ii) LDP (Long Day Plants) :

* These plants flowers only when they exposed to critical photoeperiod or photoperiod longer than their critical day length.
* The light period is critical for LDP.
* Ex. Henbane (Hyoscyamus) Spinach, Sugarbeets, Radish, Carrot, Wheat, Larkspur, Barley, Avena, Potato.

  A brief exposure in the dark period stimulates flowering in LDP.

(iii) DNP (Day Neutral Plants) or Intermediate plants :

* These plants do not need a specific light period for flowering. Ex. Zea, Cotton, Tomato, Sunflower, Cucumber.

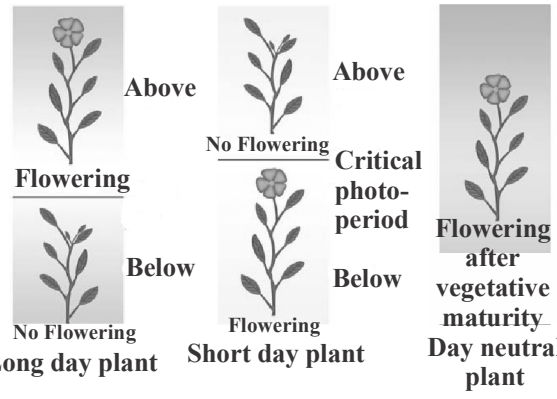


Figure : Photoperiodism : Long day, Short day and Day neutral plants

* **L-SDP :** These are SDP but must be exposed to long days during early stage of growth. Ex. Bryophyllum.
* **S-LDP :** These are LDP but must be exposed to short photoperiod during early stage of growth. Ex. Wheat & Rye sps.

Phytochrome :

* Phytochrome detects day length The main photoreceptor for photoperiodism and many other light-initiated plant responses (such as germination and seedling establishment) is phytochrome, a family of about five blue-green pigment proteins, each of which is coded for by a different gene.
* A mixture of phytochrome proteins is present in cells of all vascular plants examined so far. For example, five members of the phytochrome family, designated phy A, phy B, phy C, phy D, and phy E, occur in Arabidopsis.
* Phytochrome is also a photoreceptor in certain bacteria, fungi, and slime molds.
* Each member of the phytochrome family exists in two forms and readily converts from one form to the other after absorption of light of specific wavelengths.
* One form, designated **Pr** (for redabsorbing phytochrome), strongly absorbs light with a relatively short red wavelength (660 nm).
* In the process, the shape of the molecule changes to the second form of phytochrome, **Pfr**, so designated because it absorbs far-red light, which is light with a relatively long red wavelength (730nm). When it absorbs far-red light, Pfr reverts to the original form, Pr.
* Pfr is the active form of phytochrome, triggering or inhibiting physiological responses such as flowering.
* Sunlight consists of various amounts of the entire spectrum of visible light, in addition to ultraviolet and infrared radiation. Because sunlight contains more red than far-red light, however, when a plant is exposed to sunlight, the level of Pfr increases.
* During the night, the level of Pfr slowly decreases as Pfr, which is less stable than Pr, is degraded.
* The Pfr (Yellowish) form, gradually changed in to Pr (Bluish) form in dark.

* Phytocrome - Pfr (P_{730}) is active form which controls many photophysiological processes in plants.

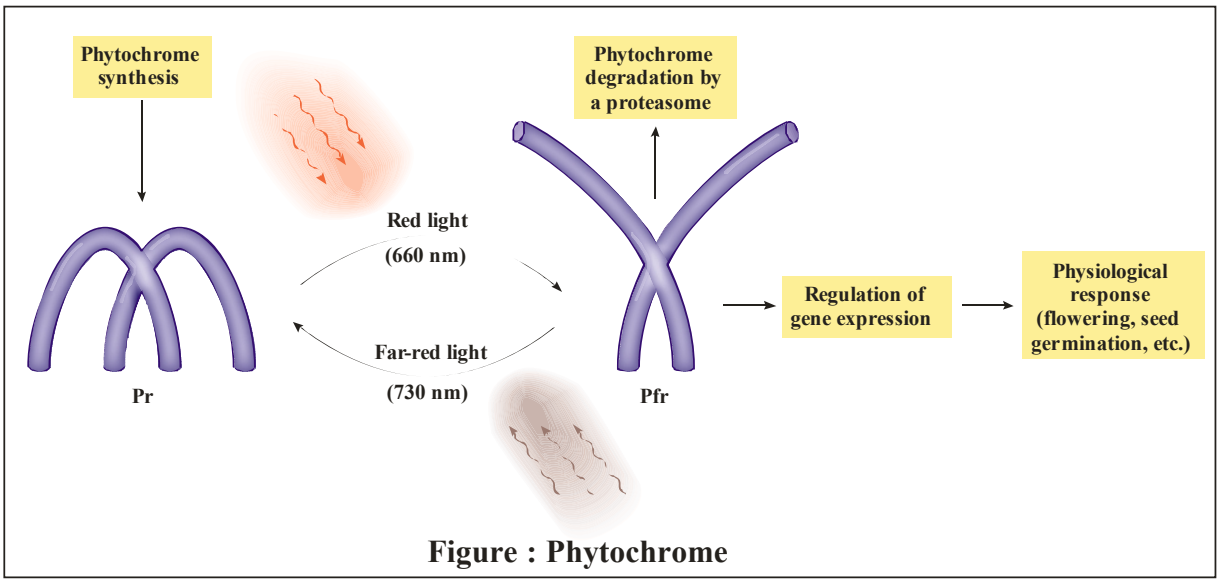


Figure : Phytochrome

VERNALISATION

* Effect of low temperature on the initiation and development of flower, was first realised by Klippart 1857
(Exp. on winter & $\rightleftharpoons$ Spring wheat)
* Acceleration of ability to produce flower by chilling treatment is called Vernalisation.
* Mainly embryo tip, shoot apex & leaves percepts induction of low temperature on plants.
* Concept of hormone Vernalin in vernalisation was given by Melcher. This is hypothetical plant hormone because has been isolated till today.
* Vernalisation of seeds or plant propagule in laboratory can be induced at 1°C to 10°C in presence of O_2 & H_2O.
* If vernalized plant propagules are kept in high temperature just after the low temperature treatment then effect of vernalisation is reverse, this effect is called as **devernalization**.
* Vernalisation is seen in biennial plants. Biennials are monocarpic plants that normally flower and die in the second season. Sugarbeet, cabbages, carrots are some of the common biennials. Subjecting the growing of a biennial plant to a cold treatment stimulates a subsequent photoperiodic flowering response.

Significance :

(i) Better & early flowering.

(ii) It prevents precocious reproductive development late in the growing season, and enables the plant to have sufficient time to reach maturity.

PLANT MOVEMENT

* Nastic movements and tropisms are the two kinds of plant movements that occur in response to external stimuli. **Nastic movements**, which are temporary and reversible, occur in response to external stimuli, but the direction of movement is independent of the direction of the stimulus.
* Tropisms are directional growth responses (i.e., the direction of growth is dependent on the direction of the stimulus).
* **Phototropism** is plant growth in response to the direction of light. (i) +ve Ex : Stem (ii) –ve Ex : Root.
* **Gravitropism** is plant growth in response to the influence of gravity.
(i) +ve Ex : Root (Root cap percept stimulus)
(ii) –ve Ex : Stem & Magrove plant roots.
* **Thigmotropism** is plant growth in response to contact with a solid object. Ex : Tendrils, Houstoria of Cuscuta.
* **Hydrotropism :** Ex : Roots of seedlings

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CONCEPT REVIEW

* **Germination** is the process of seed sprouting. Internal factors affecting whether a seed germinates include the maturity of the embryo, the presence or absence of chemical inhibitors, and the presence or absence of hard, thick seed coats.
* External environmental factors that may affect germination include requirements for oxygen, water, temperature, and light. For example, before germinating, dry seeds absorb water by **imbibition**.
* **Photoperiodism** is any response of plants to the duration and timing of light and dark. In many plants, flowering is a photoperiodic response; some are short-day plants, some are long-day plants, and others are intermediate-day plants. In day-neutral plants, flowering is not affected by photoperiod.
* **Auxin** is involved in cell elongation; tropisms; apical dominance, the inhibition of axillary buds by the apical meristem; and fruit development. Auxin also stimulates root development on stem cuttings. Some synthetic auxins (2,4-D and 2,4,5-T) are selective herbicides.
* **Gibberellins** are involved in stem elongation, flowering, and germination.
* **Cytokinins** promote cell division and differentiation; delay senescence, the natural aging process; and interact with auxin and ethylene in apical dominance. Cytokinins induce cell division in **tissue culture**, a technique in which cells are isolated from plants and grown in a nutrient medium.
* Ethylene plays a role in ripening fruits; apical dominance; leaf abscission; wound response; **thigmomorphogenesis**, a developmental response to mechanical stressors such as wind; and senescence.
* **Abscisic acid** is an environmental stress hormone involved in stomatal closure caused by water stress and in seed dormancy.

IMPORTANT POINTS

* Induce rooting in a twig – Auxins
* Quickly ripen a fruit – Ethylene
* Delay leaf senescence – Cytokinins
* Induce growth in axillary buds – Cytokinins
* 'Bolt' a rosette plant – Gibberellic acid
* Induce immediate stomatal closure in leaves – Abscisic acid
* . . . . $_3$ is applied to rice seedlings, then the rice seedlings will exhibit internodeelongation and increase in height.
* A phase of growth which is maximum and fastest is log phase.
* Apical dominance as expressed in dicotyledonous plants is due to the presence of more auxin hormone in the apical bud than in the lateral ones.
* In addition to auxin, a cytokinin must be supplied to culture medium to obtain a good callus in plant tissue culture.
* Leaves of a vegetative plants are the sites of photoperiodic perception.
* Increase yield of sugar cane : Gibberellins
* Promote lateral shoot growth : Auxins
* Cause sprouting of potato tuber : Cytokinin
* Inhibit seed germination : Abscisic acid
* Gibberellins promote the formation of male flowers on genetically female plants in Cannabis whereas ethylene promotes formation of female flowers on genetically male plants.
* Long-day plants (LDP)-Henbane (*Hyoscyamus niger*), rice, spinach.
  Shortday plants (SDP)- *Xanthium*, strawberry and sunflower
  Day neutral plants (DNP)- Maize and tomato
  Long-short day plants- *Bryophyllum*.
* IAA is synthesised in tip of coleoptile.
* Gibberellins are synthesised in side the plastids of immature seeds, young leaves or even roots.
* Cytokinins are synthesised in meristematic regions such as in root tips of plants.

* The rice seedlings infected with fungus *Gibberella fujikuroi* is called foolish because seedlings grew foolishly so tall that they ultimately resulted into death of plants.

