

Extension  
**2018**  
Version



# Cells and Living Things - Plants

## Junior Science

# 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

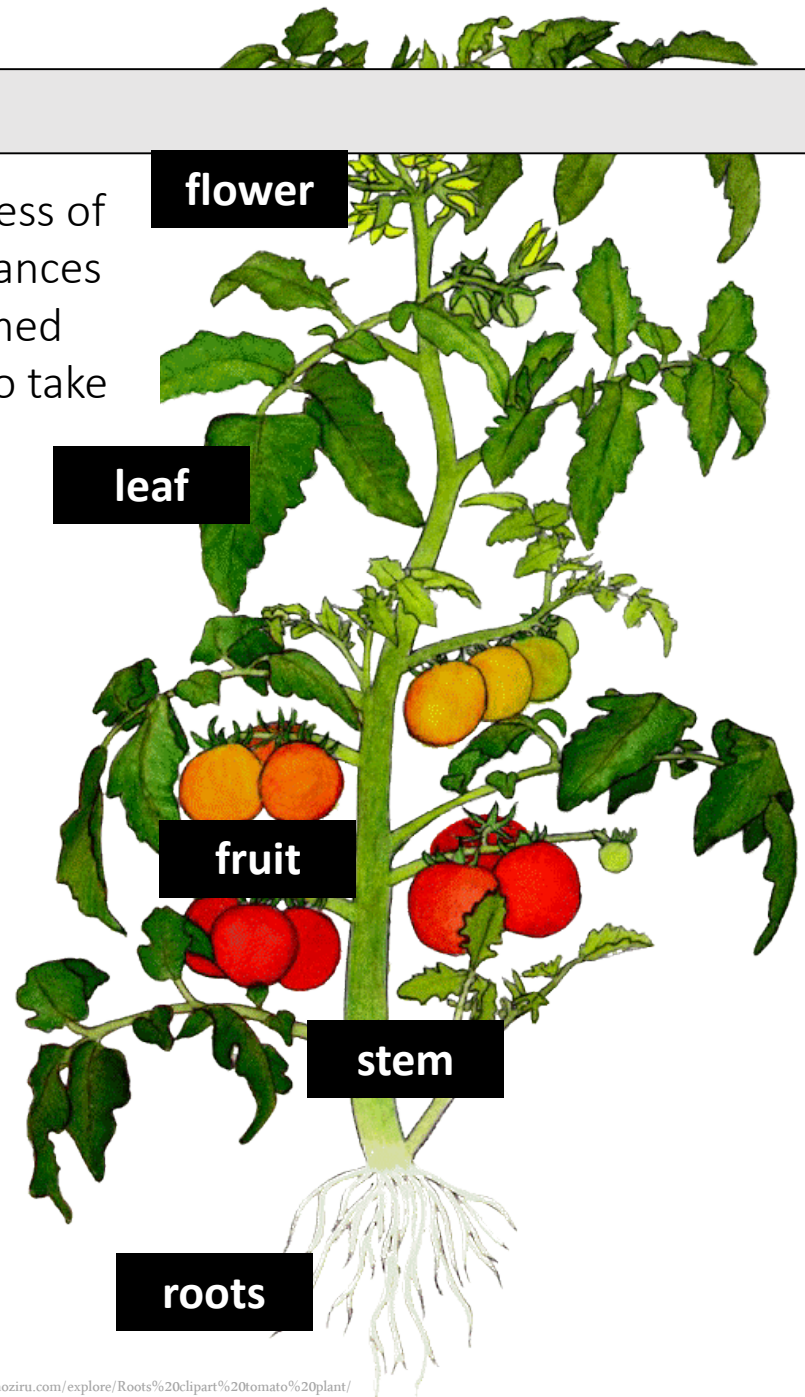
**Stem** - food and water transport

**The Root System** - Underground (usually)  
Anchor the plant in the soil. Main functions include:

**Absorb** water and nutrients

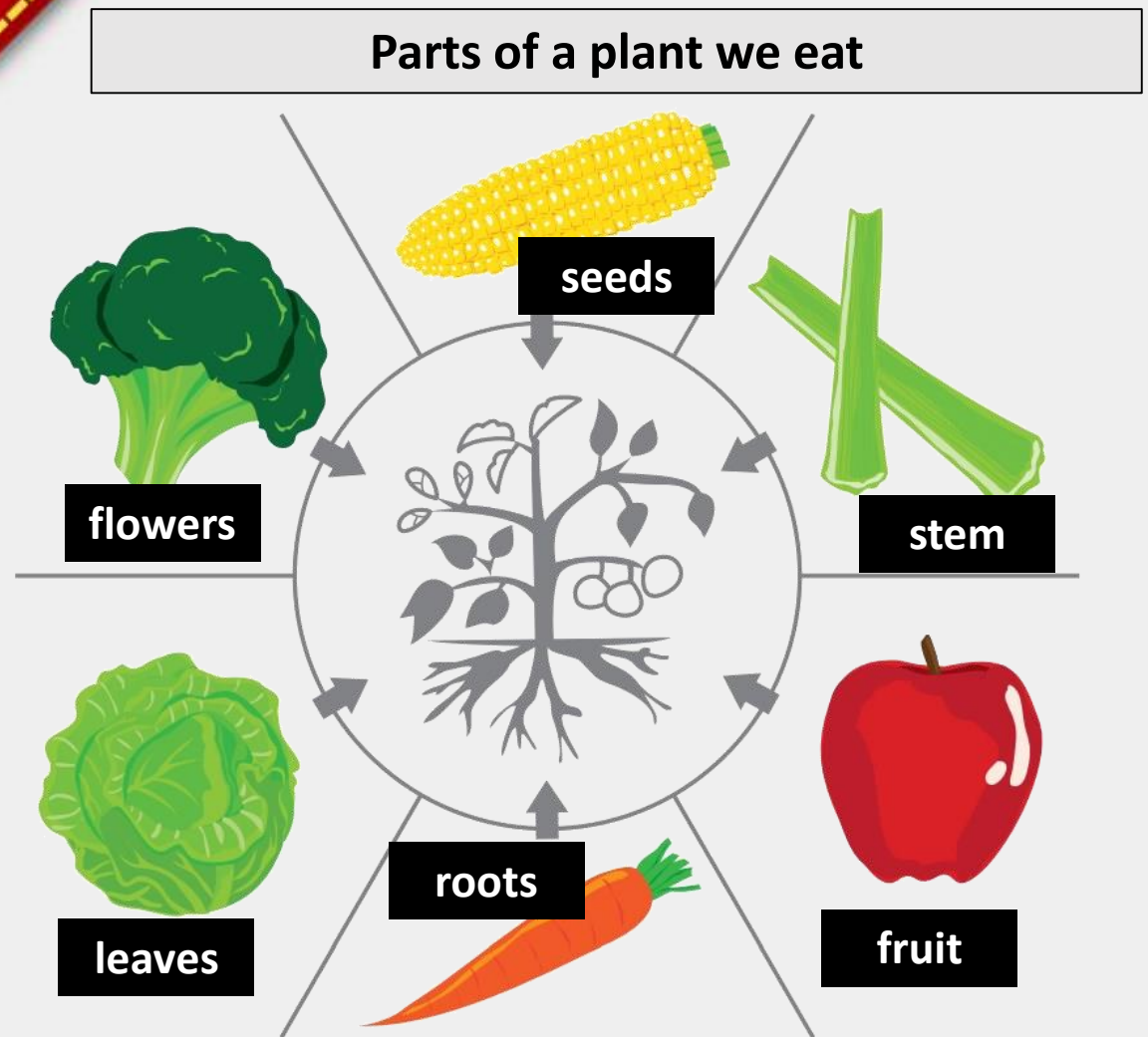
**Transport** water and nutrients

**Food Storage**



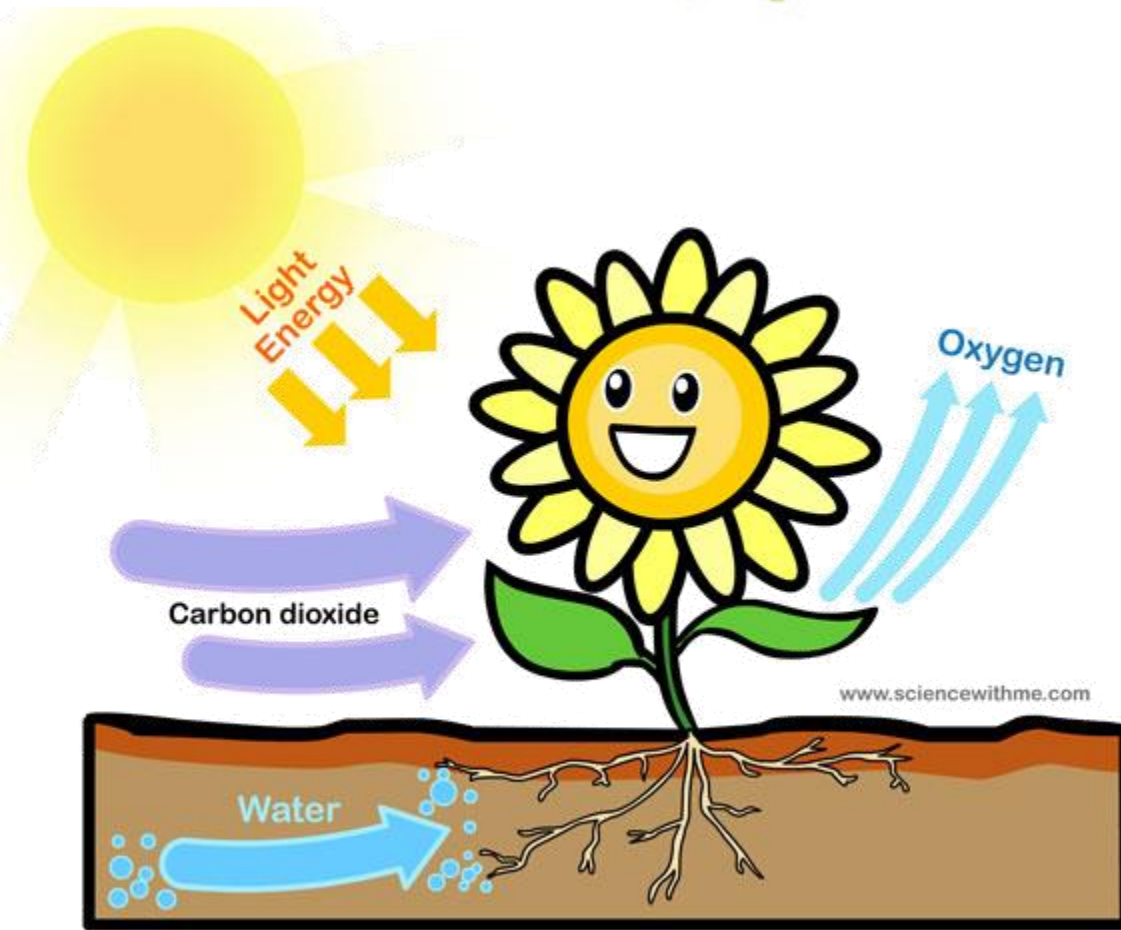


# Background Knowledge



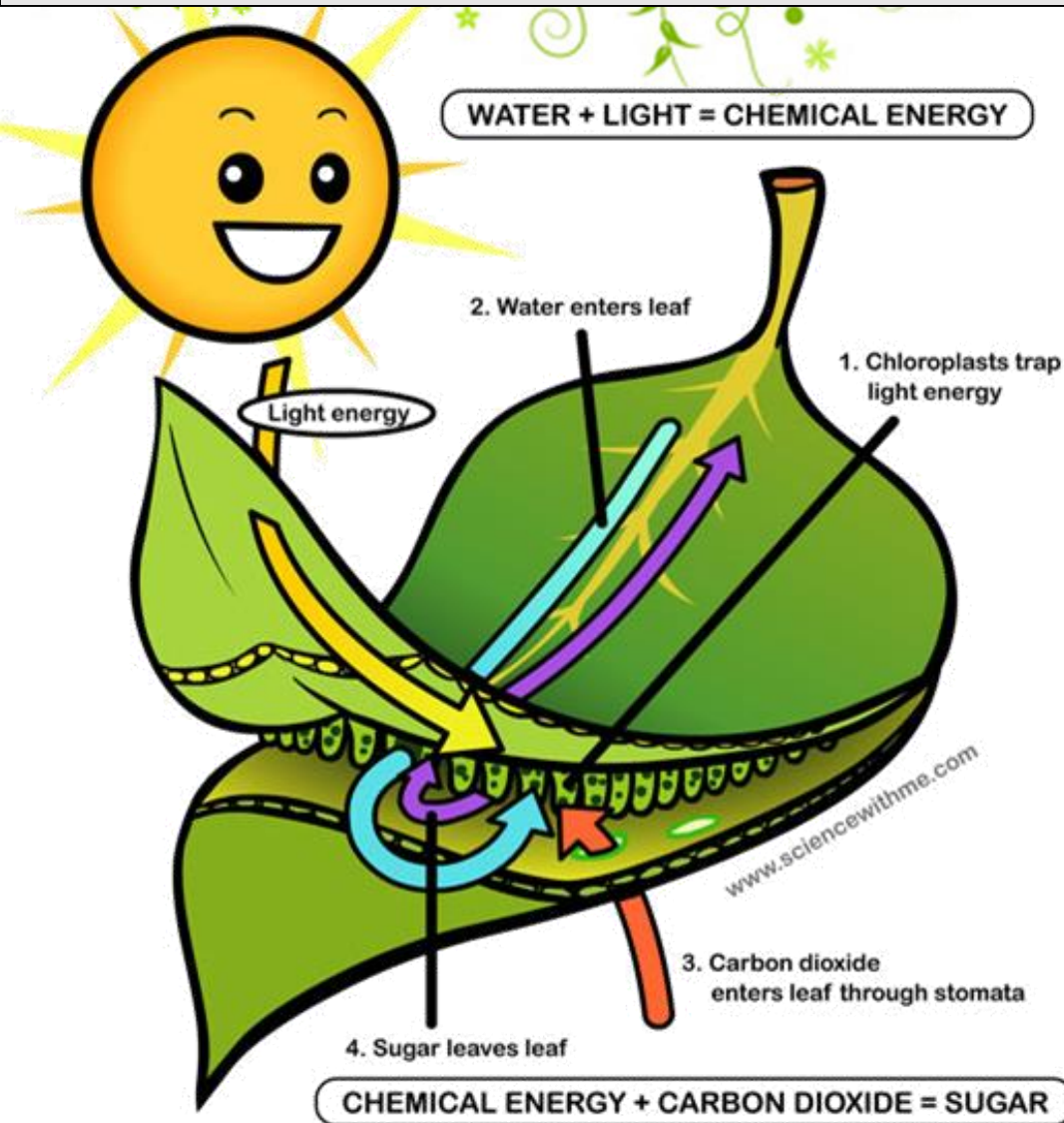
We use many types of plants for food. The fruit and vegetables that we eat, and grow for eating, come from various parts of the plant. We often breed types of plant for food by **exaggerating** a part of a plant, such as flowers of the plant to grow broccoli, to make better use of them.

