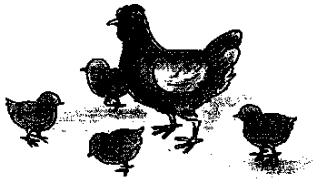
Growth, Development, and Reproduction

2

LEARNING OUTCOMES

- Reproduction in Plants
- Germination of Seeds
- Reproduction in Animals
- Reproduction in Humans
- Growth and Development
- Characteristics of Adolescence



(a)

(b)

(c)

All organisms produce living beings similar to themselves, as shown in pictures (a) to (c). This ability, called *reproduction*, is one of the seven basic characteristics shown by living organisms, which you must have studied in lower classes. Thus, reproduction may be defined as *the ability of living organisms to produce living beings similar to themselves.*

What are the different means of reproduction? What is its importance to a living organism? We will discuss these aspects in this chapter.

As you are aware, organisms exhibit great diversity, from microorganisms to large plants and animals. All of them reproduce because only then can they ensure that their kind continues to exist. Reproduction may be sexual or asexual. *Sexual reproduction* involves the formation of special reproductive cells called *gametes*—male gametes produced in the male reproductive organs and female gametes produced in the female reproductive organs. *Asexual reproduction* does not involve the formation of gametes. In this type of reproduction, new organisms are formed either by division of the parent body or by differentiation of the parent body. Let us examine different modes of reproduction in plants and animals one by one.

FACT FILE

In organisms such as humans, male and female gametes are of different sizes. The female gametes are large and non-motile whereas the male gametes are much smaller and motile.

TECH FILE

Artificial methods of vegetative reproduction are popular among farmers and gardeners. Vegetative reproduction is especially useful for growing plants whose seed production or germination is low or whose seeds are very expensive. Cutting, grafting, and layering are commonly practiced artificial methods of vegetative reproduction.

REPRODUCTION IN PLANTS

Plants show both sexual and asexual modes of reproduction. Let us discuss asexual reproduction first.

Asexual Reproduction in Plants

In plants, asexual reproduction takes place through *spore formation and vegetative propagation*. Let us understand what happens in each mode.

Spore Formation

Lower plants such as ferns, mosses, fungi, and lichens reproduce asexually through spores. Figure 2.1 shows spore formation in bread mould, a fungus. Spores are similar to seeds in higher plants.

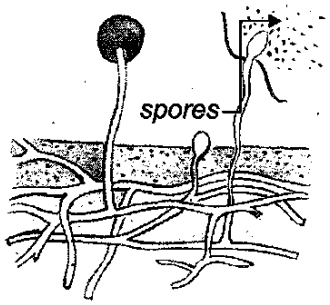


Fig. 2.1 *Spore formation in bread mould*

Vegetative Propagation

Budding and fragmentation are vegetative means of reproduction in lower plants.

Budding Budding is commonly seen in fungi (e.g., yeast) (Fig. 2.2). A small, bulb-like outgrowth (bud) emerges from the body of the parent and continues to increase in size. The nucleus divides into two, one of which moves into the bud. The bud breaks off from the parent once it is capable of existing independently.

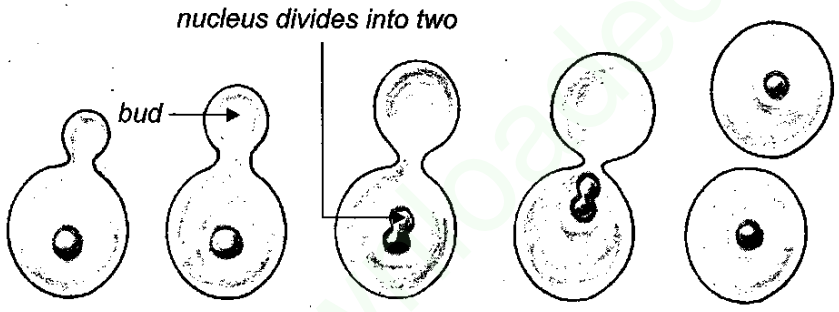


Fig. 2.2 *Budding in yeast*

Fragmentation Fragmentation is another common form of asexual reproduction in the plant kingdom. An adult organism simply breaks up into two or more fragments, each of which grows to become a new individual. *Spirogyra* (Fig. 2.3) reproduces by fragmentation. However, it must be noted that fragmentation in filamentous algae such as *Spirogyra* is more or less accidental.

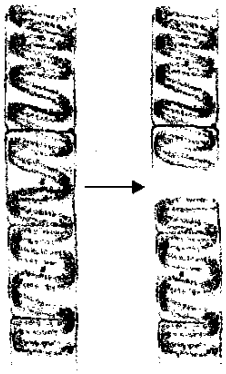


Fig. 2.3 *Fragmentation in Spirogyra*

Higher plants show a tendency to multiply using their ***vegetative parts***, namely the *root*, the *steam*, or the *leaf*.

Roots

The tuberous roots of dahlia (Fig. 2.4), sweet potato, and asparagus are true roots modified to store food in them. In some cases, such as dahlia, the tuberous root needs to be planted along with the bud for it to develop into a new plant. The bud is present where the stem joins the root. In sweet potato the tuberous root develops adventitious shoots called *slips*, which can be broken off and planted.

Fig. 2.4 *Tuberous roots of dahlia*

Stems

Vegetative propagation through stems, which is very common in plants, can be considered under two heads: sub-aerial stems and underground stems.

Sub-aerial stems

Runners and stolons Plants such as strawberry, oxalis (Fig. 2.5), and grass grow stems that run parallel to the ground and produce a new plant at each node. The new plants may then be detached from the parent plant. Both runners and stolons are horizontal stems, the only difference being that stolons are usually arched while runners extend straight on.

Sucker In certain plants, horizontal stems arise from the base of the shoot, grow horizontally in the soil for some length, and then come out to form shoots. The suckers then break away to form independent plants.

Offset Offset means a side shoot emerging from a bud on the main stem. The offset falls off easily in most cases and continues to develop as an independent plant after rooting. An offset is shorter and thicker than a runner. Water lettuce (Fig. 2.6) and water hyacinth are examples of plants that reproduce by this method.

