CONCEPT MAP

PHYTOHORMONES

Phytohormones refer to a chemical substances other than nutrient molecules produced naturally in plants. They may be translocated to another region and are capable of regulating one or more physiological reactions, when present in low concentrations.

PHYTOHORMONES

Plant growth regulators or hormones are broadly classified into two categories.

Growth Promoting Hormones

Auxin

Nature: Weakly acidic growth hormone having an unsaturated ring structure. Auxins refer to natural (IAA, PAA, IAN) and synthetic (Indole 3-butyric acid, NAA, 2, 4-D, 2, 4, 5-T) compounds having similar structure and properties.

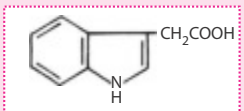
Discovery: Darwin (1880) was first to find sensation of unilateral illumination in the coleoptile tip of canary grass. Later Kogl and Smith (1931) isolated three chemicals from human urine which they named as auxin a , auxin b and hetero auxin. **IAA** is the universal natural auxin.

Location: It is found in shoot apices, leaf primordia and developing seeds and is synthesised from amino acid **tryptophan**, a precursor of IAA or auxins.

Bioassay: Avena curvature test and root growth inhibition test are done for examining auxin effect.

Physiological functions:

- Promotes cell enlargement and division and initiates root formation on stem cuttings.
- Cambial activity and xylem differentiation is also regulated by auxins.
- Shows apical dominance *i.e.*, inhibits the growth of lateral buds.
- Prevents or delays abscission as well as induces synthesis of ethylene.
- Produces tropic plant responses like phototropism and geotropism.
- Shows feminising effect on some plants.



INDOLE-ACETIC ACID (IAA)

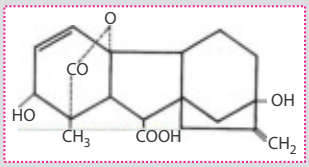
Commercial uses:

- In tissue and organ culture to form callus and initiate rooting.
- To produce parthenocarpic fruits.
- Auxins like 2, 4-D and 2, 4, 5-T acts as weedicides by being selectively harmful to broad leaved dicot weeds.
- Induces flowering in litchi and pineapple.
- NAA increases the number of dwarf shoots and fruits on them.
- Prevents pre-harvest fruit drop of orange and apple (by low concentration of 2, 4-D) and tomato (by NAA)

Gibberellin

Nature: Weakly acidic growth hormone having gibbane ring structure.

Discovery: Hori and Kurosawa discovered the active substance from filtrate of fungus, *Gibberella fujikuroi* (causing bakane disease in rice plants) and named it gibberellin. **GA_3** was first gibberellin to be isolated in its pure form and remains the most extensively studied.



Location: The major sites of gibberellin production in plants are embryos, roots and young leaves near the shoot tip. **Mevalonic acid** (derived from acetyl Co-A) acts as precursor for synthesis of gibberellins. It is transported through simple diffusion as well as *via* conducting channels.

Bioassay: Barley endosperm test and germination of dwarf pea seeds are used as bioassays.

Physiological functions:

- Stimulates stem elongation and leaf expansion.
- Overcome natural dormancy of buds, tubers, seeds etc.
- Induces elongation of reduced stem or bolting in rosette plants *e.g.*, henbane, cabbage.
- Promotes seed germination by inducing production of hydrolytic enzymes for solubilising reserve food.
- Promotes flowering in long day plants during non-inductive period.
- Controls fruit growth and development as well as induces parthenocarpy.
- Promotes formation of male flowers on female plants *e.g., Cannabis*. They can also replace female flowers with male ones on monoecious plants of cucurbits.

Commercial uses:

- Exogenous application of GA_4 and GA_7 mixture to increase the number and size of fruits *e.g.*, apple, grapes, tomato.
- Production of seedless pomaceous fruits by parthenocarpy.
- GA_7 delays senescence of fruits and delays its ripening thus, extending its shelf life and storage period.
- Induces offseason flowering in many long day plants as well as those requiring vernalisation.
- Application of gibberellins increases length of stem and yield of sugarcane.
- Promotes early maturity resulting in seed production in juvenile conifers.

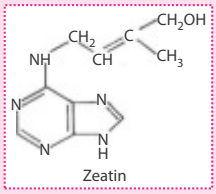
Cytokinin

Nature: These are basic hormones, being derivatives of either **aminopurine** or **phenyl urea** that promote cytokinesis.