## 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



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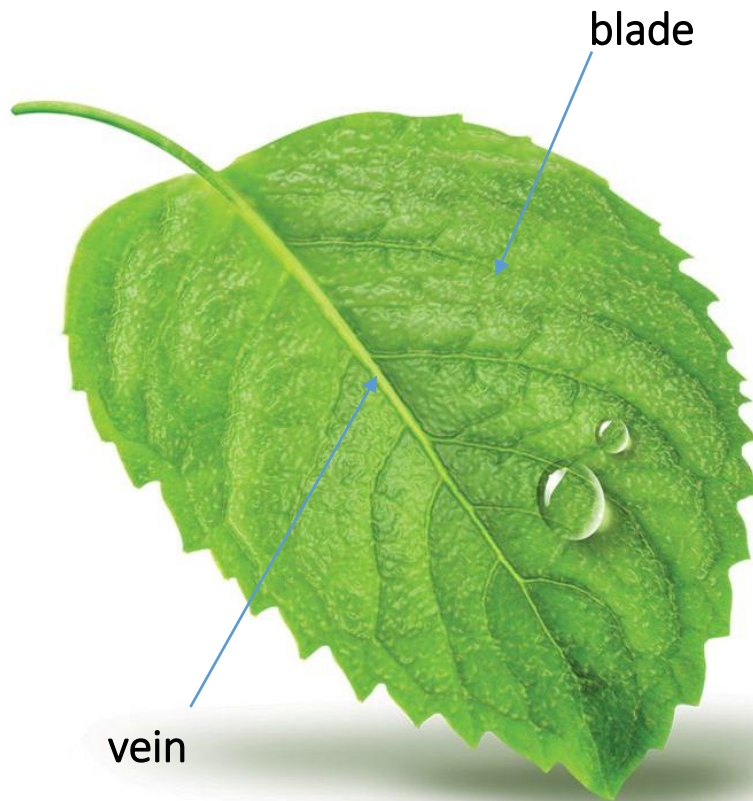
The photosynthesis reaction can be written as a chemical equation with the reactants needed on the left and the products produced on the right

light

Carbon dioxide + Water → Glucose + Oxygen

Word equation

## The leaf is the location of most photosynthesis



The **flat surface** of the leaf called the blade helps capture maximum sunlight for **photosynthesis**.

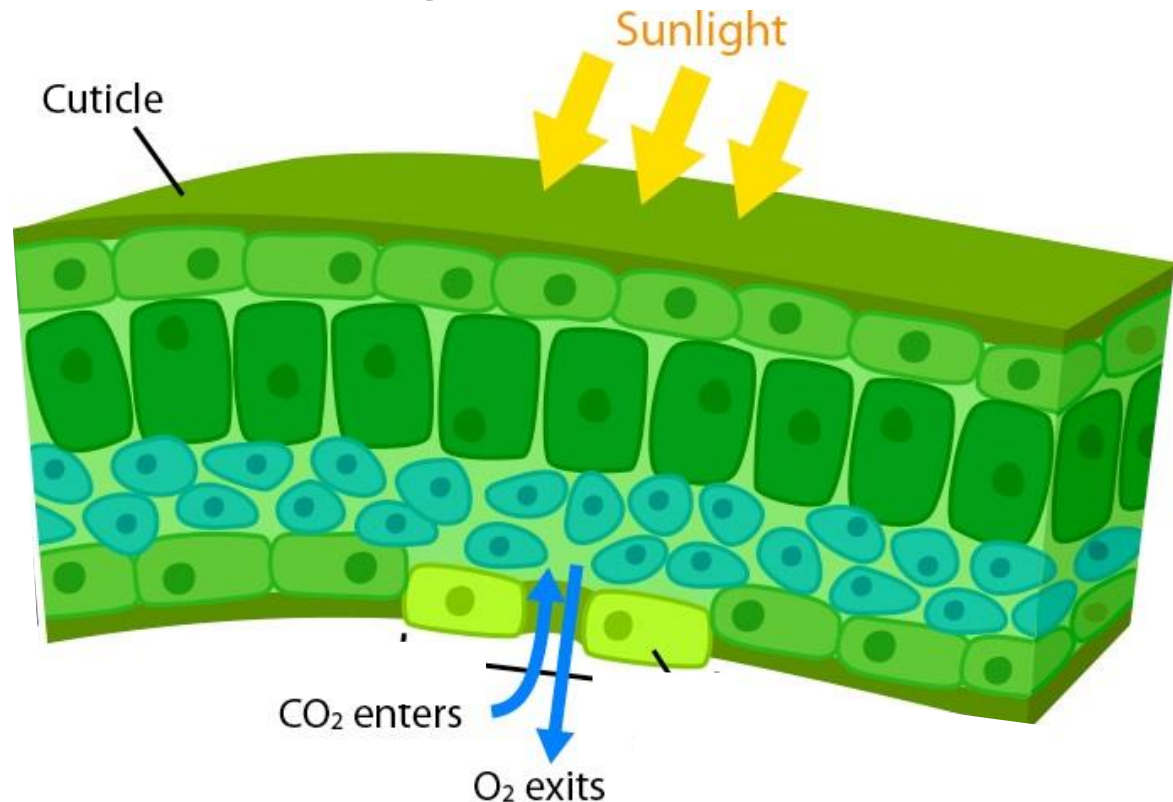
The leaf is attached by a stem to the plant which branch out into veins. The **large surface area** of the leaf helps capture as much sunlight as possible.

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.



**Cross-section of a leaf**

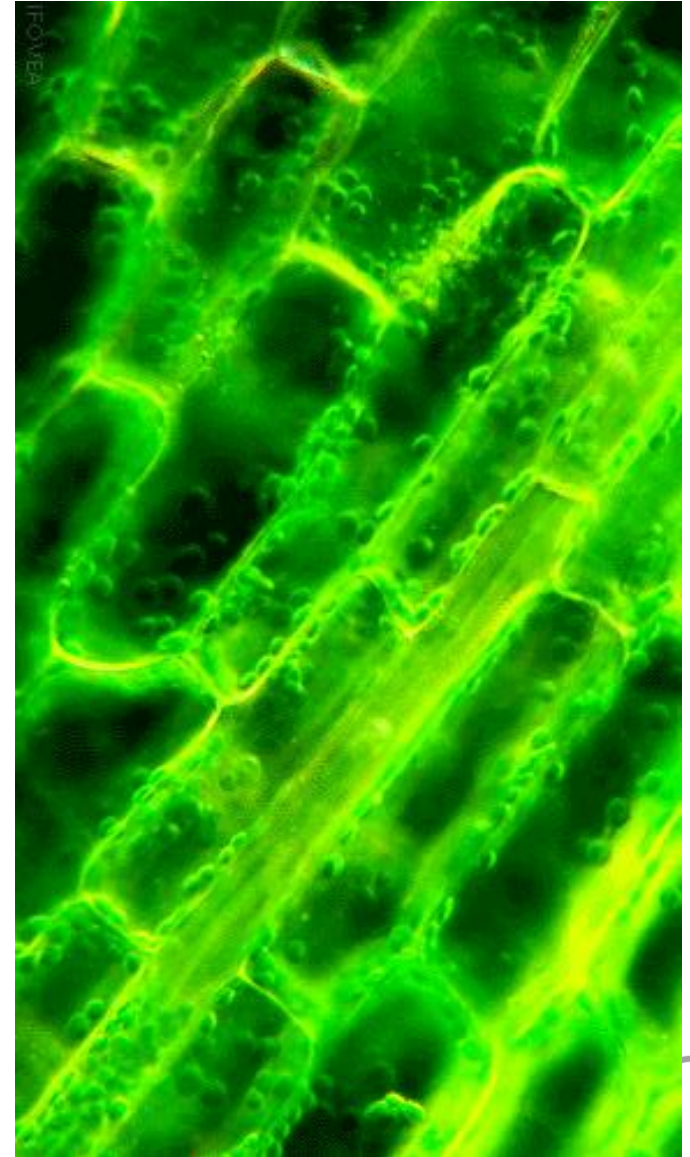
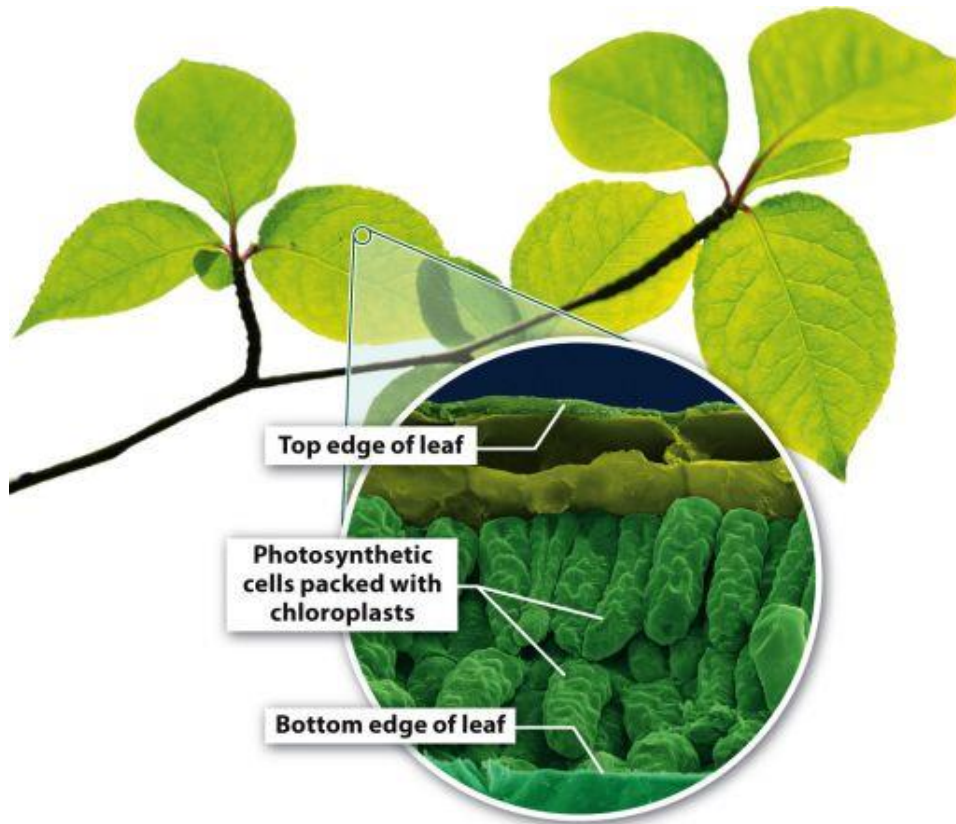


# Chloroplasts and Photosynthesis

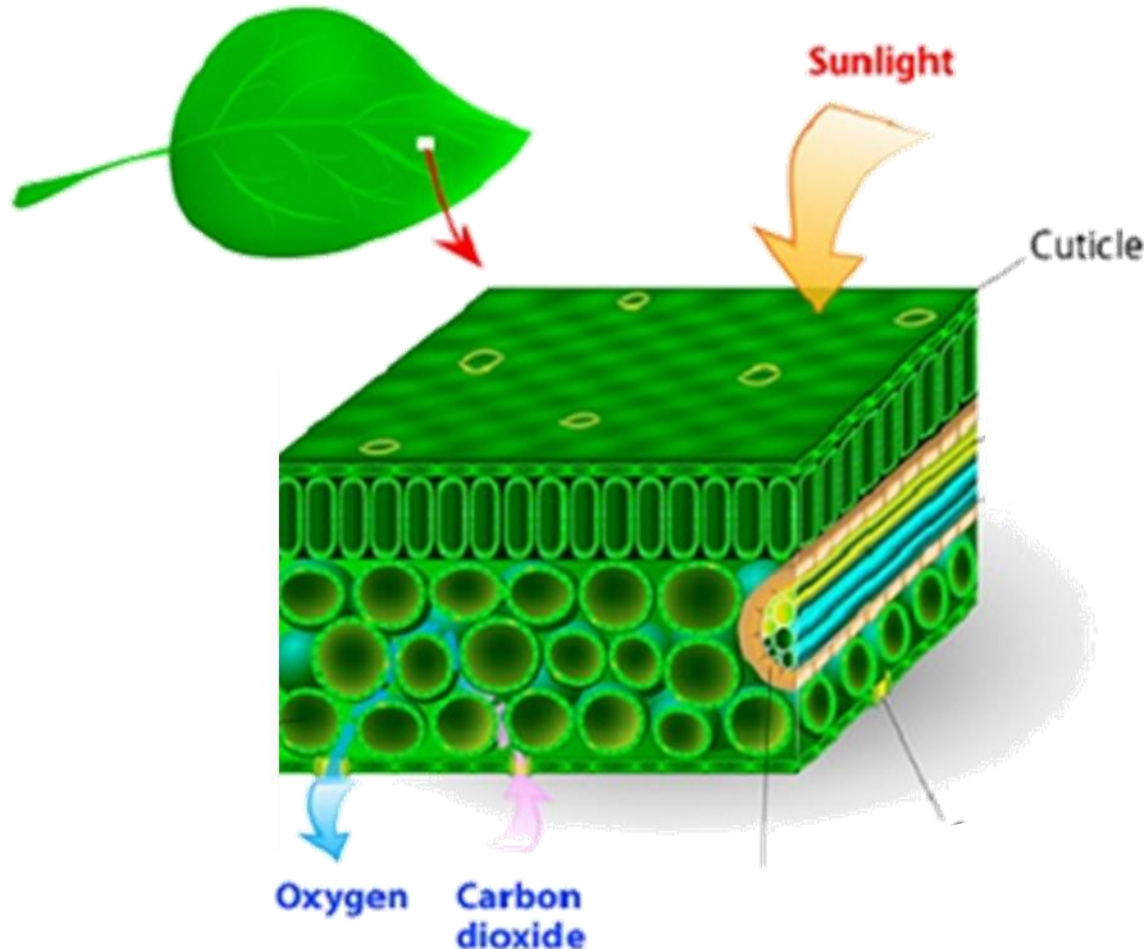
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The chloroplasts circulate around the cells, especially the layer of cells that are close to the top of the leaf. This allows maximum amounts of light to be distributed to the chloroplasts for photosynthesis to take place.



