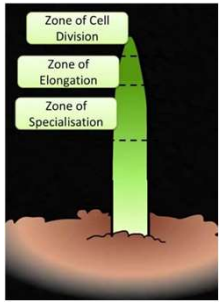
Synergy Science Knowledge Organiser
6 Plants and Photosynthesis

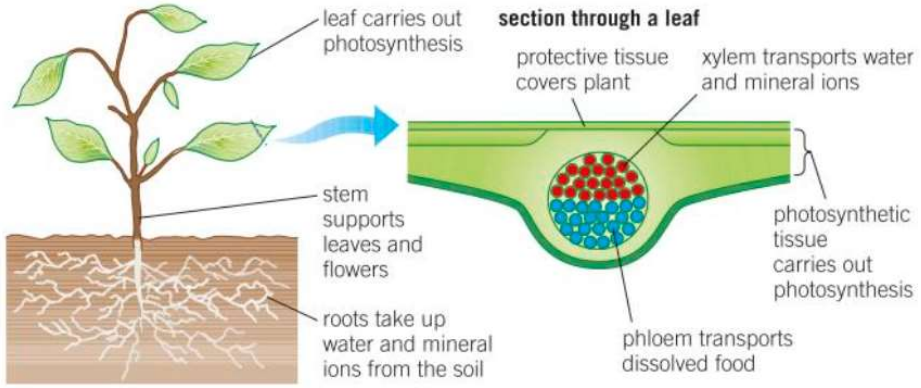
Meristem

- Meristem tissue contains the cells in a plant that divide as the plant grows. This type of tissue is found at the growing tips of shoots and roots. The cells differentiate into different types of plant cells depending on where they are in the plant.



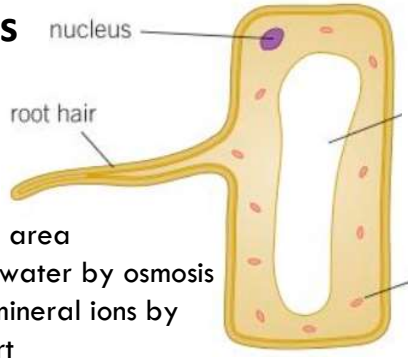
Structures

- Plants need specialised structures for transporting and exchanging materials. The roots, stem and leaves form a plant organ system for transport of substances around the plant.



- Within each plant organ there are collections of different tissues working together to perform specific functions for the organism
- Plants take in carbon dioxide from the atmosphere for photosynthesis and oxygen for respiration. Plants take in water from the soil with dissolved ions including nitrate ions to make proteins and magnesium ions to make chlorophyll.

Root Hair Cells

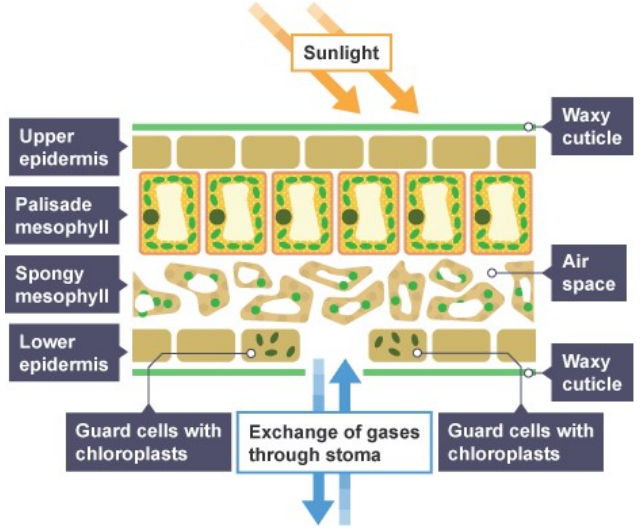


- Larger surface area
- Absorbs more water by osmosis
- Absorb more mineral ions by active transport

Large permanent vacuole to speed up the movement of water across the cell

Many mitochondria to transfer energy for active transport

Leaf



Waxy cuticle	Transparent to let light through Prevents water loss by evaporation
Palisade mesophyll	Closely packed Contain many chloroplasts to absorb light for photosynthesis
Spongy mesophyll	Air spaces to allow gases to move through the leaf
Stomata	Carbon dioxide enters by diffusion Water exits be evaporation
Guard cell	Close to prevent water loss or infection

