BIOLOGY NOTE (SS 2)

**SECOND TERM 2024/2025 SESSION**

**SCHEME OF WORK**

Lesson One: Reproductive System in other Vertebrates

Lesson Two: Development of new organisms

Lesson Three: Reproduction in the moss and fern plants

Lesson Four: Courtship behavior in animals

Lesson Five: Reproductive system in flowering plants

Lesson Six: Pollination

Lesson Seven: Germination of seeds

Lesson Eight: Fruits

**LESSON ONE**

**REPRODUCTIVE SYSTEM IN OTHER VERTEBRATES**

**Reproductive System in Fish**

Fertilization is external, the male have two testes, each testis is joined to the sperm tube by the vas deferens which drains into a common duct called the Wolffian duct which carries both sperm and urine to the cloaca.

In the female reproductive system, there are two ovaries which produces egg cells with small amount of yolk. There are also two oviducts. The motile sperms swim to fertilize the eggs

*Drawing of the male reproductive organs of the tilapia fish*

*Drawing of the female reproductive organs of the tilapia fish*

**Reproductive System in Amphibians**

The reproductive system of the amphibian is very similar to that of the fishes. In some frogs and toads, each wolffian duct enlarge towards the posterior ends to form a seminal vesicle where sperms are stored temporarily.

In both amphibians and fishes as the eggs moves through the oviducts, they receive albumen from the albumen glands in the oviducts. In both amphibians, the posterior part of each oviduct enlarges to form an ovisac in which eggs are stored before they are discharged. Fertilization is external

Reproductive System in Reptiles

The male agama lizard has 2 testes located in the abdomen (fertilization is internal). The right testis is slightly higher than the left testis. From the testes, the sperms are carried to the vasa deferentia which leads to the epididymis. The sperm cells are finally passed onto the two protrusible penis (i.e. hemipenis).

In the female, the two ovaries are located in the abdomen in the same position as the testes in the male. The eggs are released into the abdomen space and by the action of some cilia, the eggs are moved into the oviduct.

Albumen and shell are deposited on the eggs as they move down, the oviduct opens at the posterior and into the cloaca near the openings of the ureters. Only the egg cell is living in this egg.

*Drawing of the male reproductive organs of an Agama Lizard*

*Drawing of the female reproductive organs of an Agama Lizard*

**Reproductive System in Birds**

The male domestic fowl has two ovoid and large testis which are attached to the outer edges of the kidney. From each testis, a vas deferens leads towards the hind end, alongside the ureter. Birds do not have penis. The sperm ducts expand at the posterior ends to form seminal vesicles. Sperms accumulate here during copulation and are transferred from the male to the female when their cloaca come in contact.

In the female, only the left ovary is functioning, the right oviduct is vestigial. The single ovary produces ova in capsules attached to the ovary by short stalks. The ovary also produces the yolk. Fertilization takes place before the formation of albumen and chalaza.

The infundibulum receives the yolk released by the ovary. Albumen and chalaza are formed in the magnum. The two shell membranes and the shape of the egg are formed in the ISTHMUS.

The egg shell is formed in the uterus after which the egg is laid through the cloaca. Fertilization takes place in the oviduct before formation of albumen and chalaza.

*Drawing of the male reproductive organs of Domestic fowl*

*Drawing of the female reproductive organs of Domestic fowl*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Type of vertebrate | Fish | Amphibian | Reptiles | Birds | Mammals |
| Time of breeding | Seasonal | Seasonal | Seasonal | Seasonal | Seasonal except in human |
| No of eggs laid | Million or very many | Many | Few | Few | Few |
| Mode of fertilization | external | External | internal | Internal | internal |
| Feeding of embryo | From yolk and albumen | From yolk and albumen | From yolk and albumen | From yolk and albumen | From mother through placenta |
| Growth | Oviparous | Oviparous | Oviparous | Oviparous | Viviparous |
| Parental care | Mostly none | None | None | Occurs for a short time | Occurs for long time |
| Site where embryo develops | Water | Water | Holes in ground covered with soil | Nests | Uterus |
| Site of fertilization | External (water | External (water | Oviduct (internal) | Oviduct (internal) | Oviduct (internal) |

The life history of a toad

Amphibians lay many eggs and each egg contains a small amount of yolk and is covered by gelatinous layer which is distasteful to animals. The fertilized eggs develop into larvae and then adults.

*Drawing of the history of a toad*

*Drawing of lateral(side) view of a tadpole*

*Drawing of ventral view of a tadpole*

The sucker is for attachment to leaves from the ventral side of a tadpole we can see:

* long coiled intestine
* Tail muscle
* Sucker
* Limb bud (sprout)
* Tail fin

At this stage, the diet of tadpole is plants (herbivorous) because of its long coiled intestine.

**LESSON TWO**

**DEVELOPMENT OF NEW ORGANISMS**

The fusion of the male sex cell and female sex cell is known as fertilization. The fusion results in the formation of a zygote. The zygote undergoes cell division to form the embryo.

In flowering plants, the embryo becomes enclosed in a seed which remains dormant for a period before germinating and growing to a new organism.

In various animal groups, the embryo pass through remarkably similar embryonic stages. The young that hatch out generally look like miniature adults, such young just increase in size, though all parts do not grow at the same rate. Further development only occurs at sexual maturity which is under the control of hormones.

Development of toad

1. Courtship stage: Reproduction in toad normally takes place during the rainy season. The males make loud croaking noises to attract females that are swollen with eggs.
2. The egg stage: the eggs laid are surrounded in strings of jelly. This jelly performs the following functions
3. It protects egg from mechanical injury when water is disturbed
4. It separates the eggs to enable them receive adequate oxygen
5. It prevents bacterial and fungal attack on the eggs
6. It prevents the eggs from drying up.

The fertilized eggs (zygote) undergo cell division by mitosis to form the embryo. The embryo feeds and grows round the egg yolk. Dissolved oxygen diffuses through the jelly into the embryo.

1. The young tadpole stage: then after 1-2 days, the young tadpoles come out of the jelly and grows. It attaches itself to a water weed used by a sticky substances secreted by a v-shaped cement gland on the underside of the head. At this stage, the tadpole has no mouth and still feeds on the egg yolk. It gets dissolved oxygen through the skin for gaseous exchange.
2. The external gill stage: The young tadpole then develops three external gills at the side of the head for gaseous exchange, a clear head, body and tail. It also has horny jaws for feeding on water weeds and the intestine is long and coiled (for carrying out herbivorous nutrition).
3. Internal gills stage: After 6-10 days, operculum develops over the external gill and it becomes internal gills. The tadpole now breath like a fish. Water enters the mouth and move out through the operculum sprout. The operculum sprout over the muscles then develops, the hind legs also appear.
4. The limb stage: The hind limbs grows more (i.e. it is the first to appear). The fore limbs emerge through the operculum. The left limb appears first. At this stage, the internal gills gradually disintegrate, while the lungs start developing. Mouth develops and replaces the horny jaws. The intestine become shorter and the tadpole starts feeding on small animals in the water. Eyes become big and prominent.
5. Young toad stage: Tadpole changes into a small toad by reabsorbing the tail. It then comes out of water into land and grows into a full adult toad. It takes about 40-45 days for metamorphosis in toad to take place.

Role of Hormone in the development of toad

Metamorphosis is controlled by the hormones thyroxine in toad and other amphibians. For thyroxine to be made, there must be iodine in the water. Tadpole cannot become an adult in the absence of this hormone and over secretion of this hormone hastens metamorphosis.

Demonstrating the effect of thyroxine on tadpole metamorphosis

Method

1. Place three tadpoles which are just beginning to develop their hind limb in three aquaria with equal volume of water from the same pond.
2. The three batches of tadpoles in the three aquaria were tested as follows:

Batch I: Placed in ordinary pond water

Batch II: Placed in pond water to which 1mg of thyroxine was added with pieces of meat.

Batch III: Placed in pond water to which 0.25mg of thyroxine was added.

1. Observe the tadpoles each day for a week

Observation

1. Thyroxine accelerates the development and growth of the tadpoles in batches II and III
2. The higher concentration of thyroxine in Batch II caused the faster development in limbs and earlier absorption of the tail.
3. The growth of tadpoles in Batch I was very slow.

Conclusion

The thyroxine promotes the development of tadpole.

Egg laid by reptiles and birds are called amniote egg.

Reptile and Birds

The male birds do not have penis. The ovaries of the birds and reptiles produced egg cells with large amount of yolk. These are discharged into the body cavity. From here they enter the oviduct. The eggs are covered with albumen, shell membranes and shells, secreted by posterior part of the oviduct before they are laid. Fertilization occurs in the anterior part of the oviduct. Only the egg cell is living in this egg. Fertilization is internal and there is parental care in birds. Birds also incubate their eggs. The shell egg membranes are yolk sac, amnion, chorion and allantois. There is little parental care in reptiles.

