Plant reproduction

Sexual reproduction in flowering plants

Objectives :

- Define Sexual and asexual reproduction and differentiate between them

- Explain some examples of asexual reproduction in plants including tubers in potatoes, bulbs in onions and runners in strawberries

- Identify the sepals, petals, stamens, filaments and anthers, carpels, style, stigma, ovary and ovules, of an insect- pollinated flower and state their functions.

- Describe the structural adaptations of insect-pollinated and wind-pollinated flowers

- Define self-pollination as the transfer of pollen grains from the anther of a flower to the stigma of the same flower or different flower on the same plant

- Define cross-pollination as transfer of pollen grains from the anther of a flower to the stigma of a flower on a different plant of the same species

- Discuss the implications to a species of self-pollination and cross-pollination in terms of variation, capacity to respond to changes in the environment and reliance on pollinators

- Describe the growth of the pollen tube and its entry into the ovule followed by fertilization

- Identify the different parts of the seed including the testa , cotyledons , radicle and plumule

- Explain the environmental conditions that affect germination of seeds, limited to the requirement for water, oxygen and a suitable temperature

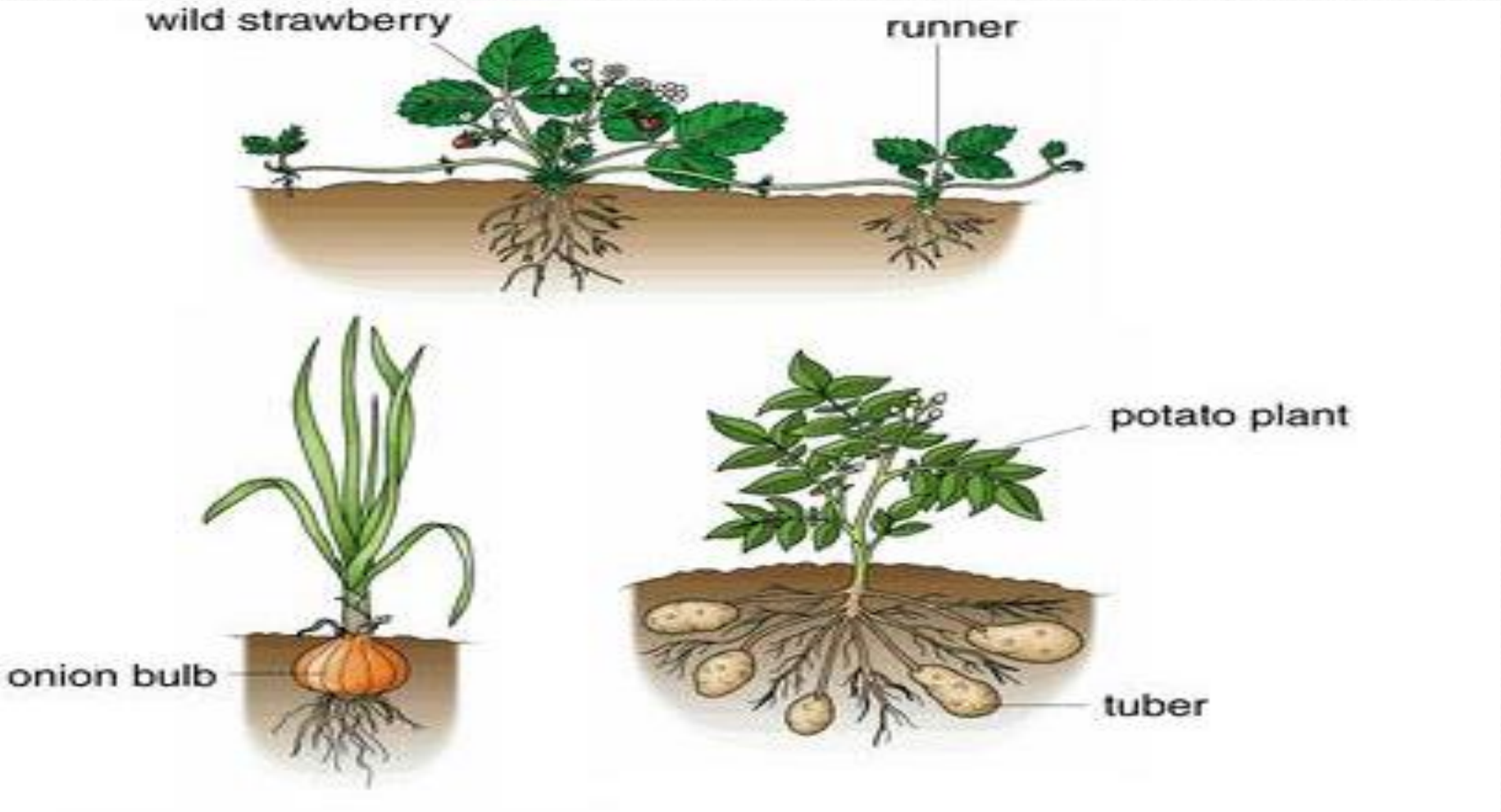
Resources : Only from the power point

Reproduction in flowering plants can be either

- Sexual Reproduction
- Asexual Reproduction

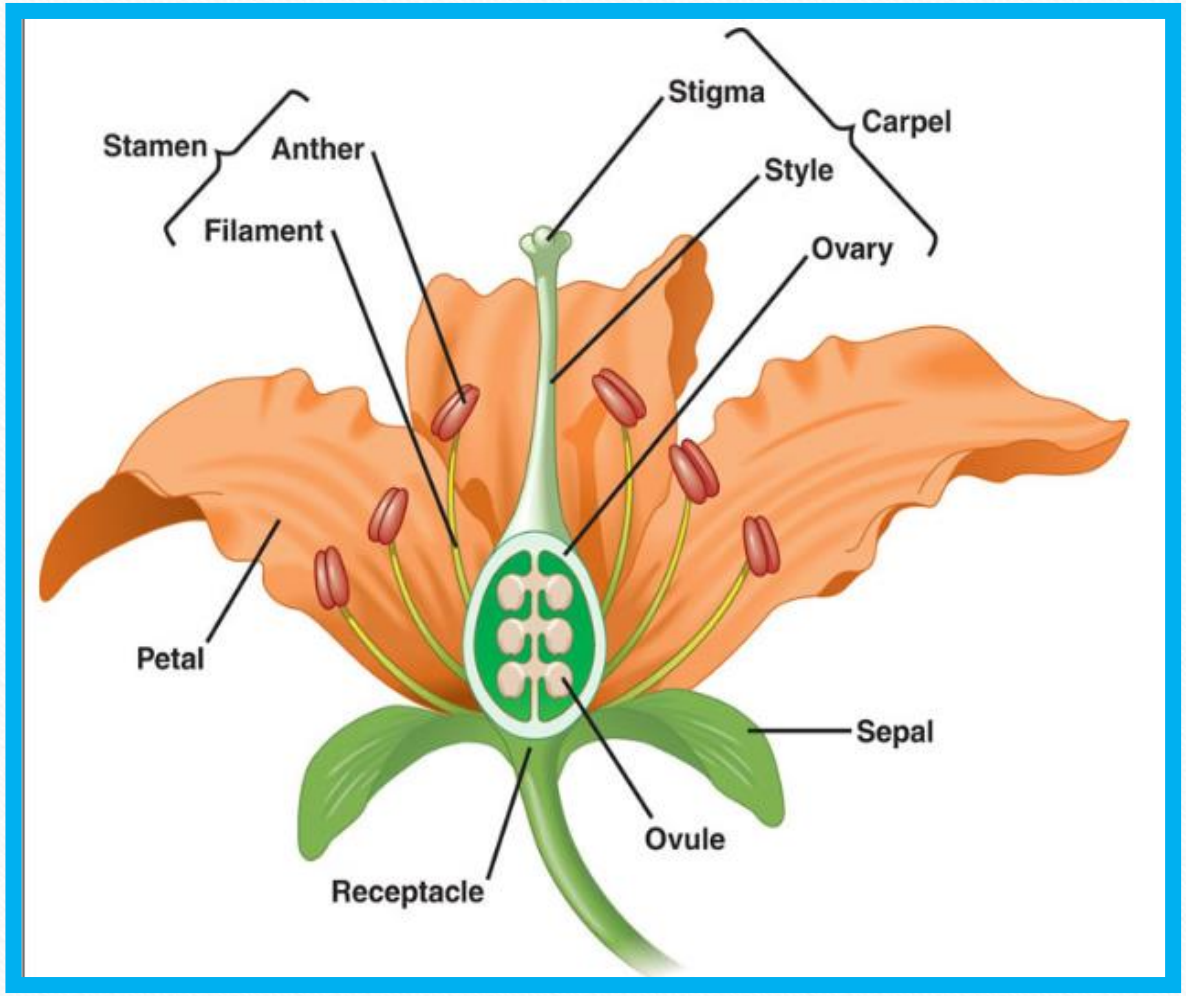
Sexual	Asexual
2 parents are needed	Only one parent is needed
The offspring has a unique combination of genes inherited from both gametes of the two parents	Genetically identical to parent plant
Gametes (sex cells) are involved	No gametes involved

Some examples of asexual reproduction



Sexual reproduction in flowering plants is defined as a process involving the fusion of the nuclei of two gametes to form a zygote and the production of offspring that are genetically different from each other .

