Cells and Living Things – Plants (Extension)

The structure and functions of the plant

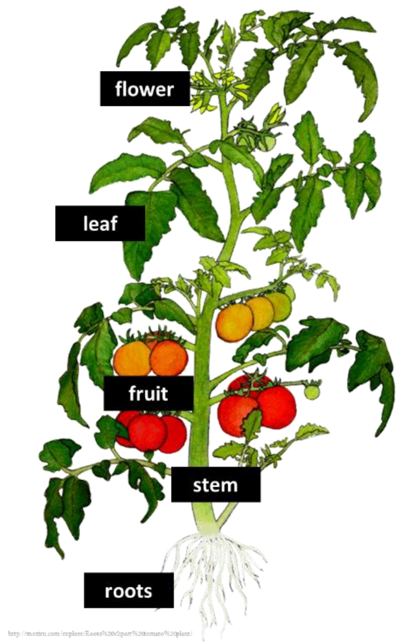
Many parts of the plant are involved with the process of photosynthesis, either by helping collect the substances needed (roots, stem, leaves), storing products formed (roots, stem) or providing a place for the process to take place (leaf cells).

The Shoot System - Above ground (usually)

Lifts the plant above the soil. Main functions include:
- Leaves - photosynthesis
- Flowers - reproduction
- Fruit – seed dispersal
- Stem - food and water transport

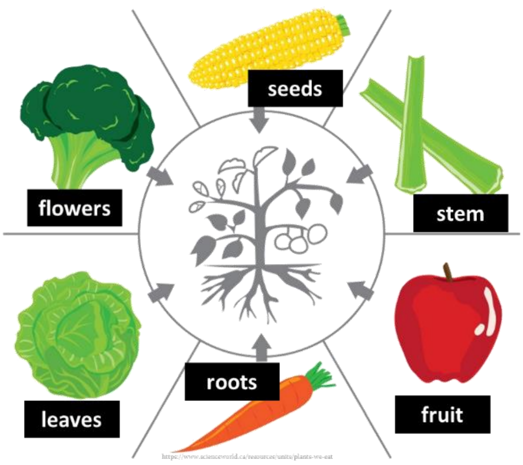
The Root System - Underground (usually)

Anchor the plant in the soil. Main functions include:
- Absorb water and nutrients
- Transport water and nutrients
- Food Storage



Parts of a plant we eat

We use many types of plants for food. The fruit and vegetables that we eat, and grow for eating, come from various parts of the plant. We often breed types of plant for food by exaggerating a part of a plant, such as flowers of the plant to grow broccoli, to make better use of them.



The significance of photosynthesis in making food

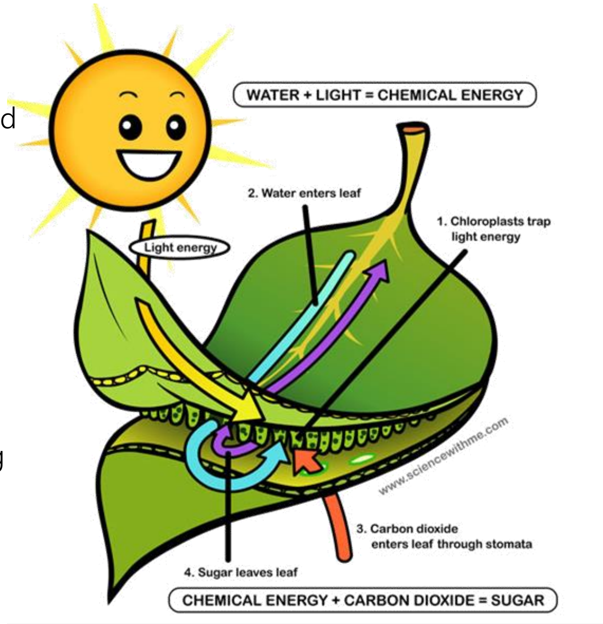
Most living organisms depend on plants to survive. Plants convert (change) energy from sunlight into food stored as carbohydrates through photosynthesis. Because animals cannot make their own food, they must eat plants (producers) to gain nutrition. Plants produce oxygen, which is released during photosynthesis, which all organisms need for respiration.

Photosynthesis transfers energy from sunlight into energy in chemicals such as glucose and starch.

Light enters the leaf and is trapped by a green substance called chlorophyll contained within structures called the chloroplasts in the cells.

Water is transported via water tube cells called xylem, to the leaf cell and the carbon dioxide enters through the stomata and diffuses (spreads) to the leaf cells.

These substances react chemically within the chloroplasts; powered by the light then glucose (a sugar) is produced along with oxygen, which diffuses out. The sugar leaves the leaf via sugar/food tube cells.