*Drawing showing fertile egg with developing embryo*

*Parts and their functions*

1. Embryo: Develops into a new organism
2. Porous calcerous shell

(i) protects the embryo against mechanical damage and desiccation

(ii) Allows for gaseous exchange

1. Air space: stores air for gaseous exchange
2. Albumen:consist of water to absorb shock and also supply protein
3. Yolk: contains high level of protein and fat/ provide food for embryonic growth.
4. Amnion:
   1. secretes amniotic fluid which provides aquatic environment for the embryo
   2. it acts as a shock absorber, protecting the embryo
5. Chorion: Controls permeability and prevents water loss from amnion. Protects the embryo or yolk sac
6. Allantois:
7. stores embryo’s nitrogenous wastes
8. acts as a gaseous diffusion surface for embryo
9. Chalaza : It is a piece of thick protoplasm; which holds the yolk and embryo in position within the albumen.
10. Shell membrane: allow gaseous exchange and for protection.
11. Shell: for protection or aeration or for gaseous exchange or gives shape.

*Drawing of the structure of an egg*

*Drawing of the longitudinal section of a boiled egg*

Metamorphosis

This is the series of changes animal passes through during its development from fertilized egg until the adult stage is reached. This is shown by insects and amphibians.

There are two types of metamorphosis

1. Complete metamorphosis
2. Incomplete metamorphosis

Complete metamorphosis: This is the series of gradual changes which takes place in an organism from fertilized egg to larva period and finally to the adult.

The life of the organism passes through the stage of egg, larva, pupa and imago (adult). The young stage is different from the adult and one stage gives rise to the next by series of moulting e.g. butterfly, mosquito, housefly.

Incomplete metamorphosis: This is the series of gradual changes in an organism from fertilized egg to nymph and the adult stage. The eggs here, hatches to nymph which resembles the adult without the pupa stage i.e.

Egg → Nymph → Adult

e.g. cockroach, grasshopper, termites and toads

Differences between complete and incomplete metamorphosis

|  |  |  |
| --- | --- | --- |
|  | complete metamorphosis | Incomplete metamorphosis |
| 1 | Four stages of development are involved | Three stages of development are involved |
| 2 | There is presence of pupa (resting stage | There is absence of pupa |
| 3 | There is no resemblance between pupa and adult | There is resemblance between nymph and adult |

Life cycle of a Butterfly

parthenogenesis: Production of unfertilized eggs from which offsprings develop. This leads to or give rise to sterile male or female.

The butterfly undergoes a complete metamorphosis. The larva is an agricultural pest while the adults are pollinators. They lay their eggs on the under surface of the younger leaves of a citrus plant. After a few days the eggs hatches into the larva called caterpillar. The young caterpillar has black and white patches while the older caterpillar is green above and almost white below. Each caterpillar is cylindrical, segmented, worm like and the body is made up of the head, thorax and abdomen. The whole body is enclosed in a thin cuticle.

The head has 6 simple eyes and a pair of very short, jointed antennae; the mouthparts are tiny with well –developed mandibles and the remaining mouthparts form a spinneret which produces a fluid that hardens in air to form silk threads which helps it to grip the slippery leaf surface.

The caterpillar has a pairs of spiracles for breathing. It undergoes 5 to 4 moulting before becoming an adult and after each moulting it eats up in cast cuticle.

It has a structure called osmeterium for defence and it also produces a pungent odour which drives away potential predators. The larva moults and become a pupa or chrysalis. The wall of the pupa case splits and the imago emerges.

*Drawing showing the life cycle of a butterfly*

Butterfly uses both visual and smell signal to attract one another. They use their antennae to detect smell and their compound eyes can distinguish certain colours and detect patterns and movement.

The male is attracted to the female by the chemical she releases, her colour pattern and flight behavior. After a brief courtship flight, the male holds the female’s abdomen with its claspers and internal fertilization occurs.

The claws on the true legs and the double rows of tiny hooks on the clasper enables the caterpillar to grip the surface of the leaf firmly.

|  |  |  |
| --- | --- | --- |
| Insect | Larva | Larva lives in |
| Mosquito | Wriggler | Stagnant freshwater |
| Butterfly, moth | Caterpillar | Green leafy vegetation |
| Housefly | Maggot | Rotten organic matter |
| Weevil, beetle | Grub | Soil or grains |
| Ant, bee, Wasp | Grub | Nest |

Adaptive features of Defence of a caterpillar

It has a structure called osmeterium which is found on the first thoracic segment. It is small, red and forked and lies hidden in a slit in the body wall. It extends rapidly in times of danger. It also has large eyespot markings on the third thoracic segment which gives it a frightening appearance. It produces a pungent odour to drive its predators away.

The butterfly lays its egg at the underside of leaves for the following reasons:

* + 1. It protects the eggs from predators
    2. To prevent desiccation
    3. To ensure there is food all around the larva when it hatches

*Drawing of the dorsal view of Butterfly*

Tsetse-fly

This relative of the housefly causes the dreaded sleeping sickeness. It undergoes complete metamorphosis and exhibits viviparity. It has a short life span, lasting 1 to 3 months.

A female tsetse –fly needs to mate only one in her lifetime. The sperms are retained in her body. Each time conditions are suitable, she produces an ovum which becomes fertilized by a sperm. This fertilized egg hatches into a larva within the female’s uterus and feeds on a nutrient fluid secreted by the uterine walls. the female tsetse-fly will only produce a well developed larva if she has an adequate blood meal. The larva is born in a shady spot. Under normal conditions, a female tsetse-fly gives birth to a larva every 10 days.

The larva is white and cylindrical with two knobs bearing pores for respiration. It burrows into the ground and pupates. After about 3 to 8 weeks, the imago emerges from its pupal case and crawls out to the surface. as soon as its wings are dry. it flies away to a shady place.

*Drawing of the Tsetse-fly; larva and pupa*

Aphid

The aphid is commonly known as the greenfly or plant louse. There are 400 kinds of aphid. It feeds on plant juices, spreading many diseases among crop plants. It undergoes incomplete metamorphosis and has a complicated life cycle involving parthenogenesis and viviparity.

Male and female aphids mate at the onset of the unfavourable season (the dry season in the tropics). The female lays egg which she glues to the stems of the plants on which that species of aphid feeds. The eggs hatch at the beginning of the favourable season into wingless nymphs. These feed, grow and moult a few times. In about a week, all of them mature into wingless females, known as stem-mothers. These reproduce without mating parthenogenetically. Each stem-mother gives birth to live nymph viviparously. Thus, the second generation of nymphs, which are also females, resemble the stem-mothers but differ in having one parent only, and in having been born alive. Then, follows the development of a series of generations of wingless females by parthenogenesis. This results in a very large colony, all members of which feed on the cell sap of the host plant , which starts to die. When food becomes scarce, some of the nymphs begin to develop wings from external wing pads attached to the thorax. In this way a generation of winged female arises.

Some of these winged females migrate to other plants and continue to produce wingless female by parthenogenesis. However, soon, male and female winged reproductive forms develop. This usually happens at the onset of dry adverse conditions. The winged females produce wingless female by parthenogenesis. The wingless females so produced are true females capable of laying fertilized eggs after having mated with the winged males of the previous generation. After each of these females has laid 1 to 4 or more eggs, it dies. The eggs are tough and resistant , and so are able to withstand adverse conditions. When favourable conditions returns the egg hatch into stem-mothers, and the whole complicated life cycle is repeated.

*Drawing of the life cycle of an aphid (incomplete metamorphosis involving pathenocarpy and viviparity)*

***LESSON THREE***

**REPRODUCTION IN MOSS PLANT**

Moss shows separate male and female plants. At maturity, the spermatozoa which has cilia (antherozoids) and large ovoid eggs are formed at the top of the plants.

Reproduction takes place in the rainy season as male gametes swim in water into the archegonium (female reproductive organ). Male gametes (antherozoids) are released by the male plant after rainfall when the water level is high and the male gametes can swim into the archeogonium which contains the ova. This is the gametophyte generation.

A zygote is formed on the top of the female plant, the zygote develops into sporangium which constitutes the sporophyte generation. This is the spore-producing structure which is partly dependent on the gametes producing structure for its nourishment.

The bryophytes consist of two stages:

1. Gametophyte which reproduces sexually by means of gamete
2. Sporophyte which reproduces asexually by means of spores

This is what is known as alternation of generation

The sporophytic generation consist of the sporogonuim which is made up of foot, seta and capsule. The capsule contains the spores which when matured, the capsule breaks open to liberate them. The spores are tiny and light. They float in the air and light. They float in the air and are dispersed by wind. When a spore lands on suitable substratum it generates into a gametophyte.