# 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.

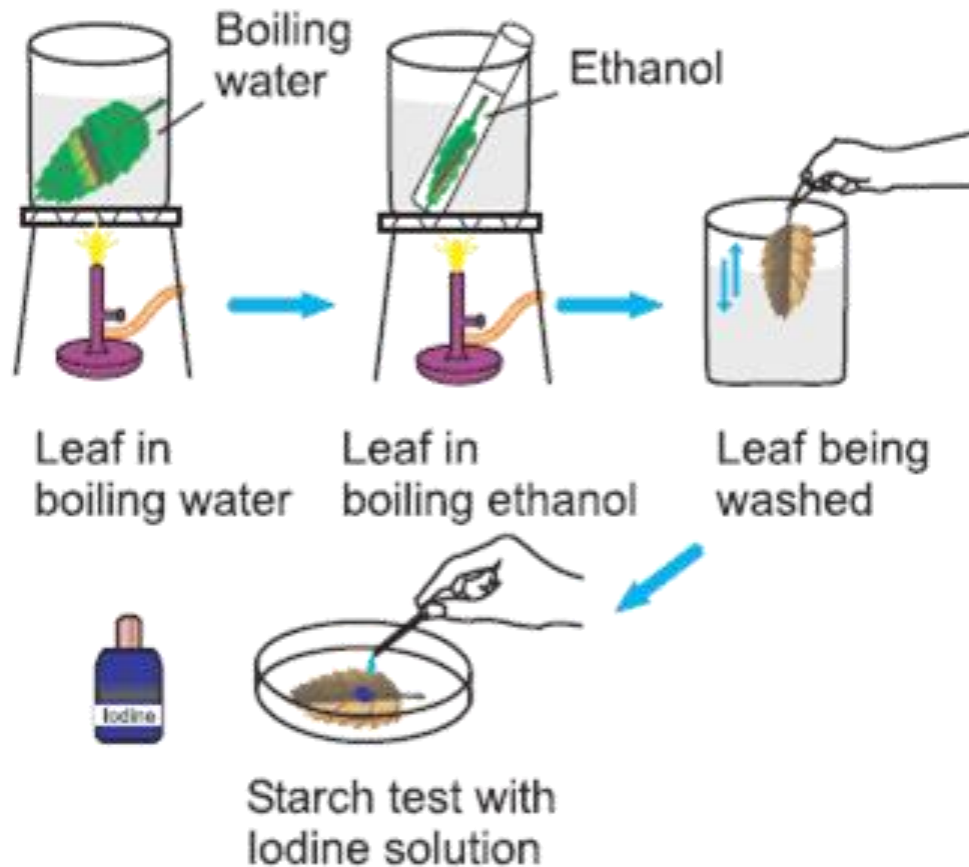
Openings (usually on the underside of the leaf) called **stomata** allow carbon dioxide to enter and diffuse into cells as well as allowing oxygen to move in and out.

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.

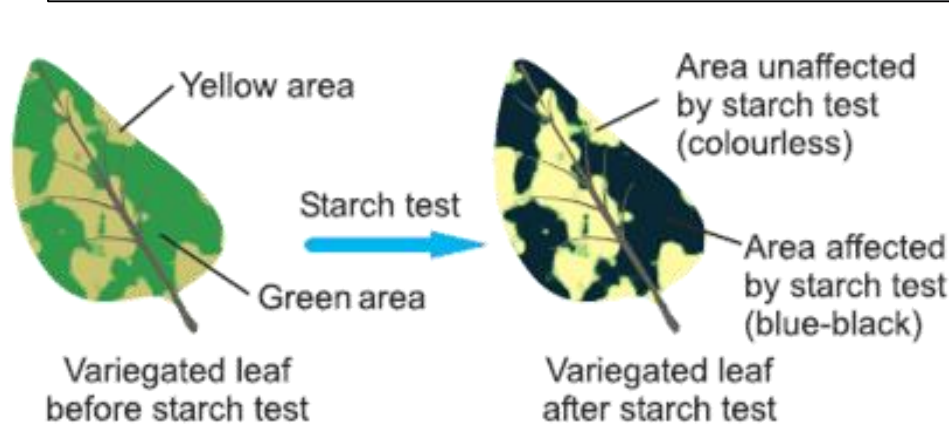
**Step 2.** The leaf is then placed into a boiling tube of ethanol, which is placed in a beaker of water and heated gently. This will remove the green chlorophyll.

**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.

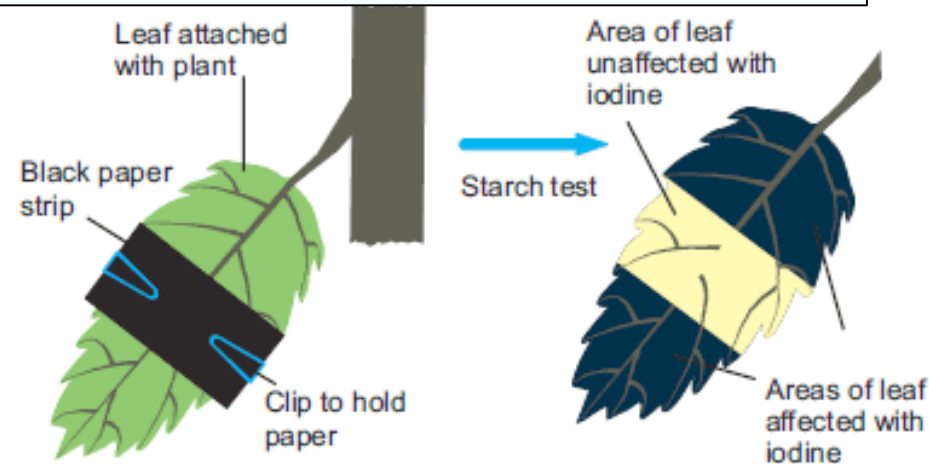
## Investigations into photosynthesis requirements

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**.



# Background Knowledge



## Water movement through a plant

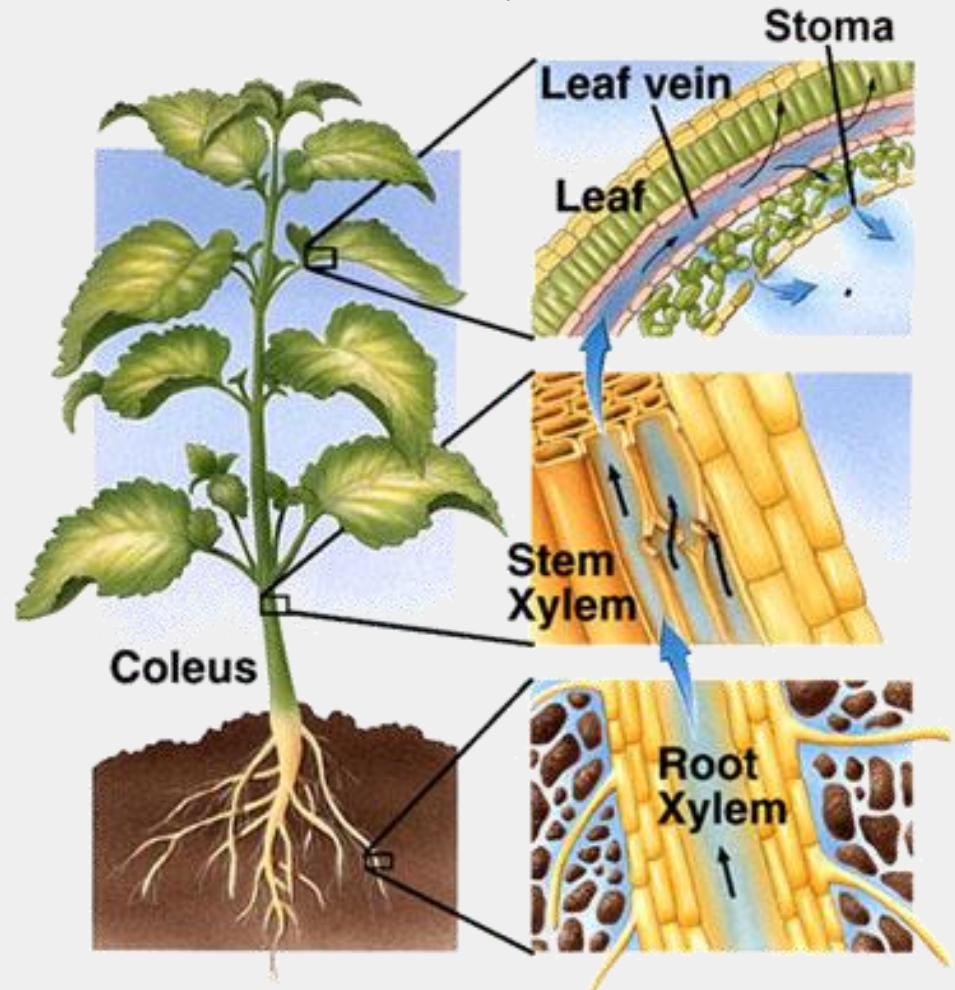


Water is required for photosynthesis and it moves through the plant in **one direction only**.

**Step three:** water moves out of the plant by transpiration through the stomata on the underside of the leaf

**Step two:** water moves up through the xylem by molecules “sticking” together and being pulled upwards

**Step one:** Water uptake by the process of osmosis into the root hairs

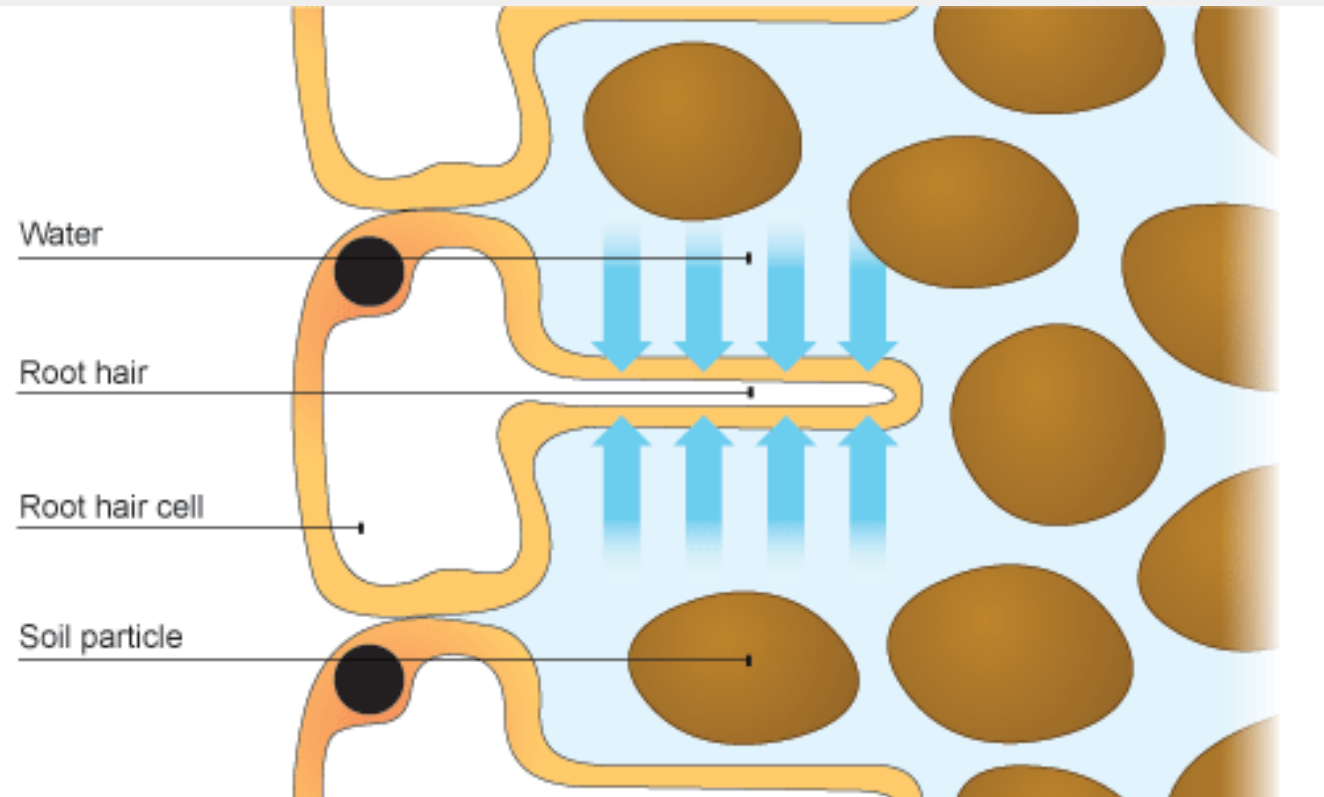


## Water movement - Plants take up water through root hairs



**STEP ONE:** Water moves into the plant through root hairs. Water being pulled up the plants water tubes (xylem) due to transpiration decreases the pressure inside the root hair cells and this reduced pressure pulls water in.

**Transpiration** – water loss through the leaf stomata (holes in the leaf) due to evaporation





## Background Knowledge

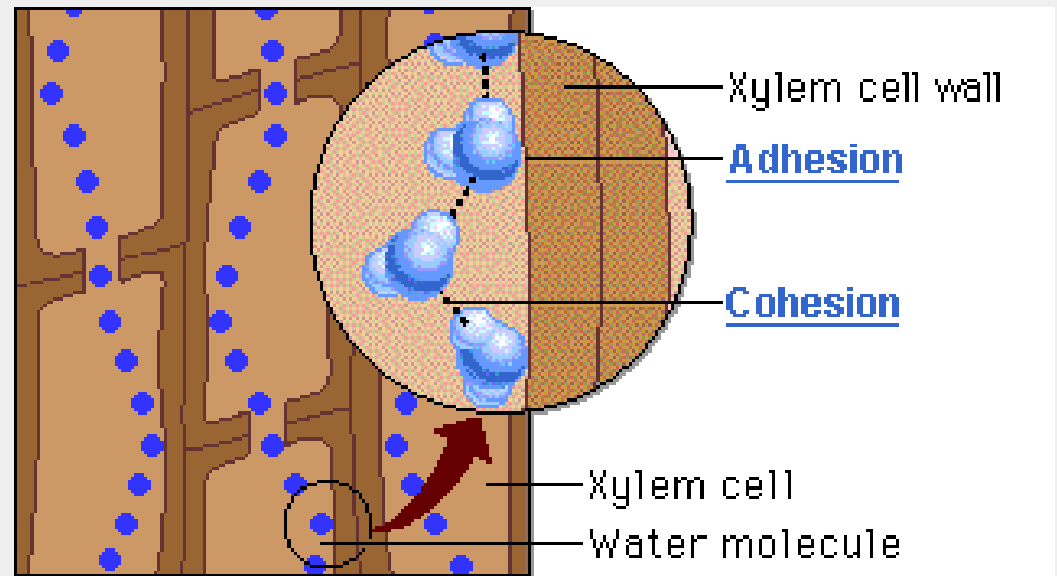
**The xylem transports water and the phloem transports the products of photosynthesis**



**STEP TWO:** Water is pulled up the xylem as each water particle sticks to each other. The xylem is probably the longest part of the pathway that water takes on its way to the leaves of a plant. Transpiration of water in the leaf pulls the water up.



