# PLANT GROWTH REGULATORS PHOTOPERIODISM AND VERNALIZATION

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**Growth**

Growth in a plant is the outcome of cell division, enlargement of the new cells and their differentiation into different types of tissues.

Generally, growth is accompanied by metabolic processes (both anabolic and catabolic), that occur at the expense of energy.

These processes of growth are accompanied by

- Usually an increase in length or volume
- An increase in the dry weight
- Root and shoot apical meristems are responsible for the primary growth of the plants and elongation of the plants along their axis.
- The lateral meristems, vascular cambium and cork-cambium appear later in life of dicotyledonous plants and gymnosperms.
- It causes the increase in the girth of the organs in which they are active. This is known as secondary growth of the plants.

# GROWTH HORMONES IN PLANTS

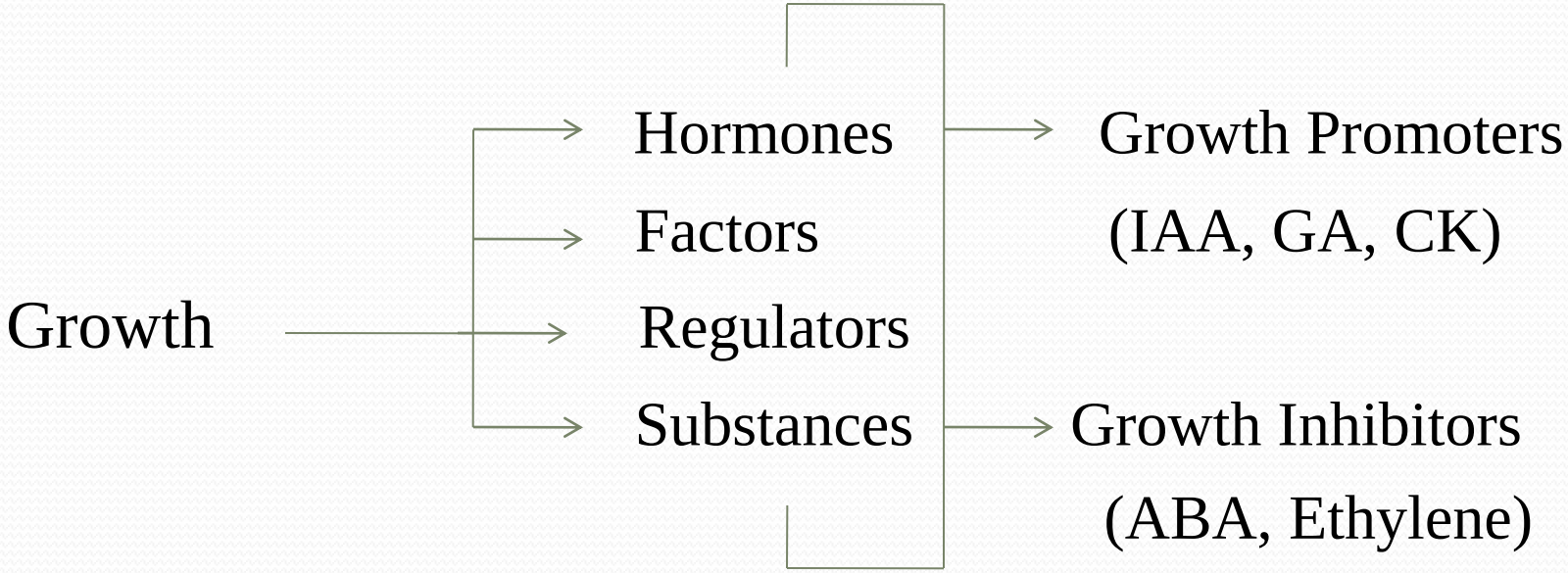
**Definition**

"Organic substance produced naturally in the higher plants, controlling growth or other physiological functions at a site remote from its place of production and active in minute amounts." – Pincus and Thimann (1948)

Growth hormones can be divided into two groups based on their functions in a living plant body.

- First groups are involved 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.
- Second groups are involved in various growth inhibiting activities such as dormancy and abscission. e.g., Abscisic cid, Ethylene.

# Plant Growth Regulators (PGRs)



## Growth Promoters

**Auxins** introduced – Kogl and Hangen Smit in (1931)

Auxins are organic compounds which promote growth along the longitudinal axis.

