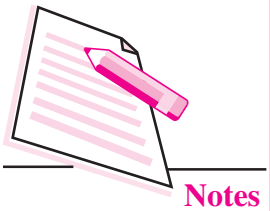


Notes

20

GROWTH AND DEVELOPMENT IN PLANTS

If you sow a seed in your garden or in a pot, after few days you would find a tiny seedling coming out from the seed. As days pass, the tiny seedling grows in size, the number of leaves increases, and later, it grows into a mature plant and produces flowers and fruits. This is the process of growth and development. Besides growth and development plants also show movement, but it is not as clearly visible as in the case of animals. In this lesson you will learn about growth, development and movements in plants.

OBJECTIVES

After studying this lesson, you will be able to:

- *define the terms growth and development;*
- *differentiate between growth and development and explain growth curve;*
- *list the various stages of cellular growth;*
- *explain the various methods of measurement of plant growth;*
- *describe the factors affecting plant growth and importance of growth regulators;*
- *explain the role of growth regulators in dormancy and germination of seeds;*
- *differentiate among short-day plants, long-day plants and day-neutral plants;*
- *define the terms abscission and senescence;*
- *identify the effects of salt stress and water stress on plants;*
- *define the various types of movement like geotropism, phototropism, nastic and turgor movements.*

20.1 GROWTH AND DEVELOPMENT

You must have noticed that all living organisms grow in size. But have you ever thought how a do they grow? Growth takes place due to cell division, which increases the number of cells in the body. This process continues and we observe increase in weight, size and volume of all plants and animals. This is called **growth.**

> Growth in living organisms may be defined as an irreversible increase in the number and size of a cell, organ or whole organism.

Growth in living organisms is not uniform throughout the life span. Growth takes place at a faster rate till the plants or animals attain maturity. Then it slows down and at a particular time it stops. Later in life death occurs. All these changes that occur in an organism starting from its beginning till its death may collectively be termed as development. Development is associated with **morphogenesis** and **differentiation**. **Morphogenesis** is the process of development of shape and structure of an organism; and **differentiation** is the process of change in cells, tissues or organs to carry out different functions.

Development is the whole series of qualitative and quantitative changes such as growth, differentiation and maturation, which an organism undergoes throughout its life cycle.

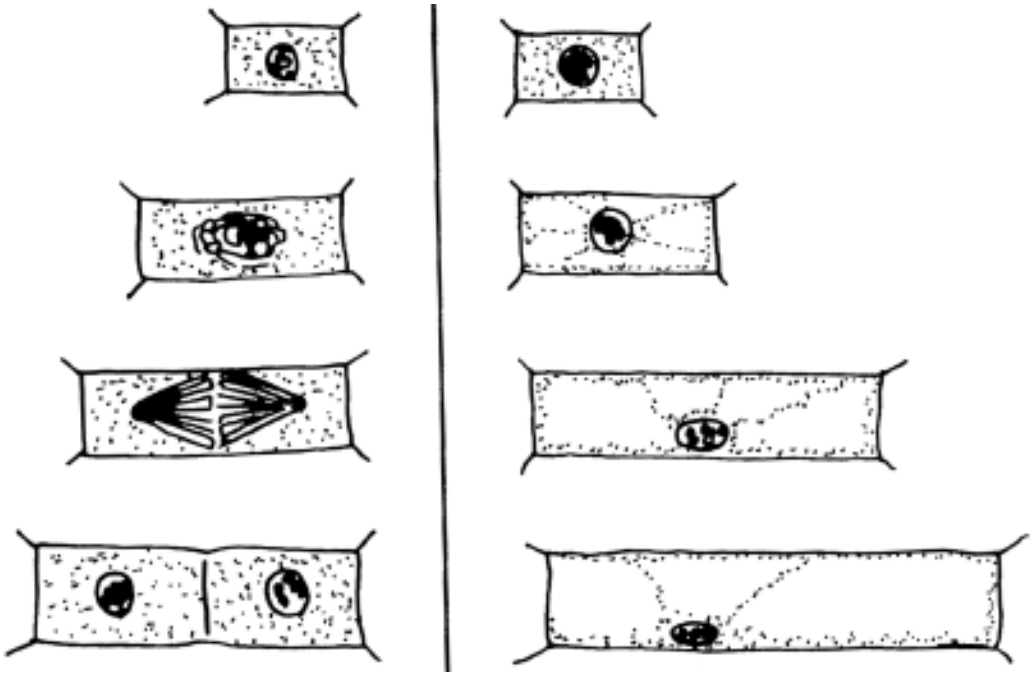
20.2 STAGES OF CELLULAR GROWTH

You have already learnt that growth of an organism is always associated with growth in size and number of cells. The growth of an organ or an organism occurs in three successive stages. They are

(i) **Cell division** : The number of cells increases due to mitosis (Fig. 20.1a).

(ii) **Cell enlargement**: The size of individual cell increases after cell division due to increase in the volume of its protoplasm (Fig. 20.1b).

