SB6e.1 Investigating leaf structure

Your teacher may watch to see if you can:

- use a microscope correctly.

Aim

To look at the internal arrangement of tissues in a privet leaf.

Method

Apparatus

- Microscope
- prepared slide of privet leaf

⚠ Safety

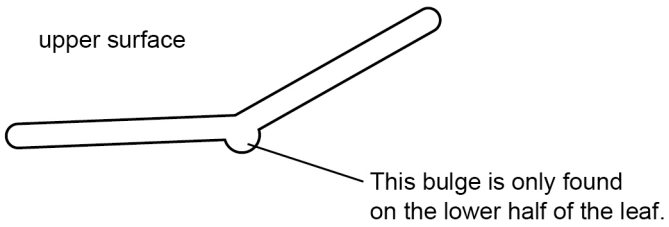
- Take care with any trailing electrical leads for the microscopes.

A Place the prepared slide on the microscope stage. Centre it and secure it in place using one or two of the stage clips.

B Using the lowest power objective lens, bring the leaf section into focus. You will need to ensure that you have adequate light to view the specimen; adjust the light source as necessary.

C Carefully move the slide so that you understand the shape of the whole leaf section. Work out which side of the leaf is the upper surface (use the diagram on the right to help you).

D Use the higher power objective lenses to examine the structure of the leaf.



Recording your results

1 **a** How many distinct layers of tissue are in a privet leaf?

b Draw a simple diagram to show the different thicknesses of the layers.

Considering your results/conclusions

2 **a** In which layers does photosynthesis occur?

b How did you work out your answer to part **a**?

3 **a** Where are the guard cells in a privet leaf?

b How are guard cells an adaptation for photosynthesis?

4 One of the tissue layers has many air spaces. How is this an adaptation for photosynthesis?

5 Privet leaves are thin. How is this an adaptation for photosynthesis?

Extra challenge

6 **a** Draw a cell from one or more of the layers in a privet leaf.

b Add a scale bar to your drawing (or drawings).

c Label the cell or different types of cell you have drawn.

7 Observe one or more prepared slides of leaves from other plants. Compare and contrast the structures of the different leaves. Suggest reasons for any differences that you observe.

Your teacher may watch to see if you can:

- work accurately.

Introduction

You will be given a leaf from a brightly lit part of a plant and a leaf from a dimly lit part of a plant. You are going to measure the surface area of the upper surface of each leaf.

Aim

To find out how light intensity affects the surface area of leaves.

Method

Apparatus

- squared paper
- ruler
- pencil
- leaf from a well-lit part of a plant
- leaf from a shaded part of a plant

⚠ Safety

- Wash your hands after handling leaves.

A Calculate the surface area of one square on the squared paper.

B Place the leaf from the well-lit part of the plant onto the squared paper and draw around it with a pencil.

C Count the number of squares inside your leaf. Some squares will not be completely inside your leaf outline.

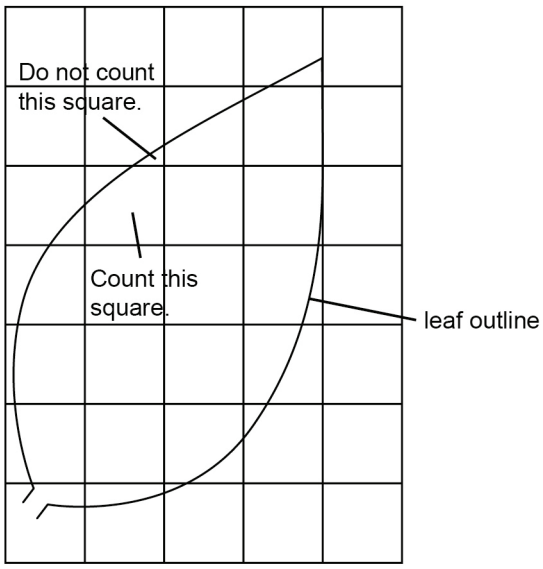
- If more than half a square is inside the outline, count it as one square.
- If less than half a square is inside the leaf, ignore it.

Record the total number of squares.

D Use this equation to work out the area of one side of your leaf:

area of leaf side = area of one square × number of squares

E Repeat steps **B** and **D** with your other leaf.



Recording your results

1 Present your results as a neat table.

Considering your results/conclusions

2 **a** Which of your leaves has the larger surface area? **b** Suggest an explanation for this.

3 Use your results to predict whether plants growing on the ground in forests generally have larger or smaller leaves than those growing in the open.

4 Suggest an explanation for why well-lit leaves have thicker **cuticles** than those from shady parts of a tree.

5 In some plants, leaves in the sun have more than one layer of palisade cells, whereas leaves in the shade only have one layer. Suggest an explanation for why leaves in the sun have more layers of palisade cells.