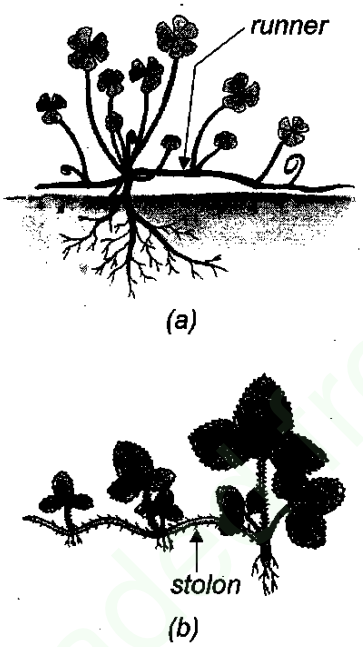


Fig. 2.5 *(a) Runner of Oxalis and (b) stolon of strawberry*

Underground stems

Rhizome A rhizome is an underground stem that produces roots and shoots at the nodes, giving rise to new plants. It is commonly seen in ginger, turmeric, and banana.

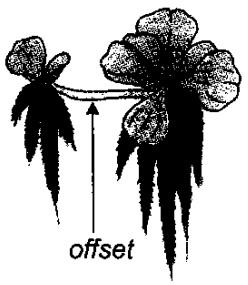


Fig. 2.6 *Offset of water lettuce*

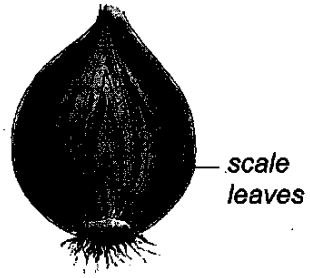


Fig. 2.7 *Bulb of onion*

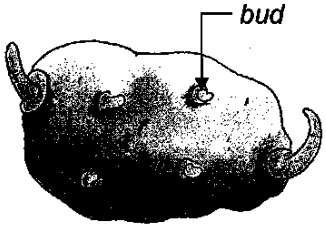


Fig. 2.8 *Tuber of potato*

Fig. 2.9 *Corm of Gladiolus*

Fig. 2.10 *Bryophyllum leaf*

Bulb It is a very short vertical stem which is surrounded by scale leaves (e.g., onion) (Fig. 2.7). Scale leaves are fleshy as they accumulate food.

Tuber Tubers are underground stems formed by swelling of their tips due to food accumulation (e.g., potato) (Fig. 2.8). Each 'eye' of a potato contains a bud which has the capability to develop into a new plant. These new plants use up the food stored in the underground stem to grow.

Corm A corm is usually round in shape and is borne in clusters (e.g., *Gladiolus*) (Fig. 2.9). Roots develop from the base of the corm, sometimes also from the sides.

Leaves

In plants such as *Bryophyllum*, rows of buds develop at the leaf margins, each at the end of a vein (Fig. 2.10). These buds may drop off from the leaf and grow into new plants. Sometimes the leaf itself may drop off, and the buds continue to grow in the soil.

Sexual Reproduction in Plants

Sexual reproduction is observed in flowering plants and many non-flowering plants. In this chapter, we will only consider sexual reproduction in flowering plants, which make up roughly 90% of the plant kingdom. Flowering plants reproduce sexually. The reproductive organs in flowering plants are *flowers*, from which the group derives its name. Flowers may be *bisexual* (with both male and female organs), as in rose, or *unisexual* (with only male or female organs), as in papaya.

ACTIVITY

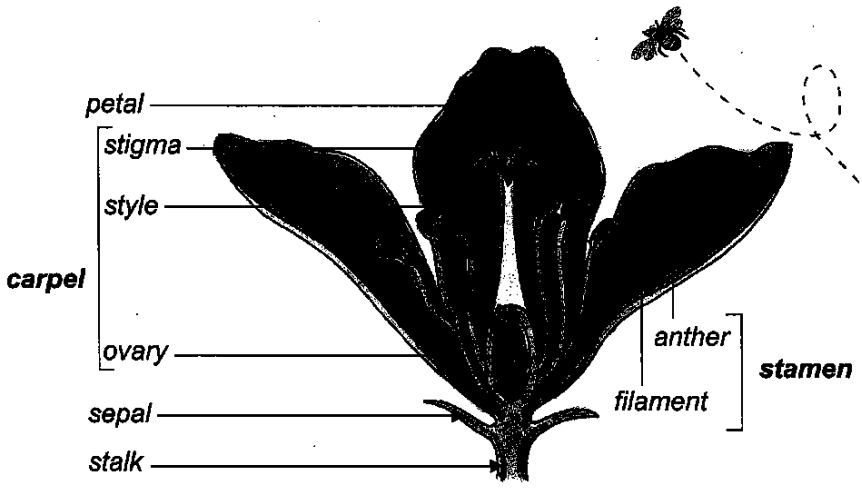
Aim: To observe vegetative reproduction in plants.

Materials required: Leaves of *Bryophyllum*, rhizome of ginger, stem tuber of potato, and a bulb of onion.

Procedure:

1. Fill four medium-sized flower pots with garden soil. Place the *Bryophyllum* leaf on the surface of the soil in one pot and place all other specimens just below the soil level.
2. Adventitious buds on the leaves of *Bryophyllum* will give rise to new plants in a few weeks' time. Ginger, potato, and onion need to be watered and looked after for about six months to see the establishment of a new set of underground stems.

All flowers are constructed on the same basic plan, though variations do occur in different species. The stalk that attaches the flower to the stem is expanded at its tip to form the thalamus or receptacle, which supports the four floral whorls: the *calyx*, the *corolla*, the *androecium*, and the *gynoecium*.

