4 The Flower

In the Chapter

Syllabus : *Flower : Structure of a bisexual flower, functions of various parts.*

A brief introduction to complete and incomplete flowers. Essential and non-essential whorls of a bisexual flower; their various parts and functions. Inflorescence and placentation (meaning only). (Charts or actual specimens may be used to help enhance clarity of concepts).

You have already learnt that reproduction is the most important function of any living organism for the survival of the species. In flowering plants this function is performed by the flower. The flower is usually the most beautiful and conspicuous part of a plant.

4.1 STRUCTURE OF A BISEXUAL FLOWER (FIG. 4.1)

Flower is a specialized shoot in which the leaves are modified into floral structures.

First of all, there is the **stalk** (pedicel) which supports the flower. Some flowers may be without stalk (sessile). The tip of the flower stalk may be expanded to form a cup-shaped **receptacle** or **thalamus**.

The floral parts are borne on the thalamus in four whorls.

1. First whorl — green **sepals** (collectively called **calyx**).
2. Second whorl — large brightly coloured **petals** (collectively called **corolla**).
3. Third whorl (male parts) (♂ = symbol for male) — long thread-like structures somewhat projecting out and each usually ending in a bilobed tip. These are **stamens** (collectively named **androecium**). Each stamen consists of threadlike **filament** and bilobed **anther.**

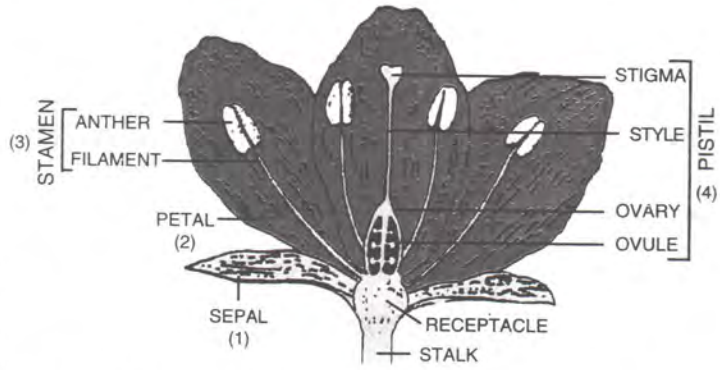


Fig. 4.1 Generalized arrangment of parts of a bisexual flower

4. Fourth whorl (female parts) (♀ = symbol for female) (centrally located **pistil** that may be formed of a single female unit (carpel) or of several fused carpels (collectively called **gynoecium**). Each carpel consists of a basal **ovary**, a middle **style** and an uppermost **stigma**.

4.1.1 Complete and incomplete flowers

A ***complete*** (or ***perfect***) flower is one which contains all the four floral structures. If one or more sets of floral structures are missing, the flower is called ***incomplete*** (or ***imperfect***).

Essential (reproductive) and non-essential (non-reproductive) **parts of a flower.** The *essential parts* of a flower are those that are directly concerned with reproduction. These parts consist of the stamens (male parts) and the carpels (female parts).

The *non-essential* (accessory) **parts** are simply the helping parts which either **protect** the

reproductive parts of the flower or make the flower **attractive** for pollination. These parts include the sepals and petals. In some cases the petals and sepals are undifferentiated together called **perianth**. When the perianth is non-green it is described as **petaloid**.

When the perianth is green like the sepals, it is described as **sepaloid** perianth.

Bracts—When a flower arises in the axil of a leaf-like structure, this structure is known as **bract**. Bracts may be green like ordinary leaves or at times they are coloured. The large and colourful bract of Bougainvillea (Fig 4.2) is easily mistaken for petal. The actual flower in this case is small, somewhat cylindrical and attached on the inner side of the bract.

Fig. 4.2 Bougainvillea. Large, coloured bracts bear the flowers

Nectaries : Most flowers produce a sweet fragrant liquid called nectar. Groups of nectar-secreting cells, **nectaries** are situated usually at the base of the pistil or on the bases of the petals. The nectar attracts insects like honeybees, for cross pollination. In some cases nectaries are very prominent as in Nasturtium (Fig 4.3)

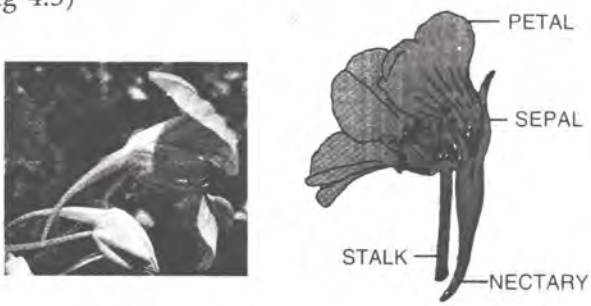


Fig. 4.3 Nasturtium. A flower cut medially to show the nectary containing a clear liquid (the nectar) at the bottom

4.1.2 Sexuality In Flowers

Male, female and bisexual flowers. The **anthers** of the stamens produce **pollen** which forms the male cells (male gametes). The **ovary** of the carpel bears the **ovule** which encloses the egg cell (female gamete). The stamens and the carpels are the male and female parts respectively of the flower.

- A flower which contains both stamens and carpels is called a **bisexual** or **hermaphrodite flower.**
- A flower which has only one of these parts, that is, having only the stamens or only the carpels is called **unisexual** or incomplete **(imperfect)** flower, *e.g.* papaya and palm.
- A unisexual flower which contains only the stamens is called the **male** or **staminate flower.**
- A flower which contains only the carpels is called the **female** or the **pistillate flower.**

Neuter flower — A flower in which both male and female reproductive organs are lacking. *Example:* Ray florets of sunflower (pistillate but sterile).

4.2 GENERAL DESCRIPTION OF THE FLORAL PARTS

(a) Calyx (sepals). Usually there are five sepals. Sometimes they may be less or in a few cases even more. The sepals may be free **polysepalous** or fused **gamosepalous** (Fig 4.4). Sometimes, as in *Hibiscus* (shoe-flower) there may be a second series of sepals called episepals, collectively called **epicalyx.** When the flower opens the sepals may fall off or persist. Sepals are usually green but in some cases they are brightly coloured (called petaloid) as in Gul Mohur (flame of the forest) where they are red.

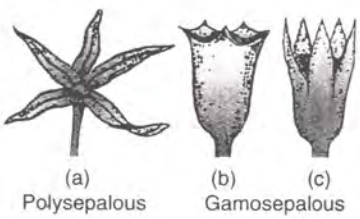


Fig. 4.4 Calyx – free (a) and fused (b and c) types of sepals

The sepals **protect the young flower bud** and **when green they also perform photosynthesis.**

(b) Corolla (petals). The petals are generally arranged in a single whorl but sometimes there may be a double whorl (e.g. Poppy) or in a spiral (*e.g.* Water lily). They may be free **polypetalous** or united **gamopetalous** forming a tube (Fig. 4.5).

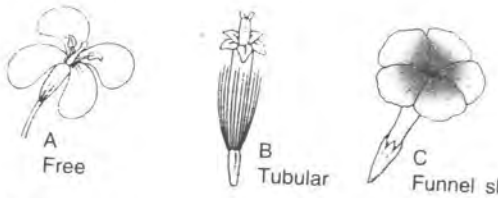


Fig. 4.5 Kinds of corolla : A—Petals free, B—Petals fused in a tubular form (c—Petals fused) corolla and calyx

The petals **attract insects** for pollination. They also **protect stamens and pistils** especially when the petals form a tube.

(stamens). The number of stamens in different flowers may vary from a few to a large number. Each stamen consists of: a long **filament** and an **anther** attached to its extremity. The anther is usually two lobed. Each lobe has two **pollen sacs** [four sacs in all (Fig. 4.6A)]. Within the pollen sacs are contained **pollen grains.** When fully matured, the pollen sacs rupture to liberate pollen grains. The pollen grains are generally powdery particles of different shapes and sizes (Fig. 4.6B).

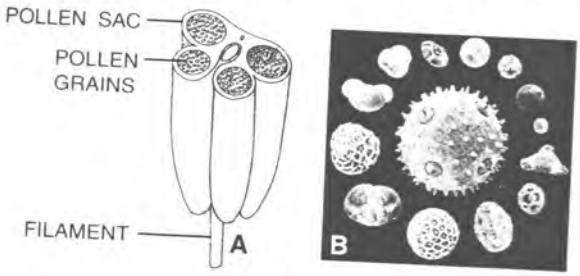


Fig. 4.6 A—Pollen sac and bilobed pollen grains, B—Pollen grains with different kinds showing different shapes and sizes

In androecium, stamens may be free (polyandrous) as in Petunia, or joined in different ways in **single, double** or **several** groups (Fig. 4.7):

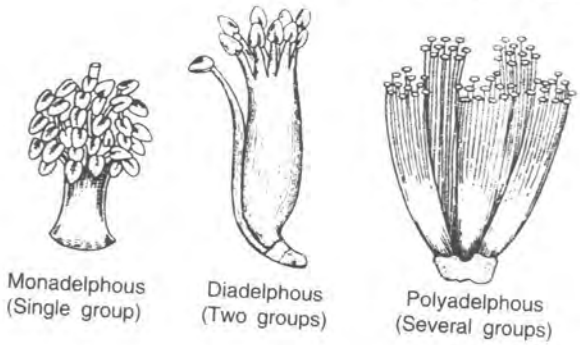


Fig. 4.7 Cohesion (union) of stamens

(i) **Monadelphous** : Stamens are united in one group by their filaments. Only anthers are free. *e.g.*, china rose (staminal tube),cotton.

(ii) **Diadelphous** : The filaments are united in two bundles. *e.g.* pea (out of ten, nine stamens form a staminal tube while one is free).

(iii) **Polyadelphous** : The filaments are united in several groups. *e.g. Bombax.*

How to remember the above three terms ?

