

Plant growth regulators

Class notes · NCERT Class XI, Plant Growth and Development · Thu 1 Oct 2026

What they are

Plant growth regulators (PGRs) are small, simple molecules of diverse chemical composition. They can be **indole compounds** (indole-3-acetic acid, IAA), **adenine derivatives** (N^6 -furfurylamino purine, kinetin), **derivatives of carotenoids** (abscisic acid, ABA), **terpenes** (gibberellic acid, GA_3) or **gases** (ethylene, C_2H_4). They are also called plant hormones or phytohormones.

Promoters and inhibitors

- **Growth promoters** — auxins, gibberellins and cytokinins: cell division, enlargement, pattern formation, tropic growth, flowering, fruiting and seed formation.
- **Growth inhibitor** — abscisic acid: responses to wounds and stresses, dormancy and abscission.
- **Ethylene** can fit either group, but it is largely an inhibitor.

How they were discovered

- **Auxin** — Charles and Francis Darwin saw coleoptiles of canary grass bend towards light (phototropism). F. W. Went isolated auxin from the coleoptile tips of oat seedlings.
- **Gibberellins** — E. Kurosawa found that the 'bakanae' (foolish seedling) disease of rice is caused by the fungus *Gibberella fujikuroi*; the active substance was gibberellic acid.
- **Cytokinins** — F. Skoog and co-workers, and later Miller, found kinetin in autoclaved herring sperm DNA. Zeatin was later isolated from corn kernels and coconut milk.
- **Abscisic acid** — three independent groups described inhibitor-B, abscission II and dormin in the mid-1960s; all three were the same chemical, ABA.
- **Ethylene** — Cousins (1910) confirmed that ripened oranges release a volatile substance that hastens ripening of stored, unripe bananas; it was identified as ethylene.

Auxins

Natural: IAA and indole butyric acid (IBA). Synthetic: naphthalene acetic acid (NAA) and 2,4-D.

- Initiate rooting in stem cuttings — widely used in plant propagation.
- Promote flowering, e.g. in pineapple; prevent early fruit and leaf drop but promote abscission of older, mature leaves and fruits.
- **Apical dominance**: the growing apical bud inhibits lateral (axillary) buds. Removing shoot tips (decapitation) gives side branches — used in tea plantations and hedge-making.
- Induce parthenocarpy, e.g. in tomatoes. Help xylem differentiation and cell division.
- 2,4-D is a weedicide: it kills dicotyledonous weeds and does not affect mature monocotyledonous plants — used to make weed-free lawns.

Gibberellins

More than 100 gibberellins are known (GA_1 , GA_2 , GA_3 ...). GA_3 was one of the first discovered and is the most intensively studied. All gibberellins are acidic.

- Increase axis length — used to increase the length of grape stalks; cause fruits like apple to elongate and improve their shape.
- Delay senescence, so fruits can be left on the tree longer to extend the market period.
- Spraying sugarcane with gibberellins increases stem length, raising yield by as much as 20 tonnes per acre.
- Speed up the malting process in the brewing industry; hasten maturity in juvenile conifers for early seed production.
- Promote **bolting** (internode elongation just before flowering) in beet, cabbage and many plants with rosette habit.

Cytokinins

Natural cytokinins (e.g. zeatin) are synthesised in regions where rapid cell division occurs — root apices, developing shoot buds and young fruits.

- Promote cell division (cytokinesis), new leaves, chloroplasts in leaves, lateral shoot growth and adventitious shoot formation.
- Help overcome apical dominance.
- Promote nutrient mobilisation, which helps delay leaf senescence.

Ethylene

A simple gaseous PGR, synthesised in large amounts by tissues undergoing senescence and by ripening fruits.

- Horizontal growth of seedlings, swelling of the axis and apical hook formation in dicot seedlings.
- Promotes senescence and abscission of plant organs, especially leaves and flowers.
- Highly effective in fruit ripening — it raises the rate of respiration during ripening (the **respiratory climacteric**).
- Breaks seed and bud dormancy, starts germination in peanut seeds and sprouting of potato tubers.
- Promotes rapid internode and petiole elongation in deep-water rice, keeping leaves above water. Promotes root growth and root hair formation.
- Used to initiate flowering and synchronise fruit-set in pineapples; also induces flowering in mango.
- **Ethephon**, the most widely used source of ethylene, is absorbed and transported within the plant and releases ethylene slowly. It hastens ripening in tomatoes and apples, accelerates abscission in flowers and fruits (thinning of cotton, cherry, walnut) and promotes female flowers in cucumbers.

Absciscic acid (ABA)

- A general plant growth inhibitor and an inhibitor of plant metabolism; it inhibits seed germination.
- Stimulates closure of stomata and increases tolerance to various stresses — hence the **stress hormone**.
- Important in seed development, maturation and dormancy, helping seeds withstand desiccation.
- In most situations ABA acts as an antagonist to gibberellins.

One-look summary

Hormone	Group	Remember for NEET
Auxin (IAA)	Promoter	Apical dominance; 2,4-D kills dicot weeds
Gibberellin (GA ₃)	Promoter	Bolting; sugarcane yield; bakanae of rice
Cytokinin (zeatin)	Promoter	Cell division; delays leaf senescence
Ethylene	Largely inhibitor	Fruit ripening; respiratory climacteric
Absciscic acid	Inhibitor	Stomatal closure; seed dormancy

Check yourself

- 1 Which hormone would you spray to make cabbage bolt? Answer: gibberellin.
- 2 Kinetin was first isolated from ...? Answer: autoclaved herring sperm DNA.
- 3 Which hormone closes stomata during water stress? Answer: absciscic acid.