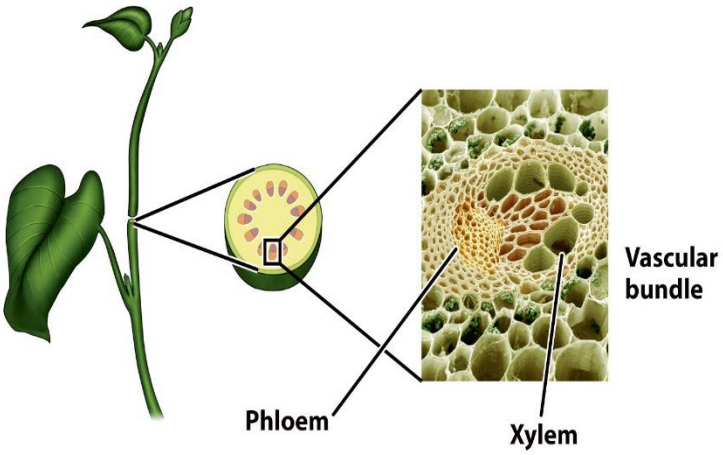
Lesson 1

Parts of a plant

Plant tissues and organs

Although flowering plants are simpler than animals, they have tissues and organs too. These tissues and organs enable the plant to carry out essential functions such as photosynthesis, transport and reproduction. For example, many plants use flowers to reproduce and so flowers are their reproductive organs.

Transport tissue



Materials are transported around plants in two types of cells:

- **Xylem** carries water from the roots. Xylem cells are long thin tubes with strong walls that also form an important part of the skeleton of the plant.
- **Phloem** carries glucose from the leaves to all other plant parts.

Phloem and Xylem together form a network of vascular tissue throughout the plant. The vascular tissue in a leaf can be seen below.

Plant organs

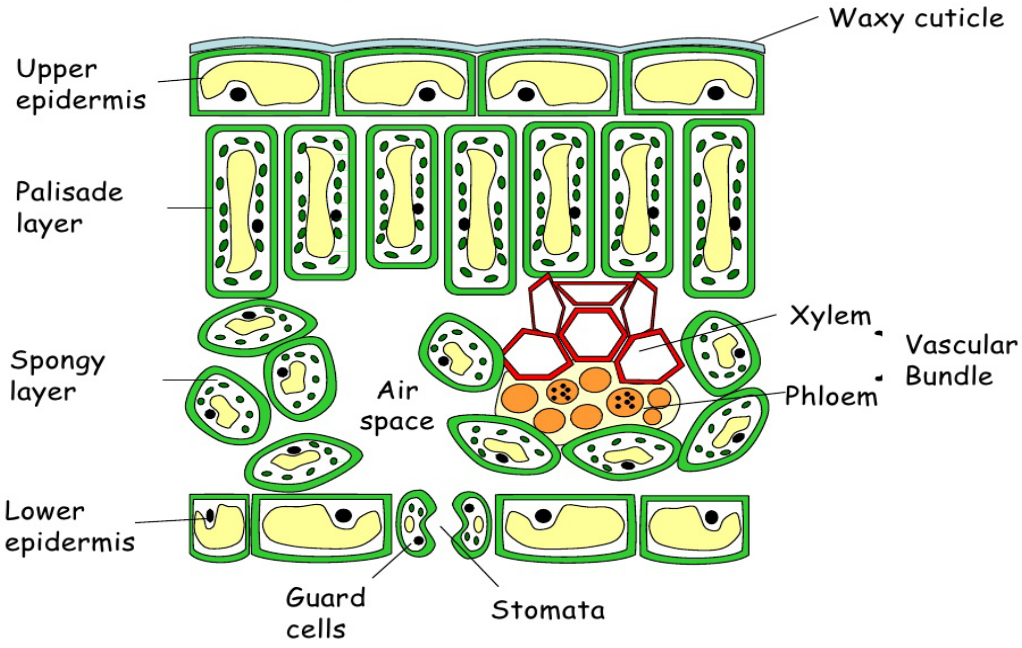
The main organs of a plant are its roots, stems and leaves. These organs work together to bring together the raw materials required for photosynthesis.

The roots is the plant organ that takes water into the plant from the soil. The structure of the root is shown below. Water moves through cells to the vascular tissue. It moves up the xylem to the stem.

The stem is the organ that holds the leaves of the plant up to the light. Stems also carry water from the root to the leaves and transport glucose to all parts of the plant.