- *Mono* -, *Di* - and *Poly* - respectively mean single, two and several.
- *Adelphous* literally means "group of brothers", here referring to the part from which the anthers grow out in bundles. Thus the bundle of anthers arising from a single part (monadelphous or monodelphous), the bundles from two parts (diadelphous) and from several parts (polyadelphous).

(carpels). Gynoecium is also known as . It is composed of one or more carpels. Each carpel consists of three parts—stigma, style and ovary.

Stigma is the terminal knob-like part, it may be divided into two or more lobes and may assume a feathery appearance. The stigma is covered with hair or with glandular papillae. It serves as the landing place for pollen during pollination.

Style is the tubular slender stalk which connects the stigma to the ovary.

Ovary is the swollen basal portion composed of one or many carpels. The inner cavity of the ovary may be a single chamber or divided into several chambers (locules) each containing a number of rounded bodies, the **ovules.** The cushion or swollen region in the ovary attaching the ovules to the wall of the ovary is called **placenta.**

Sexuality in plants

In most plants the flowers are bisexual. They have both male and female parts.

In many plants the male and female flowers are separate. Such plants are of two types :

(i) **Monoecious plants** (***mono:*** one, ***oecium*** : house) : Male and female flowers grow on the same plant *e.g.* maize, cucumber, pumpkin, etc.

(ii) **Dioecious plants** (***di*** : two): Male flower (staminate) and female flower (pistillate) grow on different plants *e.g.* palm, papaya, etc.

Progress Check

1. Mention if the following statements are true (T) or **false** (F)
   (i) Flowers can be complete or incomplete. T/F
   (ii) A flower typically has six floral whorls. T/F
   (iii) Bracts are usually green, but sometimes large and colourful. T/F
   (iv) Nasturtium has nectaries. T/F
   (v) Stamens and carpels are the male and female parts T/F
   (vi) The prefix "gamo-" is used whenever any of the floral whorls are fused T/F
   (vii) Stigma may be simple or divided into two or more lobes. T/F
   (viii) Papaya is monoecious plant. T/F

4.3 INFLORESCENCE AND PLACENTATION

Inflorescence is the mode of arrangement of flowers on the axis of the plant

The flowers may be arranged in several different ways in different plants, this manner of arrangement is termed inflorescence.

- Singly either at the apex of the main stem or at the terminal apex of the lateral branches.

- In the axils of the leaves.

Placenta : Tissue that attaches the ovule to the wall of the ovary.

- Growing out from the axils of different leaves reaching the same level making a cluster.
- The axis is laterally flattened making a disc as in sunflower. The youngest flowers are in the centre and oldest in the periphery.

Placentation is the manner in which the ovules are arranged/attached to the wall of the ovary.

Ovules turn into *seeds* in the mature fruit (transformed *ovary*). Their different arrangements can be seen in fruits such as those of pea, tomato, mango, lotus, etc.

POINTS TO REMEMBER

- Flower is a reproductive organ.
- Essential parts of a flower include the stamens (male parts) and the carpels (female parts).
- Sepals protect the bud, petals attract insects, stamens produce pollen grains, carpel receives pollen and its ovary becomes the fruit containing seeds (ovules).
- Essential parts of a flower are the reproductive parts (stamens and carpels) and non-essential ones the non-reproductive parts (petals and sepals).
- Nectaries are common in most brightly coloured (insect-pollinated) flowers.
- Sepals may be brightly coloured, these are then said to be petaloid.
- The pollen grains are fine powdery particles of different shapes.
- The manner of arrangement of flowers on the plant is termed inflorescence.

Review Questions

A. MULTIPLE CHOICE TYPE

1. Bougainvillea flower is an **example** of
   (a) incomplete flower
   (b) having a large nectary
   (c) water pollination
   (d) large colourful bracts
2. A flower is said to be complete when :
   (a) It has the corolla and calyx
   (b) It has the corolla and gynoecium
   (c) It has the androecium and gynoecium
   (d) It has all the four whorls.
3. The part of the flower that gives rise to the fruit is
   (a) Sepals (b) Petals (c) Ovary (d) Stamens
4. The part of the flower that gives rise to the seed is
   (a) Ovary (b) Placenta (c) Ovule (d) Pollen grain
5. The essential whorls of a flower are the
   (a) Calyx and corolla (b) Stamen and ovary
   (c) Calyx and epicalyx
   (d) Androecium and gynoecium

B. VERY SHORT ANSWER TYPE

1. **Match** the parts in Column A with the flowers or parts of flower in Column B.

Column A	Column B
(a) Polyadelphous	(i) Polypetalous
(b) Pollen grains	(ii) Calyx, corolla
(c) Free petals	(iii) Nectar
(d) Non-essential	(iv) Bombax
(e) Sweet fragrant fluid	(v) Pollen sac

C. SHORT ANSWER TYPE

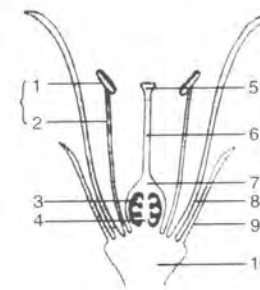
1. **Explain** the following terms :
   (a) Incomplete flower (b) Staminate flower
   (c) Pistillate flower (d) Bisexual flower
2. **Distinguish** between the following pairs :
   (a) Flower and inflorescence,
   (b) Petals and petaloid sepals.
   (c) Polyandraus and Polyadephous androecium
3. **Where** are the following structures/parts located and what are their functions ?
   (a) Placenta (b) Thalamus
   (c) Anther (d) Stigma
4. **Why** are the following described as stated :
   (a) The androecium of pea flower is **diadelphous**
   (b) Ray florets of sunflower as **neuters**
   (c) Salvia sepals as **petaloid**

D. LONG ANSWER TYPE

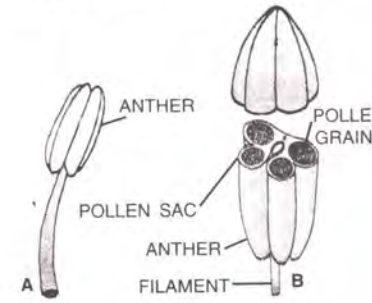
1. Name the different types of androecium found in flowers .
2. Name the type of androecium found in
   (a) China rose (b) Bombax (c) Pea

E. STRUCTURED/APPLICATION/SKILL TYPE

1. The figure given alongside represents generalised arrangement of the different parts of a bisexual flower. **Name** the parts numbered 1-10.



2. Given alongside are two figures (A & B) of a certain part of a flower. Study the figures carefully and answer the following questions:
   (a) **Which major organ** of a flower does the figure A represent ? **What** is the collective term for this organ ?
   (b) Are the contents of the pollen sacs in B **male or female** ?
   (c) Can you state **how** the contents of the pollen sacs would come out ?



3. What are bracts ? State their function.
4. Explain the terms Monadelphous, Diadelphous and Polyadelphous. In each case name a flower possessing such an androecium.

5 Pollination and Fertilization

In the Chapter

Syllabus : *Pollination : self and cross-pollination. Fertilization.*

Explanation, advantages and disadvantages of self and cross-pollination, agents of pollination and the characteristic features of flowers pollinated by various agents such as insects, wind and water.

A brief idea as to how nature favours cross pollination.

Events taking place between pollination and fertilization leading to the formation of zygote in the embryo sac. A brief explanation of the terms double fertilization and triple fusion.

5.1 POLLINATION

What is pollination ? You have read that the stamens of a flower are the male organs. The anthers of the stamens produce powdery material called **pollen** which consists of particles called **pollen grains.** Each pollen grain contains nuclei that participate in reproduction. For initiating this process of formation of fruit and seeds the first step is that the pollen grains must reach the stigma. It may happen in three principal ways (Fig. 5.1).

1. The pollen of the ***same flower*** may fall on its stigma by itself **(autogamy)** (*auto* : self, *gamy:* marriage).
2. The pollen of ***another flower of the same plant*** may fall on the stigma **(geitonogamy)** (*geitono:* neighbouring).
3. The pollen of a flower of ***another plant of the same species*** may fall on the stigma **(allogamy)** (*allo* : other). This transfer can occur through wind, insects, or other agents and the term used for this transfer is cross pollination.

Pollination is the process of transfer of pollen grains from the anther to the stigma.

