CHAPTER

14

Reproduction

Animation14.1:Geotropism,
Source & Credit: Leaving Bio.net

In this chapter we shall explore the various ways in which organisms reproduce.

14.1 Reproduction

Reproduction is defined as the production of individuals of the same species i.e. the next generation of species. While it is one of the fundamental characteristics of living things, it is not an essential life process.
Reproduction is thus essential for the continuation of species. It ensures that the genetic material of one generation is transmitted to the next. Each generation produces more offsprings for the next generation. Many individuals die due to various reasons like diseases, competition, genetic factors etc. before reaching the reproductive age. Only the fittest and the best survive can reach the reproductive age. This ensures that the advantageous characteristics are transmitted to the next generation.

In previous classes we have learnt the two basic types of reproduction. Asexual reproduction means simple cell division that produces an exact duplicate of an organism. There are many types of asexual reproduction which we shall discuss on the following pages. Sexual reproduction involves the joining (fusion) of male and female sex cells i.e. gametes.

14.2 Methods Of Asexual Reproduction

Asexual reproduction does not involve the fusion of gametes. There are many types of asexual reproduction, all producing individuals that are genetically identical to each other and to the parent.

14.2.1 Binary Fission

Binary fission means “division into two”. It is the simplest and most common method of asexual reproduction. It occurs in prokaryotes (bacteria), many unicellular eukaryotes e.g. protozoa (Fig. 14.1) and some invertebrates. During binary fission in bacteria, the DNA is duplicated and so two copies of DNA are formed. The two copies move towards the opposite poles of cell. The cell membrane invaginates in centre and divides the cytoplasm into two. New cell wall is deposited between two cross membranes. It results in the formation of two daughter bacteria, which grow in size and divide again.

An individual can live without reproducing, but a species cannot survive without reproduction.

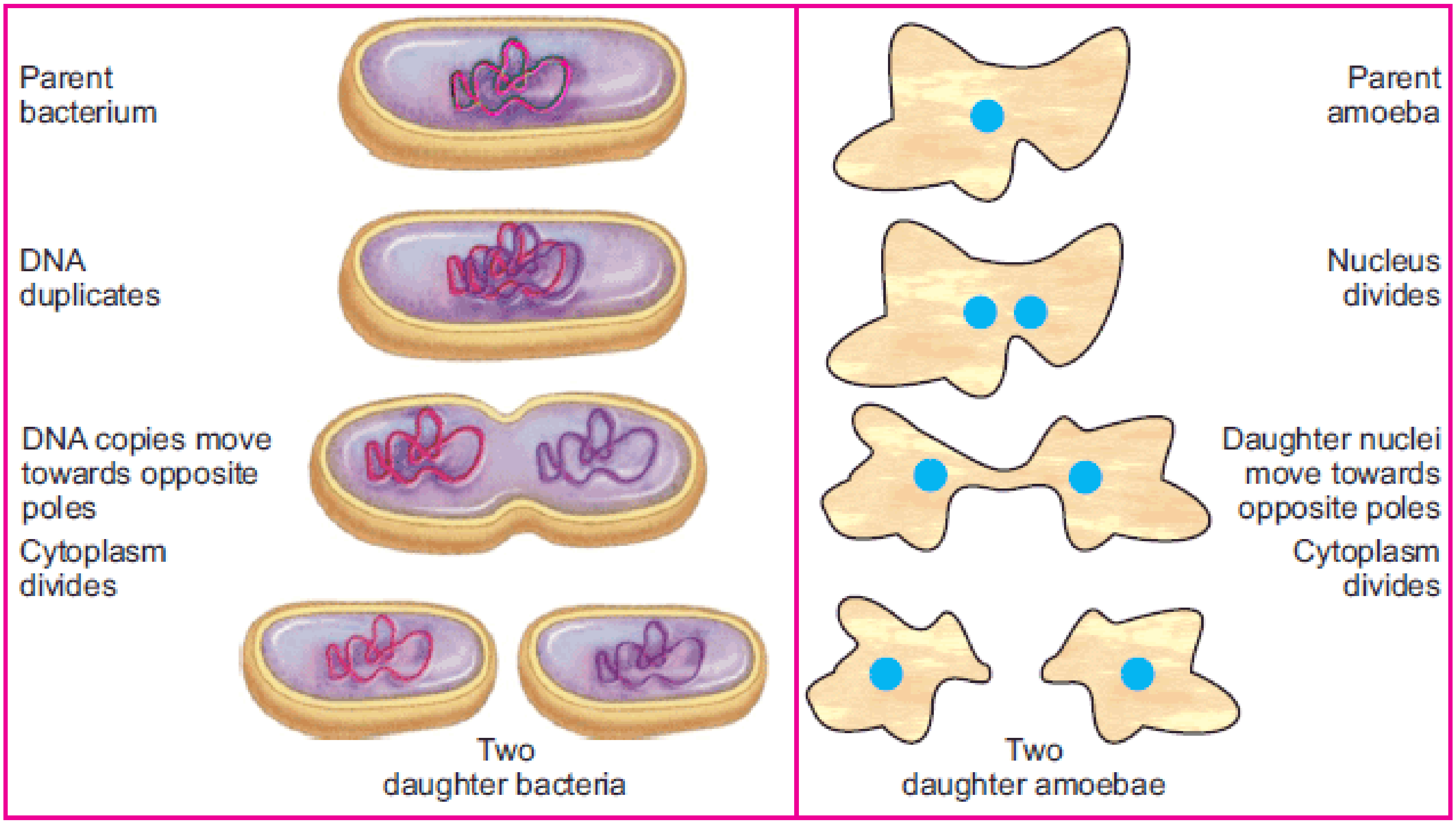


Figure 14.1: Binary fission in a bacterium (left) and in an Amoeba (right)

Animation14.3:Reproduction in plants
Source & Credit:washingtonch

During binary fission in unicellular eukaryotes, the nucleus of parent organism divides into two (by mitosis). It is followed by the division of cytoplasm. So two daughter cells of almost equal size are formed. Daughter cells grow in size and then divide again.

Practical:
Draw different stages of binary fission in Amoeba after observing them in slides or charts.

Some invertebrates also reproduce asexually through binary fission. During this reproduction, body is cut into two halves (fission) and the missing body parts are regenerated in both halves. This type of asexual reproduction is common in planaria (Fig. 14.2) and many echinoderms.

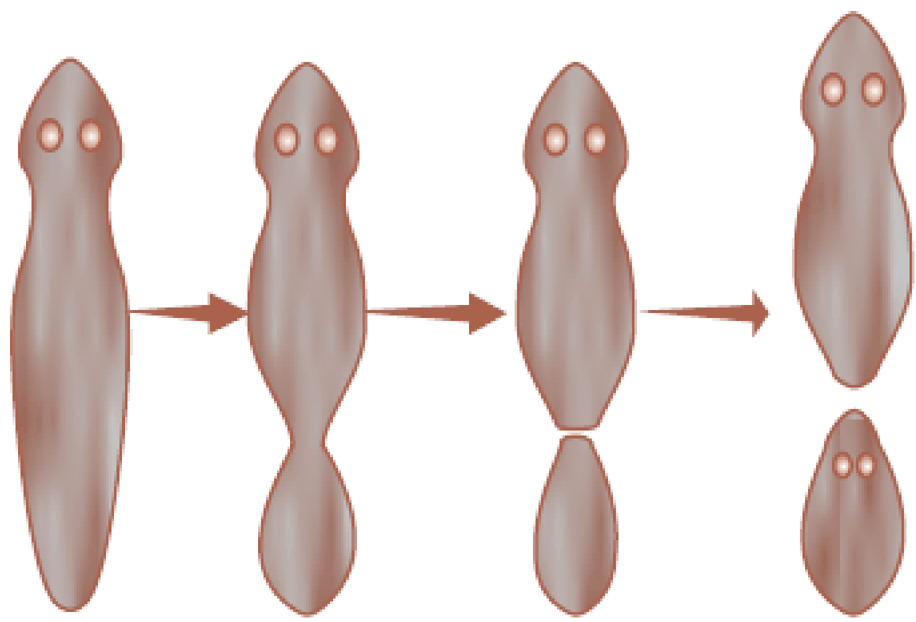
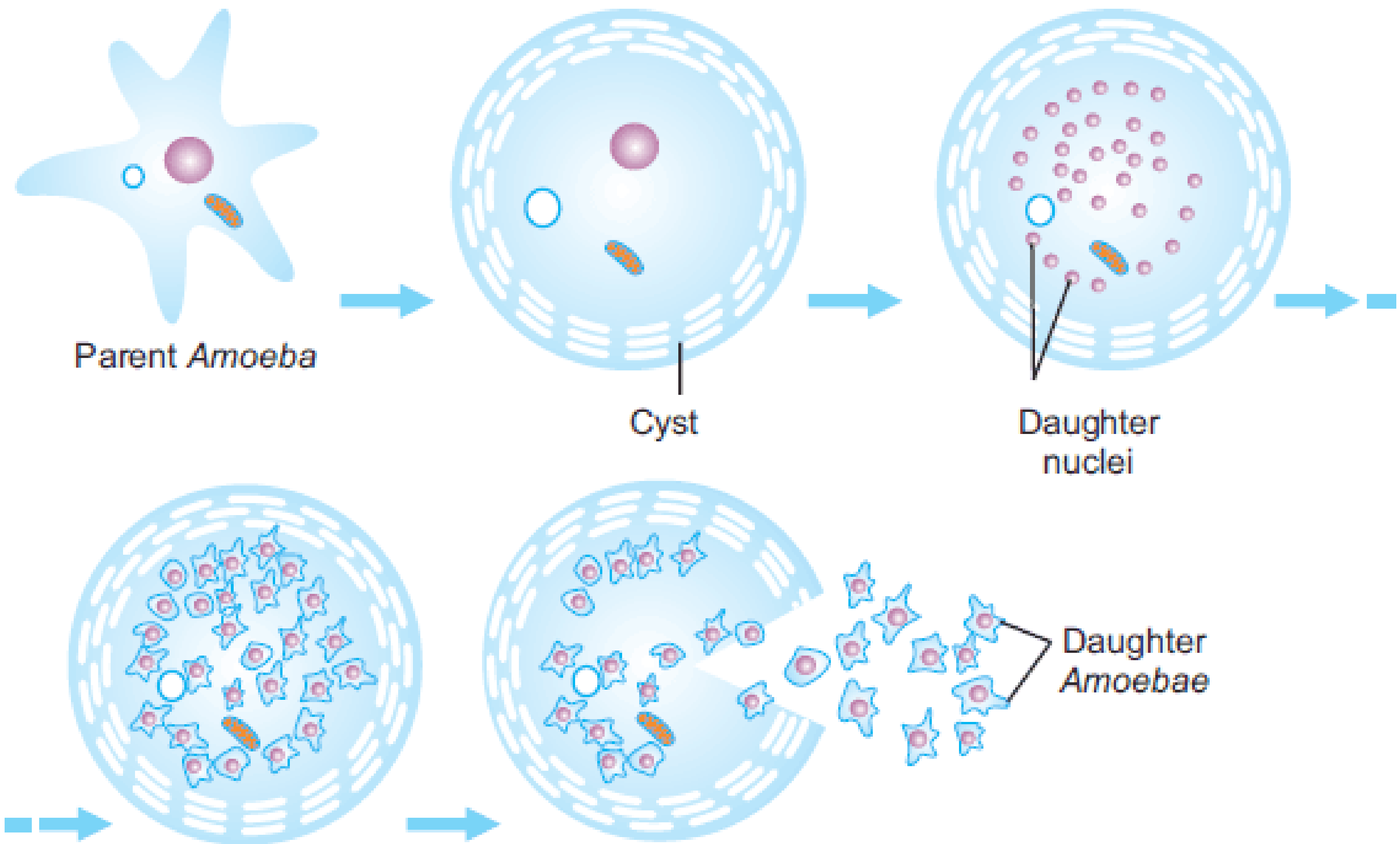