Reactants and products of photosynthesis

The photosynthesis reaction can be written as a chemical equation with the reactants needed on the left and the products produced on the right

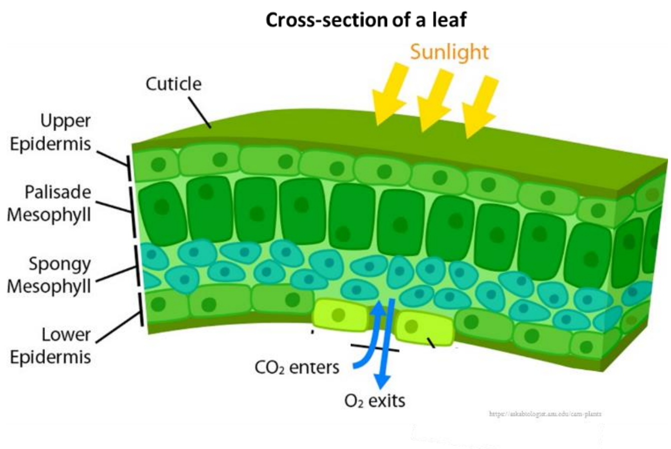
$$\boxed{\text{Carbon dioxide} + \text{Water} \xrightarrow{\text{light}} \text{Glucose} + \text{Oxygen}}$$

The leaf is the location of most photosynthesis

The flat surface of the leaf called the blade helps capture maximum sunlight for photosynthesis. The leaf is attached by a stem to the plant, which branch out into veins. The large surface area of the leaf helps capture as much sunlight as possible. The green colour is due to chlorophyll in the leaf cells that captures the light, and where photosynthesis takes place. The leaf is thin to allow light (and carbon dioxide gas from the air) to circulate to every cell in the leaf.

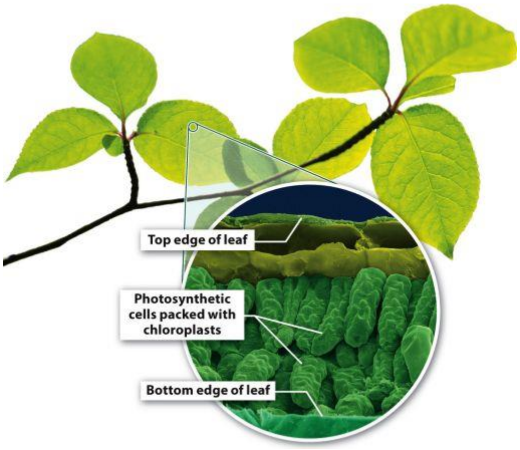
Photosynthesis happens in the chloroplasts/ chlorophyll in the leaf cells

The cells at the top of the leaf are filled with chlorophyll, which gives leaves the green colour. The chlorophyll allows the leaf to absorb light energy, which is required for photosynthesis. The spaces between cells in the middle allow carbon dioxide to diffuse around through the cells.



Chloroplasts and Photosynthesis

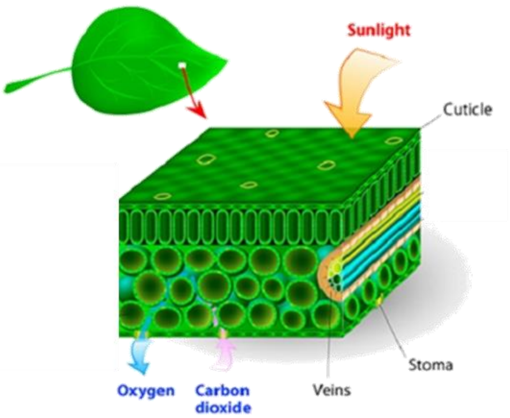
The chloroplasts circulate around the cells, especially the layer of cells that are close to the top of the leaf. This allows maximum amounts of light to be distributed to the chloroplasts for photosynthesis to take place.

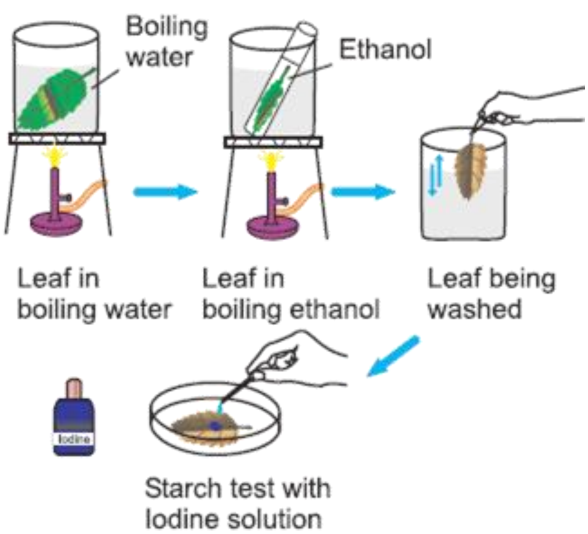


The adaptations of leaves for photosynthesis

A waxy cuticle on the outside of the leaf provides a waterproof covering while remaining transparent to allow light into the leaf cells for photosynthesis.

Openings (usually on the underside of the leaf) called stomata allow carbon dioxide to enter and diffuse into cells as well as allowing oxygen to move in and out. Two guard cells on either side of the stomata open and close the openings.





Starch test

A positive test for starch is the leaf turning blue- black when iodine is added. The starch is the storage product of the plant when it produces photosynthesis. A positive test means photosynthesis has occurred.

