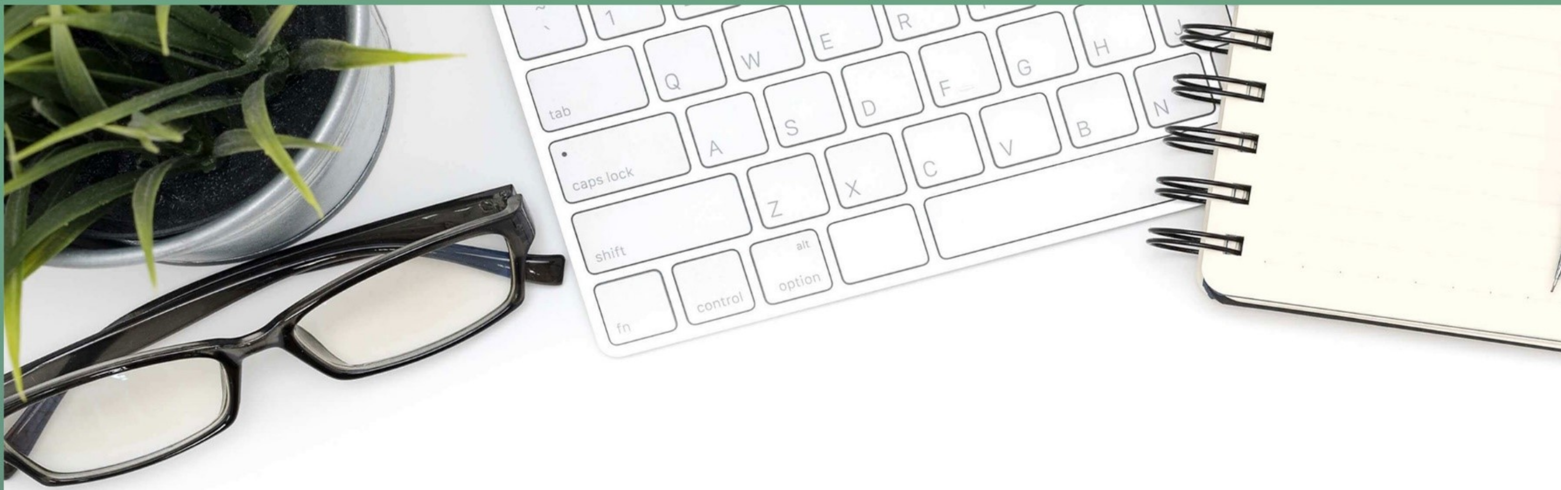

NEET Biology
Short Notes

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Check Plant Growth and Development **Notes for NEET 2019 exam**! In medical exams like NEET, AIIMS, and JIPMER there are many questions asked from the Plant Physiology. Here we are sharing detailed notes on Plant Growth Regulators, Seed Dormancy, Photoperiodism and Vernalization. Growth and differentiation are the two processes that contribute to development. So, Let's begin with a brief introduction of Respiration in Plants.

Growth: In a living being, growth refers to an increase in the size of an individual cell, part, or an organ. This increase is permanent and irreversible. It is accompanied by both the catabolic and anabolic processes by using energy.

Plant Growth Regulators (PGRs)

PGRs or phytohormones or plant hormones are the molecules that are simple and small. In a living plant, on the basis of their functions, they can be classified into two groups:

- **Plant growth promoters** are involved in the activities promoting growth, such as cell enlargement, tropic growth, fruiting, cell division, pattern formation, seed formation, and flowering. It includes cytokinin's, gibberellins, and auxins.
- **Plant growth inhibitors** are associated with various activities inhibiting growth, such as abscission and dormancy. They also play a role in the responses of the plant to abiotic and biotic stresses, and wounds. It includes ethylene and abscisic acid (ABA).

PGRs were discovered accidentally when Charles Darwin and his son observed phototropism shown by the coleoptiles of canary grass. These coleoptiles showed the response to the unilateral illumination and grew towards the light source.