Flowers carry the reproductive structures and the non reproductive structure of the flower .



Non reproductive structures :

✓ Petals

- Brightly colored usually, and sometimes scented.

- Petals are arranged in a circle or a cylinder.

Function:

1. The color & scent attracts insects to the flower for pollination.

2. Protection of internal structures.

Note: grasses do not have petals instead they have green leafy like structures which enclose the reproductive organs.

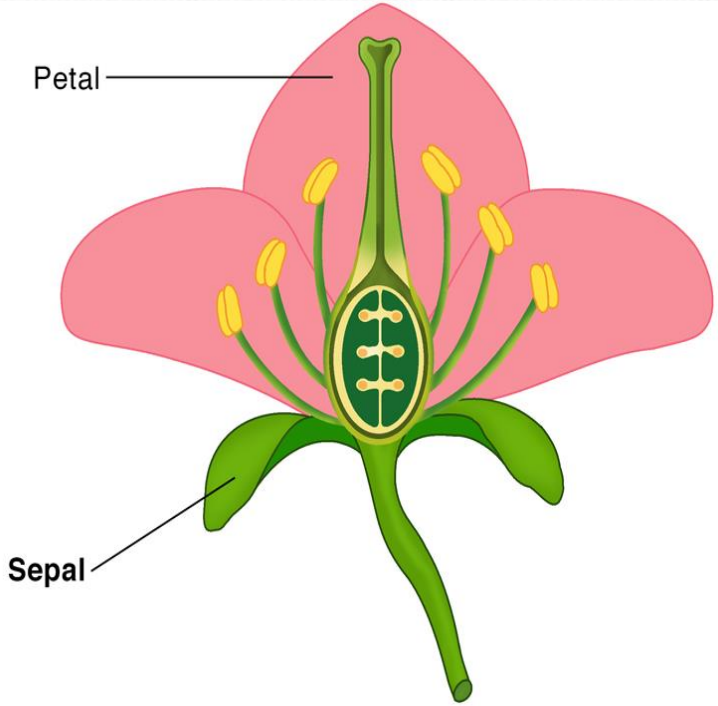
✓ Sepals

Sepals are normally green found outside petals; they are arranged in a circular pattern to form the calyx.

Function:

1. Hold the petals together

2. Sepals are used to protect the flower while it is still inside the bud.

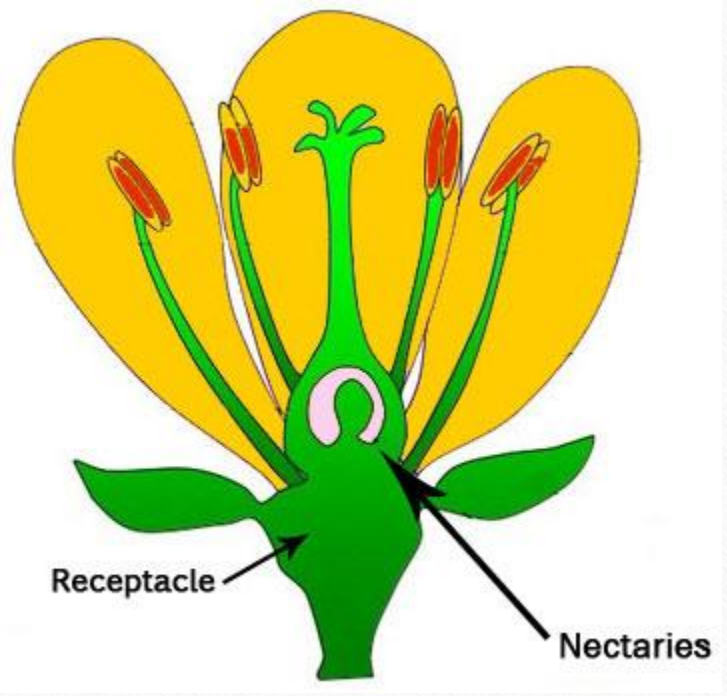


✓ Nectary:

It is a swelling at the base of the carpel that contains nectar which is a sugary solution used to attract insects for pollination.

✓ Receptacle:

Carries all the structures of the flower



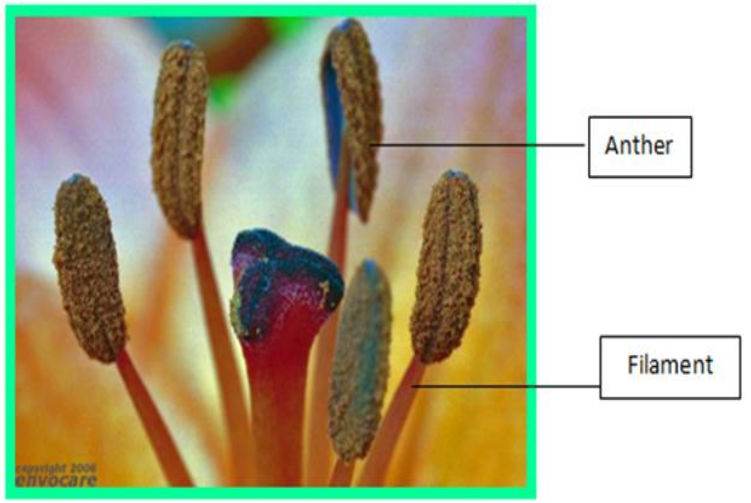
Reproduction organs in flowers

- **Male** reproduction organ is called **stamen**
- **Female** reproduction organ is called **carpel**

1. Stamen:

Stamen is the Male reproductive organ in a flower.

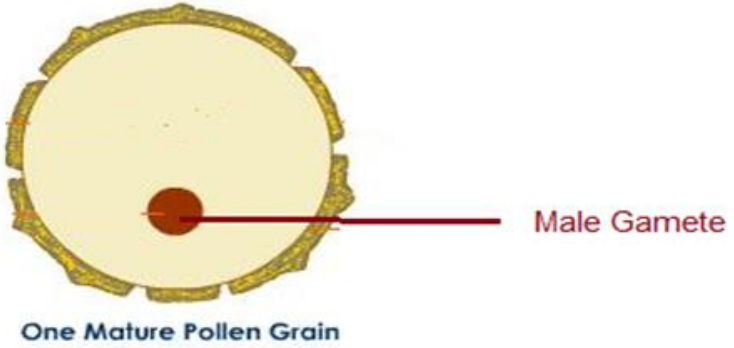
Stamens consist of **Anthers and Filaments**.