(iii) **Cell differentiation**: In this stage, structure of the cells changes to perform specific functions. And similar type of cells having same functions form a group, which is known as tissue.



(a) Cell Division (b) Cell Enlargement

Fig. 20.1 Comparison of cell division and cell enlargement

In lower organisms such as bacteria and algae the entire body grows. But in higher organisms like ferns, pine and flowering plants, growth is restricted to the cells present only in the growing regions, like shoot apex and root tip and close to the lateral sides of the stem and root. Growth at the tips leads to elongation of body parts and lateral (side ways) growth leads to increase in the thickness of stem and root.

20.3 GROWTH CURVE

The rate of growth of a plant or plant part is not always the same during its life span. Sometimes it is slow and at other times rapid. If we plot the increase in cell number (growth rate) against time, a typical S-shaped curve is obtained. This is called growth curve or **sigmoid growth curve**. (Fig 20.2)

This curve has three phases of growth.

(i) **Lag Phase** – This is the initial phase of growth when the rate of growth is very slow.

(ii) **Log Phase** – It shows rapid growth and is maximum during the entire life span.

(iii) **Stationary Phase** – Here the rate of growth starts decreasing and finally it stops.

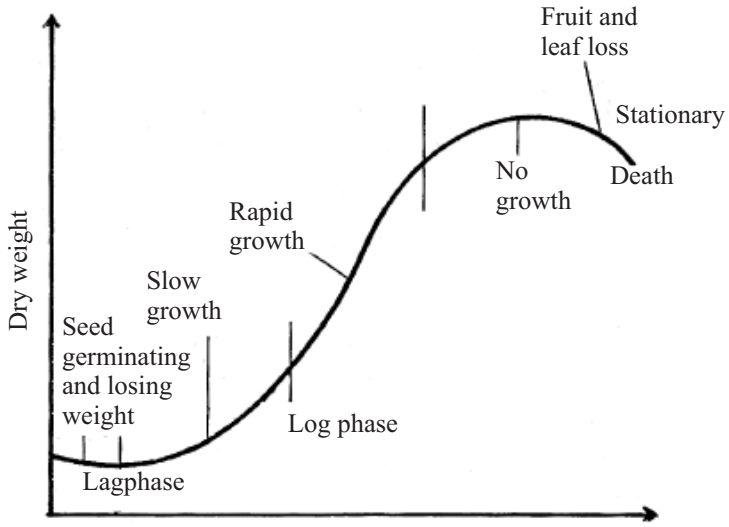


Fig. 20.2 Sigmoid curve

The total time period during which the festest growth of the organ or organism occurs is called **grand period of growth**.

20.4 MEASUREMENT OF GROWTH

After knowing the different phases of growth let us know how to measure growth in plants. Growth in plants being a quantitative phenomenon can be measured in relation to time. It can be measured in terms of

- Increase in length or growth – in case of stem and root;
- Increase in area or volume – in case of leaves and fruits;
- Increase in the number of cells – in algae, yeast and bacteria.

Let us discuss some methods of measuring growth in length.

20.4.1 Direct Method

We know that growth generally takes place at the apical region of plant. So growth in length can be directly measured by means of an ordinary measuring scale at any particular interval of time.

ACTIVITY FOR YOU

Aim

To use an ordinary scale to measure growth in length of the stem of a plant in your garden.

What do you require?

Thread, a piece of stone and a measuring scale.

What to do?

- Tie the stone at one end of the thread;
- Take the length of the stem from above the soil surface with the help of the thread;
- Mark the length of the stem on the thread with the help of a pen;
- Put the thread on the scale and note down the length;
- Record the length citing date of the activity;
- Repeat the procedure and at an interval of one week.

Is there any change in length?

Make a table.

No. of the week	Length in cms.
1	
2	
3	
4	
5	

20.4.2 Auxanometer

For more accurate measurement of length, we can use the specially designed equipment called **auxanometer**. (Fig 20.3). We can use it to measure the rate of growth of shoot length of plants. A thread is tied to the tip of stem of a potted plant and the thread is hung on the pulley of auxanometer. The other end of the thread is tied to a weight. The pulley is fixed with a long needle, which slides over a graduated arc. As the stem grows in length the weight pulls the thread down. The movement of the needle is read on the scale of arc.

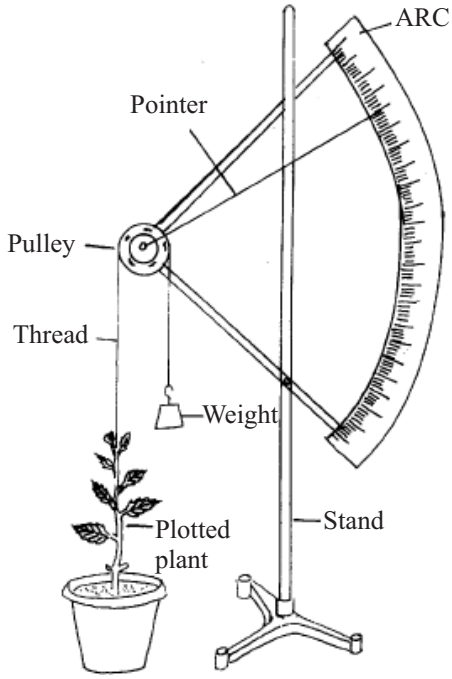


Fig. 20.3 Auxanometer

INTEXT QUESTIONS 20.1

1. Distinguish between growth and development.

   .....