* **Table : Plant Hormones and Signaling Molecules**

Hormone	Site of production	Principal actions
Auxins (e.g., IAA)	Shoot apical meristem, young leaves, seeds	Stem elongation, apical dominance, root initiation, fruit development.
Gibberellins (e.g., GA_3)	Young leaves and shoot apical meristems, embryo in seed.	Seed germination, stem elongation, flowering, fruit development.
Cytokinins (e.g. Zeatin)	Roots	Cell division, delay of leaf senescence, inhibition of apical dominance, flower development, embryo development, seed germination.
Ethylene	Stem nodes, ripening fruit, damaged or senescing tissue.	Fruit ripening, responses to environmental stressors, seed germination, maintenance of apical hook on seedlings, root initiation, senescence and abscission in leaves and flowers.
Abscisic acid	Almost all cells that contain plastids (leaves, stems, roots)	Seed dormancy, responses to water stress.

QUESTION BANK

EXERCISE - 1 (LEVEL-1) [NCERT EXTRACT]

SECTION - 1 (VOCABULARY BUILDER)

Choose one correct response for each question.
For Q.1-Q.5
Match the column I with column II.

Q.1

	Column I		Column II
(a)	Formative phase	(i)	Cell develops into special or particular type of cells.
(b)	Phaseof enlargement	(ii)	Plastic extension through the enzymatic loosening of microfibrils.
(c)	Phase of differentiation	(iii)	New cells are produced by mitosis.

Codes
(A) (a) – (i), (b) – (ii), (c) – (iii)
(B) (a) – (i), (b) – (iii), (c) – (ii)
(C) (a) – (iii), (b) – (ii), (c) – (i)
(D) (a) – (iii), (b) – (i), (c) – (ii)

Q.2

	Column I		Column II
(a)	Differentiation	(i)	Act of maturation
(b)	Redifferentiation	(ii)	Act of again loosing cell division capacity and mature to perform special function act of gaining cell division after dedifferentiation
(c)	Dedifferentiation	(iii)	Act of gaining cell division after differentiation

Codes
(A) (a) – (i), (b) – (iii), (c) – (ii)
(B) (a) – (iii), (b) – (ii), (c) – (i)
(C) (a) – (i), (b) – (ii), (c) – (iii)
(D) (a) – (iii), (b) – (i), (c) – (ii)

Q.3

	Column I		Column II
(a)	Apical meristem	(i)	Present at terminal position
(b)	Intercalary meristem	(ii)	Secondary growth
(c)	Lateral meristem	(iii)	Localised growth

Codes
(A) (a) – (i), (b) – (ii), (c) – (iii)
(B) (a) – (i), (b) – (iii), (c) – (ii)
(C) (a) – (iii), (b) – (ii), (c) – (i)
(D) (a) – (iii), (b) – (i), (c) – (ii)

Q.4 Match the following columns.

	Column I	Column II
(a)	Genetic factor	(i) Extrinsic factor
(b)	Plant growth regulators	(ii) Intrinsic factor
(c)	Temperature	

Codes
(A) (a) – (i), (b) – (i), (c) – (ii)
(B) (a) – (i), (b) – (ii), (c) – (ii)
(C) (a) – (i), (b) – (ii), (c) – (ii)
(D) (a) – (ii), (b) – (ii), (c) – (i)

Q.5

	Column I	Column II
(a)	Darwin & Darwin	(i) Kinetin
(b)	E Kurosawa	(ii) Gibberellin acid
(c)	Skoog and Miller	(iii) Auxin
(d)	Cousin	(iv) Ethylene

Codes
(A) (a) – (i), (b) – (ii), (c) – (iii), (d) – (iv)
(B) (a) – (iii), (b) – (ii), (c) – (i), (d) – (iv)
(C) (a) – (iv), (b) – (iii), (c) – (ii), (d) – (i)
(D) (a) – (iii), (b) – (ii), (c) – (iv), (d) – (i)

SECTION - 2 (BASIC CONCEPTS BUILDER)

For Q.6 to Q.25 :

Choose one word for the given statement from the list.

Closing , Increases, Stress, Early, Dedifferentiation, Promote, 3, Arithmetic, Vernalisation, Differentiate, Root, Shoot, Phytochrome, Tip, Plasticity, Bending, Meristems, Differentiation, Sigmoid, Absolute growth rate, Phenology, Linear, Apical, Lateral, Sclophytes, Different.

Q.6 In ____ growth, following mitotic cell division, only one daughter cell continues to divide, while other ___ and matures.

Q.7 _____ curve is a characteristic of living organisms growing in natural environment.

Q.8 Auxin helps to prevent fruit and leaf drop at ___ stages, but ____ the abscission of older mature leave and fruit.

Q.9 Flowering of plants by exposure to low temperature is called ____.

Q.10 Measurement and comparison of total growth in geometrical growth of a plant per unit time is called ____.

Q.11 The study of different aspects or appearance of plants in different seasons of the year is called ____.

Q.12 Photoperiod stimulus is perceived by ____ pigment.

Q.13 After a series of experiments, it was concluded that the _____ of coleoptile was the site of transmittable influence that caused the ___ of the entire coleoptile.

Q.14 ABA stimulates the ___ of stomata in the epidermis and ___ the tolerance of plant to various kind of stresses. Therefore, it is called ___ hormone.

Q.15 On plotting the length of an organ against time, a _____ curve is obtained in arithmetic growth.

Q.16 Growth period of plant is generally divided into ____ phases

Q.17 The cells derived from cambium, root apical and shoot apical meristem differentiate and mature to perform specific functions. This act is called ____.

Q.18 The ability of plants to follow different pathway to form different structures in response to environment is called ____.

Q.19 Increased growth per unit time is termed as ____.

Q.20 In plant tissue culture experiments, high auxin to cytokinin ratio favours ___ development and high cytokinin to auxin ratio favours ___ development.

Q.21 In most of the higher plants, the growing __ bud inhibits the growth of ___ bud, a phenomenon called apical dominance. Removal of the shoot tips usually results in growth of _____ buds.

Q.22 Plants requiring low light intensity for optimum photosynthesis are called ____.

Q.23 The living differentiated cells, regain capacity of division under certain condition which called ____.

Q.24 Plants follow _____ pathways in response to environment or phases of life to form different kind of structures. This ability is called _____.

Q.25 Specific areas in the higher plants which takes part in the formation of new cells are called ____.

SECTION - 3 (ENHANCE PROBLEM SOLVING SKILLS)

Choose one correct response for each question.

PART - 1 : GROWTH

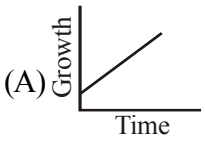
Q.26 In geometrical growth, lag phase is represented by
(A) initial rapid growth (B) latter rapid growth
(C) initial slow growth (D) latter slow growth

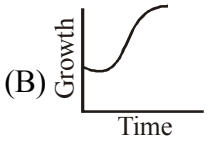
Q.27 Constantly dividing cells, both at the root apex and shoot apex represents
(A) elongation phase of the growth.
(B) meristematic phase of the growth.
(C) maturation phase of the growth.
(D) None of the above

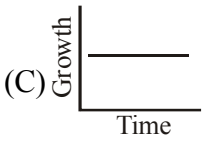
Q.28 Primary growth of plants is contributed by
(A) root apical meristem
(B) shoot apical meristem
(C) intercalary meristem
(D) All of these

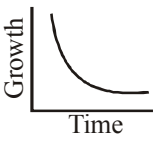
Q.29 The cells proximal (just next away from the tip) to the meristematic zone represents the phase of
(A) division (B) maturation
(C) elongation (D) meristematic division

Q.30 Which one is the correct graph for arithmetic growth?

(A) 

(B) 

(C) 

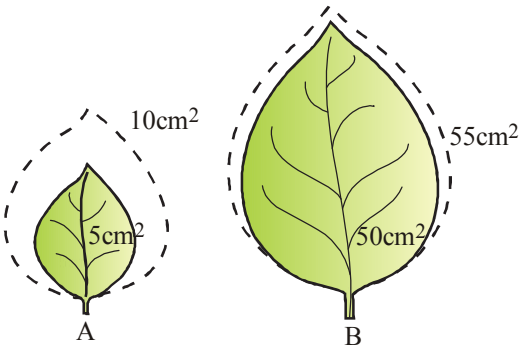
(D) 

Q.31 Water is required in plant growth for
(A) enzymatic reactions (B) cell enlargement
(C) extension growth (D) All of these

Q.32 Growth in plants is measured by the increase in
I. fresh weight
II. dry weight
III. length, area and volume
IV. cell number
Choose the correct option.
(A) All except I and II (B) All except III
(C) All except IV (D) I, II, III and IV

Q.33 In S-shaped curve, the growth is highest in which phase?
(A) Lag phase (B) Steady phase
(C) Log phase (D) All of these

Q.34 The given figure shows growth of two leaves over the period of one day. If, AG = absolute growth and RGR = relative growth rate, then select the correct option.

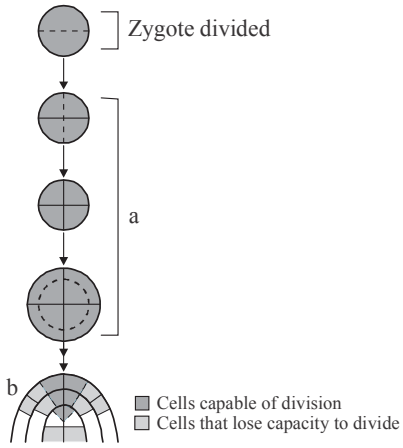


(A) AG for leaf A = 1%, RGR for leaf A = 1
AG for leaf B = 2%, RGR for leaf A = 2
(B) AG for leaf A = 100%, RGR for leaf A = 5
AG for leaf B = 10%, RGR for leaf A = 5
(C) AG for leaf A = 5, RGR for leaf A = 100%
AG for leaf B = 5, RGR for leaf A = 10%
(D) AG for leaf A = 5, RGR for leaf A = 100%
AG for leaf B = 5, RGR for leaf A = 100%

Q.35 The cells in the root and shoot apex
(A) are rich is protoplasm.
(B) have conspicuous nuclei.
(C) have their cell wall which are primary in nature, thin and cellulosic with abundant plasmodesmatal connections.
(D) All of the above.

Q.36 Grand phase of growth is an another name of
(A) lag phase
(B) stationary phase
(C) diminishing growth phase
(D) exponential growth phase

Q.37 The given figure shows development of an embryo that undergoes two phases A and B. Select the correct option regarding it.



(A) a = Geometric phase, b = Arithmetic phase
(B) a = Arithmetic phase, b = Geometric phase
(C) a = Arithmetic phase, b= Exponential phase
(D) a = Exponential phase, b = Stationary phase

Q.38 S-shaped or sigmoid growth curve have
I. lag phase
II. log phase
III. stationary phase
IV. diminishing growth phase
Select the correct option.
(A) All except IV (B) All except III
(C) All except II (D) I, II, III and IV

Q.39 I. Lag phase.
II. Stationary phase.
III. Exponential phase.
Arrange the above steps of geometrical growth (from beginning to last) in a correct sequence of their occurrence and choose the correct option accordingly.
(A) I → II → III (B) I → III → II
(C) III → II → I (D) III → I → II

Q.40 Increase in the girth of plant (organ) takes place by –
(A) vascular cambium
(B) cork cambium
(C) Both (A) and (B)
(D) root and shoot apical meristem

Q.41 Efficiency index in the exponential phase of geometrical growth is the ability of plants to produce
(A) cell wall
(B) new enzyme
(C) new plant material
(D) young ones through mitosis

Q.42 Which one of the following statement is incorrect?
(A) Apperent growth is an irreversible increase in mass or volume.
(B) Real growth is the formation of new protoplasm.
(C) Growth in plants is open ended.
(D) Growth in plants is closed ended.