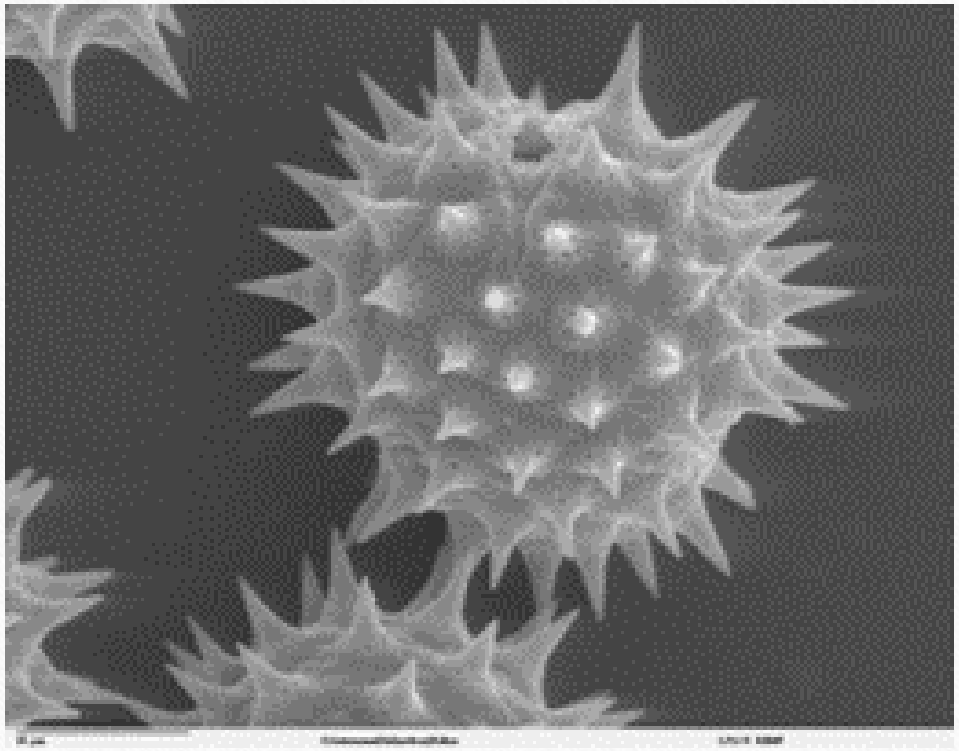


Anther: contain pollen grains, which contain male gametes. Each anther contains **four pollen sacs** inside which pollen grains are produced by a division called **meiosis** (a division that halves the number of chromosomes → producing haploid cells).

Note : Pollen grains contain the male gamete

Filament: thread like structure that holds the anther.





Magnified pollen grain

They can have different shapes depending on flower type

2. Carpels (or Pistil):

Is the female part of the flower, found at the center, made up of **stigma, style and ovary**

Stigma: has a sticky surface to make pollen grains stick to it during the process of pollination.

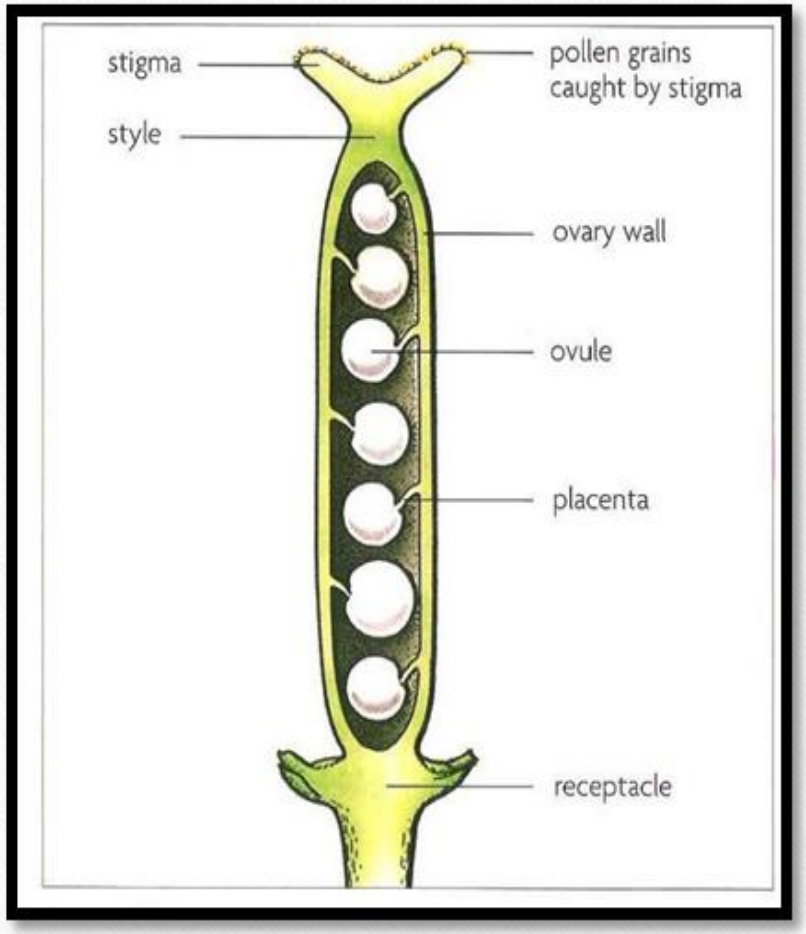
Style: the part that connects stigma to ovary.

Ovary: Inside the ovary, there are one or more ovules.

Each Ovule Contains a female gamete (egg cell) containing half the number of chromosomes (Haploid)

Flowers can be bisexual that is; the flower contains both female & male reproduction organs, *

Or Unisexual containing either the male or female reproduction organs.

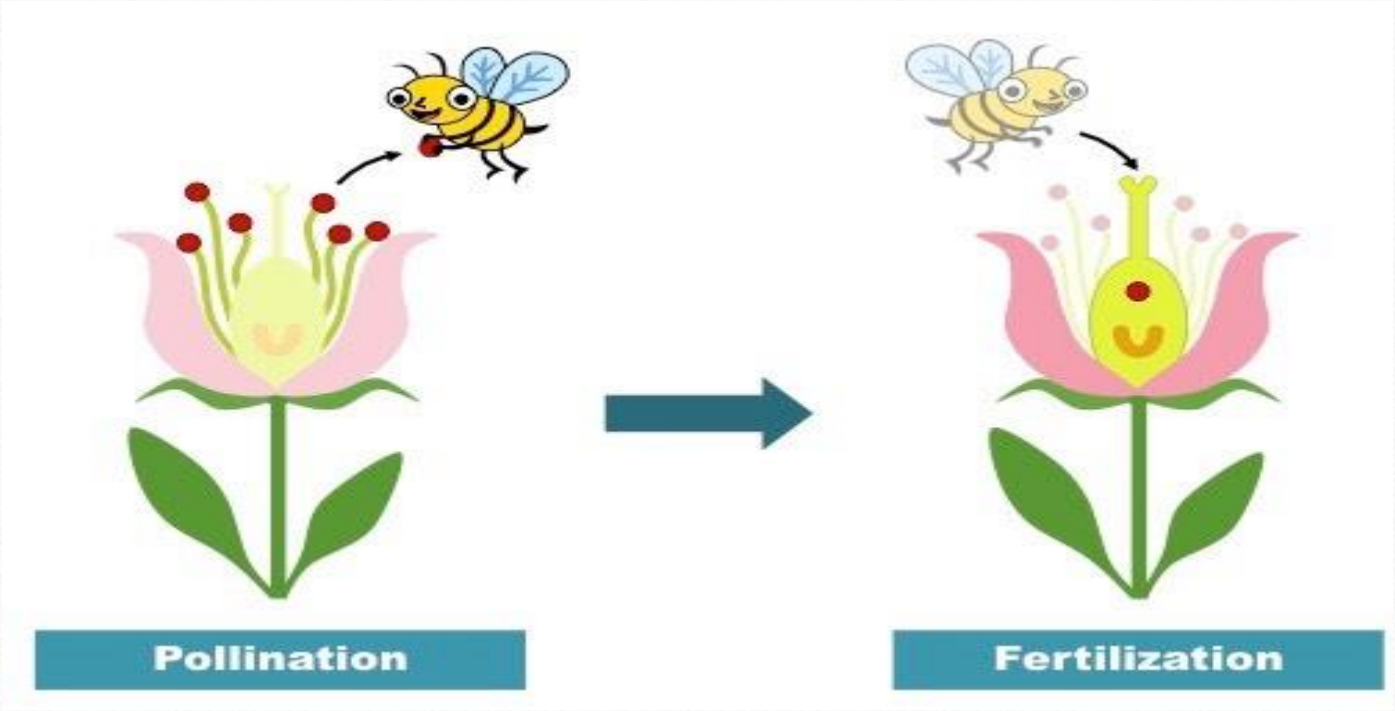


The Mechanism of Sexual Reproduction in plants:

Sexual reproduction in plants involves two steps:

1- Pollination

2- Fertilization



Pollination

The transfer of pollen grains from the anther of a stamen to the stigma of a carpel. Once the pollen grains reach the stigma pollination ends.