The sporophyte is always attached and dependent on the gametophyte.

*Drawing of Life cycle of the Moss Plant*

Reproduction in fern plants

The leaf of a young fern plant is known as the frond which is made up of a main axis the rachis, the leaflet called the pinna and the sub leaflet called pinnule. The sporophyte in the vegetative plant unlike the bryophyte. It reproduces asexually by spores.

In Dryopteris (example of fern the spores are borne on the under surface of the leaves. Many spores are produced in a single sporangium. Many sporangia are organized into a sorus with or without a cover known as indusium.

When the spores mature, the indusium breaks open to expose the sporangia. The spores are then dispersed by wind. Each germinates into a bisexual prothallus. The prothallus is a separate plant on its own which is green and carries out photosynthesis. It has both male and female reproductive organs it reproduces sexually by gametes.

The prothallus is flattened and shield like in structure. The antherozoids (male gametes) are ciliated and swim in film of water to the archeogonuim. Where one enters and fuses with the egg. The prothallus is the gametophyte.

A zygote develops within the archeogonium in the prothallus. The zygote germinates into sporophyte sending the young roots into the substratum and the young shoot above the prothallus. As the sporophyte grows older, the prothalus (gametophyta) breaks down and rots away.

*Drawing of Life cycle of fern plants*

Types of asexual reproduction in animals

|  |  |
| --- | --- |
| Types | Examples |
| Binary fission | Amoeba, Paramecium |
| Budding | Hydra, obelia |
| Spore formation | Amoeba |
| Parthenogenesis | Aphids, Honey bee |
| Schizogony | Plasmodium |
| Fragmentation | Sponges, Planaria |

**LESSON FOUR**

**COURTSHIP BEHAVIOR IN ANIMALS**

Reproductive behaviors refers to the development of behaviours that make fertilization possible. It brings gametes from different individuals of the same species together, directly or indirectly.

In almost all animals, making occurs only during specific breeding season that are connected with the onset of favourable environmental conditions.

Courtship behavior: This consist instinctive behavior in response to certain stimuli from opposite sexes of the same species. It is carried out as a series of fixed actions alternatively performed by male and female leading to mating.

Courtship behavior in animals consist of instinctive behaviours in response to certain external stimuli, the behavior is usually carried out in sequence and alternatively performed by male and female organisms, each step acts as a stimulus for the next step.

Importance of courtship behaviours in reproduction

1. It beings males and females together, thereby making the female partner more responsive to the male.
2. It prepares male and female for possible mating
3. It stimulates egg laying and sperm formation in partners.
4. It ensures fertilization as it coincides with ovulation in female (i.e it enables mating and ovulation to be synchronized).
5. It indicates when the animals are on heat/sexual interest
6. It announces the presence of sexually receptive individuals
7. The territory acquired during courtship ensures adequate supply of food, nesting material and food supply
8. It ensures the female chooses the right male partner.
9. It indicates sexual interest and not aggression thereby stimulating egg laying and sperm release in partners
10. It makes intraspecific mating more certain in case of closely related species.

Types of courtship in animals

1. Pairing
2. Display
3. Territoriality
4. Seasonal migration
5. Sound / Croacking
6. Release of attractive sex hormone
7. Nest making
8. Pairing: This involves two animals usually a male and a female which separate themselves from other in a group to form a mating pair. Examples are:
9. Pairing in winged termite: During breeding season, the winged termites usually male and female pair up and then fly out to form a new colony. On landing in the new area, the male mounts on the female, mates with her and fertilized eggs are laid. The male becomes the king while the female becomes the queen in the new colony.
10. Pairing in tilapia fish: The male picks a female as a partner. They swim together to a quiet portion of the river. The male stimulates the female to lay eggs. As the eggs are laid the male releases sperms on the eggs for external fertilization to take place.
11. Pairing in toad: During the rainy season, the male goes to a pond. It croaks, the croaking attracts and possibly excites the female. When the female comes close, the male mounts on the back of the female. The female carries the male on its back for 2-3 days during which it lays eggs in shallow water and male pour sperms over the eggs for external fertilization to take place.
12. Display: This is a situation where animals use certain behavior in order to attract the opposite sex. This includes all sort of movements ranging from flashing of colour, dancing, nodding, strutting, plumage display etc.
13. Display in Agama lizard
14. A sexually active male lizard is large, brightly coloured with orange head
15. Female lizard is smaller and less colourful (brown with greenish body).
16. Dominant male lizard protects its territory by driving away other males with its tail.
17. Male displays its full colour in front of female
18. The female responds by arching her back and lifting her tail vertically and the male wags its tail and nods its head
19. The male tries to catch her.
20. The female usually runs away
21. When caught, the male grips her by her neck and pushes its tail under her body so that the cloaca comes in contact such that mating takes place.
22. Display in birds: The male domestic fowl dances towards the female hen. This cock lowers the wing on the side away from the hen and dances in a staggering manner sideways towards the hen, beating the lowered wing against the body and legs as it moves. The hen runs away if it is not ready for courtship. If ready, the cock chases the hen, overtakes her, mounts on her back and pecks on her head. While it stoops down and raises her tail feather, exposing her cloaca. Mating then takes place.
23. Territoriality: in many animal species individuals usually makes mark out areas/ territories where they can live and breed, they guard these territories fiercely, chasing away other members of the species, only rigorous individuals are able to establish large territories, secure suitable mates and produce many offsprings e.g. in lizards, lions etc.

The territory is acquired by an animal defends the specific area against intruders, particularly of its own species.

Usually it is the male that establishes the territory.

Functions of territory

1. It ensures adequate supply of food, nesting materials for the young thereby resulting in better growth.
2. The young and the female are protected from the attack of other males
3. The population is reduced to a density that the territory can support
4. It reduces the attack of diseases and parasites
5. It makes the male to be familiar with its sites.
6. It is important in wildlife management e.g.if the territorial habits of an animal is known, it will help to determine the number of such animals that will occupy the area.
7. It ensures that only the fittest individual breed, passing on their favourable characters to the offspring e.g Agama Lizard, birds, mammals.
8. Seasonal migration: This occurs when some animals undergo periodic journeys from their natural habitats to different habitats for the purpose of breeding, search of food etc or avoiding unfavourable climate like temperature change e.g. fishes migrate upstream into their territories for breeding, this prevents the bigger fishes from eating the young ones.

Migration leads to population control because many birds may meet adverse environmental condition and die before returning to their original habitat. It also leads to reduction in the number of predators due to migration when their prey are no longer there. The preys multiply fast in number when they return due to the absence of their predators. Other animals that carry out seasonal migration are insects.

**LESSON FIVE**

**REPRODUCTIVE SYSTEM IN FLOWERING PLANTS**

The flower is the reproductive structure of a flowering plant. It has male and female sex organs. Fertilization inside the flower leads to the production of seeds which are capable of germinating into new plants. Flowers that occur singly are called solitary flowers while others growing clusters or inflorescences e.g. sunflower.

Structure of a flower

A flower is a cluster of modified leaves which is borne on a shortened stem known as stalk or pedicel

It has four floral parts which are:

1. Calyx (group of sepals)
2. Corolla (group of petals)
3. Androecium (stamen)
4. Gynoecium (carpel

The flesh base of a flower to which the different floral parts are attached is known as the receptacle or thalamus.

1. **Calyx or sepals**: This is the outermost part of a flower. It is made up of about 2-5 leaf like parts known as sepals. Sepals are usually green in colour and serve to protect the inner part of the flower during the bud stage.

Sepals may be free and then they are called polysepalous e.g. morning glory or maybe fused together to form a cup-like structure called gamosepalous e.g. crotolaria.When there is another floral part outside the calyx, the structure is called episepal e.g. Hibiscus

In some cases, instead of sepals to be small and green they maybe large, brightly coloured and attractive. In this case, the sepals are said to be petaloid e.g caesalpina, clerodeadron.

1. **Corolla or petals:** This is the most conspicuous part of the flower and it includes all the petals. It serves to attract insect to the flower in connection to the process of pollination. Also it protects the stamens and carpels especially when the petals are united to form a corolla tube enclosing these organs e.g morning glory.

Petals may be free from one another in which case they are called polypetaloids e.g. Hibiscus or fused to one another and they are said to be gamepetaloids e.g. Allamanda. Sometimes the petals may be green and sepal – like and they are called sepaloid.