Q.43 I. Increased vacuolation.
II. Cell enlargement.
III. New cell wall deposition.
Which of the above are the characteristics of phase of elongation?
Choose the correct option accordingly.
(A) I and II (B) II and III
(C) I and III (D) I, II and III

PART - 2 : DIFFERENTIATION, DEDIFFERENTIATION AND REDIFFERENTIATION

Q.44 Differentiation in plants is open because
(A) cells/tissue arising out of meristem regain the capacity of division under certain conditions.
(B) cells/tissue arising out of different meristem have different structures at maturity.
(C) cells/tissue arising out of different meristem have same structures at maturity.
(D) All of the above.

Q.45 Maximum elongation takes place in
(A) conducting tissue
(B) fibre
(C) Both (A) and (B)
(D) cell wall and membrane

Q.46 During differentiation, the cells undergo few to major structural changes in their
(A) cell wall (B) protoplasm
(C) Both (A) and (B) (D) cytoplasm

Q.47 Permanent localised qualitative change in size, biochemistry, structure and function of cells or organs is called
(A) cell division (B) meristematic division
(C) differentiation (D) dedifferentiation

Q.48 Which one is the example of dedifferentiation?
(A) Procambium and vascular cambium.
(B) Cork cambium and interfasicular cambium.
(C) Cork cambium and vascular cambium.
(D) Procambium and cork cambium.

Q.49 Name the process when dedifferentiated cells again loss the ability to divide and get mature?
(A) cell-enlargement (B) redifferentiation
(C) dedifferentiation (D) differentiation

Q.50 During differentiation of tracheary elements,
(A) the cells lose its protoplasm.
(B) cells develop very strong elastic lignocellulosic secondary cell walls.
(C) Both (A) and (B)
(D) the cell increases its protoplasm

Q.51 Intussusception is
(A) removal of old material from cell wall.
(B) deposition of new material into cell wall during differentiation.
(C) deposition of new material into cell wall during cell division.
(D) another name of cell division.

Q.52 Which one is an example of redifferentiation?
(A) Cork cambium (B) Secondary cortex
(C) Meristems (D) Interfasicular cambium

Q.53 The final structure at maturity of a cell/tissue is determined by –
(A) type of cells
(B) type of cell division
(C) location of cell within tissue
(D) nutrient in cells

PART - 3 : DEVELOPMENT

Q.54 Which of them is not an extrinsic factor?
(B) Temperature, CO_2
(C) Nutrient, water
(D) Growth regulator and genetic factor

Q.55 Environment heterophylly is seen in
(A) cotton (B) coriander
(C) larkspur (D) buttercup

Q.56 Growing season is the season of plants in which there is –
(A) maximum vegetative growth
(B) minimum vegetative growth
(C) moderate vegetative growth
(D) maximum reproduction occurs

Q.57 When transition from juvenile to adult is gradual than this type of development is called
(A) homoblastic development
(B) heteroblastic development
(C) homoheteroblastic development
(D) hetero and homoblastic development

PART - 4 : PLANT GROWTH REGULATORS

Q.58 The Plant Growth Regulator (PGR), ethylene comes under the category of
(A) simple plant hormone
(B) complex plant hormone
(C) plant growth inhibitor hormone
(D) plant growth promoter hormone

Q.59 Large amount of ethylene is synthesised by
(A) developing roots and fruits
(B) developing shoots and flowers
(C) senescence tissues and ripening fruits
(D) young tissue and unripened fruits

Q.60 Which one of the following is not a effect of gibberellin?
(A) Increase grapes stalk
(B) Delay senescence of fruit
(C) Induce dormancy
(D) Increase sugarcane stem

Q.61 The hormone which reduces transpiration rate by inducing stomatal closure is
(A) ABA (B) ethylene
(C) cytokinin (D) gibberellin

Q.62 'Bakane' (foolish seedling) disease of rice seedlings, was caused by
(A) fungi (B) Protozoa
(C) bacteria (D) virus

Q.63 Natural and synthetic-auxin (IAA, NAA, IBA, 2-4-D) have been used extensively in
(A) agriculture (B) horticulture
(C) Both (A) and (B) (D) sericulture

Q.64 Which plant hormone is found in gaseous form?
(A) Auxin (B) Cytokinin
(C) Ethylene (D) ABA

Q.65 Select the pair that consists of plant growth promoters only.
(A) Auxins and cytokinins
(B) Gibberellins and ABA
(C) Ethylene and ABA
(D) All of these

Q.66 Auxin was isolated by
(A) Charles Darwin (B) Francis Darwin
(C) FW Went (D) de Vries

Q.67 Hormone responsible for ageing is
(A) GA (B) IAA
(C) ABA (D) cytokinin

Q.68 How many gibberellins are reported from widely different organism such as plant and fungi?
(A) More than 50 (B) More than 75
(C) More than 100 (D) More than 25

Q.69 Canary grass experiment for phototropism was firstly conducted by
(A) Went (B) Darwin
(C) Cousins (D) Kurosawa

Q.70 Hormone primarily connected with cell division is
(A) IAA (B) NAA
(C) cytokinin (D) gibberellic acid

Q.71 Parthenocarpy in tomatoes is induced by
(A) cytokinin (B) auxin
(C) gibberellin (D) $CH_2 - CH_2$

Q.72 Fruits can be left on the tree longer, so as to increase the market period. This is due to the function of
(A) delay senescence by auxin
(B) delay senescence by $CH_2 - CH_2$
(C) delay senescence by cytokinin
(D) delay senescence by GA

Q.73 Which of the following is both a growth promoter as well as a growth inhibitor?
(A) Auxin (B) Gibberellic acid
(C) ABA (D) Ethylene

Q.74 In plants, phototropism is the movement
(A) towards the light source.
(B) away from the light source.
(C) parallel to the light source.
(D) lateral to the light source.

Q.75 Which one is not an ethylene effect?
(A) Swelling of axis
(B) Apical hook formation in dicot seedlings
(C) Horizontal growth of seedling
(D) Apical dominance

Q.76 Initially, the ABA was identified as
(A) inhibitor B (B) abscission II
(C) dormin (D) All of these

Q.77 Functions of auxins include
(A) promoting flowering in pineapple
(B) inducing parthenocarpy in tomato
(C) use as herbicides to kill dicot weeds
(D) all of these.

Q.78 Natural cytokinins are synthesised in which regions of plants?
(A) root apices (B) young fruit
(C) developing shoot buds (D) All of the above

Q.79 Artificial ripening of fruits is caused by the treatment of
(A) IAA (B) NAA
(C) ethylene (D) kinetin

Q.80 Abscission and dormancy are caused by
(A) ABA (B) $CH_2 - CH_2$
(C) IAA (D) IBA

Q.81 Which hormone was first isolated from human urine?
(A) Auxin (B) ABA
(C) Ethylene (D) Gibberellic acid

Q.82 Which of the following hormones is used in root formation on stem cuttings?
(A) Kinetin (B) GA
(C) ABA (D) IBA

Q.83 I. Initiate rooting in stem cuttings.
II. Promote flowering in pineapples.
III. Controls xylem differentiation.
Identify the functions of auxin and choose the correct option.
(A) I and II (B) II and III
(C) III and I (D) I, II and III

Q.84 'Apical dominance' in plants is the result of –
(A) cytokinin (B) auxin
(C) gibberellin (D) $CH_2 - CH_2$

Q.85 The phenomenon of apical dominance can be overcome by exogenous application of
(A) auxins (B) gibberellins
(C) cytokinins (D) ethylene

Q.86 Most widely used compound as a source of ethylene is
(A) nepthol (B) acetol
(C) ethephon (D) ethepcon

Q.87 Search for natural cytokinin lead to the
(A) isolation of zeatin from corn kernels.
(B) isolation of zeatin from coconut milk.
(C) isolation of zeatin from sugarcane.
(D) Both (A) and (C)

Q.88 The hormone responsible for apical dominance is
(A) IAA (B) GA
(C) ABA (D) florigen

Q.89 Member of auxin, which is widely used to kill the dicotyledonous weed is
(A) IAA (B) IBA
(C) NAA (D) 2-4-D

Q.90 In addition to auxins, must be supplied to culture medium to obtain a good callus in plant tissue culture.
(A) ABA (B) cytokinins
(C) gibberellins (D) ethylene

Q.91 Ethephon
(A) hasten fruit ripening in tomatoes.
(B) accelerate abscission.
(C) promote female flower cucumbers.
(D) All of the above

PART - 5 : PHOTOPERIODISM

Q.92 Day neutral plants relates to –
(A) loss of activity during day time
(B) overactive during day time
(C) flowering in all possible photoperiod
(D) no flowering in any photoperiod

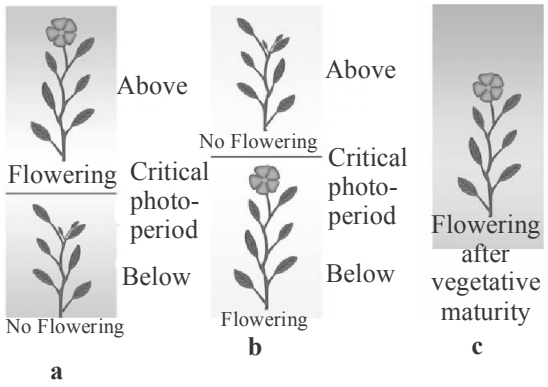
Q.93 Plants which require an exposure to light for a period greater than critical day length are
(A) long day plants
(B) short day plants
(C) long-short day plants
(D) short-long day plants.

Q.94 Which pigment is involved in photoperiodic changes in plants?
(A) phytochrome (B) chlorophyll
(C) cytochrome (D) anthocyanin

Q.95 Photoperiod was first observed in
(A) potato
(B) Maryland mammoth
(C) four O' clock
(D) evening primrose

Q.96 Photoperiodism was first studied by
(A) Garner and Allard (B) Darwin
(C) FW Went (D) Cousins

Q.97 The given figure shows flowering responses of three plants a, b and c to the photoperiod. Select the correct option regarding this.