Step 1. The leaf is boiled in water to soften it.

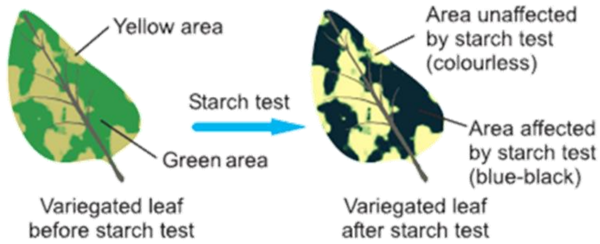
Step 2. The leaf is then placed into a boiling tube of ethanol, which is placed in a beaker of water and heated gently. This will remove the green chlorophyll.

Step 3. The leaf is washed in water to remove all of the ethanol.

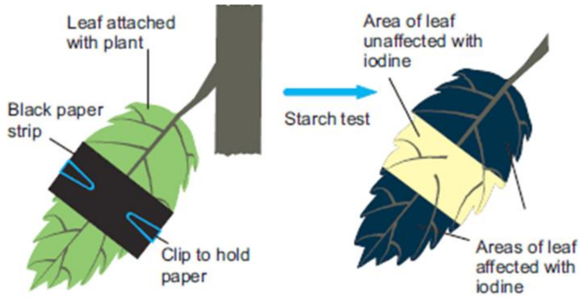
Step 4. Iodine added to the leaf. It will turn blue-black in the presence of starch. The starch indicates photosynthesis and the production of glucose has occurred.

Investigations into photosynthesis requirements

We can investigate that photosynthesis happens in the chloroplasts/chlorophyll in the leaf cells and use the starch test as evidence. When a plant undergoes photosynthesis, it produces glucose, which is converted into starch for storage. If we want to investigate what factors are required for photosynthesis we use the starch test to enable us to reach a conclusion. Factors include chlorophyll, water, carbon dioxide and light present.



Investigating if Chlorophyll is required for photosynthesis:
Select a leaf that is variegated leaf. The green parts contain chlorophyll and the white parts do not. To show chlorophyll is required for photosynthesis only the previous green areas will turn **blue - black.**

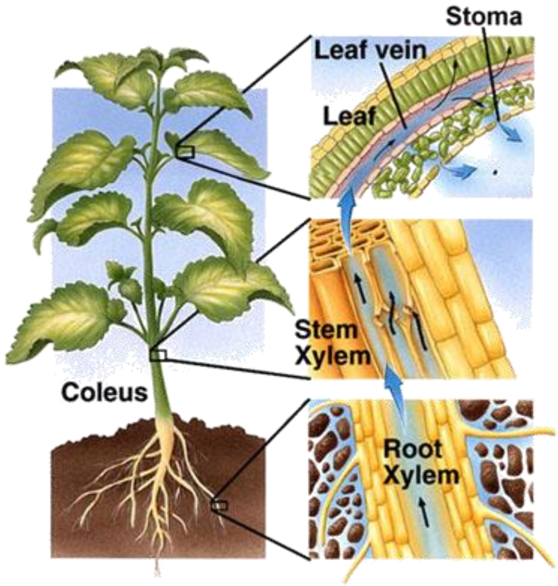


Investigating if light is required for photosynthesis:
Place a piece of black paper over a leaf and leave for a few days still on the plant.
To show light is required for photosynthesis only the uncovered areas will turn **blue - black**.

Water movement through a plant

Water is required for photosynthesis and it moves through the plant in one direction only.

Step one: Water uptake by the process of <u>osmosis</u> into the root hairs
Step two: water moves up through the <u>xylem</u> by molecules "sticking" together and being pulled upwards
Step three: water moves out of the plant by <u>transpiration</u> through the <u>stomata</u> on the underside of the leaf



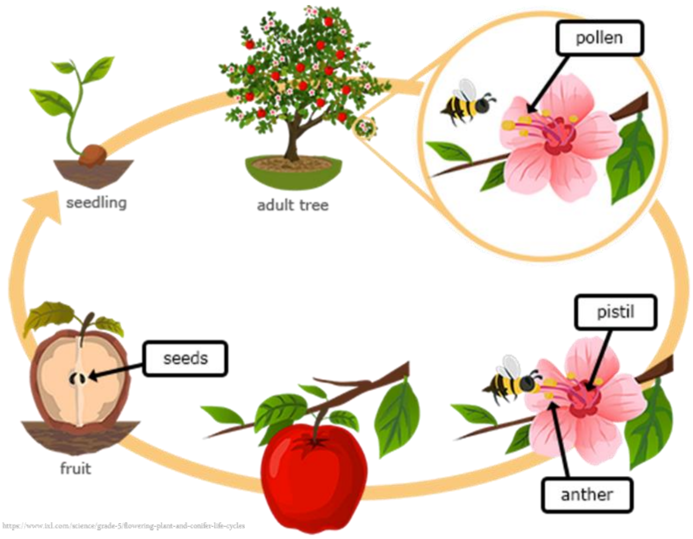
Flowering Plants

Plants that produce flowers are known as Flowering Plants (angiosperms). The flowers are the reproductive structures where fertilisation occurs and seeds are produced. Flowering plants include many of our common New Zealand such as kōwhai, harakeke (flax) and pōhutakawa, as well as flowering grasses like toetoe. Many of our New Zealand Flowering plants have been discovered by Māori to be useful for medicine, food, clothing and housing.