- 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.
- Distributed throughout the body
- Abundant in the growing tips such as coleoptiles, buds growing roots and leaves.
- 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.
- Pruning in gardens promotes densing of hedge. E.g., Tea plantations

- Auxin is important in Cell division & Cell enlargement/Callus formation – Tissue culture, Grafting, Stimulates division of intrafascicular cambium, also healing of wounds.
- Shortening of Internodes – Formation of dwarf shoot or spurs in apple, pear etc.
- Prevention of lodging - Prevents lodging of crops, immature leaves & fruits
- Flower initiation – promotes uniform flowering in pine apple & Litchi plants
- Herbicide – Dicot broad leave weeds can be eradicated by 2,4-D & 2,4,5-T.
- Auxins also induce parthenocarpy, e.g., in tomatoes.

## Gibberellins

Gibberellin coined by – Yabuta and Hayashi in 1939

- Isolated from a fungus *Gibberella fujikuroi* higher plants
- Denoted as $GA_1$, $GA_2$, $GA_3$ and so on
- Induces internode elongation, leaf expansion used in sugarcane cultivation.
- Induces seed germination in dark e.g. Lettuce and Tobacco.
- To elongate and improve fruit shape e.g. apple
- Breaks the dormancy of seeds, buds and tubers
- Elongation of genetic dwarf plants – they become tall e.g. Maize, *Pisum* & *Vicia faba.*
- Parthenocarpy - Induces the formation of seedless fruits
- More growth of yeast cells by effect of gibberellin
- Induce bolting (Shoot elongation prior to flowering) and flowering in Rossete plants e.g. Cabbage, Beet root many plant with rosette habit.

## Cytokinins

Cytokinin proposed – Letham in 1963

- Cytokinin like zeatin isolated from corn-kernels and coconut milk
- Promotes cytokinesis (cell division) in plants
- Formation of interfascicular cambium and induce secondary growth
- To induce morphogenetic changes in the presence of auxin
- Promotes growth of lateral buds & overcome apical dominance
- Induce stomata opening
- Promotes nutrient mobilization which help in the delay of leaf senescence.
- To induce flowering in short day plants
- Accelerate as well as retard the process of abscission in leaf petioles
- Breaking seed dormancy in lettuce, tobacco, whiteclover and carpet grass

## Growth Inhibitors

## Ethylene

Produced from fungi *Penicillium digitatum* & leaves, flowers of higher plants

- Gaseous phytohormone, synthesized in large amounts by tissues undergoing senescence and ripening fruits e.g. Citrus, Oranges, Banana, Apple and Tomato
- Induce horizontal growth of seedlings, swelling of the axis & apical hook formation in dicot seedlings
- Accelerates the colouring of harvested fruits e.g. lemons
- Inhibits the polar movement of auxin
- Inhibitor of root growth but stimulates the formation of root hairs
- Epinasty of leaves
- Flowering in pineapple & cucumbers

## Abscisic Acid (ABA)

Discovered Eagles and Wareing in 1963

- Causes ageing and abscission of leaves & fruits
- Induce seed maturation enabling seeds to become dormant
- induced dormancy leading to the arrest in apical growth
- Promote bud and seed dormany
- Inhibition of cell division and cell elongation & Inhibition of seeds germination
- causing stomatal closing under water stress conditions. Increases resistance to frost injury
- Delaying of flowering in long day plants (LDP)
- Inhibition of seeds germination e.g. Ash and lettuce
- Inhibits phototropism
- Inhibits growth

# Photoperiodism

Phenomenon of photoperiodism discovered – Garner and Allard in 1920 and 1922

- Observed in Soyabeans, ‘Maryland Mammoth’ variety of Tobacco
- Some plants require a periodic exposure to light to induce flowering
- Response of plants in terms of day/light in relation to flowering is called photoperiodism
- Require a relatively short day light period (8 – 10 hours) a continuous dark period of about 14-16 hours – **Short day plants (SDP) or Long-Night-Plants** e.g. ‘Maryland Mammoth’ variety of Tobacco
- Interrupted even with a brief exposure of red light (660 –665 mμ wavelength) short day plant will not flower
- Interruption of the light period with red light does not have inhibitory effect on flowering in short day plants

- Require a longer day light period (usually 14-16 hours) in a 24 hours cycle for subsequent flowering e.g. Spinach, Sugar Beet – **Long day plants (LDP) or Short-Night-Plants**
- There is no such correlation between exposure to light duration and induction of flowering response – **Day Neutral Plant (DNP)**

**VERNALISATION**

Plants for which flowering is either quantitatively or qualitatively dependent on exposure to low temperature - Vernalisation

- The vegetative period of the plant is cut short resulting in an early flowering e.g winter annuals Rye, perennials fruit apple
- Cold stimulus on plant is not immediately visible.
- Expressed only at a certain later stage in the form of flowering

# Thank You