(A) a-Long day plant, b-Day neutral plant, c-Short day plant
(B) a-Short day plant, b-Day neutral plant, c-Long day plant
(C) a-Long day, b-plant Short day plant, c-Day neutral plant
(D) a-Short day plant, b-Long day plant, c-Day neutral plant

Q.98 SDP also called –
(A) short night plant
(B) long night plant
(C) intermediate night plant
(D) None of these

PART - 6 : VERNALISATION

Q.99 Vernalisation helps in
(A) shortening of reproductive phase.
(B) shortening of juvenile phase.
(C) shortening of vegetative phase.
(D) Both (B) and (C)

Q.100 The shedding of leaves, flowers and fruits due to changes in hormonal balance in plants, is referred to as –
(A) senescence (B) abscission
(C) photoperiodism (D) vernalisation

Q.101 Vernalization can often be replaced by
(A) auxin (B) cytokinins
(C) gibberellins (D) ethylene

Q.102 Vernalisation was found by
(A) FW Went (B) Darwin
(C) Lysenko (D) Cousins

Q.103 Temperature required for vernalisation is
(A) 5°C to 10°C (B) 5°C to 15°C
(C) 0°C to 5°C (D) 3°C to 17°C

Q.104 Vernalisation can be reversed by
(A) application of high temperature
(B) application of auxin
(C) application of low temperature
(D) application of gibberellin

Q.105 The stimulus of cold treatment (vernalization) is perceived by –
(A) leaves (B) flowers
(C) roots (D) shoot apices

Q.106 Examples of plants which requires vemalisation is/are
(A) pea (B) beet
(C) cabbage (D) All of these

Q.107 Stimulus of vernalisation is perceived by
(A) shoot tips (B) mature tissues
(C) embryo tips (D) Both (A) and (C)

Q.108 Florigen is produced in
(A) leaves (B) flower
(C) fruits (D) seeds

EXERCISE - 2 (LEVEL-2)

Choose one correct response for each question.

Q.1 Which of the following was identified as the first plant hormone?
(A) Auxins (B) Gibberallins
(C) Cytokinins (D) Ethylene

Q.2 Which of the following hormones exhibits polar transport and moves away from unidirectional light?
(A) Auxins (B) Gibberallins
(C) Cytokinins (D) Ethylene

Q.3 Which of the following hormones is involved in breaking of seed and bud dormancy?
(A) Auxins (B) Gibberallins
(C) Cytokinins (D) Ethylene

Q.4 Which of the following hormones is involved in bolting seen in rosette plants?
(A) Auxins (B) Gibberallins
(C) Cytokinins (D) Ethylene

Q.5 Which of the following hormones coordinates growth of roots and shoots in concert with the auxins?
(A) Abscisic acid (B) Gibberallins
(C) Cytokinins (D) Ethylene

Q.6 Which of the following hormones is involved in ripening of fruits?
(A) Auxins (B) Gibberallins
(C) Cytokinins (D) Ethylene

Q.7 Which of the following term is used for dropping of flowers, fruits, and leaves?
(A) Senescence (B) Abscission
(C) Tropism (D) Bolting

Q.8 Which of the following terms is used for extension of the floral stem in rosette plants?
(A) Senescence (B) Abscission
(C) Tropism (D) Bolting

Q.9 Which of the following refers to movement or growth of a plant in response to contact with an object?
(A) Phototropism (B) Gravitropism
(C) Thigmotropism (D) Nastic movement

Q.10 Which of the following refers to temporary, reversible response to a unidirectional stimulus?
(A) Phototropism (B) Gravitropism
(C) Thigmotropism (D) Nastic movement

Q.11 Which of the following refers to response of a plant due to changes in the length of light and dark periods during each 24-hour period?
(A) Phototropism (B) Gravitropism
(C) Thigmotropism (D) Photoperiodism

Q.12 Which of the following term is used for low temperature stimulation of flowering?
(A) Senescence (B) Abscission
(C) Tropism (D) Vernalization

Q.13 Which of the following terms is used for aging in plants?
(A) Senescence (B) Abscission
(C) Tropism (D) Bolting

Q.14 In which of the following is phytochrome involved?
(A) Phototropism (B) Gravitropism
(C) Thigmotropism (D) Photoperiodism

Q.15 A plant's response to the relative amounts of daylight and darkness is
(A) apical dominance (B) bolting
(C) gravitropism (D) photoperiodism

Q.16 Which of the following statements about phytochrome is incorrect?
(A) Phytochrome is the main photoreceptor for photoperiodism.
(B) Phytochrome is a family of about five blue-green pigment proteins,each coded by a different gene.
(C) Most of our knowledge of phytochrome function is based on mutant corn (Zea mays) plants.
(D) Each member of the phytochrome family exists in two forms : Pr and Pfr.

Q.17 Which photoreceptor(s) is/are implicated in resetting the biological clock?
(A) phytochrome only
(B) cryptochrome only
(C) gibberellin only
(D) phytochrome and cryptochrome

Q.18 In _____, leaves or other plant organs track the sun's movement across the sky.
(A) heliotropism (B) thigmotropism
(C) phototropism (D) bolting

Q.19 The orientation of the growth of a plant according to the direction of light is called _____, whereas the twining of tendrils is an example of _____.
(A) heliotropism; gravitropism
(B) photoperiodism; nastic movements
(C) phototropism; gravitropism
(D) phototropism; thigmotropism

Q.20 A synthetic ____ known as 2,4-D is used as a selective herbicide.
(A) auxin (B) gibberellin
(C) cytokinin (D) ethylene

Q.21 The promotion of flowering by the exposure of shoot apical meristems to a low-temperature treatment is known as –
(A) thigmomorphogenesis (B) bolting
(C) gravitropism (D) vernalization

Q.22 Research on a fungal disease of rice provided the first clues about the plant hormone
(A) auxin (B) gibberellin
(C) cytokinin (D) ethylene

Q.23 This plant hormone interacts with auxin during the formation of plant organs in tissue culture.
(A) florigen (B) gibberellin
(C) cytokinin (D) ethylene

Q.24 The stress hormone that helps plants respond to drought is –
(A) auxin (B) gibberellin
(C) cytokinin (D) abscisic acid

Q.25 The plant hormone(s) about which Charles Darwin gathered information is/are
(A) auxin (B) gibberellin
(C) cytokinin (D) ethylene

Q.26 Stem elongation: is affected by.
(A) Gibberellin and florigen
(B) Auxin and gibberellin
(C) Florigen and kinin
(D) Kinin and auxin

Q.27 Apical dominance means –
(A) Suppression of growth of apical bud by axillary buds
(B) Suppression of growth of axillary buds by the presence of apical bud.
(C) Stimulation of growth of axillary buds by removal of apical bud
(D) Inhibition of growth of axillary buds by removal of apical bud.

Q.28 *Mimosa pudica* (Sensitive plant) leafs movement due to
(A) Nerve impulsion
(B) Delicate leafs
(C) Loss of tissue
(D) Turgor change in leaf base

Q.29 Plant hormone associated with Climacteric respiration is –
(A) Auxin (B) Cytokinin
(C) Ethylene (D) Gibberellin

Q.30 Which of the following prevents the fall of fruits?
(A) GA_3 (B) NAA
(C) Ethylene (D) Zeatin

Q.31 Scototropic movements induced by :
(A) Light (B) Night
(C) Touch (D) Heat

Q.32 Motor or bulliform cells In grasses shows
(A) Growth movement (B) Tropism
(C) Nastic movement (D) Turgor movement

Q.33 Gibberellins can promote seed germination because of their influence on –
(A) Rate of cell division
(B) Production of hydrolyzing enzymes
(C) Synthesis of abscisic acid
(D) Absorption of water through hard seed coat.

Q.34 I.A.A. mainly inhibits growth of –
(A) Root
(B) Leaf
(C) Shoo
(D) Generally whole plant

Q.35 Gibberellin stimulates flowering in –
(A) The plants growing in japanese farms
(B) The short day plants
(C) The long day plants
(D) Day neutral plants

Q.36 Parthenocarpic tomato fruits can be produced by –
(A) raising the plants from vernalized seeds.
(B) treating the plants with phenylmercuric acetate.
(C) removing androecium of flowers before pollen grains are released.
(D) treating the plants with low concentrations of gibberellic acid and auxins.

Q.37 Hormone involved in photoperiodism is –
(A) IAA (B) Gibberellin
(C) Kinetin (D) 2, 4-D

Q.38 Which of the following is a coconut milk factor ?
(A) Auxin (B) ABA
(C) Morphactin (D) Cytokinin

Q.39 Pine apple can made to flower in off season by the application –
(A) Zeatin (B) Ethylene
(C) Short day (D) Low temperature

Q.40 Abscisic acid treatment results in –
(A) Leaf expansion (B) Stem elongation
(C) Stomatal closure (D) Root elongation

Q.41 The coiling of tendril around some base in response to touch is called –
(A) Hydrotaxis (B) Chemotaxis
(C) Thigmotaxis (D) Geotaxis

Q.42 Prunning of plants promotes branching, because the axillary buds get sensitized to –
(A) Ethylene (B) Gibberellin
(C) Cytokinin (D) IAA

Q.43 Cell elongation in internode regions of the green plants takes place due to –
(A) Ethylene (B) Indole acetic acid
(C) Cytokinin (D) Gibberellins

Q.44 Phase of maturation is characterised by
I. Cells attaining their maximal size.
II. Proper wall thickening and protoplasmic modification.
III. Rapid cell division.
Select the correct option.
(A) I and II (B) II and III
(C) I and III (D) I, II and III

Q.45 High concentration of auxin is present in –
(A) root apex (B) stem apex
(C) node (D) petiole

Q.46 Exponential growth can't be sustained for much time due to
I. limited space and nutrient.
II. accumulation of toxic agent.
III. unlimited space and nutrient.
IV. accumulation of nutrient agent.
Choose the correct combination of options.
(A) I and III (B) III and IV
(C) I and II (D) IV and II

Q.47 Difference between kinetin and zeatin is
(A) kinetin is active zeatin, is non-active.
(B) zeatin is active kinetin, is non-active.
(C) zeatin is synthetic, kinetin is natural.
(D) zeatin is natural, kinetin is synthetic.

Q.48 Select the mismatched pair.
(A) Gibberellic acid-Increases yield of sugarcane.
(B) Cytokinin - Promotes apical dominance.
(C) Ethylene - Sprouting of potato tuber.
(D) Abscisic acid - Inhibits seed germination.

Q.49 Winter varieties of wheat and barley are planted in –
(A) spring season (B) winter season
(C) autumn season (D) summer season

Q.50 Study the following statements.
I. O_2 helps in releasing metabolic energy, which is essential for growth.
II. Nutrients are required by plants for the synthesis of protoplasm.
III. Change in temperature could be the detrimental for the survival of an organism.
IV. Light and gravity don't affect the stages of growth.
Choose the correct option.
(A) I, II, III and IV (B) I, II and III
(C) I, III and IV (D) I, II and IV

Q.51 Which of the following is correct about phytochrome?
(A) P_r absorbs red light and becomes P_{fr}
(B) P_r absorbs yellow light and becomes P_{fr}.
(C) P_{fr} absorbs yellow light and becomes P_r
(D) P_{fr} absorbs red light and becomes P_r.

Q.52 Cabbage is a biennial plant which produces flowers in second year of growth. In an attempt to make it flower in a single year, four potted plants (I, II, III, and IV) of cabbage were subjected to different temperatures for several days as given in the table.