Flowering Plant life cycle

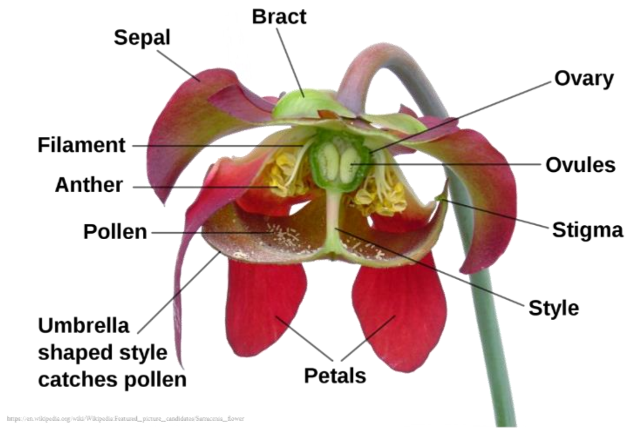
All flowering plants develop flowers that produce male pollen and female eggs. The number and structure of these depend on the species of plant.

The reproductive cycle involves the transfer of pollen to the egg in the flower (pollination), the joining of the pollen and egg to make a seed (fertilisation) and the spreading of seeds to grow a new plant (seed dispersal)



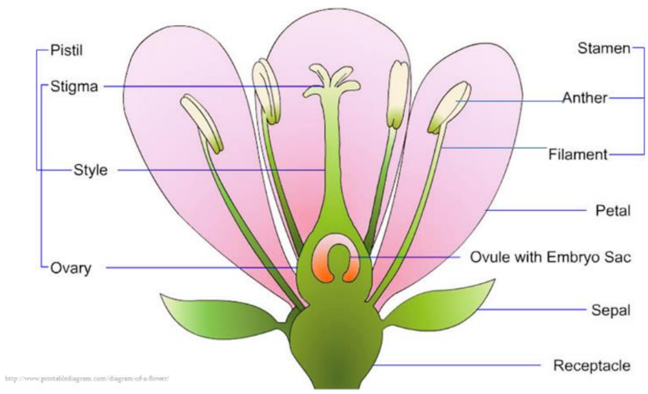
The structure of a flower

Insect / bird -pollinated flowers have visible, often colourful petals that surround the flower's sexual reproduction parts. The petals can "advertise" for specific pollinators through their shape, size, colour and sometimes smell. The flowers are surrounded by sepals, which are small and usually green structures that protect the flower as its developing.



Drawing and labelling a flower

The main parts of a typical flower that are pollinated by an animal such as a bird or insect, is shown beside in a cross-section drawing. Many flowers often have many anther/filaments surrounding one central stigma/style. When labelling, one of each is required.

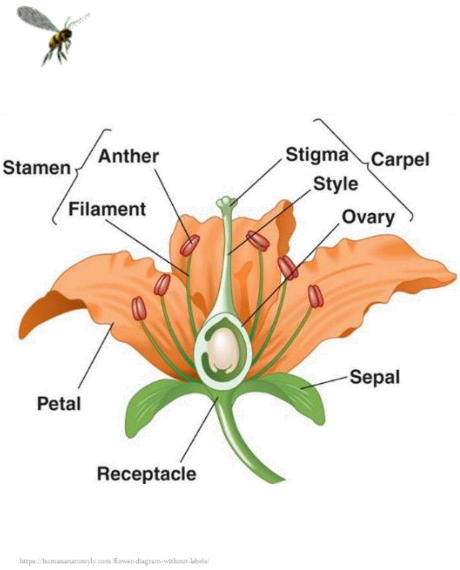


Reminders for Biological drawing:

- ❑ Clean single lines
- ❑ Label all parts
- ❑ Do not cross over lines

The reproductive parts of an insect-pollinated flower

<u>The male part</u> of a flower is called the **stamen**. The pollen is produced in the **anther** which is held up by the **filament**. The pollen is collected by a pollinator. (or spread by wind) The pollen contains male sex cells (**gametes**) which will later join with the female gametes in the ovule during fertilisation.

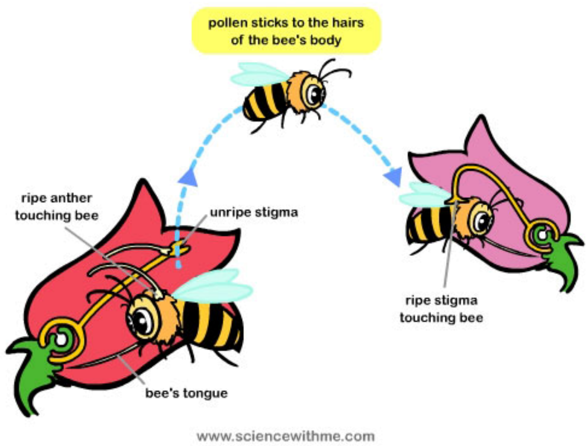


<u>The female part</u> of the flower is called the **pistil (or carpel)**. The pollen from a male part of a flower is brought to the stigma by a pollinator. This process is called **pollination**. The pollen travels down the **style** into the **ovary** to join with an egg cell inside the ovules in a process called **fertilisation**.