Pollination must occur between plants of the same species. Many different kinds of flowering plants may be growing in the same vicinity. *For example*, an orchard may have trees of mango,

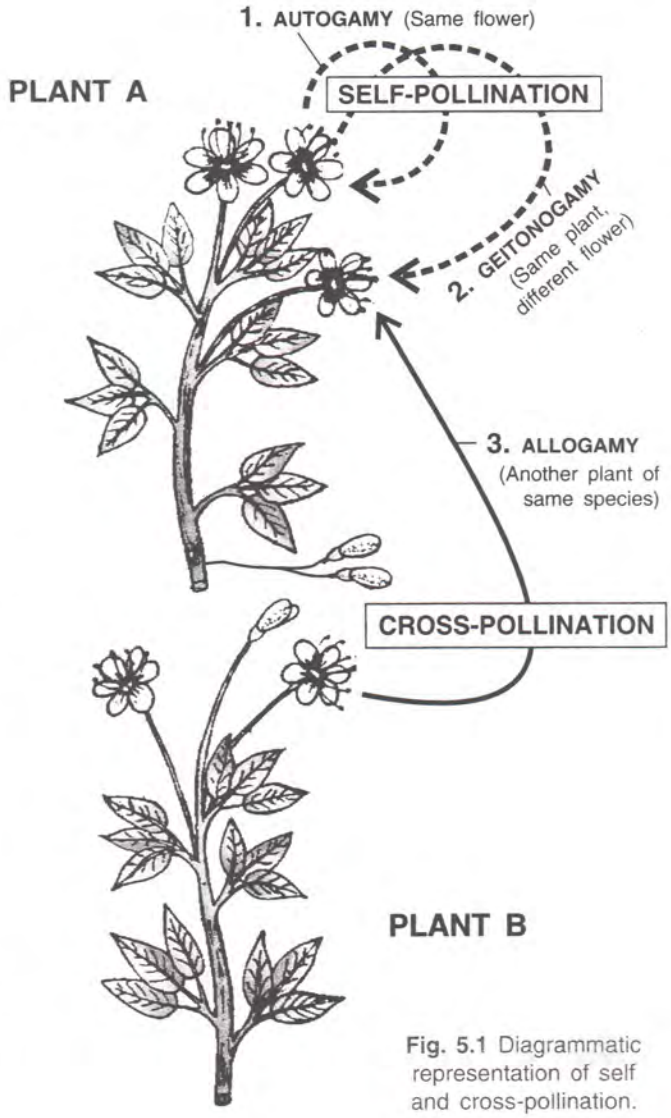


Fig. 5.1 Diagrammatic representation of self and cross-pollination.

guava, litchi, etc., and even some wild trees like neem, jamun or sheesham may also be growing in the neighbourhood. Similarly, various crops may be growing in neighbouring agricultural fields—wheat, mustard, pulses, vegetables and so on. The **wind may blow away** the pollen from all such plants together and thus the flowers of a particular plant may receive all kinds of pollen—of its own kind as well as of others. Similarly, **insects like bees and butterflies** generally do not discriminate between plants and collect nectar from all kinds of flowers. In the process, the insects are carrying different types of pollen on their bodies. Therefore, the stigma of a flower of any one particular plant receives pollen of its own species as well as of others. But **Nature has so designed that only the pollen of the same species of plant will survive and grow further to continue the processes for reproduction and the rest of the types of pollen will fail to germinate and perish.**

Kinds of pollination. There are two kinds of pollination : self-pollination and cross-pollination.

5.1.1 Self-pollination

Self-pollination is the transfer of pollen from the anther to the stigma of the **same flower** *(autogamy)*, or to the stigma of **another flower** of the **same plant** *(geitonogamy)*. Pollination between flowers of the same plant is considered self-pollination on account of the common genetic characters—*i.e.* the general qualities or features of any one plant are the same in the different flowers borne on it.

In some rare cases, as in **pansy**, some flowers growing close to the ground level, do not open at all (**cleistogamy,** *cleisto* : closed), the anthers and stigma lie close to each other which mature at the same time and self-pollination is assured.

When can self-pollination occur ?

1. Bisexuality : Self-pollination can occur in bisexual flowers, *i.e.* in flowers having both male and female organs, or it can also occur in such unisexual flowers where both male and female flowers are borne on the same plant.

2. Homogamy : To ensure self-pollination, it is necessary that the *anther and stigma of a flower must mature at the same time.*

Advantages and disadvantages of self-pollination.

A. Advantages of self-pollination

1. It is much **surer** in such bisexual flowers where stamens and carpels mature at the same time.
2. **Parental characters are preserved** indefinitely.
3. There is **no wastage** of pollen grains. Even a small quantity of pollen will suffice.
4. The flowers need not be large and showy.
5. Scent and nectar need not be produced by flowers.

All the above advantages mean **great economy** on the part of the plant. A lot of nutrient material which would otherwise be used in the production of pollen, nectar, scent and large petals, etc., is saved.

B. Disadvantages of self-pollination

1. Continued self-pollination, generation after generation, may lead to **weakening of the variety** or the species. The seeds produced through it are poor in quality and give rise to less vigorous offspring.
2. The weaker or defective characters of the variety or breed cannot be eliminated.
3. It **does not yield new varieties.** The genetic traits of the same plant with no change and without any intermixing are passed on to the next generation. Thus there is little chance for improvement in the next generation.

5.1.2 Cross-pollination

Cross-pollination is the transfer of pollen from the **anthers of flowers of one plant to the stigma of a flower of another plant of the same species.** This too has advantages and disadvantages.

A. Advantages of cross-pollination

1. The offsprings are **healthier**.
2. The seeds produced are **abundant** and viable.

3. **New varieties** may be produced by cross-pollinating two different varieties of the same species or even two species.

B. Disadvantages of cross-pollination

1. The pollination is **not always certain** because some pollinating agent is always needed which may or may not be available at the proper time.
2. The pollen has to be produced in large quantity to ensure chances of pollination which means a lot of **wastage of pollen.**
3. The process is **uneconomical for the plant** because the flowers have to be large, coloured, scented and have to produce nectar—for attracting pollinating agents.

The differences between self-pollination and cross-pollination are summarised in Table 5.1.

Nature favours cross-pollination. The vast majority of flowering plants are cross-pollinated. Some of the various devices (contrivances) or the conditions which favour cross-pollination are as follows :

1. **Unisexuality.** The flowers may be either male or female and they may be borne on separate plants. In this way cross-pollination is the only possibility; *e.g.* palms and papaya. (Papaya usually has separate male and female trees, but less frequently there may also be a hermaphrodite tree bearing both kinds of flowers). In cucumber, gourd, etc., the male and female flowers may be borne on the same plant.
2. **Dichogamy** (Different timings of maturation of androecium and gynoecium). In many bisexual flowers, the anthers and stigma of the same flower mature at different times.
   - — In some plants, anthers of the flower mature earlier than the stigma **(protandry)**, *e.g.* bhindi, sweet pea, salvia, sunflower.
   - — In some plants, the stigma of the flower matures earlier than the anthers (**protogyny,** *protos* : first, *gyne* : female), *e.g.* custard apple, peepal.

   In either case, cross-pollination is the only possibility.
3. **Self-sterility.** This is a condition in which even if the stigma receives pollen from the anthers of the same flower, the pollen fails to undergo further growth. In such cases, only the pollen from another plant of the same species, can effectively complete the process of setting of the seeds *e.g.*- ray florets of sunflower, orchids, etc.
4. **Herkogamy** (Mechanical or Structural barriers) (*herkos* : barrier). In some flowers, the pollen of a flower cannot reach the stigma of the same flower. *For example*, a hood covering the stigma acts as a mechanical barrier in Pansy flowers, Iris, etc.
5. **Heterostyly** — In such flowers the stigma and anthers grow at different heights which does not favour self-pollination. *e.g.* prim rose, oxalis (Fig. 5.2).

Table 5.1 : Differences between self–pollination and cross–pollination.

Self-pollination	*Cross-pollination*
1. It is the transfer of pollen grains from the anthers to the stigma of the same flower (autogamy).	1. It is the transfer of pollen grains from the anthers of one flower to the stigma of another flower of a different plant of the same species. (allogamy).
2. No external agency or agent is required	2. An external agent (wind, water, insect) is always required.
3. Male and female parts mature at the same time.	3. Anthers and stigma mature at different times.
4. It can occur even when flower is closed.	4. It can occur when flower is open.
5. It preserves parental characters	5. It does not preserve parental characters.
6. New variations are impossible, hence young ones cannot adapt to changed environmental conditions.	6. Offsprings are healthier to adapt to environmental changes.
7. New varieties are not possible	7. New varieties can be produced.

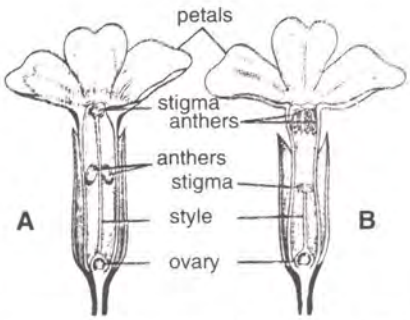


Fig. 5.2. Heterostyly : A–long styled flower B–short styled flower

5.1.3 Agents of cross-pollination

The two commonest agents of cross-pollination are insects and wind. But, some flowers are also pollinated by certain animals and birds, like squirrels, bats, *etc.*, or even by water in the case of some aquatic plants. Each category has some special features to promote chances of pollination.

Insect-pollinated (or **entomophilous;** *entomon*: insect, *phile* : affinity) flowers usually have the following characteristics :

1. The flowers are *large.*
2. They are usually *brightly coloured* to attract insects.
3. They usually emit *scent* for attracting insects.
4. They produce *nectar* which is food for the insects.
5. The pollen grains are *sticky* or spiny to enable them to be carried by the insects easily.
6. The stigma is *sticky* and does not generally hang out from the flower.
7. The flowers tend to be in *clusters* to make them conspicuous, especially in cases where individual flowers are small, e.g. Dahlia.

Wind-pollinated (or **anemophilous,** *anemo :* wind; *phile* : affinity) flowers usually possess the following special features. (*Example : Maize*)

1. The flowers are *small.*
2. They are usually *not brightly coloured* and often dull green.
3. They *do not produce scent* or nectar.
4. The stamens are *long and hang out* of the flower to be exposed to wind.
5. The anthers are *large and loosely attached* to the filaments so that the slightest wind may move them (versatile).
6. Pollen is produced in *very large quantities.*
7. Pollen grains are *light, dry and smooth* so that they can easily be carried away by wind.
8. The stigmas are *feathery and hang out* of the flower to trap the pollen grains.

Water-pollinated (or **hydrophilous,** *hydro* : water, *phile* : affinity) flowers are found only in aquatic plants. They have the following characteristics :

1. Pollen grains are produced in *large numbers.*
2. In some plants the pollen grains have a specific gravity almost equal to that of water so that they *remain floating* below the surface of water.
3. In some special cases male flowers are such that they float on the surface of water till they meet female flowers (Fig. 5.3) *e.g. Vallisneria.*

Some flowers are pollinated by birds (**ornithophily,** *ornitho :* bird), e.g. *Bignonia, canna.* Elephophily is the pollination affected by elephants.