Potted plant	Temperature
I	5°C
II	20°C
III	30°C
IV	25°C

Which potted plant will show flowering?
(A) I (B) II
(C) III (D) IV

Q.53 Heterophylly can be observed in
I. cotton II. coriander III. larkspur
Select the right option.
(A) I, II and III (B) I and II
(C) II and III (D) I and III

Q.54 Hormone involved in phototropism is
(A) IAA (B) gibberellin
(C) kinetin (D) 2, 4-D.

Q.55 In geometrical growth, log phase is represented by –
(A) rapid consumption of nutrient
(B) rapid increment of cell number
(C) highest growth rate
(D) All of the above

Q.56 The term auxin is applied to
I. IAA II. IBA
III. NAA IV. 2-4-D
Select the correct option.
(A) I, II and III (B) II, III and IV
(C) I, III and IV (D) I, II, III and IV

Q.57 In aquatic plant Ranunculus flabellaris (buttercup), submerged leaves are highly dissected whereas the emerged leaves are broad and lobed. This is an example of
(A) heterophylly
(B) environmental plasticity
(C) phenology
(D) both (A) and (B).

EXERCISE - 3 (LEVEL-3)

Choose one correct response for each question.

Q.1 The plant hormone ____ delays senescence, whereas the plant hormone _____ promotes senescence.
(A) cytokinin; auxin
(B) auxin; cytokinin
(C) cytokinin; ethylene
(D) abscisic acid; ethylene

Q.2 The hormone(s) that trigger(s) changes in plants that are exposed to unfavorable environmental conditions is/are –
(A) auxin (B) gibberellin
(C) cytokinin (D) abscisic acid

Q.3 Which of the following represents the correct order in the phytochrome signal transduction pathway?
(1) red light
(2) light responsive gene is switched on (or off)
(3) movement of Pfr to nucleus
(4) conversion of Pr to Pfr
(5) formation of PFr-PIF_3 complex that is bound to promoter region.
(A) 1-3-5-4-2 (B) 1-5-3-2-4
(C) 1-2-3-4-5 (D) 1-4-3-5-2

Q.4 Match the following:

a.	IAA	i. Herring sperm DNA
b.	ABA	ii. Bolting
c.	Ethylene	iii. Stomatal closure
d.	GA	iv. Weed-free lawns
e.	Cytokinins	v. Ripening of fruits

Options:
(A) a – iv, b – iii, c – v, d – ii, e – i
(B) a – v, b – iii, c – iv, d – ii, e – i
(C) a – iv, b – i, c – iv, d – iii, e – ii
(D) a – v, b – iii, c – ii, d – i, e – iv

Q.5 The maximum growth rate occurs in
(A) Exponential phase (B) Stationary phase
(C) Senescent phase (D) Lag phase

Q.6 Hydrotropism have seen in
(A) Flowers (B) Seedlings
(C) Stem (D) None

Q.7 Crocus and Tulip flower shows response to :
(A) Water (B) Light
(C) Temperature (D) Touch

Q.8 Primary precursor of I.A.A is –
(A) Phenyl alanine (B) Tyrosine
(C) Tryptophan (D) Lucin

Q.9 The biological activity of I.A.A .is tested by –
(A) α-amylase test
(B) Avena curvature test
(C) Soyabean callus test
(D) Xanthium leaf disc test

Q.10 Indole, 3 acetic acid called as auxin was first isolated from –
(A) Human urine (B) Corn germ oil
(C) Fusarium (D) Rhizopus

Q.11 Which of the following effects of auxins is of wide application –
(A) Induction of fruit development
(B) Induction of root initiation
(C) Prevention of abscission
(D) All of the above

Note (Q.12-Q.20) :
(A) Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement-2 is False.
(D) Statement-1 is False, Statement-2 is False.

Q.12 **Statement 1 :** Agent orange is a mixture of 2, 4-D and 2, 4, 5-T, used during Vietnam War.
Statement 2 : 2,4-D and 2,4,5-T are used as herbicides.

Q.13 **Statement 1 :** Photomodulation of flowering is phytochrome-regulated process.
Statement 2 : Active form of phytochrome (Pfr) directly induces floral induction in shoot buds.

Q.14 **Statement 1 :** Secondary roots and shoots are plagiogeotropic.
Statement 2 : Plagiogeotropic roots are those which develop at an angle of 45° from the vertical axis.

Q.15 **Statement 1 :** Cytokinism are antisenescent.
Statement 2 : Effects of cytokinins in antagonistic to ethylene.

Q.16 **Statement 1 :** Stratification of seeds may promote their germination.
Statement 2 : Stratification promote gibberellin and cytokinins.

Q.17 **Statement 1 :** The pigment which causes photoperiodic stimulus is called phytochrome.
Statement 2 : Chemically phytochrome is a starch.

Q.18 **Statement 1 :** Phototropism is a directional growth movement.
Statement 2 : Phototrophic movement occur in the direction of light.

Q.19 **Statement 1 :** Sigmoid growth curve consists of four parts.
Statement 2 : Lag phase is called as grand phase of growth.

Q.20 **Statement 1 :** Ethylene is a gaseous hormone.
Statement 2 : Ethylene causes climacteric ripening of fruits.

Q.21 Study the following statements.
I. Increase in girth of plants is primary growth.
II. Increase in girth of plants occurs due to apical meristem.
III. Secondary growth of plants occurs due to lateral meristem.
IV. Vascular cambium and cork cambium are the lateral meristem of plants.
V. Elongation of a plant along the axis is called primary growth.
Choose the incorrect options.
(A) I and II (B) III and IV
(C) IV and V (D) I and V

Q.22 Match the following columns.

	Column I	**Column II**
(a)	IAA	(i) Gases
(b)	N^6-fur furylamino purine	(ii) Terpens
(c)	ABA	(iii) Derivatives of carotenoids
(d)	GA_3	(iv) Adenine derivatives
(e)	C_2H_4	(v) Indole compounds

Codes
(A) (a)–(i), (b)–(ii), (c)–(iii), (d)–(iv), (e) – (v)
(B) (a)–(v), (b)–(iv), (c)–(iii), (d)–(ii), (e) – (i)
(C) (a)–(v), (b)–(iv), (c)–(i), (d)–(ii), (e) – (iii)
(D) (a)–(iv), (b)–(v), (c)–(i), (d)–(ii), (e) – (iii)

Q.23 Match the following columns.

	Column I	**Column II**
(a)	SDP	(i) Wheat
(a)	LDP	(ii) *Chrysanthemum*
(c)	DNP	(iii) Maize

Codes
(A) (a) – (i), (b) – (ii), (c) – (iii)
(B) (a) – (ii), (b) – (i), (c) – (iii)
(C) (a) – (ii), (b) – (iii), (c) – (i)
(D) (a) – (iii), (b) – (i), (c) – (ii)

EXERCISE - 4 (PREVIOUS YEARS AIPMT/NEET EXAM QUESTIONS)

Choose one correct response for each question.

Q.1 Dr. F. Went noted that if coleoptile tips were removed and placed on agar for one hour, the agar would produce a bending when placed on one side of freshly cut coleoptile stumps. Of what significance is this experiment? **[AIPMT 2014]**

(A) It made possible the isolation and exact identification of auxin.
(B) It is the basis for quantitative determination of small amounts of growth-promoting substances.
(C) It supports the hypothesis that IAA is auxin.
(D) It demonstrated polar movement of auxins.

Q.2 A few normal seedlings of tomato were kept in a dark room. After a few days they were found to have become white-coloured like albinos. Which of the following terms will you use to describe them? **[AIPMT 2014]**

(A) Mutated (B) Embolised
(C) Etiolated (D) Defoliated

Q.3 Which one of the following growth regulators is known as 'stress hormone'? **[AIPMT 2014]**

(A) Abscisic acid (B) Ethylene
(C) GA_3 (D) Indole acetic acid

Q.4 Auxin can be bioassayed by : **[RE-AIPMT 2015]**

(A) Hydroponics
(B) Potometer
(C) Lettuce hypocotyl elongation
(D) Avena coleoptile curvature

Q.5 The avena curvature is used for bioassay of – **[NEET 2016 PHASE 1]**

(A) ABA (B) GA_3
(C) IAA (D) Ethylene

Q.6 You are given a tissue with its potential for differentiation in an artificial culture. Which of the following pairs of hormones would you add to the medium to secure shoots as well as roots? **[NEET 2016 PHASE 2]**

(A) IAA and gibberellin
(B) Auxin & cytokinin
(C) Auxin & abscisic acid
(D) Gibberellin &abscisic acid

Q.7 Fruit and leaf drop at early stages can be prevented by the application of **[NEET 2017]**

(A) Cytokinins (B) Ethylene
(C) Auxins (D) Gibberellic acid

Q.8 What is the site of perception of photoperiod necessary for induction of flowering in plants? **[NEET 2019]**

(A) Lateral buds (B) Pulvinus
(C) Shoot apex (D) Leaves

Q.9 It takes very long time for pineapple plants to produce flowers. Which combination of hormones can be applied to artificially induce flowering in pineapple plants throughout the year to increase yield? **[NEET 2019]**

(A) Auxin and Ethylene
(B) Gibberellin and Cytokinin
(C) Gibberellin and Abscisic acid
(D) Cytokinin and Abscisic acid

ANSWER KEY

EXERCISE-1 (SECTION-1&2)

(1) (C) **(2)** (C) **(3)** (B)
(4) (D) **(5)** (B)
(6) Arithmetic; differentiate **(7)** Sigmoid
(8) Early; promote **(9)** Vernalisation
(10) Absolute growth rate **(11)** Phenology
(12) Phytochrome **(13)** Tip; bending
(14) Closing , increases, stress
(15) Linear **(16)** 3 **(17)** Differentiation
(18) Plasticity **(19)** Growth rate
(20) Root, shoot
(21) Apical, lateral, lateral **(22)** Sclophytes
(23) Dedifferentiation
(24) Different; plasticity **(25)** Meristems

EXERCISE - 1 [SECTION-3]

Q	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A	C	B	D	C	A	D	D	C	C	D	D	A	D	B	C	C	D	D	A	D	C	C	B	B	C
Q	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
A	B	B	C	D	D	A	A	C	C	C	A	A	C	C	A	C	C	C	B	C	B	D	D	A	D
Q	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
A	D	D	D	C	A	A	D	D	B	C	C	D	A	D	B	D	C	A	A	B	A	C	B	D	B
Q	101	102	103	104	105	106	107	108																	
A	C	C	C	A	D	D	D	A																	

EXERCISE - 2

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A	A	A	B	B	C	D	B	D	C	D	D	D	A	D	D	C	D	A	D	A	D	B	C	D	A
Q	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A	B	B	D	C	B	B	D	B	A	C	D	B	D	B	C	C	C	D	A	B	C	D	B	C	B
Q	51	52	53	54	55	56	57																		
A	A	A	A	A	D	D	D																		

EXERCISE - 3

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
A	C	D	D	A	A	B	C	C	B	A	D	B	A	A	B	B	C	A	C	B	A	B	B

EXERCISE - 4

Q	1	2	3	4	5	6	7	8	9
A	A	C	A	D	C	B	C	D	A

SOLUTIONS

EXERCISE-1

(1) **(C).** Plant growth takes place in three phases

(i) **Formative Phase :** It also called the phase of cell formation or cell division. New cells are produced by mitotic division of the preexisting cells. Mitosis adds new cells to the body.