Figure 14.2: Binary fission in a planarian



Some unicellular organisms (e.g. Amoebae) form hard walls called cysts around them, under unfavourable conditions. When favourable conditions return, the nucleus of parent divides into many daughter nuclei by repeated divisions. This is followed by the division of cytoplasm into several parts. Each new part of cytoplasm encloses one nucleus. So a number of daughter cells are formed from a single parent at the same time. This kind of fission is known as multiple fission.

14.2.2 Fragmentation

As certain worms grow to full size, they spontaneously break up into 8 or 9 pieces. Each piece (fragment) develops into a mature worm, and the process is repeated. If a planarian breaks into many pieces instead of two, it will also be called as fragmentation.

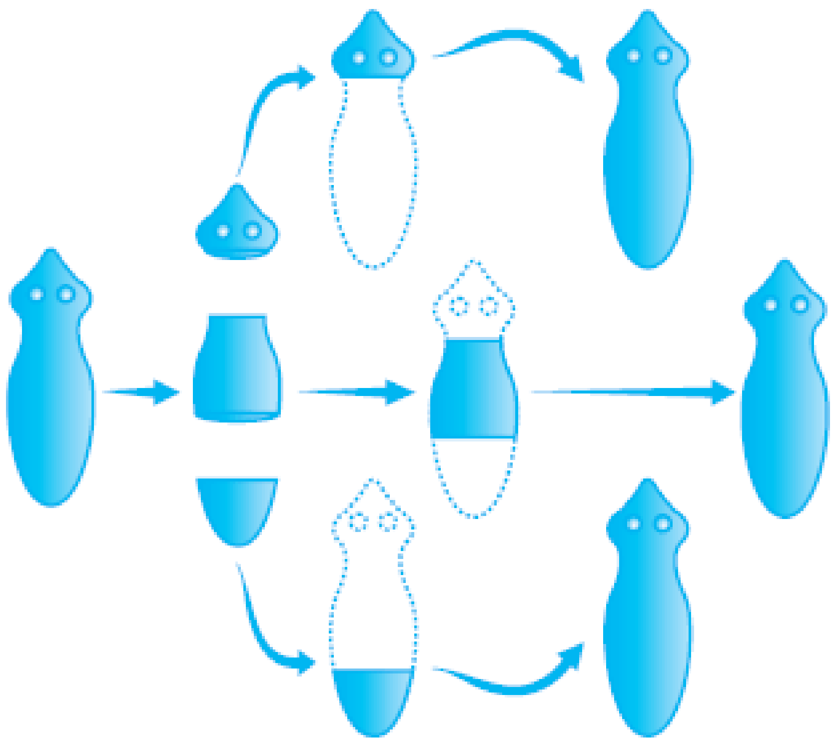


Figure 14.3: Fragmentation in a planarian

14.2.3 Budding

In this type of asexual reproduction, a bud develops as a small outgrowth on parent's body. In case of yeast (a unicellular fungus) a small bud is formed on one side of cell. The nucleus of cell divides and one of the daughter nuclei is passed into the bud. Parent cell may form more than one bud at a time. Each bud enlarges and develops the characteristics of parent organism (Fig. 14.4). The bud may separate from parent body. In some cases, the buds never separate and as a result, colonies of individuals are formed.

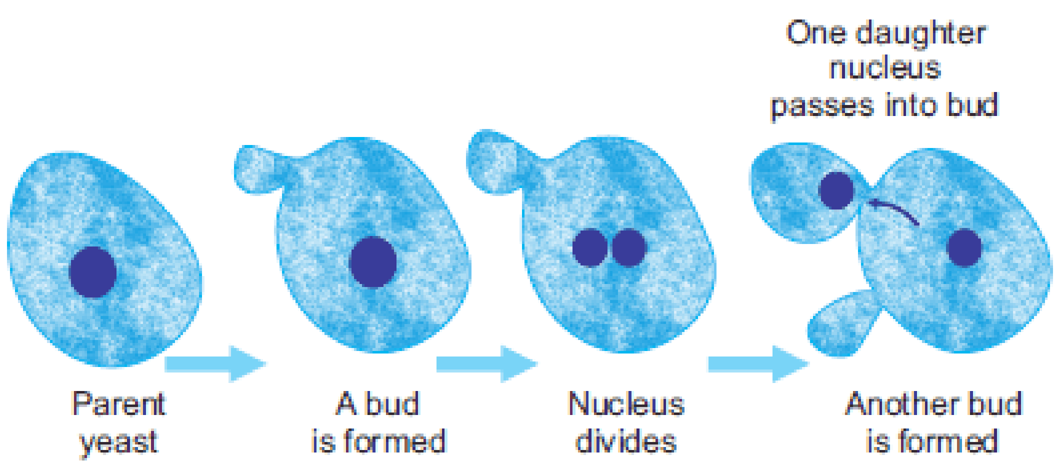


Figure 14.4: Budding in yeast

Animals such as sponges, Hydra and corals also reproduce by means of budding. In them, a small bud is formed on the side of body, by mitosis. This bud enlarges by the formation of more cells. It then detaches from the parent body and grows into new organism.

In corals, the buds do not detach from the parent body. Corals form big colonies, because the buds grow into new organisms by remaining attached to the parent body.

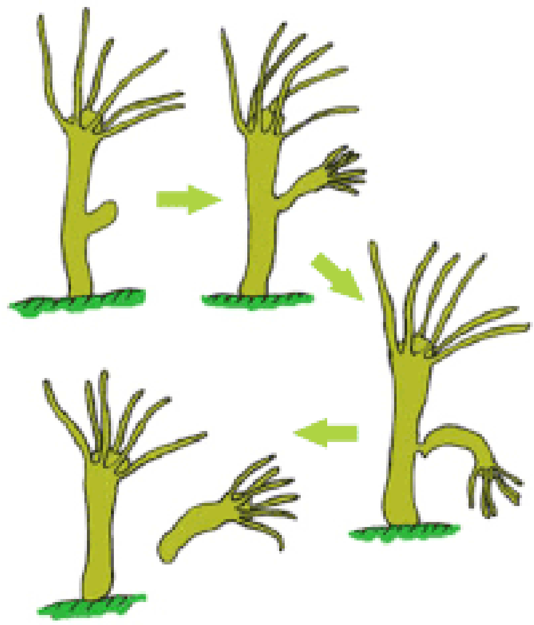


Figure 14.5: Budding in Hydra

14.2.4 Spore Formation

It is generally seen in most fungi (e.g. Rhizopus). When *Rhizopus* reaches reproductive age, its body cells form thick walled spore sacs called sporangia (sing. sporangium).

Inside each sporangium, a cell divides many times and forms many daughter cells called spores. Each spore is covered with a thick wall called cyst and it can survive unfavourable conditions. When sporangia are mature, they burst and release spores. Under favourable conditions, the spores germinate and develop into new *Rhizopus*.

Under unfavourable conditions, some species of bacteria reproduce by forming spores, e.g. *Clostridium* and *Bacillus* species. The bacterial spores are also thick-walled. They are formed inside bacterial cells, so are called endospores (Fig. 14.7).

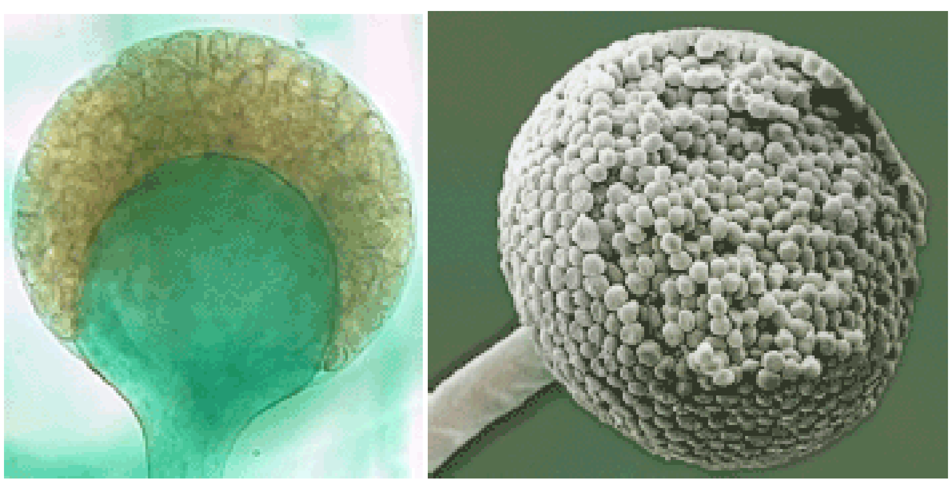


Figure 14.6: Spore formation in Rhizopus; Mature sporangium (left), sporangium bursts (right)