In some flowers, sepals and petals look alike and together are known as perianth e.g Gloriosa. Each unit of the perianth is called Tepal.When there is an additional whorl (part) or scales or ears at the base of the corolla it is called the corona e.g. passion flower. The part of the corolla may be

(i)fused to form a cup-like structure e.g spider lily

(ii)Free from one another e.g. passion flower and Oleander

1. **Androecium:** present inside the corolla and it is the male reproductive organ. It is made up of stamens. Each stamen is made up of a long stalk called filament and a bean shaped or elongated yellow body called anther. In some flowers, the filament of the stamen may be attached to the petals, in this case the stamen are known as epipetaloids e.g morning glory.

**Description of the male reproductive organ of a flowering plant.**

The male reproductive organ of a flowering plant is also known as androecium which is made up of stamen. Stamen are made up of stalks called filaments which carry the anthers. The anther are made up of pollen sacs which contains the pollen grains containing the male gametes.

*Diagram of stamen*

The anther is usually 2 lobed each lobe contain 2 pollen sacs hence there are altogether four pollen sacs in each anther. Within the sacs lie the pollen grains. These are fine dust-like particles which are usually yellow in colour. Each pollen grain has 2 coverings which protects the inner part. The outer covering is known as exine, while the inner covering is known as intine.

1. **Gynoecium:** This is also called the pistil and it consists of carpels, hence forming the female reproductive organ of the flower.

A pistil with a single carpel is monocarpous e.g. flamboyant flower while one with 2 or more carpels is known as polycarpous e.g. Hibiscus. When the carpels are free from one another, the pistil is said to be apocarpous e.g. rose flower. But when they are fused together to form a single structure, it is described as syncarpous e.g. lilies. Each carpel consist of an ovary, a style and stigma

*Drawing of the female reproductive part of a flowering plant*

*Drawing of the different arrangement of pistil*

The ovary contains 1 or more ovules which houses the egg cell or gametes. After fertilization the ovary develop into a fruit while the ovules develop into seeds which contain the embryo. The ovary protects the egg cells while the fruit protect the embryo and the fruit also helps in seed dispersal. The stigma receives the pollen grains. The stigma have some structural modifications for receiving pollen grains

1. Some grasses have large, branched feathery stigma which makes it easy for pollen grains to land it.
2. Some stigma of some flowers can be rough and hairy while some are smooth.

The stigma matures when the egg cells in the ovule are ready for fertilization. The style supports the stigma holding it in the best position to receive pollen grains.

Types of ovary

The position of an ovary in the receptacle dictates how it is classified. The ovary can be:

1. Superior ovary
2. Half inferior ovary
3. Inferior ovary
4. Superior ovary: This is when the ovary is above other floral parts e.g. Hibiscus. The flower having this type of ovary is described as hypogynous flower.

*Drawing of superior ovary*

(b)Half inferior ovary: This is when the ovary lies inside a cup-shaped receptacle and other floral parts appear to be attached slightly above it or almost at the same level e.g. Rose flower. The flower having this type of ovary is described as perigynous flower

*Drawing of an Half inferior ovary*

(c)Inferior ovary: This is when the ovary is placed below other floral parts or it is totally embedded in the receptacle e.g. cana lily, sun flower. The flower having this type of ovary is described as epigynous flower

*Drawing of an inferior ovary*

|  |  |  |
| --- | --- | --- |
| S/N | Parts of flower | Function |
| 1 | Ovary | 1. Contains the ovule 2. Develops into fruit after fertilization (main) |
| 2 | Ovule | 1. Produce the female gametes   (b)Develops into seeds after fertilization |
| 3 | Style | 1. Connect the stigma to the ovary 2. It is the passage for the pollen tube to reach the ovules |
| 4 | Stigma | 1. Receives pollen grains during pollination |
| 5 | Pollen grains | 1. Produce the male gametes that fertilize the ovules |
| 6 | Anther | Contains the pollen grain |
| 7 | Filament | Holds or carry the anther |
| 8 | Petals (Corolla) | Attract insect for pollination |
| 9 | Sepals (calyx) | (a)Protect other floral parts when the flower is in the bud stage.  (b)Attract insects for pollination if it is brightly coloured.  (c)Carry out photosynthesis if it is green |
| 10 | Receptacle | Carries and holds together the other parts of the flower |
| 11 | Pedicel (stalk) | Attaches the flower to the stem |
| 12 | Special petal or standard petal | (a)Directs agents of pollination to the location of the nectar  (b) collects nectar in the tube |

*Drawing of the longitudinal section of flower of pride of barbados*

The calyx and corolla are known as non-essential part of a flower because they are not responsible for sexual reproduction while the androecium and gynoecium are known as the essential part of a flower because reproduction cannot proceed without them.

**Actinomorphic and zygomorphic flowers**

Flowers that can be cut into two equal halves vertically along any plane are called **Actinomorphic** or regular flowers e.g. morning glory, Hibiscus and such flower are said to be radically symmetrical.

Flowers that can be divided into equal halves only in one particular plane are said to be **zygomorphic or irregular flowers** e.g. crotalaria, pride of Barbados and these flowers are said to be bilaterally symmetrical

**Complete and incomplete flowers**

Complete flowers are flowers that have all the 4 floral parts e.g. Hibiscus, pride of Barbados.

Incomplete flowers are flowers in which one or more of the floral parts are absent e.g. maize, pawpaw.

**Unisexual flower**

These are flowers that have only one of the reproductive parts if it is a male flower that is present, it s called staminate flower. If it is a female flower present, it is called pistillate flower

When male and female flowers are formed in the same plant, then the flower is known as monoecious plant e.g. oil palm etc

When male and female flowers are found on different plants, the plant is said to dioecious e.g. Pawpaw.

A bisexual or hermaphrodite flower has both male reproductive and female reproductive parts in one flower e.g. Hibiscus

Perfect flower is one that has both carpels and stamens in it e.g. pride of Barbados

Imperfect flower is one in which either the stamen or carpel are naturally missing e.g. maize flower.

**Placentation in flowering plants**

Placentation is the arrangement of the ovules within the ovary. The ovules are attached to the ovary by flesh structures called placentae through short stalks called funicles.

**Kinds of placentation**

1. Marginal placentation: The ovules are attached to the placenta along one margin of the ovary e.g. beans, cowpea, flamboyant, delonix, crotalaria (monocarpous) (all legumes)
2. Parietal placentation: The ovules are attached to the side of a synocarpous ovary having a single chamber e.g. pawpaw fruit
3. Free central placentation: The ovules are borne on a knob which projects from the back of the ovary e.g. cana lily
4. Axile placentation: In axile placentation, the carpels of a syncarpous ovary meet in the centre to form the plancenta to which the ovules are attached e.g. tomato.
5. Basal placentation: The ovules are attached to the base of a syncarpous ovary e.g. sun flower.

**LESSON SIX**

**POLLINATION**

Pollination refers to the transfer of nature pollen grains from the anthers of one flower to the mature stigma of the same flower or another flower of the same species. We have (2) types of pollination

1. Cross pollination
2. Self pollination

Self pollination: This takes place when the matured pollen grains from the anther of a flower are transferred to the stigma of the same flower of the same flower or to that of another flower of the same plant e.g. pea, cotton, tomato.

Cross pollination: This occurs when the matured pollen grains of a flower are transferred to the mature stigma of a flower of another plant of the same species or closely related species e.g. flamboyant, hibiscus, morning glory etc.

Some plant have devices which aid self pollination and this includes:

1. Cleistogamy
2. Homogamy

**Homogamy:** This is the ripening of the anther and stigma of a bisexual flower at the same time. Self pollination may occur in this ways

1. A gentle breeze might shake the mature anther which then shed their pollen grains into any ripe stigma situated below them.
2. Insects which visit a flower for its nectar may carry ripe pollen grains to the matured stigma.
3. Mature anther may be brought into contact with the stigma by the recoiling of the filament.
4. In situations where styles are longer than the filaments, the styles may also bend or recoil.

**Cleistogamy:** Some inconspicious bi-sexual flowers never open at all, they are known as closed flowers. Ripe pollen grains are therefore discharged into the stigma which ripen at the same time.

Advantages of self pollination

1. It may not waste pollen grain
2. It is a sure way of ensuring pollination, especially in bisexual flowers
3. Once pollen grains are matured, pollination is more certain to occur as it does not involve any distances

Disadvantages of self pollination

1. The offsprings produced are less adapted to changes in environmental conditions.
2. It leads to production of weak offsprings as a result of repeated self pollination.
3. The resultant offsprings show very little genetic variation.
4. Seeds produced are less healthy than seeds produced from cross pollination

Features that favours cross pollination

The following are the features shown by flowers in order for cross pollination to occur:

1. Unisexuality
2. Dichogamy
3. Self-sterility or self incompatibility
4. Positions of stigmas and anthers

**Unisexuality:** in dioecious plant like pawpaw, only cross pollination can occur as the male and female flowers are borne in separate plants. In monoecious plants e.g. pumpkin, oil palm and maize. Self pollination is possible but the probability is very small due to the following reasons: Female flowers are borne above the male flowers or male flowers and female flower ripen at different times.

