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# Pollination and Fertilisation

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## Pollination

- It is a process of transfer of pollen grains from anther to stigma.
- Stamen contains anther and filament.
- Anther is two lobed.
- Each lobe has four pollen sacs.
- Pollen grains are present inside pollen sacs.
- Each pollen contains nuclei that participate in reproduction.

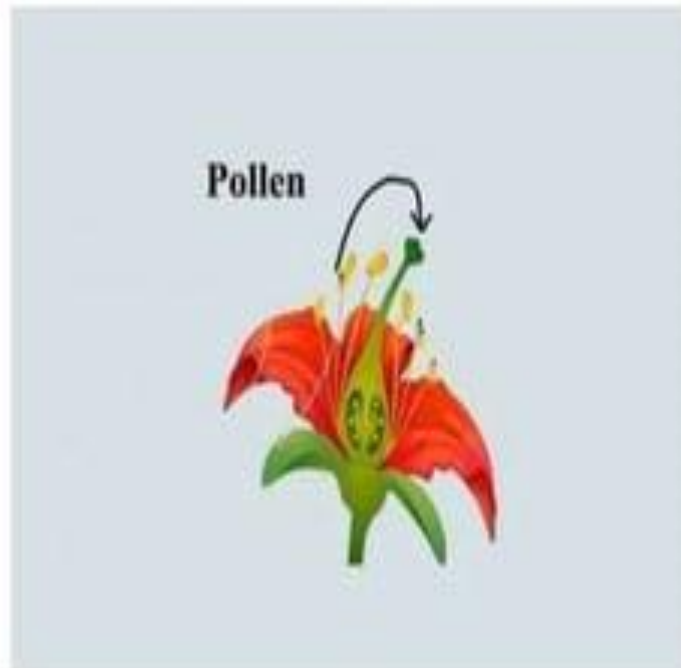
## Ways of pollination.

- There are 3 different ways of pollination:

1. Autogamy
2. Geitonogamy
3. Allogamy

## Autogamy

- 'Auto' means 'self'. 'Gamy' means 'marriage'.
- The pollen of the same flower may fall on its stigma by itself.



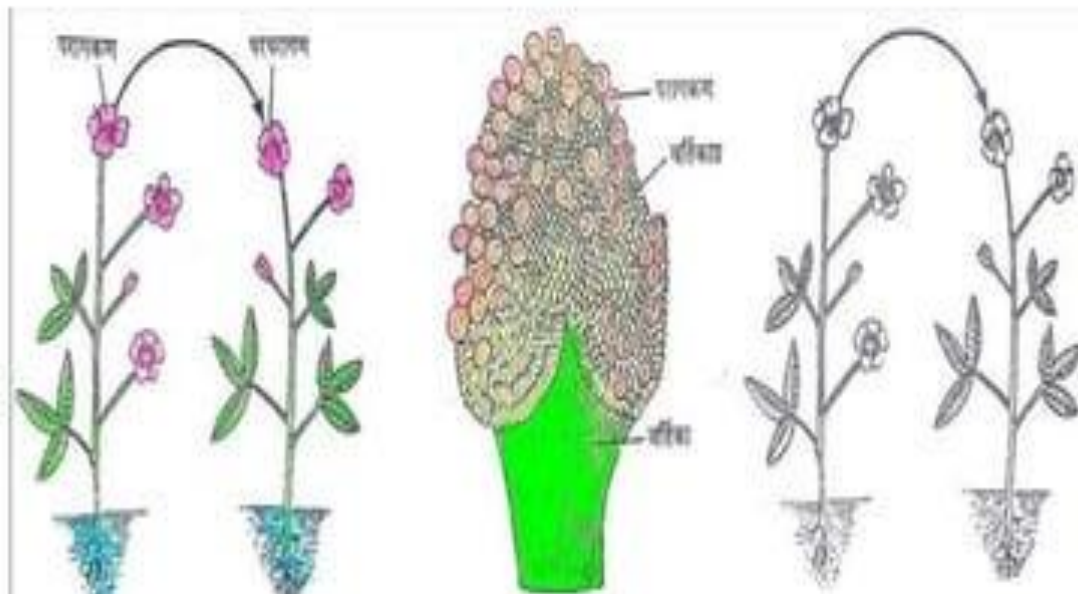
## Geitonogamy

- 'Geitono' means 'neighbouring'.
- The pollen of another flower of the same plant may fall on the stigma.



# Allogamy

- Allo means 'other'.
- The pollen of a flower of another plant of the species may fall on the stigma.



## Pollination

- Pollination must occur between plants of the same species.
- Nature has designed it such that only pollen of same species of the plant will survive and grow further to continue the processes for reproduction.
- Other types of pollen will fail to germinate and perish.



## Kinds of Pollination

1. **Self- pollination** is one that occurs either within the same flower or between two flowers on the same plant.
2. **Cross – pollination** is one that occurs between two flowers on different plants of the same species.



**Self pollination** : is the transfer of pollen grains from the anther to the stigma of the same flower or another flower of the same plant.



## Self-Pollination

- It involves autogamy and geitonogamy.
- This form of pollination is common in hermaphrodite or dioecious **plants** which contain both male and female sexual parts on the same flower.
- Self – pollination can be further divided into two types:
- *Autogamy*– In this type of self-pollination, the pollen is transferred from the anthers of one flower to the stigma of the same flower.
- *Geitonogamy*– In this type of self- pollination, the anthers are transferred from the anthers of one flower to the stigma of another flower but on the same plant.

## Cleistogamy

- self-fertilization that occurs within a permanently closed flower.
- Eg. Pansy flower
- Some flowers grow close to the ground level, do not open at all, the anthers and stigma lie close to each other which mature at the same time



## When can self pollination occur?

- Occurs in Bi-sexual flowers
- Need Homogamy – anther and stigma of a flower must mature at the same time.



