# 18

# REPRODUCTION IN PLANTS

Reproduction is one of the most important characteristic of all living beings. It is the production of ones own kind. It is necessary for the continuation of the species on earth and also to replace the dead members of the species. The process by which living organisms produce their offsprings for the continuity of the species is called reproduction.

The modes of reproduction vary according to individual species and available conditions. It may be simply by division of the parent cell as in unicellular organisms, by fragmentation of the parent body, by formation of buds and spores, or it may be very elaborate involving development of male and female reproductive organs (stamens and pistils). Irrespective of the mode of reproduction, all organisms pass on their hereditary material to their offspring during the process of reproduction. In this lesson, you will study about the process of reproduction in plants.

## OBJECTIVES

After completing this lesson, you will be able to :

- *define reproduction;*
- *differentiate between vegetative, asexual and sexual reproduction;*
- *describe the methods of asexual and sexual reproduction in lower plants (Chlamydomonas) and filamentous green algae (Spirogyra);*
- *describe the mode of reproduction in flowering plants;*
- *explain the parts of a dicot flower and their functions;*
- *describe stages of microsporogenesis;*
- *depict with the help of diagram the structure of ovule and mention the steps of megasporogenesis;*

- *describe the stages of development of gametes in flowering plants;*
- *state the types of pollination, their significance and various modes of pollination;*
- *explain the steps involved in fertilization, (syngamy and triple fusion), embryo development, endosperm development, formation of seed;*
- *differentiate between structure of dicot and monocot seeds;*
- *explain the formation of fruit and parthenocarpy;*
- *describe seed germination;*
- *define vegetative reproduction*
- *differentiate between natural and artificial propagation;*
- *explain the advantages and disadvantages of vegetative propagation;*
- *describe the role of tissue culture technique in micropropagation.*
- *state the advantages of micropropagation.*

## 18.1 MODES OF REPRODUCTION

The various modes by which plants reproduce are of three types –

(a) Asexual (b) Vegetative (c) Sexual

In **Asexual** mode of reproduction, offspring are reproduced from a vegetative unit produced by a parent without any fusion of gametes or sex cells.

– A single parent is involved

– Offsprings are genetically identical to the parent.

(a) Asexual reproduction may be of the following types—

(i) **Fission :** As in unicellular organisms like bacteria and yeast where the content of the parent cell divides into 2, 4 or 8 daughter cells and accordingly the fission is known as **binary** or **multiple** fission. Each newly formed daughter cell grows into a new organism.

(ii) **Budding :** A bud like outgrowth is formed on one side of the parent cell and soon it separates and grows into a new individual e.g. in yeast.

(iii) **Fragmentation :** In filamentous algae, an accidental breaking of the filament into many fragments, each fragment may give rise to a new filament of the algae by cell division e.g. *Spirogyra*.

(iv) **Spore formation :** In lower plants including bryophytes and pteridophytes, special reproductive units develop asexually on the parent body. These are called spores. They are microscopic and covered by protective wall. When they reach the suitable environment they develop into a new plant body e.g. in bread moulds, moss, fern.

(b) **Vegetative reproduction :** involves formation of new plantlets from vegetative (somatic) cell, buds or organs of the plant. Here, a vegetative part of the plant (Root, stem, leaf or bud) gets detached from the parent body and grows into an independent daughter plant. It is similar to a sexual reproduciton in that it also requires only mitotic division, no gametic fusion and daughter plants are genetic clones of the parent plant.

We will discuss the different types of vegetative reproduction in angiosperms later in this lesson.

(c) **Sexual reproduction** involves fusion of male and female reproductive cells (gametes) which are haploid produced by male and female reproductive organs. This fusion is known as **fertilization** and results in the production of a **zygote (diploid)**. Further development of zygote gives rise to a new individual which is diploid.

Here, at some stage of the life history meiosis is involved and the offsprings are not genetic clones of their parents.

## INTEXT QUESTIONS 18.1

1. Define reproduction.

   .....

2. How is asexual reproduction different from sexual reproduction?

   .....

3. What is a gamete?

   .....

4. Name two types of asexual reproduction.

   .....

## 18.2 REPRODUCTION IN LOWER PLANTS

We will study the different types of reproduciton in two lower plants, one unicellular algae (*Chlamydomonas*) and the other multicellular filamentous algae (*Spirogyra*).

### 18.2.1 Chlamydomonas (A Unicellular Alga)

(i) It is a haploid unicellular alga found in fresh water ponds:

(ii) The plant body is pear-shaped with two flagella attached at the narrow end.

(iii) On one side of the cell an eye spot is present.

(iv) A large cup-shaped chloroplast is present.

(v) Towards the centre, a definite nucleus is present.

(vi) Chloroplast contains a single pyrenoid. (Fig. 18.1a).

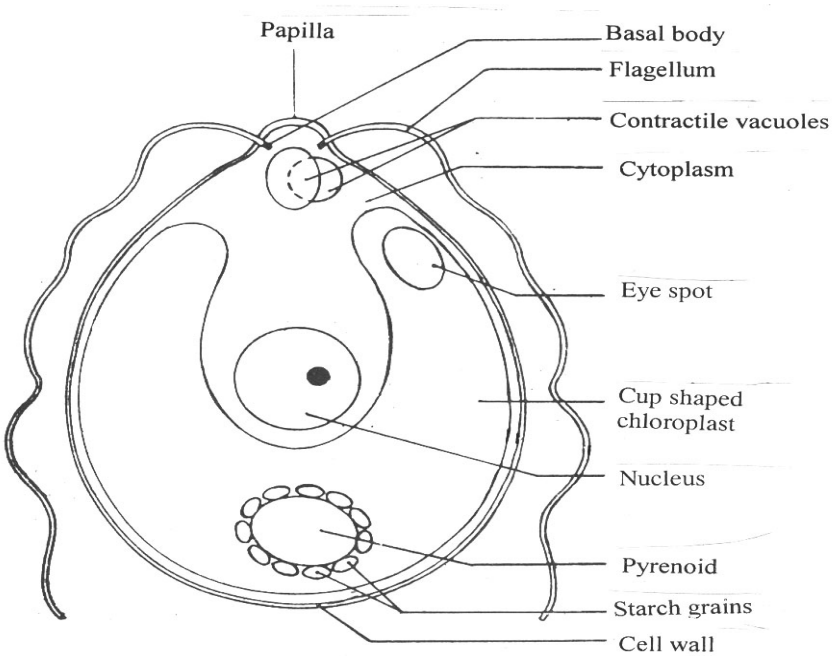



**Fig. 18.1a** A Chlamydomonas cell

## Reproduction

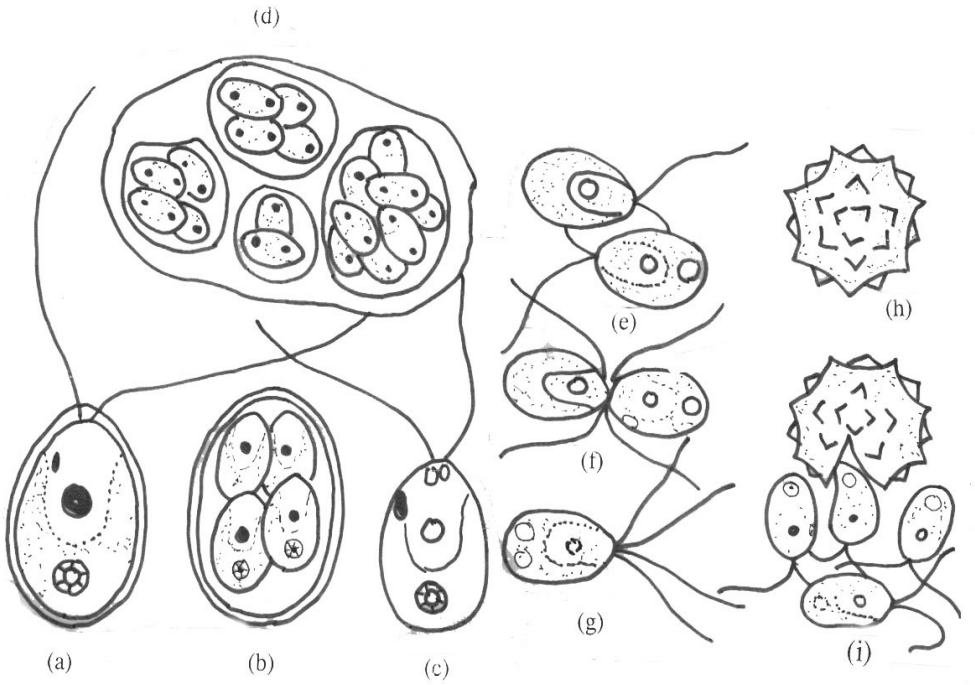
### A. Asexual-with the help of zoospores

- *Chlamydomonas* loses flagella and becomes non-motile.
- Its protoplasm (cytoplasm and nucleus) divides mitotically and forms 4-8 zoospores.
- The parent cell wall is ruptured and zoospores are released.
- Each zoospore develops a cell wall and grows into an adult cell. (Fig. 18.2-b, c)
- The parent cell does not exist, any more.