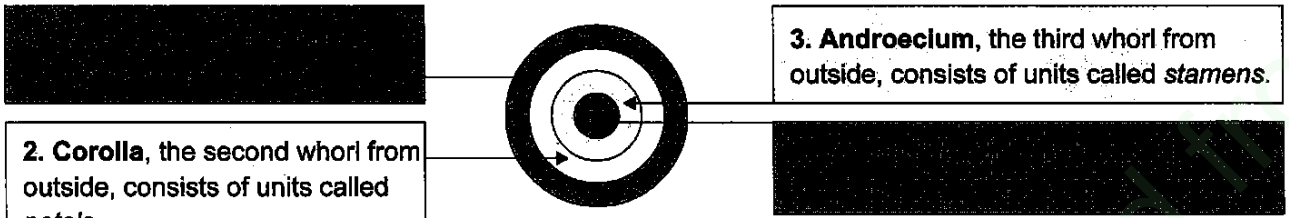


FACT FILE

Plant species bearing male flowers in one individual and female flowers in another individual are said to be *dioecious* (e.g., papaya and cycas). Plant species bearing male and female flowers on the same individual are said to be *monoecious* (e.g., maize and coconut.).

THINK QUEST

Many flowers are brightly coloured to attract insects. Why? (*Hint: How do these insects help the plants?*)



Arrangement of floral whorls

Pollination

The male and the female gamete contained in the *anther* and the *ovary*, respectively, have to be brought together in sexual reproduction. This is accomplished in the process of *pollination*.

Pollination may be defined as *the transfer of pollen grains from the anther to the stigma of a flower.*

This mechanical transportation may be effected in nature by various agencies such as wind, insects, birds, or water. Two kinds of pollination are possible: (a) self-pollination and (b) cross-pollination.

***Self-pollination** is the transfer of pollen grains produced in the anther of a flower to the stigma of the same flower or to the stigma of another flower borne by the same plant.*

Note: It must be remembered that gymnosperms (e.g., pine), which lack anther and stigma, too have pollination. In gymnosperms, pollination involves the transfer of pollen from the 'male' cone to a 'female' cone.

TECH FILE

Tissue culture is a technique that involves growing plants from tissues, rather than cells. Plants such as asparagus and chrysanthemum can be grown by this technique. Through this technique, a small piece of tissue can be used to raise thousands of plants.

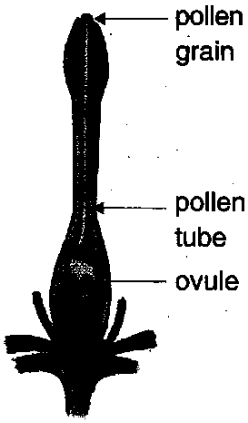


Fig. 2.11 *Events that lead to fertilization*

THINK QUEST

Some seeds have barbs, hooks, or spines? How do these structures help in their dispersal? (*Hint: Look at the picture carefully!*)

Cross-pollination *is the transfer of pollen grains produced in the anther of a flower to the stigma of another flower borne by a different individual of the same species.*

Artificial pollination The oldest method of growing plants or crops with desirable characteristics has been to select the best plants and use their seeds to raise the next generation. Once scientists understood how seeds are formed, they were able to induce pollination by deliberately brushing the pollen of one plant on the stigma of another to get a plant (initially a seed) with the desirable characteristics of both parent plants. This procedure is called *artificial pollination*.

There is another related technique called *hybridization* in which two individuals of different varieties are crossed to obtain an offspring known as a *hybrid* that has several desirable features. You will learn more about this technique in Chapter 8.

Fertilization

Successful pollination is followed by *fertilization*, during which the male and female gametes fuse to form the *zygote*. A pollen grain deposited on the stigma of a flower grows a tube (the *pollen* tube) that moves down through the style to reach the ovule (Fig. 2.11). The male gamete travels down the tube till it reaches the tip. The tip of the pollen tube dissolves to release the male gamete which fuses with the egg cell to form the zygote.

Fruit formation

The stimulus provided by pollination and fertilization sets up a series of changes in the flower. Usually, all floral whorls except the ovary fall off. The ovary enlarges to form the *fruit* and the ovules form the *seeds*.

Dispersal of seeds

Plants have developed various mechanisms to scatter or *disperse* their seeds. *The process by which seeds (or the fruits containing them) are scattered is called* ***dispersal.***

Usually, seeds are scattered by natural agencies such as wind and water. Many animals also help in seed dispersal when they throw away the seeds after eating fruits.

Germination of seeds

As a seed ripens and matures, the development of the embryo gradually ceases and the seed enters into a period of rest or *dormancy*. When conditions are favourable, the seed *germinates*.

The process by which a seed gives rise to a young plant or seedling is called ***germination***.

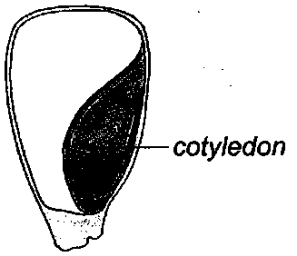


Fig. 2.12 *Monocot seed*

A typical seed has an outer seed coat, which, when removed, exposes the *embryo*. The embryo consists of an *axis* and fleshy structures called *cotyledons* that store food for the growth of the embryo. Seeds with a single cotyledon are called *monocotyledonous seeds* (or monocots) (Fig. 2.12) and those with two cotyledons are called *dicotyledonous seeds* (or dicots) (Fig. 2.13). The axis of the embryo has two parts—the *radicle* and the *plumule*. The radicle gives rise to the *root system* and the plumule gives rise to the *shoot system* of the seedling.

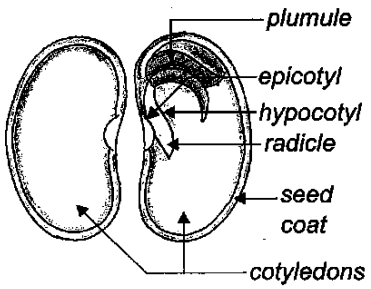


Fig. 2.13 *Dicot seed*

Conditions required for germination:

For germination to occur, it is essential for seeds to have access to water, oxygen, suitable temperature, and light.

Water Dormant seeds are dry, containing only about 5 to 10 % of water. In the right amount of water the seed starts to swell and finally the seed coat breaks open. The root emerges first followed by the shoot.

Oxygen Plants require oxygen for respiration, which in turn helps release the energy from the food they absorb from the cotyledons.

Temperature Different groups of plants have a different range of optimum temperatures for germination. A broad range would be between 10 °C and 35 °C.

