**Continuation of BIO 101 Part 3**

**Types of fertilization**

**External fertilization**:- This occurs in aquatic environments where both egg and sperm are released into the water. Fertilization takes place when the sperm reaches the egg. Most external fertilization happens during the process of spawning where one or several females release their eggs and the male releases sperms in the area, at the same time.

**Internal Fertilization**:- This occurs most often in land based animals.

There are three ways through which offsprings are produced following internal fertilization.

In **oviparity**, fertilized eggs are laid outside the female’s body and develop there receiving nourishment from the yolk that is a part of the egg. This occurs in most bony fishes, reptiles, birds and turtles.

In **ovoviviparity**, fertilized eggs are retained in the female, but the embryo obtains its nourishment from the egg’s yolk and the young are fully hatched. This occurs is some bony fish, lizards, snakes vipers and invertebrates.

In **viviparity**, the young develops within the female receiving nourishment from the mother’s blood through a placenta. The offspring develops in the female and is born alive. This occurs in most mammals.

**Sex determination**

This is the technique of relating phenotypic characteristics of organism to the structure of their chromosomes. Examination of chromosome structure revealed that males and females showed certain chromosomal differences.

Pairs of chromosomes are found in all cells, but one pair of chromosomes shows differences between the sexes. These are the **sex chromosomes**. All other chromosomes are known as body or **autosomal chromosomes** or **autosomes**. The chromosomes are known as X and Y chromosomes and the genotype of the **female** is **XX** and that of the **male** is **XY.**

The sex of the offspring depends upon the type of sperm that fertilizes the ovum. The sex having the XX genotype is described as homogametic as it produces gamete cells containing only X chromosome. Organisms with the XY genotype as described as heterogametic since half their gametes contain the X chromosome and half the Y chromosome.

**Artificial insemination**

This is a procedure or technique used to treat infertility that involves direct insertion of semen into a woman’s womb in human use. The sperm could originate from the woman’s male partner, unless the male is infertile or there is no male partner. The most commonly used of artificial insemination is **intrauterine insemination**.

**Why is Artificial Insemination Used?**

Situations where;

* the sperm count of the man is low.
* a woman may want to raise a child alone-----in this case she would request sperm cells to be artificially inseminated.
* the female may be infertile due to cervical factor infertility—the cervix is supposed to produce a mucus that helps sperm travel to the womb.

With cervical factor infertility, the cervix is either not producing enough of this mucus or maybe producing mucus containing sperm killing substances.

* the woman may be endometriotic: this is when cells from the womb lining start to grow in places they should not i.e., within the woman’s reproductive system. For example: in ovaries or fallopian tubes.
* One of the possible results condition is infertility. The female could have semen allergy: this is rare but can still happen due to certain proteins in the sperm. The woman may suffer an allergic reaction when the sperms makes contact with intrauterine lining. Most of the proteins could be removed before sperm insertion.
* the male is unable to produce enough sperm for successful fertilization.
* the man is impotent (erectile dysfunction) and would therefore be unable to perform sexual intercourse.
* the male could be infertile as a result of a medical treatment –some treatments carry the risk of infertility. Example: radiotherapy. Before the treatment the male would have been given the chance to freeze some of his sperms.

**Gametogenesis in flowering plants**

In flowering plants, male gametes are produced in the anthers, and female gametes in the ovules. Inside the anthers, diploid pollen mother cells divide by meiosis to form four haploid cells. The nuclei of each of these haploid cells then divide by mitosis, but the cell itself does not divide (cytokinesis does not take place), resulting in cells that contain two haploid nuclei.

These cells mature into pollen grains, each surrounded by a protective wall made up of a tough exine and thinner intine. One of the haploid nuclei is called the tube nucleus and the other is the generative nucleus. These are the male gametes. Inside each ovule, a large, diploid, spore mother cell develops. This cells divides by meiosis to produce four haploid cells. All but one of these degenerates, and the one surviving haploid cell develops into an embryo sac.

The embryo sac grows larger and its haploid nucleus divides by mitosis three times, forming eight haploid nuclei. One of these becomes the female gamete. Fertilization occurs when a male gamete from a pollen grain fuses with female gamete inside an ovule. This forms a diploid zygote, which grows into an embryo plant.

**Plant Reproduction**

The flower is the most advanced structure of a plant and it is the means of sexual reproduction in all angiosperms. The function of flower is sexual reproduction, as a result of which they form fruits and seeds that give rise to the next generation.

The flower is made up of two parts:

The **reproductive parts** i.e., the stamen and carpel.