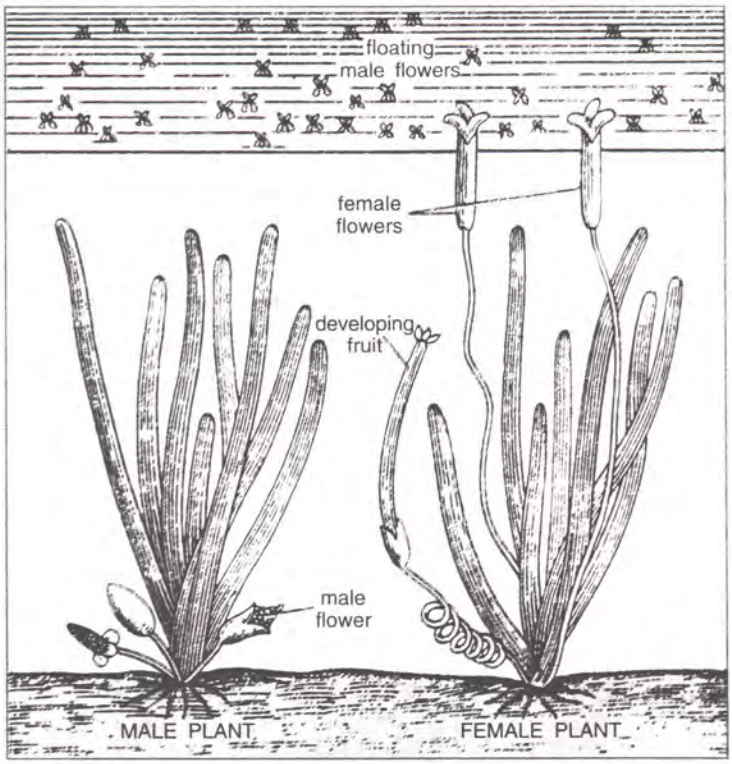


Fig. 5.3. *Vallisneria* showing male and female plants; note the free floating male flowers.

Table 5.2 : Differences between wind-pollinated and insect-pollinated flowers

Wind-pollinated flowers	*Insect-pollinated flowers*
1. Flowers are unisexual, dull coloured, without fragrance and nectar. 2. Pollen grains are produced in large numbers, some go waste. 3. Pollen grains are small, light and smooth. 4. Stigma long and hangs out of the petals, feathery or sticky 5. Stamens long and protrude above petals. *e.g.* Maize, grass, rice, wheat.	1. Flowers are brightly coloured, fragrant and secrete nectar. 2. Less pollen grains are produced because they are transported mechanically by insects. 3. Pollen grains are larger, sticky and spiny. 4. Stigma often deep in corolla and small. 5. Stamens may be within corolla tube. *e.g* China rose, Salvia, pea, sunflower

Elephophily is found in *Rafflesia* whose flowers are very large and are found at ground level. The pollen grains of one flower get attached to the feet of elephants and may be carried to the stigma of another flower when trampled by their feet.

Artificial pollination. When man himself transfers pollen to the stigma, it is called artificial pollination. In the ancient civilization of Babylonia, it was a common practice to sprinkle "male flowers" of palms on the "female" flowers; of course, at that time they neither knew the sexuality of palm flowers nor anything about pollination.

In modern times, artificial pollination (also called artificial crossing) is a standard practice adopted by plant breeders and scientists in their efforts to evolve new varieties. They remove the anthers in young flowers (emasculation) and cover these flowers with plastic bags. Later, they pollinate such flowers with the pollen from the plants of the desired variety.

5.2 SOME EXAMPLES OF POLLINATION

(1) In **insect-pollinated sweet pea** (Fig. 5.4) the insects such as the bee, alight on the conspicuous corolla. The bee thrusts its long tongue in search of nectar. In this struggle, the 'wing petals' of the flower are depressed. The 'wing petals' along with the 'keel petal' are forced down and the stamens and stigma touch the underside of the body of the insect. If this insect has already visited another flower, it may have some pollen sticking on its body. The pollen is now transferred to the stigma of this new flower thus affecting pollination. When the insect flies away, it may, in turn, carry some pollen of this flower to other similar flowers. However, if cross-pollination does not take place, there is every chance of self-pollination in this case, since both the stamens and the carpels are enclosed

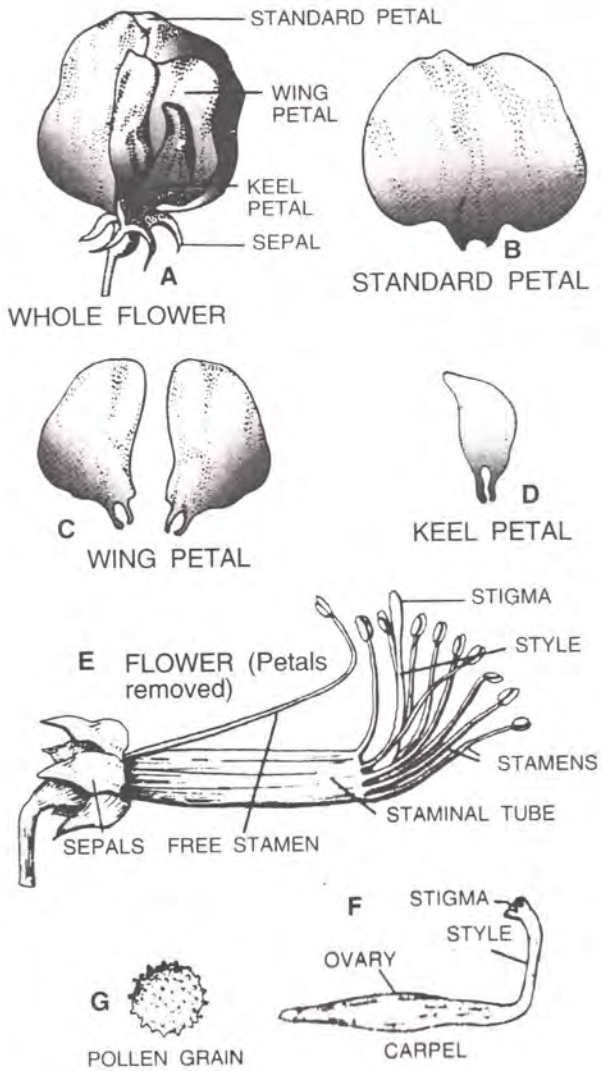


Fig. 5.4. Floral parts of sweet pea.

within the keel and are more or less at the same level.

(2) In **wind-pollinated maize** (Fig. 5.5) pollination is brought about by wind. As the wind blows, the pollen from the outwardly hanging anthers (in the tassel) is blown away easily because the anthers are so loosely attached to the filament that the slightest wind will shake them. The pollen blown away by the wind may fall on the feathery stigmas of the female flowers which have a large surface for this purpose. The male flowers mature earlier than the female ones, so that there are less chances for self-pollination.

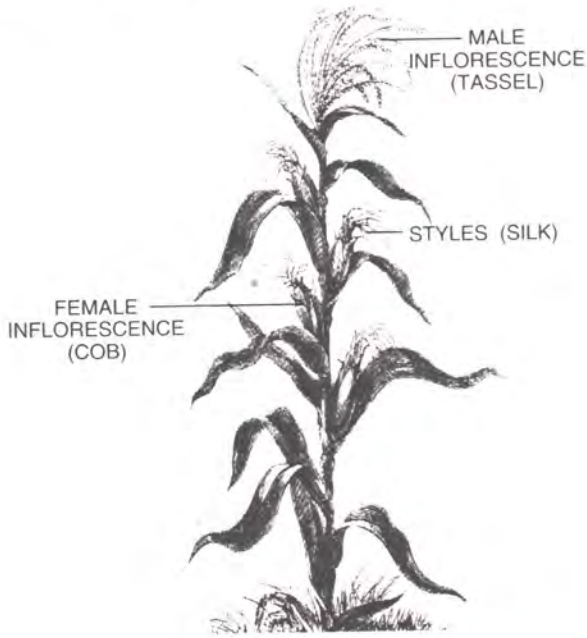


Fig. 5.5 Maize plant

? Progress Check

1. Match the items in Column I with those in Column II

Column I	Column II
(i) Feathery stigma hanging out	Rafflesia
(ii) Different timings for maturation of anthers and stigma	Entomophilous
(iii) Pollination by elephant	Wind-pollination
(iv) Flowers produce nectar	Dichogamy

2. Complete the following statements :
   (i) Pollination is the process of transfer of .....
   (ii) The two kinds of pollination are ..... and ..... .
   (iii) For self-pollination the flowers need not be ..... and showy.
   (iv) For self-pollnation, ... and ..... must mature at the same time.
   (v) Self-pollination does not yield ..... varieties.
   (vi) In ..... pollination there is much wastage of ..... .

5.3 FERTILIZATION (FIG. 5.6)

Fertilisation is the **union/fusion** of the nuclei of male and female **gametes**.

In flowering plants

- The pollen grain is the **male gamete**.
- The ovule inside the ovary is the **female gamete**.

The Pollen Grain

The mature pollen grain (Fig. 5.6 B) is a cell with a double wall — the outer **exine** and the inner **intine**. Its nucleus has already divided into a **tube nucleus** and a **generative** (male) **nucleus**. At this stage, the pollen is transferred to stigma (pollination). Further changes in pollen grain occur only if it has fallen on the stigma of a plant of the same species.

The Ovule

Ovule is the inner part of ovary. **Ovule** is destined to become the **seed** and the **ovary** to become the **fruit** containing the seed inside. There may be

- a single ovule producing single seeded fruit, or
- many ovules producing a many-seeded fruit.

Each ovule has one or two protective coverings, the **integuments**.