(ii) **Phase of Enlargement :** The newly formed cells in formative phase undergoes enlargement. Cell wall of enlarging cell shows plastic extension through enzymatic loosing or microfilament and deposition of new material called intussusception.

(iii) **Phase of Differentiation :** The enlarged cells developes into special or particular type of cells by undergoing structural and physiological differentiation.

(2) **(C).** Differentiation - Act of maturation
Redifferentiation - Act of again loosing cell division capacity and mature to perform special function.
Dedifferentiation - Act of gaining cell division after differentiation.

(3) **(B).** Meristem can be classified into three types

(i) **Apical meristem** is terminal in position and is responsible for the apical growth, e.g., shoot and root apices.

(ii) **Lateral meristem** is responsible for secondary growth, which increases the thickness of plants.

(iii) **Intercalary meristem** is responsible for localised growth of plants.

(4) **(D).** **Extrinsic factor :** It may also be called climatic factors which effects biotic growth. They are temperature, water, oxygen and nutrition. They are also called abiotic factors.
Intrinsic Factor : Intracellular (genetic) and intercellular factors (chemicals like plant growth regulators) together called intrinsic factors. In an organism's development, both extrinsic and intrinsic factor plays a significant role.

(5) **(B).** Associated with the discovery of

Name of Scientist	Related of hormone
Charles Darwin and Francis Darwin (1880)	:Auxin
E Kurosawa (1926)	: Gibberellin acid
Skoog & Miller (1955)	: Cytokinin (Kinetin)
Cousins :	Ethylene ($CH_2 = CH_2$)

(6) **Arithmetic; differentiate.** In arithmetic growth, following mitotic cell division, only one daughter cell continues to divide, while other differentiate and matures.

(7) Sigmoid

(8) **Early; promote.** Auxin helps to prevent fruit and leaf drop at early stages, but promote the abscission of older mature leave and fruit.

(9) **Vernalisation.** Vernalisation is a process of shortening of the juvenile or vegetative phase and faster flowering by previous cold treatment. It was firstly found by Lysenko (1928), a Russian worker.

(10) **Absolute growth rate.**
Quantitative comparison between the growth of living system can be made in two ways

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

(ii) The growth of the system per unit expressed on the common basis, e.g., per unit initial parameter called the relative growth rate.

(11) **Phenology.** A calender year plant shows the period of active vegetative, growth, flowering, fruiting, senescence and dormancy. The different aspects or appearances of plants in different seasons of year is called phenology. They are controlled not only by seasons and other environmental factors, but also by metabolism, heredity, and internal signals.

(12) **Phytochrome.** Experimental evidences have indicated that the photoperiodic stimulus in plants is perceived by pigment phytochrome. Phytochrome is a photoreversible pigment that absorbs light and the flowering is a phytochromemediated process.

(13) **Tip; bending.** After a series of experiments, it was concluded that the tip of coleoptile was the site of transmittable influence that caused the bending of the entire coleoptile.

(14) **Closing , increases, stress.** ABA stimulates the closing of stomata in the epidermis and increases the tolerance of plant to various kind of stresses. Therefore, it is called stress hormone.

(15) Linear

(16) **3.** The period of growth is generally divided into three phases: (i) Meristematic phase
(ii) Elongation phase (iii) Maturation phase

(17) **Differentiation.** Growth is invariably associated with differentiation. For example, when a seed germinates it does not simply increases in size but form seedlings. Differentiation is a permanent, localised qualitative change in size, biochemistry, structure and function of cells, tissues or organs, e.g., fibres, vessels, tracheids, sieve tubes, mesophyll, leaf, etc.

(18) **Plasticity.** Plant follows different pathways in response to environment or phases of life to form different kind of structures. This ability is called plasticity, e.g., heterophylly in cotton, coriander and larkspur.

(19) **Growth rate.** The increased growth per unit time is termed as growth rate. Thus, rate of growth can be expressed mathematically. An organism, or a part of an organism can produce more cells in a variety of ways. The growth rate shows an increase that may be (i) Arithmetic and (ii) Geometrical.

(20) Root, shoot

(21) **Apical, lateral, lateral.** In most of the higher plants, the growing apical bud inhibits the growth of lateral bud, a phenomenon called apical dominance. Removal of the shoot tips usually results in growth of lateral buds.

(22) **Sclophytes.** Sclophytes or shade loving plants grow in areas having moderate or low intensity of light. Optimum growth occurs with the light intensity of 10-30% of full sunlight.

(23) **Dedifferentiation.** Dedifferentiation is regaining the capacity to divide of by differentiated cells. For example, formation of meristems in interfascicular cambium and cork cambium from fully differentiated parenchyma cells.

(24) **Different; plasticity.** Plants follow different pathways in response to environment or phases oflife to form different kind of structures. This ability is called plasticity.

(25) **Meristems.** Higher plants possess specific areas, which take part in the formation of new cells. These area are called meristems. Meristems are of three types: (i) Apical meristem
(ii) lntercalary meristem (iii) Lateral meristem.

(26) **(C).** Lag phase is represent by initial slow growth rate.

(27) **(B). Meristematic Phase :** This phase is also called the formative or cell formation phase. In this phase there are constantly dividing cells present at the root and shoot apex The cells in this region are rich in protoplasm, possess large conspicuous nuclei and the cell walls are, thin and cellulosic with abundant plasmodesmatal connections.

(28) **(D).** Root Apical Meristem (RAM), Shoot Apical Meristem (SAM) and intercalary meristem are responsible for the primary growth to the plants and they principally contributes to the elongation of the plants along their axis.
In the dicotyledons and gymnosperms, the lateral meristems, vascular cambium and cork cambium appear later in life. These are the meristems that causes increase in the girth of the organ in which they are active. This is known as the secondary growth of the plant.

(29) **(C).** The cells proximal (just next, away from tip) to the meristematic zone represents the phase of elongation. Increased vacuolation, cell enlargement and new cell wall deposition are the characteristics of the cells in this phase.

(30) **(A).**

(31) **(D).** Water is required in plant growth for enzymatic reactions, cell enlargement and extension growth.

(32) **(D).** Growth is measured by variety of parameters like
(i) increase in fresh weight.
(ii) increase in dry weight.
(iii) increase in length, area, and volume.
(iv) increase in cell number.

(33) **(C).** In S-shaped curve, the growth is highest in Log/exponential phase.

(34) **(C).** Absolute growth rate (AGR) : Increase in total growth of two organs or organisms is measured and comparison of total growth per unit time is called absolute growth.
Absolute growth rate is the total growth per unit time. Relative growth rate (RGR) : It is growth per unit time per unit initial growth.

$$RGR = \frac{\text{Growth in given time period}}{\text{Measurement at start of time period}}$$

AG for leaf A = 10 cm^2 – 5 cm^2 = 5 cm^2

RGR for leaf A= $\frac{5}{5} \times 100 = 100\%$

AG for leaf B = 55cm^2 – 50 cm^2 = 5 cm^2

RGR for leaf B = $\frac{5}{50} \times 100 = 10\%$

Though the absolute growth is same for both the leaves (A and B), relative rate of growth is more in leaf A because of its initial small size.

(35) **(D).** The cells in the root and shoot apex shows the following characteristics
(i) rich in protoplasm
(ii) conspicuous nuclei
(iii) cell wall are primary in nature, thin and cellulosic with abundant plasmodesmata connection.

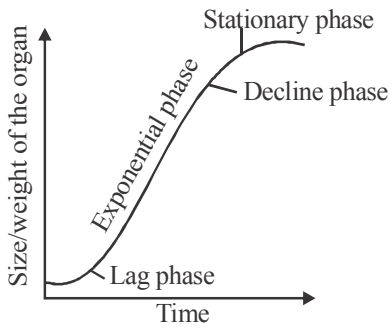
(36) **(D).** The log phase or exponential growth is also called grand phase of growth. The rate of maximum growth in the log phase is maintained for some time. It is then known as linear phase. It appears as upright line in growth curve.

(37) **(A).** An embryo initially shows geometrical growth in cells but later it passes into arithmetic phase.

(38) **(D).** Geometric growth curve shows 'S'-shaped curve.
'S'-shaped have has following phases
(i) Lag phase
(ii) Log phase
(iii) Stationary phase
(iv) Diminising of growth phase.

(39) **(B).** **Geometrical Growth :** In most system the initial growth is slow (lag phase), and it increases there after at a exponential rate (log or exponential phase). Both the progeny cells following mitotic cell division retains the ability to divide and continue to do so. However due to the limited nutrient supply, the growth slows down leading to stationary phase. If we plot the parameter of growth against time, a typical sigmoid curve is obtained.
It has following stages

1. During lag phase, organism adapt themselves to growth conditions. It is the period where the individual organism are matruing and not yet able to divide. During the lag phase of the bacterial growth cycle, synthesis of RNA, enzymes and other molecules occurs.
2. The log phase (sometimes called the logarithmic phase or the exponential phase) is a period characterised by cell doubling. The number of new organism appering per unit time is proportional to the present population.
3. The stationary phase is often due to a growth-limiting factor such as the depletion of an essential nutrient, and/or the formation of an inhibitory product such as an organic acid. Stationary phase results from a situation in which growth rate and death rate are equal.
4. Death phase, organism run out of nutrients and die.



(40) **(C).** Increase in the girth of plants (organ) takes place by vascular and cork combium.

(41) **(C).** Ability of the plants to produce new plant material is called efficiency index.

(42) **(D).** Growth of the plant is open ended because plant grows indefinitely forming new organs to replace the older or senescent ones. Meristem is responsible for undetermined growth of plants. Irreversible increase in the mass or volume is called apparent growth. Whereas in real growth, formation of new plant protoplasm takes place.

(43) **(D).** Characters of phase of elongation phase are
(i) cell enlargement.
(ii) new cell wall deposition.
(iii) increased vacuolation.

(44) **(A).** The differentiation in plants is open, because cells/tissue arising out of the same meristem have different structure at the maturity. The cells tissues arising out of meristem regain the capacity of division under certain condition.

(45) **(D).** Cell enlargement / elongation may occur in cell direction as in isodiametric parenchymatous cells. In many parts, cell enlargernent takes place predominantly in linear direction so much then this enlargement phase which is called the phase of cell elongation. Maximum elongation occurs in conducting tissue and fibres.

(46) **(C).** During differentiation, cells undergoes few to major structural changes both in their cell wall and protoplasm. For example, to form tracheary elements, the cells would loose their protoplasm. They also develop a very strong, elastic, lignocellulosic secondary cell walls to carry water to long distances even under extreme tension.