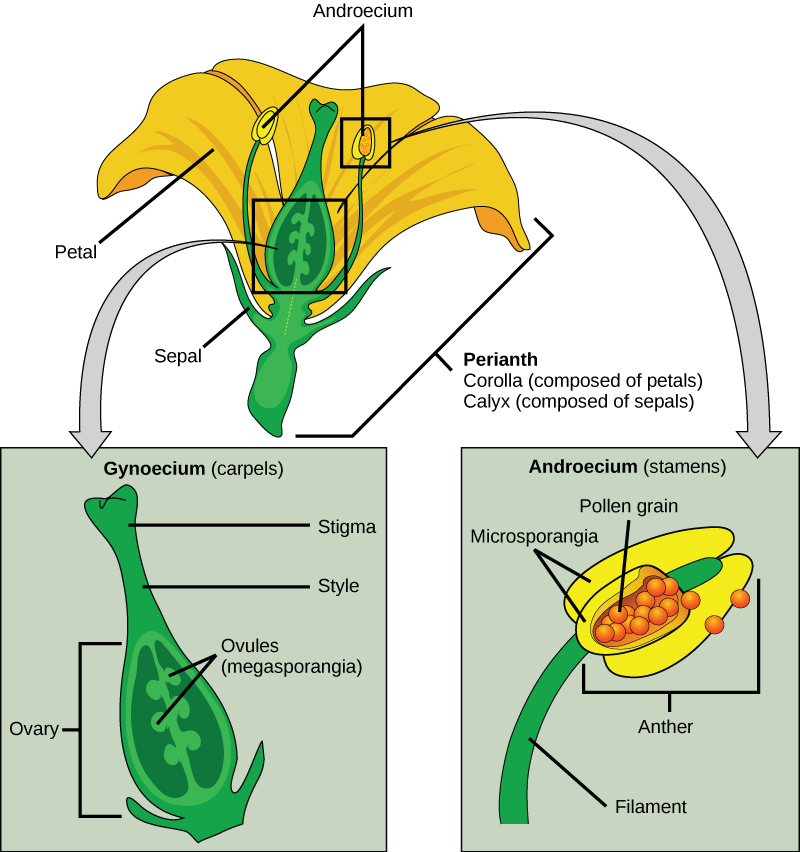
The **non reproductive parts** i.e., the calyx and corolla.

Stamen are known collectively as the **androecium** and these are the male reproductive organs. Each stamen consists of a stalk or **filament**, bearing an **anther** which consist of pollen grains embedded inside four pollen sacs, the pollen grains contains the male gametes.

**Carpel**: The carpels are situated at the center of the receptacles. Collectively, carpels are referred to as **pistil** or **gynoecium**.

Carpels are the female pistil or gynoecium. Carpels are the female reproductive organs. Each carpel consist of an expanded hollow base called **ovary**, above which is a narrow region called the **style**, which ends in a point flattened or sculptured region called the **stigma**. The stigma receives pollen from the same or another flower during pollination.

Within the **ovary** are the **ovules** which will mature into seed. At the center of each ovule is a large cell called the embryo sac, which contains several nuclei; one of which is the female gamete or egg nucleus. After fertilization, the ovary wall develops to form the pericarp.

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**Structure of a flowering plant**

**Petals**: Petals are collectively called corolla of flowers. The corolla of any flower may be gamopetalous or polypetalous, that is, united petals or free petals respectively. Some flowers have coloured and scented petals with nectary at the base which produces sugary nectar. Petals of this type attract insects which suck the nectar and in the process pollinate the flower.

**Sepals**: These are the outermost whorl collectively known as calyx; sepals are usually green and look more or less like tiny leaves. They protect the flower in bud stage of development. Sepals may be polysepalous (free sepals) or gamosepalous (fused/united)

**Pollination**

Pollination can be defined as the transfer of pollen grains from the mature anther to the mature stigma of the same flower or from the anther to the stigma of another flower of the same species which eventually leads to fertilization.

**Self and cross pollinations** are present in plants.

Features of self pollinated flowers

Characteristics/adaptations in flowers that enhance self pollination include:

**Homogamy**: This is when the anther and stigma of a bisexual flower mature at the same time.

**Cleistogamy**: This is when the bisexual flower does not open such that external pollen grains are excluded and pollination can only be by self pollen grain.

**Reduced flowers**.

**Absence of petal.**

**Stigma is situated above the anthers.**

**Cross pollination**

Characteristics/adaptations in flowers that enhance cross pollination include:

**Dioecious**: This is a situation whereby the male and female reproductive organs are located on different plants. E.g., pawpaw (*Carica papaya*).

**Protandry**: This occurs when the anther becomes matured before the stigma.

The stigma is immature and unreceptive at the time the pollen grains are deposited by anther. E.g., *Crotalaria*, sunflower, *Tridax.*

**Protogyny**: Here, the stigma becomes mature and receptive before the anther matures. E.g., water lettuce.

**Petals remain open all day.**

**Agents of pollination**

Various external agents enhance the transfer of pollen grain from one flower to another, thus enhancing pollination.