2. What is differentiation?

   .....

3. What role does it play in plant growth and development?

   .....

20.5 FACTORS AFFECTING PLANT GROWTH

Generally plant growth is influenced by a number of factors both external and internal.

20.5.1 External growth factors

External factors are those factors present in the environment that affect the growth of the plants directly or indirectly. These factors are

(i) Light (ii) Temperature (iii) Water (iv) Mineral nutrients

(i) Light

You have already learnt about the necessity of light for the process of photosynthesis. Besides photosynthesis, light is also essential for seed germination, growth of seedling, differentiation of various tissues and organs, and reproduction.

When plants grow in dark, they become tall, yellowish and weak, and the leaves are very small.

(ii) Temperature

Some plants grow in cold climate and some in hot climate. The optimum temperature required for growth of plants ranges between 28-30°C, but it may occur in the temperature range of 4-45°C. All metabolic activities of plants are directly affected by variation of temperature. A very low temperature causes injuries to the plant due to chilling and freezing, and very high temperature stops its growth.

(iii) Water

You have already learnt that a plant absorbs water by its roots, uses it in photosynthesis and other biochemical processes and some of it is lost through transpiration. For proper growth of plants a particular quantity of water is required. Both deficiency and excess of water retards the growth of plants.

(iv) Mineral Nutrients

In the lesson 9 "Plant nutrition" we have already discussed the importance of mineral nutrients for plant growth and development. All metabolic processes require inorganic nutrients. Plant growth is adversely affected by the deficiency of nutrients.

20.5.2 Internal Growth Factors

In addition to the external factors as discussed above, there are some substances produced in the plant body itself, which affects the growth of the plant. These are called **plant hormones** or **phytohormones** or **growth hormones**.

A phytohormone is an organic substance produced in a small quantity in one part of plant body and capable of moving to other parts to influence the growth of that part.

The growth of the plants can also be influenced by certain synthetic chemicals resembling plant hormones both in structure and functions. These are called **growth regulators**. They are not produced by plants naturally.

Growth regulators are chemical substances, other than naturally produced hormones, which promote, inhibit or modify growth and development in plants.

The naturally produced growth hormones are broadly grouped under five major classes. They are

(i) Auxin (ii) Gibberellins (iii) Cytokinins

(iv) Ethylene (v) Abscissic acid

Let us know details about these hormones.

(i) Auxin

Auxin is a growth promoter, generally produced by the growing apex of stem and root of the plants. It helps in the elongation of shoot and root tips behind apical meristem. The naturally produced auxins is Indole-3-Acetic Acid (IAA). They are also produced by chemical synthesis, which show same physiological responses like Auxin. Some of the synthetic auxin are Indole-3-butyric acid (IBA), 2,4-Dichlorophenoxy Acetic Acid (2,4-D), and Naphthalene acetic acid (NAA).

The Greek word **auxein** means "to grow". It was first isolated from human urine.

An experiment was performed by Fritz Went on oat seedling to see the effect of auxins. When tip of oat coleoptile (early shoot) is removed, growth stops. Then the removed tip is placed on a block of agar (gelatinous material from sea weeds) for about an hour. This agar block is then placed on the cut end of the seedling. It was observed that the growth of the seedling started again. It shows that there is something that has passed from the cut tip into the agar block, which helps to restart the growth. This was named **Auxin**, a plant hormone.

Functions of Auxin

(a) It promotes cell elongation;

(b) It suppresses the growth of lateral bud. If the tip of a plant is removed, the lateral branches begin to grow; In most of the plants apical bud suppresses the development of lateral buds. This is called **apical dominance**.

(c) It delays fall of leaves. (leaf abscission)

(d) NAA (Naphthalene acetic acid) is used for preventing fruit drop in apples before they are ripe.

(e) 2, 4-D (2, 4-dichlorophenoxy acetic acid) acts as a dicot weedicide.

(ii) Gibberellin

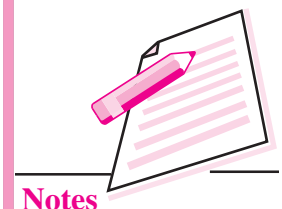
Gibberellin or Gibberellic Acid (GA) was initially isolated from a fungus *Gibberella fujikuroi*. In plants, it is produced in embryos, roots, and young leaves and it enhances growth.

Functions of Gibberellins

(a) It helps in elongation of stems in genetically dwarf plants. By using gibberellin the height of the dwarf plants can be increased.

(b) It breaks dormancy of seeds and buds.

(c) It induces parthenocarpy. (Formation of seedless fruits without fertilization) or provides stimulus received by pollination.



(iii) Cytokinins : They were extracted from coconut milk.