Extra challenge

6 Write a method to estimate the total surface area of all the leaves on a tree. Use the term sample.

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EASIER

1 Draw lines to match each adaptation of a certain cactus plant with the reason for that adaptation.

Adaptation	Reason for adaptation
no leaves	It cuts down the evaporation of water directly from cells on the surface of the stem.
stomata only open at night	Water vapour is trapped, and the rate of diffusion of water out of the plant is reduced.
stem stores water	Water loss is reduced, because the plant has less surface area.
thick **cuticle**	Less water loss occurs during the heat of the day.
stomata are hidden in dips in the stem	It provides a raw material for photosynthesis when there is no rain.

S1 Draw a table to explain the adaptations that allow cacti to grow in dry deserts.

2 Complete each of the following sentences by putting a tick (✓) next to the correct ending.

a Palisade cells in a leaf are adapted for photosynthesis by containing many:

☐ chloroplasts ☐ ribosomes ☐ mitochondria ☐ starch grains

b **Spongy cells** help the diffusion of gases to and from cells in a leaf by:

☐ opening and closing stomata ☐ moving air into and out of the leaf ☐ creating air spaces ☐ active transport

c Water is transported to the cells in a leaf by:

☐ phloem tissue ☐ xylem tissue ☐ epidermis ☐ companion cells

HARDER

3 **a** During gas exchange, carbon dioxide diffuses from the air into a leaf and then into photosynthesising cells. How is the structure of the leaf adapted to allow carbon dioxide to reach the cells quickly?

_____

b Name one gas that diffuses from cells and out into the air. _____

c Describe how the rate of gas exchange is controlled in a leaf. _____

_____

4 Pine trees are adapted to living in cold parts of the world, where water may not be available because it is frozen in the ground. The 'needles' of a pine tree have the same volume as weeping willow leaves (which have a flat shape). A pine tree needle has 80% less surface area than a willow leaf.

Explain why pine trees are better adapted than weeping willow trees to living in cold parts of the world.

_____

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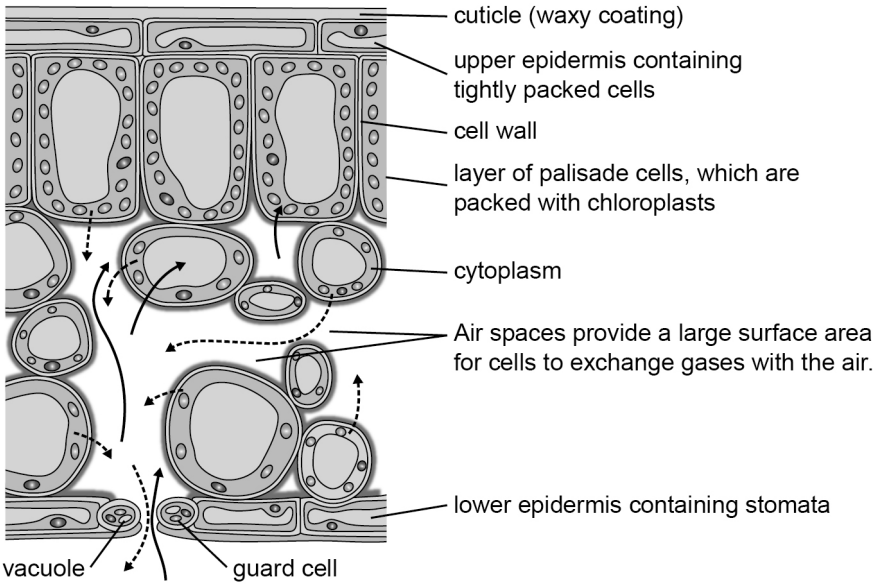
1 The drawing shows a section through a leaf from a tree with broad, flat leaves.



a The arrows show gas exchange. Give the names of three gases that are exchanged.

_____

_____

_____

_____

b Why do desert plants often have thick **cuticles**?

_____

c Complete the table below to explain how the adaptations of a flat, broad leaf help photosynthesis.

Adaptation	**How it helps photosynthesis**
Palisade cells are packed with chloroplasts.	_____ _____
Stomata open during the day.	_____ _____
The leaf is very thin.	_____ _____
Spongy cells create air spaces inside the leaf.	_____ _____

2 Tree A has leaves that can be modelled as cuboids that measure 1 mm × 1 mm × 50 mm. Tree B has leaves that can also be modelled as cuboids that measure 0.1 mm × 10 mm × 50 mm.

a Estimate the volume of each type of leaf.

volume of leaf from tree A = _____ volume of leaf from tree B = _____

b Estimate the total surface area of each type of leaf.