Some of these agents are: Insects such as butterfly, Water, Wind, Birds.

**Water pollinated flowers**

Pollination may be effected in some aquatic plants particularly the submerged ones, through the agent of water e.g., *Naias, Hydrilla, Ceratophyllum*.

Aquatic plants that lift their flowers above the water level are normally pollinated by water and they are said to be small, inconspicuous and hygrophilous.

**Animal pollinated flowers**

Animals such as birds, squirrels, bats etc., are good pollinating agents. For instance, birds and squirrels pollinate coral tree (Erythrina), silk cotton tree (Bombax), rose, apple etc. Bats pollinate *Anthocephalus,* and snail are good pollinating agents of certain variety of snake plants (*Arisaema*).

**Insect pollinated flowers (**Characteristic features):

Petals are large and often brightly coloured e.g., *Crotalaria,* Sunflower.

Scented petals e.g., Rose flower. Nectars are present e.g., *Hibiscus*, Canna lily.

Presence of honey guides: these are petals with grooves or dark line leading from the petal border to the nectarines e.g. *Crotalaria, Thevetia* (Yellow Oleander).

Brightly coloured calyx e.g., Pride of Barbados, Cowpea.

Presence of rough sticky and few pollen grains so the grains can cling or stick to insect’s body.

Stigmas have small surface area with sticky surfaces for pollen grains to stick on.

Standard petal may be present e.g. *Delonix* (Flame of the forest).

Anther may be small situated inside the flowers where insects are likely to brush against them.

**Wind pollinated flower** (Characteristic features)

Petals are absent, however when present, are small and inconspicuous.

Absence of nectar and scent e.g., Maize.

Flower is usually small not brightly coloured and unnoticeable. E.g., Guinea grass

Absence of standard petals. Abundant pollen grains are produced.

Small and light pollen grains which can float on the lightest breeze.

Large anthers with long filaments to enable them hang well outside the flower.

This allows the pollen grains to be shaken at the slightest breeze e.g. Maize, guinea corn, millet. Flowers are borne on long stalks above the foliage so that the wind can easily carry away the pollen grains.

**Fertilization in flowering plants**

After the pollen grains have been successfully deposited on the ripe stigma of a flower, the pollen grain becomes firmly attached to a stigma. At this instance, the male gamete within the pollen grain is still separated from the female egg nucleus by seemingly impassable barriers even after pollination.

The stigma (to this effect) produces a sticky fluid which nourishes the pollen grain and stimulate it to enlarge in size. Thereby causing the exine (outer coat) of the pollen grain to burst and a long, hollow and tubular out-growth called the pollen tube is formed while covering the pollen tube is the intine (inner coat) of the pollen grain. The pollen tube grows down through the style towards the ovule located in the ovary; carrying along two male gametes from the generative nucleus.

The pollen tube is eventually guided to the ovule by a stimulus of chemicals, released by the ovule, then enters the ovule by a tiny hole, called **micropyle,** through which it reaches the embryo sac.

When the pollen tube reaches the embryo sac, the tip of the pollen tube breaks down and the male nuclei are released inside the ovule. One of the male nuclei fuses with the egg cell or ovum to form zygote, this is called **fertilization**. The other male nucleus fuses with the definitive nucleus,

Which develops by cell multiplication into a food storage tissue called endosperm. After fertilization, the synergids and the antipodal cells disintegrate, this now becomes the fertilized ovule. The fertilized ovule divides by mitosis to form a small embryo plant. This embryo consists of a young root called radicle, shoot or plumule and one or two seed-leaves called cotyledons. The embryo also develops a supply of stored food. This food deposit can either be inside the cotyledons or in a mass of cells called endosperm (that surrounds the embryo) depending on the species of the plant.

**Development of the embryo**

The zygote becomes organized into an embryo. The embryo is made up of the following parts:

The plumule (embryo shoot),

The radicle (embryo root),

One or two cotyledons,

Endosperm (occasionally).

As the embryo develops, the nucleus degenerates, the endosperm may be used up by the embryo or it may persist. The ovule develops into seed; its (the seed) outer coat (testa) and an inner seed coat respectively. The ovary undergoes changes after fertilization to form the fruit. The sepals, petals, style and stigma having completed their functions, these wither away or degenerates.

**Sexual reproduction in gymnosperm**

In gymnosperms, the cone is the female reproductive part and the pollen is the male reproductive part. The male one is called the pollen cone.

The female cones are larger than the male cones and are positioned towards the top of the tree; the small, male cones are located in the lower region of the tree.

Because the pollen is shed and blown by the wind, it is difficult for gymnosperm to self pollinate.