- **There are two types of pollination:**

1. Self pollination:

Self pollination is the transfer of pollen grains from the anther to the stigma of the:

Same flower this happens in *bisexual flowers → this means that the male gametes only travel a short distance to the female gamete*

Or from one flower to another on the same tree.

Note : This type of pollination leads to less variation among offspring because the plant that produced the pollen grains is the same plant which also produced the ovule so both gametes may have almost the same genetic material.

Implications of self pollination :

- Less variation among offspring → **this is a Disadvantage**

- If the environment changes (drought or disease setting in), they might not be able to adapt with that change → whole crop will be affected → more chance of extinction → limited chance for evolution → **This is a disadvantage**

- Not dependent on pollinating agents.-→ **this is an advantage**

Other advantages

- Less Wastage of pollen grains.

- Single plants can reproduce

- Great chances of pollination, useful if no other plants of the same species is nearby

- Produces offspring that are well adapted to the environment

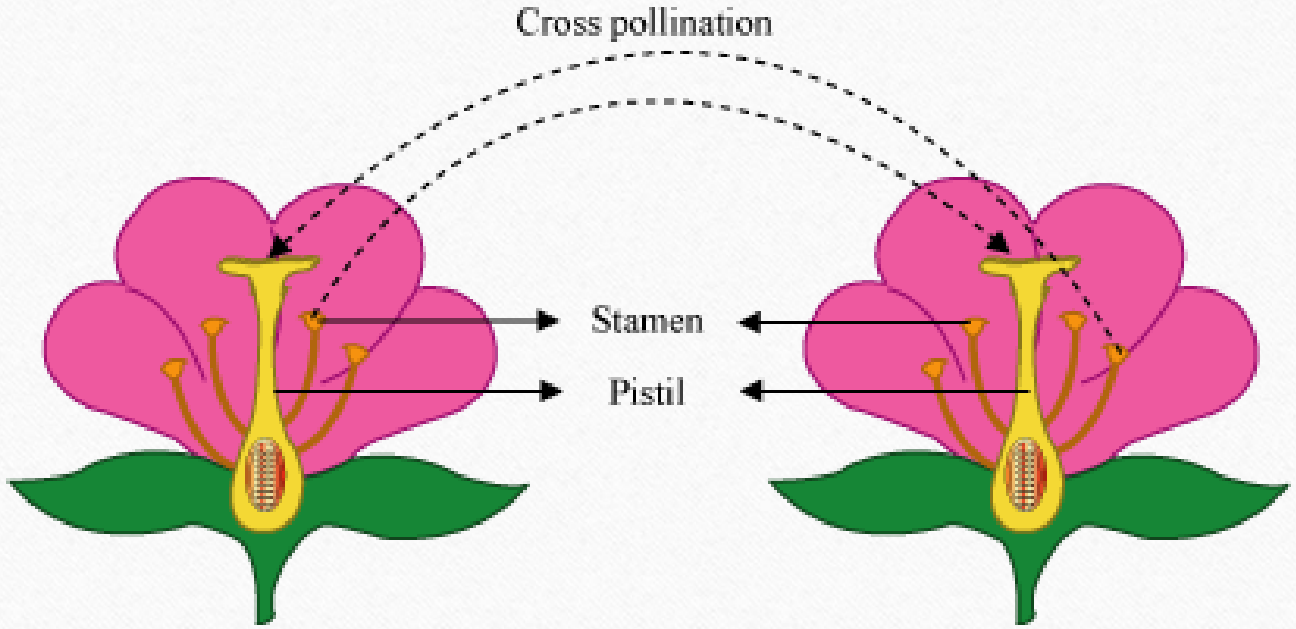
- Good characteristics are retained.

How do plants prevent self pollination ?

- Some plants produce only flowers of single sex , which makes self pollination impossible
- Some plants have flowers that contain male and female parts but the different parts mature at different times

2. Cross pollination:

Cross pollination is the transfer of pollen grains from the anther of one flower on one tree to the stigma in a flower of another tree but of the same species. This type of pollination produces great variation than self-pollination, because it is likely that the plant which produced the pollen grains & the plant which produced the ovules have different genetic makeup, so the offspring may turn out more successful than their parents.



Implications of cross-pollination

- Greater variation (different genes from different plants) → **Advantage**

- Allows adaptations to new conditions (changes in the environment) so it allows evolution to occur → **Advantage**

- More chance of disease resistance → **Advantage**

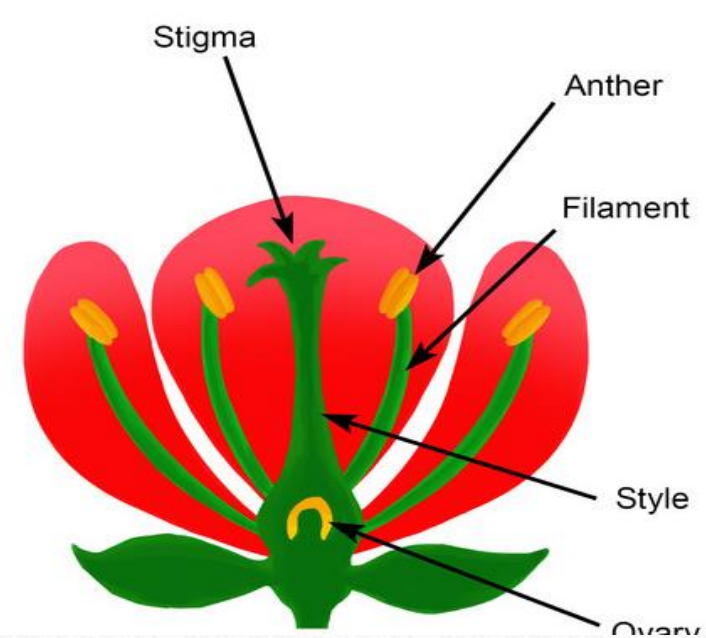
Disadvantages:

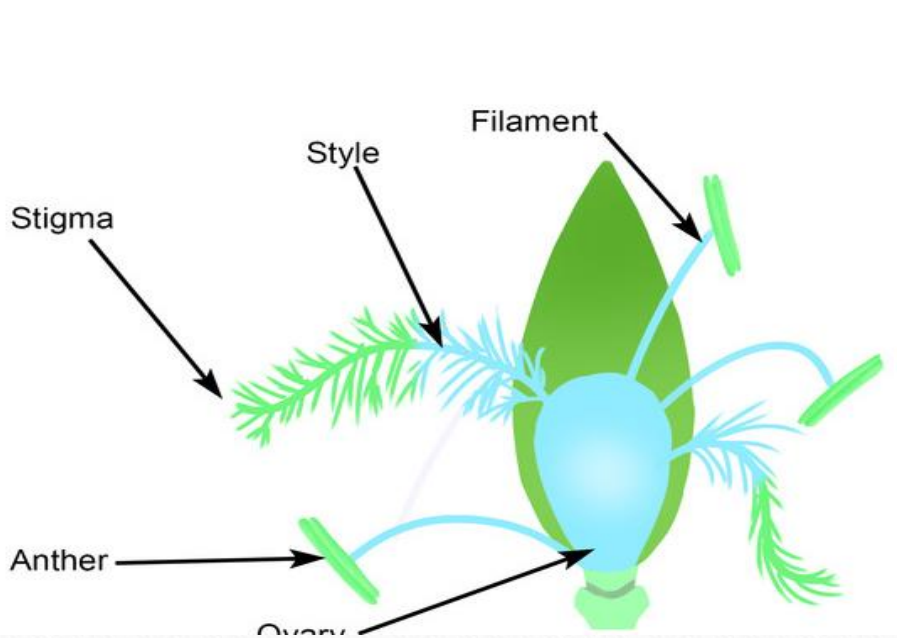
It needs a pollinating agent , Less chance of successful pollination, as the pollens may never reach the stigma.