Pollination

Pollination is the transfer of pollen from the male part of the flower to the female (stigma) part of another flower. Flowers can be wind-pollinated or animal-pollinated. Animals that assist in pollinating a flower are known as pollinators.

Insect-pollinated flowers often contain nectar, a sweet sugar produced by the plant, to attract an insect. As the insect reaches into the flower for the nectar, it may be brushed with pollen from the anther. If the insect moves to another flower, it may brush the pollen against the stigma and therefore pollinate the flower. Flowers ripen their male and female parts of the flower at different times to prevent self-pollination.



1. The male parts of the flower are the anther and filament
2. The female parts of the flower are the stigma, style and ovary
3. Male gametes are found in Pollen Produced in the Anther
4. Pollen needs to be moved to the female part called the Stigma of the same species of plant to reproduce
5. This process is called Pollination
6. Pollination can be helped by Wind Or Animal
7. An example of wind pollination is grass plants
8. A wind pollinated flower is most likely to look like - small, green, unscented
9. An example of animal pollination is a rose plant pollinated by insects
10. An animal pollinated flower is most likely to look like – colourful, with large petals, perhaps with a scent

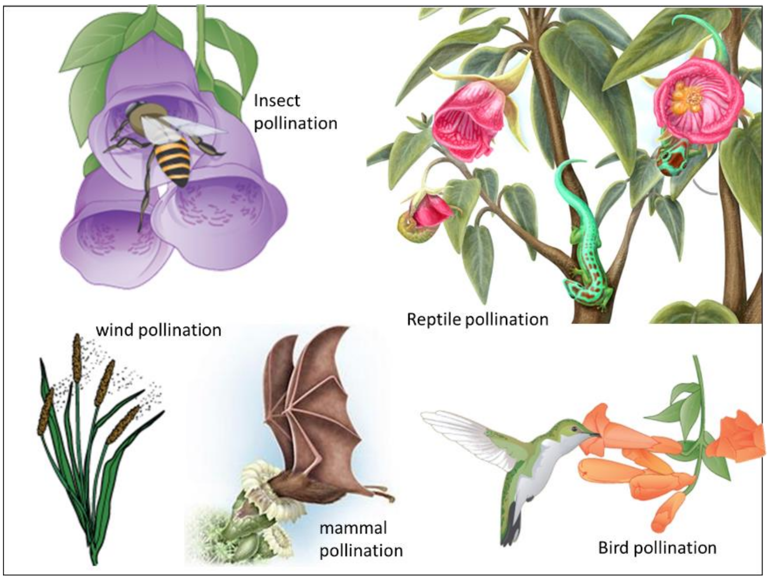
Functions of the ova and pollen

The pollen must be light enough to either be moved by wind or be attached to a pollinator and still enable it to fly.

The ova is the female equivalent to eggs and once fertilised will become the seed. The number of ova will determine the maximum possible seeds each flower will produce, as either fruit, nuts or pods.

Different ways pollen may be transferred.

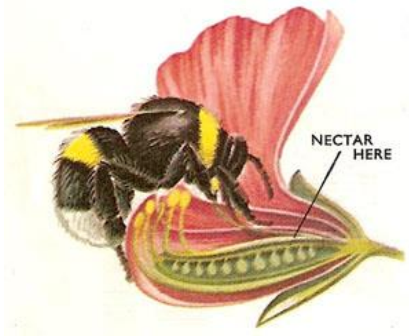
Pollen grains are tiny and they are light enough to be carried by the wind or on the bodies of flying and crawling animals. Plants and their flowers have adapted to transfer their pollen from one flower to another in many different ways that include using wind, insects, birds, mammals and reptiles.



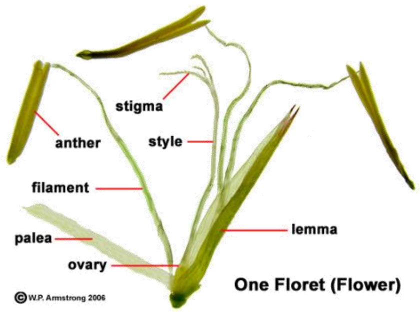
Examples of insect-pollinated flowers	Examples of wind-pollinated flowers
	

The differences in structure between insect-and wind-pollinated flowers

Insect pollinated flowers are easily seen and often contain scent and nectar to attract the insects. The male parts are adapted so they make contact with the insect as it feeds from the flower.



The differences in structure between insect-and wind-pollinated flowers



Wind pollinated flowers are often small and green with no scent. Male anthers protrude out from the flower to allow the wind to pick up the pollen and disperse it away from the plant. Male and female parts develop at different times.