Xylem cells have cell walls containing cellulose and lignin making them extremely strong. Xylem cells contain no membranes and are considered dead. These cells overlap to create a series of pathways that water can take as it heads to the leaves.



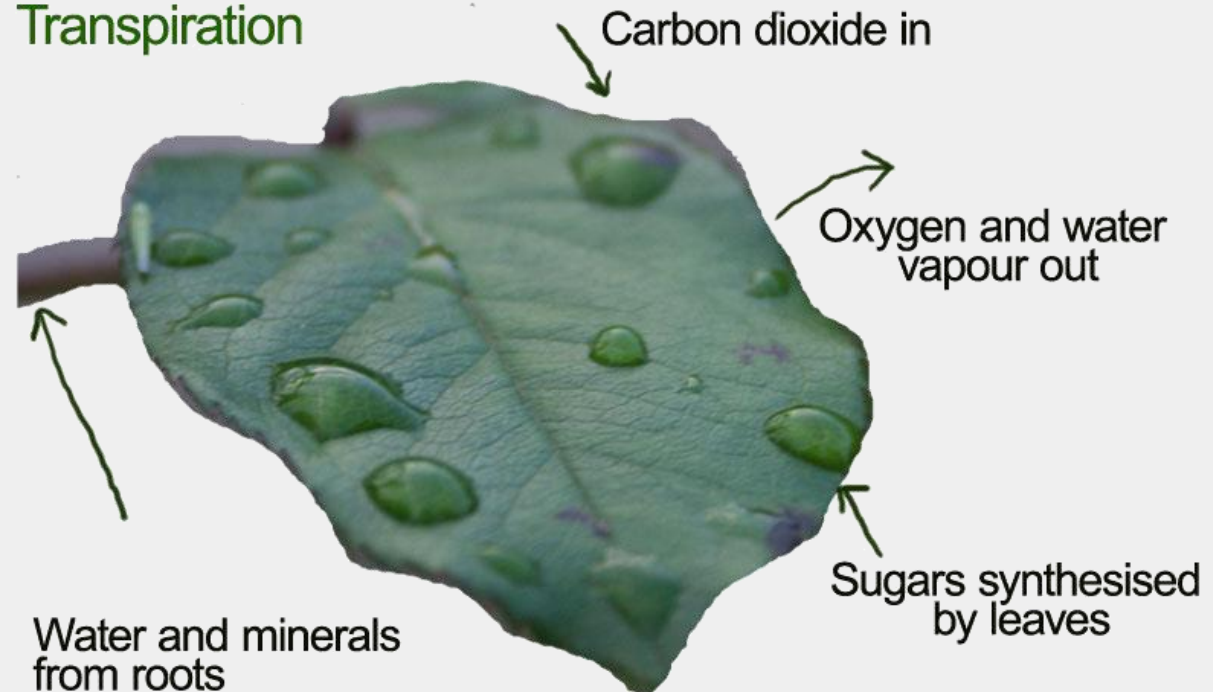
## The process of transpiration



**STEP THREE:** Transpiration is the process where plants lose water from their leaves.

Water enters a plant through root hairs. When stomata, on the underside of leaves, are open during photosynthesis to allow  $\text{CO}_2$  to diffuse in and  $\text{O}_2$  to diffuse out, water vapour evaporates and diffuses out.

### Transpiration



## Flowering Plants

Plants that produce flowers are known as **Flowering Plants** (angiosperms).

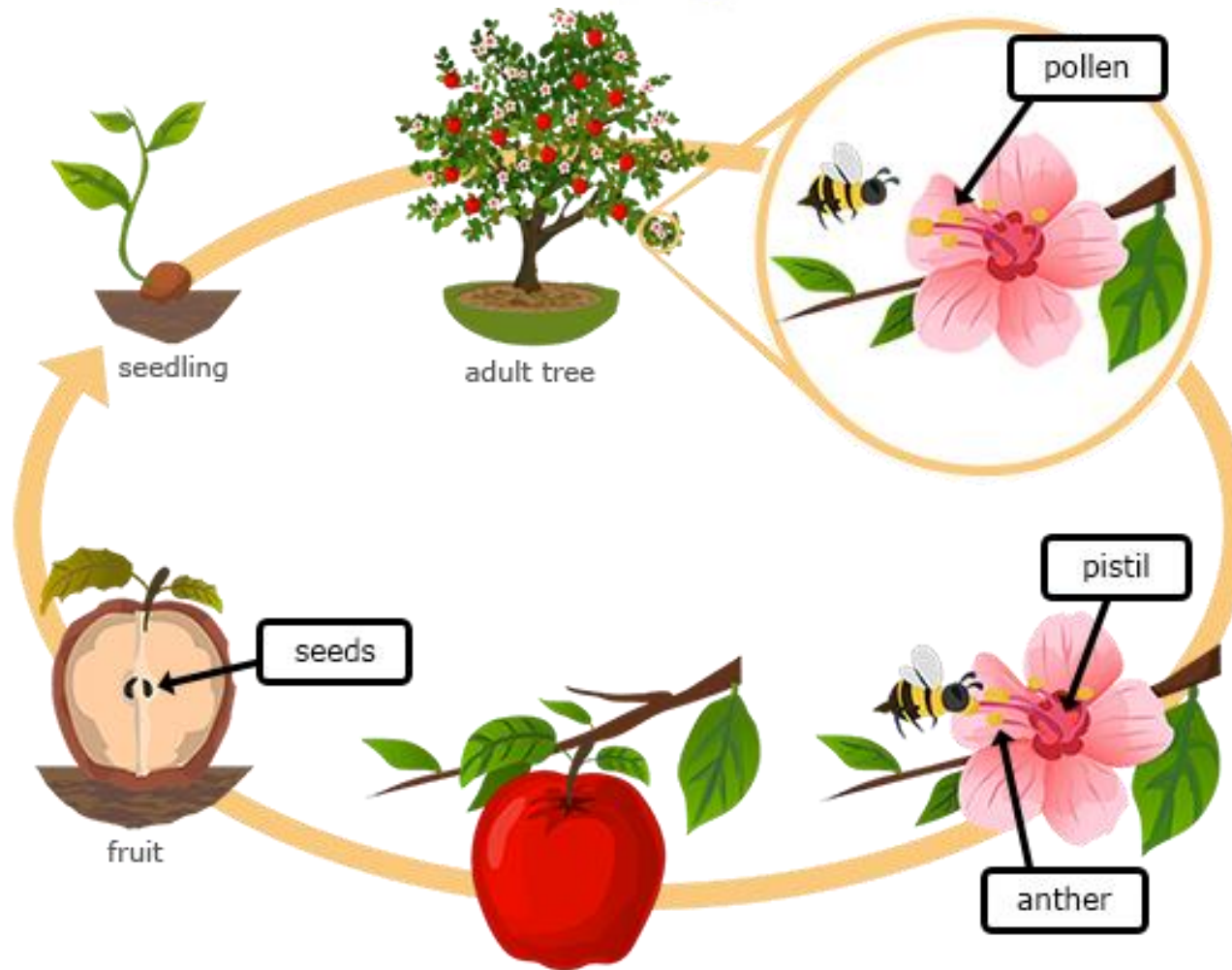
The flowers are the **reproductive structures** where fertilisation occurs and seeds are produced.

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.



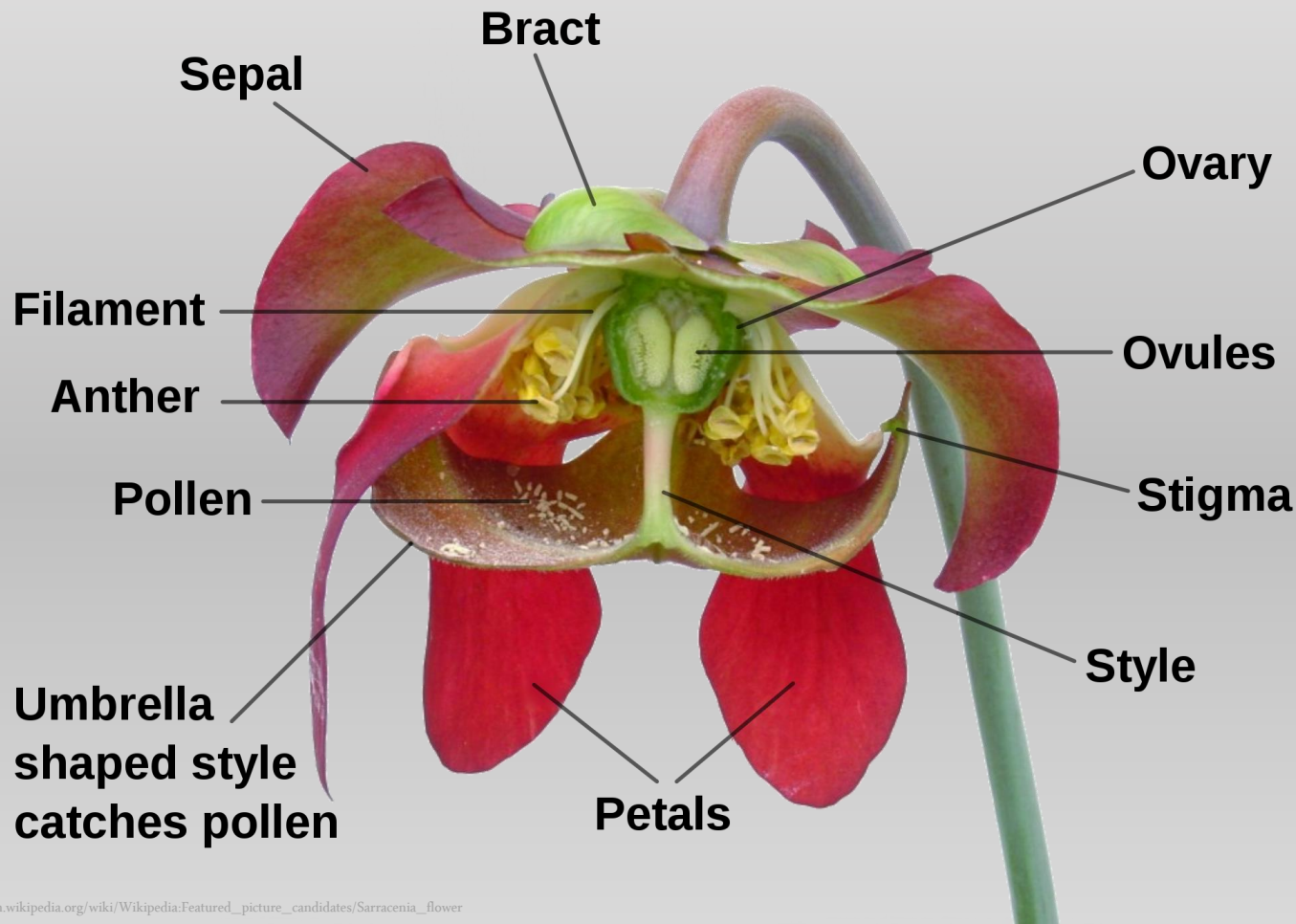
# Flowering Plant life cycle



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**)

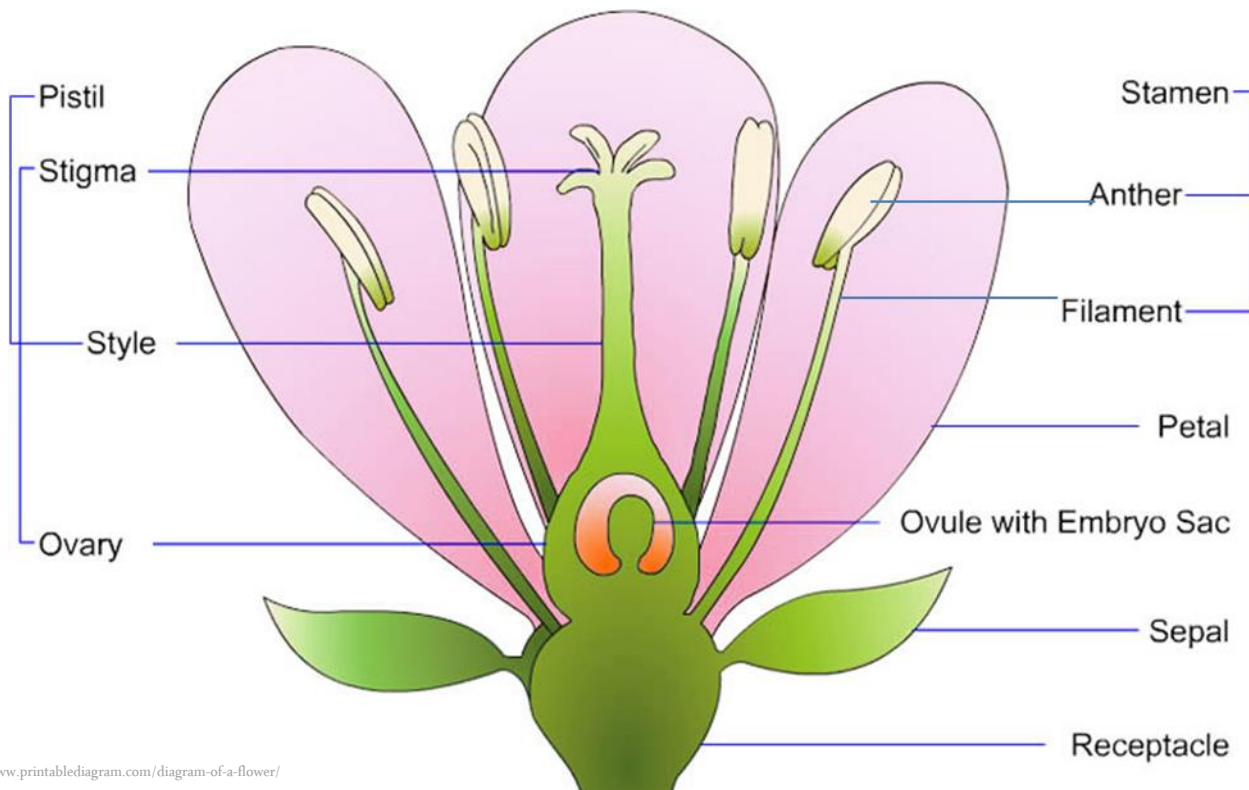
## The structure of a flower



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 below 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