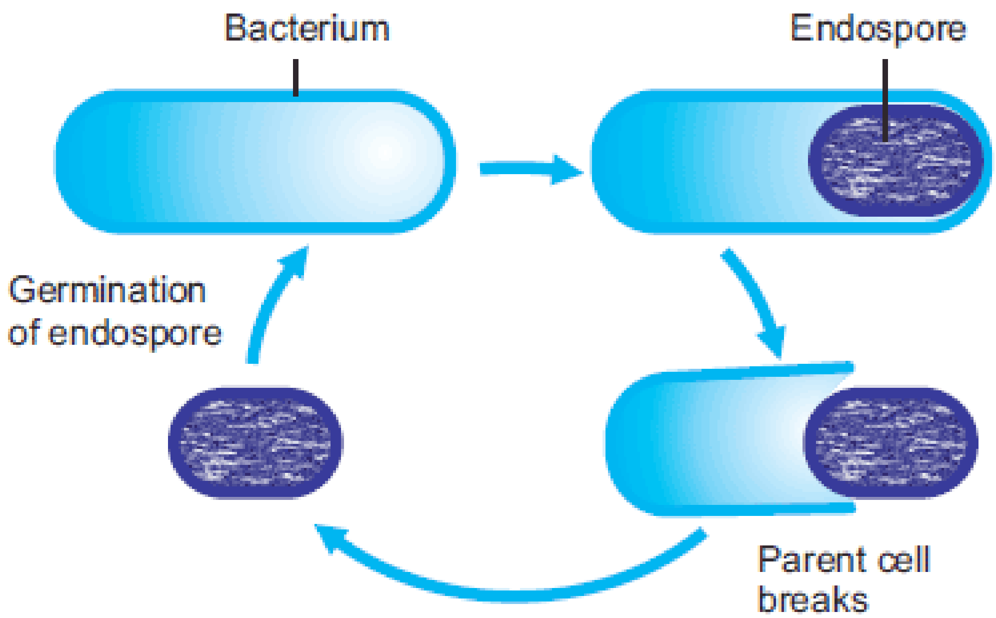


Figure 14.7: Spore formation in a bacterium

14.2.5 Parthenogenesis

Parthenogenesis is also considered as a form of asexual reproduction. In it, an unfertilized egg develops into new offspring. Some fishes, frogs and insects reproduce by means of parthenogenesis. Similarly, queen honeybee lays eggs in the cells of honeycomb. Many eggs remain unfertilised and develop into haploid males (drones) by parthenogenesis. At the same time, some eggs are fertilized by male bees and these develop into diploid females (new queen and worker bees).

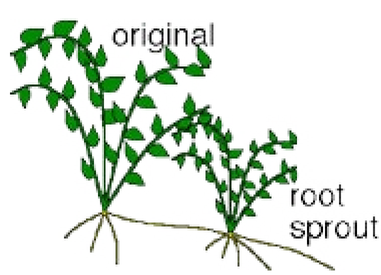
14.2.6 Vegetative Propagation

When vegetative parts of plants i.e. roots, stems or leaves give rise to new plants, the process is called vegetative reproduction or vegetative propagation. It occurs naturally, and can also be brought about artificially.

Natural Vegetative Propagation

Vegetative propagation occurs naturally in several ways.

1. Bulbs are short underground stems surrounded by thick, fleshy leaves that contain stored food. Adventitious roots emerge under the base of bulb while shoots emerge from the top of the base. Tulips, onions and lilies reproduce by bulbs.



Natural Vegetative Propagation

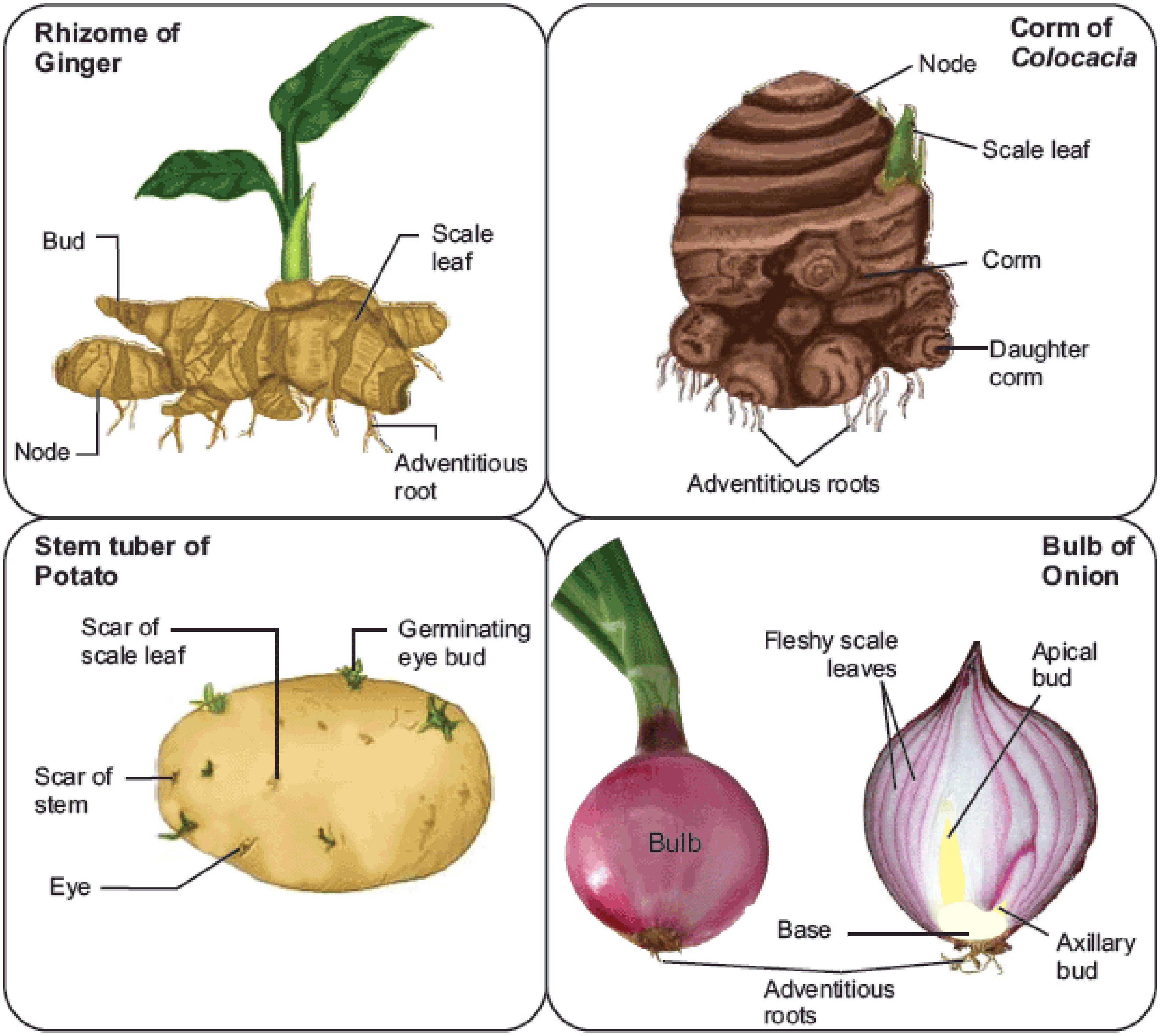


Figure 14.8: Some types of natural vegetative propagation

2. Corms are short and swollen underground stems containing stored food. Buds are present at the top of corm. From a bud, shoot grows and forms a new plant. Dasheen and garlic reproduce by corms.

3. Rhizomes are horizontal underground stems with scale leaves. There are enlarged portions called nodes on rhizome. Buds are produced at nodes. The buds present on the upper surface of rhizome give rise to shoot. The lower surface of rhizome produces adventitious roots. Ginger, ferns and water lilies reproduce by rhizomes.

4. Stem Tubers are the enlarged portions of an underground stem (rhizome). There are aggregations of tiny buds in the form of "eyes" along the surface of tuber. Each bud develops into shoot that grows upward and also produces roots. Potatoes and yams reproduce by tubers.

5. Suckers are lateral stems close to ground level. A sucker grows underground from some distance and then turns up, producing the new plant. Mint and *Chrysanthemum* reproduce in this way.

6. Vegetative propagation by **leaves** is not common and is seen in plants such as *Bryophyllum* (Pather chut). This plant has fleshy leaves and adventitious buds are present at the margins of leaves. When leaf falls on ground, the buds grow into new plants.

Artificial Vegetative Propagation

Gardeners and farmers use artificial methods of vegetative propagation to increase the stock of a plant. The following two are the most common methods of artificial vegetative propagation (Fig. 14.10).

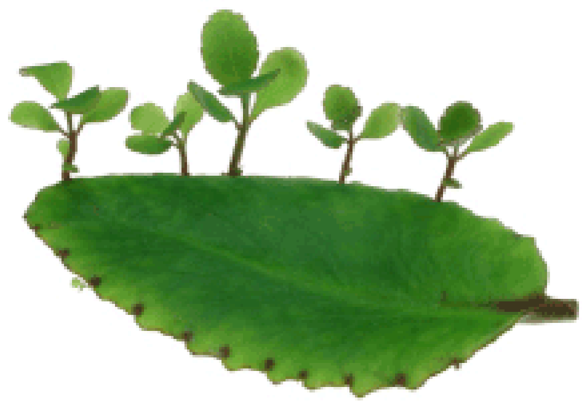


Figure 14.9: A Bryophyllum leaf with buds

1. Cuttings

In this method, cuttings may be taken mainly from the stems or roots of parent plant. These cuttings must have a meristematic region from which growth can occur. When cuttings are placed in a suitable soil and under right conditions (sufficient nutrients, water and sunlight), they form roots and shoots. Roots and shoots grow and develop into a plant identical to the parent plant from which the cuttings were taken. Roses, ivy and grapevines are propagated by stem cuttings. Sweet potato is an enlarged root. Farmers place it in moist sand or soil until it produces several plantlets. Then the plantlets are removed and planted. This process is used to produce many plants from a single plant. All new plants are exactly the same. This artificial vegetative propagation has been very beneficial on sugar cane plantation.

2. Grafting

In grafting, a piece of stem is cut from the plant and is attached with another plant with established root system. After a while, the vascular bundles of the attached stem piece and the host plant are connected to each other.