Pollination can be classified into :

Insect pollination

Wind pollination



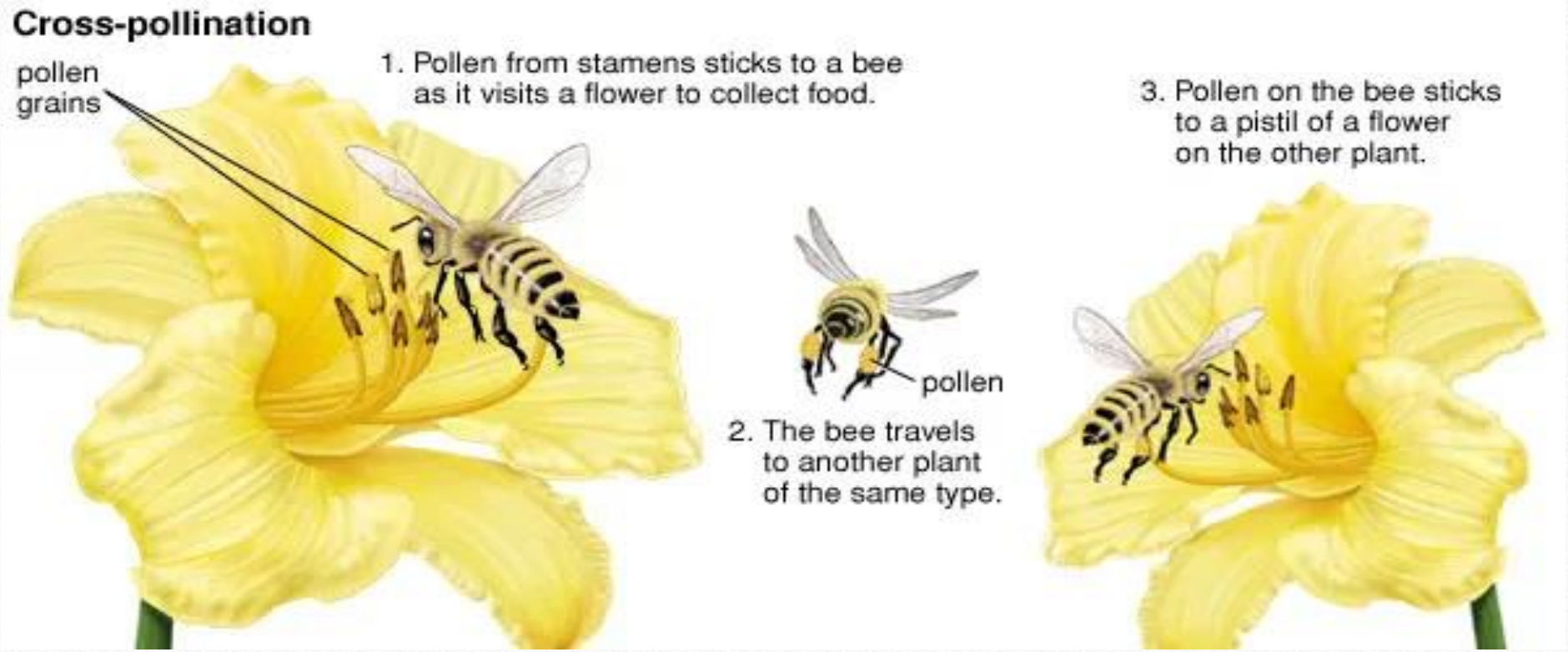


Part of flower	Insect- pollinated flowers	wind-pollinated flowers
Method description	pollen grains are transferred from anther of one flower to the stigma of another by means of insects e.g Lupin flowers	**pollens grains are transferred by means of wind e.g grasses**
Petals	Usually large , brightly colored, scented and often with produce nectar Insects are attracted to color and scent Insects also feed on nectars Some petals have guidelines that guide insects to nectaries	Small , green or dull in color no scent or nectaries Because there is no need to attract insects

Stamen	Stamens are kept within the petals; they have short filaments & small anthers that are **firmly** attached to filaments.	Stamens **hang out of the flower**; they have long filaments & large anthers that are **loosely attached** to the filament because wind can easily dislocate pollen from exposed anthers than from enclosed ones.
Carpels	Carpels are kept within the petals stigma usually have flat with a sticky surface to trap pollens.	. Stigmas hang outside the flower & they are usually feathery to trap pollens blown past the flower
Pollens	Smaller amounts of large sticky pollen grains that have spikes that can stick on to an insect's body. Some of the pollens will be carried to the wrong flower while other might be eaten	Large quantities of light smooth pollen grains to be carried easily by wind • because most will be blown away and lost

How insect pollination takes place :

The bees, which visit them, come to collect pollen for food. The insect lands on the flower they rub with the anther , Pollen grains stick to their bodies and legs , when the insect feeds at a second flower, some of the pollen grains may fall on the stigma.



Fertilization:

Fertilization is **when the nucleus of the male gamete (pollen) fuses with the nucleus of the female gamete(ovule) to form a zygote (fertilized egg).**

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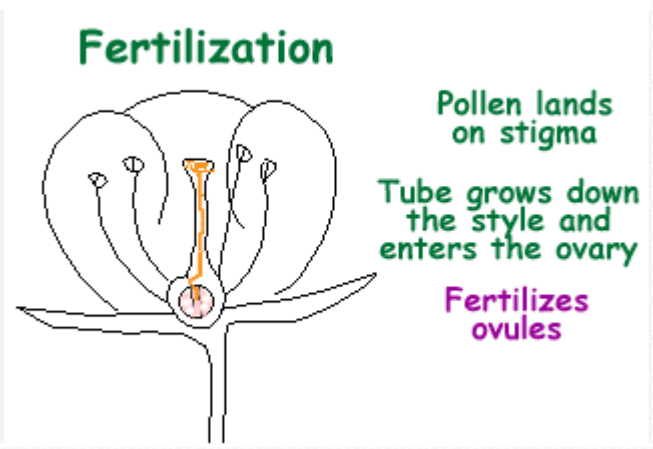


The process of fertilization :

1) As pollen lands on the stigma, if the egg cell is ready and the pollen is a suitable type , the grain starts absorbing liquids from it forming a tube called **"pollen tube" which grows down the style into the ovule inside the ovary**

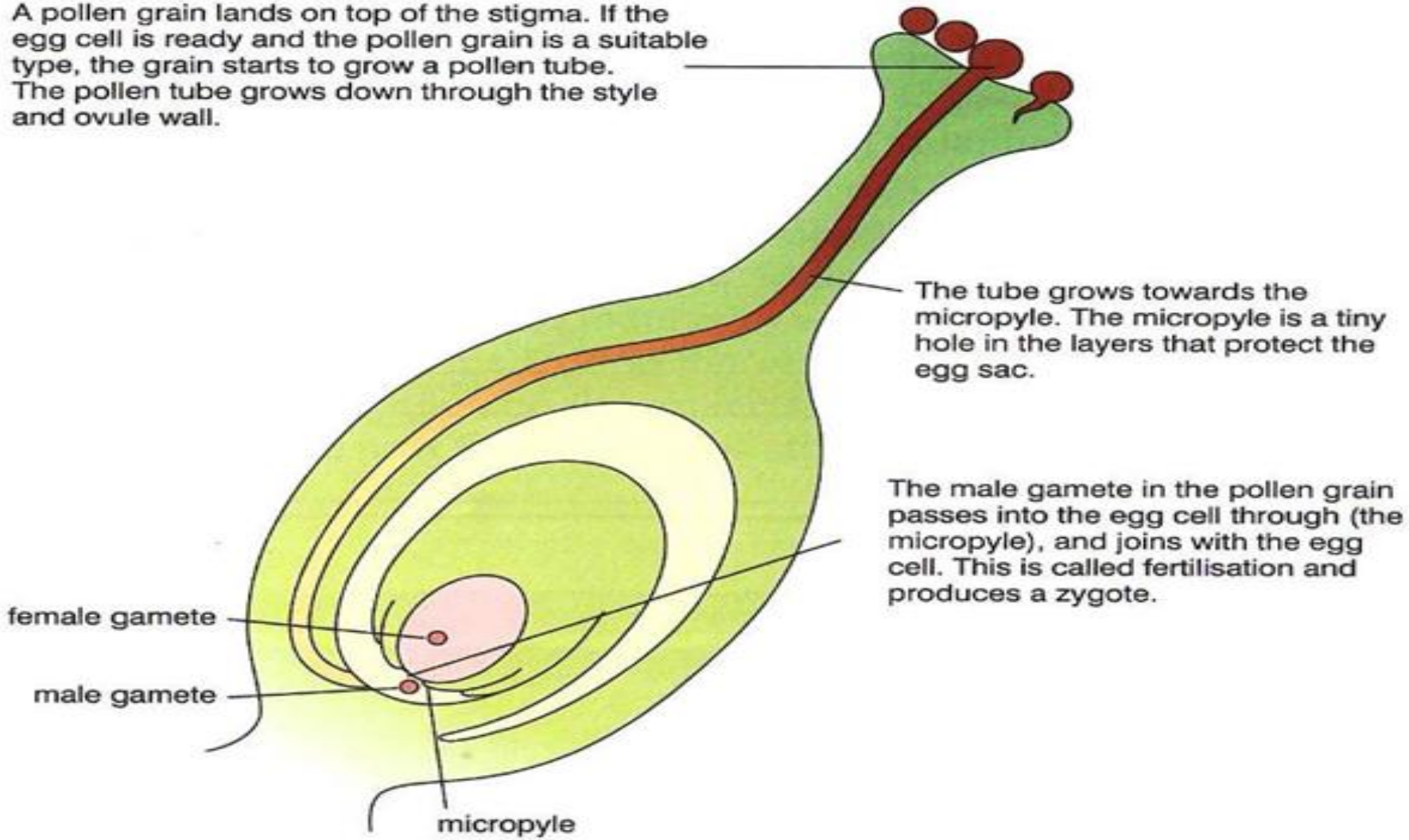
*** Enzymes are secreted from the tip of the pollen tube and these will digest the tissues of the style**