### B. Sexual Reproduction

- The cell becomes non-motile by losing its flagella.
- The protoplasm divides mitotically into 2, 4, 8, 16, 32 daughter cells.
- Each daughter cell develops flagella and is released in water by the rupture of mother cell wall. It acts as a gamete.
- The gamete is morphologically identical in structure but all identical (Isogamous).
- Gametes released from two different mother cells fuse together.
- The contents of the gametes fuse and form a zygote (diploid). This is the only diploid stage in the life cycle of *Chlamydomonas*.

- The zygote develops a thick wall around itself to tide over unfavourable conditions (zygospores)
- On the return of favourable conditions (temperature, food and water) the diploid nucleus divides by meiosis and forms four haploid zoospores. (Fig. 18.2 d-i)
- Each zoospore grows into a new adult *Chlamydomonas*.




(a) Matured cell (b) 4 daughter cell (Zoospores formed by Asexual reproduction) (c) Zoospores after it escapes from the parent cell (d, e, f, g) Free swimming gametes and fusion (h) A resting zygote (i) 4 cells formed after meiosis of the zygote cell (zygospores)

**Fig. 18.2** Asexual and Sexual reproduction in Chlamydomonas

## INTEXT QUESTIONS 18.2

l. Define the term isogamy.

.....

2. Where does meiosis occur in *Chlamydomonas* ?

.....

3. Give the method of asexual reproduction takes place in *Chlamydomonas*. What is the function of zoospores in *Chlamydomonas*.

.....

### 18.2.2 Spirogyra (A Multicellular Alga)

**Structure**

(i) It is a free floating alga found in fresh water ponds.

(ii) The body has a row of rectangular cells joined end to end (filamentous alga).

(iii) Each cell has a spiral ribbon shaped chloroplast with many pyrenoids.

(iv) Central region has a large vacuole.

(v) The nucleus is present in the centre of vacuole supported by cytoplasmic strands. (Fig. 18.3)

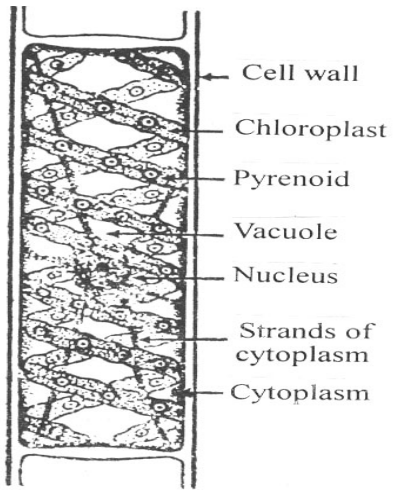



**Fig. 18.3** Spirogyra : part of the filament.

**Reproduction**

**A. Vegetative Reproduction by fragmentation :**

(i) The filament breaks into small fragments.

(ii) Each fragment grows into a new filament by cell division.

**B. Sexual Reproduction**

**Scalariform Conjugation** (conjugating filaments give a ladder-like appearance). (Fig. 18.4)

- Two filaments come to lie very close to each other.
- Cells of the two filaments form a contact with the help of a tube called the conjugation tube.
- Cytoplasmic contents of each cell round off to act as a gamete.
- Gamete from one cell (male) passes to the other cell (female) through the conjugation tube.
- Each filament acts either as male or female.
- The contents of two gametes fuse in the female cell and form a diploid zygote.

- The zygote develops a thick wall around itself and tides over the unfavourable period.
- On the return of favourable conditions the diploid nucleus divides by meiosis into four haploid nuclei. Three of these nuclei degenerate.
- On germination, wall of the zygote ruptures and a small tube like structure, containing one haploid nucleus comes out.
- The small tube develops into 1 filament by repeated mitotic divisions.

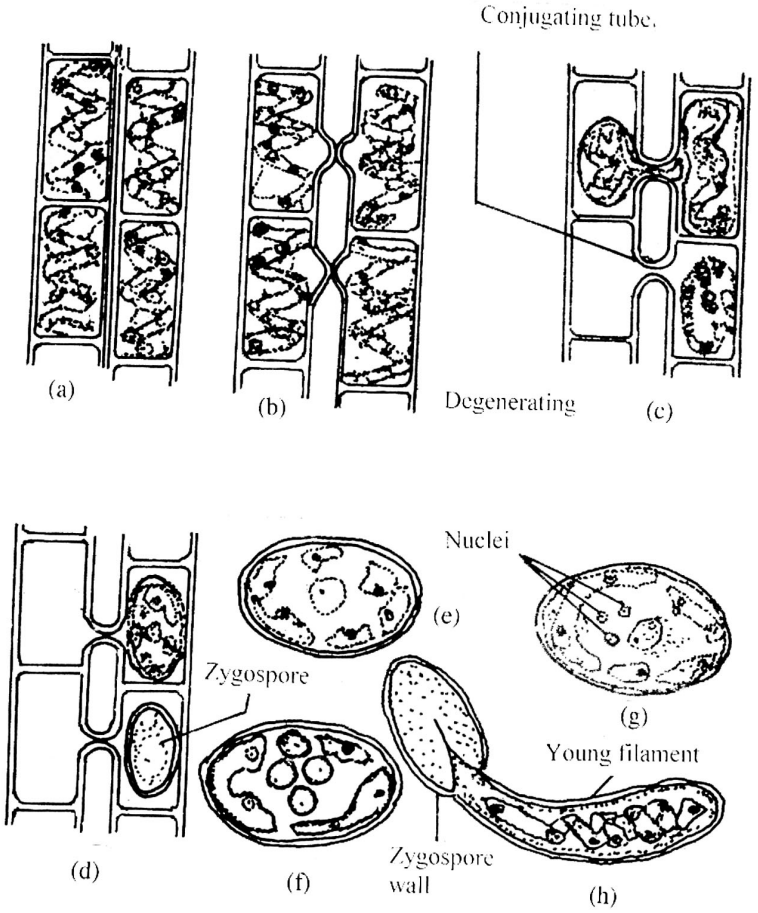



**Fig. 18.4** Life cycle of Spirogyra : Sexual reproduction-Scalariform conjugation. (a) Filaments lie close, (b) Formation of conjugation tube, (c) Transfer of gamete from the donor to the recipient cell, (d) Zygospore within the recipient cell, (e) Zygospore breaks from filaments, (f) Meiotic division in zygospore produces haploid nuclei, (g) 3-4 haploid nuclei degeneration, (h) formation of young filament

The cell in the main plant body form the gametes without meiosis, therefore *Chlamydomonas* and *Spirogyra* are gametophytes (haploid).

## INTEXT QUESTIONS 18.3

1. Vegetative reproduction in *Spirogyra* takes place by means of

   .....

2. Name the kind of sexual reproduction that occurs in *Spirogyra*.

   .....

3. When does meiosis occur in *Spirogyra* ?

   .....

## 18.3 REPRODUCTION IN ANGIOSPERMS (FLOWERING PLANTS)

Angiosperms reproduce both by vegetative as well as by sexual methods. In this section we will study the sexual reproduciton in angiosperms. As you know sexual reproduction occurs by fusion of male and female gametes present in the flower. Thus flower represents the reproductive unit of a plant.