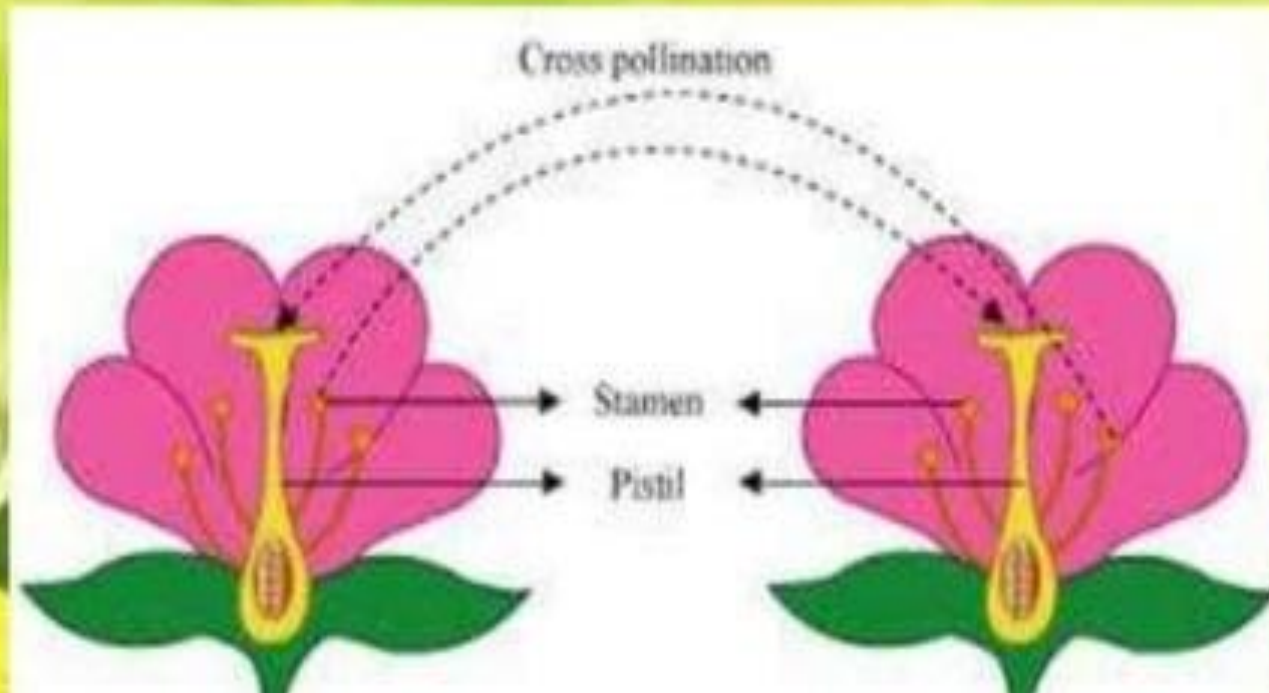
## Advantages

- In self- pollination, there is no diversity in the genes and therefore the purity of the race is maintained.
- The plants do not depend on external factors for pollination and even smaller quantities of pollen grains produce have a good success rate in getting pollinated.
- Self- pollination ensures that recessive characters are eliminated.
- Stamens and carpels mature at the same time.
- Parental characters are transferred
- Pollen grains not wasted. Flowers need not be large and showy.

## Disadvantages

- Since there is no mixing up of genes, there are no new characters or features that are introduced into the lineage of the offsprings.
- Self- pollination is said to reduce the vigor and vitality of the race as there are no new features introduced.
- Without new characters introduced, the resultant offsprings' immunity to diseases reduces.

**Cross pollination:** is the transfer of pollen grains from the anther of one flower to the stigma of another flower of the same kind.





## Cross-Pollination

- In this type of pollination, the pollen is transferred from the anthers of one flower to the stigma of another flower.
- In this case, the two flowers are genetically different from each other. Cross-pollination is always dependent on another agent to cause the transfer of pollen.
- The agents of pollination include birds, animals, water, wind, and insects.

## Advantages of cross pollination

- Produces Healthy offspring
- Seeds produced are abundant and viable.
- New varieties may be produced by cross pollinating two different varieties of the same species or even two species.

## Disadvantage of cross pollination

- Pollination is not certain
- Wastage of pollen happens
- Uneconomical for the plant. They have to be large, coloured, scented and have to produce nectar

## Difference between self-pollination and cross-pollination

### self-pollination

- Autogamy
- No external agent is required
- Male and female part mature at the same time.
- Occur even when the flower is closed
- Preserves parental characteristics

### cross-pollination

- Allogamy
- External agent is required (water, wind, Insect)
- Male and female part mature at the different time.
- Occur even when the flower is open
- Does not Preserves parental characteristics

## Difference between self-pollination and cross-pollination

### self-pollination

- No new variations are produced.
- New varieties are not possible

### cross-pollination

Variations are produced.

Offsprings are healthier to adapt to environmental changes.

New varieties are produced

## Conditions favours cross pollination

- Occurs in Unisexual flowers

Palm and Papaya

Very rarely papaya may be Hermaphrodite

Cucumber Gourd male and female flowers are borne on the same plant

- Need Dichogamy condition

Different timings of maturation of Androecium and Gynoecium

In many bisexual flowers, the anthers and stigma of the same flower mature at different times.



## Conditions favours cross pollination

- Protandry – Anthers of the flower mature earlier than the Stigma

Eg. Sweet pea, sunflower, Bhindi

- Protogyny - Stigma of the flower mature earlier than the Anthers

Eg. Custard apple, Peepal tree

In these cases, cross-pollination is the only possibility.

- Needs Self sterility

- This is a condition in which even if the stigma receives pollen from the anther of the same flower, it fails to undergo further growth.

Eg. Ray florets of Sunflower, orchids



## Self sterile flowers examples



## Conditions favours cross pollination

- **Herkogamy**
- Herkos means Barrier
- Mechanical or structural barrier
- In some flowers the pollen of the flower cannot reach the stigma due to some barriers.
- Eg. Hood covering stigma in Pancy flowers and Iris acts as a structural barrier.

## Conditions favours cross pollination

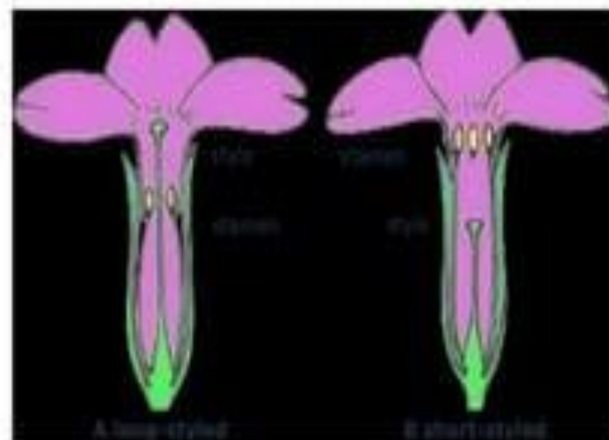
Mechanical or structural barriers – Herkogamy



There may be a hood covering the stigma which can be broken only by agents like the insects e.g. Pansy, Calotropis

## Conditions favours cross pollination

- **Heterostyly**
- The stigma and anthers grow at different heights
- Eg. Prim rose, Oxalis