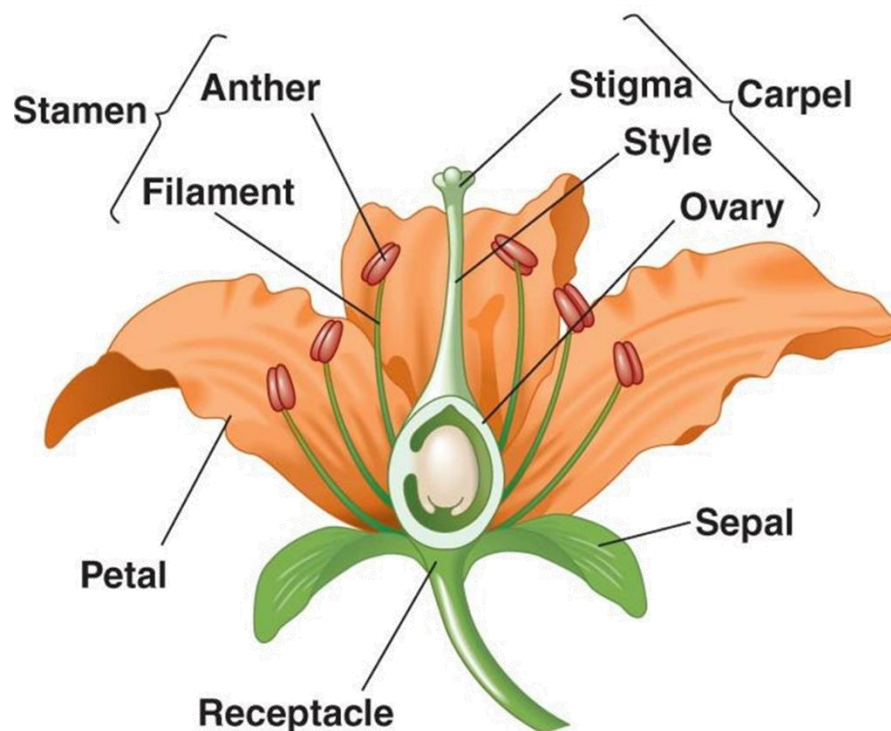
## The reproductive parts of an insect-pollinated flower

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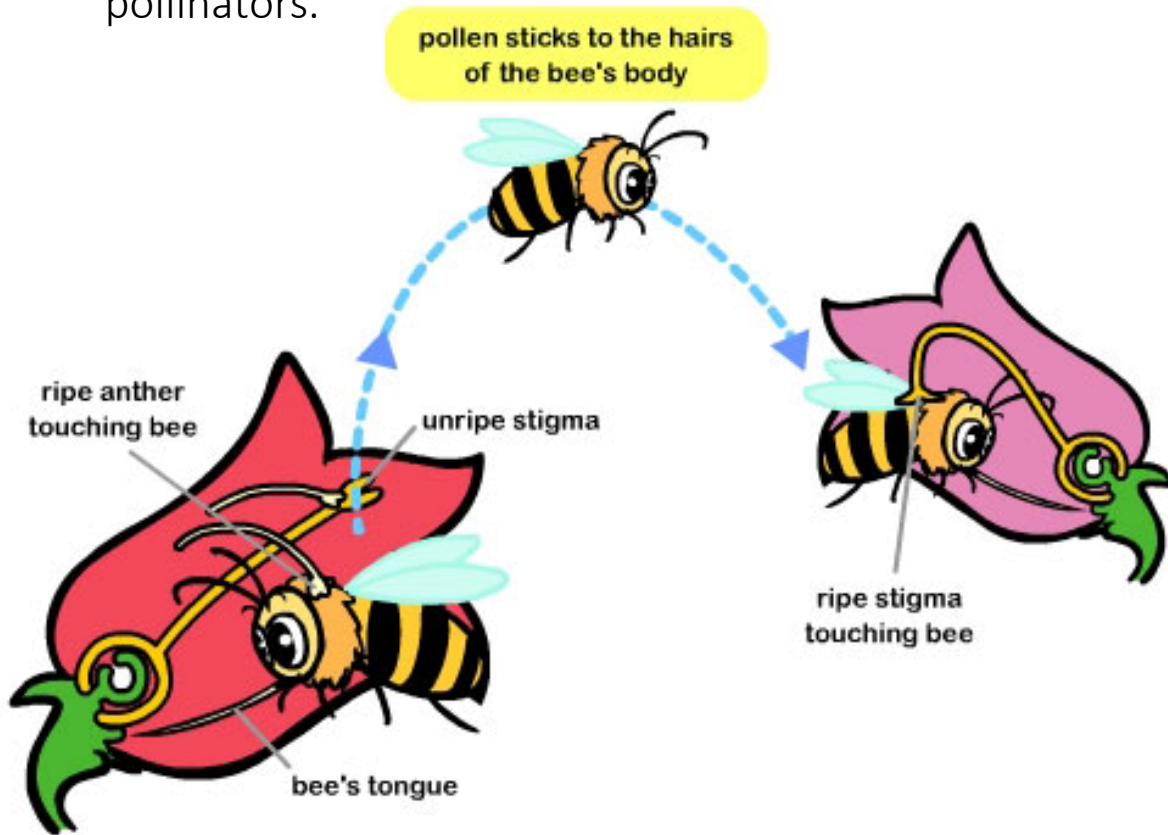
The male part of a flower is called the **stamen**. The pollen is produced in the **anther** which is held up by the **filament**. The pollen is collected by a pollinator. (or spread by wind) The pollen contains male sex cells (**gametes**) which will later join with the female gametes in the ovule during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



The female part 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.



[www.sciencewithme.com](http://www.sciencewithme.com)

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**.

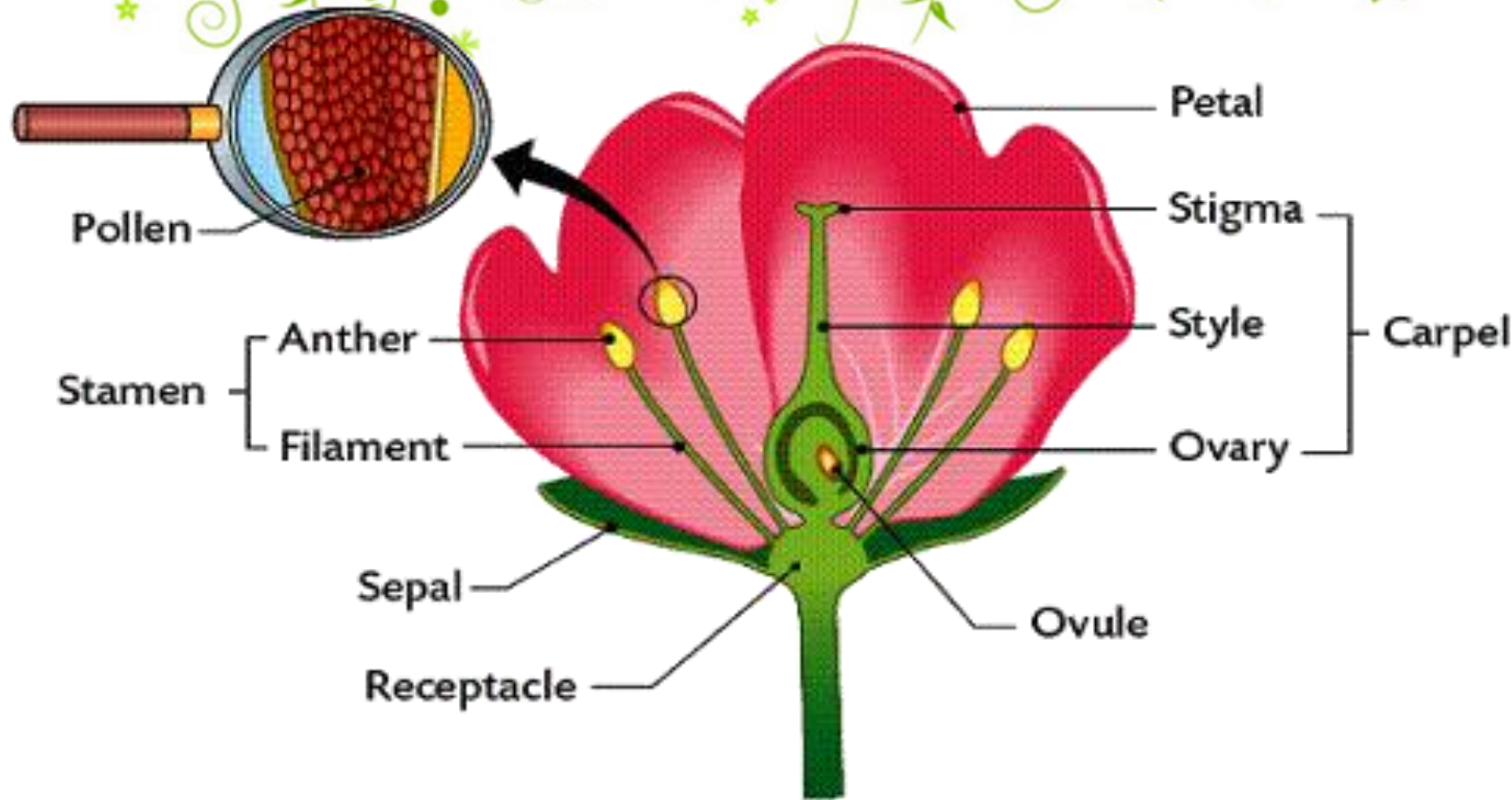
## Summary of pollination in plants

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



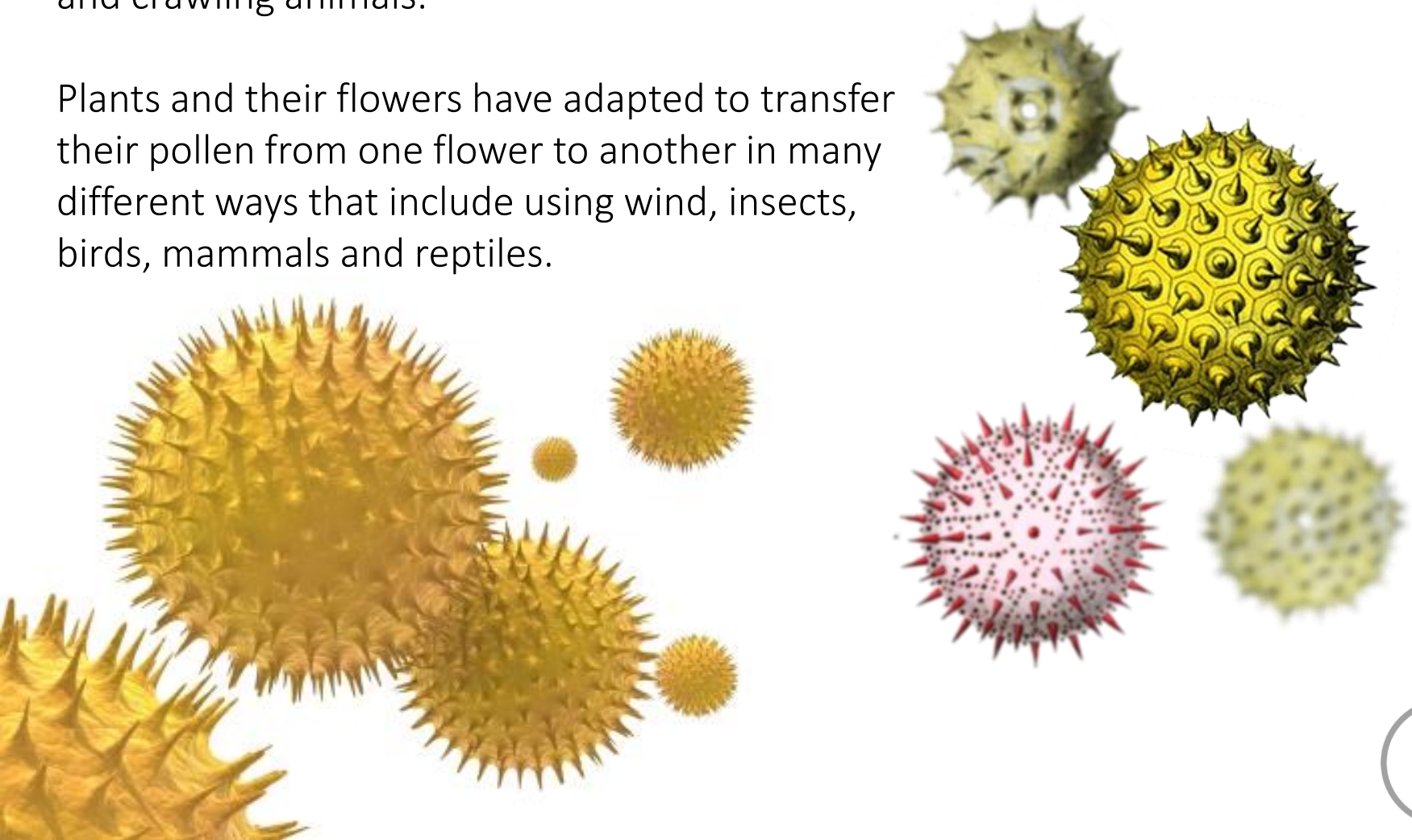
The pollen must be light enough to either be moved by wind or be attached to a pollinator and still enable it to fly.

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.