How frequently do plants flower? There is variation shown by the plants in this respect.

Angiosperms can be classified as annuals, biennials and perennials depending upon the time they take to complete the life cycle and flowering.

(a) **Annuals :** Plants live for **one year**. The plants which produce flowers and seeds within **one season** are called annuals eg. pea

(b) **Biennials :** Plants which complete their life cycle in **two seasons** are called biennials. In the first year, the plants remain in the vegetative state. In the second year, they produce flowers, fruits, and seeds and then die e.g. radish.

(c) **Perennials :** Plants which live for **several years** are termed perennials. Their vegetative stage may last from one to a few years after which they produce flowers, fruits, and seeds every year e.g. mango, peepal, neem etc.

(d) **Monocarpic :** However, some perennial plants reproduce only once in their life-time and then die. Such plants are called Monocarpic e.g. bamboo.

### Initiation of flowering

As the seed germinates a new plantlet emerges from it. The young plant grows vigorously and continue to grow till it attains a definite shape and size with its vegetative parts (roots, stem, leaves) well developed. This phase of the life cycle represents the **young** or the **Juvenile** phase.

Then, at a certain point of time on completion of vegetative growth the plant switches over to its **reproductive phase** or **adult phase** and vegetative shoot apex transforms into a reproductive or **floral apex** and starts bearing flowers. As listed above this transition from vegetative, the flowering stage may take several years in trees but only a few weeks or days in annuals.



**Table 18.1 Difference between Juvenile and Adult Shoot**

| Juvenile Shoot | Adult Shoot |
|---|---|
| 1. Small, soft stem bearing a few young leaves. | 1. Well developed stem and leaves. |
| 2. Shape and size of leaves remain same. | 2. Shape and size of leaves change. |
| 3. Shoot does not respond to stimuli to produce flowers. | 3. Shoot responds to stimuli to produce flower. |

In cereals a minimum of seven leaves must be developed before the plant can produce flowers.

**Factors Affecting Flowering**

Flowering in a plant is affected by *temperature* (vernalisation) and *light (photoperiodism).*

**Vernalisation :** Low temperature treatment which stimulates early flower formation is called **vernalisation**.

**Photoperiodism :** It is the response in growth and flowering of a plant to the duration of light and dark period per day. (For details refer to lesson 19).

**Sex in flowers :** You have studied in Lesson 5 on Shoot System (flower, inflorescence, fruit and families), that flowers may be bisexual (having both stamens and carpels) or unisexual (staminate or pistillate).

In some dioecious species there may be a (i) chromosomal basis of sex-determination, for example xx and xy chromosomes. (ii) The male and female plants may also exhibit differences in the levels of their growth substances. For example – plants of *Cucumis* which bear male flowers have a high gibberellin content as compared to those which bear only female flowers. The application of gibberellin from outside can induce the formation of male flowers even in genetically female plants and treating male plants with auxin or ethylene may develop functional female flowers. The above response has also been seen in *Cannabis*.

**Parts of a flower**

As you have already studied a typical flower consist of four whorls borne on a thalamus or stalk. These whorls are from outside

(a) Calyx - consisting of sepals.

(b) Corolla - consisting of petals

(c) Androecium - consisting of stamens

(d) Gynoecium or pistil - consisting of carpels.

Try to recollect their role in reproduction. The two outermost whorls are known as **non essential** or **accessory whorls** as they aid in reproduction but do not directly

take part in the process. The other two whorls i.e. **Androecium** (male reproductive organ) and **Gynoecium** (female reproductive organ) are known as the **essential whorls** as their absence from flowers will lead to failure of reproduction.

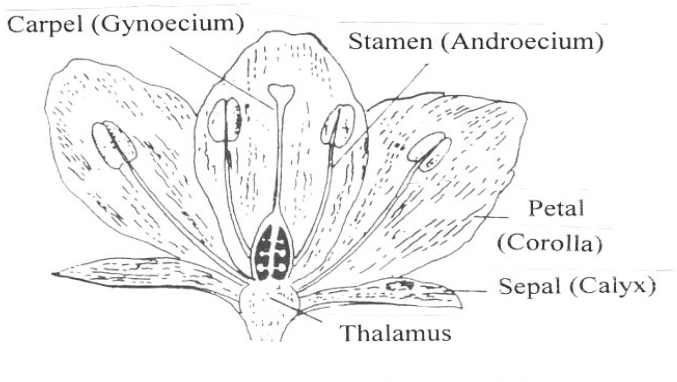



**Fig. 18.5** T.S. of a typical flower

## INTEXT QUESTIONS 18.4

1. Define the terms (i) Annual (ii) Biennial (iii) Perennial

   .....

2. List the factors which induce flowering

   .....

3. Give one example where external application of hormone can reverse the sex of a flower

   .....

4. Name the essential whorls in a flower.

   .....

## 18.4 STAMEN, MICROSPORANGIA AND POLLEN GRAIN

Stamen consists of an **anther** containing four pollen sacs or **microsporangia**, supported by a slender filament. Each sporangium contains mass of large cells showing prominent nucleus and abundant cytoplasm. These are the sporangenous cell or the microspore mother cells (Fig. 18.6). Each microsporangium when mature, has a wall made up of distinct layers of cells.

(i) Outer most layer (epidermis)

(ii) Middle layer of thin walled cells.

(iii) Innermost layer, the *tapetum* consisting of large cells, which nourish the developing pollen grains.

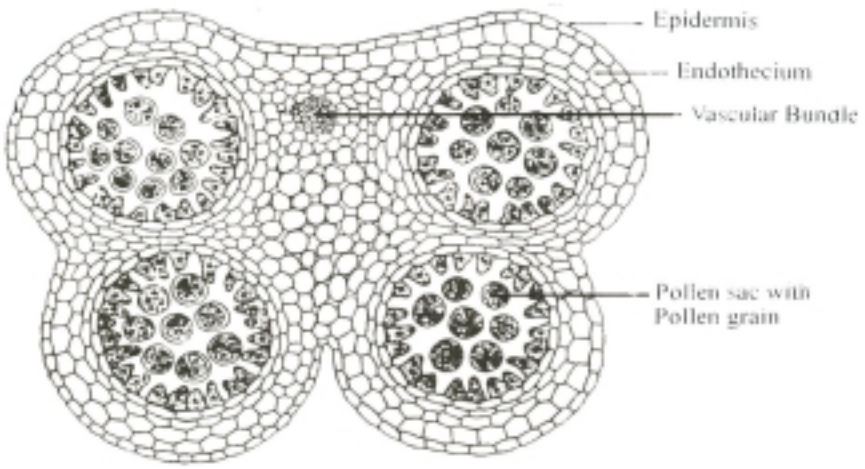



**Fig. 18.6** T.S. of anther to show the various tissues.

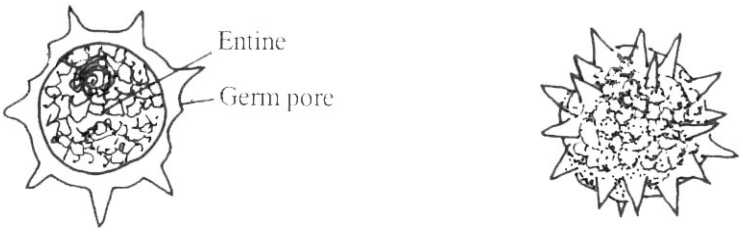
Microspore mother cells undergo meiosis and each of them forms four *haploid* microspores (Pollen grains which are diploid) arranged in a tetrad (Fig. 18.7a)

**Development of male gametophyte (pollen grains)**

(i) The wall of the microspore (pollen grain) consists of two principal layers. (Fig. 18.7b)

1. Outer exine, (design may help in identifying species) with some thin spaces (germ pores). Exine is made up of extremely durable substance called sporopollenin. The pollen tube grows out of the pollen grain through the germ pores.
2. Inner, thin cellulosic wall, the intine.