## Agents of cross pollination

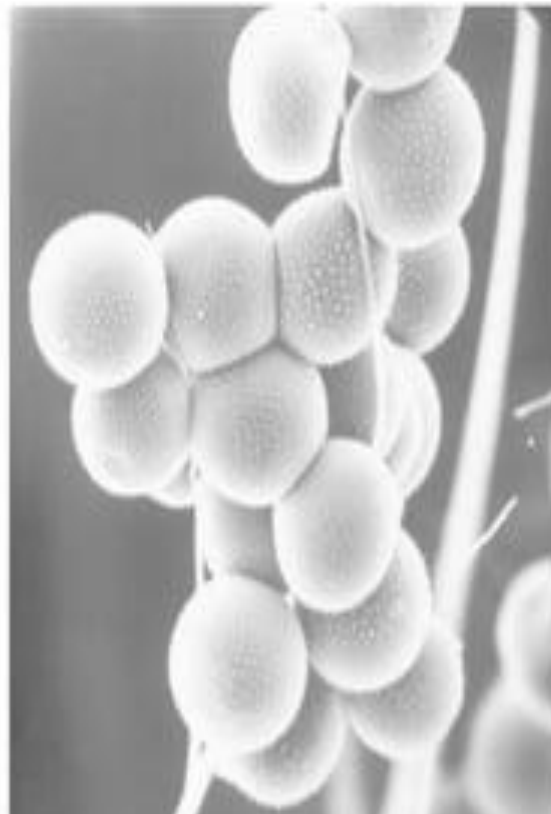
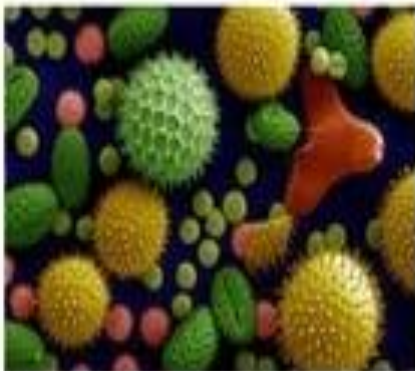
- Insects
- Wind
- Animals and birds
- Water in case of aquatic plants
- Each category of them has some special characteristics to promote the chances of pollination.

## Characteristics of insect-Pollinated Flowers

- Entomophilous
- **Entomon** means **insect**      **phile** means **affinity**
- Flowers are
  1. Large
  2. Brightly coloured
  3. Scented
  4. Pollen grains are sticky and spiny(**Spines** help in the attachment of the **pollen** to the body of pollinators)



## Characteristics of insect-Pollinated Flowers





## Characteristics of insect-Pollinated Flowers

5. Stigma is sticky and does not hang out from flowers
6. Found in clusters if the individual flowers are small



## Characteristics of wind-Pollinated Flowers

- Anemophilous
- **Anemon** means **wind**      **phile** means **affinity**
- Flowers are
  1. Small
  2. Not brightly coloured(dull green)
  3. Do not produce scent or nectar
  4. Stamens are long and hang out of the flower to be exposed to wind

## Characteristics of wind-Pollinated Flowers

5. Anthers are large and loosely attached to the filament
6. Pollen is produced in large quantities
7. Pollen grains are light, dry and smooth.
8. The stigmas are feathery and hang out of the flower to trap the pollen grains

## Characteristics of wind-Pollinated Flowers

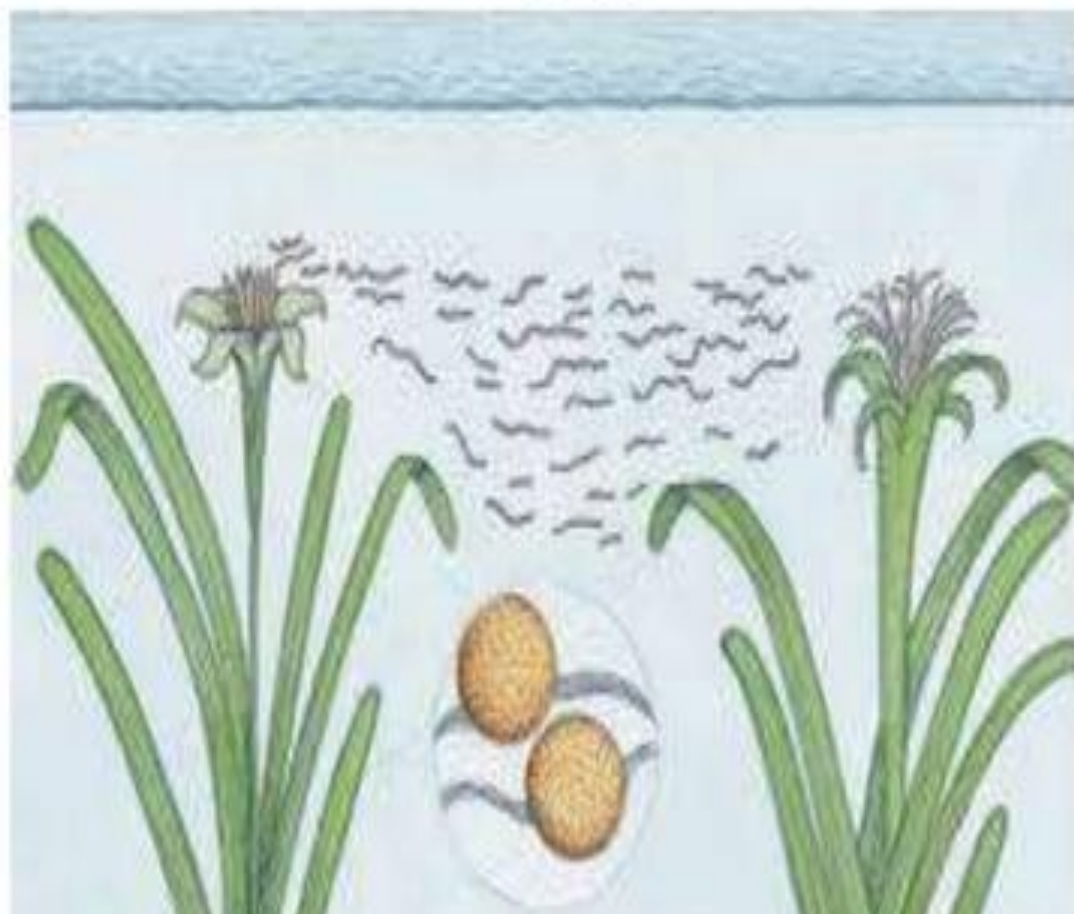




## Characteristics of water-Pollinated Flowers

- Hydrophilous
- **Hydro** means **insect**      **phile** means **affinity**
- Flowers are
  1. Small and light
  2. They are Unisexual
  3. Pollen grains are produced on large numbers
  4. In some plants the pollen grains have a specific gravity almost equal to that of water so that they remain floating below the surface of water.

ceratophyllum



## Characteristics of water-Pollinated Flowers

In some special cases, male flowers float on the surface of water till they meet female flower.