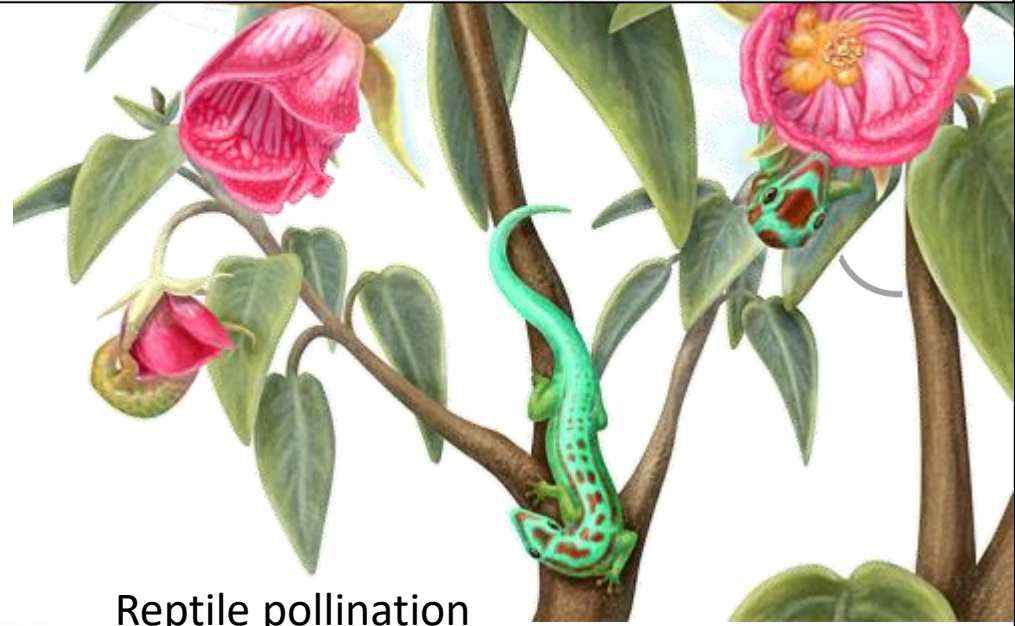




## Different types of pollination methods



Insect  
pollination



Reptile pollination



wind pollination



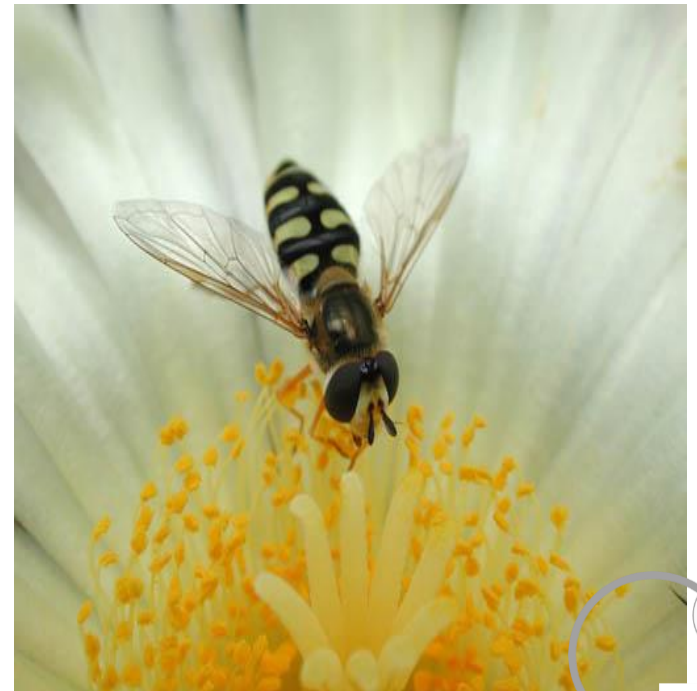
mammal  
pollination



Bird pollination



## Examples of insect-pollinated flowers

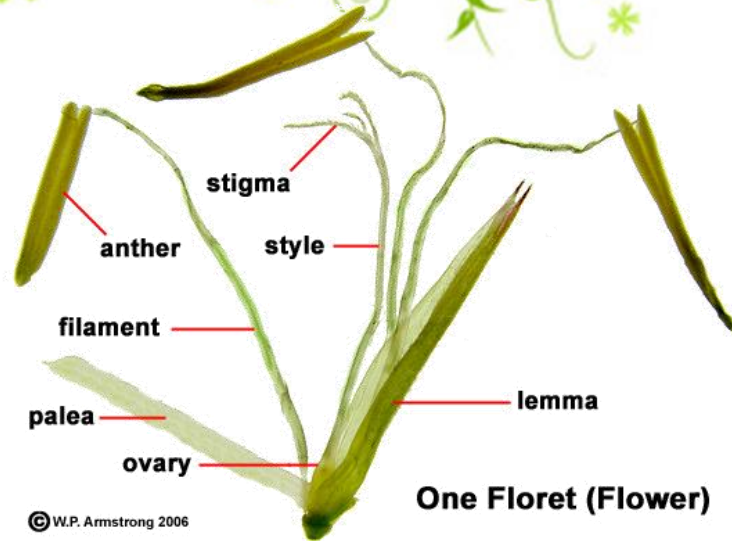




## Examples of wind-pollinated flowers



## 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.

**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 background of the slide features a close-up photograph of pink flowers, likely cherry blossoms, with delicate petals and dark stems. The flowers are in various stages of bloom, some fully open and others as buds. The lighting is soft, highlighting the texture of the petals.

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

## Summary

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

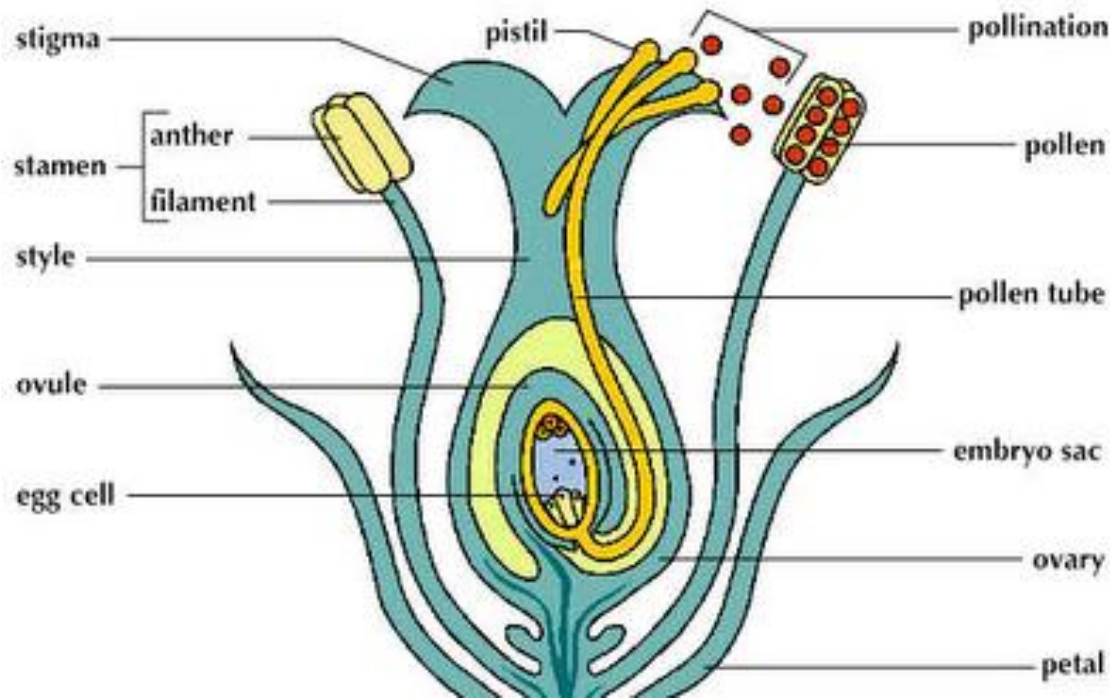
Some New Zealand plants, such as NZ Flax, pūriri and kōwhai use the tūi as a pollinator. Both the plants and tūi have evolved together to the advantage of both and have adaptations to help their survival. The tūi is a nectar eating bird and the flowers of these plants produce nutritious nectar to attract the tūi, 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 tūi's bill are a good match.



To deliver the correct pollen to the correct species, when the tūi feeds from a particular flower species the anther of each flower species deposits pollen on a **specific area** of the tūi'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 tūi 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 flower's 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)



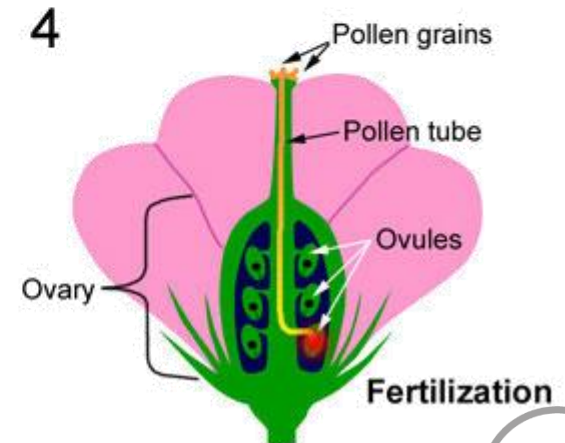
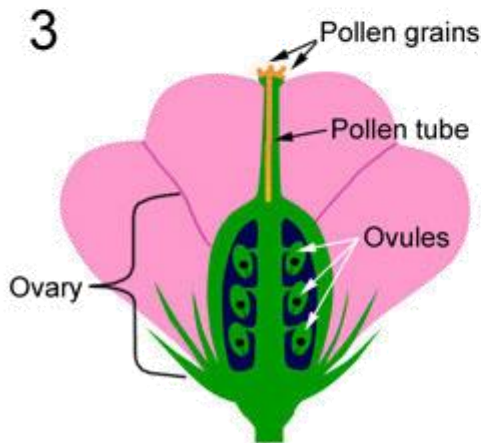
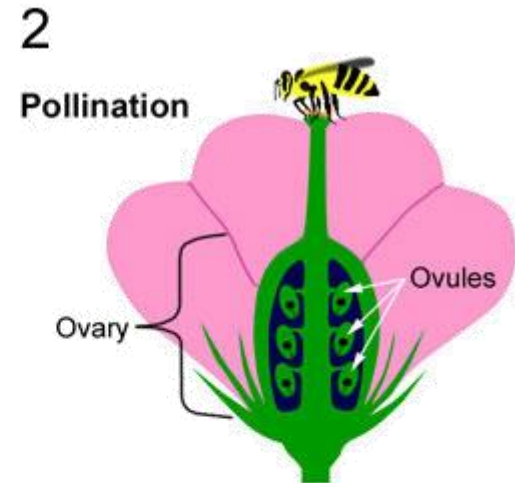
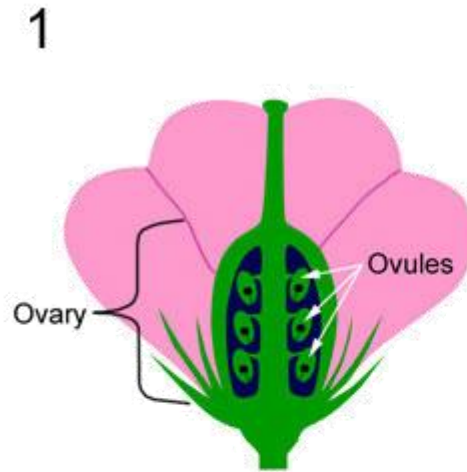


# The differences between pollination and fertilisation in flowering plants

**Pollination** just refers to pollen landing on the female stigma of the plant. This can either be with 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

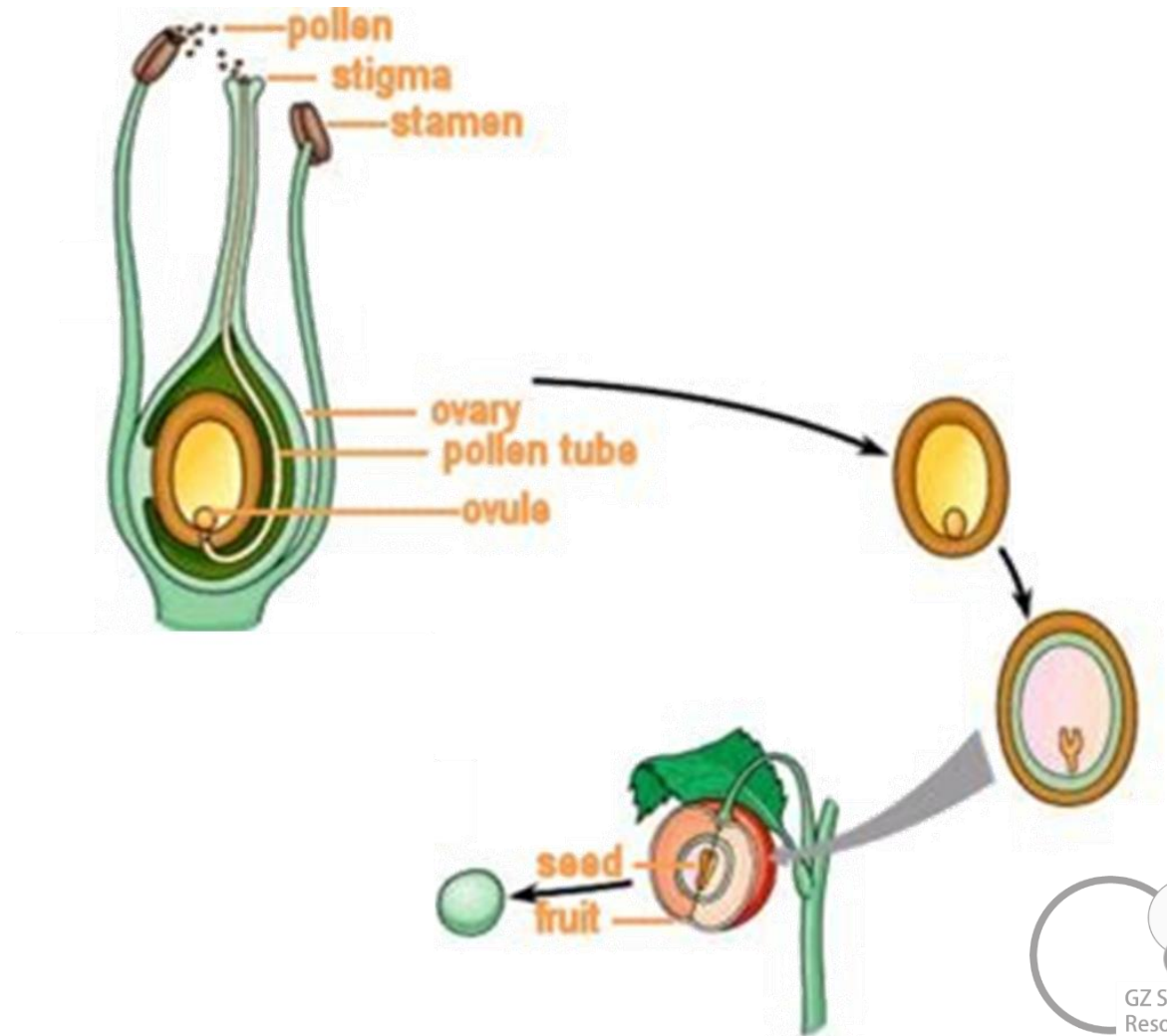
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Once the flower has been fertilised by pollen the **ovary** grows to form the **fruit**. The **ovules** become the **seeds**.