(ii) The microspore nucleus moves towards periphery and the cell divides into a large vegetative cell and a small generative cell.




(a) A pollen grain showing external view (b) Pollen grain showing internal view

**Fig. 18.7** Structure of pollen grain

At this stage pollen grains are releases by the rupture of the stomium dehiscence of the anther.

> The Pollen grain itself is not, the male gamete. It is a structure which produces male gametes, therefore pollen grain is the male gametophyte.

### The pistil, megasporangium and embryo sac

The main part of the ovule is enclosed by two integument (covering) leaving an aperture (micropyle). The ovule is attached to ovary wall by a stalk (funiculus). Chalaza is the basal part (Fig. 18.8a)

### Female gamete

The gynoecium or pistil represents the female reproductive part in the flower. Each pistil consists of a stigma, style and ovary. The ovary contain one or more ovules (megasporangia) which are the future seeds. An ovule develops as a projection on the placenta in the ovary. It consists of a parenchymatous tissue called the nucleus and is covered by one or two coverings called integuments, the integuments surround the nucellus all around but leave a narrow passage, the micropyle, through which a pollen tube may enter at a later stage. As the ovule grows it is raised on a stalk like structure called funiculus which is attached to the placenta on the other end (Fig. 18.8b).

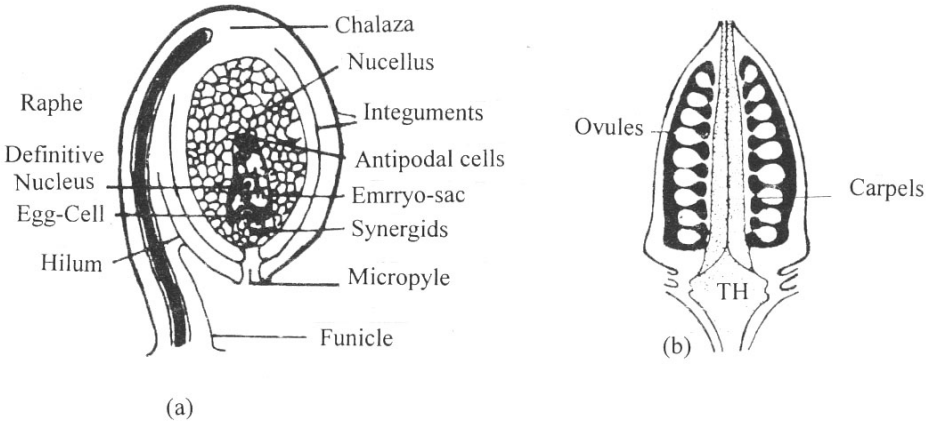



**Fig. 18.8** (a) Various parts of ovule (b) Pistil

### Development of female gametophyte

Within the nucellus, a single hypodermal cell (below the epidermis) enlarges and becomes the megaspore mother cell, the mother cell undergoes meiotic division and gives rise to four haploid megaspore cells, usually three of them degenerate and the remaining one becomes the functional megaspore. It enlarges and its nucleus undergoes three successive mitotic divisions. As a result 8 haploid nuclei are formed. This enlarged oval shaped structure with eight haploid nuclei is referred as **embryo sac**. These nuclei then migrate and get arranged into three groups. Three nuclei reach the micropylar end of the embryo sac and other three move in the opposite direction (i.e. the chalazal end) and the remaining two is the centre. cell membranes and cell walls develop around all the nuclei excepting the two at the centre of the embryo sac which now is called the central cell.



The Nucellus contains embryo sac (female gametophyte).

Thus, in a mature ovule the embryo sac contains eight haploid nuclei but only seven cell. Three cells at the micropylar end, form the egg apparatus and the three cells at the chalazal end, are the antipodal cells. The remaining two nuclei called the polar nuclei may use to form the diploid secondary nucleus. In the egg apparatus one is the egg cell (female gamete) and remaining two cells are the synergids. A fully developed embryo sac with the nucellus, integuments and funiculus, together constitute the mature ovule. In this condition the ovule awaits fertilization which must be preceded by pollination.

**Function of cells and nuclei of embryo sac**

**Secondary Nucleus :** During fertilization, the secondary nucleus fuses with one sperm to form a triple fusion nucleus (2n+n = 3n). This is called primary endosperm nucleus. It gives rise to the food storing **endosperm** of the seed in many plants.

**Egg Cell :** Fuses, with the second male gamete (sperm) to give rise to the **zygote,** which develops into the embryo. This is called double fertilization.

**Synergid Cells :** Considered to help in fertilization by directing the pollen tube to the egg cell.

**Antipodal Cells :** No function.

## INTEXT QUESTIONS 18.5

1. What is the innermost layer of microsporangium called?

   .....

2. Name the organ where Pollen grains are formed.

   .....

3. Name the two layers of pollen grain ..... and .....

4. Name two parts of a mature ovule.

   .....

### 18.4.1 Pollination

When mature pollen grains released from anther are carried to stigma of a flower of the same or different species, it is called pollination.

**Pollination : Transfer of pollen grains from the anther to the stigma of flower.**

**Pollination is of two types.**

**Pollination**

| Self-pollination | Cross-pollination |
|---|---|
| Transfer of Pollen grains to stigma of same or another flower of same plant. as in the China rose | Transfer of Pollen grains to stigma of a flower of another plant of the same species and as in palm |

**Importance of Pollination :**

1. It results in fertilization and ovule is converted into seed.
2. New varieties of plants are formed through new combination of genes in case of cross pollination.
3. During pollination pollen tube produces growth hormones which convert ovary into fruit.

Cross pollination is brought about by various external agencies such as, wind, insects, water, birds and other animals. Now let us study the various agencies of cross pollination which carry pollen grains from one flower to stigma of another flower.

**Characteristics in Flowers which favour Cross Pollination**

**1. Pollination by wind (Anemophily) :** (Anemos : wind, Phile: to love)

(i) Flowers are small, without colour, nectar and scent.

(ii) Flowers produce a large number of pollen grains to allow for wastage when carried with wind to another flower.

(iii) The pollen grains are small, light and sometimes provided with 'Wings'.

(iv) The stigmas are comparatively large, protruding and some times hairy, to trap pollen grains for example, grasses and some cacti.

**2. Pollination by insects (Entomophily) :** (entomo : insect, phile : to love)

(i) Flowers are usually large, coloured and showy to attract insects.

(ii) Some of these flowers secrete nectar to attract insects. *Salvia* flowers show special adaptations for pollination by bees. (Fig. 18.9).

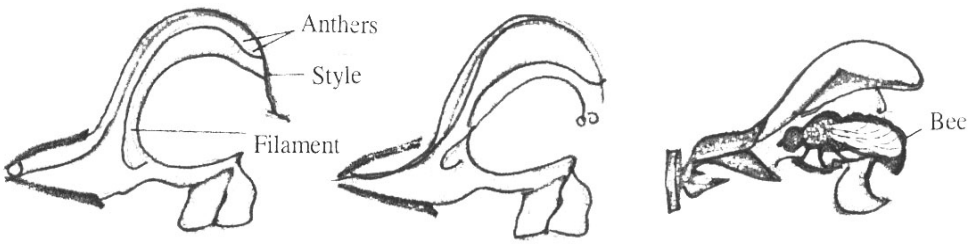



**Fig. 18.9** Pollination in Salvia by bees

**3. Pollination by Water (Hydrophily)** (Hydros : water)

This takes place in aquatic plants.

(i) Pollen grains are produced in large numbers.

(ii) Pollen grains float on surface of water till they land on the stigma of female flowers e.g. *Hydrilla, Vallisneria*.

**4. Pollination by Animals (Zoophily)** (Zoon : animal)

Flowers of such plants attract animals by their bright colour, size, scent etc. for example sun bird, pollinates flowers of *Canna*, gladioli etc., Squirrels pollinate flowers of silk cotton tree.

> Humans carry out artificial pollination in a number of plants for producing hybrids.