The integuments leave a small opening the **micropyle** at one end (for the entry of pollen tube).

Enclosed by the integuments is the **nucellus** (a mass of food laden cells), and further inside the nucellus is the **embryo sac**.

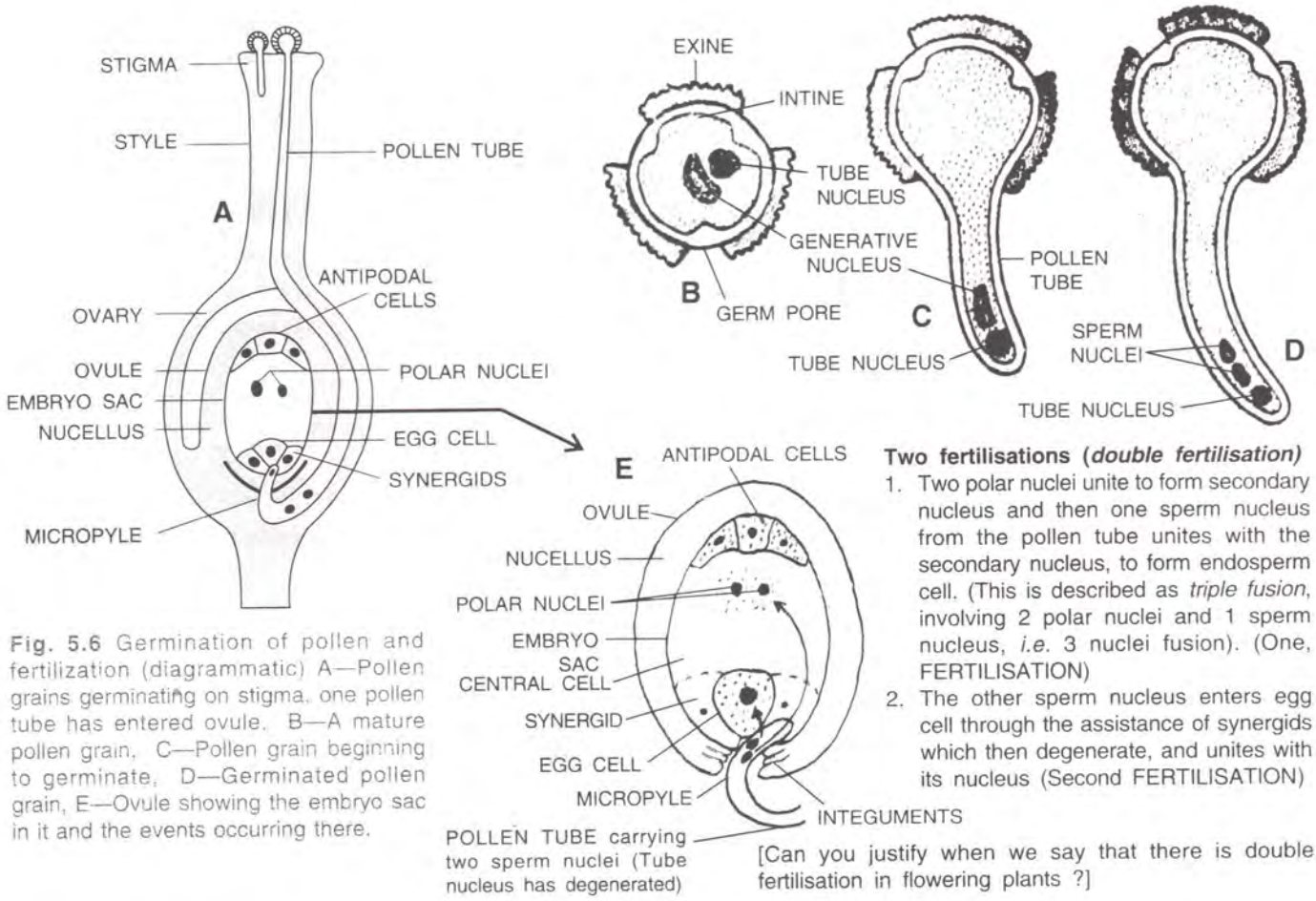


Fig. 5.6 Germination of pollen and fertilization (diagrammatic) A—Pollen grains germinating on stigma, one pollen tube has entered ovule. B—A mature pollen grain, C—Pollen grain beginning to germinate, D—Germinated pollen grain, E—Ovule showing the embryo sac in it and the events occurring there.

Two fertilisations (*double fertilisation*)

1. Two polar nuclei unite to form secondary nucleus and then one sperm nucleus from the pollen tube unites with the secondary nucleus, to form endosperm cell. (This is described as *triple fusion*, involving 2 polar nuclei and 1 sperm nucleus, *i.e.* 3 nuclei fusion). (One, FERTILISATION)
2. The other sperm nucleus enters egg cell through the assistance of synergids which then degenerate, and unites with its nucleus (Second FERTILISATION)

[Can you justify when we say that there is double fertilisation in flowering plants ?]

The embryo sac contains seven (3+3+1) **cells** :

- 3 cells at micropylar end — one **egg cell** and two **synergids**,
- 3 cells at opposite end, called **antipodal cells**, and
- 1 large **central cell**. The central cell is different containing two nuclei called **polar nuclei**.

Germination of pollen grain

Pollen grain germinates only if it falls on the stigma of the same plant species, otherwise, it disintegrates.

The pollen grain on falling on the stigma is stimulated to germinate due to the secretion of sugars by the stigma. Through a point in the exine a pollen tube grows out of the pollen grain, carrying at its tip the generative nucleus and the tube nucleus, generative nucleus divides into two nuclei (**male gamete nuclei** also called **sperm nuclei**). Thus there are three nuclei which are not separated by cell walls, they share a common cytoplasm.

The pollen tube grows through the stigma and style by dissolving the tissues with the help of enzymes and reaches the ovary. There, it pushes through the micropyle and reaches the embryo sac. The **tube nucleus** which had **directed the growth of pollen tube** all the way down, now disintegrates.

Now, the pollen tube enters one of the synergids and releases its two sperm nuclei. Of these, one sperm nucleus fuses with the egg cell nucleus to form the zygote while the other sperm nucleus moves towards the two polar nuclei in the central cell and fuses with them (thus 3 nuclei fuse together/triple fusion to produce the endosperm nucleus). All together two fertilizations have occurred and hence termed double fertilization.

Double fertilisation

1. One sperm nucleus fuses with egg cell nucleus
2. The other sperm nucleus fuses with two polar nuclei together

Fate of floral parts after fertilization. After fertilization the flower has served its purpose.

— The petals, stamens, style and stigma wither and generally fall off.

— The calyx may either fall off or may remain intact in a dried and shrivelled form. Apple and guava show such dried sepals very clearly, in brinjal it remains.

— The ovary enlarges to form fruit, the ovarian wall forming the fruit wall. The ovary wall may either form a dry and hard fruit wall or a fleshy fruit wall.

— Ovules become the seeds.

The fruit contains one or more seeds which are developed from one or more ovules attached to the ovary by means of placenta(e). When the fruit is ripe the seeds contained inside are released by one or the other method and grow into new plants in suitable conditions.

The fate of various parts of the ovary after fertilization during the formation of fruit is as follows :

PART		WHAT IT BECOMES
Ovary	→	*Fruit*
Ovary wall	→	Pericarp
Ovule	→	Seed
Placenta	→	Stalk of the seed
Outer integument	→	Testa } Seed coat.
Inner integument	→	Tegmen } Seed coat.
Secondary nucleus	→	Endosperm
Egg cell, Synergids &	→	Embryo
Antipodal cells	→	Disorganised

? Progress Check

1. Mention if the following statements are **true**
   (i) Intine is the outer wall of pollen grain.
   (ii) Pollen tube enters ovule through micropyle.
   (iii) Zygote gives rise to embryo.
   (iv) Ovule becomes fruit.
   (v) Dry sepals may persist in some fruits.

POINTS TO REMEMBER

- Self-pollination is surer and it preserves parental characters (same variety), but it leads to weaker generations.
- Cross-pollination produces healthier offspring and new varieties.
- Plants have evolved several methods to favour cross-pollination.
- Insect-pollinated flowers are large, brightly coloured, have scent and nectar-bearing with sticky pollen and sticky stigma
- Wind-pollinated flowers are small, dull, nectarless with light and dry pollen and feathery stigma.
- Pollen grain germinates on stigma and the pollen tube penetrates ovule.
- After fertilization most other floral parts dry and fall off while the ovary enlarges to form fruit with ovules becoming seeds.

Review Questions

A. MULTIPLE CHOICE TYPE

1. **Which one** of the following is one of the characteristics of self-pollinated flowers ?
   (a) Flowers are large and showy
   (b) Flowers remain closed and do not open
   (c) Stigma and anthers mature at the same time
   (d) Pollen is produced in very large quantities

2. Exine and intine are the parts of
   (a) Embryo sac (b) Pollen grain
   (c) Stigma (d) Seed

B. VERY SHORT ANSWER TYPE

1. **State the name** of the chief pollinating agent against the corresponding plant by choosing from those given in brackets.

(a) Dahlia ..... (Crow, butterflies, mosquito).
(b) Maize ..... (Bees, locusts, rain, wind).
(c) Vallisneria ..... (Wind, water, ants, rabbits).

2. **Match the items** in Column A with those in Column B.