The picture below shows a picture of the stem and root organs of a plant and what they would look like if you cut them open and looked inside with an electron microscope.

The picture below shows a picture of a leaf organ. Leaves are



important plant organs. The glucose that plants need for energy is manufactured in leaves.

The leaves are the organs in plants that carry out photosynthesis. Leaves have:

- A large surface area to capture as much light as possible
- Cells near the surface that have large numbers of chloroplasts to trap energy from the Sun
- Stomata (holes) in the leaf surface to let carbon dioxide into the leaf and let water vapor and oxygen out
- Air spaces within the leaf that allows gases to move quickly through the leaf to the cells where they will be used or away from the cells that produced them as waste
- Large amounts of vascular tissue to carry water to the cells and to carry glucose away from the cells to other parts of the plant

Plant Systems

Like all living things, plants are made up of cells that group together to form organs, which then group together to form systems. Leaf cells, for example, group together to form leaves, which are vital organs for a plant. Several leaves form a system, for the plant, in this case a food making system. Some other plant systems are:

- ***A reproductive system ,*** consisting of the parts of a flower
- ***A food storage system***, often in the form of a bulb or tuber
- ***A root system*** for securing the plant in the ground and obtaining water and nutrients
- ***A transport system of*** pathways and veins, which allow food and water to be moved around the plant

Xylem tubes

Materials:

- beaker, glass jar or jug
- stem and leaf of celery or spinach plant
- sharp knife
- cutting board
- food dye

Method:

1. Take a sharp knife and cut across the stem close to the base. This should leave a clean flat surface at the base.

Look closely at the surface you have just exposed. This surface is called a **cross-section.**

2. Set up your stem with leaves in a beaker as shown in Figure 2.

3. Add your food dye or ink to the water, enough to give it a strong colour. Be careful as it stains so don't get it on your clothes.

4. Leave to stand overnight.

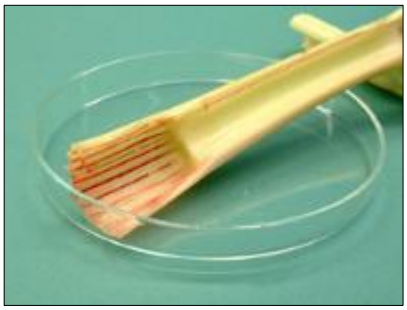
5. Remove the stem with leaves from the beaker.
Look at your cross-section at the base of the stem.
Can you see a series of small spots the same colour as your dye?

6. In the space below, draw the cross-section. Then answer the questions a), b) and c)

7. Look at your cross-section of the stem. You should notice that
the coloured spots are arranged along one side of the stem and this side has little ridges down its length. The other side is curved and smooth.

8. Take a knife and pick a point high up on the stem close to the leaf.

9. Cut carefully into the stem, but not right through to the other side. Make your cut on the smooth side of the stem. Cut 3 mm into the stem, across its full width.

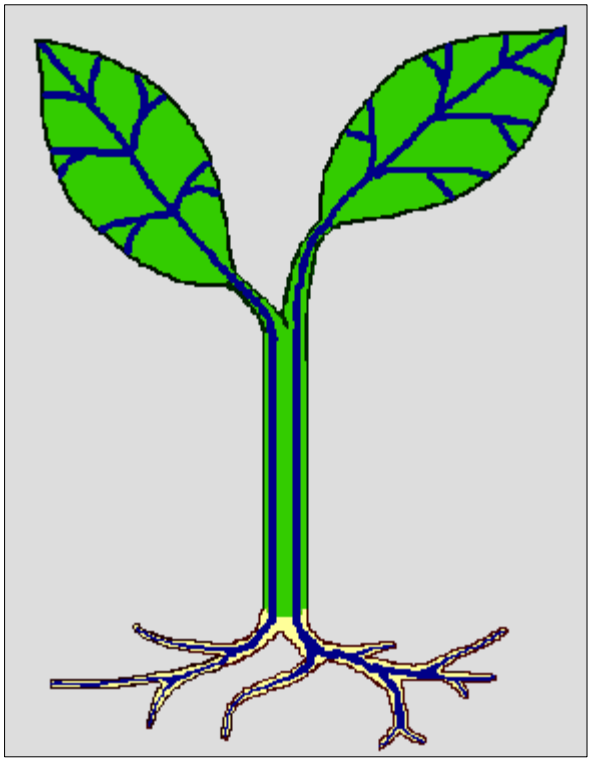


10. Take a sharp knife and scrape the surface of the stem away. You should see the dyed xylem tubes going up the stem.
Follow the tubes up the stem to the leaves.
Then answer the following questions.