FACT FILE

The length of time during which seeds can remain dormant varies from a few weeks to up to 50 years. Some lotus seeds which were 10 000 years old were planted in suitable conditions by scientists; they started to germinate!

ACTIVITY

Aim: Exploring the conditions required for germination—using controls.

Materials required: Three beakers, twelve bean seeds, cotton wool, and water.

Procedure:

1. Label the beakers A, B, and C.
2. In beaker A, put some dry cotton wool and three bean seeds. Keep the beaker in a warm place (at around 30 degree Celsius).
3. In beaker B, put some moist cotton wool and three bean seeds. Keep the beaker inside a refrigerator.
4. In beaker C, put some moist cotton wool and three bean seeds. Keep the beaker in a warm place (at around 30 degree Celsius).
5. Watch the beakers for any changes for about 5 days. Keep the cotton wool moist in beakers B and C.

Record your observations in the following format:

Beaker	Right temperature	Oxygen	Water	Germination observed?
A	Yes	Yes	No	.....
B	.....	.....	.....	.....
C	.....	.....	.....	.....
D	.....	.....	.....	.....

Note: Bean seeds require water, oxygen, and warmth (a temperature of around 30 degree Celsius) for germination. Seeds kept in beaker A received oxygen and warmth, but no water. Seeds placed in beaker B received oxygen and water, but no warmth. Only the seeds kept in beaker C received all three conditions required for germination—oxygen, water, and warmth. Beakers A and B act as *controls.*

Light Seeds of some plants (e.g., the princess tree) require light for germination.

TYPES OF GERMINATION

In the plant kingdom one comes across two main types of germination: hypogeal and epigeal. The main difference is whether the cotyledons are pushed above the ground or remain underground.

FACT FILE

Most seeds require oxygen for germination. However, there are some seeds (e.g., those of *Echinochola oryzicola*) that germinate using anaerobic respiration.

Hypogeal germination Hypogeal germination is seen in monocots and some dicots. In this type of germination, the cotyledons remain under the ground. The epicotyl grows actively and elongates to form the shoot and true leaves emerge from this structure (Fig. 2.14). Maize, rice, and wheat are examples of monocots that show hypogeal germination. Gram and pea are examples of dicots that show this type of germination.

TECH FILE

Cotyledons do not always provide the nutrients required by the seedling. Members of Orchidaceae, the largest plant family, have tiny seeds whose cotyledons store virtually no nutrients. In nature, these seedlings depend on fungi for their nutritional needs.

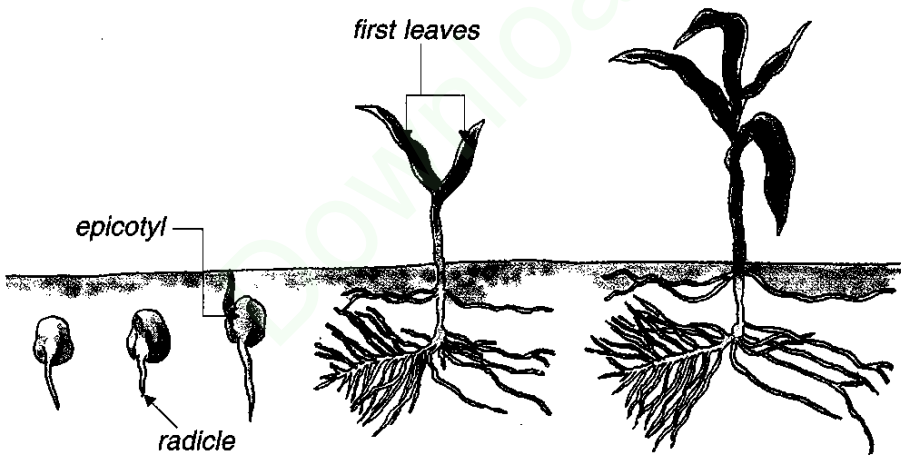


Fig. 2.14 *Hypogeal germination*

Epigeal germination Epigeal germination is seen in most dicots. In this type of germination, the cotyledons are brought above the ground. It is the hypocotyl that elongates and pulls the cotyledons above the soil. The hypocotyl, which is initially curved, straightens and the cotyledons spread horizontally to become leaf-like (Fig. 2.15).

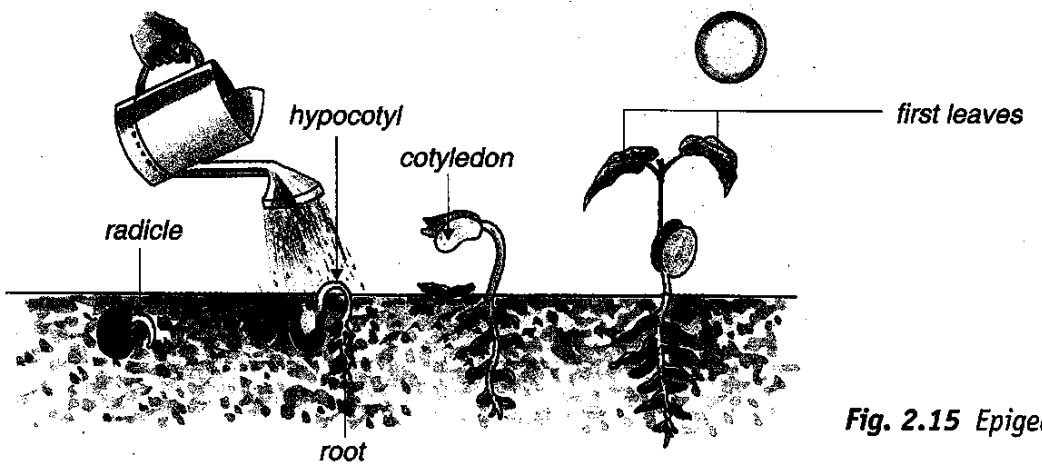


***Fig. 2.15** Epigeal germination*

ACTIVITY

Aim: To study different stages in hypogeal germination.

Materials required: Gram or maize seeds and a shallow cardboard box filled with garden soil.