Feature	Wind pollinated	Insect pollinated
petals	Small dull coloured petals	Large brightly coloured flowers
scent	Flowers do not have any scent	Flowers have scent to attract insects
stamen	Stamen is thin and hangs outside flower	Stamen is strong and inside the flower
pollen	Pollen grains are light and numerous	Pollen grains are sticky or hairy and are few in amount
stigma	Stigma is feathery to catch pollen and hangs outside the flower	Stigma is also hairy and sticky and is inside the flower
nectar	No nectar or nectary	Many have sweet nectar in a nectary to attract insects

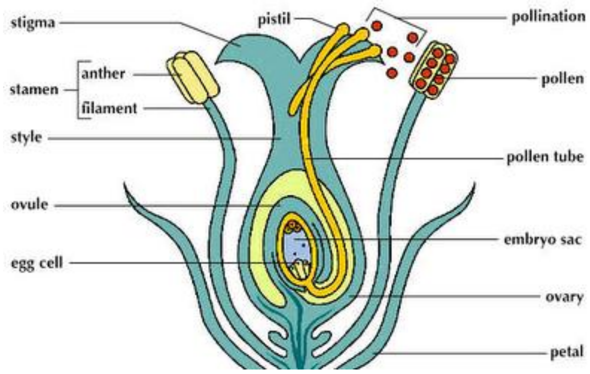
Adaptations of Tui pollinated flowers

Some New Zealand plants, such as NZ Flax, pūriri and kōwhai use the tūī as a pollinator. Both the plants and tūī have evolved together to the advantage of both and have adaptations to help their survival. The tūī is a nectar eating bird and the flowers of these plants produce nutritious nectar to attract the tūī, which then transfers pollen to other plants, ensuring pollination with another flower. The curve and length of the flowers (see flax flowers to the right) and the tūī's bill are a good match.

To deliver the correct pollen to the correct species, when the tūī feeds from a particular flower species the anther of each flower species deposits pollen on a specific area of the tūī's head. When it feeds on another flower of the same species, a sticky stigma-tipped style will brush the same spot, picking up pollen. The flowers are often red / yellow and scentless, as the tūī has limited sense of smell and can see the reddish colour range the best.

Fertilisation in flowering plants

1. Pollen from either the same plant (self-pollination) or another plant (cross-pollination) needs to arrive on the flowers stigma
2. The pollen sends a tube down the style to reach the ovule, and the male gametes (there are two in every pollen grain) enter the ovule to fertilise the egg (female gamete)
3. One male gamete joins with one female gamete to form a zygote and the plant is fertilised. (The fertilised ovule develops into a seed)

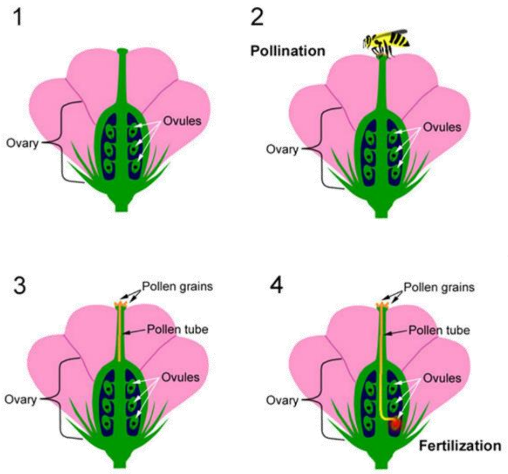


The differences between pollination and fertilisation in flowering plants

Pollination just refers to pollen landing on the female stigma of the plant. This can be with either a pollinator or wind.

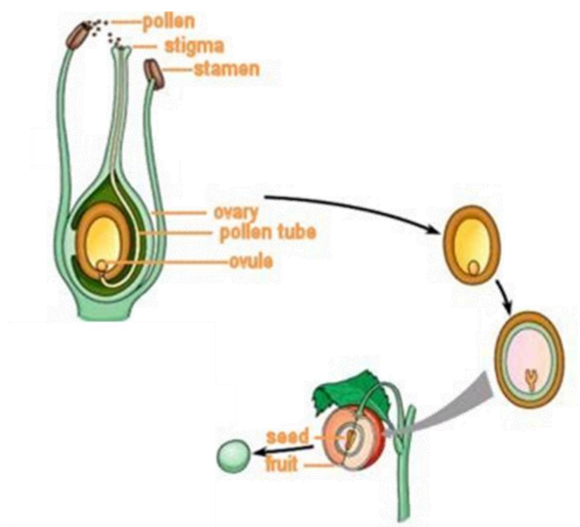
Fertilisation refers to the sperm cell (that was in the pollen grain) joining with the egg cell to form a single cell (zygote).