Lesson 2

As a flowering plant grows from a seed, cells reproduce and some of them form xylem cells that make up the xylem tubes like you saw in your celery plant. The xylem tubes deliver the water and minerals required by plant cells throughout the multicellular plant.

Water moves into **xylem tubes in** the **roots**, then moves up the xylem in the **stem** and into the xylem in the **veins** of the leaves.

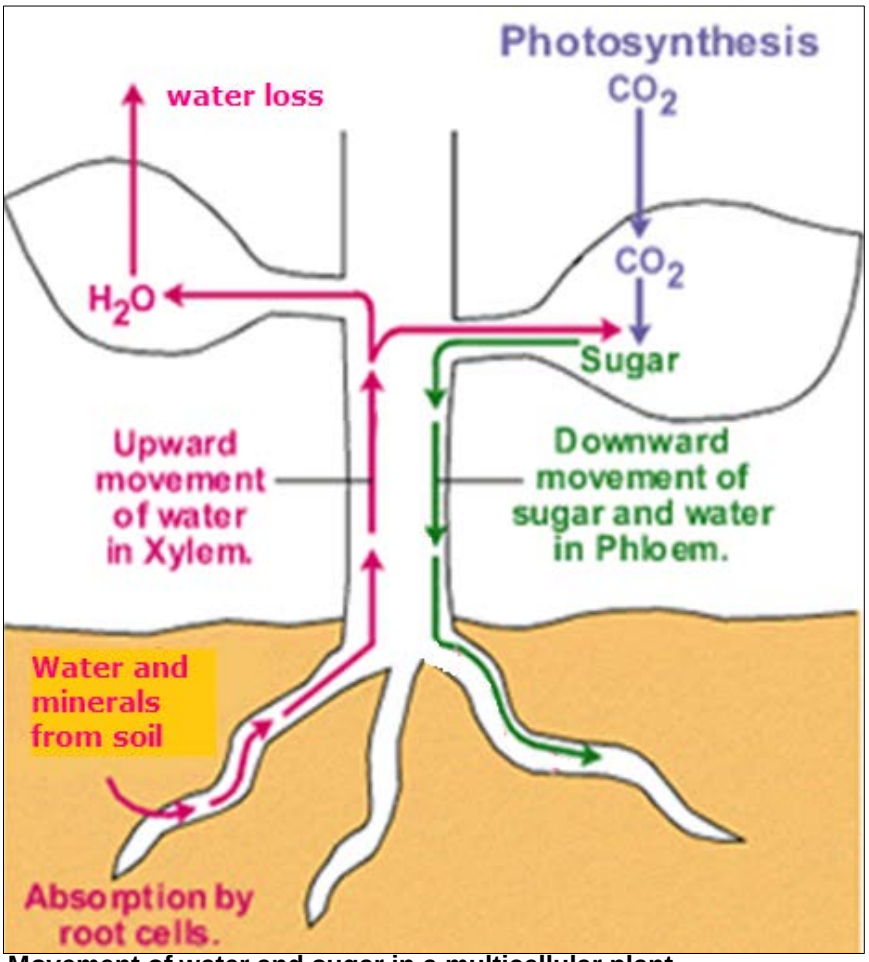


You know that the plant cells require water to carry out photosynthesis to produce glucose and oxygen. In multicellular plants, like angiosperms, photosynthesis occurs in leaves.

The glucose produced in the leaves of angiosperms (flowering plants), is distributed to all cells to use in respiration to give them energy. Glucose is also needed by cells to form compounds for growth. Minerals delivered to the cells in water, help make compounds. A set of tubes exists to transport glucose sugar.

The **phloem tubes** take glucose from the leaves to all parts of the plant. Phloem cells form a network of **tubes in veins** of the leaves, through the **stem** and to **all parts** of the plant.

The image below shows the movement of water in xylem and the movement of dissolved sugar in phloem. Dissolved minerals also move in the xylem and are used by cells to make proteins and other compounds from glucose.