Procedure:

1. Spread the soil and put five maize seeds about 2 inches apart on its surface, with just enough soil to cover the seeds.
2. Sprinkle water to moisten the soil and leave the set-up in a corner of the classroom. Water the soil daily to keep it moist and watch out for any change.
3. Take out one seed on the third day. You should be able to see that the seed has swollen up and the radicle has grown out of it.
4. Take out another seed on the fourth day; you should be able to see the epicotyl growing above the soil and roots beginning to replace the radicle.
5. On the fifth day, you should be able to see the shoot system with its leaves and stem. On the sixth day you should see the shoot system well-established. Allow the last two seeds to grow further to see additional changes. Ensure that the position of the seed is not disturbed during hypogeal germination.

Aim: To study different stages in epigeal germination.

Materials required: Bean seeds and a shallow cardboard box filled with garden soil.

Procedure:

1. Spread the soil and put five bean seeds about 2 inches apart on its surface, with just enough soil to cover the seeds.
2. Sprinkle water to moisten the soil and leave the set up in a corner of the classroom. Water the soil daily to keep it moist and watch out for any change.
3. Take out one seed on the third day; you should be able to see that the seed has swollen up and the radicle has grown out of it.
4. Take out another seed on the fourth day; you should be able to see the hypocotyl loop above the soil and the radicle establishing the primary root (tap root) and the secondary roots.
5. On the fifth day, the hypocotyl loops would have straightened up, raising the seeds above the soil level. You should also see a shoot system with its leaves and stem. On the sixth day you should see the shoot system well established. Allow the last two seeds to grow further to see additional changes.

Draw the various stages of hypogeal and epigeal germination on a sheet of paper.

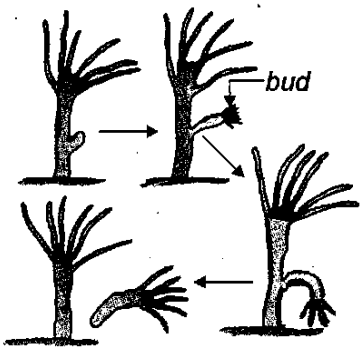


Fig. 2.16 Budding in hydra

REPRODUCTION IN ANIMALS

Animals also reproduce, both asexually and sexually.

Asexual Reproduction

Although asexual reproduction is widespread among flowering plants, it is rare in the animal kingdom and is confined to lower animals. Two common modes of asexual reproduction (budding and binary fission) are discussed below. Let us learn more about these modes of reproduction.

Budding

Hydra reproduces asexually by a process of budding. In this process the body wall bulges out and forms an outgrowth that develops a mouth and a ring of tentacles at its free end (Fig. 2.16). The cavity within the bud is continuous with that of the parent. Later a constriction appears at the point of attachment and the daughter hydra separates off to lead an independent life.

Binary fission

The reproduction and life history of *Amoeba* is simple as it only involves asexual reproduction, which usually takes place by *binary fission.*

When an *Amoeba* grows to its maximum natural size, it reproduces. The nucleus duplicates itself and the resultant nuclei move apart. A cytoplasmic constriction appears in the middle, deepens, and divides the animal into two halves, each containing a nucleus. Each of the daughter amoebae leads an independent life, grows up and reproduces again in the same manner. Figure 2.17 shows binary fission in *Amoeba.*

TECH FILE

During unfavourable conditions, *Amoeba* reproduces by a process called *multiple fission.* During this process, the *Amoeba* withdraws its pseudopodia and forms a protective cyst. The nucleus of the encysted animal enlarges and, by repeated division, forms a large number of daughter nuclei surrounded by a small speck of cytoplasm. These are called *spores.* The spores remain in a dormant state as long as conditions are unfavourable. With the return of normal conditions, the cyst wall bursts, liberating the spores. Each spore becomes an amoebula and leads a free life. It feeds actively and grows into an adult *Amoeba.*

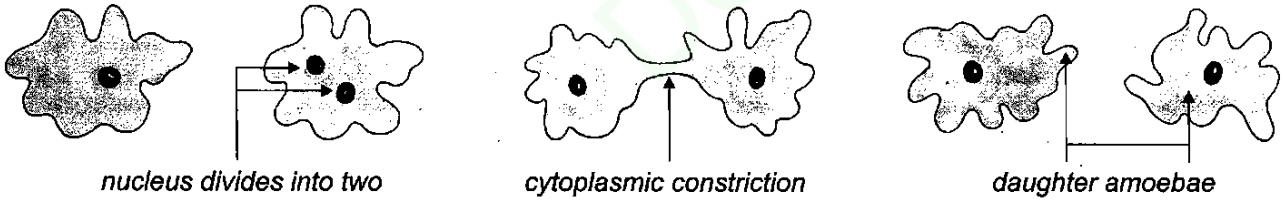


Fig. 2.17 Binary fission in Amoeba

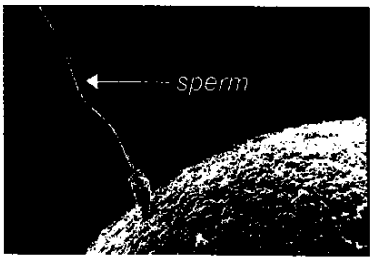
Sexual reproduction

Most animals reproduce sexually by producing special male and female reproductive cells called *sperms* and *ova* (Fig. 2.18), respectively. The sperm fuses with the ovum during fertilization, resulting in the formation of a single-celled structure called *zygote*, from which a new individual develops.

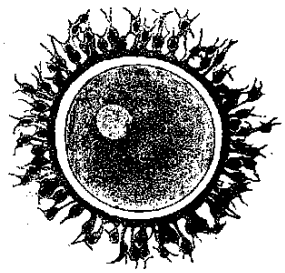
Fertilization may be internal or external. In *external fertilization* the sperm fuses with the ovum outside the body of the female (usually in water). In *internal fertilization* the ovum is fertilized inside the body of the female. Most aquatic animals have external fertilization, while land animals have internal fertilization.

In mammals, including humans, it is not only fertilization that is internal, but also the stages of development. In humans, development takes place inside a special reproductive organ called the *uterus* within the body of the female.

The *embryo* (unborn baby) derives all its nutrient requirements and oxygen from the maternal (i.e., mother's) blood and expells its metabolic wastes into the maternal blood through the *placenta*, to which it remains attached by the umbilical cord.