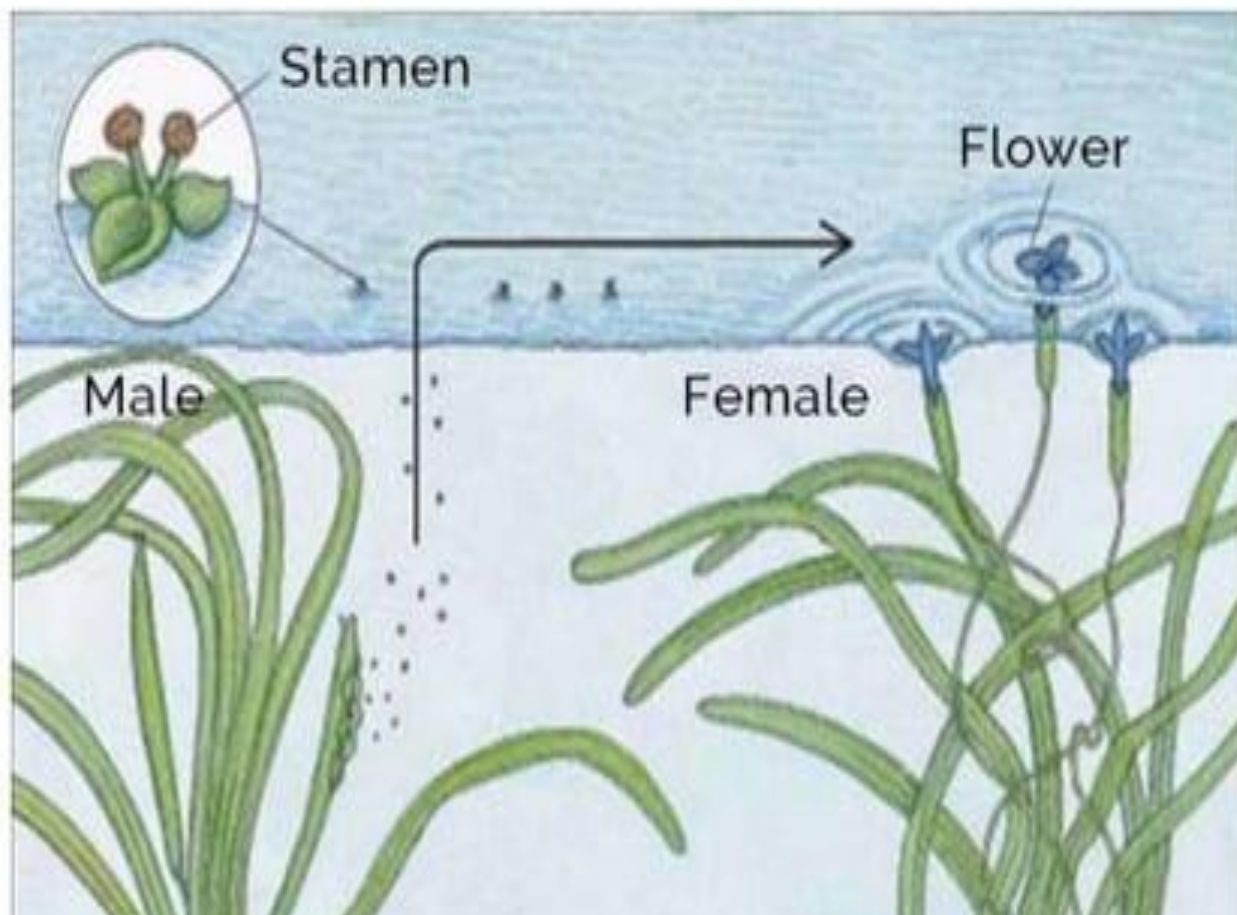
Eg. Vallisneria



## Water Pollination

- Vallisneria – Aquatic plant
- Male flowers usually submerged in water
- When mature, get detached And float on surface of water.
- When it Come in contact with female flower pollination occurs

## Water Pollination



## Other types of pollination

- Ornithophily - Pollinated by birds
- Eg. Bignonia , Canna



## Other types of pollination

- Elephophily - Pollinated by Elephants
- Rafflesia





## Difference between wind pollinated and insect pollinated flowers

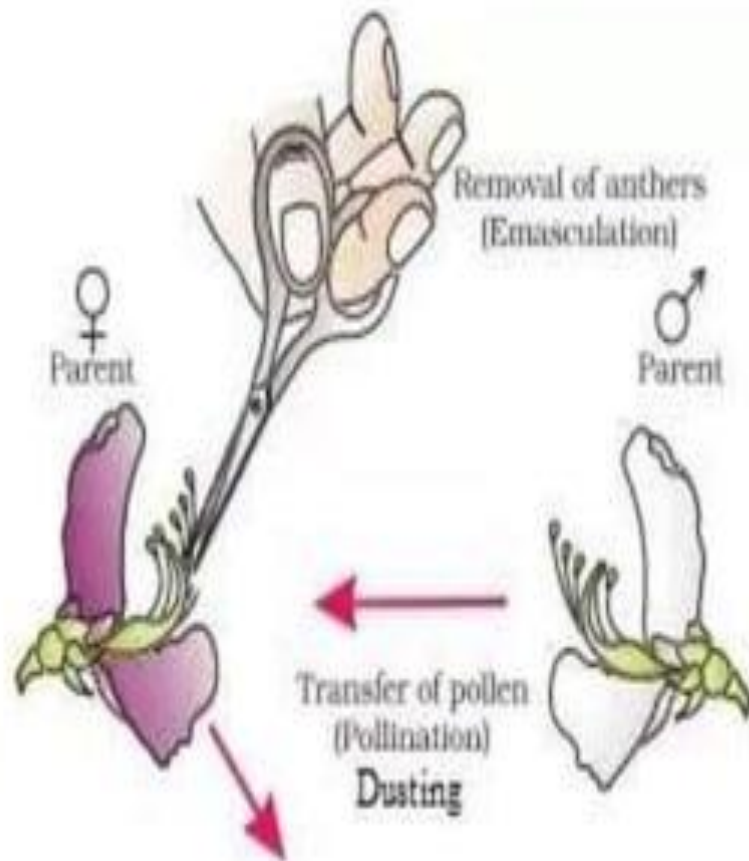
Characteristic	Insect-pollinated flower	Wind-pollinated flower
1) <b>Flowers</b>	Usually large, brightly coloured and scented to attract insects. If flower small → form an <b>inflorescence</b>	Usually small, dull-coloured and scentless (unattractive to insects)
2) <b>Nectar</b>	Often present to attract insects	Usually absent
3) <b>Scent</b>	Flowers are fragrant or sweet-smelling	Flowers do not have scent
4) <b>Pollen</b>	Fairly abundant; large, sticky and heavy, rough surfaces to cling onto insects' bodies	Abundant; small, smooth, dry, light → buoyant & easily blown about by wind
5) <b>Stamens</b>	May not be pendulous	Usually have long, slender filaments that sway in the slightest wind → pollen grains easily shaken out from anthers
6) <b>Stigmas</b>	Usually small and compact, not feathery and do not protrude; sticky so that pollen grains setting on them are not easily displaced	Protrude + large & feathery → large s.a. to catch pollen floating in air
7) <b>Nectar guides</b> (marking)	May be present	absent