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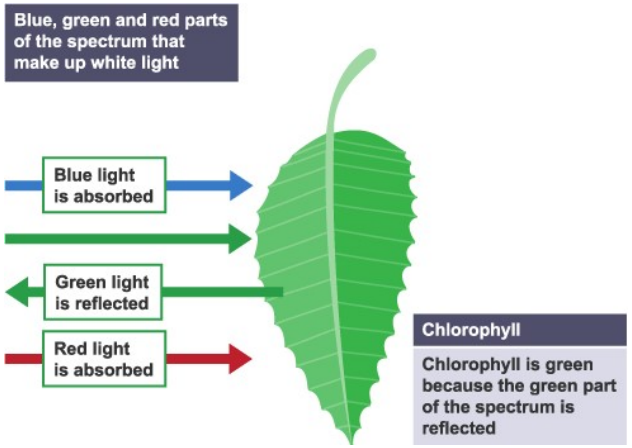
Chlorophyll

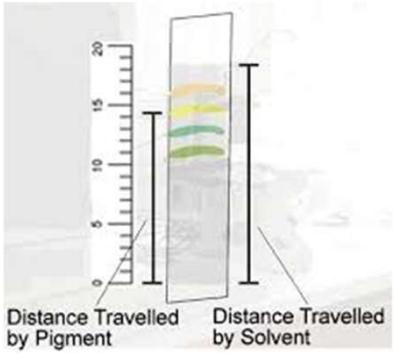
- Chlorophyll is the green pigment found in chloroplasts
- Chlorophyll absorb the light needed for the photosynthesis reaction
- Chlorophyll is green, so absorbs the red and blue parts of the electromagnetic spectrum and reflects the green part of the spectrum



Calculating Rf

- Use a pencil and ruler to measure the distance moved by the solvent
- Use a pencil to put a dot in the centre of each pigment
- Measure the distance from the base line to the first pigment dot
- Write the measurement in the book next to the pigment
- Calculate the Rf value

$$R_f = \frac{\text{distance moved by substance}}{\text{distance moved by solvent}}$$



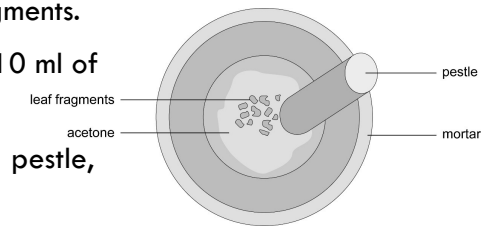
Required Practical: Chromatography

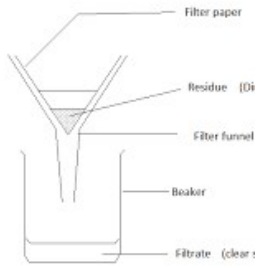
- Method

In dim light, take a leaf and cut it into fragments.

Place the fragments in a mortar and add 10 ml of acetone.

Grind the fragments in the acetone using a pestle, until a dark green solution is produced.

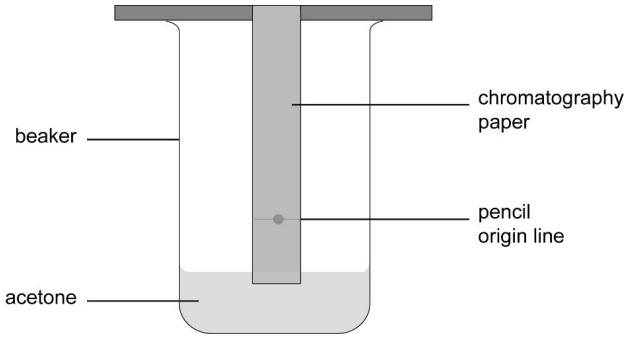




Filter through a funnel and paper, and collect the filtrate in a small beaker.
The extracted pigment in its beaker should be kept on ice in a suitable container.

Cut a length of chromatography paper approximately 10 cm long.
At 2 cm from the base of the paper, draw a pencil line called the origin.
Write your initials in pencil at the top of the chromatography paper
Using capillary tubing, draw up a small amount of the coloured solution into the tube.
With your finger over the top of the tube, carefully touch the chromatography paper in the centre of the origin.
Allow the green dot to dry, and repeat several times until the spot becomes a dark green colour.

