

Plant Growth and Development

Growth:

- It is the fundamental characteristic of all living organisms.
- It is defined as a permanent process which involves an increase in the size of an organ or an individual cell.

Characteristics of plant growth :

- It is indeterminate (not fixed).
- It is measurable.
- Growth involves three phases – meristematic phase, elongation phase, and maturation phase.
- Growth rate: It is defined as increased growth per unit time.

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- Rate of growth may be arithmetic or geometrical.
- **Arithmetic growth is represented as**

$$L_t = L_0 + rt$$

Where, L_t = Length at time 't'

L_0 = Length at time '0'

r. = Growth rate

- **Geometric growth is represented as:**

$$W_1 = W_0 e^{rt}$$

Where, W_1 = Final size

W_0 = Initial size

r = Growth rate

t = Time of growth

e = Base of natural logarithms

- The actual increase in size of an individual or population per unit time under known or specific conditions is called absolute growth rate.
- The growth of the given system per unit time expressed on common basis is called relative growth rate.
- **Growth curve:**
 - A sigmoid exponential growth curve is found in all living organisms in natural environment.
 - A sigmoid growth curve consists of the following phases.
 - i. Lag phase – Initial slow growth takes place during this phase.
 - ii. Exponential phase – Rapid exponential growth takes place during this phase.
 - iii. Stationary phase – Continuous steady growth takes place.

Conditions required for growth:

- (i) **Water** as medium for enzymatic activity
- (ii) **Oxygen** for metabolic energy
- (iii) **Nutrients** as source of energy
- (iv) **Light and Optimum temperature**

Differentiation, Dedifferentiation and re-differentiation

- **Differentiation** – It is the specialisation of a specific body part for a particular function. For example, meristems and cambium differentiate to form specific functions.

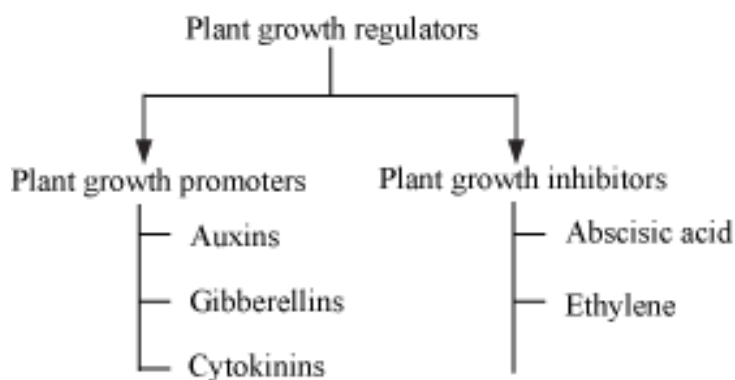
- **Dedifferentiation** – It is a process in which cell loses the specialisation in function.
- **Re-differentiation** – It is the ability of de-differentiated cell to become specialised.

Differentiation → Dedifferentiation → Re-differentiation

- It is a term used to refer to the various changes occurring in an organism during its life cycle.
- Plants exhibit plasticity in development i.e., they follow different phases to form different kind of structures.
- It is the collective result of growth and differentiation.

Plant growth regulators (phytohormones)

- These are naturally occurring organic substances that are synthesised in one part of plant bodies and translocated to another part when required. Plants growth regulators can be divided as follows.



- Auxin was first isolated by F.W. Went from the tip of coleoptiles of oat seedling.
- Gibberellin was first recognized by Kurosawa while studying *bakanae*, the "foolish seedling" disease in rice.
- It was first isolated from fungal strains – *Gibberella fujikuroi*.
- Cytokinins were crystallized from kinetin. Natural precursor of cytokinin is zeatin.
- Effects of cytokinins were first discovered through the use of coconut milk.
- Abscissic acid is a growth inhibitor.
- Ethylene is the only gaseous hormone.

- **Effects of plant growth regulators:**

- i. **Auxin**

- It causes the phenomenon of apical dominance.
 - **Apical dominance** is the phenomenon in which growing apical bud inhibits the growth of lateral buds.
 - In stem cuttings, it causes root initiation.
 - It induces parthenocarpy and prevents abscission of leaves and fruits.
 - Indole Acetic Acid (IAA) and Indole Butyric Acid (IBA) are natural auxins whereas 2, 4 – Dichlorophenoxyacetic acid (2, 4 – D) and Naphthalene Acetic Acid (NAA) are synthetic auxins.
 - 2, 4 - D is used as weedicide to kill broadleaf, dicotyledonous weeds.
 - It induces parthenocarpy.

Gibberellins and Cytokinins

- **Gibberellins**

- GA₃ is the most commonly used form.
 - It promotes bolting (internode elongation) in rosette plants.
 - It induces seed germination.
 - It delays senescence.

- **Cytokinins**

- It promotes growth of lateral branches by inhibiting apical dominance.
 - It stimulates cell division.
 - It delays senescence in leaves.

Ethylene and Absciscic acid

- **Ethylene**

- It helps in breaking seed and bud dormancy.

- It promotes senescence and abscission of leaves.
- It helps in fruit ripening by increasing the rate of respiration.
- It promotes root growth and root hair formation.

- **Abscissic acid**

- It inhibits seed germination.
- It stimulates stomatal closure during water stress conditions.
- It helps plant to tolerate different stress conditions, hence also known as stress hormone.
- It acts as antagonist to gibberellins.
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- **Photoperiodism**

- It is the response of plants with respect to duration of light.
- Based on the duration of light required, plants can be classified as:
- **Short day plants** – Example: *Chrysanthemum*
- **Long day plants** – Example: Radish
- **Day neutral plants** – Example: Tomato

- **Vernalisation**

- It is the method of inducing early flowering in plants by pre-treatment of seeds with low temperature.
- The examples include wheat, barley, rye etc.
- This phenomenon can also be seen in biennial plants.