Chapter 15
Plant Growth and Development

Question 1:

Define growth, differentiation, development, dedifferentiation, redifferentiation, determinate growth, meristem and growth rate.

Solution 1:

- **Growth** is an irreversible permanent increase in size of an organ or its parts or even of an individual cell.
- **Differentiation** is the process in which the cells derived from root apical and shoot-apical meristems and cambium differentiate and mature of perform specific functions.
- **Development** is a term that includes all changes that an organism goes through during its life cycle from germination of the seed to senescence.
- **Dedifferentiation** is the process in which permanent plant cells regain the power to divide under certain conditions.
- **Redifferentiation** is the process in which de-differentiated cells become mature again and lose their capacity to divide.
- **Determinate growth** is the type of growth in which growth stops after a certain phase.
- **Meristem** are the specialised regions in the plants where active cell division take place.
- The increased growth per unit time is termed as **growth rate**.

Question 2:

Why is not any one parameter good enough to demonstrate growth throughout the life of a flowering plant?

Solution 2:

Growth, at a cellular level, is principally a consequence of increase in the amount of protoplasm. Measuring the growth of protoplasm involves many parameters such as the weight of the fresh tissue sample, the weight of the dry tissue sample, the differences in length, area, volume, and cell number measured during the growth period. Hence, there cannot be one parameter good enough to demonstrate growth throughout the life of a flowering plant.

Question 3:

Describe briefly:

(a) Arithmetic growth

(b) Geometric growth

(c) Sigmoid growth curve

(d) Absolute and relative growth rates

Solution 3:

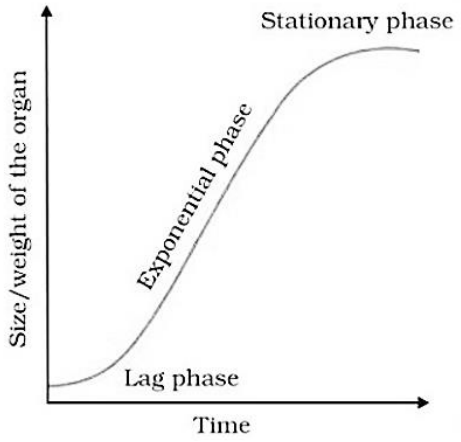
(a) In arithmetic growth, following mitotic cell division, only one daughter cell continues to divide while the other differentiates and matures. The elongation of roots at a constant rate is an example of arithmetic growth. On plotting length of the organ against time, a linear curve is obtained. Mathematically, it is expressed as:

$L_t = L_0 + r_t$

Hence, L_t is length at time 't', L_0 is length at time 0 and r is the rate per unit time.

(b) In most systems, the initial growth is slow and called lag phase, and it increase rapidly thereafter at an exponential rate and called log or exponential phase. Here, both the progeny cells following mitotic cell division retain the ability to divide and continue to do so. However, with limited nutrient supply, the growth slows down leading to a stationary phase. The graph of the geometric growth gives a sigmoid curve.

(c) A sigmoid curve is a characteristic of living organism growing in a natural environment. This curve is divided into three phases – lag phase, log phase or exponential phase of rapid growth, and stationary phase.



Exponential growth can be expressed as:

$W_1 = W_0 e^{rt}$

W_1 = final size (weight, height, number etc.)
W_0 = initial size at the beginning of the period
r = growth rate
t = time of growth
e = base of natural logarithms

(d) The measurement and the comparison of total growth per unit time is called the absolute growth rate.

The growth of the given system per unit time expressed on a common basis, e.g., per unit initial parameter is called the relative growth rate.

Question 4:

List five main groups of natural plant growth regulators. Write a note on discovery, physiological functions and agricultural / horticultural applications of any one of them.

Solution 4:

The five main groups of natural plant growth regulators are:

(i) Auxins
(ii) Gibberellic acid
(iii) Cytokinins
(iv) Ethylene
(v) Abscisic acid

A note on discovery, physiological functions and agricultural / horticultural applications of Auxins are:

→ **Discovery**: The first observations regarding the effects of auxins were made by Charles Darwin and Francis Darwin when they observed that the coleoptiles of canary grass responded to unilateral illumination by growing towards the light source (phototropism). After a series of experiments, it was concluded that the tip of coleoptile was the site of transmittable influence that caused the bending of the entire coleoptile. Auxin was isolated by F.W. Went from tips of coleoptiles of oat seedlings.