Cytokinins are synthesized in root apex, endosperm of seeds, and young fruits where cell division takes place continuously.

Functions of Cytokinins

(a) They stimulate cell division, cell enlargement and cell differentiation.

(b) They prevent aging of plant parts.

(c) They inhibit apical dominance and help in growth of lateral buds into branches.

(iv) Ethylene

Ethylene is a gaseous hormone. It is found in ripening fruits, young flowers and young leaves.

Functions of Ethylene

(a) It induces ripening of fruits.

(b) It promotes senescence and abscission of leaf, and flowers.

(c) In cells it only increases the width not the length.

(v) Abscissic acid

Abscissic acid also known as Dormin is a naturally occurring growth inhibitor found in wide variety of plants. It is synthesised in leaves.

Functions of Abscissic acid:

(a) It induces dormancy of buds and seeds as opposed to Gibberellin, which breaks dormancy.

(b) It promotes the senescence of leaf, i.e., fall of leaves happen due to abscissic acid.

(c) It inhibits seed germination and development.

(d) It causes closing of Stomata.

20.6 PRACTICAL APPLICATION OF GROWTH REGULATORS

We have already discussed that by using the various types of growth regulators we can promote, inhibit or modify growth and development in plants. Now-a-days these are widely used by horticulturists to boost their production. Some of the applications are –

(i) With the help of auxins and gibberellins seedless varieties of fruits can be produced. You might have seen seedless grapes and papayas in the market.

(ii) Early flowering in some plants is possible by applying growth regulators.

(iii) With the use of hormones some fruits can be ripened at an early stage.

(iv) Germination in seeds can be possible by applying auxins.

(v) Germination of potatoes and onions can be stopped in storage by application of growth inhibitors.

20.6.1 Differentiation, Dedifferentiation and Redifferentiation

Differentiation: Differentiation in plants is a permanent, localised qualitative change in size, biochemistry, structure and function of cells, tissues or organs. It refers to the processes by which distinct cell types arise from precursor cells and become different from each other. For example:Vascular tissues, xylem and phloem, are differentiated from meristematic cells, procambium, and vascular cambium and mature to perform specific functions. The hormones auxin and cytokinin are essential for vascular tissue differentiation. During differentiation, cells undergo few to major structural changes both in their cell walls and protoplasm. For example, to form a tracheary element, the cells would lose their protoplasm. They also develop a strong, elastic, secondary cell wall to carry water to long distances even under extreme conditions.

Dedifferentiation: It is the reversal of cell development in plants, so that the differentiation that had occurred previously is lost and the cell becomes more generalized in structure. The living differentiated cells that have lost the capacity to divide can regain the capacity of division under certain conditions. This phenomenon is termed **dedifferentiation**. For example, formation of meristems, interfascicular cambium and cork cambium from fully differentiated parenchyma cells.

Redifferentiation: While undergoing dedifferentiation plant cells once again lose their capacity to divide but mature to perform specific functions. This process is called redifferentiation.

INTEXT QUESTIONS 20.2

1. Name the plant hormones concerned with the following:
   (i) Elongation of cell .....
   (ii) Shedding of leaves.....
   (iii) Breaking seed dormancy .....
2. Mention two functions of Auxin
   (i) .....
   (ii) .....
3. What is the difference between dedifferentiation and redifferentiation?
   .....
4. Which two hormones are essential for vascular tissue differentiation?
   .....

20.7 DORMANCY AND GERMINATION IN SEEDS

In the previous lesson-7 you have already learnt about formation of seeds in plants. In developed seeds metabolic activities are generally very slow. But at the time of germination, the metabolic activities in seeds increase and they grow into new plants under favourable conditions of growth. This is called **seed germination**.

> **Seed germination** is the return of metabolic activities and growth by the seed tissue to give rise to a new plant by the development of the embryo.

Some seeds do not germinate immediately after dispersal even if suitable conditions of growth are provided. In this period growth of the seeds remains suspended and it is said to be in the rest or dormant stage. This phenomenon is called **dormancy of seeds**. It may occur due to immature embryo**,** hard or impermeable seed coat, and presence of inhibitors like abscissic acid.

20.7.1 Types of Seed Germination

In flowering plants two types of germination are found. They are:

(a) Epigeal germination; and (b) Hypogeal germination.