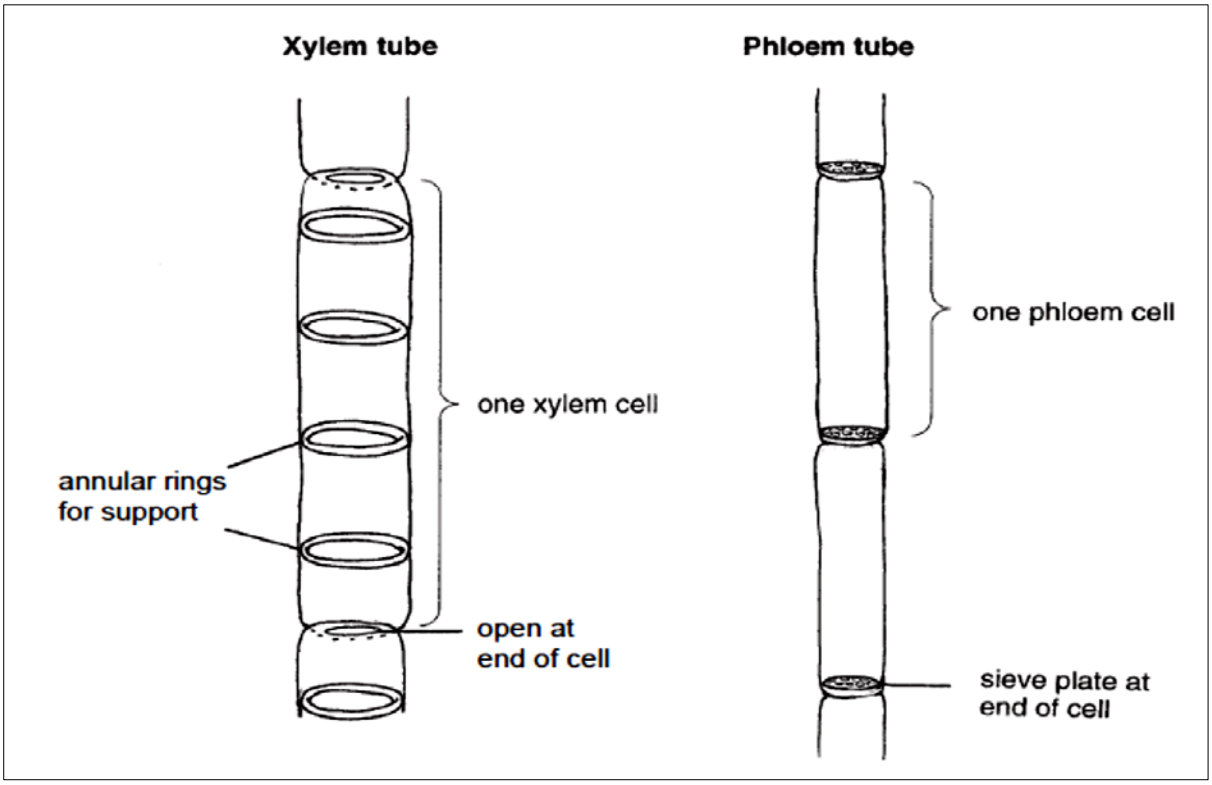


Movement of water and sugar in a multicellular plant

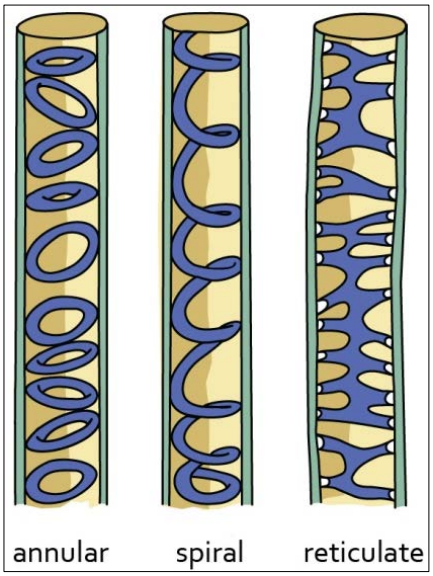
Comparing Phloem and Xylem

Xylem and phloem are both made up of cells arranged to form tubes but if you study them closely, you will see some differences.

Figure 8 shows the structure of a xylem tube and a phloem tube as seen under a microscope.

