PLANT GROWTH REGULATORS

Plant growth regulators (PGRs) refer to small, structurally diverse organic substances that, akin to hormones in animals, operate in low concentrations. These PGRs exert influence over the physiological activities of plants, either promoting, inhibiting, or modifying growth. Consequently, they are alternatively termed plant growth substances, plant hormones, or phytohormones.

- Precisely, a plant hormone can be defined as a chemical substance, distinct from nutrients, that regulates one or more physiological activities either at the site of synthesis or at a distant location. Phytohormones encompass various types of chemical compounds, including:

S.no.	Composition	Phytohormones
1.	Indole compounds	IAA – Indole – 3 – acetic acid, IBA – Indole butyric acid
2.	Terpenes	Gibberellic acid or Gibberellins (GAs)
3.	Adenine derivatives	N^6 – Furfurylaminopurine, kinetin
4.	Gases	Ethylene ($CH_2 = CH_2$)
5.	Derivatives of carotenoids	Abscisic acid (ABA)

Classification

In the context of their roles within a living plant organism, phytohormones can be broadly categorized into two groups:

- **Plant Growth Promoters:** These substances actively participate in promoting various growth-related processes such as cell division, cell enlargement, tropic growth, flowering, fruiting, and seed formation. Examples include auxin, gibberellins, and cytokinin.
- **Plant Growth Inhibitors:** These substances, exemplified by ABA, function to inhibit growth processes, including inducing dormancy and promoting abscission.
  Dormancy: Dormancy denotes a phase during which growth and development are temporarily arrested. This state often occurs when environmental conditions are not conducive to germination, resulting in the failure of seeds to sprout.
  Abscission: Abscission refers to the natural shedding or dropping of leaves, fruits, or flowers from a plant.

Another notable phytohormone, ethylene, exhibits characteristics that could align with either of the two aforementioned groups. However, it predominantly acts as an inhibitor of growth activities and is noteworthy for its gaseous nature.

The Discovery of Plant Growth Regulators

Auxin stands as the inaugural hormone to be identified in the realm of plant physiology. Charles Darwin, alongside his son Francis Darwin, played a pivotal role in its discovery. Their observations involved canary grass coleoptiles, where they noted that while the light stimulus was perceived by the coleoptile tip, the actual bending response to unilateral light occurred at a distance, specifically in the growth zone, i.e., the subapical part.

A series of subsequent experiments conducted by various scientists led to crucial conclusions:

- Removal of the coleoptile tip resulted in no bending of the shoot towards light, indicating that the light stimulus was not perceived.
- When the coleoptile tip was covered with an opaque tin foil cap, preventing it from perceiving the light stimulus, no bending was observed.

- However, when the tip was covered with a translucent cap, allowing it to sense the light stimulus, bending occurred.

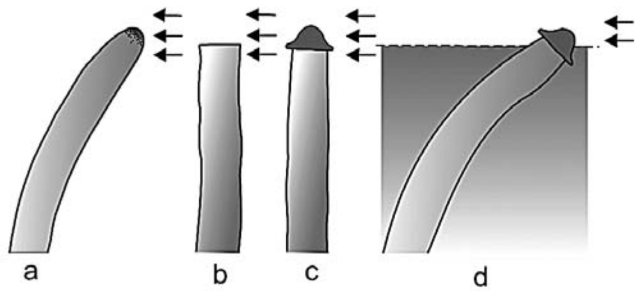


Fig. : Experiment used to demonstrate that tip of the coleoptile is the source of auxin. Arrows indicate direction of light.

Isolation of Auxin

- Auxin was initially isolated from human urine samples, as auxins do not play a metabolic role and are excreted from the body.
- It was also isolated from the coleoptile tips of oat seedlings by F.W. Went.
- Precursor: Tryptophan (an amino acid).

Occurrence of Auxin

- Auxins are present in the growing apices of stems and roots, migrating from these regions to their sites of action.

Types of Auxins

- **Natural auxins:** Produced by plants and can be isolated from them. Examples include IAA (Indole-3-acetic acid) and IBA (Indole-3-butyric acid).
- **Synthetic auxins:** Produced artificially. Examples include 2, 4 – D (2, 4-Dichlorophenoxyacetic acid), 2, 4, 5 – T (2, 4, 5 – Trichlorophenoxyacetic acid), and NAA (Naphthalene acetic acid). These synthetic auxins find extensive use in agricultural and horticultural practices.

The discovery journey continued with observations by Boysen-Jensen, demonstrating that coleoptiles with decapitated tips exhibited no growth or light-bending (phototropism). Further experiments, such as those by A. Paal, revealed that coeloptiles could bend even in the dark after specific treatments.
F.W. Went's groundbreaking work involved cutting off oat coleoptile tips, allowing the 'chemical influence' to diffuse into agar blocks, and subsequently placing these blocks on freshly decapitated coleoptiles. The resulting growth and bending away from the block's side led to the identification of this 'chemical influence' as auxin. Thus, Went is credited with the discovery of auxins.