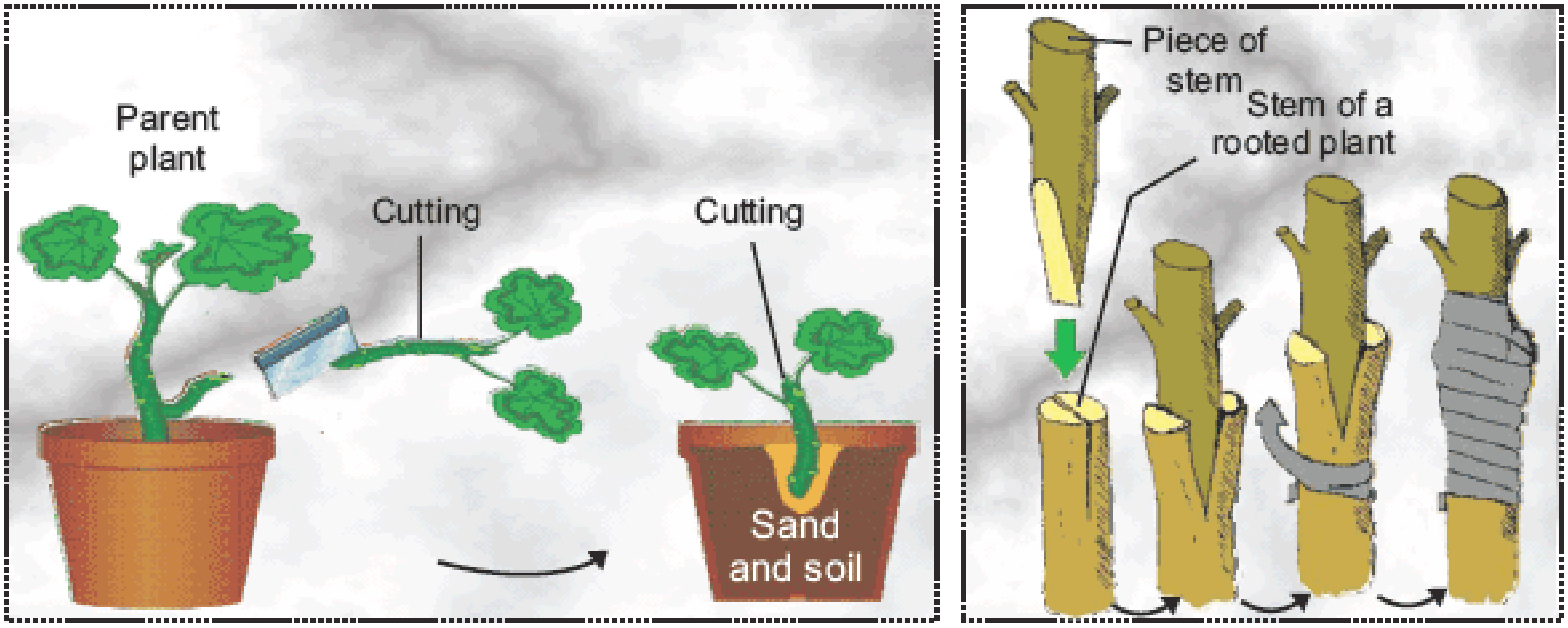


Figure 14.10: Artificial vegetative propagation: Cutting (left) and Grafting (right)

The stem piece and the plant begin to grow together. This method is used to propagate many .(roses, peach trees, plum trees and various seedless fruits (including grapes

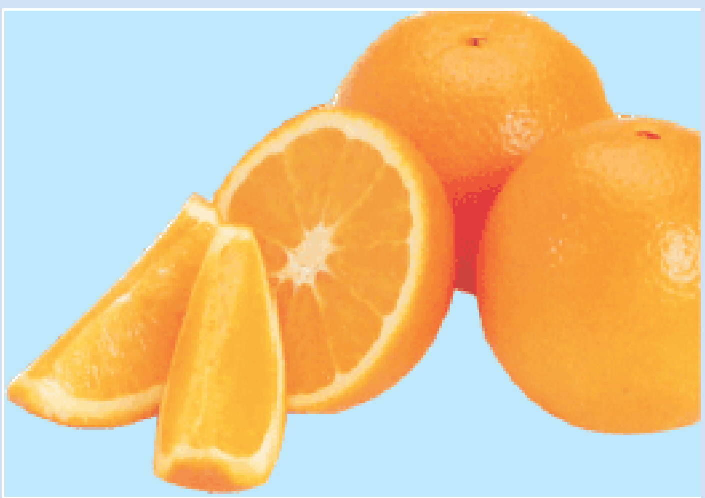


Figure 14.11: Product of artificial vegetative propagation: Seedless oranges

Advantages and Disadvantages of Vegetative Propagation of Plants

Plants can reproduce asexually via vegetative propagation. This method of reproduction has some advantages and disadvantages as well.

Advantages

The offsprings produced through vegetative propagation are genetically identical. Therefore beneficial characteristics can be preserved. In vegetative propagation, there is no need of any mechanism of pollination. It helps to increase number of plants at a rapid rate. The organs of vegetative propagation enable many plants to pass over unfavourable conditions. Plants bearing seedless fruits can be grown only by vegetative propagation.

Disadvantages

The plants do not have genetic variations. Species specific diseases can attack and this can result in the destruction of an entire crop.

Tissue Culture and Cloning

Cloning is the latest method of vegetative propagation. In this method, identical offsprings are produced from a single parent using its vegetative tissue or cell. Tissue culture is the technique applied in this method.

This method of propagation is also called micro-propagation since it uses only a small part of plant.

Tissues are taken from any part of plant and are put in a suitable nutrient medium. The tissue cells start mitosis and produce masses of cells called calluses are transferred to other medium that contains different hormones for the formation of roots, stem and leaves. Calluses make these structures and grow into new small plants. The small plants are then planted in pots and then in fields.

Practical:
Examine the specimens of onion, corn, ginger and potato and write the modes of their reproduction.

? Write in sequence the underground stems for vegetative propagation in onion, ginger, potato and garlic.

Bulb, rhizome, stem tuber and corm

14.3 Sexual Reproduction In Plants

Sexual reproduction involves the production of gametes (sperms and egg cells) and their fusion i.e. fertilization. Gametes are produced in special structures in plant body. The major plant groups are mosses, ferns and seed plants. The seed plants include gymnosperms and angiosperms (flowering plants). Plant groups use different methods for bringing the sperm and egg cells together. In mosses and ferns sperms are motile and can swim to egg cells. Therefore, these plants require water (in the form of dew or rain) for sexual reproduction. On the other hand, gymnosperms and angiosperms have special methods for carrying their sperms to egg cells. They do not need water for reproduction.

In the life cycle of plants, two different generations alternate with each other. One generation is diploid and produces spores. It is called sporophyte generation. The other generation is haploid and produces gametes. It is called gametophyte generation. The phenomenon in which two different generations alternate with each other during life cycle is known as alternation of generations.

In most plants, sporophyte generation is dominant. It means that it is big in size and is independent. Sporophyte produces haploid spores by meiosis. The spores develop into gametophyte. It is small in size and depends upon sporophyte. It produces gametes by mitosis. The male and female gametes fuse and form diploid zygote. The zygote undergoes repeated mitosis and develops into a new diploid sporophyte (Fig. 14.12).

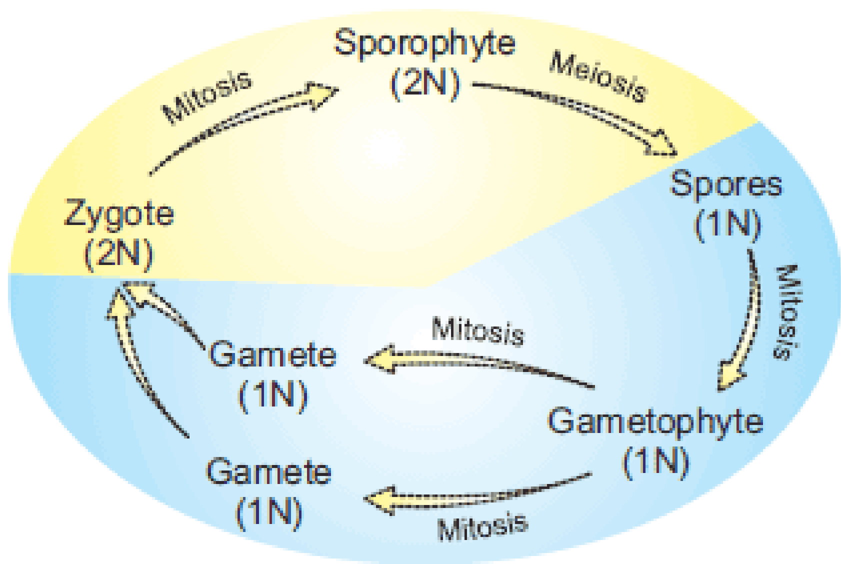


Figure 14.12: An overview of alternation of generations in plants

14.3.1 Sexual Reproduction in Flowering Plants

We know that in angiosperms, parent plant is diploid sporophyte generation. Flower is the reproductive structure in this generation. The flower components are arranged in the form of whorls. The outer two whorls in a flower are are the non-reproductive whorls while the inner two
whorls are the reproductive whorls.

The flower is actually a condensed shoot with the nodes present very close to each other. The different parts of the flower are attached to the nodes. All the structures present at one node are collectively called the whorl.

Calyx is the outermost whorl. It is usually green in colour. Its individual units (leaflets) are called sepals. Sepals protect the inner whorls at bud stage. Corolla is the next inner whorl and is often coloured brightly. Its individual units (leaflets) are called .petals. They serve to attract bees, birds, etc. which are the agents of pollination

Third whorl i.e. **androecium** is the male reproductive part of flower. Its units are called **stamens.** Each stamen has a thread-like **filament** at the free end of which **anther** is attached. Anther has **pollen-sacs** in which haploid **microspores** (pollen grains) are produced through meiosis. Each microspore germinates into the male gametophyte generation. During it, the nucleus of microspore undergoes mitosis and produces two nuclei i.e. a t**ube nucleus** and a **generative nucleus.** The generative nucleus again undergoes mitosis and produces two **sperms.** So, a germinated microspore has a tube nucleus and two sperms. All these structures are the male gametophyte generation of plant.

Animation14.5:Mitosis,
Source & Credit: tokyo-med.ac.jp

Fourth whorl i.e. **gynoecium** is the female reproductive part of flower. Its units are called **carpels** (or pistils). Each carpel is made up of the basal **ovary,** middle **style** and upper **stigma**. Inside ovary, there are one to many **ovules**. Inside each ovule, one haploid **macrospore** is produced through meiosis. Macrospore germinates into the female gametophyte generation. During it, macrospore undergoes mitosis and produces an **egg cell** and some associated structures (e.g. fusion nucleus). Egg cell and associated structures are the female gametophyte generation of plant.