(47) **(C).** Permanent localised qualitative change in size, biochemistry, structure and function of cells or organs is called differentiation.

(48) **(B).** Formation or cork cambium and interfascicular cambium is the example of dedifferentiation.

(49) **(B).** Redifferentiation as the name suggest, indicates again differentiation. When dedifferentiated cell again get differentiated, the phenomena is called redifferentiation. e.g., secondary cortex.

(50) **(C).** During differentiation of tracheary elements the cells lose its protoplasm and cells develop very strong elastic lignocellulosic secondary cell walls.

(51) **(B).** During the phase of elongation/enlargement the cell wall of the enlarging cell shows plastic extension through enzymatic loosening of microfibrils and deposition of new material. This deposition of new material into cell wall is called intussusception.

(52) **(B).** Redifferentiation as the name suggest, indicates again differentiation. When dedifferentiated cell again get differentiated, the phenomena is called redifferentiation. e.g., secondary cortex.

(53) **(C).** The final structure at maturity of a cell tissue is determined by the location of cells.

(54) **(D).** **Intrinsic growth factors:**
(i) Chemicals such as plant growth regulators.
(ii) Genetic factors, e.g., chromosome, gene, etc.

(55) **(D).** Environmental heterophylly is the difference in shapes of leaves produced in air and water. Buttercup represents the heterophyllous development due to environment.

(56) **(A).** Parts of the year when maximum vegetative growth occurs is known as growing season.

(57) **(A).** Juvenile phase is followed by adult phase. Transition from juvenile to adult is gradual in many cases, e.g., Ipomea, cotton. It is called homoblastic growth. In others, the transition is abrupt. This is called heteroblastic development.

(58) **(C).** The Plant Growth Regulator (PGR), ethylene comes under the category of plant growth inhibitor hormone.

(59) **(C).** Large amount of ethylene is synthesised by senescence tissue and ripening fruit.

(60) **(C).** **Functions of Gibberellin are**
(i) Increase in the length of axis (used to increase the length of grapes stalk).
(ii) Causes fruit like apple to elongate.
(iii) Delay senescence of fruits
(iv) Used to speed up the malting process in brewing industry.
(v) Spraying on sugarcane increases the stem height.

(vi) Early seed production.
(vii) Promotes blotting.

(61) **(A).** ABA (Absisic acid) is a stress hormone which is synthesized by the plant during drought or other stress conditions. It causes rapid movement of K^+ ions out of the guard cells, closes stomatal pores and thus reduces the transpiration rate.

(62) **(A).** The effect of gibberellins had been known in Japan for over a century where a certain rice plant were found to suffer from 'Bakane' (foolish seedlings) disease. The disease was found by Kurosawa (1926) and it is caused by a fungus (*Gibberella fujikuroi*).

(63) **(C).** Due to their wide application, auxins have been used extensively in agriculture and horticulture.

(64) **(C).** Ethylene is a simple gaseous PGR. It is synthesised in large amounts by tissues undergoing senescence and ripening fruits.

(65) **(A).**

(66) **(C).** Auxin was isolated by FW Went from the tips of coleoptiles of oat seedlings in 1928.

(67) **(C).** ABA is a plant growth inhibitor. It promotes senescence and ageing in plant parts.

(68) **(C).** More than 100 gibberellins, reported from widely different organisms such as fungi and higher plants. They are denoted as GA_1, GA_2, GA_3 and so on. However, GA_3 was one the gibberellic acid to be discovered first and mostly intensively studied form.

(69) **(B).** In 1880, Charles Darwin and his son Francis Darwin observed that coleoptiles of canary grass responds to unilateral stimulation.

(70) **(C).**

(71) **(B).** **Functions of Auxin**
(i) Auxin helps to initiate rooting in stem cuttings, an application widely used for plant propagation.
(ii) Auxin promotes flowering, e.g., in pineapples.
(iii) It helps to prevent fruit and leaf drop at early stages.
(iv) They promote the abscission of older mature leaves and fruits.
(v) Apical dominance.
(vi) Induce parthenocarpy in tomatoes.
(vii) Controls xylem differentiation and helps in cell division.

(72) **(D).** Gibberellin delay senescence. Thus, the fruit can be left on tree longer so as to extend the market period.

(73) **(D).**

(74) **(A).** Phototropism movement of plants towards the light is called phototropism. Charles Darwin and his son observed that the coleoptiles of canary grass respond to unilateral illumination by growing towards the light source (phototropism).

(75) **(D).** **Effects of Ethylene**
(i) Horizontal growth of seedling.
(ii) Swelling of axis.
(iii) Apical hook formation in dicot seedling.
(iv) Promotes senescence and abscission of plants.
(v) Break seed and bud dormancy.
(vi) Initiate flowering in pineapple and flowering in mango.
Apical dominance is the effect of auxin hormone.

(76) **(D).** During mid 1960s, three independent researches reported the purification and chemical characterisation of three different kind of inhibitors as inhibitor B, abscission II and dormin. Later, three were proved chemically identical. It was named Abscisic Acid (ABA).

(77) **(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. 2, 4-D and 2, 4, 5-T are used as weedicides (herbicides) which destroy broad leaved weeds in cereal crops and lawns. Dalapon (2, 2-dichloropropionic acid) kills grasses in broad leaved crops.

(78) **(D).** Since the discovery of zeatin, several naturally occuring cytokinins and some synthetic compounds with cell division promoting activity have been identified. Naturally, cytokinins are synthesised in the regions where rapid cell division occurs like root apices, developing shoot buds, young fruit, etc.

(79) **(C).**

(80) **(A).** ABA (Abscisic Acid) was discovered for its role in regulating abscission and dormancy. It acts as the general plant growth inhibitor and an inhibitor of plant metabolism. ABA inhibits seed germination.

(81) **(A).** Auxin (derived from Greek word auxin, which means to grow) was first isolated from human urine. Kogl and Heagen Smith (1931) isolated three chemicals from human urine and named them as auxin.

(82) **(D).** Auxins stimulate root formation on the stem cuttings, e.g., IBA, IBA-alanine, NAA. NAA is synthetic auxin while IBA is considered as both natural and synthetic.

(83) **(D).** **Functions of auxin**
(a) Initiate rooting in stem cuttings.
(b) Promote flowering in pineapples.
(c) Controls xylem differentiation.

(84) **(B).** In most of the higher plants, the growing apical bud inhibits the growth of the lateral (axillary) buds. This phenomenon is called apical dominance. This phenomenon takes place due to the synthesis of auxins by apical buds.

(85) **(C).** 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 dominancec,aused by auxins.

(86) **(C).** The most widely used compound as a source of ethylene is ethepton. Ethepton, in an aqueous solution is readily absorbed and transported within the plant and releases ethylene slowly.

(87) **(D).** Natural cytokinin was first obtained from corn kernels and coconut milk.

(88) **(A).** Auxins are mainly responsible for apical dominance. IAA is a natural auxin.

(89) **(D).** Auxins are widely used as herbicides. 2-4-D is widely used to kill dicotyledonous weeds. It does not affect mature monocotyledonous plants.

(90) **(B).** Callus is an unorganised, undifferentiated mass of diving cells formed during tissue culture which requires both auxins and cytokinins for its growth and differentiation In callus, shoot regeneration is promoted by a cytokinin, such as BAP (Benzylaminopurine) and root regeneration is promoted by an auxin, such as NAA (Naphthalene acetic acid). Thus, shoot and root regenerations in callus are controlled by auxin-cytokinin balance. Usually, an excess of auxins promote root regeneration and that of cytokinins promote shoot regeneration.

(91) **(D).** Ethepton hastens fruit ripening in tomatoes and apples and accelerates abscission in flowers and fruits. It promotes female flowers in cucumbers thereby increasing the yield.

(92) **(C).** Day neutral plants relates to flowering in all possible photoperiod.

(93) **(A).** The effect of photoperiods or daily duration of light hours (and dark periods) on the growth and development of plants, especially flowering, is called photoperiodism. Photoperiodism was first studied by Garner and Allard (1920) in 'Maryland mammoth', a variety of Tobacco. Long Day Plants (LDPs) flower when they receive long photoperiods or light hours which are above a critical length, e.g., henbane (*Hyoscyamus niger*), wheat, oat, sugarbeet, spinach (*Spinacea oleracea*), radish, barley, larkspur, lettuce.

(94) **(A).** Phytochrome is a pigment, which is universally present in green flowering plants and is responsible for photo morphogenic photoperiodic changes and developmental processes.

(95) **(B).** Garner and Allard (1920) firstly observed photoperiod in 'Maryland Mammoth'. A variety of tobacco could be made to flower in summers by reducing the amount of light hour along with artificial darkening. It could be made to remain vegetative in winters by providing extra light.

(96) **(A).** Photoperiod was first studied by Garner and Allard (1920).

(97) **(C).**

(98) **(B).** Short day plants are also called long night plants because they requires continuous or critical dark period for flowering.

(99) **(D).** Vernalisation made plant to flower by shortening the vegetative or juveline growth of the plant.

(100) **(B).** Abscission, the shedding of body parts, commonly refers to the process by which a plant intentionally drop one or more of its parts, such as a leaf, fruit, flower or seed.

(101) **(C).** Vernalization or low temperature treatment of some plants can be replaced by gibberellins.

(102) **(C).** Vernalisation is a process of shortening of the juvenile or vegetative phase and faster flowering by previous cold treatment. It was firstly found by Lysenko (1928), a Russian worker.

(103) **(C).** Temperature between 0°C to 5°C is required during vernalisation.

(104) **(A).** Low temperature required for vernalisation is usually 0°-5°C. Low temperature should not be immediately followed by very high temperature (40°C) otherwise the effect of vernalisation is lost. This phenomenon is called devernalisation.

(105) **(D).**

(106) **(D).** Common examples of plants requiring vernalisation are winter rye, winter wheat, winter oat, winter barley, pea, beet, cabbage, henbane, viola, clover, *Chrysanthenum*, etc.

(107) **(D).** Site of vernalisation The stimulus of vernalization is perceived only by the merismatic cells, e.g., shoot tip, embryo tip, root apex, developing leaves, etc.

(108) **(A).** Florigen (a flowering hormone) start synthesising in leaves and then transferred to flowering region. Florigen initiates the floral bud initiation.

EXERCISE-2

(1) **(A).** Auxins were the first plant hormone to be identified.

(2) **(A).** Auxins exhibits polar transport and move away from unidirectional light.

(3) **(B).** Gibberallins are involved in breaking of seed and bud dorrnancy.

(4) **(B).** Gibberallins are involved in bolting seen in rosette plants.

(5) **(C).** Cytokinins coordinate growth of roots and shoots in concert with the auxins.

(6) **(D).** The diploid central cell fuses with the sperm cell and eventually forms the endosperm.

(7) **(B).** Abscission is the process of dropping of tlowers, fruits, and leaves.

(8) **(D).** Bolting is used for extension of the tloral stem in rosette plants.

(9) **(C).** Thigmotropism movement or growth of a plant in response to contact with an object.