**Dichogamy:** This refers to the ripening of anthers and stigma of a bisexual flower at different times. This occurs in (2) ways:

1. Protandry: In this case, the anther of a flower matures earlier than the stigma of that flower or the other flowers of the same plant so that the mature pollen grains are useful only to the flowers to other plants which have matured stigma to receive them e.g. sunflower, okro, cotton etc.
2. Protogyny: In this case, the stigma of a flower matures earlier than its own pollen grain or those of other flowers of the same plant so that it can only receive pollen grains from flowers of other plants e.g. fig, palm trees, Dutchman pipe.

**Self – sterility:** This refers to the situation in which some plants make themselves sterile. The presence of pollen of the same plant on their stigma is injurious to further development of the plant. However, when pollen grains come from other plants, fertilization can take place in such plants e.g. passion flowers and tea, tobacco, crotalaria and other legumes.

Advantages of cross pollination

1. It leads to production of healthier offsprings than self pollination
2. It produces viable seeds.
3. Offsprings produced are more adapted to changes in environmental conditions.
4. It leads to the formation of new varieties with good characteristics or leads to greater variation among species.

Disadvantages of cross pollination

1. It relies in external agents e.g. wind, insects, whose presence at the right time cannot be guaranteed
2. It may lead to wastage of pollen grains especially by wind.

Differences between self pollination and cross pollination

|  |  |  |
| --- | --- | --- |
| **S/N** | **Self pollination** | **Cross pollination** |
| 1 | Self pollination takes place only in bisexual plants | It can take place in both bisexual and unisexual plants |
| 2 | Only (1) plant is involved | (2) plants are involved |
| 3 | Pollination may occur without an external agent | It requires external agents e.g insects and winds |
| 4 | It does not ensure new varieties | It results in the formation of new varieties |
| 5 | Pollen grains are not wasted | Much of the pollen grain are wasted |

Agents of pollination

In flowers, pollination depends on external agents and this include

1. Insects (b) wind (c) other animals like birds, squirrels, bats and snails (4) Water

Of these agents of pollination, insects and winds are common pollinator.

Characteristics of insect pollinated flower

Insect pollinated of flower are also called entomorpholous flowers. They have the following characteristics:

1. They have large conspicuous petals (sepals).
2. Petals are usually brightly coloured
3. They possess scent
4. Nectar is present
5. Pollen grains are rough, sticky and few
6. The stigma is flat with sticky surface to enable it to receive pollen grains
7. Petals are shaped and arranged to enable visiting insects dusted with pollen grains

Examples of insect pollinated flowers are: Hibiscus, delonix, pride of Barbados etc.

Examples of insects that bring about pollination are bees, butterflies, moth and ants.

Characteristics of wind pollinated flower

Wind pollinated flowers are also known as anemophilous flowers. They have the following characteristics.

1. They have small inconspicuous petal (sepals)
2. Petals are usually dull coloured
3. There is a absence of scent
4. There is absence of nectar
5. Large quantities of pollen grains are produced
6. Pollen grains are small, smooth, light and not sticky
7. Stigma is elongated, feathery with sticky large surface area.
8. Anthers are attached to the flower in such a way that they readily swing in the air and release the pollen grains.

Examples of wind pollinated flowers are maize, guinea grass, rice, millet and wheat.

Structure and pollination of maize [zea mays]

The maize has male and female flowers. Separated on the same plant and it is therefore monoecious.

The male flowers are contained in panicle of inflorescence in the uppermost part of the plant and they are made up of many spikelets. The spikelets are arranged in pairs on the main axis.

A single spikelet consists of two green bracts or glumes which becomes brown at maturity. One of the flowers matures before the other. At maturity, the pales (i.e. 2 sets of flowers each covered by 2 smaller bracts) open with three long stamens hanging freely in the air. At the base of the stamens are 2 small structures called lodicles (there are no petals and sepals). The lodicles have no function except that they help to open the pales when they swell.

The female flowers are borne in a cob –which develops from the axis of a leaf far below the male inflorescence. The cob has numerous green bracts known as husk covering the spikelets of flowers inside. A spikelet also has a pair of glumes with a flower made up of an ovary with a long style ending in hairy stigma and two lodicles. The second flower in the glume is sterile.

The male flowers mature before the female flowers therefore self pollination does not occur. The slightest wind shakes the anthers which releases a cloud of pollen grains which carries by wind to land on a matured sticky stigma of another maize plant.

*Drawing of the female flower of the maize plant*

Differences between of insect pollinated flower and of wind pollinated flower

|  |  |  |
| --- | --- | --- |
| **S/N** | **Insect pollinated flower** | **Wind pollinated flower** |
| 1 | Flowers are large and conspicuous | Flowers are small and inconspicuous |
| 2 | Petals are brightly coloured | Petals are usually dull coloured |
| 3 | Presence of scent | Absence of scent |
| 4 | Nectars are present | Nectars are absent |
| 5 | Pollen grains are rough, sticky and relatively few | Pollen grains are light, smooth and very numerous |
| 6 | Anthers may or may not be enclosed by the petals | Filaments are long so that anthers hang outside the flower |
| 7 | Flowers may or may not be held above the leaves | Flowers are carried above the leaves where they are exposed to the wind |
| 8 | Stigma is flat or lobed with sticky surfaces for easy adherence pollen grains | Stigma is large and feathery hanging outside the flower providing large surface area for easy trapping of pollen grains |
| 9 | The shape and floral parts are such that they enable insects get dusted with pollen grains during visiting | There is particular adaptive shape as flowers are small and exposed |

Description of petals and sepals of Pride of Barbados

1. Sepals are of the same colour as the petals i.e. they are petaloids.
2. Sepals are smaller than petals in size.
3. Petals are fan shaped and brightly coloured.
4. The standard petal is tubular and flat with marks.
5. One sepal is keel shaped.

Features of Pride of Barbados which have led to the success of flowering plants

1. Bright coloured petals attract insects which pollinate flowers
2. Large petals which are easily seen.
3. Presence of nectar which attract insects thus enhancing cross pollination leading to variety and survival of the sepals.
4. Sticky stigma to hold pollen grains for pollination
5. Sticky or rough pollen grains to ensure pollination and attachment to insects.

Pride of Barbados has:

1. Five sepals (one special keel shaped)
2. Five petals (one special or standard petal)
3. Ten filaments, Ten anthers
4. One style

Description of the rattle box flowers

|  |  |  |  |
| --- | --- | --- | --- |
|  | Part | Number | Description |
| 1. | Calyx | Five (5) sepals | Green, fused at box to form a cup shaped structure |
| 2. | Corolla | Five petals | Yellow with purple markings; different shapes and sizes, 1 large shaped petal, 2 small wing petals and 2 still small |
| 3. | Androecium | Ten stamens | 5 antisepalous stamens with short filaments and elongated anthers and 5 antipetalous stamens with long filaments and rounded anthers, lower parts of the filaments are fused to form a sheath around the ovary |
| 4. | Gynoecium | One Carpel | Ovary-superior; pod shaped containing about 10 ovules, marginal placentation; 1 style, 1 stigma |
| 5. | Nectary | 1 | At base of keel |

Description of the pawpaw flowers

|  |  |  |
| --- | --- | --- |
| Part | Number | Description (Male flower) |
| Calyx | Five (5) sepals | Green, free at tips but united at bases to form a cup-shape structure. |
| Corolla | Five (5)petals | Light yellow; free at tips but united at bases to form a corolla tube. |
| Androecium | Ten (10) stamens | Arranged in two whorls of five, with the stamens in the upper whorl having longer filaments, epipetalous. |
| Gynoecium | Five (5) Carpel | Reduced (non functional) |
|  |  | *Description (Female flower)* |
| Calyx | Five (5) sepals | Green, free at tips but united at bases to form a cup-shape structure. |
| Corolla | Five (5)petals | Light yellow, petals brooder than those in the male flower and nearly free. |
| Androecium | - | - |
| Gynoecium | Five (5) Carpel | Ovary-superior, numerous ovules, parental placentative, short style which forks to form a five- branched sticky stigma. |

*Drawing of the pride of Barbados without stamen and three petals*

*Diagram of the flamboyant flower without two petals*

Fertilization and zygote development in a flowing plants

The pollen grain and the ovule are the main sex cells involved in the formation of zygote in following plant.