**Some Adaptations to Promote Cross Pollination :**

1. **Unisexuality :** Flowers may be only male or female, borne on different plants e.g. papaya, palm.
2. **Dichogamy :** Male and female sex organs mature at different times. In sweet pea, and *salvia*, Anther matures earlier than the stigma and in custard apple (sharifa) carpel matures earlier than the anther.
3. **Self Sterility :** Pollen grains are incapable of affecting fertilization even after being placed on the stigma of the same flower e.g. petunia, apple.

**Devices to ensure self pollination :**

(i) **Cleistogamy :** Flowers do not open completely on maturity.

(ii) Male and female sex organs mature at the same time e.g. ground-nut.

## INTEXT QUESTIONS 18.6

1. What is pollination?

   .....

2. Mention suitable terms for the following :

   (i) Flowers do not open and gets self pollinated.

   .....

   (ii) Male and female reproductive organs mature at different times.

   .....

3. Give two features of insect pollinated flowers :

   (i) .....

   (ii) .....

### 18.4.2 Fertilization

- Pollen grains reach the right stigma and begin to germinate.
- Pollen grain form a small tube like structure called pollen tube which emerges through the germ pore. The contents of the pollen grain move into the tube.
- Pollen tube grows through the tissues of the stigma and style and finally the ovule through the *micropyle*.
- Vegetative cell degenerates and the generative cell divides to form two sperms (or male gametes).
- Tip of pollen tube bursts and the two sperms enter the embryo sac.
- One sperm fuses with the egg (syngamy) and forms a diploid zygote. The other sperm fuses with the secondary nucleus to form the primary endosperm nucleus which is triploid in nature. Since two types of fusion syngamy and triple fusion take palace in an embryo sac the process is termed as **double fertilization**.
- After triple fusion, primary endosperm nucleus develops into an endosperm.
- Endosperm provides food to the developing embryo.
- Later the synergids and antipodal cells degenerate.

**Significance of Fertilisation**

(i) Gives stimulus for the growth of ovary, leading to fruit formation.

(ii) Helps in recombination of characters as genes from two different individuals combine and form the zygote.

**Post fertilisation change**

Events that follow double fertilisation are development of endosperm and embryo and maturation of the ovule into seed and ovary into fruit.

**(a) Endosperm :** The endosperm development begins before embryo development. Can you tell why this is to establish the nutritive tissue for the growth of the zygote into an embryo. The primary endosperm cell divides repeatedly and forms an endosperm tissue. There are three ways in which the endosperm may develop.

(i) **Nuclear type :** The nucleus undergoes repeated division to give rise to free nuclei which arrange themselves at the periphery leaving a large central space. Cell wall formation starts subsequently and endosperm becomes cellular at maturity. This is the most common type of endosperm development and is seen in maize, wheat, rice etc.

**(b) In Cellular,** each nuclear division is followed by cytokinesis, making it cellular from the beginning

**(c) In Helobial type,** the first mitosis gives rise to two unequal cells, subsequently division are free nuclear but becomes cellular after cytokinesis.

Endosperm may be completely consumed by the developing embryo before seed maturation as in many dicot seeds like pea, beans etc. or it may persist in the mature seeds or may even enlarge considerably as in cereals, coconut etc.

**Development of embryo**

(i) The zygote divides into two cells, the upper cell (embryonal cell) and; lower cell (Suspensor cell). (Fig 18.10)

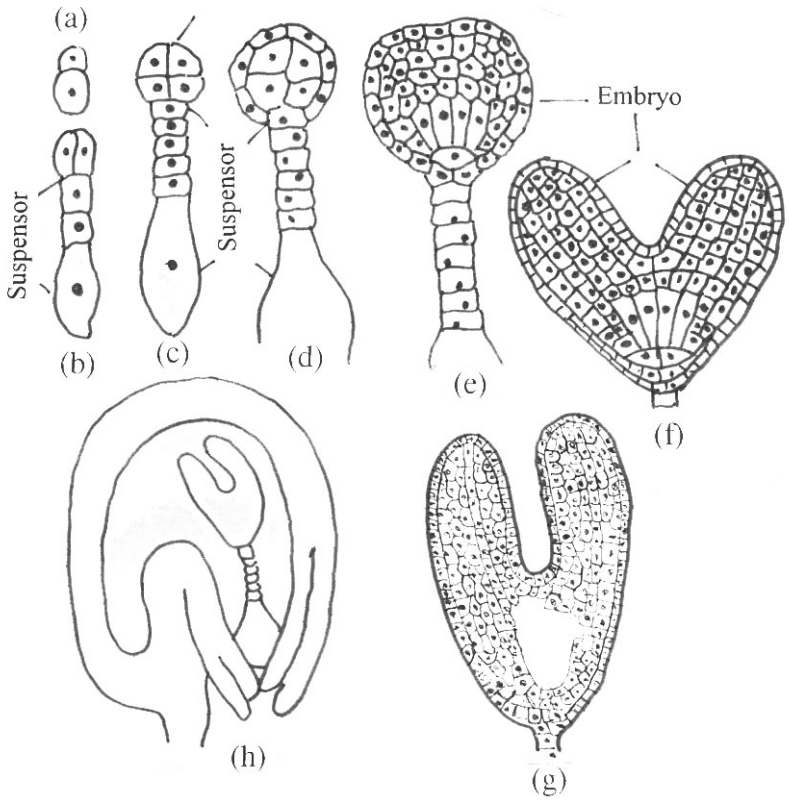



**Fig. 18.10** Development of embryo, A-H

(ii) The lower cell divides and forms the suspensor.

(iii) The suspensor pushes the developing embryo into the endosperm to get food.

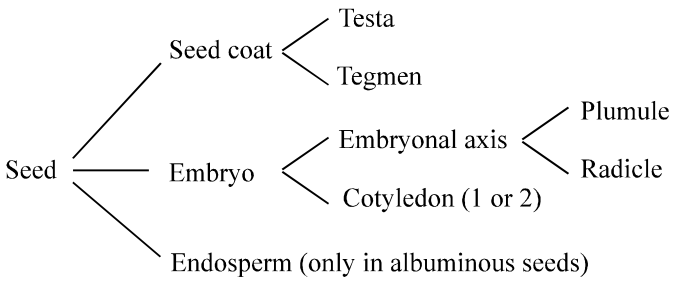
(iv) The embryonal cell divides several times and finally gets differentiated into radicle, plumule and cotyledon.

(v) The integuments become hardened and thus form the seed coat, seed coat protects the seed.

(vi) Thus a seed may be dicotyledonous with two cotyledons. (pea, gram) or monocotyledonous with one cotyledon (wheat, rice).

### 18.4.3 Seed

The seed is defined as a **ripened ovule.**




**Importance of Seed**

1. It contains embryo which develops into a new plant.
2. The seed coat protects the embryo against dehydration and mechanical damage.
3. Seeds can be stored and transported from one place to another thus help in dispersal.

**A. Structure of Gram (dicot) Seed :**

(i) The seed is enclosed in the pod. (Fig. 18.11a)

(ii) It is somewhat conical in shape. (Fig. 18.11b)

(iii) The seed is attached to a small stalk.

(iv) The point of attachment of seed to the stalk is called hilum.

(v) Testa is the brown seed coat, fused with the inner coat the tegmen

(vi) Below it is a small pore, the micropyle.

(vii) The embryo is enclosed by the two fleshy cotyledons. (Fig. 18.11c)

**B. Structure of Maize grain :** (Monocot)

(i) The maize grain is broader in shape. (Fig. 18.11d)

(ii) Testa and tegmen are fused together.

(iii) The embryo is towards the narrower side of endosperm.

(iv) The endosperm stores starch and protein. The outermost layer which contains only protein is called aleurone layer.

(v) The embryo consists of one large cotyledon, called scutellum.