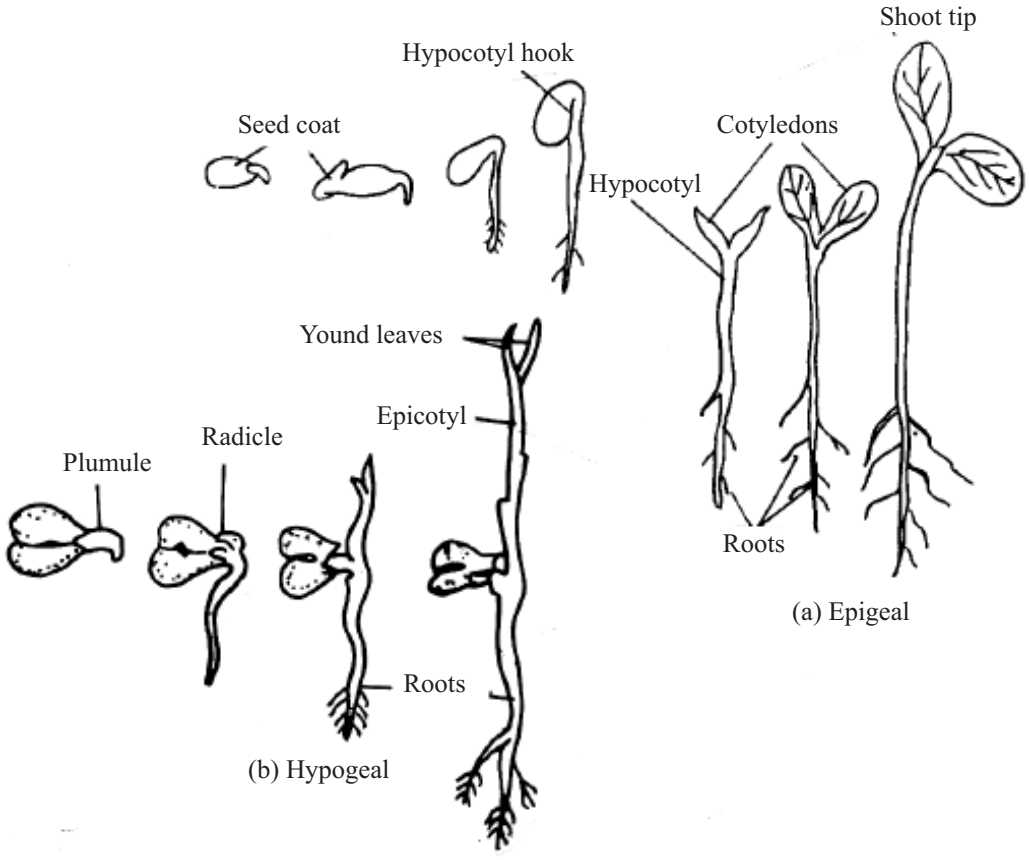


Fig.20.4 Epigeal Germination and Hypogeal Germination
Vivipary (= producing baby plants)

(a) Epigeal Germination

In epigeal (*epi* - above; *geo* - soil)germination hypocotyl elongates and cotyledons come out above the soil surface. Examples : seeds of pumpkin, mustard, tamarind, and french bean.

(b) Hypogeal Germination

In hypogeal (hypo = below, geo = earth) germination the epicotyl elongates and *cotyledons remain below the soil surface*. Examples : Most monocots seed like rice, wheat, maize, and coconut.

Some plants, which grow in marshy places show a special type of germination called **Vivipary** (Fig. 20.5). Here the seed germinates inside the fruit while it is attached to the parent plant. The weight of the seed increases because of germination and seedling separates from the plant and falls down into the mud. Then roots develop to fix it in the soil. These plants are called viviparous plants. For example, *Rhizophora* and *Sonneratia*.

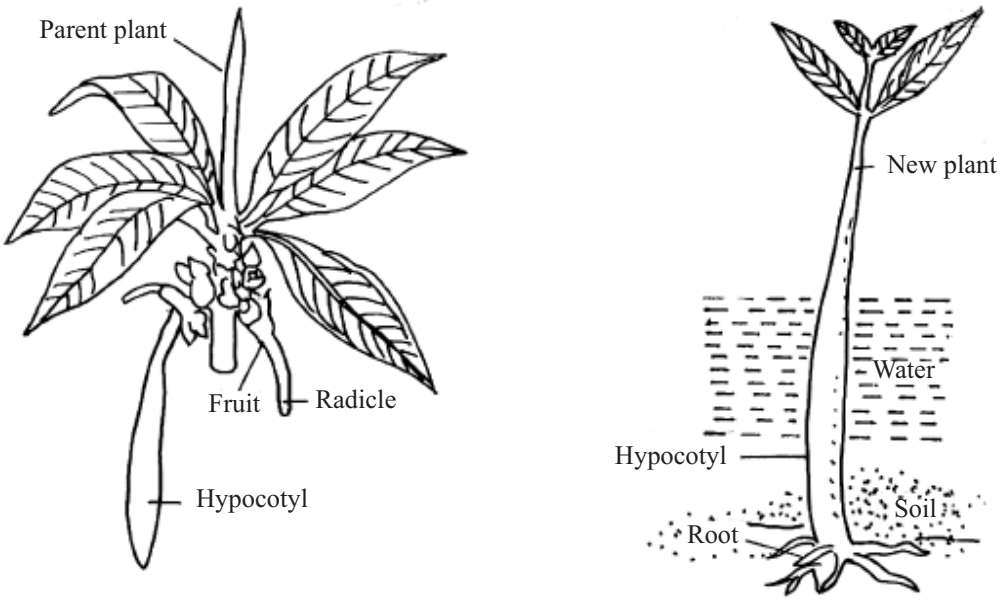


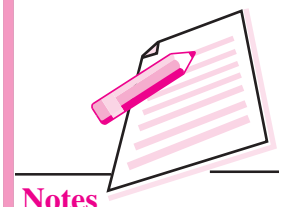
Fig 20.5 Viviparous Germination

20.7.2 Mechanism of Seed Germination

In seed germination, the first step is the imbibition or absorption of water by seed. Then the seed swells and the seed coat ruptures. Through the ruptured seed coat the radicle comes out from one end of embryonic axis. This radicle gives rise to root system. From the other end of embryonic axis the plumule elongates and develops as the shoot of the plant.