2) The male gamete travels down the pollen tube which grows down the style into the ovary and eventually into the ovule.

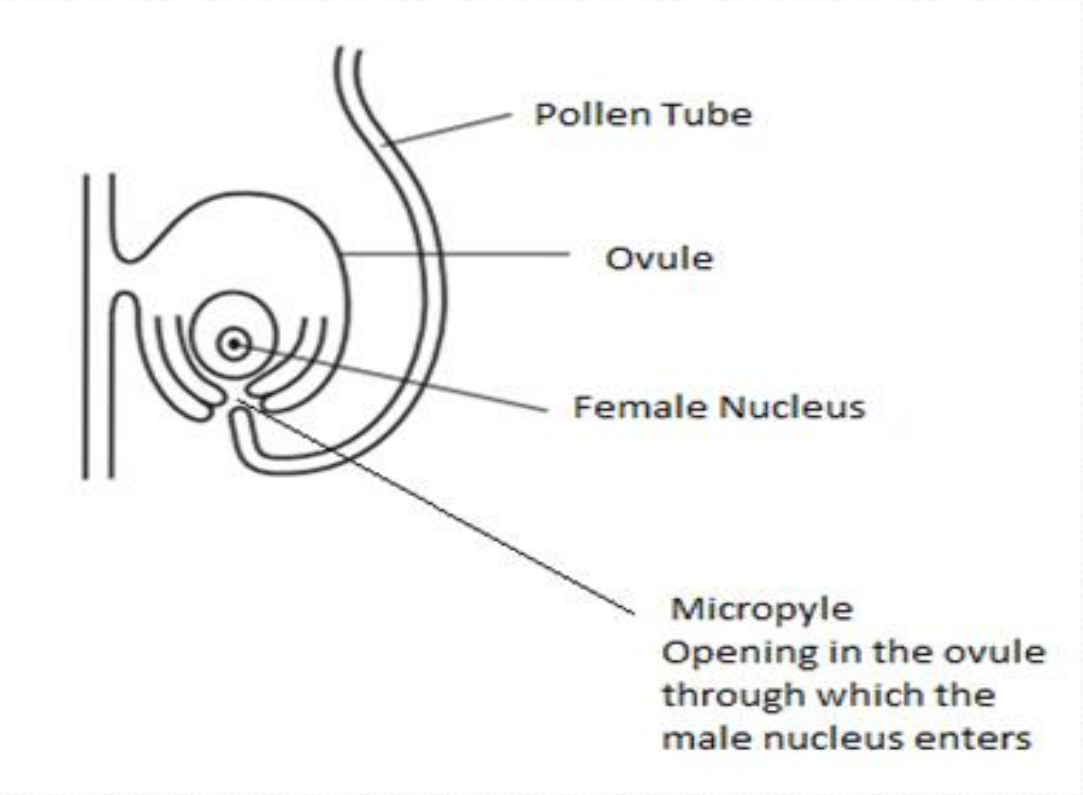
The pollen tube tip then opens into an opening called micropyle in the ovule (Which contains Female gamete) releasing the male gamete into the ovule.

3) At last, the **nucleus of the male gamete fuses with the nucleus of the female gamete** producing a fertilized egg called zygote which is diploid (containing full number of chromosomes)**diploid**

4) The Zygote undergoes many cell divisions by mitosis producing the embryo which consist of a tiny root called radicle and a tiny shoot called plumule.



Δ Fig 16.15 Pollination leads to fertilisation.