Column A	Column B
(a) Generative nucleus	(i) Pollen tube
(b) Germ pore	(ii) Endosperm nucleus
(c) Exine	(iii) Testa
(d) Secondary nucleus	(iv) Fertilization
(e) Integument	(v) Male nuclei
(f) Egg nucleus	(vi) Rough

3. Fill in the **blanks** with suitable words.
   (a) Transfer of pollen grains from anthers to stigma of the same flower is called .....
   (b) Different timings for maturation of gynoecium and androecium, is called .....
   (c) ..... is a water-pollinated flower.
4. **Name the parts** of the ovary which give rise to:
   (a) Seed ..... (b) Fruit .....
   (c) Fruit wall .....
5. Give **one word/term** for the following :
   (a) A flower containing both male and female parts
   (b) Arrangement of flowers on a twig/stem
   (c) When pollen grains of a flower reach the stigma of the same flower.
   (d) When maturation time of reproductive parts in a flower is different.
   (e) When stigma and anthers do not grow up to same height, which favours only cross-pollination ?
   (f) Pollination of flowers by insects.
   (g) Pollination of flowers by birds.

C. SHORT ANSWER TYPE

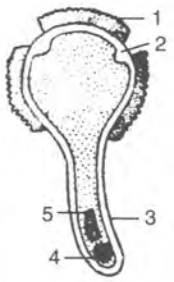
1. **Explain** the following terms :
   (a) Ornithophily. (b) Elephophily.
   (c) Artificial pollination.
2. **What happens** to the following after fertilization?
   (a) Ovules (b) Calyx
   (c) Petals (d) Stamens
3. **Mention** any *two* contrivances in flowers which favour cross-pollination.

D. LONG ANSWER TYPE

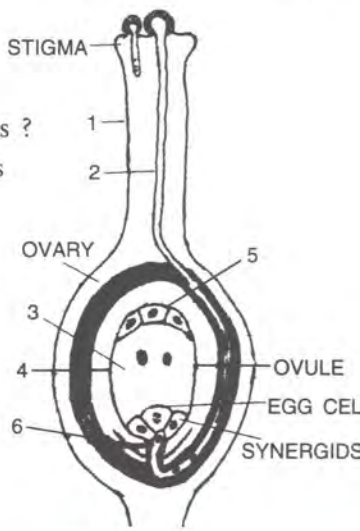
1. **What are the advantages** of the following in the flower to the plant concerned ?
   (a) Long and feathery stigma
   (b) Brightly coloured petals
   (c) Smooth and light pollen
   (d) Protruding and easily movable anthers
   (e) Fragrant nectar
2. **Describe** the advantages and **disadvantages** of cross-pollination to the plant.

E. STRUCTURED/APPLICATION/SKILL TYPE

1. What is the **function** of the pollen tube ? **Explain** it with the help of a diagram.
2. Given alongside is a diagrammatic sketch of the sectional view of a germinating pollen grain. Study the same and then answer the questions that follow :



   (a) Name the parts labelled 1, 2, 3, 4 and 5
   (b) Where does the germination of the pollen grain takes place and how ?
   (c) What is the function of the part labelled '4' ?
   (d) What happens to the part labelled '5' during the process ?
3. Given below is a diagrammatic representation of the process of fertilization. Study the same and then answer the questions that follow :
   (a) Name the parts labelled 1, 2, 3, 4, 5 and 6.
   (b) What happens to (i) Ovary (ii) Ovule after fertilization ?
   (c) What is the function of the synergids ?
   (d) What part does the stigma play in the process of fertilization ?



6 Seeds — Structure and Germination

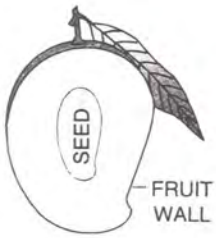
In the Chapter

Syllabus : *Fruit and seed (definition and significance). Structure of dicot and monocot seeds. Germination of seeds, types, and conditions for seed germination.*

Structure and germination of Bean seed and Maize grain. Differences between monocot and dicot seeds. Differences between hypogeal and epigeal germination. Conditions for seed germination to be explained and supported by experiments.

6.1 WHAT IS A SEED ?

Before we talk about the germination of seeds it will be appropriate to refresh your knowledge what the three terms FRUIT, SEED and GRAIN actually mean.



Fruit is the enlarged ripened **ovary**, the ovarian wall forming the fruit wall enclosing the seed. The fruit protects the seed and helps in seed dispersal. *Examples.* Mango, pea pod.

Seed is the ripened **ovule**. It contains embryo which develops into a new plant. The seed coat protects the embryo from mechanical damage. *Example* : Bean seed, peas.

Grain as found in maize, wheat, etc, is actually the fruit in which the fruit-wall and the seed coat are fused together to form a protective layer.

MORE ABOUT SEED

- It is a mature ovule **after fertilisation**.
- It contains a tiny living plant, the **embryo** (developed from the fused sperm nucleus and the egg nucleus).
- The embryo remains in an inactive (dormant) state until exposed to favourable conditions when it germinates.
- The seed also contains food material for the nourishment of the embryo during germination.
- The embryo can withstand unfavourable conditions of temperature, drought, etc. (Some seeds are known to remain dormant even up to 100 years or more).

6.2 CLASSIFICATION AND STRUCTURE OF SEEDS

Types of Seed

Broadly the seeds are of two kinds — monocotyledonous and dicotyledonous.

- Monocotyledonous seeds contain one cotyledon (seed-leaf) e.g. maize, grasses.
- Dicotyledonous seeds contain two cotyledons e.g. pea, gram, bean.

Seeds vary in size

- Some are so small that they are barely visible to the naked eye e.g. poppy seeds, orchid seeds.
- Some are quite large as in watermelon and pumpkin or even in mango (the stone).
- Largest seeds are those of coconut and double coconut.

The size, shape and structure of seeds of different plants vary considerably but the basic structure of most seeds is same.

On the **basis of endosperm**, seeds are classified as :

(i) *Albuminous* (endospermic) cotyledons are

thin and membranous and endosperm persists e.g. Dicot albuminous seeds : poppy, custard apple. Monocot albuminous seeds : cereals, millets, palm.

(ii) *Exalbuminous* (non-endospermic) - In such seeds, the cotyledon stores food and becomes thick and fleshy e.g. Dicot exalbuminous seeds - Gram, pea, mango, mustard and Monocot exalbuminous seeds - Vallisneria, orchids, amorphophallus.

1. THE BEAN SEED (Fig. 6.1)

There are a number of different kinds of beans such as broad bean, lima bean, french bean, etc., but the general structure of their seeds is the same. Most are kidney-shaped with a convex and a concave side.

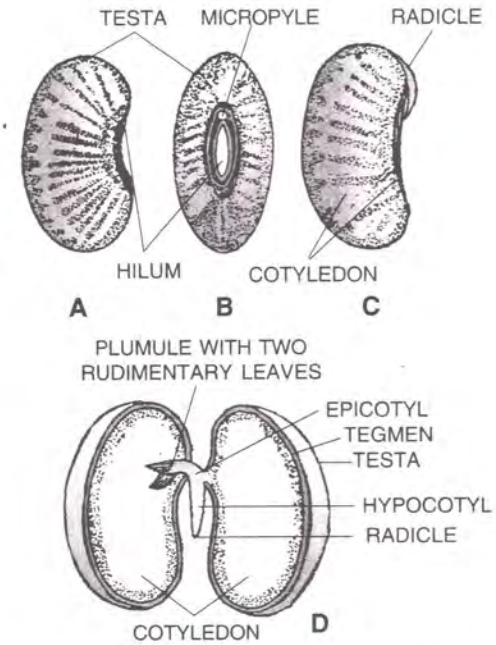


Fig. 6.1 Structure of Bean seed. A & B—External structure, C—Testa removed, D—Seed cut open to show various parts.

Seed coat consists of the testa the outermost hard brownish covering. It protects the delicate inner parts of the seed from injury and from the attack of bacteria, fungi and insects and tegmen (Fig. 6.1 D) is a thin inner layer lying next to the testa, and this also is protective.

Hilum is a distinct whitish oval scar on the concave side of the seed. It represents the spot where the ovule (now the seed) was attached to the ovary wall through placenta.

A tiny pore **micropyle** is situated close to the hilum. It marks the opening through which the pollen tube had entered the ovule. Micropyle serves two functions :—

(1) When soaked in water the seeds absorb water mainly through this micropyle and make it available to the embryo for germination.

(2) It provides for the diffusion of respiratory gases for the growing embryo.

Below the seed-coat are two thick cotyledons which contain food for the embryo and protect it.

On carefully separating the two cotyledons the tiny embryo can easily be seen attached to one of the cotyledons. The embryo consists of two parts—the radicle which later forms the root and the plumule which later forms the shoot. The plumule consists of a short stem with a pair of tiny leaves and a growing point between them.

(Do not misspell radicle as "radical" which is a term in chemistry).

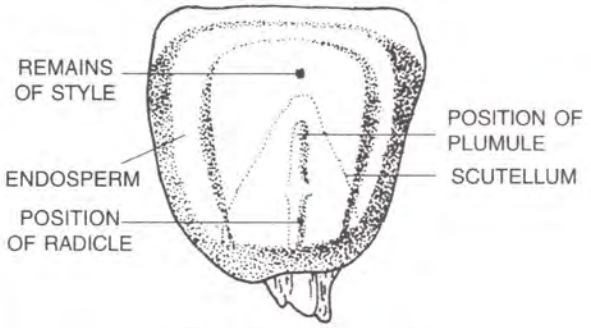
2. MAIZE GRAIN (Fig. 6.2)

The maize grain is actually a one seeded fruit in which the *fruit wall and the seed-coat are fused* together to form a protective layer. Therefore, we call such a fruit as *grain*.