20.7.3 Factors Affecting Seed Germination

Seed germination requires five factors : water, temperature, oxygen, light and growth hormones.



(a) Water : The seed must swell up to rupture its seed coat. A ripe seed contains very low quantity of water. So for swelling to cause rupture of seed coats supply of adequate water is essential. Biochemical reactions required for growth and development of the seedling require water.

(b) Temperature : For germination of seeds a particular temperature is required. The degree of temperature required varies from species to species. Warmth accelerates chemical reactions inside.

(c) Oxygen : Oxygen is required in breaking down reserve food of seed and release energy for metabolism of growth of the embryo.

(d) Light : In most of the seeds light is not an essential factor for germination. But in some cases like lettuce and tobacco light is absolutely essential.

(e) Hormone : Besides the above external factors, hormones also control germination of seeds. Some roles played by hormones are as follows.

- Gibberellins can induce germination in some cases even in complete darkness.
- Auxin, Cytokinins and Ethylene can break dormancy in many seeds and initiate germination.
- In some seeds Abscissic acid inhibits germination process.

20.8 PHOTOPERIODISM – RESPONSES DUE TO LIGHT EXPOSURE DURATION

You must have observed plants like spinach, wheat, etc. which produce flowers in summer; and dahlia, cosmos, etc. flower in winter. Why is it so? Because the plants that flower in summer require longer duration of light per day than those flowering in winter. Thus, we can say that duration of light plays an important role in flowering of plants. **This effect of duration of light on the growth of plants is known as photoperiodism**.

Photoperiodism is the response in growth, transpiration, photosynthesis, and reproduction (flowering) of a plant to the specific duration of light, which falls on it per day.

On the basis of day-length required by the plants for flowering, the plants are classified into the following three categories:

(i) Short-day Plants (SDP) : Some plants produce flowers when exposed to a light period shorter than a required day-length. These are called Short-day Plants. Chrysanthemum, Cosmos, Dahlia, Soyabean, are short-day plants.

(ii) Long-day Plants (LDP) : They produce flowers when exposed to a light period longer than a fixed day-length. Gulmohar, radish, spinach, are long-day plants.

(iii) Day-neutral Plants (DNP) : In these plants flowering is not affected by length of light period i.e. they produce flower in almost all photoperiods.Cucumber, Tomato, and Sunflower, are day-neutral plants.

Though flowering is the best known example of photoperiodism, many other plant processes are also controlled by duration of light. Bud dormancy, bulb formation in onion, and tuber formation in potato are affected by period of light.

20.9 ROLE OF FLORIGEN AND PHYTOCHROME IN FLOWERING

After the discovery of effect of light on flowering, the scientist tried to find out the hormone responsible for flowering in plants. It is hypothesized that a plant hormone called **Florigen** is responsible for initiation of flowering in plants. Florigen is a hypotheticals flowering stimulus synthesized in the leaves under favourable photoperiod, which migrates to shoot apex where flowering occurs.

Have you ever thought how a plant comes to know about the presence or absence of light in its environment? It is due the presence of a particular type of pigment in the plants, called **Phytochrome**. It is also known as light absorbing pigment and it makes the plants sensitive to light and participates in seed germination and flowering. This pigment occurs in two different forms, one Pr and the other, Pfr. While Pr absorbs red light P_{fr} absorbs far-red light (such rays are invisible). Both these forms are inter- convertible. The P_r form absorbs red light and gets converted into P_{fr} form and the P_{fr} form absorbs far-red light and gets converted into P_r form.

$$P_r \underset{\text{Far-red light}}{\overset{\text{Red light}}{\rightleftharpoons}} P_{fr}$$

Fig: 20.6 Inter-conversion of the phytochrome into P_r and P_{fr}

20.10 VERNALISATION—APPLICATION OF LOW TEMPERATURES

You have already learnt that temperature affects growth and development of plants. For flowering in some plants, a particular temperature is required. Studies show that if temperature is reduced to a particular point then flowering occurs at an early stage. For example by applying a temperature ranging between 1-10° C to certain variety of wheat, rice and cotton, growth of seedlings is accelerated and flowering occurs earlier. This method of inducing early flowering in plants at low temperature is called **vernalisation**.

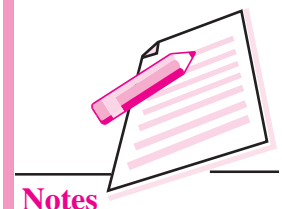
> Vernalisation is the process of accelerating the process of flowering by subjecting or exposing the plant to low tempratue.