(a)



(b)

Fig. 2.18 *(a) Human sperm and (b) ovum*

REPRODUCTION IN HUMANS

Human reproduction, as in all higher animals, is accomplished sexually by the union of the specialized reproductive cells called gametes produced in the gonads—the testes producing sperms and the ovary producing ova. As in all other higher animals, sexes are separate in the humans.

Male reproductive system

In the reproductive system of the human male, the primary organs are a pair of *testes*. The testes produce the male reproductive cells or the male gametes called the *sperms*. The testes are located outside the body cavity in special structures called *scrotal sacs*. The sperms produced in the testes move out through the *vas deferens* into the *urethra* present inside the penis. Figure 2.19 shows the male reproductive system in humans.

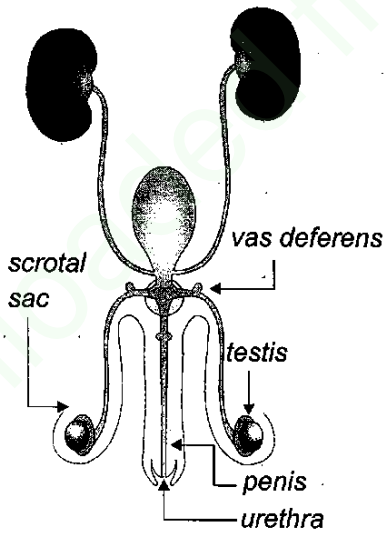


Fig. 2.19 *Male reproductive system*

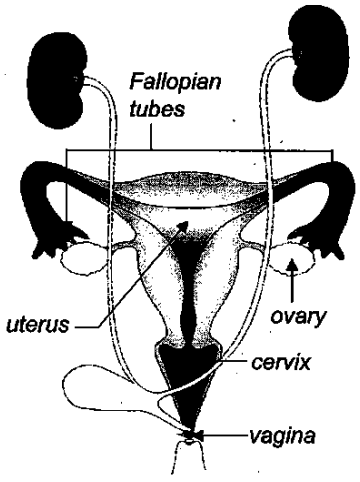


Fig. 2.20 *Female reproductive system*

Female Reproductive System

In the female, the primary reproductive organs are a pair of *ovaries*, situated in the abdominal cavity at the hip level. Each ovary is about the size and shape of a shelled almond. The female gametes called *ova* (*singular* ovum) are produced within the ovaries. The ova, when released, are carried by the oviducts or *Fallopian tubes* to the *uterus*. The uterus is situated behind and above the urinary bladder, in the lower part of the abdominal cavity. The narrow lower part of the uterus, called the *cervix*, opens to the exterior through a muscular tube called *vagina*. The vagina receives sperms during sexual intercourse and also serves as the birth canal. Figure 2.20 shows the female reproductive system in humans.

Fertilization

In the human female there is a reproductive cycle which is normally repeated every twenty-eight days. The cycle involves the maturation of an ovum in the ovary, its release, and the preparation of the uterus to receive the ovum *if it is fertilized.*

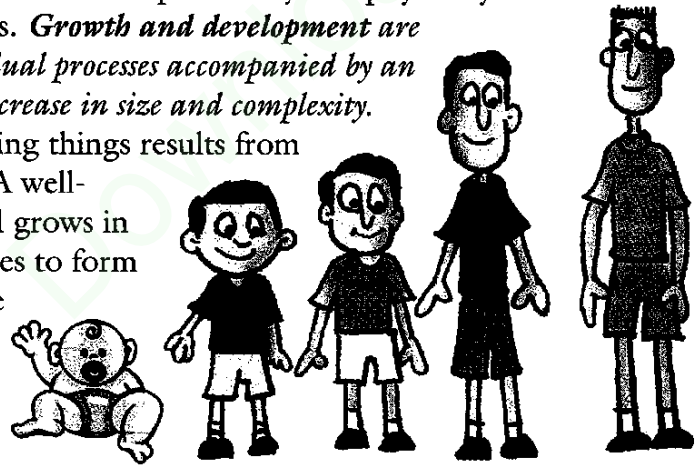
If the ovum is not fertilized, the lining of the uterus breaks down and disintegrates. The discharge of the disintegrated tissues and blood is termed *menstruation.* The bleeding lasts for about four days and the next menstruation takes place after twenty-eight days, if there is no fertilization within that time.

Steps to fertilization

1. The mature ovum or egg is released and travels up into the fallopian tube (also called the oviduct).
2. During sexual intercourse, a fluid called semen is discharged into the vagina. Each discharge of semen contains hundreds of millions of sperms. However, only one sperm is required to fertilize the ovum.
3. The sperms deposited in the vagina swim up to the uterus and then further up into the fallopian tubes. Here if a sperm meets an ovum, it fuses with it.
4. The fertilized ovum moves through the fallopian tube into the uterus. It gets implanted in the uterus and develops (over a period of nine months) into a foetus and then into a baby.

GROWTH AND DEVELOPMENT

A flower bud grows and develops to become a flower and the ovary in the flower grows further and develops into a fruit; children grow and develop mentally and physically to become adults. ***Growth and development*** *are slow and gradual processes accompanied by an irreversible increase in size and complexity.* Growth in living things results from cell division. A well-nourished cell grows in size and divides to form two cells. The resultant cells may repeat the processes.



Growth and Development in Plants

Plants continue to grow throughout their lives. Growth in plants is localized, being confined to the apical meristems at the tips of roots and stems, and to the cambium or the lateral meristem below the bark.

Growth and Development in Animals

In sexually reproducing animals, the zygote formed after fertilization divides rapidly to form a mass of cells. These cells eventually separate into groups, each group specializing to perform a particular function.

The process by which young, immature cells assume different characteristics to achieve a specific form and function is called ***cell differentiation.***

The specialized cells are, in time, organized into tissues, organs, and finally organ systems.

Sexually reproducing animals are divided into two broad groups:

(a) those that give birth to young ones (mammals) and
(b) those that lay eggs (most insects, fish, and reptiles; birds; and amphibians).