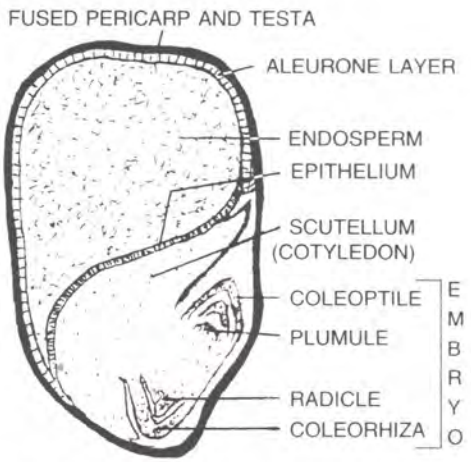
On one side of the grain occurs a small light-coloured oval area which marks the location of the embryo inside. The remaining major part of the grain contains a large endosperm which is rich in starch. The endosperm and the embryonic part are separated from each other by a thin epithelial layer. The outermost layer of the endosperm is rich in protein and is called aleurone layer.

The embryo consists of a single cotyledon here called **scutellum**, a radicle and a plumule. The radicle is towards the pointed end and it is enclosed in a protective sheath, the coleorhiza. The plumule is towards the upper broader side of the embryonic region and is enclosed in a protective sheath, the coleoptile.

The maize grain is monocotyledonous and endospermic. Some other examples of this type of grain are rice, wheat and oat.



EXTERNAL FEATURES



LONGITUDINAL SECTION

Fig. 6.2 Maize grain

MAJOR DIFFERENCES BETWEEN BEAN SEED AND MAIZE GRAIN

BEAN	MAIZE
1. **Two** cotyledons.	**One** cotyledon (scutellum)
2. **No** endosperm.	**Large** endosperm present.
3. **Large** embryo.	**Small** embryo.
4. Plumule leaves **folded**.	Plumule leaves **rolled**.
5. Plumule **large**.	Plumule very **small**.
6. Hilum and micropyle **visible**.	Hilum and micropyle **not visible**
7. Seed separately contained **in the fruit** called pod.	The seed wall and the fruit wall fused to form **a single grain** with no separate seed.

Progress Check

1. Mention whether the following statements are **True** (T) or **False** (F)
   (i) Plumule is the future root and radicle the future shoot of the plant. (T/F)
   (ii) Micropyle serves for the emergence of the radicle. (T/F)
   (iii) Cotyledons in castor are a big store of food for the embryo. (T/F)
   (iv) Maize grain has a large endosperm. (T/F)
   (v) Tegmen is the outermost layer of the seed (T/F)

6.3 GERMINATION

The seed contains a dormant embryo. In a dry seed the embryo is inactive. It is said to be in a state of dormancy (a period of rest.) Outwardly, it appears to be without life, but in fact all the chemical activities of life are going on in it although they are very slow and little food is utilized. The dry seeds consume oxygen and give out carbon dioxide, both in extremely minute quantities, and they release some heat as well. When placed under proper conditions the dormant embryo awakens, *i.e.* it becomes active and starts growing into a seedling. All the changes leading to the formation of a seedling are collectively called germination. **Germination** is the process of **formation of a seedling developed from the embryo.**

A fresh seed from a plant normally does not germinate even if the conditions for germination are favourable. It must pass through a period of dormancy during which it undergoes physiological maturation.

CONDITIONS NECESSARY FOR GERMINATION

Water, suitable temperature and air (oxygen) are necessary for germination.

1. Water : The seed obtains water from its environment, *i.e.* from the soil, in natural conditions. The water is absorbed all over the surface but mainly through the micropyle. Two main uses of water are:

(i) The seed swells and consequently the seed-coat ruptures allowing the elongating radicle to come out and form the root system.

(ii) Water is necessary for chemical reaction and for the enzymes to act upon the food stored in the cotyledons or endosperm so that it may convert into a diffusable form dissolved and utilized by the growing embryo.

2. Suitable temperature : Both very low and very high temperatures are unsuitable for germination. A very low temperature inhibits the growth of the embryo and a very high temperature destroys its delicate tissues. A moderately warm temperature (25°C to 35°C) is usually favourable for germination and it is also called **optimum temperature.** Seeds of tropical plants often need a higher temperature for germination than those of the temperate regions.

3. Oxygen : During germination there is rapid cell division and cell growth for which energy is required. This energy is available only by respiration (oxidation of food) and hence the need for oxygen (or air).

Seeds sown very deep in soil fail to germinate

Two main reasons :

1. No proper supply of oxygen (for respiration)
2. Insufficient pushing force in the embryonic parts (hypocotyl or epicotyl) to break through the upper layers of soil.

6.4 SOME EXPERIMENTS ON GERMINATION

1. Experiment to prove that water is necessary for germination.

Take two beakers and mark them A and B. In beaker A place some seeds of green gram (or pea, etc.) on **wet** cotton wool. In beaker B place some similar seeds on **dry** cotton wool. Keep both the beakers in an ordinary room. In a day or two, the seeds in beaker A will germinate but not in beaker B, showing that water is necessary for germination.

2. Experiment to prove that a suitable temperature is necessary for germination.

Take two beakers and name them A and B. Place some green gram seeds on wet cottonwool in each of the two beakers. Keep beaker A in an ordinary room and beaker B in a refrigerator. In a day or two, the seeds in beaker A will germinate, showing the importance of a suitable temperature for germination. The seeds in beaker B may not show signs of germination, or may germinate after several days though not to the extent the seeds in beaker A germinate.

3. Experiment to prove that air (oxygen) is necessary for germination (Fig. 6.3).

Take two conical flasks. Name them A and B. Spread **wet** cottonwool in each flask and place on it some **soaked gram seeds**. Lower a small test-tube containing alkaline ***pyrogallic acid, which absorbs oxygen***, in flask B by means of a thread, taking care that not a single drop of the chemical falls on the seeds, or the cotton-wool. Keep the tube hanging by fixing a cork on the mouth of the flask. Arrange flask A in the same way, except that the test-tube in this flask contains plain water. Place the two flasks in an ordinary room. The seeds in flask A will germinate showing the importance of oxygen for germination. The seeds in flask B do not germinate because there is no oxygen (there may at the most be very slight germination due to anaerobic respiration in the absence of oxygen).

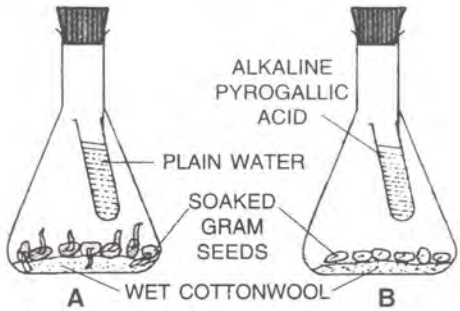


Fig. 6.3 Seeds require air (oxygen) for germination.
A—Seeds germinate in ordinary air,
B—Seeds do not germinate in air without oxygen

4. The three–bean seeds experiment (Fig. 8.4).

In this experiment three mature air dried bean seeds are taken and tied to a glass slide at three positions as shown in the figure. This slide is kept in a beaker containing water in a manner that the top seed is well above water, the middle one is just at the water level and the bottom one is deep in water. The experimental set-up is left in a warm place for a few days and the result is as follows :

— The **middle seed** germinates. It gets both oxygen and water.

— The **top seed** does not germinate at all. It gets only oxygen but no water.

— The **bottom seed** does not germinate or stops germinating after the emergence of a small radicle. It gets water but very little oxygen (from the air dissolved in water)

The experiment conclusively proves that water is essential for germination, but the other requirement of oxygen is not fully demonstrated.

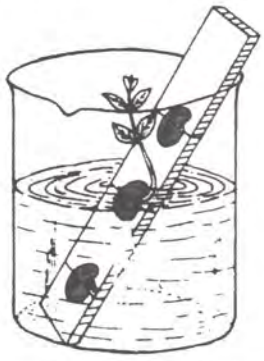


Fig. 6.4 The three-bean experiment to demonstrate germination

6.5 TYPES OF GERMINATION

The region of the axis between the point of attachment of cotyledons and the plumule is called epicotyl. The region of the axis below the cotyledons is called hypocotyl. Both the epicotyl and hypocotyl of a seed never elongate together during germination. It is either the epicotyl or the hypocotyl that elongates. If the epicotyl elongates, the cotyledons remain underground (or on the ground if the seed is just on the ground) and the germination is then called hypogeal *e.g.* pea and gram. If the hypocotyl elongates, the cotyledons are pushed above the ground and this type of germination is called epigeal (*e.g.* castor, bean, *etc.*).

HYPOGEAL GERMINATION	EPIGEAL GERMINATION
1. Cotyledons remain underground.	1. Cotyledons pushed above the ground.
2. Epicotyl elongates faster.	2. Hypocotyl elongates. faster.
3. Usually occurs in mono-cotyledonous seeds	3. Usually occurs in dicotyledonous seeds.

A method to observe stages of germination. Put sterilized sand in a glass vessel in which filter paper or ordinary white paper is lined beside the inner wall, and place seeds in between the paper and the glass. When water is added to the sand in the vessel, seeds will absorb the water and germinate in a few days.

6.6 GERMINATION IN SOME COMMON SEEDS

Pea seed (Fig. 6.5) (Hypogeal) : The seed absorbs water and swells considerably. The testa softens and bursts. The radicle emerges, grows downwards and forms the root system. The plumule grows upwards and forms the shoot of the seedling. In the earlier stages of development, the plumule is arched and thus protects the young shoot from injury during its emergence from the soil. The cotyledons supply food till the seedling is able to exist independently. Later they wither and shrivel up. The ***cotyledons remain underground*** and germination is **hypogeal** (***hypo :*** below + ***geo :*** earth).