Practical Utility of Vernalisation

Vernalisation has some practical applications like:

(a) Plants whose life cycle is completed in two seasons (biennials) can produce flower in one season if their seeds are pre-treated to a low temperature.

(b) Crops can be grown and harvested earlier i.e. biennials can be turned into annuals.



20.11 SENESCENCE/AGING OF PLANTS

Like animals, plants also have fixed life span and after completing that perioid, they die. Before death we can observe several degradation processes in their body. You might have noticed yellowing of leaves, and fading of flower colour, in plants. It is due to loss in structure and function of an organ or the whole plant. **The deteriorative processes which ultimately lead to complete loss of organization and functioning of the plant or its parts is known as Senescence**.

Senescence occurs due to the deposition of waste material. In some plants the whole plant dies after flowering and producing seeds. This is called **whole plant senescence.** Example-annual plants like rice, wheat, beans, and tomato. In many other plants, parts above soil die each year and root system stays alive. This is called **organ or shoot-senescence.**

Role of hormones in senescence: Abscissic acid and ethylene promote senescence of leaves but cytokinin delays senescence and helps leaves remain green for long period.

20.12 ABSCISSION – SHEDDING OFF

You might have noticed whenever a leaf becomes old it separates from the plant body and falls down. Again ripe fruits and older flowers also become separated from plants. This detachment of older plant parts or organs from the main plant body is called **abscission**.

In plants, a layer of tissue generally forms an abscission zone at the base of the petiole of a leaf or flower or fruit. The cells of this layer become soft and weak due to destruction of middle lamella and cell wall. So the organ is easily detached by wind or rain fall. Plant hormones like abscissic acid and ethylene promote leaf abscission and auxin prevents it.

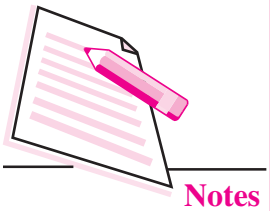
20.13 STRESS FACTORS

What happens if you do not supply water to a potted plant for four to five days? You may observe that the leaves bend down and the plant wilts. Here due to lack of water the usual life processes of plant are disturbed. We can say that the plant is facing stress in its life. This may be called as **biological stress**. Not only water, there are a number of factors responsible for causing stress in plants like temperature, salt, shade, light, and pollutants.

Any change in the environmental conditions that may adversely affect the growth or development in plants is called biological stress.

The effect that is produced in plant as a result of stress is called strain. In the above example bending of leaves and wilting of plant are strains.

So the reaction of plant facing the stress is called strain



Notes

20.13.1 Types of Stress

There are a variety of stresses to which plants are exposed. Some common stresses are-

(a) Water stress; and (b) Salt stress.

Let us know details about them.

(a) Water Stress

Water stress includes both excess of water (flood) and scarcity of water (drought). Deficiency of water in the plant makes the leaves yellow and they wilt. The various processes in plants like photosynthesis and respiration are reduced, cell enlargement is checked, cell size is deformed and cell rigidity lost due to deficiency of water. Flooding or excess amount of water in soil reduces root and shoot growth, and causes blackening of root tips and yellowing of leaves.

(b) Salt Stress

Salt stress occurs mainly due to the presence of excess amount of calcium and sodium salts in plant body. It causes dehydration of cell, change in shape of cell and disturbance in metabolic processes. Thus cell growth as well as growth and development of plants are retarded.

20.14. PLANT MOVEMENTS

While doing any work our body parts move and also entire body moves from one place to another as per our desire. This is called movement of our body. Plants also show movement. But their movements are completely different from our body movement. Except some unicellular plants, all other higher plants cannot move from place to place as their roots are fixed in the soil. Still they show movement by folding the buds, opening and closing the flowers, and bending towards sun light. These movements in plants are very slow and we have to wait and observe them carefully and patiently to notice these movements. Let us learn about various types of movements shown by plants.

(a) Tropic Movement (directional response or growth movements)

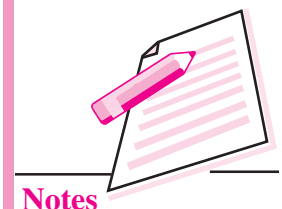
Movement in plants or in any part of the plants towards or away from some environmental factors is known as tropic (trope : turn) movement. You must have observed the movement of plants in the direction of light, the downward movement of roots in the soil, drooping of leaves of some sensitive plants by touch, etc. These are examples of tropic movement.

(i) **Phototropism :** Induced by light e.g. bending of stems towards light.

(ii) **Geotropism :** Induced by gravity e.g. growth of roots towards gravity.

(iii) **Thigmotropism :** Movement caused by contact e.g., twining stem and tendril and the drooping of leaves of sensitive plant by touch.

(iv) **Hydrotropism :** Induced by water i.e., growth of roots towards source of water.