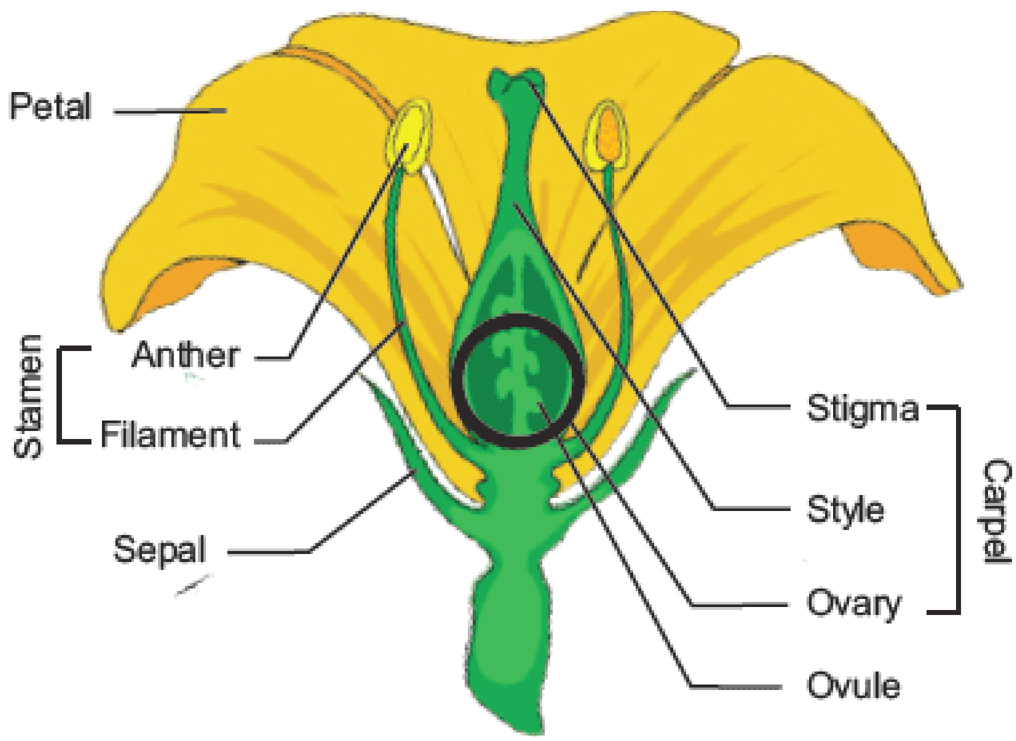


Figure 14.13: Structure of a flower

When pollen grains mature, they are transferred to stigma. It is called **pollination**. On reaching the stigma, the tube nucleus of pollen grain constructs a **pollen tube**. The pollen tube contains a tube nucleus and two sperms. The tube grows through style and ovary and enters ovule. Here, it bursts and releases the sperms. Both sperms enter the female gametophyte. One sperm fuses with egg and forms a diploid **zygote**. The other sperm fuses with diploid **fusion** nucleus and forms a triploid (3N) nucleus called **endosperm nucleus.** Since the process of fertilization involves two fusions, it is called **double fertilization.** Zygote develops into embryo and endosperm nucleus develops into endosperm tissue (food of the growing embryo). Ovule then becomes **seed** and ovary changes into **fruit.**

When seeds mature, they are dispersed (we shall discuss in the next section). If seeds get suitable conditions, their embryos develop into new plants (the diploid sporophytes of the next generation).

Animation14.6:Fertilization,
Source & Credit: urbanext.illinois

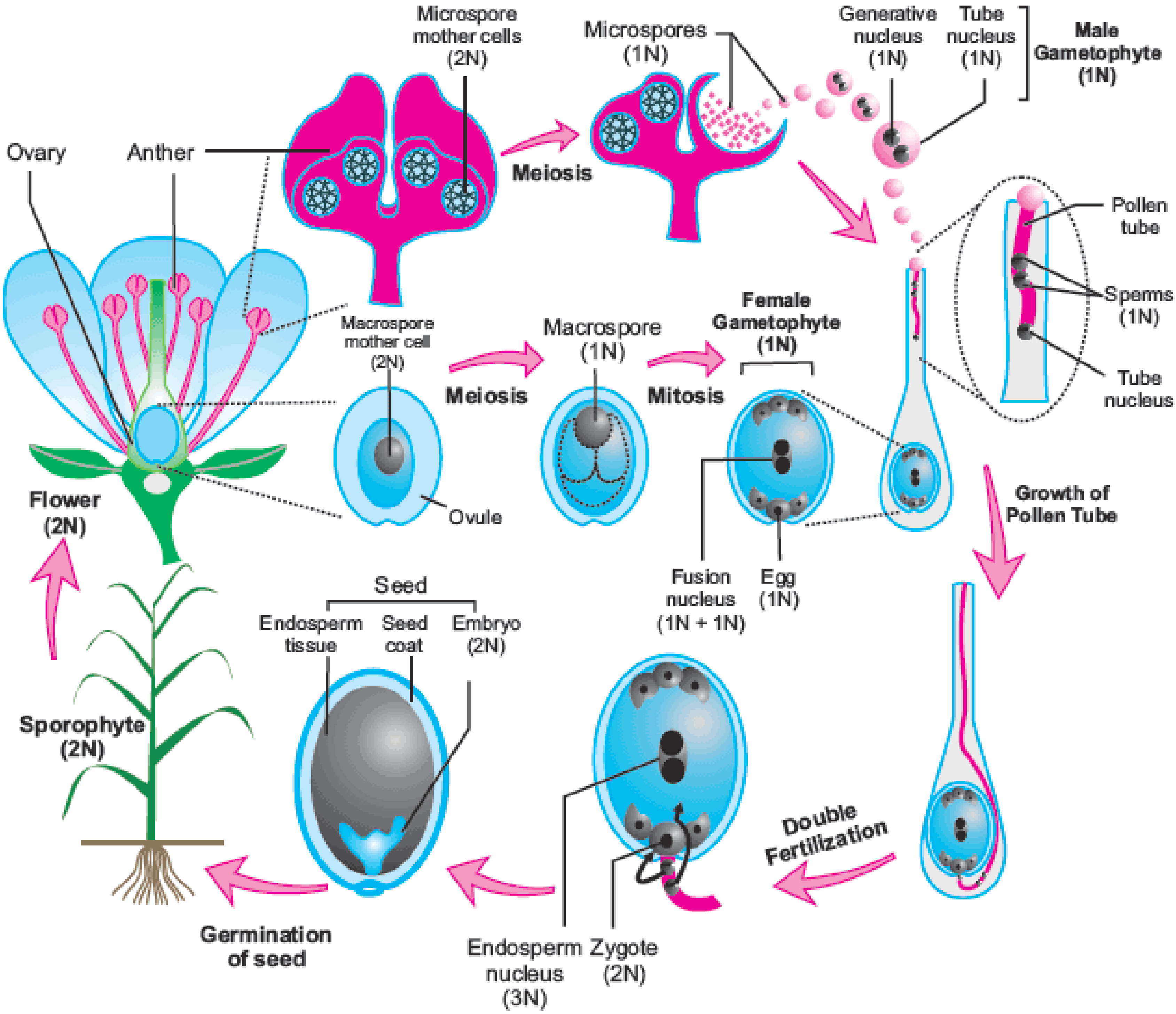


Figure 14.14: Life cycle of a flowering plant

14.3.2 Pollination

Pollination is defined as the transfer of pollen grains from flower's anther to stigma. Two types of pollination are recognised.

Self pollination is defined as the transfer of pollen grains from the anther to the stigma of the same flower or other flower of the same plant.

Cross pollination is the transfer of pollen grains from the flower on one plant to the flower on other plant of the same species. Cross pollination is brought about by various agencies like wind, water, bees, birds, bats and other animals including man.

The insect pollinated and wind pollinated flowers have structural adaptations that facilitate the transfer of pollen grains between two plants. Some of these adaptations are described in Table 14.1.

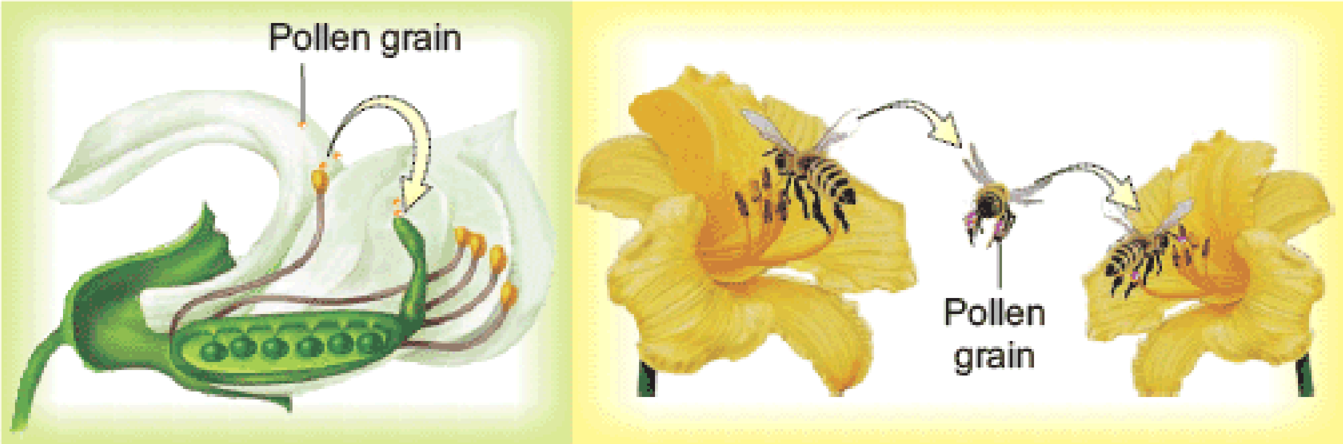


Figure 14.15: Self pollination (left) and cross pollination (right)

Table 14.1: Adaptations in insect-pollinated and wind-pollinated flowers

Feature	Insect Pollinated Flowers	Wind Pollinated Flowers
Size	Generally large	Generally small
Color	Petals brightly colored	Petals green or dull in color
Nectar	Produce nectar	Do not produce nectar
Floral arrangement	Flowers face upwards	Flowers hang down for easy shaking
Stamens and stigmas	Enclosed inside ring of petals	Hang out of ring of petals
Pollen grains	Small number produced/ heavy and sticky	Large number produced/light with smooth surface
Stigma	Pinhead shaped with no branches	Feathery branches for catching pollen

Figure 14.16: An insect-pollinated flower (left) and a wind-pollinated (right) flowers

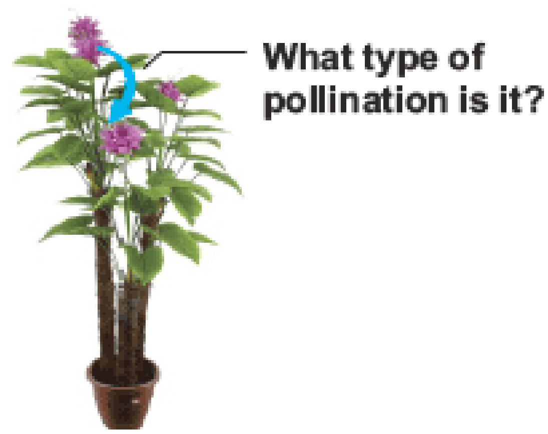
Initiating and Planning
Hypothesize why Mendel used Pea plants for his experiments.