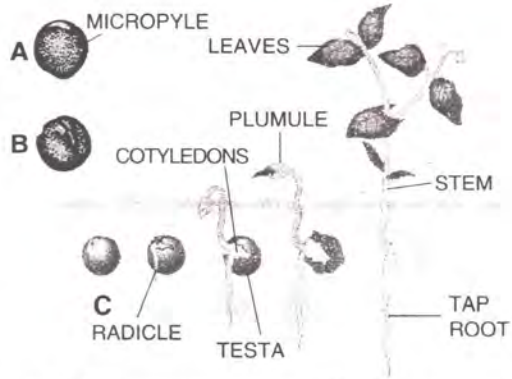


Fig. 6.5 Germination of pea. A—Seed (outer view), B—Seed showing emergence of radicle, C—Stages of germination in soil ; note that the cotyledons remain underground (hypogeal)

Bean seed (Fig. 7.6) (Epigeal) : The seed absorbs water and swells. The radicle grows downwards to form the root system. The arched

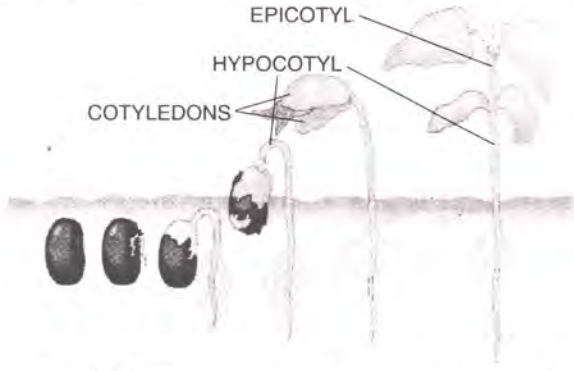


Fig. 6.6 Germination of bean. Hypocotyl (region below cotyledon) elongates to push the cotyledons up above the ground (Epigeal)

hypocotyl grows forming an arch/loop above the soil, it then straightens bringing the cotyledons above the soil. Germination is, therefore, **epigeal** (***epi :*** above; ***geo :*** earth). The cotyledons become the first green leaves and soon fall off after the foliage leaves grow.

Maize grain (Fig. 6.7) (Hypogeal) : The grain imbibes water and swells considerably. The radicle pierces through the protective root sheath (coleorhiza) and the fruit wall and grows downwards to form the root system, but it dies off soon. New roots develop from the base of the stem (adventitious roots).

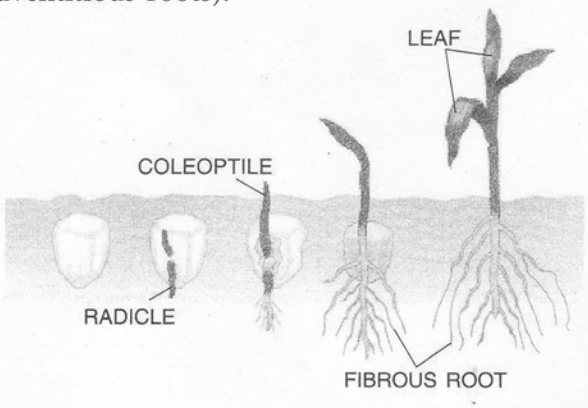


Fig. 6.7 Germination of maize. Hypocotyl does not elongate (Hypogeal)

The plumule pierces through its protective sheath, coleoptile, and grows straight upwards. The two protective sheaths, coleorhiza and coleoptile, may be seen as a membranous covering on the axis of the seedling.

The cotyledon (scutellum) absorbs food from the endosperm till it is exhausted. The hypocotyl does not elongate. Germination is **hypogeal.**

Viviparous germination - (a special type) - The mangrove plants like *Rhizophora* (Fig. 6.8) and *Sonneratia*, show a special mode of seed germination called vivipary in which **seed germinates inside the fruit while it is still attached to the parent plant.** After germination, the plant drops the seedling into the soil which develops root and fixes itself. (*Viviparous :* producing live young ones)

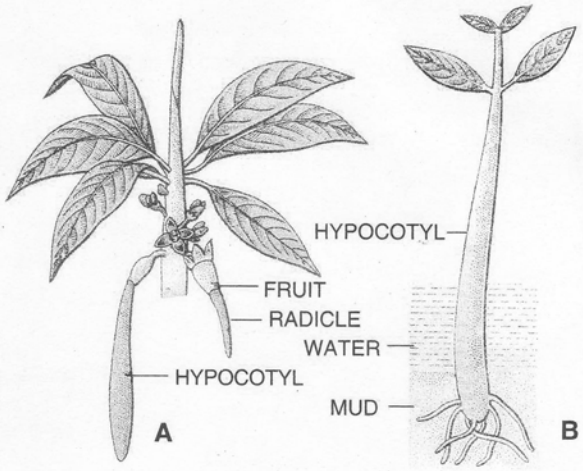


Fig. 6.8 Vivipary. A—Twig of *Rhizophora* showing viviparous germination; B—Seedling growing in mud.

THE SEEDLING

Germination in any plant ends with the formation of a seedling.

Seedling is a stage in the growth of a plant from a seed before it has become wholly independent of the food stored in it.

The roots of the seedling absorb water and minerals from the soil. The leaves start manufacturing food for the young plant which keeps growing and becomes a mature plant and produces flowers and seeds in its turn.

Progress Check

1. Fill in the blanks by choosing the correct alternative
   (i) In a dry seed the embryo is in ..... state (active/quiescent)
   (ii) Water is absorbed by the seed mainly through ..... (entire surface/micropyle)
   (iii) Very low temperature ..... the growth of embryo (inhibits/destroys).
   (iv) Germination in pea is ..... (epigeal/ hypogeal).
   (v) Coleoptile is a part found in the germinating ..... (castor/maize).
   (vi) Alkaline pyrogallic acid is used for absorbing ..... during experiments on germination (oxygen/carbon dioxide)

POINTS TO REMEMBER

- A dicot seed consists of an embryo with two cotyledons enclosed in a seed coat.
- The embryo consists of a radicle (small root) and a plumule (small shoot)
- The cotyledons contain the food for the embryo
- A monocot seed such as the maize grain has a single cotyledon, a large endosperm, a small embryo in which the plumule is small with rolled plumule leaves.
- Three conditions necessary for the germination of seeds are water, suitable temperature and oxygen.
- Germination of seeds may be hypogeal (cotyledons remaining underground) or epigeal (cotyledons carried above the soil)

Review Questions

A. MULTIPLE CHOICE TYPE

1. **Which one** of the following plant parts is **correctly matched** with one of its stated characteristic?
   (a) Mango seed ..... aleurone layer
   (b) Bean seed ..... endosperm
   (c) Maize grain ..... coleoptile
   (d) Wheat grain ..... exalbuminuous
2. Seeds sown very deep in the soil fail to germinate **because** they
   (a) cannot exert enough force to push the soil upward.
   (b) do not get enough sunlight.
   (c) get too much water.
   (d) do not get enough oxygen.

B. VERY SHORT ANSWER TYPE

1. Are the following statements ***true*** (T) or ***false*** (F) ?
   (a) Some seeds have no cotyledons at all. (T/F)
   (b) Maize grain is fruit and not a seed. (T/F)
   (c) Seeds fallen in a flower-bed from the previous crop usually do not germinate until the next sowing season. (T/F)
   (d) Oxygen is necessary for the germination of seeds. (T/F)
2. **Name** the following :
   (a) A monocotyledonous endospermic seed.
   (b) A chemical used in experiments, which absorbs oxygen.
   (c) Part of the plumule above the embryonic axis of the seed.
   (d) A plant which shows viviparous germination.
   (e) The layer of endosperm of maize, rich in protein.
   (f) A seed with folded plumule leaves.
3. **Fill in** the blanks :
   (a) In bean seeds, ... grows faster and the seeds are brought ..... ground.
   (b) ..... is a protective layer of radicle and ..... protects the rolled plumule.
   (c) A seed is protected by ..... and .....
   (d) Seeds absorb water through ..... which also helps in diffusion of respiratory gases.
   (e) Rice, wheat, and maize are rich in ..... food.
4. Arrange the following set of terms in order, so as to be in logical sequence. Rewrite the correct order.
   (a) Embryo, 1st male gamete, zygote, egg cell, micropyle.
   (b) Zygote, embryo, seed, allogamy, fusion of gametes.
   (c) Seed coat bursts, hypocotyl elongates, radicle grows downward, hypocotyl forms loop above the soil, epicotyl elongates.

C. SHORT ANSWER TYPE

1. What is the **difference** between an embryo and a seed?
2. Give any *two* **examples** each of endospermic (albuminous) seeds, and non-endospermic (exalbuminous) seeds.
3. Germinated grams are considered highly nutritive. **What** is the reason for this belief ?

4. **Why do we not use the terms** maize fruit and maize seed ? What do we say instead?

D. LONG ANSWER TYPE

1. What are the **functions** of the following in a seed?
   (a) Seed coat (b) Micropyle
   (c) Cotyledons (d) Radicle
   (e) Plumule
2. Suggest **an experiment** to prove that a suitable temperature is necessary for germination.
3. Sometimes the potatoes kept in a basket during the late rainy season start giving out small shoots. **Would you call it germination? Give reason** in support of your answer.
4. Give *two* **differences** in each of the following pairs :
   (a) Epigeal germination and hypogeal germination
   (b) Coleorhiza and coleoptile.
   (c) Bean seed and maize grain.
5. **Differentiate** between germination and vivipary.
6. Justify the statement that the maize grain is a 'one seeded fruit'.
7. What is the role played by the hypocotyl in epigeal germination ?
8. With regard to germination in bean seed, answer the following questions :
   (a) State the function of the 'Micropyle'.
   (b) Name the part of the seed that grows into the seedling.
   (c) Name the part of the seed that provides nutrition for the growing seedling.
   (d) Draw a neat labelled diagram of a mature bean seed.

TAMARIND

("Tamar-i-Hind" meaning "Date of India")

*The English name **"tamarind"** for this plant is derived from the Persian word **"Tamar-i-Hind"** which means "Date (khajur) of India". Just as "khajur" is everywhere in "Persia" so is tamarind in India.*