## Artificial pollination

- The process by which the man himself transfers pollen to the sigma.
- Ancient civilization of Babylonia
- Modern times
- Artificial crossing
- Remove anther in young flowers
- Cover the flower with plastic bags
- Later they pollinate such flowers with the pollen from another flower



## Artificial pollination

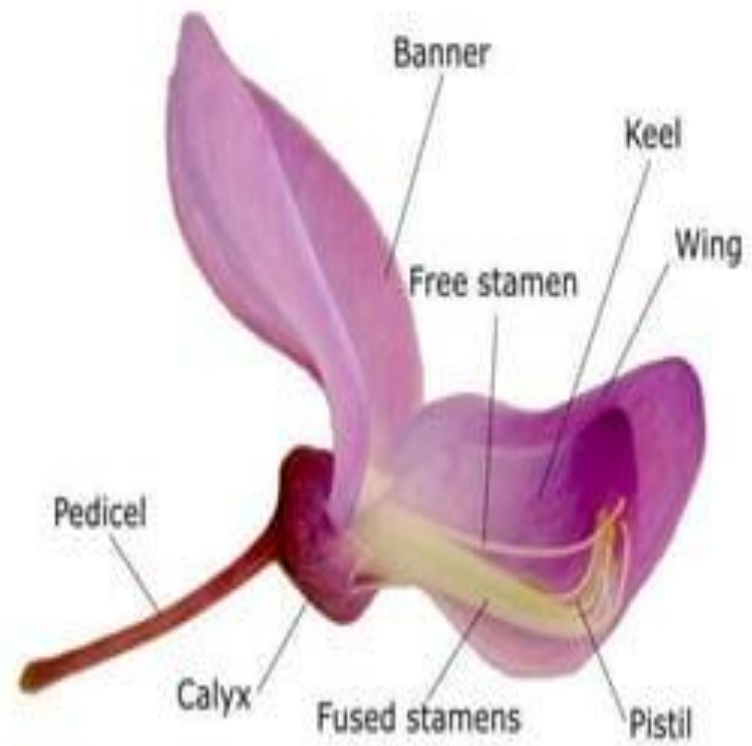
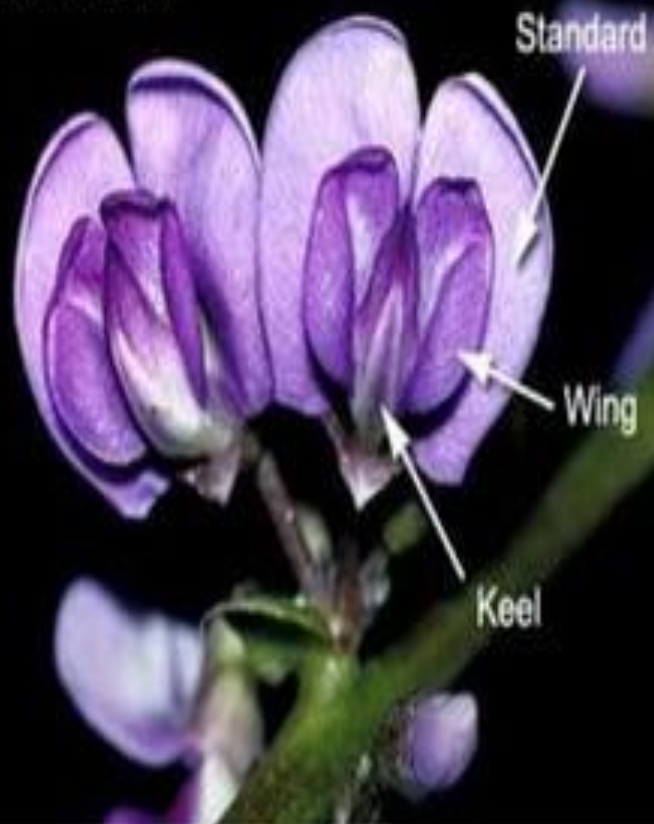


## Examples of pollination

- In insect pollinated sweet pea
- **Insects** typically **pollinate flowers** as they move from **plant** to **plant** searching for food. ... When an **insect** lands on a **flower** to feed, pollen grains stick to its body. As the **insect** moves to another **flower** of the same species, these pollen grains are transferred to the **flower's** stigma and **pollination occurs**.

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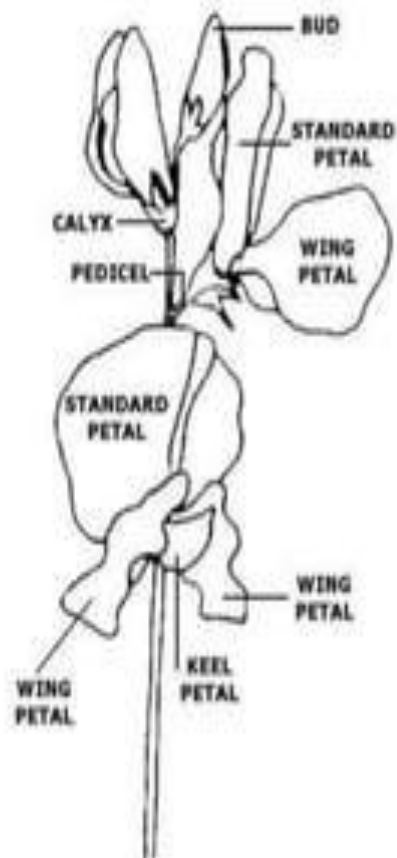
*Vandasia retusa*