Banana flower and developing fruits

Grape flowers

In some plants, ovaries develop into fruit without the fertilization inside their ovules. This process is known as parthenocarpy and it results in seedless fruits e.g. bananas and seedless varieties of grapes.

Examples of insect pollinated flowers are buttercup, rose, wallflower, sunflower, orchid etc. Examples of wind pollinated flowers are grasses, hazel, willow, corn etc.



The evolution of seed has been proved as an important step in the success and spread of flowering plants, as compared to the seed-less plants like mosses and ferns.

14.3.3 Development and Structure of Seed

We know that after fertilization in the female gametophyte, zygote divides repeatedly by mitosis and develops into an embryo. At this stage (in gymnosperms and angiosperms), ovule changes into seed. The formation of seed completes the process of sexual reproduction in seed plants.

Angiosperm seeds consist of three distinct parts:
(1) the embryo formed from zygote,
(2) the endosperm tissue formed from endosperm nucleus, and
(3) the seed coat which develops from the wall of ovule (integument).

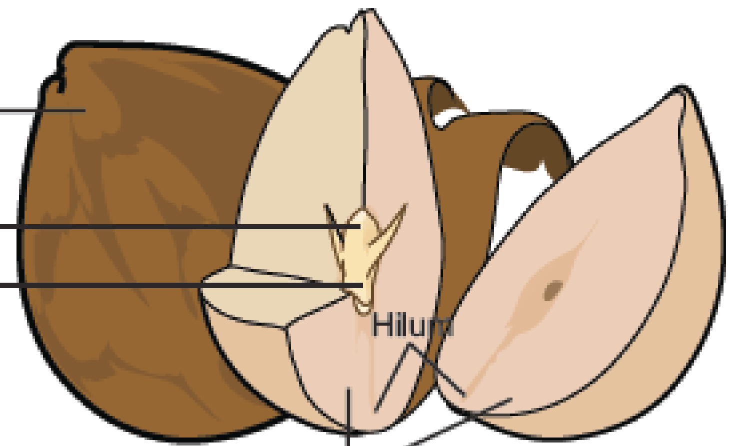


Figure 14.17: The structure of a dicot seed

Seed coat (or testa) develops from the integument, originally surrounding the ovule. It may be a paper-thin layer (e.g. peanut) or thick and hard (e.g. coconut). Seed coat protects embryo from mechanical injury and from drying out. There is a scar on seed coat, called hilum. It is where the seed is attached to ovary wall (fruit). At one end of **hilum,** there is micropyle. This is the same opening through which the pollen tube entered ovule. Seed uses it for the absorption of water.

The form of the stored nutrients in seeds varies depending on the kind of plant.

Embryo is actually an immature plant. It consists of a **radicle,** a **plumule** and one or two cotyledons (seed leaves). The radicle of embryo develops into new root while the plumule develops into new shoot. The embryonic stem above the point of attachment of cotyledon(s) is called **epicotyl.** The embryonic stem below the point of attachment is **hypocotyl.** Within seed, there is a **store of nutrients** for the seedling that will grow from embryo. In angiosperms, the stored food is derived from the endosperm tissue. This tissue is rich in oil or starch and protein. In many seeds, the food of the endosperm is absorbed and stored by cotyledons.

14.3.4 Germination of Seed

For the germination of seeds, they must arrive at a suitable location and be there at a time favourable for germination and growth.

Seed germination is a process by which a seed embryo develops into a seedling. During germination, embryo soaks up water which causes it to swell, splitting the seed coat. Root is the first structure that emerges from the radicle present in seed. It grows rapidly and absorbs water and nutrients from soil. In the next phase, plumule develops into tiny shoot which elongates and comes out of soil.

On the basis of the elongation of hypocotyl and epicotyl, there are two types of germination (Fig. 14.18). In **epigeal** germination, the hypocotyl elongates and forms a hook, pulling the cotyledons above ground. Beans, cotton and papaya are the examples of seeds that germinate this way. In **hypogeal** germination, the epicotyl elongates and forms the hook. In this type of germination, the cotyledons stay underground. Pea, maize and coconut germinate this way.

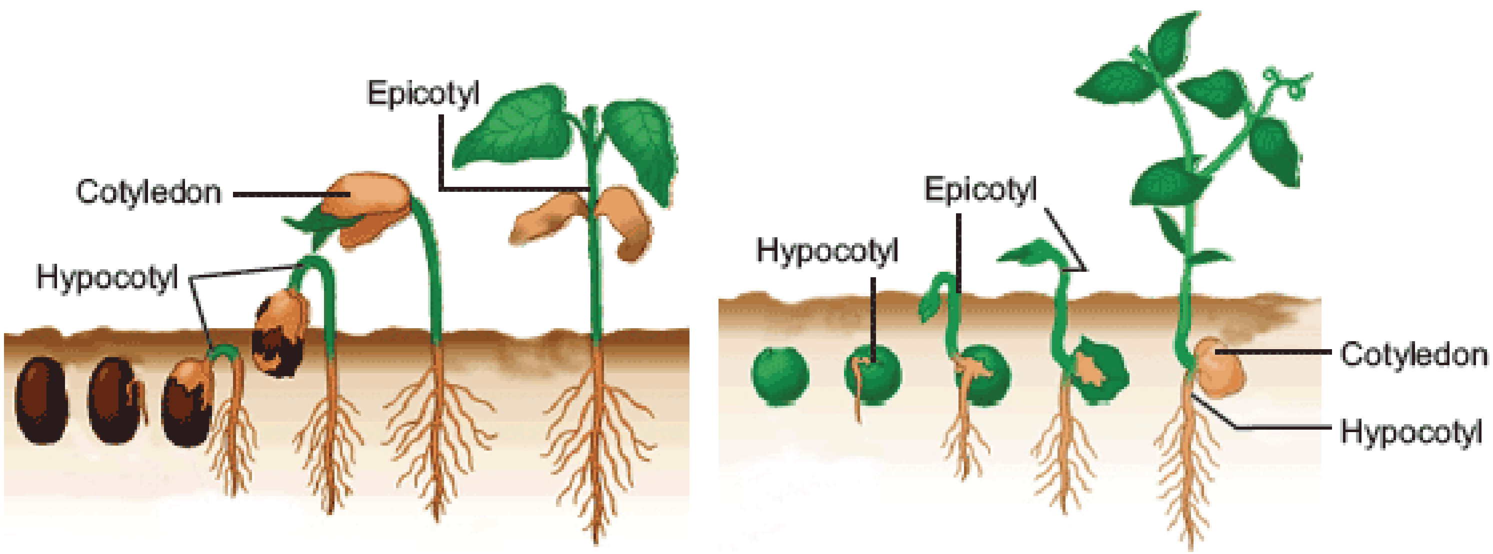


Figure 14.18: Types of seed germination; epigeal (left) and hypogeal (right)

Most seeds go through a period, during which there is no growth. This period is called the dormancy of the seed. Dormant seeds are ripe seeds but do not germinate. Under favourable conditions, the seeds break dormancy and begin to germinate

Conditions for Seed Germination

Seed germination depends on both internal and external conditions. The internal conditions include a live embryo and sufficient food storage. The most important external conditions include water, oxygen and favourable temperatures.

Water (moisture): Seeds of most plants have low water content, and germination cannot occur until seed coat or other tissues have imbibed (taken in) water. The absorbed water is used in the digestion of the stored food and it also helps in the elongation of hypocotyl and epicotyl.

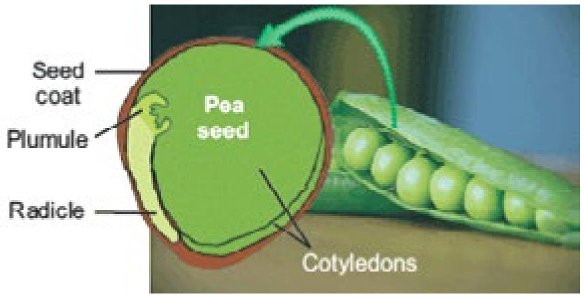
Oxygen: Oxygen is essential for the respiration in the cells of embryo.

Temperature: Seeds differ greatly in their temperature requirements for germination. The optimum temperature for the germination of the seeds of most plants ranges from 25-30^{o}C.

Germination of seeds of many plants is also favoured by light. In others, germination is retarded by light.

Practicals:

- Identify different parts of flower.
- Identify and draw the component of the seeds of pea or gram.
- List some of the ripened ovaries and ovules, which are eaten in daily life.
- Perform experiment to investigate the necessary conditions for seed germination



? What is the future of ovule and ovary after fertilization in flower?

Ovule develops into seed while ovary wall develops into fruit

14.4 Sexual Reproduction In Animals

Most animals reproduce sexually. The sexual reproduction is based on the formation and the fusion of male and female gametes.

14.4.1 Formation of Gametes (Gametogenesis)

The formation of gametes is called gametogenesis. In this process, diploid (2N) gamete mother cells undergo meiosis and form haploid (1N) gametes. The male and female gametes (sperms and egg cells or ova) are produced in specialized organs called gonads. Male gonads are called testes (Singular: testis) while female gonads are called ovaries. The production of sperms in testes is called spermatogenesis and the production of egg cells in ovaries is called oogenesis (Fig. 14.19).