Pollination does not always lead to fertilisation

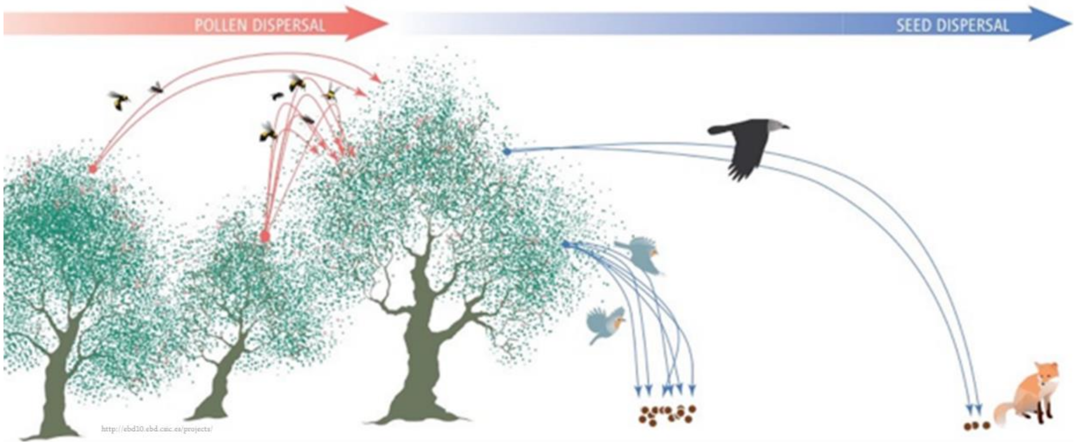


The formation of seed and fruit from ovule and ovary

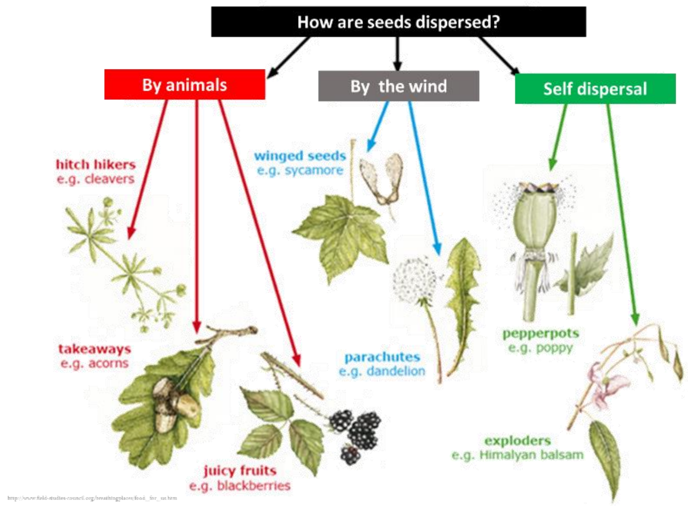
Once the flower has been fertilised by pollen the ovary grows to form the fruit. The ovules become the seeds. The outer part of the ovule grows into the seed coat. The zygote grows into the young plant – or embryo. A fruit may have one or more seeds. The petals, sepals and other parts of the flower start to die and fall off.