(vi) The embryo is found inside scutellum. (Fig. 18.11e)

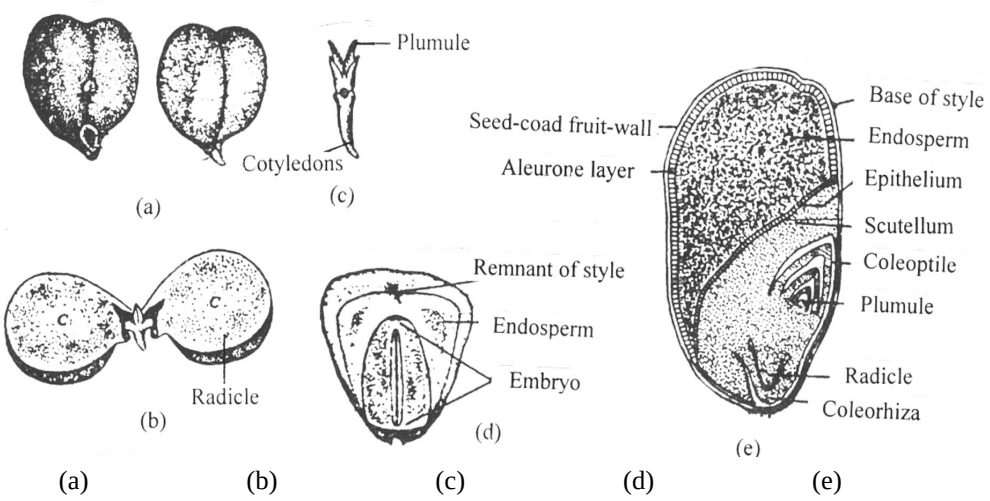



**Fig. 18.11** Structure of dicot and monocot seeds : (a) External view of gram seed; (b) Internal structure of gram seed (c) embryo (gram) (d) Maize grain entire; (e) L.S. of maize grain

### 18.4.4 Fruit

A fruit is defined as a ripened ovary. Different parts are edible in different fruits.

**Significance of Fruit :**

1. It protects seeds.
2. On decay, fruits which contain chemical substances enrich the soil.
3. It helps in dispersal of seeds.

The unripe fruit has a different taste but no smell. But the same fruit when it ripens has a good taste and smell e.g. mango, banana. The following changes take place during the ripening of fruit :

(i) Starch is converted into sugar.

(ii) The production of various organic substances (esters) gives a different texture, taste and flavour.

(iii) The breakdown of chlorophyll leads to changes in colour of the skin of the fruit.

**Parthenocarpy :** When fertilisation fails, seeds are not formed. But in certain plants the ovary develops into a fruit e.g. grapes, banana etc.

The phenomenon of development of fruit from unfertilised ovary is called **parthenocarpy** and such fruits are called parthenocarpic fruits.

**Commercial value of parthenocarpic fruits :**

(i) The fruits are seedless and are hence valued more, for eating purposes and contain seeds which can not develop into a new plant.

(ii) The fruits contain sufficient growth hormones.

## INTEXT QUESTIONS 18.7

1. Which part of the ovule forms the seed coat ?

.....

2. Define a seed.

.....

3. Give one example of a dicot seed and one of a monocot seed.

.....

4. Define a fruit.

.....

5. List the parts of mature seed.

.....

### 18.4.5 Seed

Seed is the final product of sexual reproduction and seed becomes relatively dry. The metabolic activity of the embryo slows down and in majority of cases the embryo enter into a phase of inactivity called dormancy or in some case if favourable conditions are available they germinate. Dormancy help the plants to survive under unfavourable conditions and ensures its germination only under favourable conditions.

**Germination -** Embryo lies dormant in the seeds, but when the seed receives the favourable signals and the inputs from the environment (moisture, suitable temperature and oxygen) they germinate. Germination is the process by which the embryo grow and establishes itself as a seedling.

**Step of germination**

- Imbibition of water (through the micropyle) and by the seed coat.
- Seed swells up as it gets hydrated.
- Enzyme activity converts the reserved seed food into soluble forms (glucose, amino acid, fatty acids)
- The seed coat bursts and radicle emerges (grows into root) and then the plumule grows and develops into shoots.



Germination can be of two types

**(a) Epigeal** where cotyledons come above the ground and form the first leaves of the new plant e.g. in castor, neem, bean, plumule emerges from the cotyledon

**(b) Hypogeal** where cotyledons remain underground and plumule emerges from the soil and develops into the shoot system. e.g. maize, rice etc.

## 18.5 VEGETATIVE REPRODUCTION IN ANGIOSPERMS

**Vegetative reproduction in Angiosperm :** Reproduciton of new plants from the portion of the vegetative parts of a plant is very common and is called **vegetative reproduction**. Stems, roots, leaves and even buds are variously modified to suit this requirement. This is called **natural** vegetative reproduciton.

The new plants formed by vegetative propagation are genetically similar to the parents.

**Natural Method :** In natural methods, a portion of the plant gets detached from the body of the mother plant and grows into an independent plant. The parts may be stem, root, leaf or even flower.

You have studied about the various modifications of root, stem and leaf in lesson 4 and 5. You have also learnt that these modified portions perform some special functions and also help to overcome unfavourable conditions.

1. The underground modification of stem, like rhizome, (in ginger), tuber (potato), bulb (onion) and corm (zamikand) are provided with buds which develop into a new plant and are therefore used to carry out vegetative propagation of the plant in the field. Plants with subaerial modification such as *Pistia* (offset) and *Chrysanthemum* (sucker) are also used for vegetative propagation.

2. Similarly, tuberous roots (*Asparagus* and sweet potato) can also be used for propagation as these roots have adventitious buds which ground into a new plant.

3. Sometimes even leaves contribute to propagation of plants leaves of *Bryophyllum* and *Kalancloe* have buds on the margin and these buds grow into small plantlets. When detached from the mother plant they grow into independent plants.

4. In plants like Agave and Oxalis multicellular bodies called bulbils develop near the flower. These are called bulbils which when fall on the ground grow into new plant.

**Table 18.2 Modes of Vegetative reproduction with examples**

| Mode of Reproduction | Specialised plant part | Examples |
|---|---|---|
| (A) **Natural Methods** | | |
| (a) Roots (Adventitious) | | *Asparagus*, *Sweet potato* |
| (b) Stem | (a) Runner | *Lawn grass*, |
| | (b) Sucker | *Mint*, *Onion*, |
| | (c) Bulb | Onion |
| | (d) Tuber | Potato, *Canna* |
| | (e) Rhizome | Ginger |
| (c) Leaves | Adventitious Buds | *Bryophyllum* |
| (d) Special Parts | Bulbil | *Oxalis*, *Pineapple Onion* |
| (B) **Artificial Methods** | | |
| (a) Cutting | | Rose, Money Plant |
| (b) Layering | | Jasmine, |
| (c) Grafting | | Grapewine |
| (d) Tissue Culture | | *Citrus*, Mango |
| | | Orchids, *Chrysan themum*, *Asparagus*. |

## INTEXT QUESTIONS 18.8

1. Define vegetative reproduction.

   .....

2. Give an example of each of the following :
   (a) rhizome .....
   (b) tuber .....
   (c) bulb .....
   (d) runner .....
   (e) sucker .....
3. Give an example of vegetative reproduction which is carried out by leaves.

   .....

4. Name two ways by which vegetative reproduction occurs in plants.

   .....