→ **Physiological Functions**:

- They control plant cell-growth.
- They cause the phenomenon of apical dominance.
- They control division in the vascular cambium and xylem differentiation.
- They induce parthenocarpy and prevent abscission of leaves and fruits.

→ **Horticulture Application**:

- They help to initiate rooting in stem cuttings, an application widely used for plant propagation.
- 2-4 D is used weedicide to kill broadleaf, dicotyledonous weeds.
- They induce parthenocary in tomatoes.
- It promote flowering e.g. in pineapples.

Question 5:

What do you understand by photoperiodism and vernalisation? Describe their significance.

Solution 5:

The response of plants to periods of day/night is termed as photoperiodism. It is hypothesised that the hormonal substance responsible for flowering is formed in the leaves, subsequently migrating to the shoot apices and modifying them into flowering apices. Photoperiodism helps in studying the response of flowering in various crop plants with respect to the duration of exposure to light.

There are plants for which flowering is either quantitatively or qualitatively dependent on exposure to low temperature. This phenomenon is termed vernalisation. It refers specially to the promotion of flowering by a period of low temperature. It prevents precocious reproductive development late in the growing season, and enables the plant to have sufficient time to reach maturity.

Question 6:

Why is Abscisic acid also known as stress hormone?

Solution 6:

Abscisic acid stimulates the closure of stomata in the epidermis and increases the tolerance of plants to various kinds of stresses. Therefore, it is also called the stress hormone. It promotes seed dormancy and ensures seed germination during favourable conditions. It helps seeds withstand desiccation. It also helps in inducing dormancy in plants at the end of the growing season and promotes abscission of leaves, fruits, and flowers.

Question 7:

'Both growth and differentiation in higher plants are open'. Comment.

Solution 7:

The higher plants retain the capacity for unlimited growth throughout their life. This ability of the plants is due to the presence of meristems at certain locations in their body. The cells of such meristems have the capacity to divide and self-perpetuate. Therefore, growth in higher plants are open. Also, some of these cells always undergo differentiation after some rounds of cell division. Hence, the differentiation is also open.

Question 8:
'Both a short day plant and a long day plant can flower simultaneously in a given place'. Explain.

Solution 8:
Flowering in some plants depends on relative durations of light and dark periods. The short-day plant and long-day plant can flower at the same place, provided they have been given an adequate photoperiod.

Question 9:
Which one of the plant growth regulators would you use if you are asked to:
(a) Induce rooting in a twig
(b) Quickly ripen a fruit
(c) Delay leaf senescence
(d) Induce growth in axillary buds
(e) 'Bolt' a rosette plant 4
(f) Induce immediate stomatal closure in leaves.

Solution 9:
(a) Auxins
(b) Ethylene
(c) Cytokinins
(d) Cytokinins
(e) Gibberellins
(f) Abscisic acid

Question 10:
Would a defoliated plant respond to photoperiodic cycle? Why?

Solution 10:
No, a defoliated plant will not respond to the photoperiodic cycle as the leaves are the sites of perception of light / dark duration.
Therefore, in the absence of leaves, the plant would not respond to light.

Question 11:
What would be expected to happen if:
(a) GA_3 is applied to rice seedlings
(b) Dividing cells stop differentiating
(c) A rotten fruit gets mixed with unripe fruits

(d) You forget to add cytokinin to the culture medium.

Solution 11:

(a) If GA_3 is applied to rice seedlings, then the rice seedlings will show internode-elongation and increase in height.
(b) If dividing cells stop differentiating, then the plant organs such as leaves and stem will not be formed.
(c) If a rotten fruit gets mixed with unripe fruits, then the ethylene produced from the rotten fruits will hasten the ripening of the unripe fruits.
(d) If you forget to add cytokinin to the culture medium, then cell division, growth, and differentiation will be slower.