Remove the chromatography paper, and draw a pencil line across the top of the acetone line
Allow it to dry



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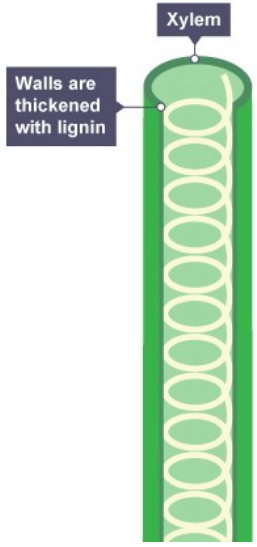
Transpiration

- Water evaporates in the leaves and the water vapour escapes through tiny holes in the surface of leaves called stomata. The stomata can open or close as conditions change because the guard cells can gain or lose water by osmosis.

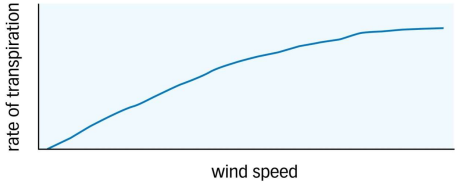
- Water flows from the roots through xylem in its stems to its leaves.
- A continuous column of water is therefore pulled up the stem in the transpiration stream by evaporation from the leaves.
- Water is drawn into the roots of plants from the soil. Water moves into the root hairs by osmosis. Mineral ions move from the soil into the root hairs by active transport.



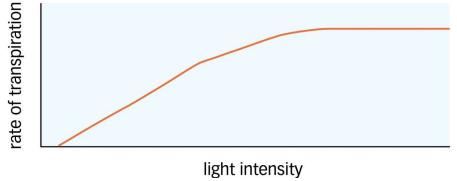
- Xylem tissue is adapted for the transport of water in the transpiration stream from the roots to the leaves.
- Lose their end walls so the xylem forms a continuous, hollow tube.
- Xylem cells are no longer alive. Lignin gives strength and support to the plant.

Rate of Transpiration

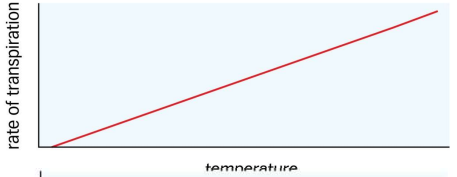
- Environmental conditions can affect the rate of transpiration



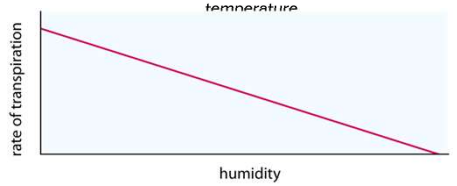
Higher wind speeds maintain a concentration gradient between the leaf and the air. Water molecules evaporate faster.



As light intensity increases, more stomata will open, allowing water to evaporate, increasing the rate of transpiration.



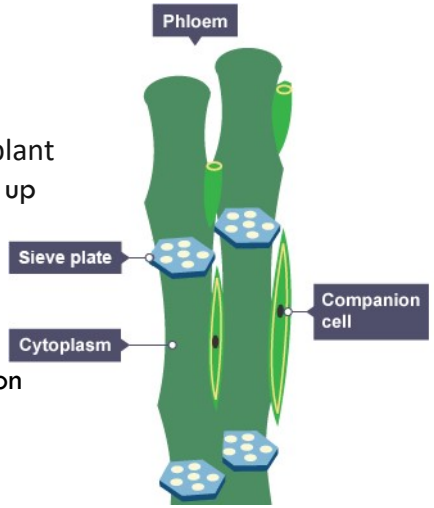
At higher temperatures water molecules will move faster (more heat energy leads to more kinetic energy) and evaporate quicker, increasing the rate of transpiration.



Less humidity means less water in the air, this maintains a concentration gradient between the leaf and the air. Water molecules will diffuse out quicker.