(10) **(D).** Nastic movement refers to temporary, reversible response to a unidirectional stimulus.

(11) **(D).** Photoperiodism refers to response of a plant due to changes in the length of light and dark periods during each 24-hour period.

(12) **(D).** Vernalization is low temperature stimulation of flowering.

(13) **(A).** Senescence is aging in plants.

(14) **(D).** Phytochrome is involved in photoperiodism.

(15) (D)

(16) **(C).** Phytochrome is a photoreceptor, a pigment that plants, and some bacteria and fungi, use to detect light. It is sensitive to light in the red and far-red region of the visible spectrum.

(17) (D)

(18) **(A).** Heliotropism, a form of tropism in response to the direction of the sun.

(19) (D)

(20) **(A).** Auxins were the first of the major plant hormones to be discovered.

Auxin (namely IAA) is present in all parts of a plant, although in very different concentrations. Some synthetic auxins, such as 2,4-D and 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), are used also as herbicides.

(21) (D)

(22) **(B).** Gibberellin was first recognized in 1926 by a Japanese scientist, Eiichi Kurosawa, studying bakanae, the "foolish seedling" disease in rice.

(23) (C)

(24) **(D).** The phytohormone abscisic acid (ABA) plays a regulatory role in many physiological processes in plants. Different stress conditions such as water, drought, cold, light, and temperature result in increased amounts of ABA.

(25) (A) **(26)** (B) **(27)** (B) **(28)** (D)

(29) **(C).** Respiration is a process of oxidative breakdown (catabolism) of complex molecules into simpler molecules, yielding energy, water, carbon dioxide and simpler molecules needed for other cellular biochemical reactions required for ripening. Early examples of the human utilisation of ethylene to enhance fruit ripening include the ancient Egyptian practice of gashing figs to enhance ripening responses. The ethylene produced by the injured fruit tissue triggers a broader ripening response.

(30) (B) **(31)** (B) **(32)** (D) **(33)** (B)

(34) (A) **(35)** (C) **(36)** (D) **(37)** (B)

(38) (D) **(39)** (B) **(40)** (C) **(41)** (C)

(42) (C)

(43) **(D).** Brassinosteroid (BR) and gibberellin (GA) are two predominant hormones regulating plant cell elongation. A defect in either of these leads to reduced plant growth and dwarfism.

(44) **(A).** Further away from the apex, i.e., more proximal to the phase of elongation, lies the portion of axis which is undergoing the phase of maturation. The cells of this zone, attain their maximal size in terms of wall thickening and protoplasmic modifications.

(45) **(B).** The term 'auxin' is applied to the indole-3-acetic acid (IAA), and to other natural and synthetic compounds having certain growth regulating properties. They are generally produced by the growing apices of the stem, from where they migrate to the regions of their action.

(46) **(C).** Exponential or log phase can not sustain for long period because the nutrients and space are limited and there is competition as well. Microorganisms, when nutrients get exhausted, secrete toxic chemicals which inhibit the growth of other organisms.

(47) **(D).** The first cytokinin was discovered as kinetin (A modified form of adenine). Kinetin does not occur naturally in plants. Search for natural substances with cytokinin like activity led to the isolation of zeatin from corn-kernels and coconut milk.

(48) **(B).** Gibberellic acid increases the yield of sugarcane crop. Cytokinins inhibit apical dominance and act antagonistically to auxins which promote apical dominance. Rhizomes, corms, tubers, seeds (e.g., Peanut) and other storage organs can be made to sprout early by exposing them to ethylene. Abscisic acid is a plant growth inhibitor, which inhibits seed germination.

(49) **(C).** Winter varieties of wheat and barley are planted in autumn so that they can get stimulus of cold in winter and produce seed in spring season.

(50) **(B).** Every organism has an optimum temperature range best studied for its growth. Any deviation from this range could be detrimental to its survival. Environmental signals such as light and gravity also affect certain phases/stages of growth.

(51) **(A).** Phytochrome is a bright blue or bluish green pigment which was first of all isolated from plasma membrane of alga *Mougeotia*. Phytochrome is the photoreceptor pigment that controls flowering. It exists in two interconvertible forms: P_{fr} or P_{730}(absorbs far-red light) and P_r or P_{660} (absorbsred light).

By absorbing red light, P_r is converted to P_{fr} rapidly. P_{fr}, on absorbing far-red light is converted to P_r rapidly. P_{fr} is physiologically active form; P_r is inactive.

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

(P_r: inactive in cytosol; P_{fr}: Active, attached to plasma membrane)

(52) **(A).** Low temperature required for vernalization is usually 0-5°C. In nature, the plants requiring vernalization are commonly biennials (e.g. cabbage, sugarbeet, carrot), which complete their life cycle in two years. They germinate and grow vegetatively in the first year and produce flowers in the second year of growth. These plants fulfill their cold requirement during winters. However, such biennial plants can be made to flower in one growing season by providing low temperature treatment (i.e. 0-5°C temperature) to young plants or moistened seeds.

(53) **(A).** Heterophylly can be observed in cotton, coriander, and larkspur.

(54) **(A).** Phototropic curvature is the result of uneven distribution of auxin. Darwin and Darwin observed that the coleoptiles of canary grass responded to unilateral illumination by growing towards the light source (phototropism). After a series of experiments, it was concluded that the tip of coleoptile contains auxin that caused the bending of the entire coleoptile in relation to the direction of light.

(55) **(D).** In the exponential phase of growth (S-shaped), there is a rapid increase in size, cell number and mass of an organism, due to the rapid consumption of nutrients. Due to rapid consumption of nutrients, the growth rate is highest at this phase.

(56) **(D).** The term 'auxin' is applied to the indole-3 acetic acid and to other natural and synthetic compound having certain growth regulating properties.

Auxin –

(i) Naturtal : IAA (Indole Acetic Acid)
IBA (Indole Butyric Acid)

(ii) Synthetic:NAA (Naphthalene Acetic Acid)
2-4-D (2-4-Dichlorophenoxy Acetic Acid)

(57) **(D).** Heterophylly is the occurrence of different types of leaves on the same plant in different growth phases or under different environmental conditions. In case of environmental plasticity as shown by aquatic plant *Ranunculus flabellaris* (Buttercup), the submerged leaves are highly dissected while the emerged leaves are broad and lobed.

EXERCISE-3

(1) (C) **(2)** (D) **(3)** (D) **(4)** (A)
(5) (A) **(6)** (B) **(7)** (C) **(8)** (C)
(9) (B) **(10)** (A) **(11)** (D)

(12) **(B).** The first selective herbicides to be discovered and used widely were 2,4-D and its derivatives. These compounds are very potent auxins. 2,4-D and 2,4,5-T destroy dicots weeds. They block their seive elements and disturb mitosis. The plant is ultimately destroyed. Agent orange, which was used in the war in Vietnam as a defoliant is an effective mixture of free 2,4-D and the N-butyl ester of 2,4,5-T.

(13) **(A).** Phytochrome is a receptor pigment present in leaves. They are responsible for flowering in plants. Phytochrome are two types P_r (Red light) and P_{fr}(far-red light) P_{fr} are responsible for flowering in LDP.

(14) **(A).** Secondary roots and shoots are plagiogeotropic that is, they grow to a position at an oblique angle (45°) to the gravitational force. Root and stem branches lie at an angle other than 90° to the direction of gravity

(15) **(B).** When cytokinins are added directly to the abscission layer, senescence of the zone is retarded. They delayed the degradation of protein and chlorophyll of the plant parts and hence delay senescence. As they act as antisenescent, they act as antagonistic to ethylene which accelerate senescence.

(16) **(B).** Stratification of seeds may affect the disappearance of inhibitors and the buildup of germination promoters such as the gibberellins and cytokinins. Natural stratification occurs when seeds shed in the fall are covered with cold soil, debris and snow. In artificial stratification, layers of seeds are alternated with layers of moistened Sphagnum sand or some other appropriate material and stored at low temperatures.

(17) **(C).** Phytochrome is a pigment involved in the perception of photoperiodic stimuli controlling flowering, seed germination and other morphogenetic phenomena. It is a protein with a chromophore (pigment-coloured portion) prosthetic group (e.g., Chromoprotein).

(18) **(A).** Phototropism is a paratonic directional growth movement of curvature which is induced and determined by the direction of light stimulus. Shoots grow towards the source of light hence called positively phototrophic while roots grow away from the source of light hence called negatively phototrophic.

(19) **(C).** If total growth is plotted against time, an s-shaped or sigmoid curve is obtained. It consists of four parts-lag phase, log phase, phase of diminishing growth and stationary phase. Growth is slow in the lag phase, rapid during log or exponential phase, slow again during the phase of diminishing growth. Growth stops completely during the stationary phase. Log phase is also called as grand phase of growth due to fast growth in this phase.

(20) **(B).** Ethylene is a gaseous hormone. It aids in ripening of climacteric fruits and dehiscence of dry fruits. Climacteric fruits are the fleshy fruits which show a sudden sharp rise of respiration rate at the time of ripening (respiratory climacteric). They are usually transported in green or unripe stage. Ethyleneis used to induce artificial ripening of these fruits e.g., Apple, Mango, Banana, etc.

(21) **(A).** Primary Growth results due to
(i) Elongation of plant along the axis is called the primary growth.
(ii) Primary growth happens due to the presence of root apical meristem and shoot apical meristem.

(22) **(B).** Plant growth regulators (PGRs) are small, simple molecules of diverse chemical composition. They could be indole compounds (Indole-3-Acetic acid, IAA); Adenine derivatives (N^6-fur furylamine purine, kinetic) derivatives of of carotenoids (Abscisic Acid, ABA); terpenes (Gibberellic Acid, GA_3) or gases (Ethylene C_2H_4). Plant growth regulators are variously described as plant growth substances, plant hormone or phytohormone.

(23) **(B).** SDP (Short Day Plant)-*Chrysanthemum*
LDP (Long Day Plant)-wheat
DNP (Day Neural Plant)-maize and rice.

EXERCISE-4

(1) **(A).** F.W. went isolated auxin from *Avena* coleoptile tip.

(2) **(C).** Etiolation is depigmentation is leaf when plant is placed in dark for more than 36hrs.

(3) **(A).** ABA stimulates the closure of stomata in the epidermis and increases the tolerance of plants to various kinds of stresses.

(4) **(D).** Avena coleoptile curvature test is the bioassay for auxin.

(5) **(C).** Bioassay - It is a quantitative and qualitative test used to determine the nature and function of a biochemical by using living material e.g., *Avena* curvature test used as bioassay for auxins.

(6) **(B).** Auxins and cytokinin induce development of root and shoot in a culture medium (respectively).

(7) **(C).** Auxins prevent premature leaf and fruit fall. NAA prevents fruit drop in tomato; 2,4-D prevents fruit drop in Citrus.

(8) **(D).** During flowering, photoperiodic stimulus is perceived by leaves of plants.

(9) **(A).** Plant hormone auxin induces flowering in pineapple. Ethylene also helps in synchronization of flowering and fruit set up in pineapple.