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.

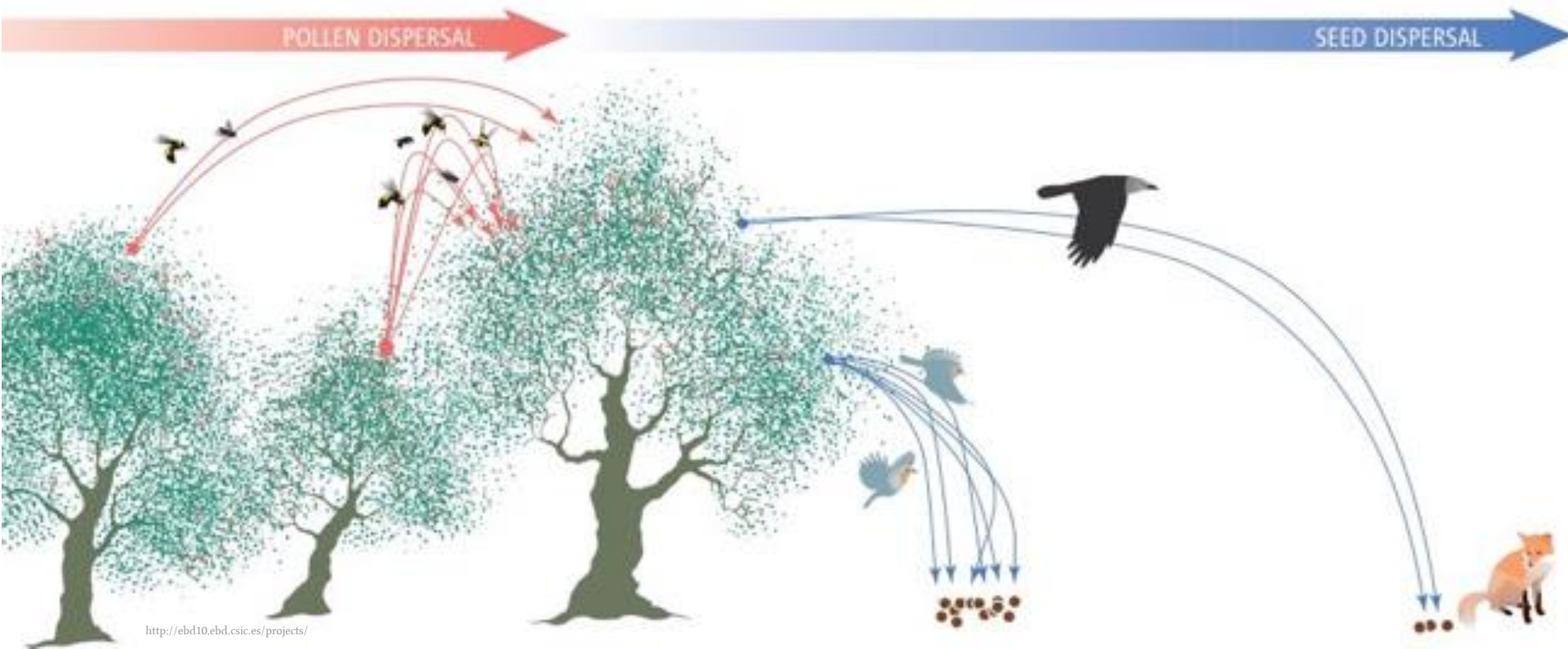
The petals, sepals and other parts of the flower start to die and fall off.



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# 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 dispersal

How are seeds dispersed?

By animals

By the wind

Self dispersal

hitch hikers  
e.g. cleavers

winged seeds  
e.g. sycamore

takeaways  
e.g. acorns

parachutes  
e.g. dandelion

pepperpots  
e.g. poppy

juicy fruits  
e.g. blackberries

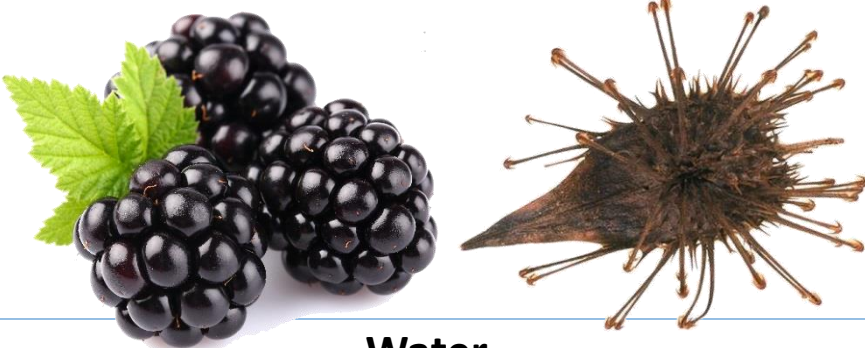
exploders  
e.g. Himalyan balsam

# Seed structure is linked to Seed dispersal



## Animals

These fall into two main groups: fruits to attract animals to eat them or seed pods that are sticky or have hooks to attached to animals coats and be carried away



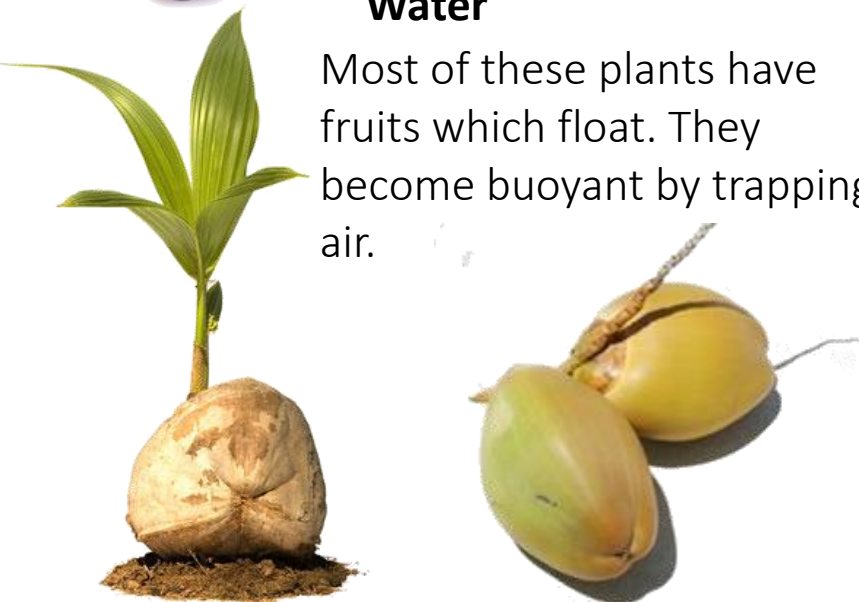
## Wind

Most of these seeds are light and either have wings or plumes



## Water

Most of these plants have fruits which float. They become buoyant by trapping air.



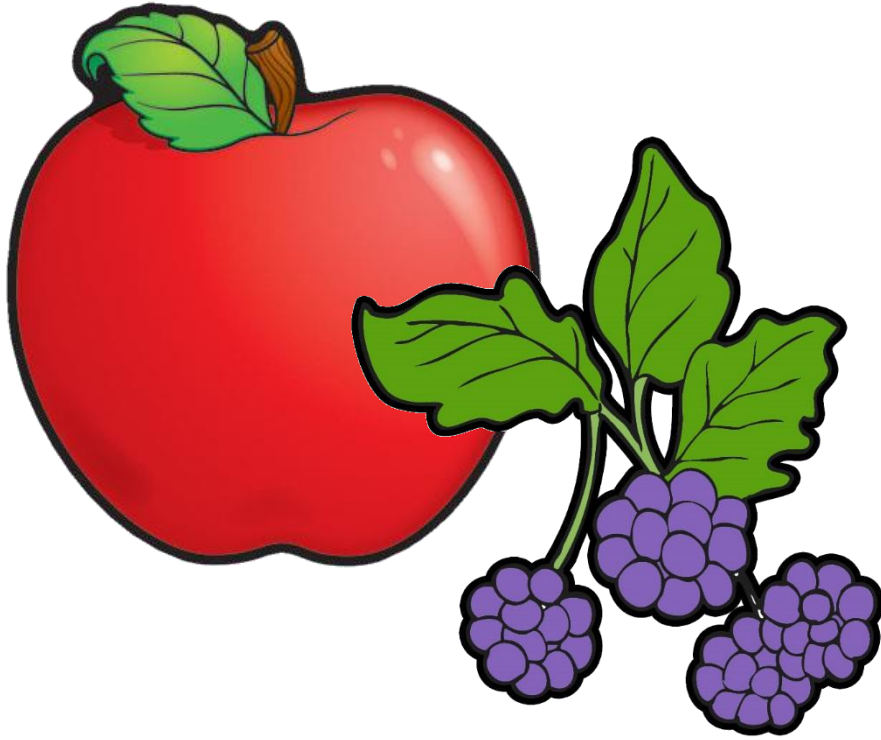
## Expulsion

Fruits explode or burst and seeds are flicked away



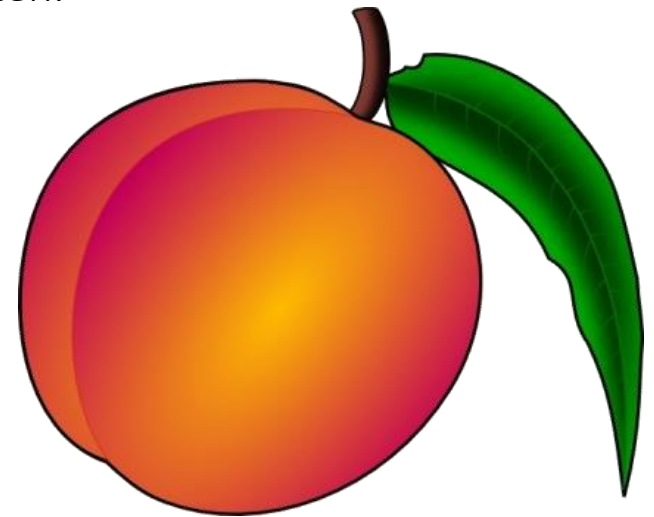
## Types of fruit

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extra  
info



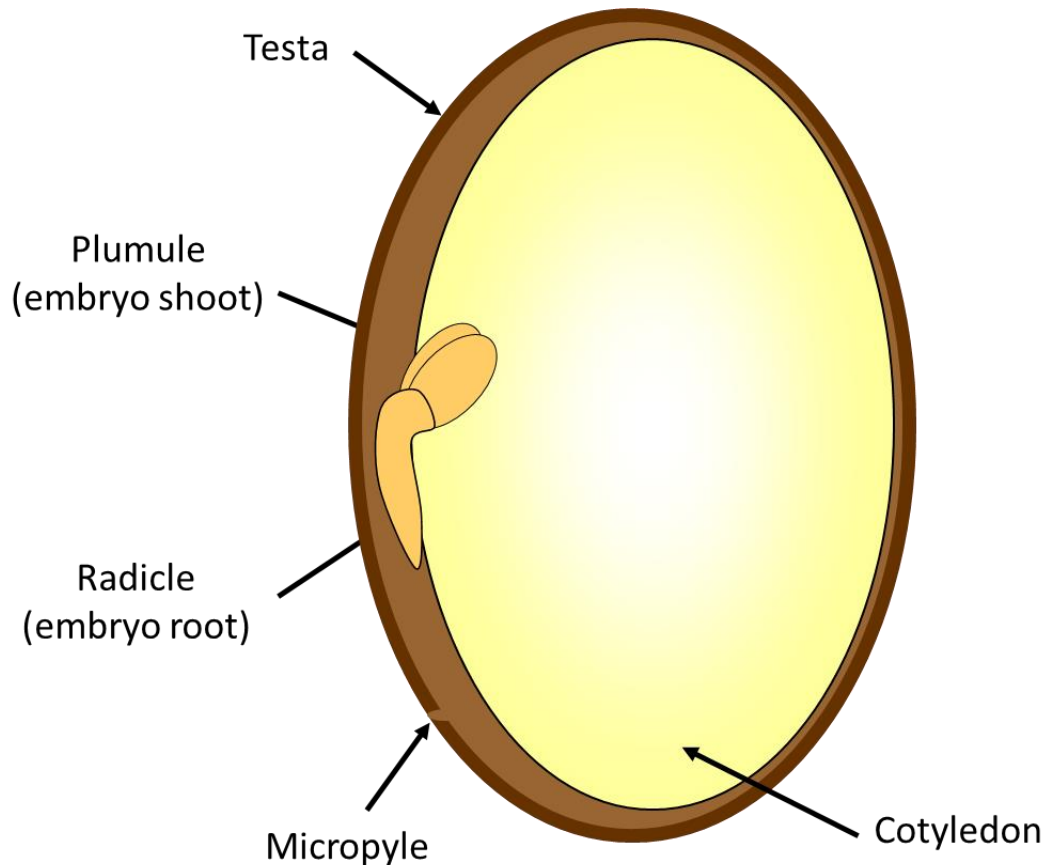
Fleshy fruits contain numerous small seeds either on the inside like the apple or on the outside like berries. The seeds normally go through the animal when eating and are dropped out after the animal has moved away from the tree.

Like most fruit the colour, smell or size of the fruit attracts animals. Fruit like the peach with one hard inner seed are known as stone fruit. The fruit is usually carried off by the animal and eaten with the large stone in the middle dropped somewhere once all the sugary fruit is eaten.