Translocation

- Movement of sugar produced in photosynthesis to all other parts of the plant
- Transport in the phloem takes place both up and down the stem
- Sieve tubes have pores so its cytoplasm connects one cell to the next, allowing substances to move between cells
- Sieve cells have no nucleus , the companion cells provide energy for transport



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Photosynthesis

- Photosynthesis takes place in the chloroplasts in the cells of the leaves of plants. The chloroplasts contain the chlorophyll, which absorbs sunlight.
- Photosynthesis is an endothermic reaction

Root hair cells absorb water by osmosis

Starch turns iodine solution blue-black

Light

$6CO_2$ Carbon Dioxide + $6H_2O$ Water → $C_6H_{12}O_6$ Glucose + $6O_2$ Oxygen

Chlorophyll

Enters through the stomata by diffusion

Exits through the stomata by diffusion

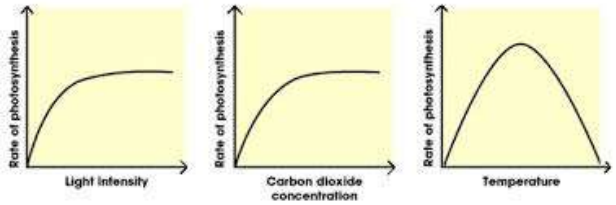
Transported to the leaf in xylem vessels by transpiration

Stored as insoluble starch

- The glucose produced in photosynthesis may be:
  - used for respiration
  - converted into insoluble starch for storage
  - used to produce fat or oil for storage
  - used to produce cellulose, which strengthens the cell wall
  - used to produce amino acids for protein synthesis.

Rate of Photosynthesis

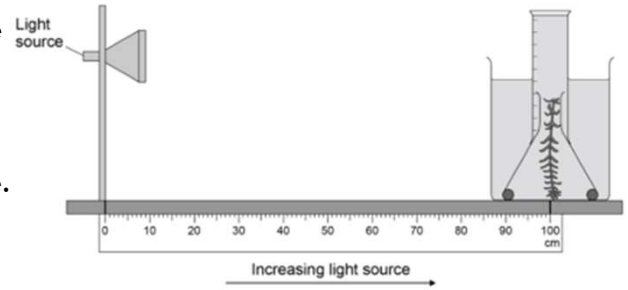
- The rate of photosynthesis depends on:
  - the energy available from light
  - the concentration of carbon dioxide in the air
  - the temperature.
- A limiting factor, if in short supply, limits or reduces the rate of photosynthesis



Required Practical: Light Intensity

1. Put your 10 cm piece of pond weed (cut edge at the top) into a beaker of water.
2. Cover the pondweed with an inverted filter funnel – raised off the bottom of the beaker with plasticine.
3. Fill the measuring cylinder with water and gently position as in the diagram.
4. Use the ruler to position the beaker of pondweed 1 metre away from the light source
5. Start the stopwatch and:
   count and record the number of bubbles released in three minutes
   record the volume of gas produced and collected in the measuring cylinder in the same three minutes.
6. Move the light source so that the pondweed beaker is 80 cm away.
7. Refill the measuring cylinder with water and gently position as in the diagram. Then repeat step 5.
8. Repeat for distances of 60, 40 and 20 cm.

As light intensity increases the number of bubbles and the volume of gas increases. Eventually the rate of photosynthesis stays the same. At this point light is no longer a limiting factor.



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Plant Diseases

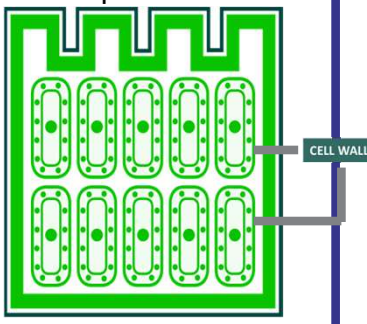
- Plants can be infected by communicable diseases caused by pathogens
- The pathogens can be passed from one plant to another
- Infected plants may have
  - Stunted growth
  - Spots or discolouration on leaves
  - Areas of decay (rot)
  - Malformed stems or leaves
- Tobacco mosaic virus forms a distinctive 'mosaic' pattern of discolouration on the leaves, which affects the growth of the plant due to lack of photosynthesis.