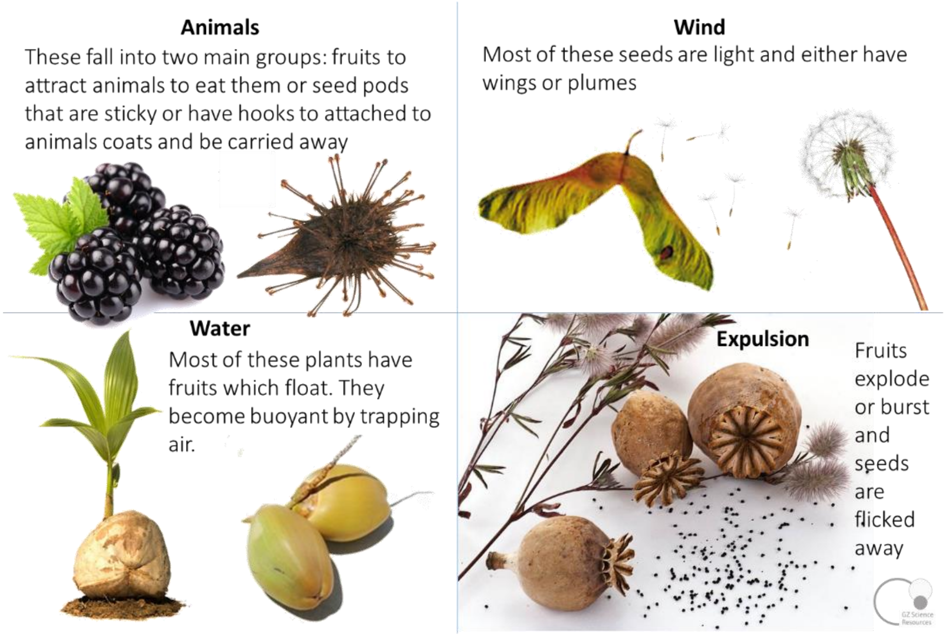
Seed dispersal



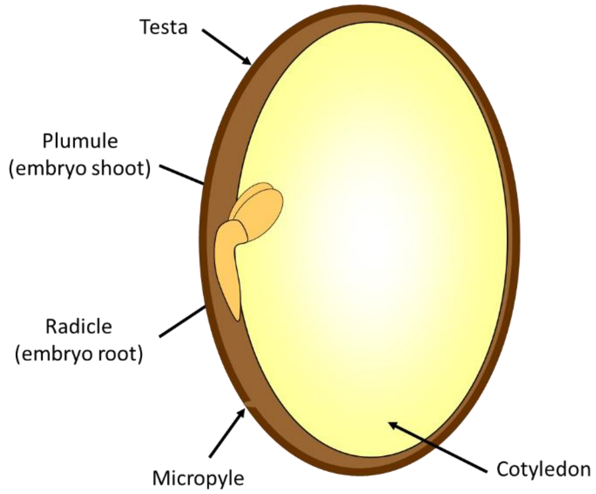
Pollen is dispersed (or spread) from plant to plant so the flowers can be pollinated and fertilised seeds produced. Once the seeds are mature they then also need to be dispersed so they are not competing with the parent plant for space, light, water and nutrients. There are various ways that plants have evolved to disperse their seeds; forming inside fruit that animals will eat and spread, forming structures on the seed so the wind will carry them away, can float away, be forced away or tangle in the coat of an animal to be carried away.



Seed structure is linked to Seed dispersal



The Structure of seeds



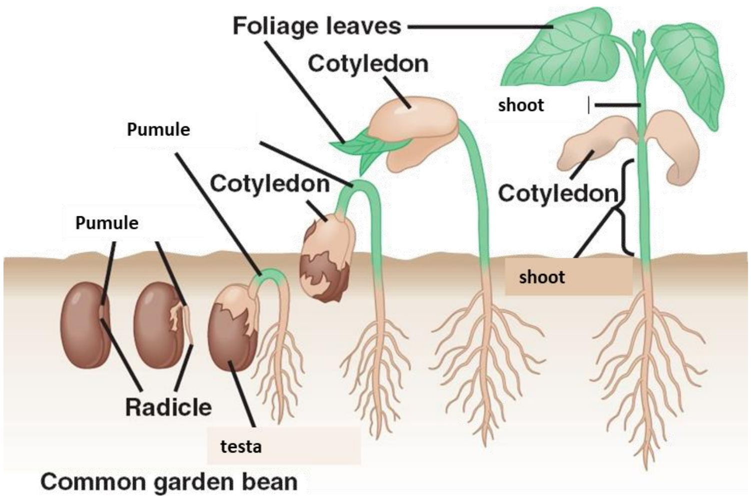
A seed is a fertilised ovum (egg) containing a small embryonic plant and a supply of food to help it germinate and grow before it can start to photosynthesis and make its own food. The seed consists of the seed coat or the testa, which surrounds the cotyledons or the food storage area. The embryo consists of the radicle which is the embryonic root and the plumule, which forms the first shoots and leaves of the plant. A small pore in the seed may be seen called the micropyle. This is where the pollen originally entered the ovule.

The conditions needed for germination of seeds

Seeds will remain dormant until they receive (WOW)

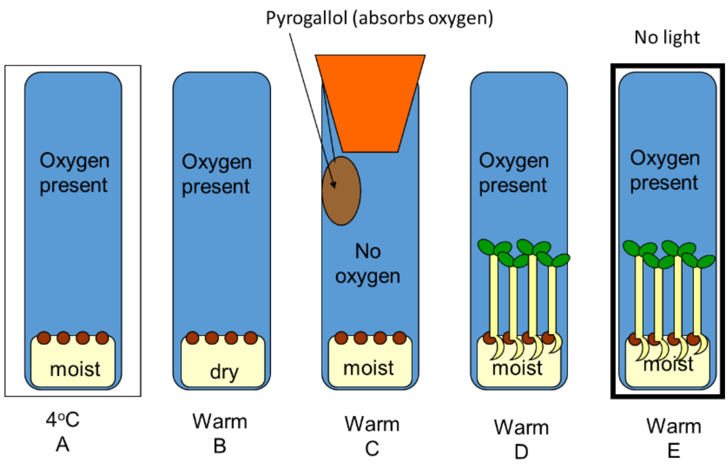
Water
Oxygen
Warmth

Then they will germinate.
Other types of seeds may also require
>fire to burn seed coat
>light
>soaking in water
>scratched seed coat
>being digested by animals
Before they germinate



Germination Investigation

By altering the conditions in containers with seeds, we are able to see what conditions are required for germination. The range of conditions include light, water, oxygen and warmth. The seeds germinated when seeds has warmth, water and oxygen - whether there was light or not did not affect germination.



Māori scientific knowledge and understanding of their use of plants - Tawa

Over a long period of time, Māori have built up their scientific knowledge and understanding of their use of plants for medicine (Rongoa), food, clothing and housing. Many of these uses are still practiced today.



Tutu. Photographer: Michael Hall. © Te Papa & Ngati Toa. Tutu ointment being applied to arthritic wrist.

The rātā tree bark can be made into a lotion or poultice, and the flower nectar can used for sore throats.	  White and Red Rata from Maungatautari
Kawakawa can be made into a tea, poultice or chewed for toothache, sore stomach, and pains	 Te Ara - The Encyclopedia of New Zealand Photograph by Emily Tutaki  Kawakawa from Maungatautari