The pollen is a haploid cell made up:

1. An exine (outer membrane)
2. The intine (inner membrane)
3. A nucleus (generative nucleus and tube nucleus)

*Diagram showing the structure of a mature pollen grain*

Structure of a mature ovule

1. Hilum is the point of attachment of the ovule to the placenta
2. Integuments: Covering of the ovule
3. Embryo sac: In the tissue that produces the female gamete
4. Nucellus: It is enclosed by the integument, it is nutritive in function
5. Micropyle : is an opening into the ovule left by the integuments

Structure of the ovule

Ovary of a flower is a hollow cavity which is protected by the ovary wall. Within the ovary are ovoid structures called ovule. Each ovule is protected by the covering called the integuments. The integuments consists of testa and tegmen. The integument do not completely cover the ovary, there is a tiny opening called micropyle through which air and water enter the ovule and it is also the opening through which the pollen tube which carries the male gametes enters into the ovule.

In the centre of the ovule is a sac which is called the embryo sac, it encloses several cells. These cells are:

1. An egg cell or ovum and two other cells (synergid cells) at the end near the micropyle. The functions of the synergid cells is to guide the pollen tube to the female gametes during fertilization.
2. Two polar nuclei in the centre that usually fuse at some stage to give a diploid nucleus or definitive nucleus.
3. Three cells called antipodal cells found at the extreme towards the styles. It plays a function in fertilization. Each ovule is attached to the placenta by a stalk called funicle.

*Drawing of the longitudinal section of a mature ovule*

Process of fertilization in flowering plants

1. Pollen grains falls on the mature stigma then absorbs a sugary liquid on the stigma, swells and the exine splits.
2. The pollen tube germinate and grows out and down inside the style
3. The male nucleus divides into 2, a larger generative nucleus and a smaller tube nucleus.
4. Generative nucleus divides into two male gametes
5. The pollen tube is guided to the ovule by stimulus of chemical
6. The pollen tube grows into the ovule through the micropyle. The tip of the pollen tube breaks down to release the male gametes
7. The male gametes are released into the embryo sac
8. One of the male nuclei fuses with the ovum / egg nucles to form a zygote.
9. The zygote develops into the embryo (This is the first fertilization)
10. The other male gametes fuses with the definite nucleus to form the endosperm nucleus that produces the endosperm (This is the second fertilization)

*Drawing of a fertilized ovule*

Changes that occur after fertilization

1. Stamen, calyx, petals, stigma, style wither off.
2. Fertilized secondary / definitive nuclei becomes the endosperm
3. The fertilized ovule becomes the seed
4. The integuments form the testa / seed coat
5. The fertilized ovary becomes the fruit
6. Antipodal / synergid cells disintegrate
7. Fertilized ovum/ egg cell becomes the embryo
8. Ovary wall develops into pericarp/ fruit wall.

*Drawing of a Germinating pollen grain*

Development of zygote after fertilization

After fertilization, the zygote divides by mitosis to form embryo. The embryo consists of:

1. Embryonic root (radicle)
2. Embryonic shoot (plumule)
3. One / two cotyledon (s) / seed leaves.

The endosperm cell also undergoes division to form nutritive endosperm i.e the food for the developing embryo.

The ovule becomes a seed covered by a seed coat (testa) formed by the integuments. In the seed coat, the embryo’s outer cover is called the testa and the inner is called tegmen. The funicle becomes the seed stalk.

The ovary becomes the fruit while the ovary wall enlarges and develop into the fruit wall (pericalp). The petals, style, stigma and stamens wither off leaving the ovary behind which formed the fruit. In some flowers, the calyx may remain attached to the fruit but it may shrink e.g. guava, tomato, garden egg etc.

**LESSON SEVEN**

**GERMINATION OF SEEDS**

A seed is a matured and fertilized ovule. A seed can be true or false. A true seed is formed through fertilization while a false seed are seeds that are not formed through fertilization but through outer processes. They do not germinate and are referred to an false seeds.

Structure of a seed

The seed generally has the following:

1. A seed coat or testa which covers the seed. Tegmen (inner cover) may or may not be present. The seed coat protects the seed from bacterial/fungal and other harmful attack of other organisms. It also protects the embryo.
2. The scar or hilum which marks where the seed was attached to the funicle.
3. An opening in the testa called micropyle
4. An embryo which consists of the plumule, radicle and cotyledons. Around the radicle we have coleorhiza i.e. a sheath that protects the radicle white coleoptile is a sheath that protects the plumule.
5. An endosperm, a food store outside the cotyledon may be present e.g. in monocot like maize, rice, wheat etc. such seeds are known as endospermic seeds while the food store in the dicot is the cotyledon e.g. cowpea, mango seeds etc.

*Drawing of the longitudinal section of a bean seed*

Tutorial Question

**Question:** You are given a wet bean seed, that has been in water for 6 hours. You are to split the seed into its cotyledons and name the observable parts and their functions.

**Answer:**

|  |  |  |
| --- | --- | --- |
| S/N | Parts | Functions |
| 1 | Cotyledon or seed leaf | Source of stored food |
| 2 | Testa / seed coat | Protects the embryo, cotyledon |
| 3 | Embryo | Growth / produces radicle and plumule |
| 4 | Hilum | Point of attachment to ovary wall |

Differences between pollination and fertilization

|  |  |  |
| --- | --- | --- |
| S/N | Pollination | Fertilization |
| 1 | No fusion of male and female gametes | Involves the fusion male and female gametes |
| 2 | Pollination takes place externally | Fertilization takes place internally |
| 3 | Germinating pollen tube not formed | Germinating pollen tube formed |
| 4 | Agent is required | Agent is not required |
| 5 | Zygote not formed | Zygote formed |
| 6 | Includes the transfer of pollen grains | Pollen grains not involved |
| 7 | Gametes not involved | Gametes are involved |

*Drawing of the External view of a cowpea seed*

*Drawing of the longitudinal section of a cowpea seed*

*Drawing showing the external view of a cowpea seed*

In the above diagram showing epigeal germination, the following parts carry out functions as stated

1. Foliage leaves: manufactures food through the process of photosynthesis
2. Hyocotyl/Epicotyl: They raised the seed leaf above the ground to receive sunlight and also transport water and dissolved mineral salts to leaf and other growing regions.
3. Root hair / Secondary root: For absorption of water and dissolved mineral salt and also anchors the plant
4. Cotyledons: provides food for developing plant / seedling
5. Tap root / primary root: For absorbing water and nutrients.

Descriptions of epigeal germination

1. Seed absorbs or imbibes water and swells
2. Testa splits and radicle emerges
3. The hypocotyl of the germinating seed elongates
4. Raising the seed leaf or cotyledon out of the soil
5. The cotyledons become exposed to sunlight and turn green to carry out photosynthesis.
6. The plumule develops into a green shoot
7. The cotyledons dry up or shrivels and fall off

Hypogeal germination

This is when the cotyledons remain below the soil surface and the epicotyl elongates. It occurs in maize grain, millet grain etc

*Drawing showing stages of germination of the maize grain*

*Drawing showing the external view of a maize grains*

*Drawing showing the longitudinal section of a maize grains*

**Germination of seed**

Germination is the process by which changes occur to make the embryo in a seed resume its growth and development, to become an independent seedling when the environmental conditions are favourable.

The embryos of a fully developed seed usually pass through a period of rest. That period of rest is known as dormancy. During this time, all its life activities are performed slowly.

Seed dormancy

This is an inactive period of a seed during which growth slows down completely ceases due to certain internal or external factors.

Importance of dormancy

1. It gives seeds time reach a suitable habitat
2. It enables seeds to tide over unfavourable seasons

Causes of Seed dormancy

1. The embryo may not be fully matured at the time the seed is released from the fruit
2. It seed coat may be too hard or impermeable and may not be able to absorb water that is necessary for germination.
3. Growth inhibitors (Absicsci acid)
4. Sometimes the embryo needs the presence of certain chemicals from the soil before it can germinate and unless these chemicals are available, it will remain dormant.

Ways of breaking dormancy in seeds

1. Removal / corrosion of testa
2. Treatment of seed with digestive enzymes or water or acid
3. Exposure to alternating high and low temperature
4. Addition of dormancy breaking hormones (Auxin, Gibberilin, cytokinnins)
5. Exposure to light
6. Exposure to fire

Types of germination

1. Epigeal germination
2. Hypogeal germination

Epigeal germination (Dicotyldon)

This is the type of germination in which the cotyledon is brought above or appears above the soil surface and hypocotyl elongates e.g. in cowpea plant, castor oil etc.