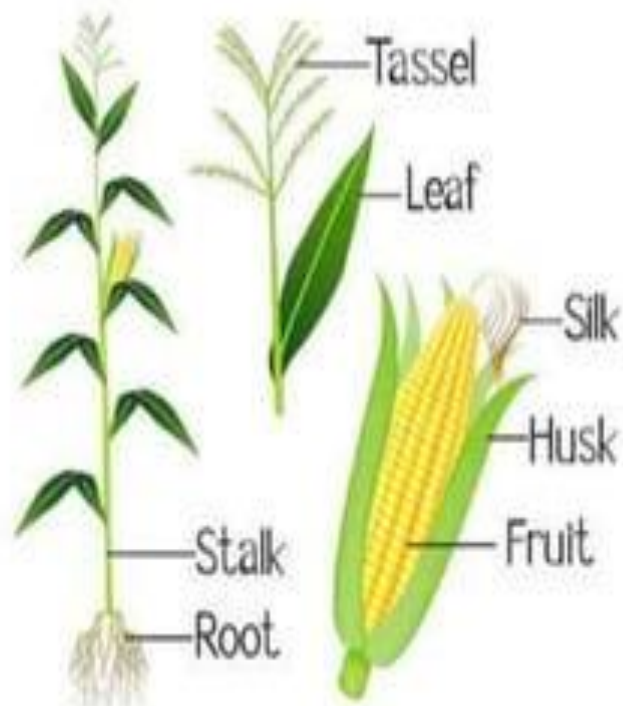
## Insect pollination

- A bee is an agent of pollination in Sweet pea. The flowers are colorful and contain nectar.
- It lands on the petals and inserts its long tongue in the flower for search of nectar. This makes the wing petal and the keel petal to push down. In this process the pollen grains from the anther are stuck to the underside of the bee.
- There is always a chance that the body of the bee having pollen grain of another flower on it which comes in contact to the stigma of this flower.
- The bee also carries some pollen of this flower stuck on its body to another flower.
- There is also a chance of self pollination in sweet pea as the flower is bisexual and both the organs lie on the same level.

## Floral parts of Sweet Pea



## Wind pollinated Maize





## Wind pollination in Maize

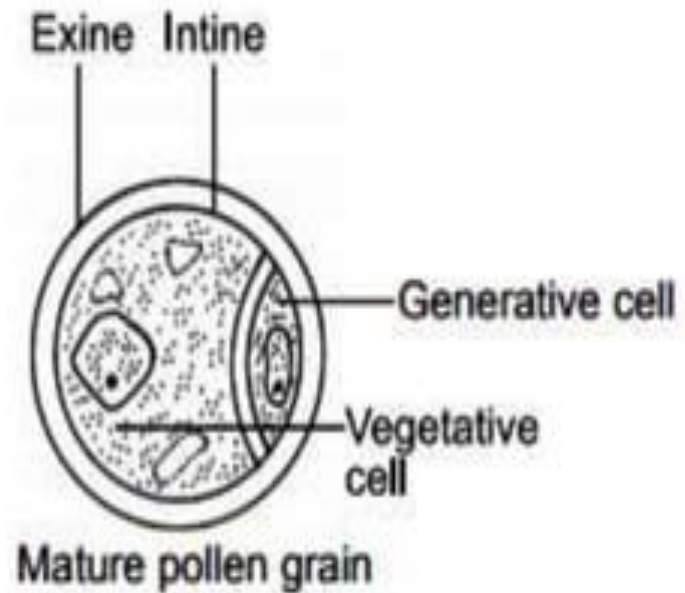
- Pollen grains from outwardly hanging anthers is blown away easily by the wind.
- It will fall on the feathery stigmas of the female flowers
- Female flowers will large surface area.
- Both male flower and female flower mature at different time.

## Fertilization

- The fusion of male and female gamete is called fertilization.
- In flowering plants
- Pollen grains- Male gamete
- Ovule - Female gamete

## Pollen grain

- Mature pollen grain
- Double wall
  - Outer Exine
  - Inner Intine
- Nucleus
  - Tube Nucleus
- - Generative Nucleus



## Ovule

- Ovule is the inner part of ovary
- Ovule becomes SEED
- Ovary becomes FRUIT
- There may be
- Single ovule producing single seeded fruit (**Avocado,Dates,Mango, Cherries**)
- Many ovules producing a many seeded fruit(Papaya, Watermelon)

## FRUITS WITH SINGLE SEED







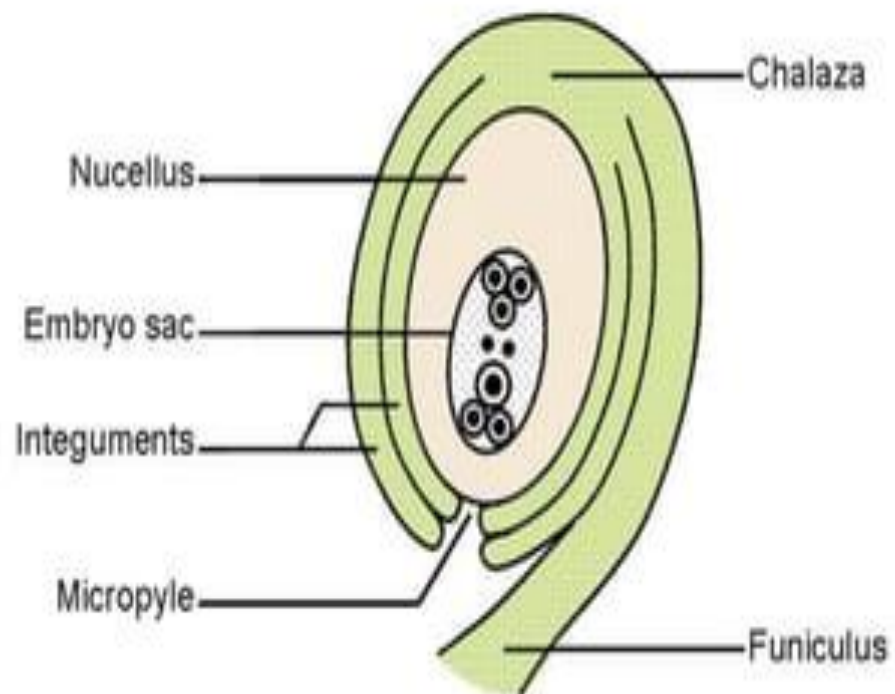
## ***Multiple seeds fruits***





## Ovule

- Each ovule has one or two protective coverings called as INTEGUMENTS
- The integuments have a small opening at one end called MICROPYLE.
- It helps for the entry of pollen tube
- Inside the integuments a mass of food laden cells are present. They are called as NUCELLUS
- Inside the Nucellus EMBRYO SAC is present