- Common control methods for tobacco mosaic virus include:
  - removing and destroying infected plants
  - washing hands and tools after handling infected plants
  - crop rotation to avoid planting in soil that has been infected for at least two years.
- Rose black spot is a fungal disease where purple or black spots develop on leaves, which often turn yellow and drop early. It affects the growth of the plant as photosynthesis is reduced. The disease is spread by spores of the fungus that are produced in the black spots.

- Methods to control black spot include:
  - not planting roses too close together
  - avoiding wetting the leaves when watering
  - cleaning up any infected leaves from the ground round the roses
  - using a fungicide to prevent infection .

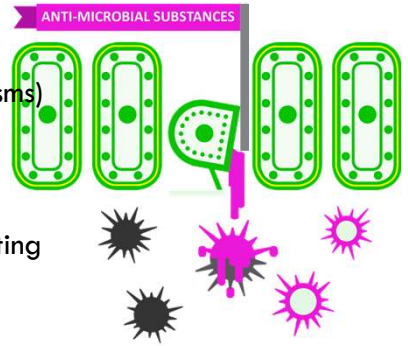
Defence Against Disease

- The spread of communicable diseases can be reduced or prevented in plants



Plants have their own defences against disease

Physical defences (barrier to entry):
- cellulose cell walls
- tough waxy cuticle on leaves
- layers of dead cells around stems/bark



Chemical defences:
- antibacterial chemicals (or antimicrobial chemicals) – kill bacteria (or microorganisms)
- poisons to deter herbivores

Mechanical adaptations:
- thorns and hairs – deter animals from eating or touching them
- leaves that droop or curl when touched
- mimicry – to trick animals into not eating them or not laying eggs on the leaves.

Human Control of Plant Disease

Avoid or eliminate the pathogen
- Remove and destroy infected plants
- Wash equipment after contact with infected plants

Make the plant resistant through genetic or other methods
- Only breed disease resistant plants
- Spray with a fungicide or pesticide

Manipulate the environment to favour the plant
- Rotate crops to avoid planting in infected soil
- Avoid getting leaves wet when watering to reduce the growth of fungus

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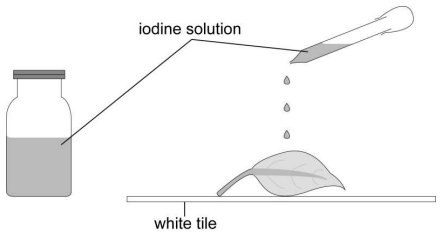
Plants

- Task: answer the questions



What colour does iodine turn when starch is present?

Why is glucose stored as starch?

Meristem is a specialised tissue found at the tips of shoots and roots.
What is the function of meristem tissue?

Tick one box

Cell division	
Fertilisation	
Transpiration	

Highlight the keywords: nucleus, cytoplasm. mitochondria, chloroplast, cell wall, permanent vacuole, meristem, division, elongation, specialised, xylem, phloem, pores, companion, palisade mesophyll cells, diffusion, surface area, lignin, osmosis, guard cells, transpiration, translocation, chlorophyll, chromatography, limiting factor, respiration, Tobacco Mosaic Virus, Rose Black Spot

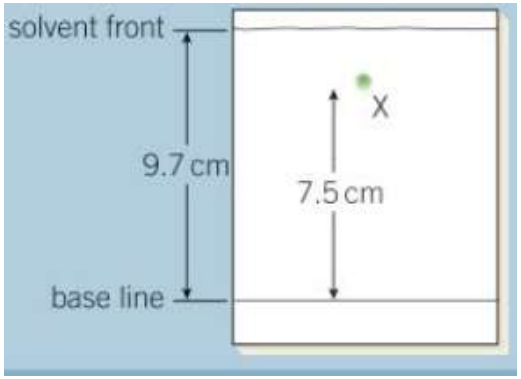
Chromatography

- What is the Rf value of substance x?

Equation: Rf =

Substitute: Rf =

Answer: Rf =



The table shows some features of xylem and phloem tissue.
Complete the table by putting one tick in each row to show if the feature is true for

- Xylem only
- Phloem only
- Both xylem and phloem

Feature of tissue	Xylem only	Phloem only	Both xylem and phloem
Involved in transport of substances in the plant			
Transports water and mineral ions from roots to leaves			
Consists of hollow tubes of dead cells			
End walls of the cells have pores			