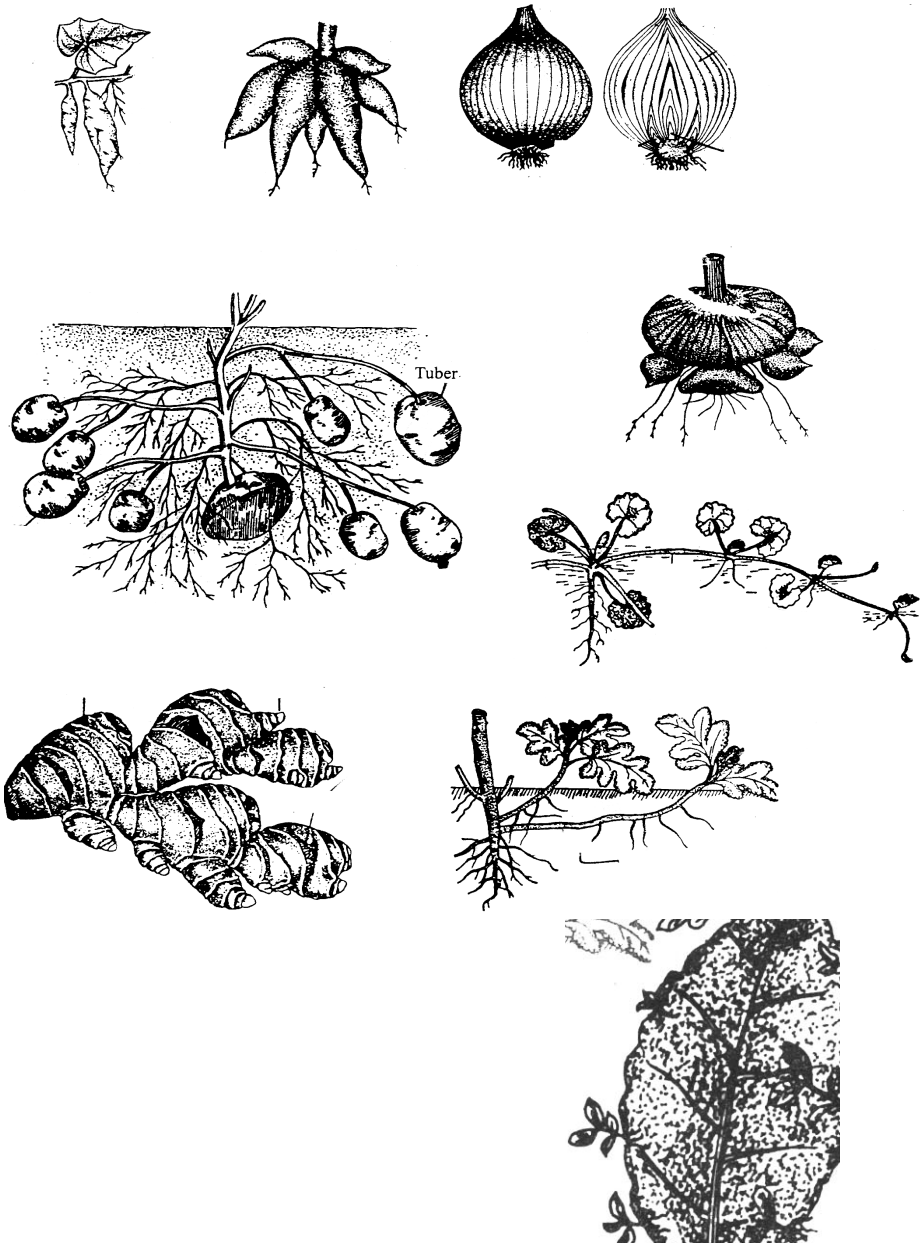



**Fig. 18.12a** Sweet potato
**Fig. 18.12b** Dahlia
**Fig. 18.12c** (a) Bulb of onion (b) L.S. of bulb
**Fig. 18.12d** Tuber of potato
**Fig. 18.12e** Rhizome of Ginger
**Fig. 18.12f** Corm of colocasia
**Fig. 18.12g** Runner of grass
**Fig. 18.12h** Sucker of Chrysanthemum

**Fig. 18.12** Vegetative propagation of adventitious buds in the margins of leaves in Bryophyllum

## 18.6 ARTIFICIAL METHODS

Humans have taken advantage of this natural phenomenon and have artificially propagated plants vegetatively by using the specialized parts as described earlier or by cutting, grafting and layering. When, we use the vegetative parts for propagating crops or ornamental plants it is termed as **artificial vegetative propagation**.

**(a) Cuttings :** Many plants like rose, *Bougainvillea*, *Croton*, Coleus, money plants, sugarcane etc. are grown through their stem cuttings. (Fig. 18.13). Cuttings of these plants can be grown even in water where they strike roots and develop adventitious buds.

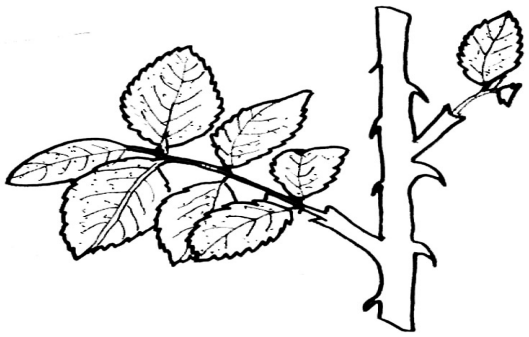


**Fig. 18.13** Vegetative reproduction be cutting

(b) **Layering :** In this method, a lower branch of a plant is bent down and covered with moist soil leaving the growing tip above the soil. A ring of bark is removed from the stem before it is bent down (Fig. 18.14). In a few weeks time when enough roots have developed on the underground portion above the ringed part, it. is cut off from the parent plant and grown separately as an independent plant. Example: Jasmine, straw berry, grapevine, *Bougainvillea* etc.

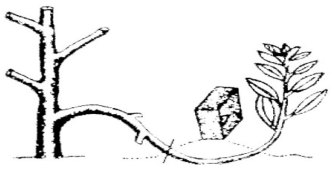


**Fig. 18.14** Vegetative reproduction by layering

(c) **Aerial layering or Goatee** is a similar practice where bending of branches isn't possible because of the height of plant or due to woody nature of stem. In this method a ring of bark is removed from a selected branch, and it is covered with moist moss and enclosed in a polythene sheet when roots appear, the stem is cut below the roots and planted to form a new plant Fig. 18.15).

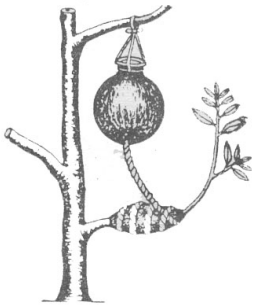


**Fig. 18.15** Vegetative reproduction by goatee

(d) **Grafting :** It is especially important for propagation of seedless varieties of plants. It consists of inserting a small branch into a rooted plant. The rooted plant taken as a stock is resistant to disease and is physically sturdy. In this stock a branch is inserted which is known as scion or graft. This scion or graft is the stem cutting from the desired plant. Usually the grafted end of stock and scion fit well with each other and are bound firmly with tape or rubber-band until their tissues unite and vascular continuity is established. Grafting is mostly. practised in dicot plants. Grafting has been found extremely useful in propagating improved varieties of various flowers and fruits like rose, Bougainvillea, Citrus, mango, apple etc. (Fig. 18.16)

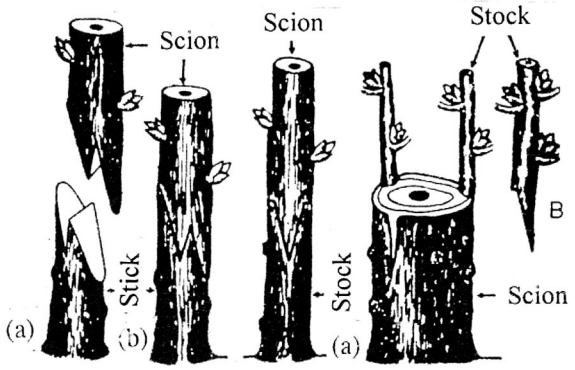



**Fig. 18.16** (a) The lower part of the stem of scion is cutin a wedge. (b) The shoot of the plant to be used as a stock is cut off. The stem is slit vertically the scion is inserted into the stock and is tied with a tape (c) the graft union occurs within a short time

## 18.7 ADVANTAGES AND DISADVANTAGES OF VEGETATIVE REPRODUCTION

### Advantages

(a) Rapid means of reproduction and spread.

(b) Offsprings identical to parent. The desired varieties can thus be preserved genetically for use.

(c) Food storage organs allow perennation or survival in adverse conditions.

(d) Improved varieties of ornamental plants and fruit trees can be multiplied easily.

(e) Vegetative propagation is a quicker, easier and a less expensive method of multiplying plants.

**Disadvantages**

(a) Overcrowding and competition for space unless separated artificially.

(b) New varieties cannot be produced by this method except by mutation.

(c) Diseases typical of the species are rapidly transmitted and can decimatr a crop.

## INTEXT QUESTIONS 18.9

1. What are the various methods which man uses for propagating plants artificially?

   .....