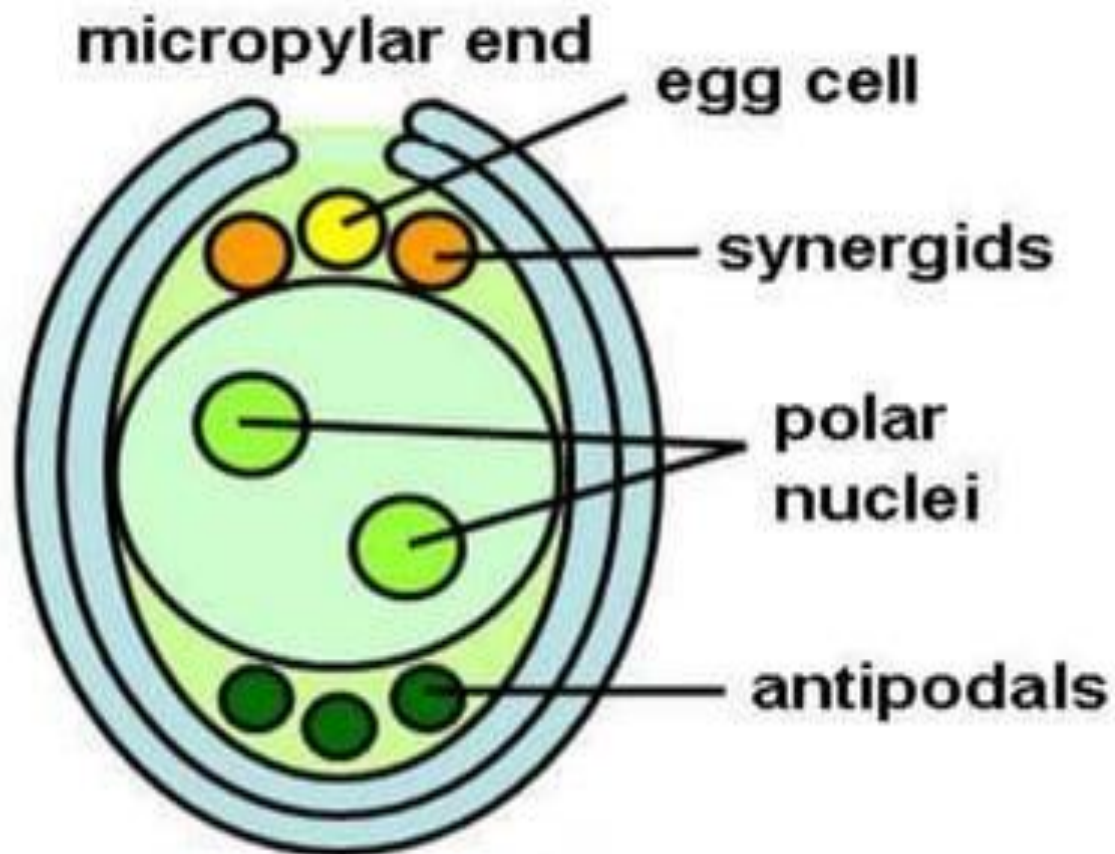


Cross-section through Ovule

## Ovule

- The embryo sac contains seven ( $3+3+1$ ) cells.
- 3 cells at **micropylar end**
  1. **One** egg cell
  2. **Two** synergids.
- 3 cells at opposite end, called **antipodal cells**
- **One** large central cell
- The central cell contains two nuclei called **Polar Nuclei**.

# Embryo sac



## Germination of pollen grain

- Pollen grain germinates only if it falls on stigma
- Otherwise it will disintegrate.
- Once a **pollen grain** settles on a compatible pistil, it may **germinate** in response to a sugary fluid secreted by the mature **stigma**.
- Lipids at the surface of the **stigma** may also stimulate **pollen** tube growth for compatible **pollen**. ..



## Germination of pollen grain

- Pollen germination starts with the pollen grain landing on stigma. The cell of the pollen grain divides into two cells- one of these is **smaller** in size and called **generative cell** and **bigger** one is called **tube cell**.
- Through a point in the exine pollen tube grows out of the pollen grain, carrying at its tip the generative nucleus and tube nucleus.
- Generative nucleus divides into two nuclei. (Male gamete nuclei also called as Sperm nuclei).
- As a whole there are three nuclei not separated by cell walls but they share a common cytoplasm.

## Germination of pollen grain

- Pollen tube grows through the stigma and style by dissolving the tissues with the help of enzymes and reaches the ovary.
- Through the micropyle it reaches embryo sac.
- Tube nucleus till now it helps for the growth of pollen tube disintegrates.
- Now the pollen tube enters one of the synergids and releases its two sperm nuclei.
- One sperm nucleus fuses with the egg cell nucleus to form a zygote
- Other sperm nucleus moves towards the polar nuclei and fuses with them (triple fusion) to produce endosperm nuclei.