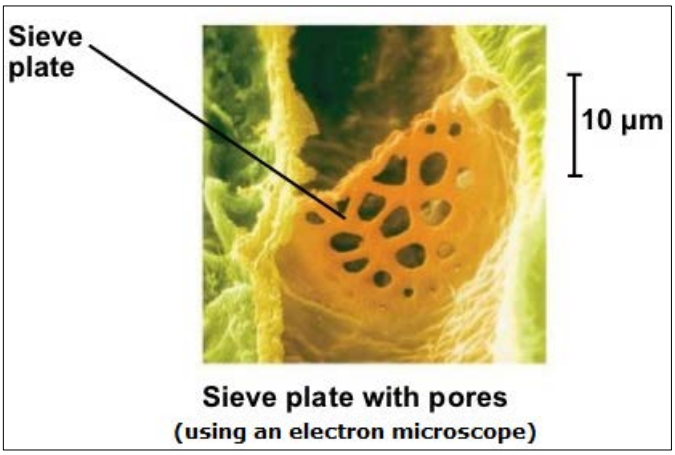


Note: In the example of xylem given in Figure 8, support thickening is in the form of rings. However, xylem tubes in other plants may have support thickening with different shapes, such as spirals or bumps as shown in Figure 9.



Some types of xylem thickening

At the end of each phloem cell is a plate with pores that allow dissolved sugar to flow continuously.



Pores in sieve plate of phloem

Sieve plate with pores
(using an electron microscope)

Go to the send in pages and complete exercise 2.1

Now use information from the diagram and from your table to complete the summary about xylem and phloem tubes.

Summary of Xylem and Phloem

• Xylem and phloem are _____ arranged end to end to form _____ that run through the whole plant.

• The _____ tubes carry water and dissolved minerals up to the leaves.

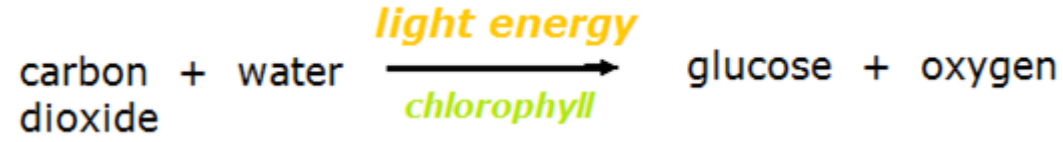
• The _____ tubes carry sugars from the leaves to every part of the plant.

• _____ tubes have annular rings and are larger than phloem tubes.

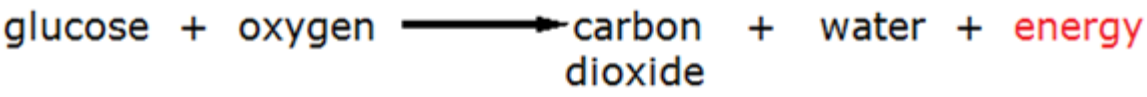
• _____ tubes have sieve plates.

So now you know that xylem and phloem cells form structures to deliver the requirements for photosynthesis and respiration to all cells in a multicellular plant. Remember from Set 1:

Photosynthesis:



Cellular respiration:



Lesson 3

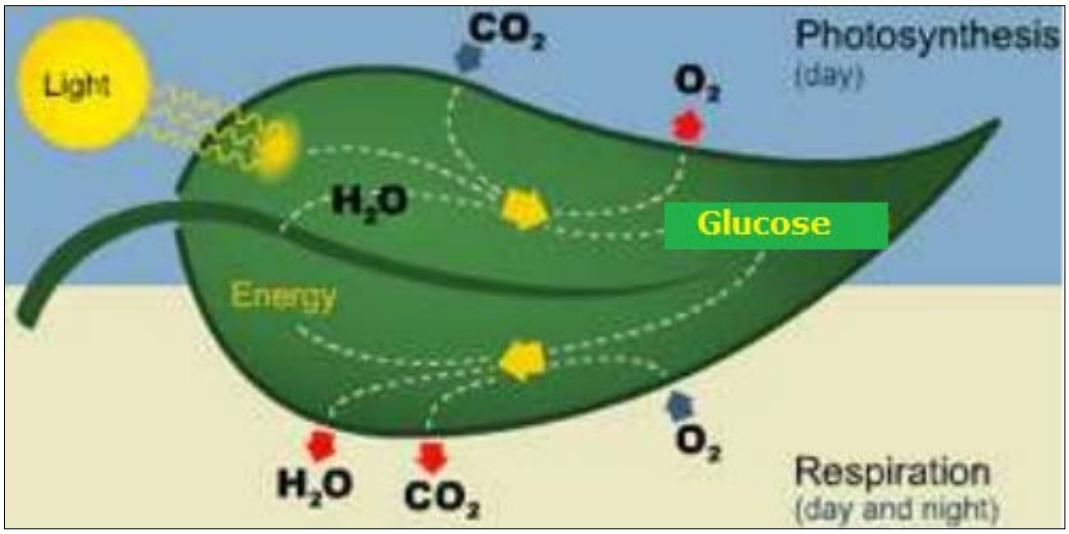
A closer look at leaves

In this lesson you will look at another structure of a flowering plant, the leaf, and how it allows requirements to be delivered where needed in the plant.