2. Name at least four specialised plant parts which help in vegetative propagation.

   .....

3. Write one advantage of vegetative reproduction.

   .....

## 18.8 THE MICROPROPAGATION

The technique of plant tissues culture is utilised for propagation of plants. The process as explained below with the help of diagrams.

A small piece of tissue, organ or even a single cell is taken from a plant and is transferred to a sterilized container with nutrient medium in aseptic conditions. The tissue grows very-very fast into an unorganised mass, called **callus**. The callus can be maintained and multiplied for an indefinite period. When small portions of the tissue are transferred to another specialised medium with hormones, it induces differentiation and plantlets (little plants) are formed.

The plantlets can be transplanted into pots and or soil by a gradual process and are grown to mature plants.

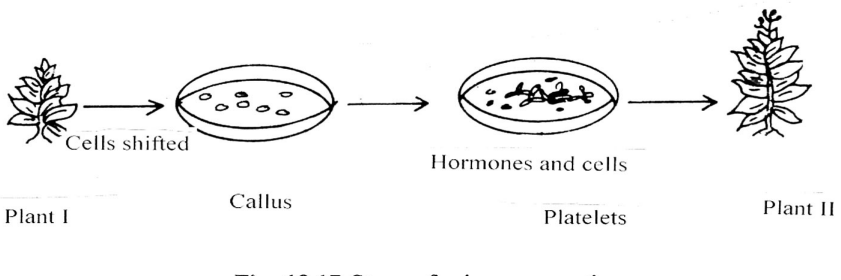



**Fig. 18.17** Steps of micropropagation.



### 18.8.1 Advantages of micropropagation

By this method an indefinite number of identical plants can be obtained vegetatively starting from a small amount of parent tissue.

In orchids, carnations, Chrysanthemum and Asparagus, micropropagation is being successfully tried in some parts of our country.

## INTEXT QUESTIONS 19.10

1. Give two examples each of plants which are propagated by the following methods:
   (a) Cutting
      (i) .....
      (ii) .....
   (b) Layering
      (i) .....
      (ii) .....
   (c) Grafting
      (i) .....
      (ii) .....
2. Name the artificial means of vegetative propagation commonly used in the laboratory.

   .....
3. Give two examples of plants which are propagated by micropropagation technique.

   .....

## WHAT YOU HAVE LEARNT

- *Chlamydomonas* reproduce asexually by zoospores and sexually by isogamy.
- *Spirogyra* reproduce by fragmentation and scalariform conjugation.
- In angiosperms flowers are the organs of reproduction.
- Temperature and light are two main factors which influence flowering.
- Stamens and carpels are the male and female organs of reproduction respectively.
- Male gametes are produced in pollen grains, formed inside the anther.
- Female gamete is produced in the embryo sac in the nucellus of the ovule.
- The embryo sac contains egg apparatus, antipodals and secondary nucleus.

- Egg cell fuses with one of the male gametes received from pollen grains. Secondary nucleus fuses with the other male gamete. Occurrence of two such fusions is called **double fertilisation**.
- Pollination is the transference of the pollen grains from anther to stigma. It may be in the same plant (self pollination) or in different plants (cross-pollination).

  Wind, water, insects and animal are agencies of cross pollination.
- Wind pollinated flowers have light pollen grains or bringed pollen and the stigma is usually large feather and protruding feathers.
- Insect pollinated flowers are usually large, brightly coloured, scented and with nectar.
- Most plants have devices to favour cross pollination.
- The zygote develops to produce an embryo.
- The embryo is present in the ovule which later becomes seed and ovary on maturity becomes fruit.
- Development of fruit without fertilisation is called parthenocarpy.
- Ripening of fruit involves chemical changes in the stored food and pigments of the fruit wall.
- Vegetative reproduction is the production of new plants from parts other than flower and seeds.
- Specialised plant parts which bring about vegetative reproduction are as follows

  (a) Roots - tuberous root of *Dahlia*

  (b) Stems - runners and suckers near ground surface, rhizomes, tubers, corm and bulb are underground parts.

  (c) Leaves - adventitious buds in leaf notches as in *Bryophyllum*.

  (d) Bulbils - Modified buds in the inflorescence of pineapple called bulbils are also used for vegetative propagation.
- All the above kinds of parts have been used by man in agriculture and horticulture as artificial methods of vegetative propagation.
- Micropropagation by tissue culture enables production of little plants on a large scale.
- Vegetative reproduction is rapid, easy and cheap. The plants produced are exactly like the parent plant.

## TERMINAL EXERCISE

1. Explain the term isogamy taking *Chlamydomonas* as an example.
2. Describe scalariform conjugation in *Spirogyra*.
3. Differentiate between annuals, biennials and perennial plants.



4. Give significance of pollination.
5. Draw a labelled sketch of a mature ovule.
6. Give a labelled diagram of a mature pollen grain.
7. Mention important characteristics in Anemophilous and Hydrophilous plants.
8. Give the significance of fertilisation.
9. Mention the changes that take place when the fruit ripens.
10. Define the following terms :
    (a) Corm (b) Scion
    (c) Callus (d) Micropropagation
    (e) Vegetative reproduction
11. In what ways do plants reproduce vegetatively without human assistance ?
12. In what ways do plants reproduce vegetatively with human assistance?
13. Define and give an example of each of the following:
    (a) Rhizome (b) Stolon (c) Cutting
    (d) Layering (e) Grafting
14. What are the advantages and disadvantages of vegetative reproduction ?
15. In what way is vegetative reproduction simple ?
16. Write short notes on
    (a) Runner (b) Sucker (c) Bulb (d) Tuber
17. In brief describe the various steps of micropropagation.
18. What is the significance of micropropagation ?
19. If a branch of dasehri mango is grafted on a tree producing desi mango. What type of mangoes will be produced on the grafted branch and on other branches of the tree?

## ANSWER TO INTEXT QUESTIONS

**18.1**

1. The process by which living organisms produced their offsprings for the continuity of the species.
2. Offsprings reproduce from a vegetative unit produces by a parent without fusion of gamete. In case of sexual reproduction fusion of male and female reproductive cells from male and female reproductive organs.
3. Male and female reproductive cells are known as gametes.
4. Fission, budding, fragmentation and spore formation.

**18.2**

1. Male and female gametes are identical in structure.
2. Zygote
3. Asexual reproduction

**18.3**

1. Fragmentation
2. Scalariform Conjugation.
3. Diploid nucleus in zygote on return of favourable conditions.

**18.4**

1. Annual - Plants which produce flowers and seeds within one season.

   Biennial - Plants which complete there life cycle in two seasons. In First year they are in vegetative state and in second year reproductive state.

   Perennial - Plants which live for several years. For first few years they are in vegetative state and later in reproductive state.
2. Temperature, light - day length
3. *Cannabis* or *Cucumis*
4. Stamens and carpels

**18.5**

(i) Tapetum

(ii) Pollen sac

(iii) Exine and intine

(iv) Nucellus and integuments

**18.6**

1. Transfer of pollen grains from anther to stigma of a flower.
2. (i) Cleistogamy

   (ii) Dichogamy
3. (i) Flowers are large, coloured and showy.

   (ii) Some flowers secrete nectar.

**18.7**

1. Integuments.
2. Ripened ovule.
3. Pea or Gram, Maize grain.
4. Ripened ovary.

   Seed coat
5. Embryo

   Endosperm

   Cotyledons



**18.8**

1. The process of multiplication in which a portion of the plant body becomes detached and develops into new plants.
2. (a) Ginger (b) Potato (c) Onion (d) Lawn grass (e) mint
3. Bryophyllum
4. Rhizomes and Bulbs

**18.9**

1. (a) Cutting (b) Grafting (c) Layering
2. (a) Runner (b) Tuber (c) Bulb (d) Sucker
3. Desirable varieties of ornamental plants and fruit trees can be multiplied easily.

**18.10**

1. (a) (i) Croton (ii) Money plant
   (b) (i) Jasmine (ii) Grapevine
   (c) (i) Rose (ii) Mango
2. Micropropagation
3. Orchids, Chrysntheum, Asparagus etc.