Physiological effects of Plant Growth Regulators:

1. **Auxin –** The initial isolation of auxin was from the urine of humans.
   - Auxins are those synthetic and natural compounds including **IAA (indole-3-acetic acid)** which have growth regulation properties. Their production occurs by the growing root and shoots apices from where they migrated to their region of action.
   - The auxins that are isolated from plants are natural auxins, for example, **IBA (indole butyric acid)** and **IAA**.
   - Synthetic auxins include **2, 4 – dichlorophenoxyacetic acid (2, 4 – D)** and **Naphthalene acetic acid (NAA)**.
   - **Uses and applications:**
   - They are widely used in plant propagation as auxin initiates rooting in stem cuttings.
   - In plants, such as pineapples, the flowering is promoted by auxins.
   - At the early stages, they prevent leaf and fruit drop. However, older mature fruits and leaves' abscission is also promoted by them.
   - Higher plants show apical dominance, that is, the phenomenon in which lateral buds growth is inhibited by the growing apical buds. These lateral buds usually grow by decapitation in which shoot tips are removed. This makes an application in tea plantations.

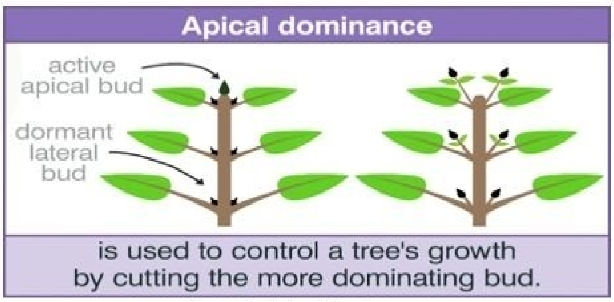

Figure 1: Apical dominance

- In plants, such as tomatoes, parthenocarpy is induced by auxins.
- They are herbicide. Dicotyledonous weeds can be killed by 2, 4-D.
- Auxins are associated with cell division and control of xylem differentiation.

2. **Gibberellins –** More than 100 gibberellins are reported in different organisms, such as higher plants and fungi.

- The first gibberellin discovered was gibberellic acid, that is, **GA_3**.
- These have **Acidic nature.**
- Due to their ability to increase axis length, they can be used to increase the stalk length in fruits, such as grapes, and stem length in sugarcane.
- They help in elongation of fruits and shape improvement, such as in apple.
- They increase the market period of fruits by **delaying senescence**
- GA_3 hasten the process of malting in the brewing industry, speed up the maturity period in juvenile conifers, and promotes bolting in cabbages, beet, and other plants.

3. **Cytokinin's –** They have an effect on the process of cytokinesis and were discovered from a modified adenine form, **Kinetin**. These are not found naturally. However, zeatin is the natural cytokinin isolated from coconut milk and corn kernels. Some other natural cytokinins were also identified.

- Their synthesis occurs in young fruits, developing shoot buds, root apices and other regions of rapid cell division.
- These help in new leaves production, the formation of adventitious shoot and growth of lateral shoot.
- They help in the promotion of nutrient mobilisation and in overcoming apical dominance.

4. **Ethylene –** This is found in gaseous form and is found to be synthesized in ripening fruits and tissues undergoing senescence in quite large amounts.

- It helps in axis swelling, fruit ripening, the formation of the apical hook in dicot seedlings, and horizontal growth.
- It also helps to promote abscission of organs and senescence.
- During fruit ripening, it increases the rate of respiration. This increase is referred to as respiratory climatic. It is associated with
    i. germination initiation in peanut seeds
    ii. promotion of rapid elongation of petiole/internode in deep water rice plants
    iii. root growth promotion and formation of root hair
    iv. breaking of bud and seed dormancy, potato tuber sprouting, and
    v. flowering initiation and synchronization of fruit-set.

It is widely used in agriculture. **Ethephon** is an ethylene source that is used most widely.

5. Abscisic acid – ABA (Abscisic acid) also plays various significant roles in the growth and development of plants. It is associated with

- inhibition of plant growth, metabolism and seed germination
- stimulation of stomatal closure in the epidermis
- development of seeds and their dormancy and maturation, and
- increase in stress tolerance in plants, that's why it is also known as the **Stress hormone**.