In the former, the baby at the time of birth has the same basic structure and shape as the parent and adult. In some of the latter, however, the newborn looks very different from the adult. So, how does the adult finally emerge from this young one? Let us learn about this process by taking the butterfly as an example.

Growth and development in a butterfly

After the male and the female mate, the female butterfly lays the eggs in batches of about fifty. The young one that hatches out of the egg, after about 10 days, feeds by itself but looks different from its parents.

A self-supporting immature young organism that does not resemble its parents is known as a ***larva.***

The larva of a butterfly or a moth is called a *caterpillar*. The tiny caterpillar grows as it feeds and *moults* (sheds its skin) five times at intervals. A full-grown caterpillar stops feeding and spins a pad of silk on a twig or a stem and attaches itself to it. This stage is referred to as the *pupa* or chrysalis (Fig. 2.21).

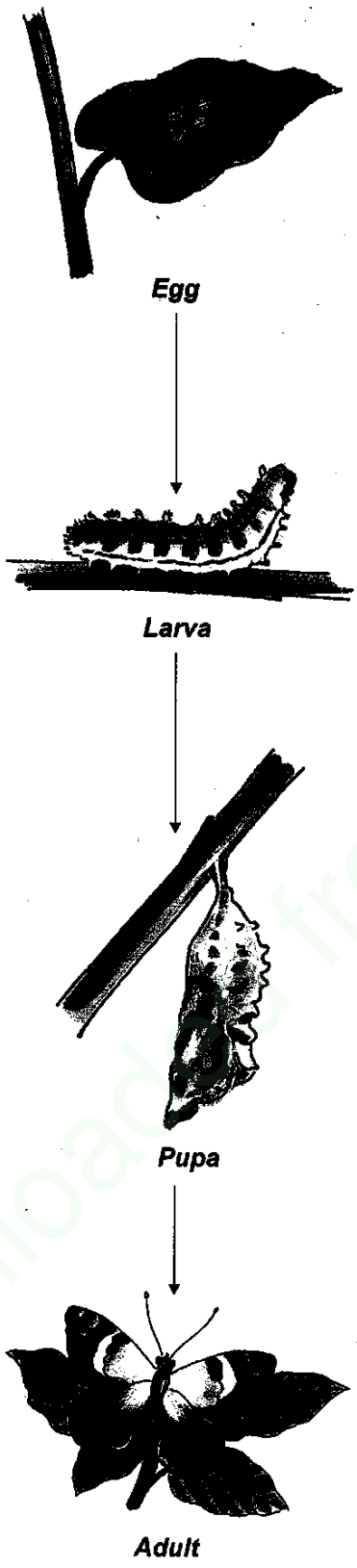


Fig. 2.21 *Stages in the life cycle of a butterfly*

FACT FILE

Some insects such as grasshoppers and cockroaches skip the larval and pupal stages in their life cycle. The eggs hatch into tiny nymphs, which resemble the adults except for their smaller size and absence of wings. This kind of development is referred to as *incomplete metamorphosis.*

During the early part of the pupal period, larval tissues break up and adult tissues and organs are built up.

The series of changes by which a larva becomes an adult are collectively termed ***metamorphosis.***

Growth and development in humans

Humans also undergo changes during their lifetime. Ask your parents for your old photographs, which were taken when you were still an infant. Now look at yourself in the mirror. Do you realize how much you have changed over the years! You are now at a very important stage in life called *adolescence.* This period is a very critical stage of growth characterized by important *physical, physiological, and emotional changes.*

Growth and development in humans can be divided into the following stages.

Infant This stage refers to the period between 1 month and 1 year of age.

Toddler This is the period between 1 and 4 years of age. Growth is very rapid and the children learn to balance themselves and walk, as the body's muscles and the arms and legs grow quickly to bear the weight of the head and the upper body.

Growth continues steadily till the onset of *puberty.*

Puberty refers to the sequence of events by which a child becomes a young adult.

Adolescent *The period (usually between the ages of 11 and 19) of transition from childhood to adulthood is called* ***adolescence*** (Fig. 2.22).

During this stage children usually experience a growth spurt, growing taller and gaining weight, in addition to a number of other physical and emotional changes.

Girls attain puberty before boys, usually around the age of 11 or 12 years, and the transition to adulthood is complete by the age of 17. In boys puberty starts between the ages of 12 and 14 and continues till the age of about 18. During this period, the following changes (called secondary sex characteristics) occur in the body.

Fig. 2.22 *Adolescent children*

1. Reproductive organs grow in size and become functional.
2. Boys develop a deep voice.
3. There is growth of hair in the pubic region. Boys also develop facial hair (moustache and beard).
4. In girls, breasts develop and increase in size and the menstrual cycle begins. The pelvic region also widens.

Problems related with adolescence: Adolescence is characterized by a series of physical, mental, and emotional changes. One may experience the following problems during this period of transition.

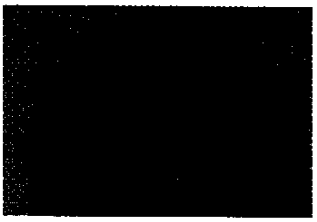
1. As the mind tries to adapt to the changes, One may experience periods of confusion and worry about how their changing body looks.
2. An adolescent may be extra sensitive to other people's opinions and may become easily upset or angry.
3. One might have lots of questions about sex and it is important to get them answered by the right source.
4. One may feel the urge to be independent yet feel unsure of oneself.

Adjusting to these changes may be difficult at first, but gradually an adolescent will become more comfortable. It can also help to talk to one's parents, or elder sister or brother, or any adult one feels close to.

In the teenage years, there will be many decisions that an adolescent will need to make to ensure good health. Eating right, exercising, and getting enough rest are important during puberty because of all the changes the body is going through. It is also important to feel good about oneself and the decisions one makes. One has to learn to care for one's own body, work hard and maintain good health, and to like oneself as they are.

Adult From the age of 18 years onwards, a person is called an adult. Growth does not cease entirely at the end of adolescence. The limb bones stop growing in length but the face and the jaws continue to grow slowly throughout life, and the nose and the jaw become more prominent. The bones of the hand and feet also widen.