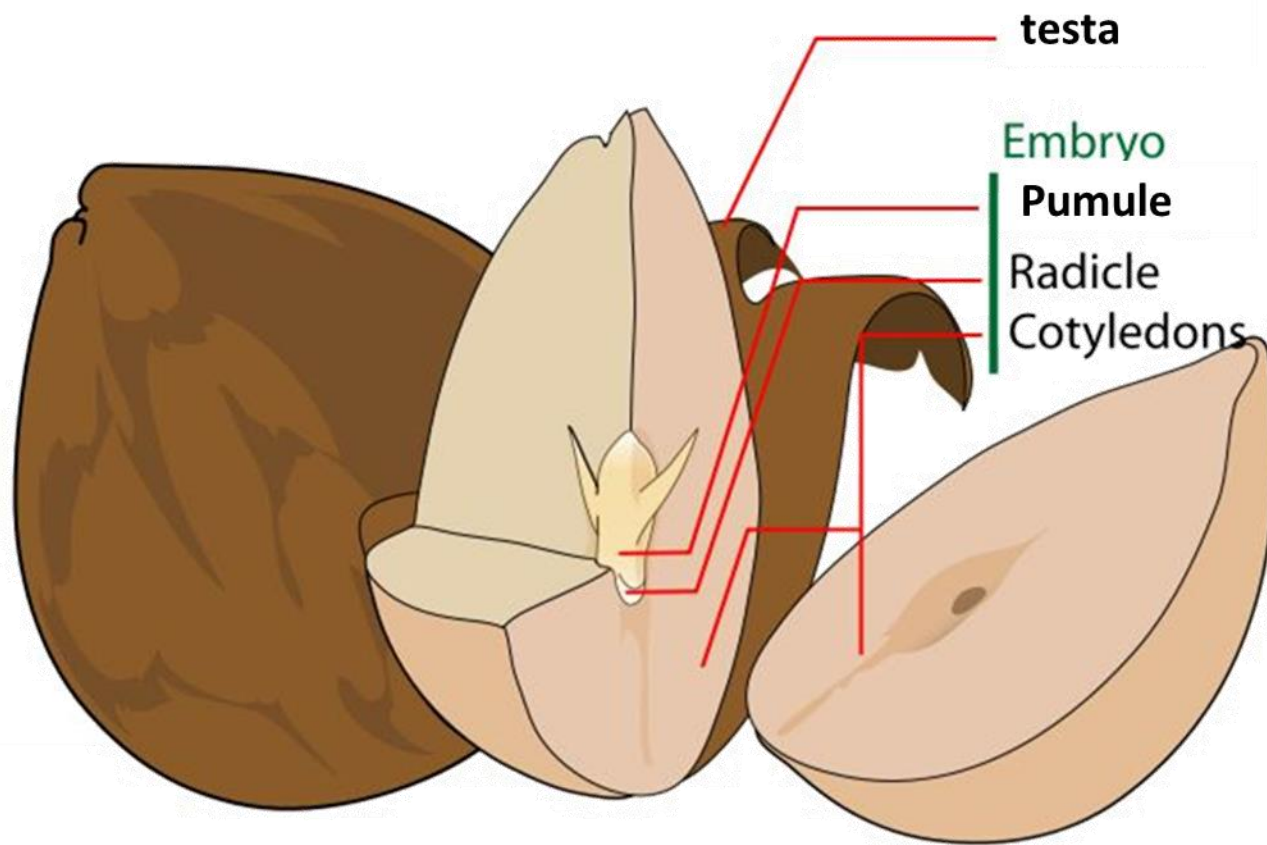
## The Structure of seeds



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 embryo plant is made up of the plumule and radicle and cotyledons contain the starch/food stores.

Water enters the seed through the micropyle and starts the seed germinating. The water also softens the testa to allow it to split.

## The functions of parts of a seed



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)

**W**ater

**O**xygen

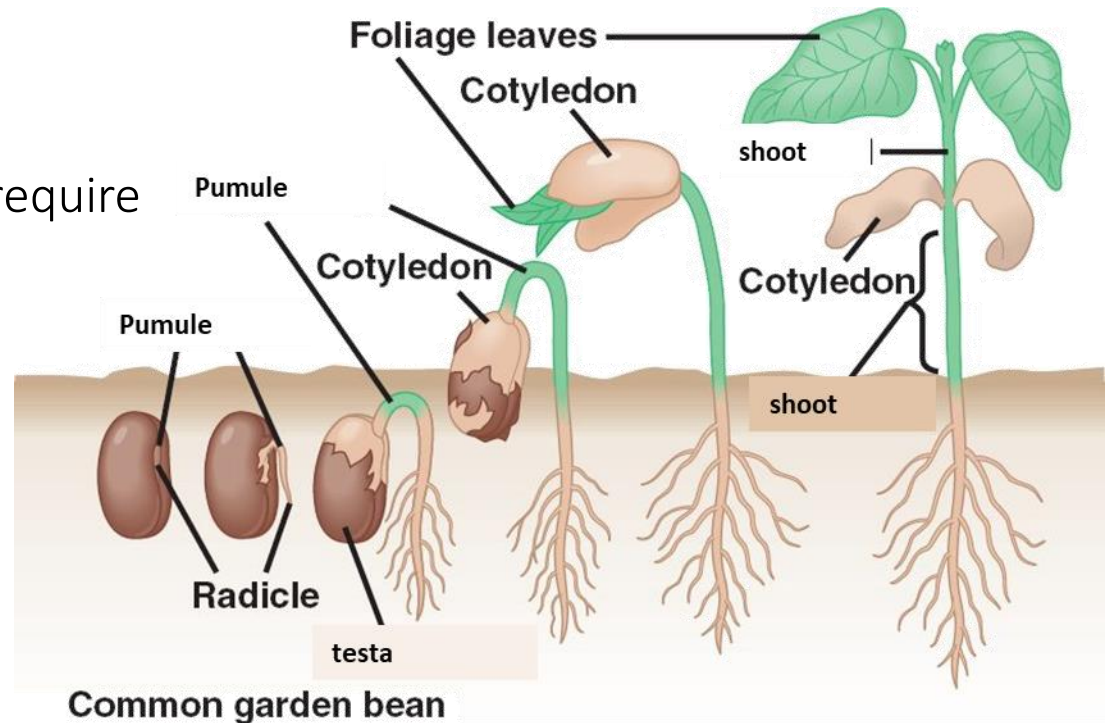
**W**armth

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





## The conditions needed for germination of seeds

Whilst germinating the plant uses food stores in the cotyledon to provide energy for growth

The seedling can now photosynthesise and make its own food

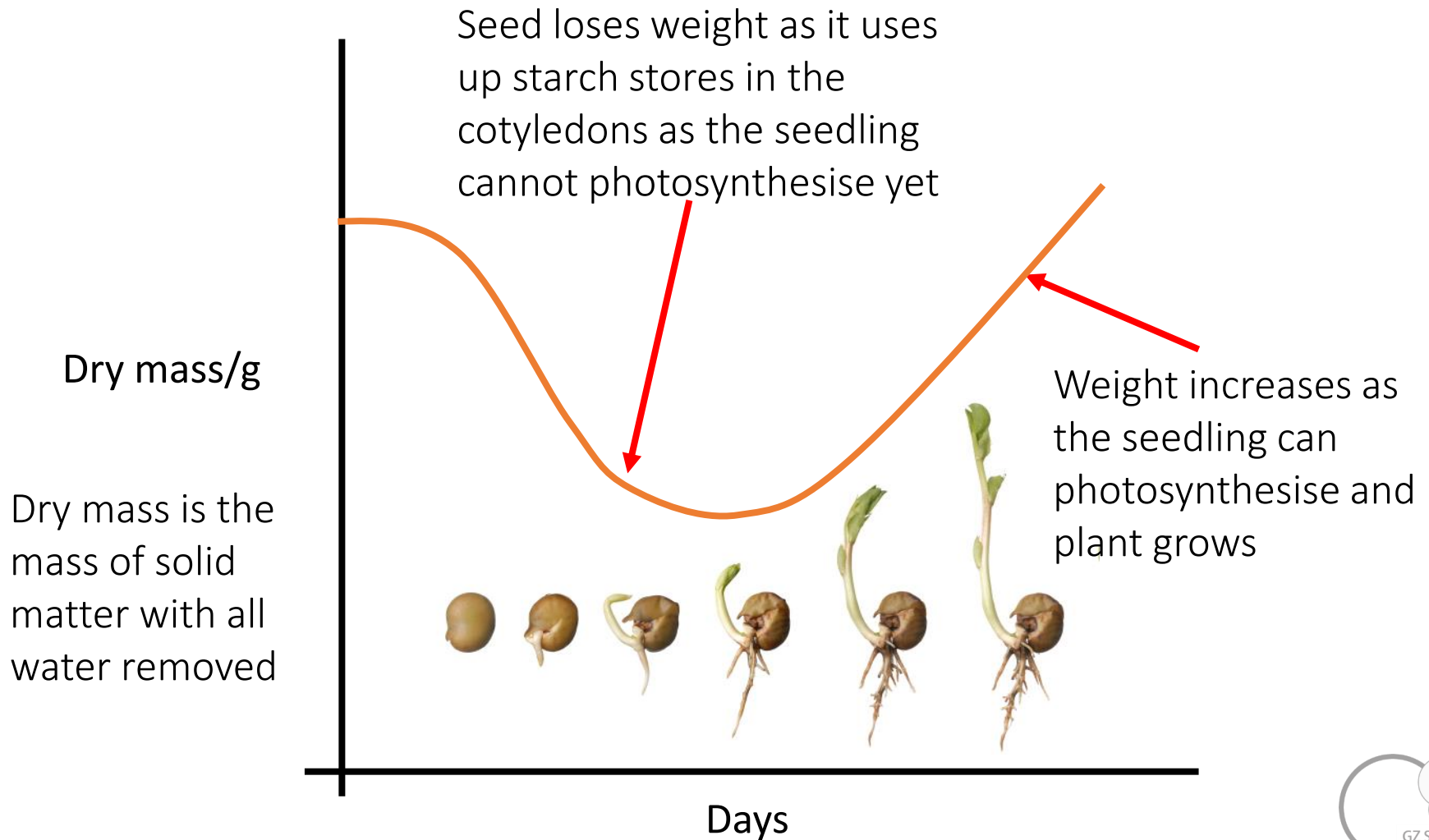


germination

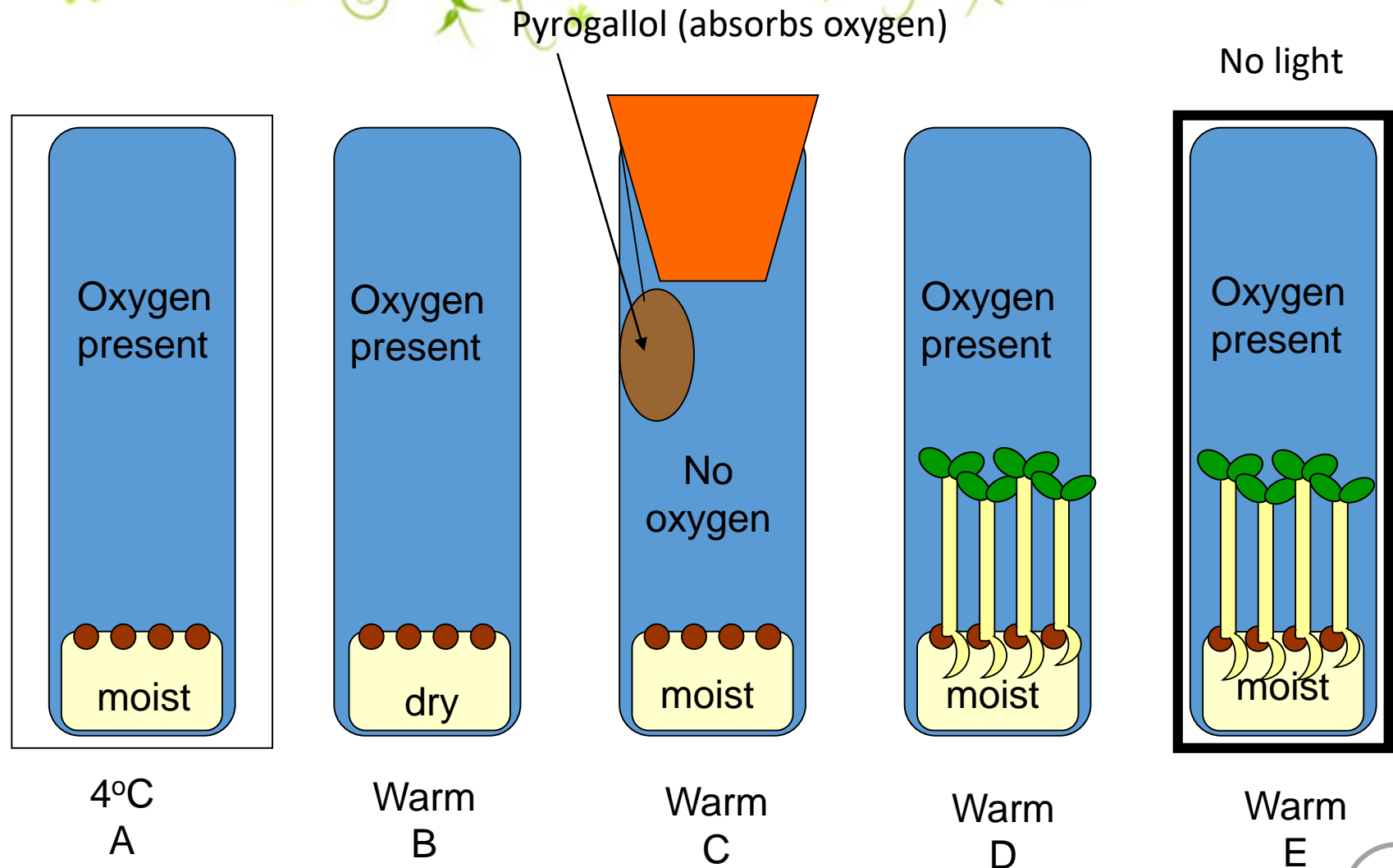


Plant growth and development

# The conditions needed for germination of seeds



# Germination Investigation





## 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.



## Māori scientific knowledge and understanding of their use of plants - Rata



The rātā tree bark can be made into a lotion or poultice, and the flower nectar can be used for sore throats.



White and Red Rata from Maungatautari



## Māori scientific knowledge and understanding of their use of plants - Kawakawa

Kawakawa can be made into a tea, poultice or chewed for tooth ache, sore stomach, and pains




[Te Ara - The Encyclopedia of New Zealand](#)

Photograph by Emily Tutaki



Kawakawa from Maungatautari



The background of the entire image is a close-up, slightly blurred photograph of several long, green flax leaves. The leaves are oriented diagonally from the top-left towards the bottom-right, creating a strong sense of movement and texture. The lighting is natural, highlighting the veins and edges of the leaves.

The root can be boiled and then smeared it on as an ointment.

The flax root and leaf can be used for boils, bruises and bleeding, burns, toothache, worms, indigestion, measles.

Harakeke also has many uses as kete (baskets) and food carriers. The tough fibre in the plant can be used for fishing nets and traps, footwear, cords and ropes.

Various types (cultivars) of flax were seen as having specific uses by different iwi. 'Māeneene' - Ngāi Tūhoe - fine patterned mats. Ngāti Porou - 'Tākirikau' - piupiu (kilts). 'Kōhunga' - Ngāti Maniapoto - finest cloaks.