GERMINATION

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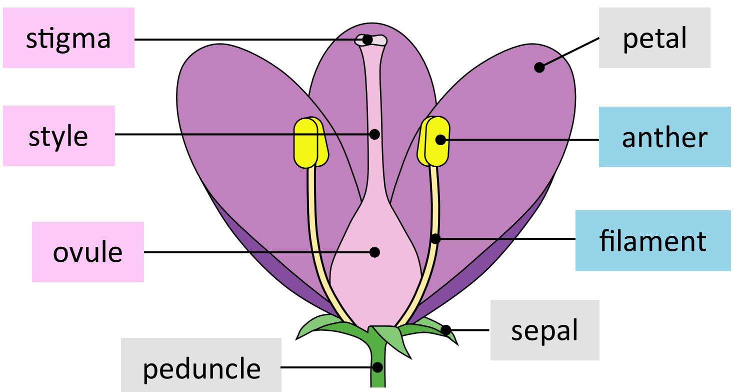
PLANT REPRODUCTION

Reproduction in plants can involve either asexual or sexual mechanisms. Plants can reproduce asexually via vegetative propagation and may undergo sexual reproduction by a variety of methods (such as flowering or spore formation in moulds). Sexual reproduction in **flowering plants** will occur across four distinct phases:

1. **Gamete production:** Gametes are made in the flowers (pollen grains in anthers and egg cells in ovules)
2. **Pollination:** The male gamete (sperm) is transferred via pollen grains to the female components (pistil)
3. **Fertilisation:** The sperm crosses the stigma in a pollen tube and fuses to the egg cell within the ovule
4. **Seed Dispersal:** A fertilised ovule develops within a seed casing, which is then released for germination

FLOWER STRUCTURE

Flowers are the reproductive organs used by certain plants (angiosperms) to produce and transfer gametes between the members of a species. Most flowers contain both male and female structures (monoecious plants), some only possess one type of structure (dioecious plants). Male parts of a flower are collectively called the **stamen** and produce pollen, while the female flower parts are called the **pistil**.



POLLINATION

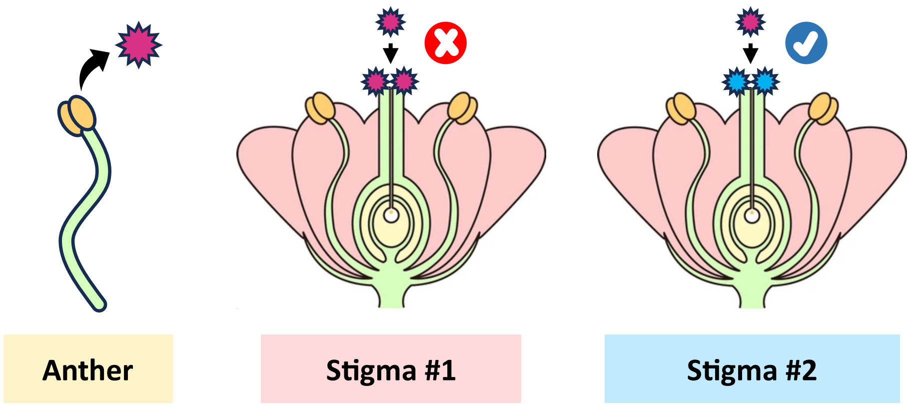
Pollination involves the transfer of pollen grains (containing sperm) from the anther of a male stamen to the stigma of a female pistil. Pollination can be mediated by animals called **pollinators**, who feed on the nectar secreted by the flower. Pollen grains can also be transferred by the wind or water. Most plants will pollinate other plants (**cross-pollination**) but some plants pollinate themselves (self-pollination) – leading to inbreeding that lowers the genetic diversity and vigour of the population. Plants may possess a number of diverse mechanisms to prevent self-pollination and promote cross-pollination – such as having distinctly male and female plants, possessing separate male and female flowers that may blossom at different times, or by having heteromorphic (different shaped) reproductive structures to prevent successful pollen transfer.

FERTILISATION

When a pollen grain settles on a stigma, it develops a protrusion called a **pollen tube** that will extend along the style to penetrate the ovule. The sperm is transported via this pollen tube in order to fertilise the ovum.

SELF-INCOMPATIBILITY MECHANISMS

Monoecious plants possess genetic mechanisms to ensure that the male and female gametes fusing during fertilisation are from different plants. Their flowers produce **specific proteins** that are present on both the pollen grain and the stigma. The stigma will reject any pollen that possesses identical proteins – thereby preventing self-fertilisation. Only pollen with different proteins can fertilise a stigma (i.e. cross-pollination).



Stigma #1 is from the *same plant* as the anther and so produces the same protein (red). This means the pollen and stigma are incompatible. **Stigma #2** is from a *different plant* and produces a protein that will be compatible (blue).

SEED DISPERSAL

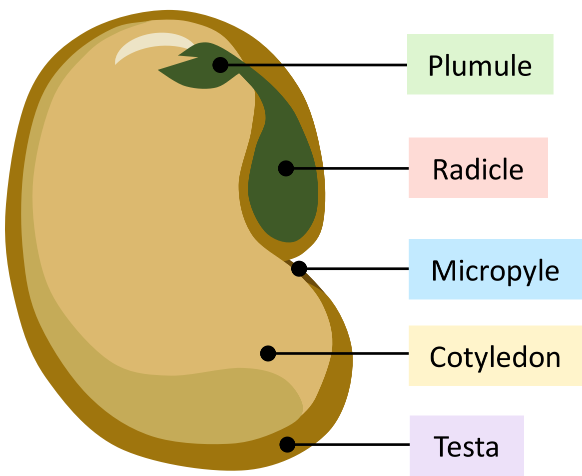
Following fertilisation, the ovule will produce a structure called a **seed** (in certain plants, this is contained in a fruit). The embryo in a seed initially develops within the parental plant until growth is halted (**dormancy**). The seed is then dispersed away from the parental plant, to reduce the competition for resources between parent and offspring. There are a variety of seed dispersal mechanisms, including wind, water and animals. Most seeds do not germinate immediately and instead require specific conditions to damage the seed coat and break a state of dormancy – such as exposure to heat (fire), pH changes (animal digestion) or washing.

SEED STRUCTURE

A typical plant seed will possess the following features:

- An outer seed coat (**testa**) that protects the plant
- A small pore (**micropyle**) to allow for water entry
- An embryonic leaf (**cotyledon**) that contains starch
- An embryonic root (**radicle**) and a shoot (**plumule**)

The cotyledon functions as the **food reserves** for the seed. When a seed starts to germinate, if this energy supply becomes exhausted before leaves can develop and begin photosynthesising, the plant won't survive.



GERMINATION

Germination begins with the absorption of water through the micropyle, which metabolically activates the seed by causing gibberellin to be produced. **Gibberellin** is a plant hormone which triggers the synthesis of enzymes capable of digesting the food reserves within the cotyledon. The sugars that are made will either be hydrolysed to produce energy (cell respiration) or polymerised to form cell components (biosynthesis). Once the seed is metabolically activated, the seed coat ruptures and the embryonic root grows into the ground to extract key nutrients and minerals. The cotyledon emerges and produces the growing shoot's first leaves (allowing photosynthesis to begin). Continued growth and development will then result in the formation of distinct plant structures – including root systems, stems and leaves (and potentially flowers).