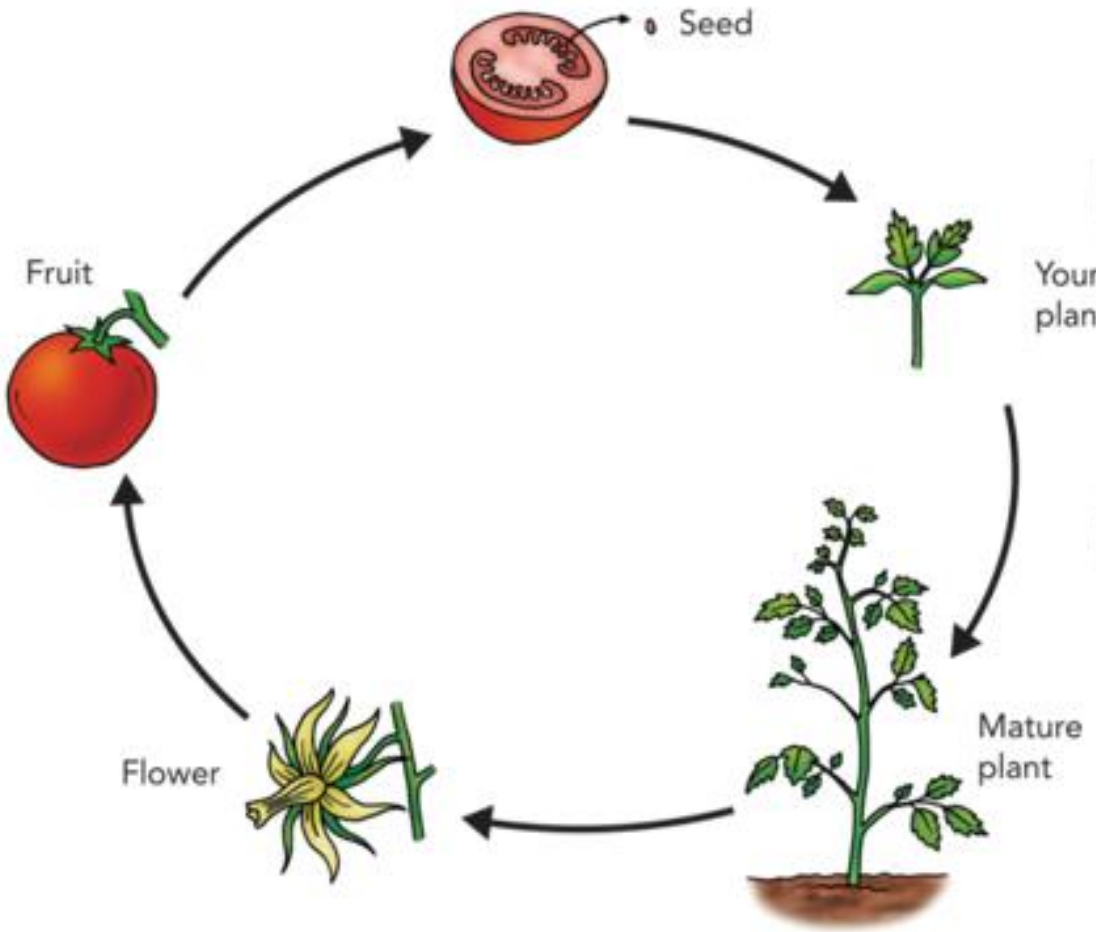


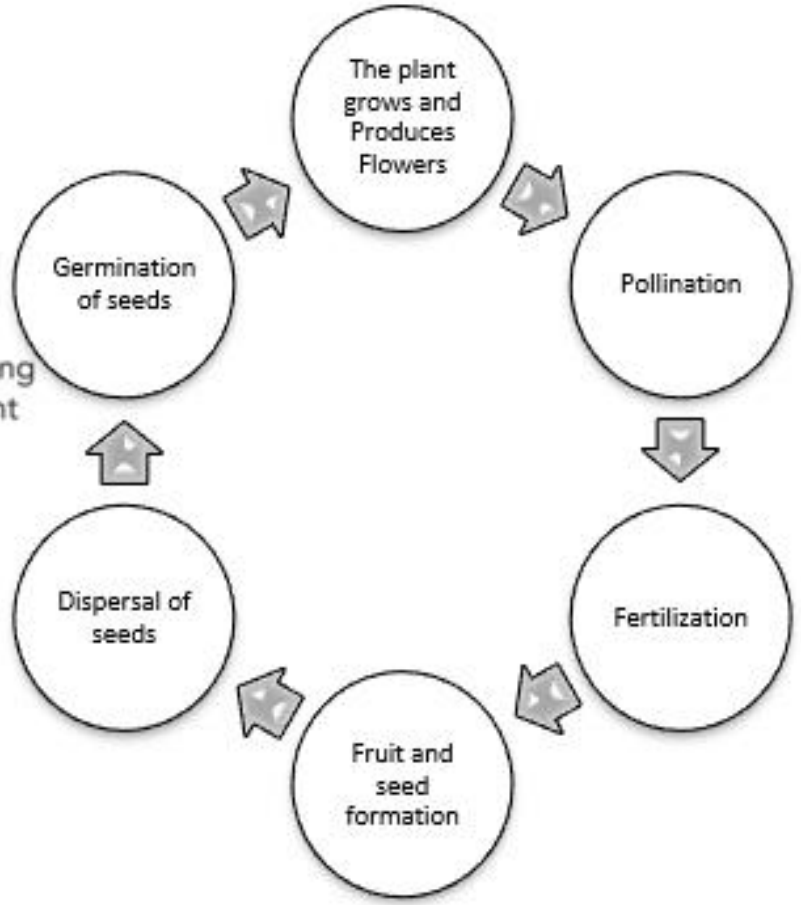
One pollen grain can only fertilize one ovule.

E.g. Watermelons contains hundreds of seeds inside, therefore hundreds of fertilization.

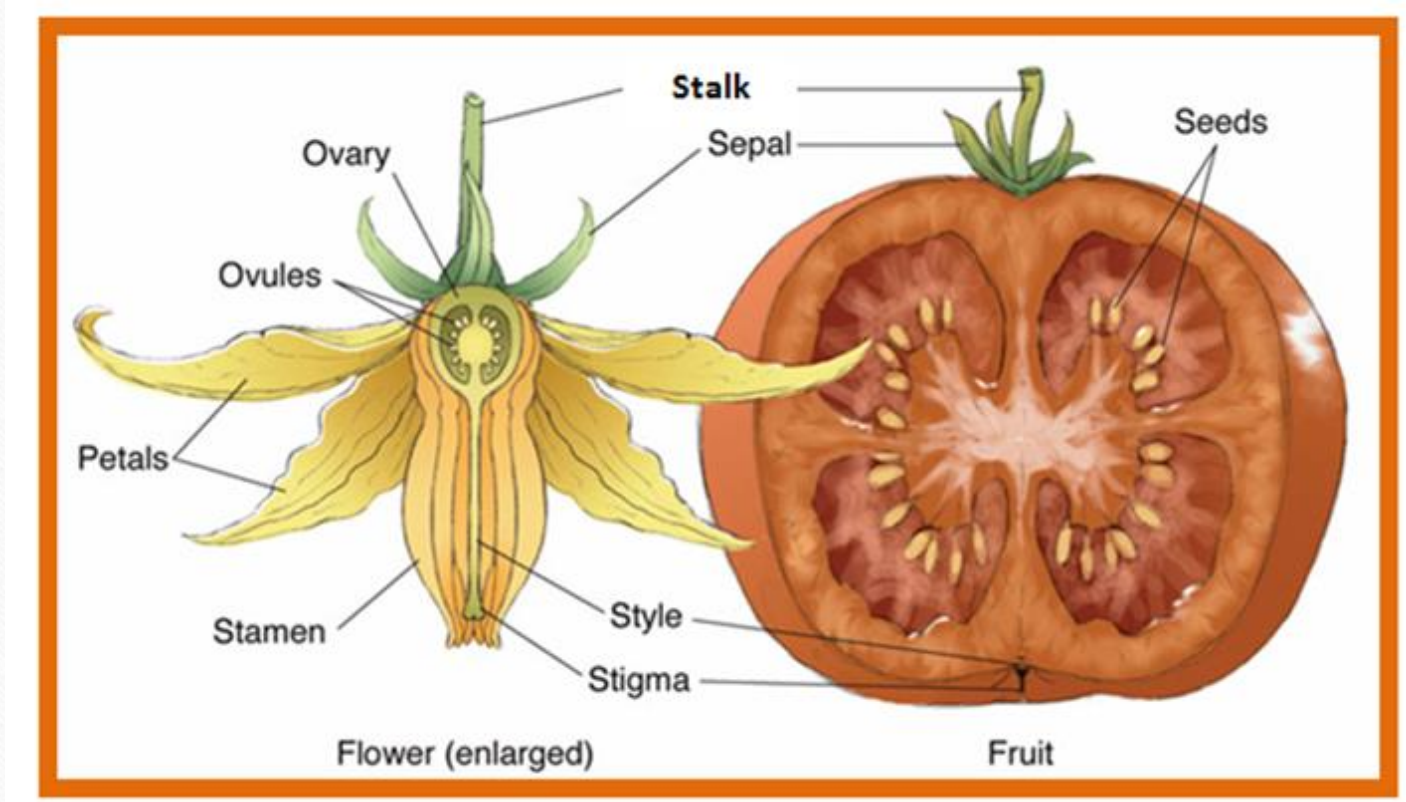
Peach contains only one seed which indicates that only one fertilization took place

The lifecycle of a flowering plant :





From a Flower into a Fruit:



Before Fertilization	After Fertilization
Ovule	Seed
Ovary	Fruit

The seed consists of two special parts called cotyledons which enclose the embryo which consists of a tiny shoot called plumule and a tiny root called radicle.

Note:

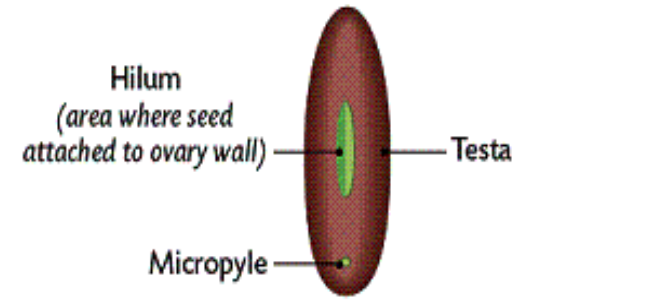
- The number of cotyledons in the seed, depends on species,

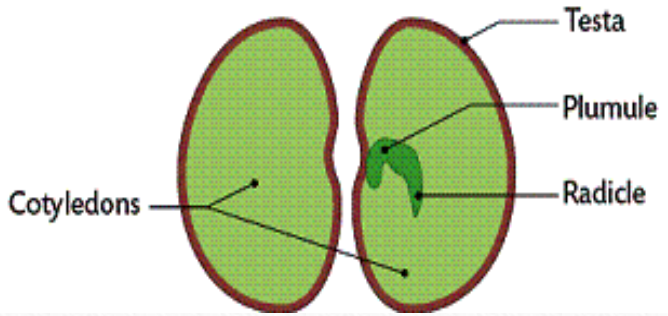
- Monocots have one cotyledon, whilst dicots have two cotyledons.