Spermatogenesis

Some cells present in the walls of the seminiferous tubules of testes divide repeatedly by mitosis to form large number of diploid spermatogonia. Some spermatogonia produce primary spermatocytes. Each primary spermatocyte undergoes meiosis-I and produces two haploid daughter cells called secondary spermatocytes. These cells undergo meiosis-II. In this way four haploid spermatids are produced from each primary spermatocyte. The spermatids are non-motile and many changes occur in them to convert them into motile cells. Their nuclei shrink and some structures are formed e.g. a corner called acrosome, a tail and a mitochondrial ring. After these changes, the spermatids are called sperms.

Oogenesis

Some cells of ovary prepare structures called follicles, in which many diploid oogonia are present. Some oogonia produce diploid primary oocytes.

One of the primary oocytes completes meiosis-I and produces two haploid cells. The smaller cell is called first polar body and the larger one is called secondary oocyte. The secondary oocyte completes meiosis-II and produces two haploid cells i.e. a second polar body and an egg cell.

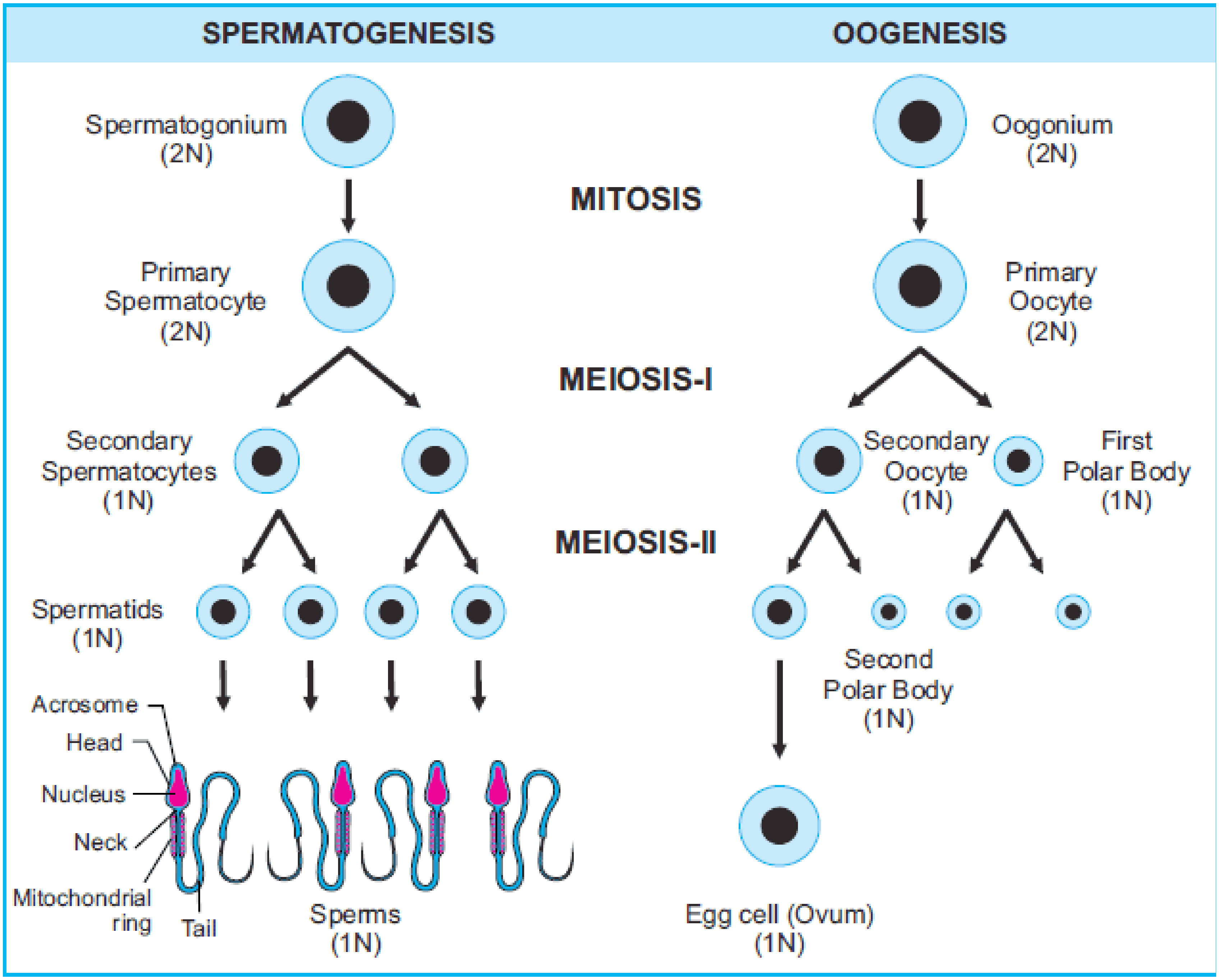


Figure 14.19: Gametogenesis in animals

14.4.2 Fertilization

After the formation of gametes, fertilization occurs. There are two mechanisms by which fertilization can take place i.e. external fertilization and internal fertilization.

In **external fertilization**, egg cells are fertilized outside of body. External fertilization occurs mostly in aquatic environment. It requires both the male and the female animals to release their gametes into their surroundings at almost the same time. For external fertilization, the animals have to release great number of gametes. In external fertilization, there is risk of loss of gametes due to environmental hazards such as predators. External fertilization occurs in many invertebrates and the first two groups of vertebrates i.e. fishes and amphibians.

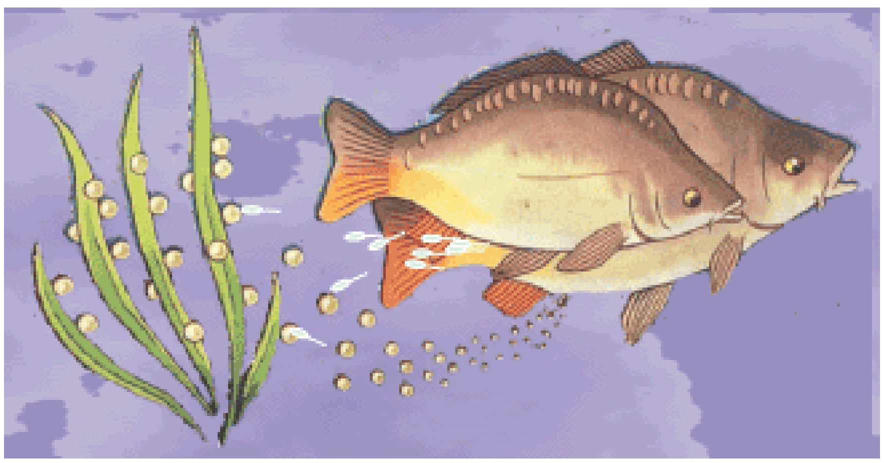


Figure 14.20: External fertilization in fish

In **internal fertilization,** egg cells are fertilized within the reproductive tract of female. It occurs in reptiles, birds and mammals. Such animals provide protection to the developing embryo. After fertilization, reptiles and birds make protective shells around their egg cells and then lay them.

The shell is resistant to water loss and damage. In mammals (with the exception of egg-laying mammals) the development of fertilized egg into new baby takes place within mother body. In this case, there is extra protection to the embryo and mother also supplies everything that embryo needs.

Figure 14.21: Reptiles and Bird's egg provides protection and food to embryo

14.4.3 Reproduction in Rabbit

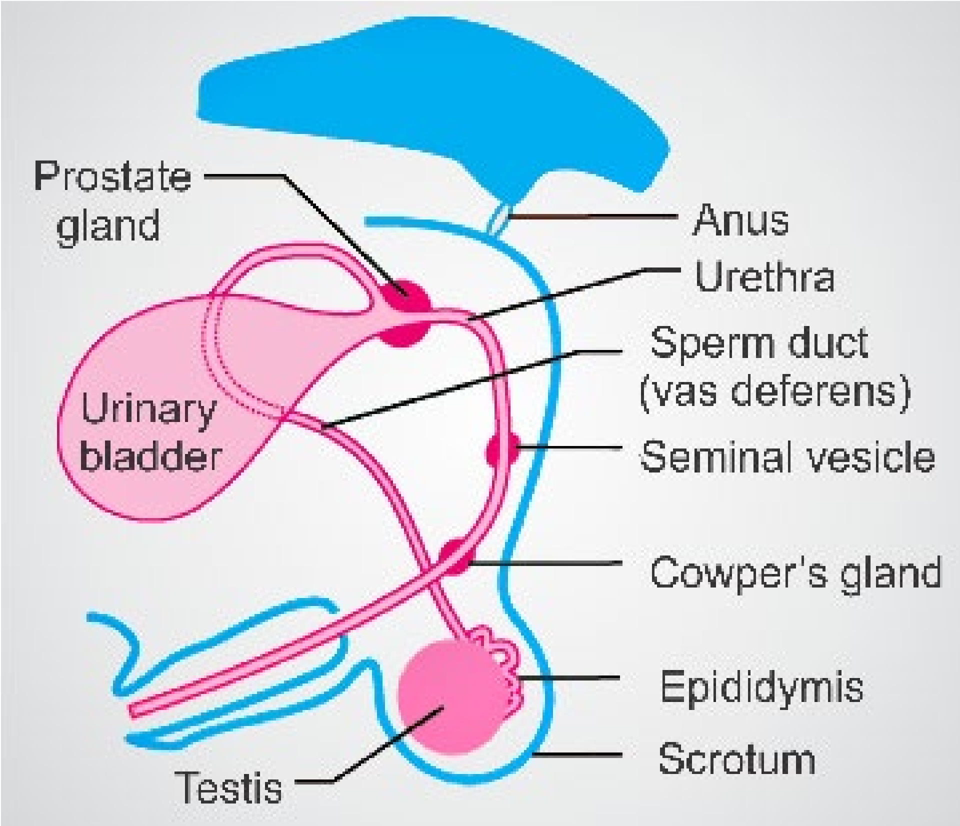
Rabbits are small mammals found in several parts of the world. They are used in research as experimental animals.

Rabbits reingest their own pellet-like faeces to digest their food further and extract sufficient nutrients.

Male Reproductive System

The male reproductive system of rabbit consists of a pair of testes that produce sperms, the associated ducts that transport sperm to external genitalia and glands that add secretions to sperms (Fig. 14.22). Testes are located in a bag of skin called the scrotum that hangs below the body. Each testis consists of a mass of coiled tubes called the seminiferous tubules. In these tubules, the sperms are formed.

When sperms are mature, they accumulate in the **collecting ducts** of testes and then pass to **epididymis.** From epididiymis, sperms move to a sperm duct called **vas deferens.** Both sperm ducts join **urethra** just below urinary bladder. The urethra transports both sperm and urine.