Discovery: The first cytokinin was discovered from autoclaved herring sperm DNA which stimulated cell division in tobacco pith cells. It is called **kinetin** and does not occur naturally in plants.

The first natural cytokinin was obtained from unripe maize grains, called **zeatin** (6-hydroxy 3-methyl trans 2-butenyl amino purine).

It is found in coconut milk.



Zeatin

Location: It is mainly found in roots, however it is also synthesised in endosperm regions of seeds, growing embryos, young fruits and developing shoot buds.

Bioassay: Tobacco pith culture, retardation of leaf senescence and excised radish cotyledon expansion are used as bioassays for cytokinins.

Physiological functions:

- Promotes cell division.
- Essential for morphogenesis and differentiation of tissues and organs.
- Delays senescence by mobilisation of nutrients.
- Overcome apical dominance caused by auxins and promote lateral bud development.
- Induces accumulation of salts inside cells and help in phloem transport.
- Promotes femaleness in flowers.

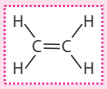
Commercial uses:

- Forms essential component of tissue culture as required for morphogenesis.
- Application of cytokinin increases the shelf life of flowers and vegetables, keeping them fresh for longer periods.
- Helps in developing resistance to pathogens and extremes of temperature, in plants.
- Delays senescence of intact plant parts.

Growth Inhibiting Hormones

Ethylene

Nature: It is the only gaseous phytohormone which stimulates transverse or isodiametric growth but retards the longitudinal one.



Discovery: R. Gane (1934) found that substance causing ripening was ethylene. But it was recognised as a plant hormone by Crocker *et al* (1935).

Location: It is found in almost all parts of plants in minimal amount but maximum production occurs during ripening of fruits and in tissues undergoing senescence. It is synthesised from amino acid **methionin**e in plants.

Bioassay: The 'triple response' of etiolated pea plant and gas chromatographic assay are used as bioassays.

Physiological functions:

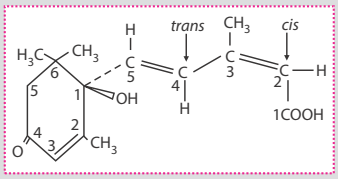
- Promotes apical dominance and prolongs dormancy of lateral buds but breaks the dormancy of buds, seeds and storage organs.
- Induces abscission and senescence of various parts *i.e.*, leaves, flowers and fruits etc.
- Induces epinasty, a phenomenon which decreases the sensitivity to gravity.
- Helps in root initiation, growth of lateral roots and root hairs.
- Stimulates flowering in pineapple and other related plants and helps in synchronising fruit set.
- Induces ripening of fleshy climacteric fruits and dehiscence of dry fruits.

Commercial uses:

- Ethylene lamps are used for ripening of fleshy fruits *e.g.*, banana, mango, apple, tomato.
- Ethylene is used to induce feminising effect *e.g.*, number of female flowers and thus fruits in cucumber.
- Ethylene also permits thinning of excess flowers and young fruits so as to allow better growth of remaining fruits.

Abscisic Acid

Nature: It is a mildly acidic growth hormone which acts as a general growth inhibitor. It is also called as **stress hormone** since its production is stimulated under conditions of drought, water logging and adverse environmental conditions.



Discovery: The hormone was first isolated by Addicott *et al* (1963) from cotton bolls.

Location: It is found in many parts of the plant but is more abundant in chloroplast of green cells. It is synthesised from **mevalonic acid** or **xanthophyll**.

Bioassay: Rice seedling growth inhibition test and inhibition of α-amylase synthesis in barley endosperm are used as bioassay.

Physiological functions:

- Induces dormancy of buds, seeds and underground stems, hence also called as **dormin**.
- Promotes abscission of flowers and fruits.
- Induces senescence of leaves by promoting degradation of chlorophyll and proteins.
- Stops cambium activity (in vascular cambium) towards the approach of winter.
- Inhibits seed germination by inhibiting gibberellin mediated amylase formation.
- It is antagonist to gibberellin and counteracts the effect of growth promoting hormones-auxins and cytokinins.

Commercial uses:

- Used as antitranspirant (as application of even minute quantities of ABA on leaves causes partial closure of stomata), thus, preventing transpiration as well as reducing photosynthesis.
- Induces flowering in some short day plants, even under unfavourable photoperiods.
- External application on stem cuttings initiate rooting.
- Induces parthenocarpic development in rose.
- Used in prolonging dormancy of buds, storage organs and seeds.