Descriptions of hypogeal germination

When maize seed is placed in the soil

1. The seed imbibes/absorbs water and swell up
2. The testa / seed coat splits
3. The radicle appears and grows downwards into the soil
4. Epicotyl of the germinating seed elongates
5. The seed leaf (endosperm) remains below the soil surface
6. The plumule appear and grows upward above the soil

Differences between epigeal and hypogeal germination

|  |  |  |
| --- | --- | --- |
| S/N | Epigeal germination | Hypogeal germination |
| 1 | Hypocotyl elongates | Epicotyl elongates |
| 2 | Cotyledon emerges out of the soil | Cotyledons remains in the soil |
| 3 | Cotyledons turn green to carry out photosynthesis | Cotyledons do not carry out photosynthesis |
| 4 | Plumule does not emerge simultaneously with radicle | Plumule emerges simultaneously with radiale |
| 5 | Energy derived from cotyledon | Energy derived from endosperm |
| 6 | Cotyledons is the first photosynthetic tissue | Foliage leaves are the first photosynthetic tissue. |
| 7 | Testa splits | Pericarp splits |

Tutorial Questions

Describe the general process of germination

Answer: When the seed is placed in the soil

1. It absorbs water and swells up
2. The testa / seed coat splits
3. The radicle appears and grow downwards into the soil
4. The seed leaf appears and grow upwards above the soil (if it is a dicot plant e.g. cowpea) or the seed leaf or cotyledon remain below the soil and also plumule appear and grow upwards above the soil (if it is a monocot e.g. maize)
5. In dicot, as the seedling grows the food stored in the cotyledon is used up and the seed leaves eventually wither away while in monocot, as the seedlings grows, the food store in the endosperm below the soil is used up and eventually wither off
6. The seed absorbs water and reactivate the activities of the enzymes and respiration rate increases as the growth of the seedlings increases.

Conditions necessary for germination

1. Water or moisture
2. Warmth or suitable or (optimum) temperature
3. Air or oxygen
4. Viable seeds

Other condition that are needed are

1. Enzyme
2. Energy or food

How the developing embryo obtains energy during germination

For a viable seed to germinate oxygen, water and suitable temperature are necessary. Water is necessary to reactivate the enzymes which hydrolyse the complex food materials stored either in the cotyledons or in the endosperm of the seed to simple soluble products which can be passed to the embryo for respiration and growth.

It is for this reason that germination starts with absorption of water. During the enzyme hydrolysis starch is hydrolysed to simple sugar, protein to amino acids and fatty acid and glycerol. The oxygen in the air is required to oxidize simple sugar to carbon (iv) oxide, water and energy, a process known as aerobic respiration

C6H12O6 + 6O2 enzymes 6CO2 + 6H2O + energy

The reaction takes place in the growing cells of embryo thus providing the energy required for growth.

Experiment to demonstrate the conditions necessary for germination of seeds

**Aim:** Experiment to demonstrate conditions necessary for the germination of seeds

**Apparatus:** Four conical flasks, cotton wool, string, stopper, bean seed, selection of pyrogallic acid and caustic soda, test tube, water.

**Method:** Place a few bean seed in each of the four conical flasks A, B, C and D. In conical flask B, we have warmth, water and no oxygen. This is done by suspending a test tube containing pyrogallic acid (absorbs oxygen) and caustic soda (removes O2) by means of a string in the conical flask. In conical flask C, we have warmth, oxygen and water. In conical flask D, we have oxygen, water and no warmth (i.e. by putting A in a refrigerator i.e. low temperature). Water is added to flask B, C and D at intervals to ensure that the cotton wool in always neat and moist.

The conditions present in each of the flasks are as follows:

Flask A: Warmth, Oxygen, no water

Flask B: Warmth, water, no oxygen

Flask C: Warmth, oxygen, water

Flask D: Oxygen, water, no wamth

**Observation:** only the seeds in flask C germinate because they have all the conditions necessary for germination of seeds which are not complete in other flasks.

**Conclusion:** The experiment shows that warmth oxygen and water are necessary for germination of seeds.

*Drawing showing the demonstration of the conditions necessary for germination of seeds*

**LESSON EIGHT**

**FRUITS**

A fruit is a structure that develops from a fully grown fertilized ovary of a flower which may or may not contain seeds.

Fruit formation results from pollination and fertilization sometimes some fruits are formed without fertilization (i.e. unfertilized ovary) e.g. banana, pineapple etc and they are called parthenocarpic fruits and they are also known as seedless fruit.

Structures of a fruit

During fruit fertilization, the ovary wall forms the fruit wall known as the pericarp. The pericarp encloses one or more seeds and it is attached to the plant by a fruit stalk that develops from the flower stalk.

The pericarp of a typical fruit has 3 layers i.e.

1. Epicarp – the outer layer
2. Mesocarp – the middle layer
3. Endocarp – the inner layer

The pericarp also has two scars; one from the style (at the top) and the other by the receptacle (at the bottom).

The three layers of the pericap may be well developed or indistinct. They may be hard, soft, dry, flesh or fibrous. When the fruit in ripe, the pericarp can store food like sugars, fats and oils. It may be attractively coloured due to the presence of pigment like carotenes and anthocyanins.

Differences between a fruit and a seed

|  |  |  |
| --- | --- | --- |
| S/N | Fruit | Seed |
| 1 | Outer covering in fruit wall / pericarp | Outer covering in seed coat/testa |
| 2 | Develops from a fertilized ovary of a flower | Develops from a fertilized ovule of a flower |
| 3 | Contains seed or seeds | Contains the embryo |
| 4 | Has two scars | Has only one scar |
| 5 | Has no pore / micropyle in the pericarp | Has a pore / micropyle in the testa |
| 6 | Bears remain of style | Does not bear remains of style |
| 7 | Has a fruit stalk due to receptacle | Has a scar (hilum) formed by attachment of funicle. |

Similarities between fruits and seeds

1. They both have scar
2. They both have protective covering
3. They both have stalk

Types of fruits

Fruits are classified in different ways. The following are common ways of classifying fruits.

1. True and false fruits
2. Simple, aggregate and composite or multiple fruits.
3. Succulent / fleshy and dry fruits
4. Dehiscent and indehiscent fruits

True and false fruits

True fruits are formed only or solely from a fertilized ovary. It consists of pericarp and seed(s) e.g. mango fruits, orange fruit, tomato fruit etc.

False fruit is the fruit that develop from a fertilized ovary and other floral parts such as calyx, corolla and receptacle. They are also developed from inflorescence e.g. pineapple fruit, apple fruit, pear fruit, cashew fruit etc.

Simple, aggregate and composite or multiple fruits

These are classified based on the numbers of flowers on the carpels or ovaries from which fruits develop.

1. Simple fruits: These are fruit formed from one flower with single ovary. The ovary may be monocarpous e.g. cowpea and maize fruits or syncarpous e.g. okro, tomatoes and pawpaw fruits.
2. Aggregate fruit: These are formed from one / single flower with several separated free carpels or ovaries (apocarpous). It is a collection of a simple fruit e.g. strawberry, apple, custard and raspberry fruit
3. Multiple / composite fruit: These are formed from several flowers or inflorescence or flowers positioned very close to one another. Here, all the fruitlets and floral parts fuse together to form a single large fruit. Multiple fruits are false fruits e.g. fig fruit, pineapple fruit and bread fruit.

Fleshy and dry fruits

This classification is based on the nature of fruit wall or pericarp. They are:

1. Dry fruits
2. Fleshy fruits

Fleshy fruit: They are juicy, succulent and indehiscent. They store large quantities of water and carbohydrates / sugar in their tissues. There are six main types of fleshy fruits. They are

1. Drupe
2. Berry
3. Hesperidium
4. Pome
5. Sorosis
6. Syconium

Drupe

This is a simple, true fruit with well developed pericarp. The epicarp is thin. It is one seeded, mesocarp is succulent or fleshy. The pericarp is made up of three layers i.e the epicarp, mesocarp and endocarp. The endocarp is stony and hard.

In some fruits like coconut fruit, the mesocarp is fibrous and some the mesocarp can be flesh and succulent e.g. coconut fruit, mango fruit, oil palm fruit etc.

*Drawing of transverse section of mango fruit*

*Drawing of the longitudinal section of the mango fruit*

*Drawing of the longitudinal section of the coconut fruit*

*Drawing of the longitudinal section of a fig fruit*

Berry

It is a true, simple fruit in which the epicarp is thin and membraneous. The mesocarp and endocarp are fused together and fleshy. It contains many seeds. The whole fruit is succulent, fleshy and edible e.g. guava fruit, garden egg fruit, orange fruit, tomato fruit, pawpaw fruit etc.