- Cotyledons are structures that store starch and other nutrients, that the embryo will make use of when it starts germinating.

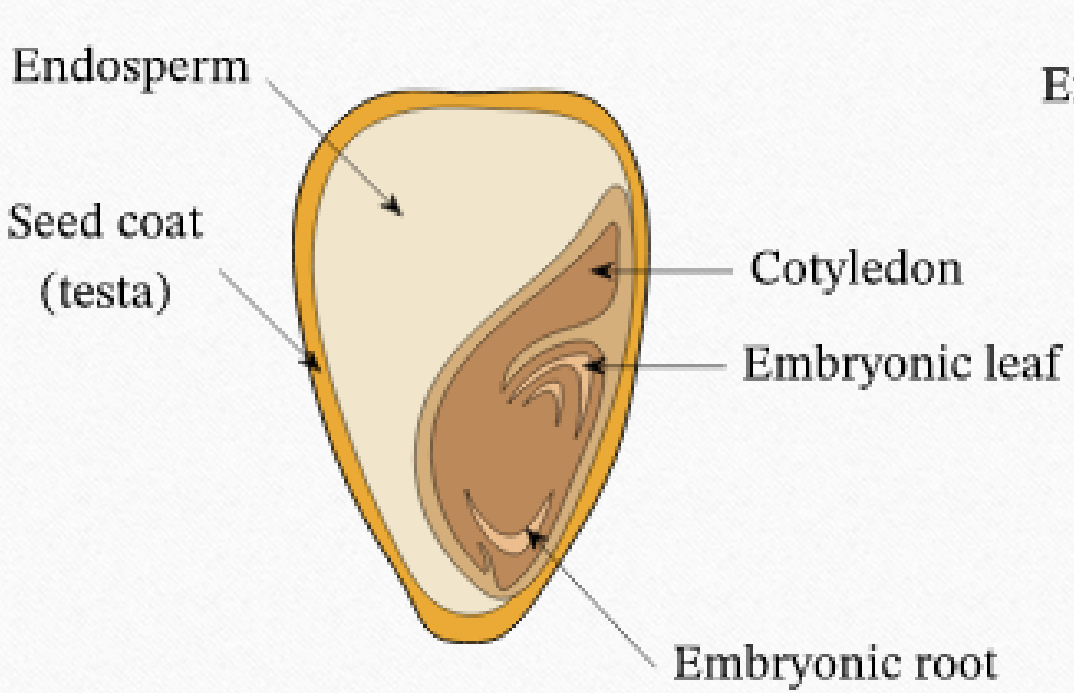
- In Monocots, the food store is laid down in a special tissue called endosperm

Lastly, water is withdrawn from the seeds; as a result, seeds become dehydrated and enter through dormancy because without water all the metabolic reactions inside the seeds stop.

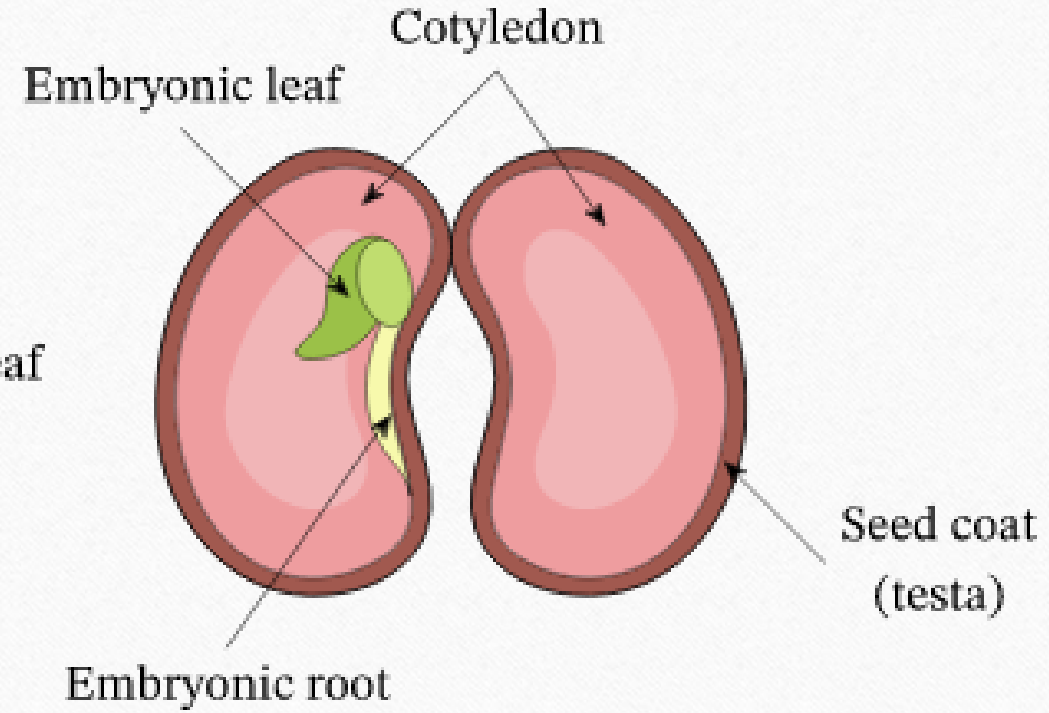




Monocot vs dicots



Single cotyledon
(monocot)



Two cotyledons
(dicot)

Seed Germination :

Seed germination: is when the seed coat breaks open and the embryo starts to grow and develop into a new plant .

Conditions needed for germination :

1. Use of water in seedling:

As we said previously, the seeds are dehydrated, so to start germinating the seed must absorb water by osmosis from the soil through the micropyle , as a result the seeds begin to grow in mass. As soon as a seed starts to grow , it starts to use its food stores . The absorbed water is used

To activate the enzymes inside it which will digest the stored food (mainly starch and proteins) The sugars dissolve is water so they can now diffuse to the embryo and respiration can now begin to release energy needed for growth

Amylase breaks down **starch into maltose** which is then broken down by **maltase into Glucose** some of which will be built up into cellulose to make cell walls for the new cells , water is needed for this hydrolysis reaction

Proteases break down proteins into amino acids which are used to make new protein molecules for cell membranes (which is made up of phospholipids and PROTEINS)

Transport of sugar (food) from the cotyledons to the growing regions.

Expands the vacuoles of the new cell & thus keeps the shoot straight & the leaves expanded.

2. Use of Oxygen:

In some seeds, the seed coat is not very permeable to oxygen and the early stages of germination are anaerobic (with very little energy produced and the by-products are toxic). When the seeds absorb water they increase in size as a result the seed coat splits open, it allows oxygen to enter, and then oxygen is used in aerobic respiration providing energy for the growing embryo to germinate.

3. Temperature:

IMPORTANT NOTE : Factors affecting germination are very similar to those that affect enzyme activity this indicates that **GERMINATION IS A PROCESS THAT IS CONTROLLED BY ENZYMES**

Germination takes place rapidly at temperatures up to 40 ^{0}C (as the temperature increases the activity of the enzymes increases).

At temperatures above 40^{0}C the enzymes will be denatured and the chemical reactions will stop and the seedling will die.

At very low temperatures enzymes will be inactive and germination will not be taking place.

Keep in mind that plant enzymes have an optimum temperature of around 28-30 ^{0}C

4. Light

Light is not a major factor for germination because it takes places under the ground (away from light), but some species of seeds need to be exposed to light before germination starts e.g. lettuce seeds (light is a trigger for germination)

In general, seeds require light once the shoot is above the ground

Steps of germination

1. The seed contains only 5-20% water, so it starts absorbing water by osmosis (seeds have low water potential compared to the solution of water around them).

2. Water enters.

3. Water activates enzymes , which will start digesting the stored food in the cotyledons which is then used to release energy in respiration for growth.

The radicle grows first with its tip is covered by root cap, which protects the root tip.