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'

12. $_0$ = Length at time '0'

r. = Growth rate

- **Geometric growth is represented as:**

- $_1 = W_0 e^{rt}$

Where, W_1 = Final size

23. $_0$ = 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.
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- 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.

- **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.