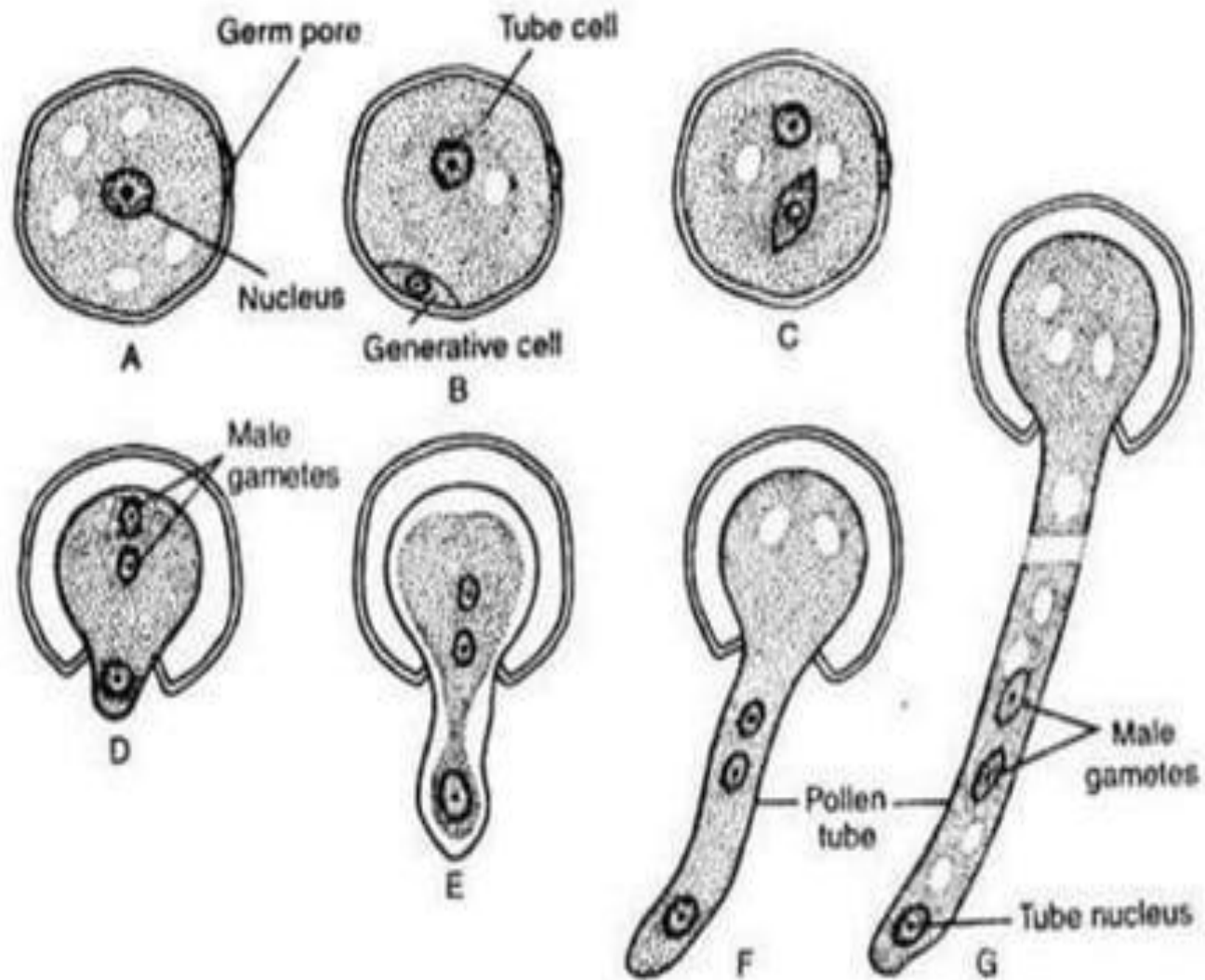
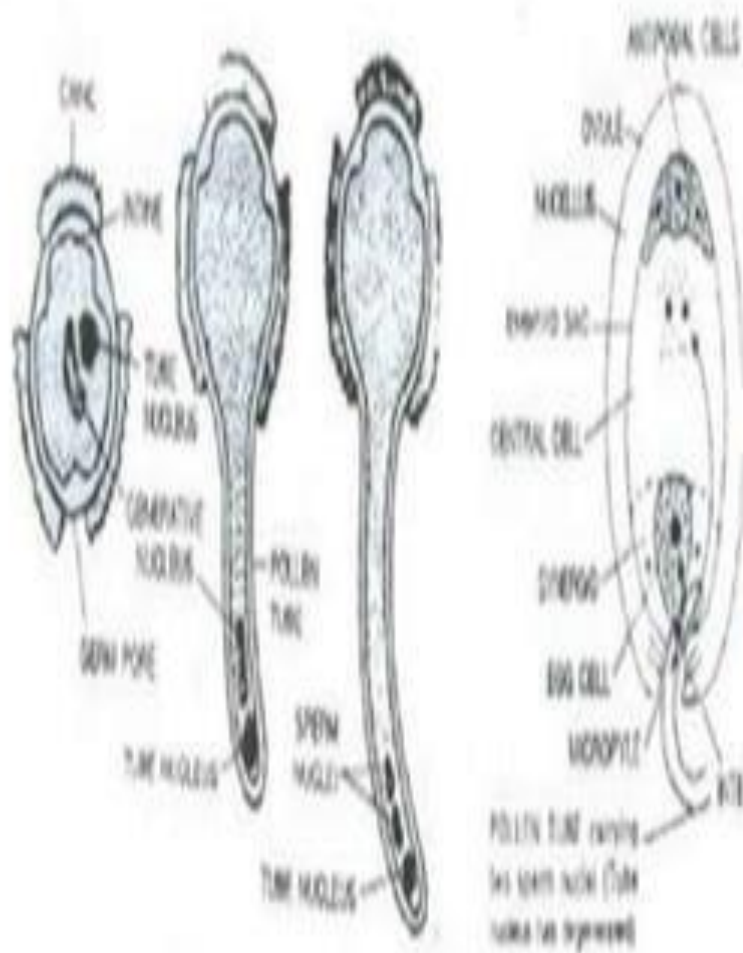
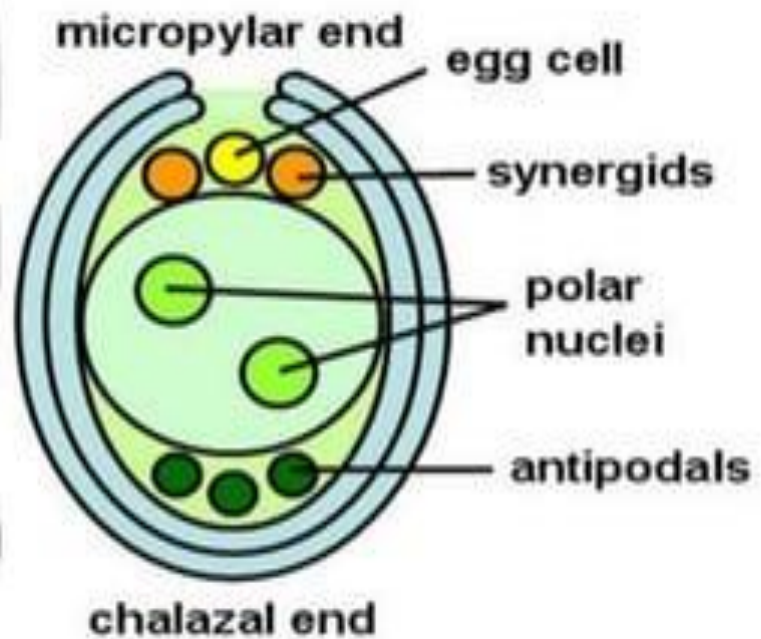


Fig. 3.5 : A-G. Germination of the pollen grain and development of the male gametes



## Embryo sac



Germination of pollen grain and the entry of pollen tube inside the ovule

## Double fertilization

- One sperm nucleus fuses with the egg cell nucleus to form a zygote
- Other sperm nucleus moves towards the polar nuclei and fuses with them (triple fusion) to produce endosperm nuclei.
- Two fertilizations are taking place.
- Seeds are attached to the ovary by placenta.



## Fate of floral parts after fertilization

### Development of Fruits and Seeds

#### ✧ Fate of floral parts after fertilization

Floral Part	Fate after fertilization
(a) sepals, petals & stamens	All wither and drop off
(b) ovary	Becomes the fruit
i) ovary wall	→ fruit wall
ii) ovule	→ seed
iii) integuments	→ seed coat (testa)
iv) fertilised egg	→ embryo

Parts before fertilization	Transformation after fertilization
Sepals, petals, stamens, style and stigma	Usually wither and fall off
Ovary	Fruit
Ovule	Seed
Egg	Zygote
Funicle	Stalk of the seed
Micropyle (ovule)	Micropyle of the seed (facilitates $O_2$ and water uptake)
Nucellus	Perisperm
Outer integument of ovule	Testa (outer seed coat)
Inner integument	Tegmen (inner seed coat)
Synergid cells	Degenerate
Secondary nucleus	Endosperm
Antipodal cells	Degenerate