*Drawing**of the longitudinal section of the tomato fruit*

*Drawing**of the transverse section of the tomato fruit*

Hesperidium

True, simple fruit. The epicarp and mesocarp fuse to form the skin or rind, the endocarp is a sheet-like forming chamber filled with succulent hair e.g. orange fruit, lemon fruit, lime fruit etc.

*Drawing**of the transverse section of an orange fruit*

*Drawing**of the longitudinal section of an orange fruit*

Similarities between a drupe and a berry

1. Both have fleshy or succulent mesocarp
2. Both have thin epicarp
3. Both have seed(s)

Differences between a drupe and a berry

|  |  |  |
| --- | --- | --- |
| S/N | Drupe | Berry |
| 1 | One seeded | Has several seeds |
| 2 | Endocarp is hard, stony and woody | Endocarp is fleshy and succulent |
| 3 | Mesocarp and endocarp are not fused | Mesocarp and endocarp are fused |
| 4 | Seed enclosed in endocarp to form a stone | Seed enclosed in fleshy mesocarp / endocarp |
| 5 | Endocarp is not edible | Endocarp is edible |

Structure differences between coconut fruit and tomato fruit

|  |  |  |
| --- | --- | --- |
| S/N | Coconut fruit | Tomato fruit |
| 1 | Contains a single seed | Contains several seeds |
| 2 | Hard / stony endocarp | Soft endocarp |
| 3 | Mesocarp and endocarp not fused | Mesocarp and endocarp fused |
| 4 | Spongy / fibrous mesocarp | Fleshy / succulent mesocarp |

Pome

This is a simple, false fruit. The skin and the fleshy edible part are derived from the receptacle. Only the core enclosing the seeds are formed from the ovary e.g. apple fruit and pear fruit.

*Drawing of the longitudinal section of an apple fruit*

Sorosis

It is a multiple false fruit formed from an inflorescence e.g. pineapple fruit and bread fruit. In the sorosis, each part of every flower forms part of the fruit while the pedicel or stalk of the inflorescence swells to form the core.

*Drawing**of the longitudinal section of an pineapple fruit*

Syconium

It is a fleshy multiple false fruit having a hollow cuplike fleshy pedicel e.g. fig fruit.

Dry fruit

They are fruits which have dry, hard, fibrous or woody pericarp when the fruit ripen. There are two types

1. Dry dehiscent
2. Dry indehiscent
3. Dry dehiscent: The pericarp dries and break open to liberate the seeds when ripe leaving the fruit wall or pericarp on the plant. There are four types
4. Legume
5. Follicle
6. Capsule
7. Siliqua
8. Schizocarpic

Legume: it is a simple, dry dehiscent fruit formed from one carpel / monocarpous. The pericarp is long and flattened sideways. When ripe it dehiscent along two longitudinal sutures with seeds attached along one margin of the carpel e.g. cowpea fruit, crotalaria fruit, soyabeans fruit, pride of Barbados fruit, flamboyant fruit etc.

*Drawing of a cowpea fruit*

Follicle: it is a simple dry fruit formed from one carpel / monocarpous. It has one or more seeds. The dry fruits dehisced longitudinally in one side only to release the seed(s) e.g. sodom’s apple fruit, strophanthus

Capsule: it is a simple fruit which contains many seeds. It is formed from a superior syncarpous pistil. The pericarp dehisces longitudinally at more than two places e.g. okro fruit, babam fruit etc.

*Drawing of an okro fruit*

Schizocarpic fruit: These are several seeded complete dry fruit formed from a syncarpous ovary. When it breaks up into units each units encloses one seed e.g. desmodium fruit, cassia etc

*Drawing of desmodium and cassia fruit*

Siliqua: it is a long narrow capsule formed from a bicarpellary ovary. It has 2 chambers separated by a false septum or reptum e.g. Tecoma fruit

1. Dry indehiscent fruit: They are simple dry fruit which do not split open when matured but usually fall on the ground where the pericarp eventually decay to release the seeds.

There are five types, they are:

1. Achene
2. Cypsela
3. Caryopsis
4. Samara
5. Nut
6. Achene: It is a small, dry, simple indehiscent fruit which develops from a superior monocarpous ovary. They are one seeded with one chamber. The pericarp is free from the seed coat e.g. clematis, sunflower, strawberry and rose flower fruits.

*Drawing**of a sunflower fruit*

1. Nut: it is an achene-like fruit, small, dry indehiscent with seed. The pericarp is hard and woody e.g. cashew fruit (the actual fruit, the nut is on a fleshy edible receptacle)

*Drawing**of a cashew fruit*

1. Cypsela: It is similar to achene two but develops from a bicarpous ovary. Part of the fruit wall is from the receptacle. The calyx is persistent as a tuft of hairs called pappus. The seed coat is hard and does not split open on drying e.g. tridax fruit, Emilia etc

*Drawing of the lateral view of the tridax fruit*

1. Caryopsis: It is also like achene except that the pericarp and the seed coat are fused together to form a covering over the entire seeds e.g. fruit of grasses and cereal like maize fruit. The presence of two scars identifies it as a fruit.

*Drawing of the maize fruit*

1. Samara: The pericarp extends to form one or more wing like structures. It is a simple true fruit. It usually contains one or more seeds and it develops from a superior ovary made up of more than one carpel e.g. combretum, pterocarpus fruit etc

*Drawing combretum fruit*

Differences between the garden egg fruit and tridax fruit

|  |  |  |
| --- | --- | --- |
| S/N | Garden egg | Tridax fruit |
| 1 | Fleshy pericarp | Dry pericarp |
| 2 | Smooth epicarp | Hair epicarp |
| 3 | No pappus | Pappus present |
| 4 | Calyx beneath fruit | Calyx on top of fruit |
| 5 | Calyx present | Calyx modified into pappus |
| 6 | Large fruit | Small fruit |

Dispersal of fruit and seeds

Dispersal is the scattering or removal or carrying of seeds and fruit from the parent plant to another place by an agent of dispersal in order to reduce overcrowding and competition.

Advantages / importance of dispersal of seeds

1. To prevent competition and overcrowding among plants for water, light, space and mineral salts.
2. Plants are introduced into new habitat / environment where the conditions may be favourable as to enhance survival
3. It minimizes the spread of epidemic diseases
4. It enables barren land to become covered with vegetation
5. It prevents destruction of species in environment in the event of local hazards like erosion, bush fires etc.

Agents of dispersal

Fruits and seeds are modified in different ways to be dispersed by various agents. These agents are:

1. Wind
2. Water
3. Animal/ man
4. Explosive mechanism

Wind dispersal

The fruits and seeds dispersed by wind are characterized by the following features

1. Small and light weight of fruits and seeds which enables them to be carried by air current or for easy float in the wind e.g. fruit of grasses and seeds of orchid, sunflower seed.
2. Some have parachute like hairs or pappus for floating or to be carried by wind e.g. tridax fruit.
3. Some fruits like fruits of cotton and silk have seeds surrounded by a mass of thread or floss which makes them blow about easily in wind.
4. Some fruits and seeds develop or wing-extension of testa for buoyancy e.g. combretum, tecoma etc.

Disadvantages of wind dispersal

It is wasteful process because a great number of fruit and seeds may fall on sterile or unsuitable ground or carried out to the sea. Because of this, seeds and fruits dispersed by wind are produced in relatively large numbers than those dispersed by animal.

Animal dispersal

1. Sticky hairs or hooks for attachment to the body of the animal
2. Succulent or fleshy pericarp which is eaten by animals and the hard part containing the seeds are then thrown on the ground or spat out.
3. Brightly coloured and scented fruit for attraction
4. Tough testa which withstands digestive enzymes.

Examples of such fruits are guava fruit, garden egg, oil palm fruit, tomato fruit etc.

Water dispersal

1. Waterproof coats or skin to prevent soaking and sinking.
2. Fibrous or spongy mesocarp and air spaces which enables the fruits / seeds to remain afloat (i.e. buoyancy)
3. The fruits are light in weight which enables them to float on the surface of the water e.g. coconut fruit.

Explosive mechanism

1. Dry pericarp for twisting at the line of dehiscent for easy splitting
2. Turgid pericarp for easy splitting
3. Seeds are lightly attached to placenta enhancing easy detachment e.g. delonix fruit, cowpea fruit, flamboyant fruit, castor oil fruit, cassia fruit, okro fruit.

Process of explosive mechanism

1. The fruit matures / ripens and the pericarp dries up
2. Tension is set up in the fruit wall
3. Due to uneven drying of the fruit wall or pericarp
4. Fruit splits with explosion along weak lines or lines of dehiscence
5. Seeds are scattered.