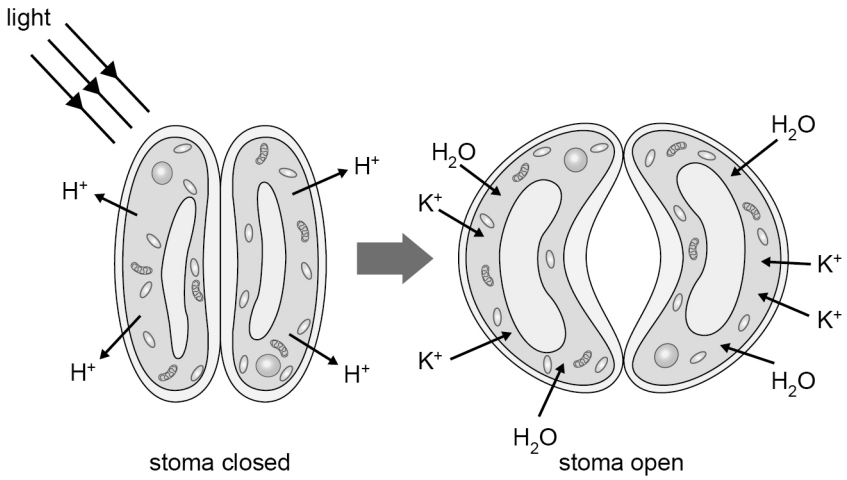
surface area of leaf from tree A = _____ surface area of leaf from tree A = _____

c Both leaves have the same number of stomata. Explain which tree is likely to live in the Arctic Circle.

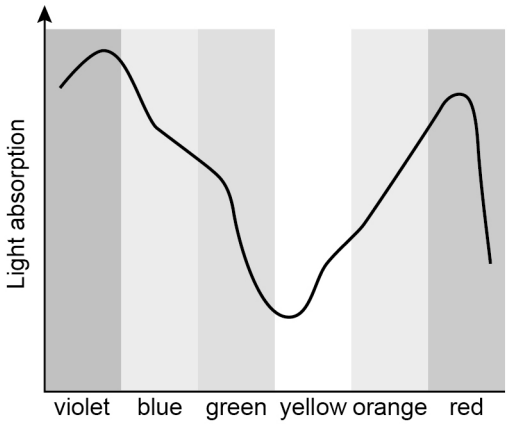
_____

_____

The two guard cells around a **stoma** contain chloroplasts but do not photosynthesise. Instead, when activated by light, the chlorophyll causes ion-pump molecules in the cell membrane to switch on. These molecules pump out hydrogen ions (H^+), causing the inside of the cell to become negatively charged compared with the outside. This in turn causes an ion channel in the membrane to open that allows potassium ions (K^+) to flood into the cell. This results in a greater concentration of ions in the cell compared with outside. Water flows into the guard cells, causing them to swell and open the stoma between them.



Chlorophyll absorbs only some colours of light, so the process is affected by the colour of the light. The absorption spectrum on the right shows how well chlorophyll molecules absorb different colours of light.



All these colours are contained in white light.

1 By what process:

- **a** are H^+ ions moved out of guard cells
- **b** do K^+ ions move into guard cells
- **c** does water move into guard cells?

2 Use the graph to explain why chlorophyll looks green.

3 Scientists are investigating more efficient ways of growing plants on spacecraft. It is more efficient to use a single colour of light rather than white light. Explain which colour is likely to be the best to use.

4 **a** Explain why it is an advantage for most plants to have stomata that open in the day and shut at night.

- **b** Explain why it is an advantage for cacti to have stomata that open at night and shut during the day.
- **c** The stomata of cacti are found deep in the grooves of their stems. Explain how this reduces water loss.
- **d** Some cacti have hairs, which trap air. Explain how this adaptation helps them to survive.

5 Tree A has leaves that can be modelled as cuboids that measure 1 mm × 1 mm × 50 mm. Tree B has leaves that can also be modelled as cuboids that measure 0.1 mm × 10 mm × 50 mm.

- **a** Calculate the volumes and total surface areas of the two types of leaf.
- **b** Use your answers to part **a** to explain which tree is more likely to grow in the Arctic Circle.

Extra challenge

6 Explain the purpose of the adaptations of the following desert plants.

- **a** Manzanita plants keep their leaves parallel to the direction of the Sun's rays.
- **b** The rose of Jericho plant curls up into a tight ball during the dry season.
- **c** The creosote bush has small, fat leaves coated in a layer of resins with a nasty taste.

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Progression questions

Answer these questions.

1 How is the structure of a leaf adapted for photosynthesis and gas exchange?

_____

_____

2 Why do some plants have needle-shaped leaves?

_____

_____

3 How do plants reduce water loss?

_____

_____

Now circle the faces in the 'Start' row in the table showing how confident you are of your answers.

Question	1	2	3
Start	☹ ☹ 😐 🙂 🙂	☹ ☹ 😐 🙂 🙂	☹ ☹ 😐 🙂 🙂

Assessment

Using a different colour, correct or add to your answers above. You may need to use the back of this sheet or another piece of paper. Then circle the faces in the 'Check' row in the table.

Question	1	2	3
Check	☹ ☹ 😐 🙂 🙂	☹ ☹ 😐 🙂 🙂	☹ ☹ 😐 🙂 🙂

Feedback

What will you do next? Tick one box.

☐ strengthen my learning ☐ strengthen then extend ☐ extend

Note down any specific areas you need to improve.

_____

Action

You may now be given another activity. After this, note down any remaining areas you need to improve and how you will try to improve in these areas.

_____

_____

_____

_____