FACT FILE



Acne (also known as pimples) is a skin condition characterized by inflammation of oil glands in the skin. This condition is common during adolescence. In most people, acne tend to disappear in the early twenties.

KEYWORDS

Reproduction The ability of living organisms to produce living beings similar to themselves
Asexual reproduction The formation of individuals from the cells of a single parent
Sexual reproduction The formation of individuals by the fusion of male and female gametes
Calyx Outer protective floral whorl; consists of units called sepals
Corolla Inner protective floral whorl; consists of units called petals
Androecium Inner floral whorl consisting of units called stamens
Gynoecium The innermost whorl
Carpel Units of gynoecium
Pollination Transfer of pollen from the anther to the stigma of a flower
Self-pollination The transfer of pollen grains produced in the anther of a flower to the stigma of the same flower or to the stigma of another flower borne by the same plant
Cross-pollination Transfer of pollen grains produced in the anther of a flower to the stigma of another flower borne by a different individual of the same species
Gametes Cells specially produced for reproduction
Fertilization The process of fusion between the male and female gametes
Zygote Structure formed by the fusion of the male and female gametes
Metamorphosis The series of changes by which a larva changes into an adult
Adolescence The period of transition from childhood to adulthood

SUMMARY

- All living things reproduce.
- In plants, asexual reproduction takes place through budding, fragmentation, and spore formation. Plants also multiply using their vegetative parts such as root, stem, or leaf.
- A flower typically has its parts arranged in four whorls: calyx, corolla, androecium, and gynoecium.
- In plants, sexual reproduction is preceded by pollination, during which the pollen produced in the anther is deposited in the stigma of a flower.
- Seeds that are dormant begin to germinate when conditions become favourable; these conditions being availability of water, oxygen, and suitable temperature.
- Germination may be hypogeal (during which the cotyledons remain underground) or epigeal (during which the cotyledons are raised above the ground).
- Simple animals like *Amoeba* reproduce asexually by fission.
- Growth and development in certain animals, such as butterflies and moths, involve a larval stage and metamorphosis of the larva into an adult.
- Adolescence is characterized by a series of physical, mental, and emotional changes.

EXERCISES

I. Review questions

A. Fill in the blanks

1. Yeast multiply by ..... (fragmentation/budding).
2. Flowers with both male and female organs are termed ..... (unisexual/bisexual).
3. The four floral whorls are the calyx, the ..... (stigma/corolla), the androecium, and the gynoecium.

4. The process by which seeds (or the fruits containg them) are scattered is called ..... (pollination/dispersal).
5. Gram and pea show ..... (hypogeal/epigeal) germination.

B. Tick the correct answer

1. Sexual reproduction involves formation of special reproductive cells called
   (a) buds (b) gametes (c) grafts (d) offsets
2. The leaves of this plant can give rise to a new plant
   (a) rose (b) sunflower (c) *Bryophyllum* (d) dahlia
3. The usual mode of reproduction in *Amoeba* is
   (a) multiple fission (b) fragmentation (c) budding (d) binary fission
4. The primary organs of human male reproductive system:
   (a) vas deferens (b) ovaries (c) testes (d) kidneys
5. The series of changes by which a larva changes into an adult:
   (a) adolescence (b) metamorphosis (c) puberty (d) hybridization

C. Correct the statements that are false

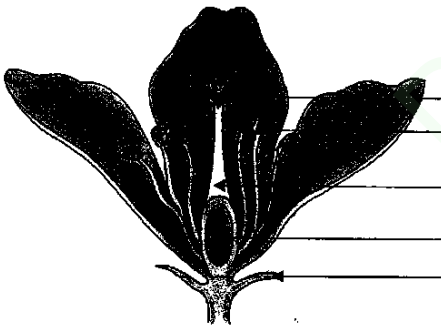
1. Monocotyledonous seeds have a single cotyledon.
2. The radicle gives rise to the shoot system.
3. The embryo derives its nutritional requirements from the maternal blood.
4. Epigeal germination is common in monocots.

D. Answer the following

1. Define reproduction? Describe any two modes of asexual reproduction in plants.
2. Name any two plants that can grow vegetatively with the help of their (a) roots and (b) stem.
3. Define pollination? What is the difference between self-pollination and cross-pollination?
4. What is artificial pollination?
5. What is germination? List the conditions required for germination.
6. Explain hypogeal germination and epigeal germination with the help of labelled diagrams.
7. Explain the process of binary fission.
8. Draw a labelled diagram of the human male reproductive system.
9. Draw a labelled diagram of the human female reproductive system.
10. What is adolescence? What changes occur in the body during this period.

II. Skill-based questions

E. Insert the missing labels in the following diagram:



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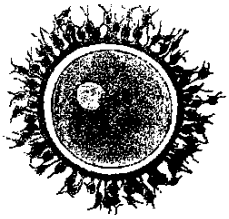
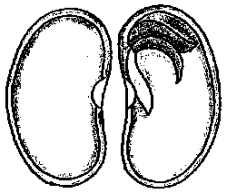
F. Identify the following images:



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III. Fun Time

Complete the following words (Hint: You must have come across these terms in this chapter.)

P.... .... I .... A T I .... C .... L .... Z .... GO .... E E .... I .... A L

PROJECT IDEAS

- Students can write a report on Siamese twins. The report should answer the following questions.
  (a) How are Siamese twins produced?
  (b) Is it possible to separate Siamese twins? How?
- Students can measure heights and weights of children in different classes and find the average height/weight for each age group. They can present their findings in the form of a report.
- Students can make a chart on vegetative reproduction in plants.

TEACHER'S NOTES

- Students may think of pollen grains as the male gamete in flowers rather than carriers of the male gamete. This should be clarified
- It should be emphasized that in plants sexual reproduction can take place even with a single parent since plants can be bisexual too, bearing both male and female reproductive organs in the same flower.
- Films on human development and puberty can be shown in the classroom, if possible.
- The activity carried out in lower classes to study different parts of a flower could be repeated.

Website References

http://www.bbc.co.uk/scotland/education/bitesize/standard/biology/world_of_plants/growing_plants_rev3.shtml (accessed 28 May 07)
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