Semen is the material containing sperms in a fluid. It consists of 10% sperms and 90% fluid. As the sperms pass down the ducts from testes to urethra, the associated glands add various secretions. **Seminal vesicles** produce secretions that provide nutrients for sperms. **Prostate gland** produces a secretion that neutralizes the acidity of the fluid. **Cowper's glands** produce secretions that lubricate the ducts.

Female Reproductive System

The female reproductive system of rabbit consists of ovaries and associated ducts (fig.14.23). **Ovaries** are small oval organs situated in abdominal cavity just ventral to kidneys. Like most animals, female rabbits have a pair of ovaries. The outer region of ovary produces egg cells. A cluster of specialized cells called **follicle** surrounds and nourishes each egg cell. From ovaries, egg cells are released in **fallopian tubes.**

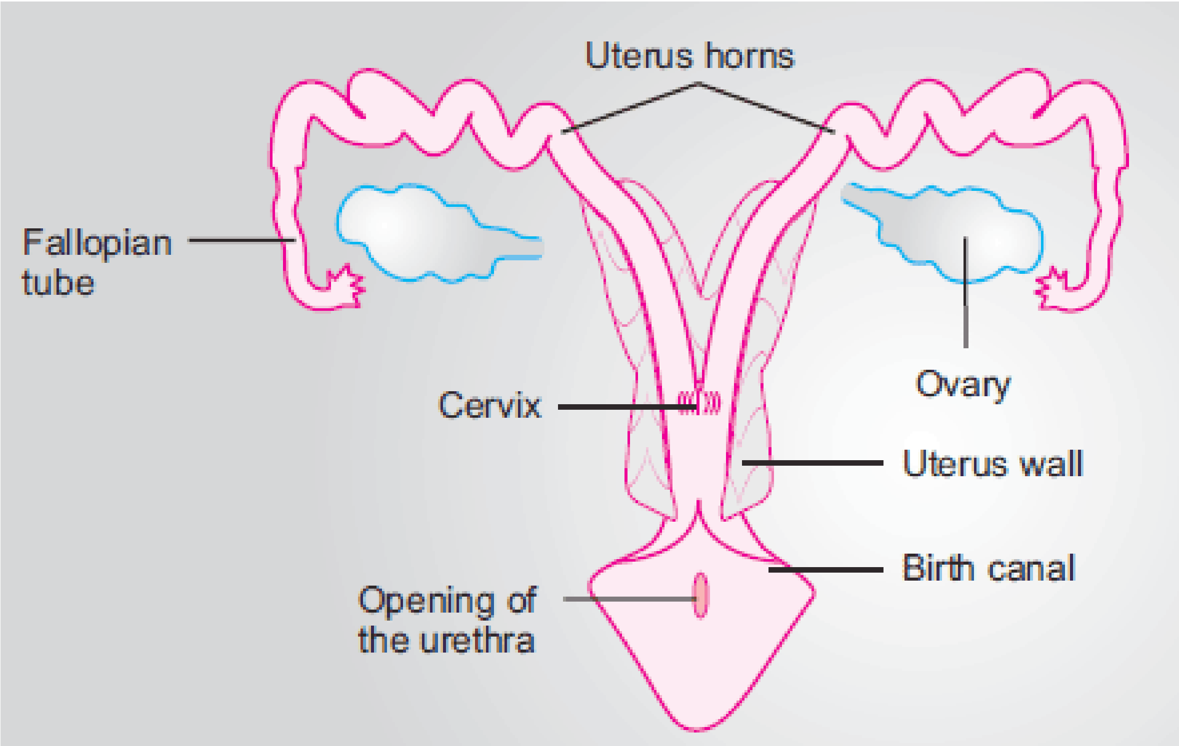


Figure 14.23: Female reproductive system of rabbit

Activity:

Locate the different organs of rabbit's male and female reproductive systems on a chart or diagram.

The opening of fallopian tube lies close to ovary. Fertilization occurs in fallopian tubes and the fertilized egg (zygote) is carried to **uterus.** The uterus of rabbit is divided into two separate parts or **horns.** The uterus horns join and open into **vagina** or **birth canal. Cervix** is the portion of uterus, which separates it from birth canal, where sperms of male are deposited.

Fertilization and Development in Rabbit

Rabbits can breed throughout the year but male rabbits are commonly sterile during the summer months. Male rabbit deposits its sperms in the vagina (birth canal) of female. Sperms swim through cervix and uterus to fallopian tubes where they fertilize the egg cells, released from ovary. After fertilization, zygote is carried to uterus. By this time, the zygote has started dividing and is now called embryo. The embryo is implanted in uterus walls. A connection, called **placenta,** is established between embryo and uterus wall. Embryo develops into new offspring (rabbit kit) in 30–32 days, after which it is born.

14.4.4 Growth in Human Population and its Consequences

Pakistan's population in the year 2007-2008 was 163,775,000. By the end of this decade, our population is expected to exceed 176 million. Pakistan's population had a relatively high growth rate in past. When population growth exceeds the carrying capacity of an area or environment, it results in overpopulation.

Logo of an organization working for awareness of overpopulation

Many problems are associated with human overpopulation. The overpopulated areas face severe shortage of fresh water and natural resources. Overpopulation results in deforestation and loss of ecosystems. It leads to more pollution and global warming. There is high infant and child mortality rate in overpopulated areas due to poverty. Overpopulation raises demands for more housing units, more hospitals, more jobs, more educational institutions, increase in food crops etc. We have to check overpopulation otherwise we will have to face huge problems because of our limited resources. People should be educated about the problems of overpopulation. Pakistan's Ministry of Population Welfare has taken a number of steps to make people aware of the hazards of overpopulation and to stabilize the population to match our resources.

Pakistan has a multicultural and multiethnic society and hosts the largest refugee population in the world.

The United Nations Population Fund
UNFPA began operations in 1969. It is the largest international organization funding for population and health programmes. The UNFPA works in over 140 countries, for awareness about the consequences of overpopulation.

14.4.5 AIDS: A Sexually Transmitted Disease

Sexually Transmitted Diseases (STDs) are defined as the diseases that are transmitted through sexual act. The most serious and challenging health problem faced by the world today is AIDS. It is also a sexually transmitted disease. AIDS stands for Acquired Immune Deficiency Syndrome. It is caused by human immunodeficiency virus (HIV). The virus destroys white blood cells, which results in loss of resistance against infections. It is a fatal disease. It spreads through transfer of body fluids such as blood and semen. Thus the main causes are unprotected sexual activities, use of infected needles or transfusion of infected blood.

According to the United nations Programme on AIDS i.e. UNAIDS estimates, some 70,000 to 80,000 persons, or 0.1 percent of the adult population in Pakistan, are infected with HIV.

Role of National AIDS Control Programme (NACP) and Non-Governmental Organizations (NGOs)

Pakistan's Federal Ministry of Health established NACP in 1987. The main objective of this programme is to help the public for the prevention of HIV transmission, safe blood transfusions and reduction of STDs.

The frequency of HIV infection in Pakistan is still low. But, the country is at risk of epidemic due to various risk factors e.g. exposure to infected blood or blood products, homo-sex, and injecting drug users. For improved prevention by the general public, the NACP started services through TV and radio channels and print media in 2005. The objectives of this activity were to:

- Change public attitude for safe sexual activities,
- Create demand for information on HIV and AIDS, and
- Improve attitudes and behaviour among healthcare workers

The number of drug addicts in Pakistan is currently estimated to be about 500,000, of whom 60,000 inject drugs.

According to the latest data by the World Bank, at least 54 NGOs are working in Pakistan for HIV/AIDS public awareness and for the care and support of persons living with HIV/AIDS. These NGOs also work on AIDS education and prevention for sex workers and other high-risk groups. NGOs serve as members of the Provincial consortium on HIV/AIDS, which has been set up in all the provinces of Pakistan

Although NGOs are very busy in HIV/AIDS prevention activities, it is believed that they are reaching less than 5 percent of the vulnerable population.

UNDERSTANDING THE CONCEPT

1. Give an introduction of Pakistan's National AIDS Control Program.
2. What are the different ways by which prokaryotes, protozoans and fungi reproduce asexually?
3. Explain the different parts of the plant that help in natural vegetative propagation.
4. Explain, how the epigeal and hypogeal germinations are different?
5. What conditions are necessary for the germination of seeds?
6. Outline the methods of asexual reproduction in animals.
7. Write a note on the male and female reproductive systems of rabbit.
8. Describe the processes of spermatogenesis and oogenesis.
9. Why do we consider that overpopulation is a global problem?

SHORT QUESTIONS

1. How are the natural and artificial vegetative propagations the methods of asexual reproduction in plants?
2. Why do gardeners use the methods of cutting and grafting?
3. "Parthenogenesis is a type of asexual reproduction". Give comments on this statement.
4. Outline the life cycle of a flowering plant.
5. What structural adaptations will you find in a wind-pollinated flower?

THE TERMS TO KNOW		
Acrosome	Cloning	Epididimys
Alternation of generations	Corm	Epigeal germination
Androecium	Corolla	Fallopian tube
Anther	Cotyledon	Follicle
Binary fission	Cowper's gland	Fragmentation
Budding	Endosperm nucleus	Fusion nucleus
Bulb	Endosperm tissue	Gametogenesis
Calyx	Endospore	Gametophyte
Carpel	Epicotyl	Grafting
Cervix		Gynoecium

Hilum
Hypocotyl
Hypogeal germination
Micropyle
Microspore
Multiple fission
Oogenesis
Oogonium
Ovary
Ovule
Parthenogenesis
Plumule
Pollen grain
Pollen tube
Prostate gland
Radicle
Rhizomes
Seed dormancy
Semen
Seminal vesicle
Seminiferous tubule
Sperm
Spermatid
Spermatogenesis
Spermatogonium
Sporophyte
Stamen
Stigma
Style
Testa
Testis
Tuber
Uterus horn
Vas deferens
Vegetative propagation

ACTIVITIES

1. Identify different stages of budding in the prepared slides of yeast and draw diagrams.
2. Examine the specimens of onion, corn, ginger and potato and write the mode of their reproduction and describe their cultivation to get new plants.
3. Identify different parts of flower.
4. Identify and draw the component of the seeds of pea or gram.
5. Perform experiment to investigate the necessary conditions for seed germination.
6. Draw different stages of binary fission in amoeba after observing them through slides or charts.