Physiological Effects of Plant Growth Regulators

- **Abscission:** Auxin plays a crucial role in regulating the abscission process, the natural shedding of plant organs such as fruits and leaves. At normal levels, auxin inhibits abscission by preventing the formation of an abscission layer between the organ and the stem. However, when auxin levels decrease, as in the case of older mature leaves or fruits, the abscission layer forms, leading to shedding. Auxin thus inhibits the abscission of young organs while promoting the shedding of older ones.
- **Apical Dominance:** Apical dominance refers to the phenomenon where the presence of the apical bud suppresses the growth of nearby lateral or axillary buds. This suppression occurs due to auxin

secretion by the apical bud, which inhibits lateral bud growth. Removal of the apical bud (decapitation) allows lateral bud growth. Interestingly, even when the apical bud is removed and a paste containing auxin is applied to the cut portion, the lateral buds remain inhibited, mimicking the presence of the apical bud. This technique is employed in horticulture for shaping plants, such as tea plants, where removal of the apical bud encourages lateral bud growth and branching.

- **Cell Division and Xylem Differentiation:** Auxin plays a vital role in initiating and promoting cell division in the cambium, the layer of tissue responsible for secondary growth in plants. Additionally, auxin controls the differentiation of xylem tissue.

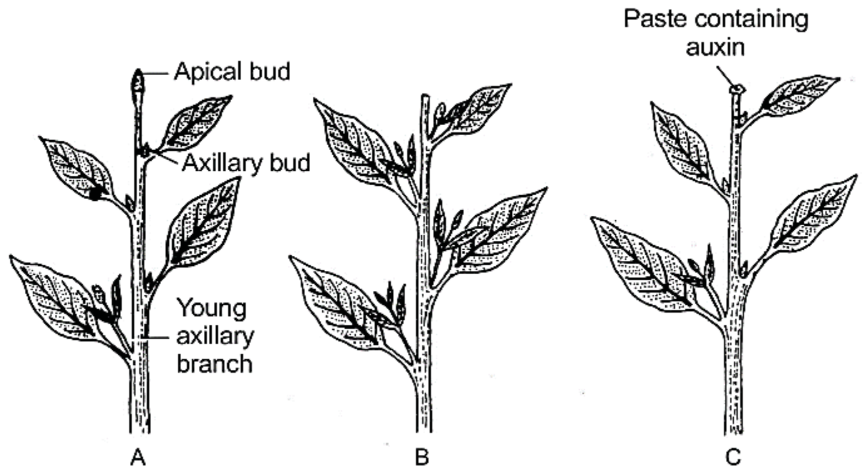
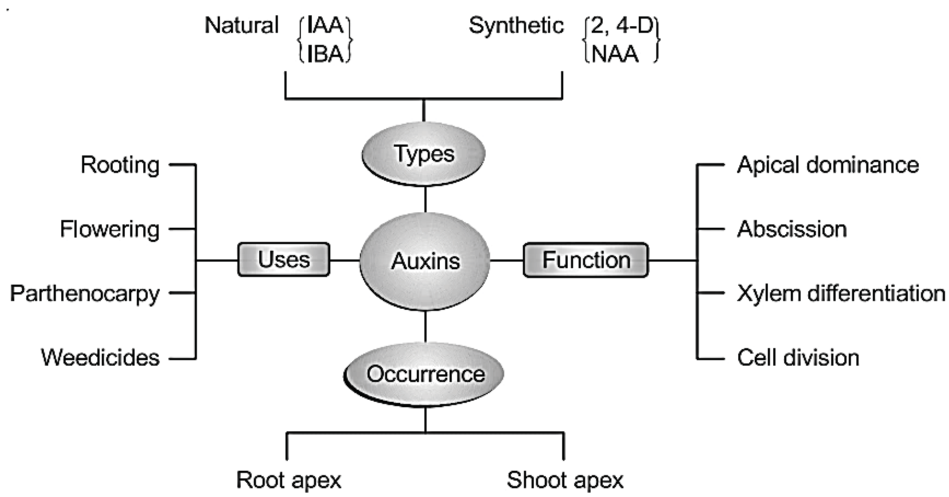


Fig. : Apical dominance and auxin. A, apical but intact. B, removal of apical bud and loss of dominance. C, auxin applied over cut end inhibits lateral bud growths as in apical dominance.

Applications of Auxin:

- **Rooting:** Auxin stimulates root formation in stem cuttings, particularly woody ones. Commonly used auxins for inducing rooting include NAA (Naphthalene acetic acid) and IBA (Indole-3-butyric acid).
- **Flowering:** Dilute solutions of auxins such as NAA and 2, 4 – D (2, 4 – Dichlorophenoxyacetic acid) are sprayed on crops like litchi and pineapple to induce flowering. Conversely, high concentrations of auxins can inhibit flowering, which is advantageous in crops like lettuce, where only the leaves are harvested for consumption.
- **Parthenocarpy:** Auxins like IAA and IBA, when applied in diluted form, induce parthenocarpy, the production of seedless fruits. This technique is employed in crops like tomatoes to ensure the formation of seedless fruits. Interestingly, carpels producing parthenocarpic fruits like bananas and grapes exhibit higher internal auxin production.
- **Weedicides:** Some synthetic auxins are utilized as weedicides to control the growth of unwanted plants (weeds) in agricultural fields. For instance, 2, and 4 – D is commonly used to eliminate broad-leaved or dicotyledonous weeds in cereal crops or monocotyledonous plants. Gardeners also use auxins to prepare weed-free lawns, highlighting the widespread application of auxins in agriculture and horticulture.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Uses
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Cell division
Occurrence
Root apex
Shoot apex