(b) Nastic Movement

The nastic (nastein : bending) movements are the growth movements resulting due to difference in the rate of growth on **opposite sides of an organ** e.g., opening of petals, coiling of leaves, etc. When upper side of an organ grows faster than the lower side, the movement is called **epinasty**. (e.g., downward curling of leaf, opening of sepals of goldmohur flower. When the lower side grows more rapidly than upper side, it is called as **hyponasty**. (e.g. upward curling of leaf blade)

(c) Turgor Movements

These movements are due to change in the volume of water inside the cell. When more water is present in the cell it is fully expanded and becomes rigid or hard. Such a condition is called turgidity and the cell is said to be **turgid**. When less water is present inside the cell, it is not fully expanded and remains soft. This is called **flaccid** condition. The leaves bend in hot summer due to excessive transpiration on account of loss of turgidity of cells of the leaf.

Some examples of turgor movements are :

(i) Leaves or leaflets of some plants close on the fall of darkness (sleep movement). Example - *Portulaca*, *Acacia*.

(ii) Closing of leaflets and drooping of leaves in response to a strong stimulus of blowing wind or of touch. Example - Sensitive plant (*Mimosa pudica*)

(iii) Closing of leaves of Venus Flytrap to catch a landing insect.

(iv) Seed pods of some plants open on maturity, vigorously expelling their seed. Example - Balsam (Gulmehandi).

INTEXT QUESTIONS 20.3

1. Distinguish between Phototropism and Geotropism

   .....

2. Give two examples of turgor movement

   .....

WHAT YOU HAVE LEARNT

- Growth in living organisms results from increase in the number and size of a cell, organ or whole organism.
- Development is the whole series of qualitative and quantitative changes (growth, differentiation, maturation), which an organism undergoes throughout its life cycle.

- Growth of cells occurs in three successive stages i.e., cell division, cell enlargement, cell differentiation.
- Plants show three phases of growth - Lag Phase, Log Phase, Stationary Phase
- Auxanometer is a specially designed equipment used to measure the rate of growth of shoot length of plants.
- The external factors that affect the growth of the plant are light, temperature, Water and mineral nutrients.
- The internal factors responsible for plant growth are auxin, gibberellins, cytokinins, ethylene, and abscissic acid. These are substances produced in a small quantity in one part of plant body and capable of moving to other parts to influence the growth of that part.
- Seed germination is the return of metabolic activities and growth by the seed tissue to give rise to a new plant. The germination in seeds is mainly affected by factors like Water, temperature, oxygen, light, and hormone. Flowering plants show two types of germination, epigeal germination; and hypogeal germination.
- Photoperiodism is the biological response in growth, reproduction (flowering) of a plant to the duration of light, which falls on it per day.
- Florigen is a hypothetical plant hormone, which is responsible for initiation of flowering in plants.
- The method of accelerating the ability of flowering in plants by keeping them at low temperature for sometime is called vernalisation
- Senescence is a gradual process during which any plant part or the whole plant completely loses its function and ultimately dies.
- The process of detachment of any leaves, fruits, flower or any part of the plant from the main body after getting older is called abscission.
- Any change in the environmental conditions that may adversely affect the growth or development in plants is called biological stress. This stress occurs mainly due to temperature, water, salt, shade, light, and various pollutants.

TERMINAL EXERCISES

1. State the different stages of cellular growth.
2. Distinguish between growth and development.
3. What is a sigmoid growth curve? State the different phases of sigmoid curve.
4. Describe the various external factors that affect the growth of plants.
5. What is vernalisation?
6. Define the term Photoperiodism.
7. What is auxin? What is its role in the growth of plants?
8. State any two functions of Gibberellin?

9. Explain the role of Cytokinins and Ethylene in growth and development of plants.
10. Distinguish between epigeal germination and hypogeal germination.
11. What is meant by seed germination? Describe the various factors responsible for seed germination.
12. What is senescence?
13. State any two practical utilities of growth hormones.
14. What is biological stress? Describe the different types of biological stress.
15. What is apical dominance? Name the hormone responsible for it.
16. What is meant by plant movement? Describe any two types of movement of plants with example.

ANSWERS TO INTEXT QUESTIONS

20.1 1. Growth : Increase in number and size of a cell, organ organism.

Development : Series of qualitative & quantitative changes including growth, differentiation and maturation.

2. Process of change in cells, tissues or organs in order to carry out different functions.
3. Similar cells organise to form a group called tissue to perform a particular function

20.2 1. (i) Auxin, (ii) Ethylene (iii) Abscissic acid

2. (i) Cell elongation (ii) Delays fall of leaves (iii) suppresses growth of lateral bud (any two)
3. *Dedifferentiation:* Process by which precursor cells become distinct cell types to perform a specific function.

Redifferentiation: Process by which the plant cells while undergoing dedifferentiation lose their capacity to divide once again but mature to perform specific functions.

4. Auxin and Cytokinin.

20.3 1. Movement induced by light – Phototropism

Movement induced by gravity – Geotropism

2. (i) Closure of leaves on fall of darkness

(ii) dropping of leaves on touch

(iii) closing leaves of venus fly trap to catch a landing insect (any two)