Since it induces dormancy, it enables seeds to withstand unfavourable conditions and desiccation. **ABA and GAs are antagonistic to each other in most situations.**

Seed Dormancy

Seed dormancy is the state in which a seed cannot germinate for a time period in the conditions that are generally suitable for non-dormant seeds.

- These conditions are a combination of environmental factors, that is, light, gases, seed coats, water, temperature, hormone structures, and mechanical restrictions.
- This mechanism generally occurs to prevent seed germination when its survival chances are low. Dormant seeds, thus, enter a state of rest before germination.

Photoperiodism

In certain plants, flowering is dependent on the combination of dark and light exposures and their relative durations as well. This physiological reaction of plants to night/day periods is called **Photoperiodism**.

- Before flowering, shoot apices are modified into flowering apices. However, leaves perceive the light/dark duration. From leaves, a hormone, responsible for flowering, is hypothesised to migrate to the shoot apices only during plant exposure to necessary photoperiod. Based on the response of plants to the duration of light, plants can be grouped as:

1. **Long day plants –** The plants that require light exposure for a duration more than that of critical duration, that is, they flower only when exposed to longer days. This critical duration varies for different plants and species. Common examples: **Barley** and **Onion**.
2. **Short day plants -** The plants that require light exposure for a duration less than that of critical duration, that is, they flower only when exposed to shorter days. Common examples: **Soybean** and **Tobacco**.
3. **Day-neutral plants –** The plants in which flowering response is induced irrespective of the exposure to light duration. Common examples: **Maize** and **Cotton**.

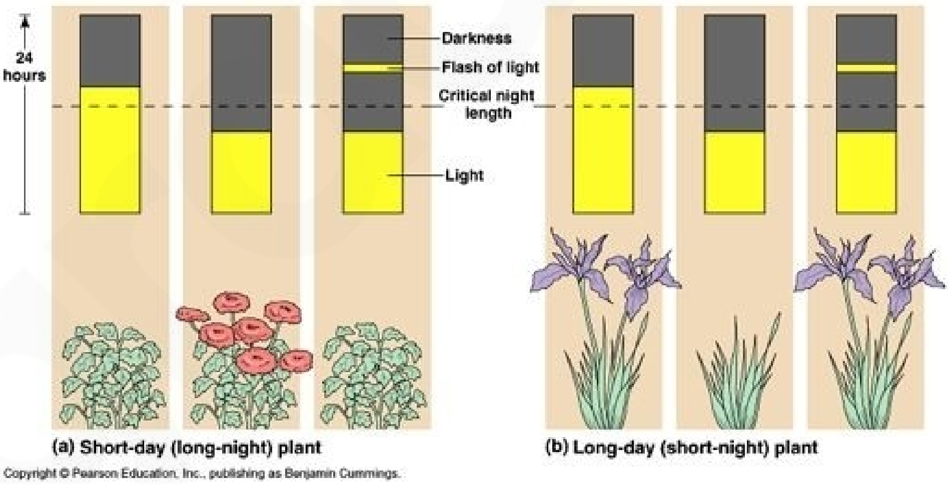

Figure 2: Photoperiodism

Vernalisation

Certain plants do not flower until exposed to low temperature. This dependency of plants for flowering on temperature is called as **Vernalisation**. It indicates the role of temperature in plants' metabolic activities, their flowering, and seed germination. Later in the growing season, it gives sufficient time to the plant to attain maturity.

- **Examples of vernalisation:**
  - Some food plants, such as **rye, barley, wheat** can have spring and winter varieties. The planting of spring variety is done in spring itself and before the growing season's end, the plants flower and produce grain. However, the planting of winter variety is done in autumn. Germination occurs and small seedlings are formed over winter. Growth is resumed during spring and the harvesting is done around mid-summer.
  - Biennial plants, such as carrots, and cabbage, are those plants that flower normally and in the second season, they die. When the growth of these plants is subjected to a low temperature, a photoperiodic flowering is stimulated subsequently.

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