7. Plant Growth and Development

- **Seed Germination**
- It is the process of the seed develops into an individual plant utilizing the reserve nutrients present in the cotyledons.
- **Conditions necessary for germination**

  1. Water

  2. Oxygen

  3. Favourable temperature

- **Process of germination**

  1. The seed takes up water and swells.

  2. The embryonic radicle and plumule start growing and force the seed coat to rupture.

  3. The radicle comes out first and forms the root followed by the plumule which develops into the shoot.

- **Types of germination**

1. **Epigeal germination:** in this method the cotyledons are lifted above the ground and they act as the first leaves as a result of the rapid elongation of the hypocotyl. It takes place in seeds like Castor, cotton, sunflower etc.

2. **Hypogeal germination:** in this germination the cotyledons remain inside the soil and the epicotyls elongates and pushes the plumule above. It takes place in seeds like pea, maize, mango etc.

3. **Viviparous germination:** A special mode of germination in which seed starts germinating inside the fruit while it is still attached to the parent plant. Once germinated, the seedling is dropped into the soil where it fixes itself by developing roots. It takes place in mangrove plants, like *Rhizophora* and *Sonneratia.*

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 = $L0$ + rt

Where, L_t = Length at time 't'

L. 0 = Length at time '0'

r. = Growth rate

- **Geometric growth is represented as:**

W. $_1$ = W0 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

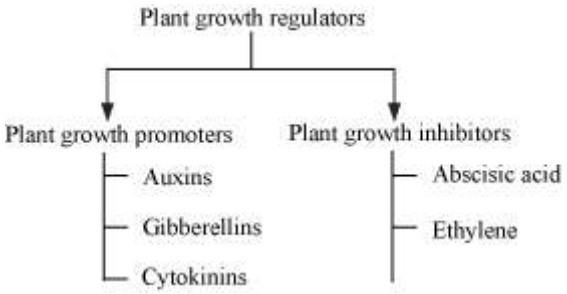
- **Differentiation –** It is the specialisation of a specific body part for a particular function. For example, meristems and cambium differentiate to form specific functions.
- **Dedifferentiation** – It is a process in which cell loses the specialisation in function.
- **Re-differentation** – It is 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.
- Abscisic 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**

- GA_3 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 Abscisic 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.

- **Abscisic 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.