Look back at Figure 7 in Lessons 1 and 2. This figure reminds you that **carbon dioxide enters** the plant through the leaves and **water goes out** of the plant through the leaves.

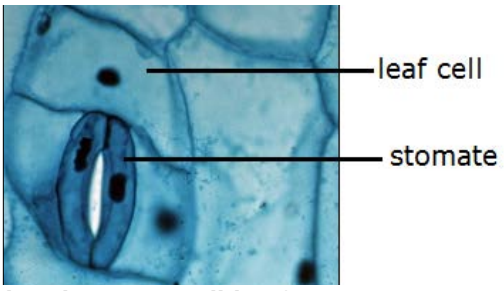
You may also know that **oxygen goes out** of a plant via the leaves after it has been produced in photosynthesis.

Oxygen to be used in cellular respiration **enters** via the leaves. **Carbon dioxide goes out** of the leaves after it has been produced by cellular respiration. Figure 11 summarises the movements in and out of a leaf.



The ins and outs through a leaf

The gases and water move through small holes in the leaf surface called **stomates**. The stomates can be closed to stop gas and water movement.



light microscope slide of an open stomata, stained blue

Finding stomates

Aim: To test the hypothesis that stomates are distributed on both upper and lower surfaces of leaves.

Materials:

• a beaker or glass

• very hot water from tap

• rubber gloves

• three small, soft, leafy stem branches (Each branch should be from a different type of plant and should stand a little higher than your beaker/glass. Try to include some gum leaves if you can.)

Method:

1. Put on your rubber gloves and collect your three soft plant stem branches.

2. Keep your rubber gloves on and pour hot water into the beaker to 2 cm from the top. (Stomates are so small that you cannot see them with your naked eye. However, if you place leaves in hot water, you can see bubbles of gas. Each bubble shows the position of one stomate).

3. Choose one plant branch with at least three leaves and carefully submerge the leaves in the hot water in the beaker.

4. Look closely at both the upper and lower surface of the leaves for bubbles.

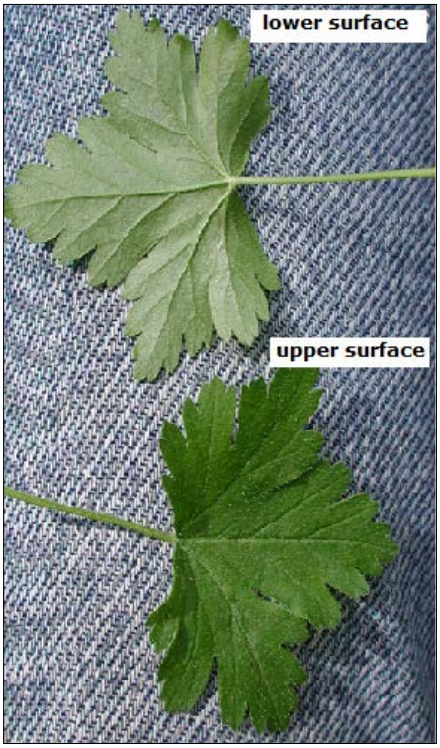


Figure 13

Note: The upper surface of the leaf is usually smoother and a darker green colour than the lower surface. The lower surface usually has raised leaf veins. Figure 13 shows these differences.

5. Count the number of bubbles on the upper and lower sides of the leaves and record your observations in the results table below.

6. Repeat the above steps and make your observations for the other two branches you collected.

Go to the send in exercises and complete exercise 3.1

Lesson 4

Leaf surfaces

Aim: To test the hypothesis that one surface of a leaf loses more water.

Materials:

• four large soft leaves- the same size and from the same type of plant

• vaseline (petroleum jelly) Vaseline is used in this activity to stop water escaping from the stomates.

• sticky tape

• sheet of paper.

Method:

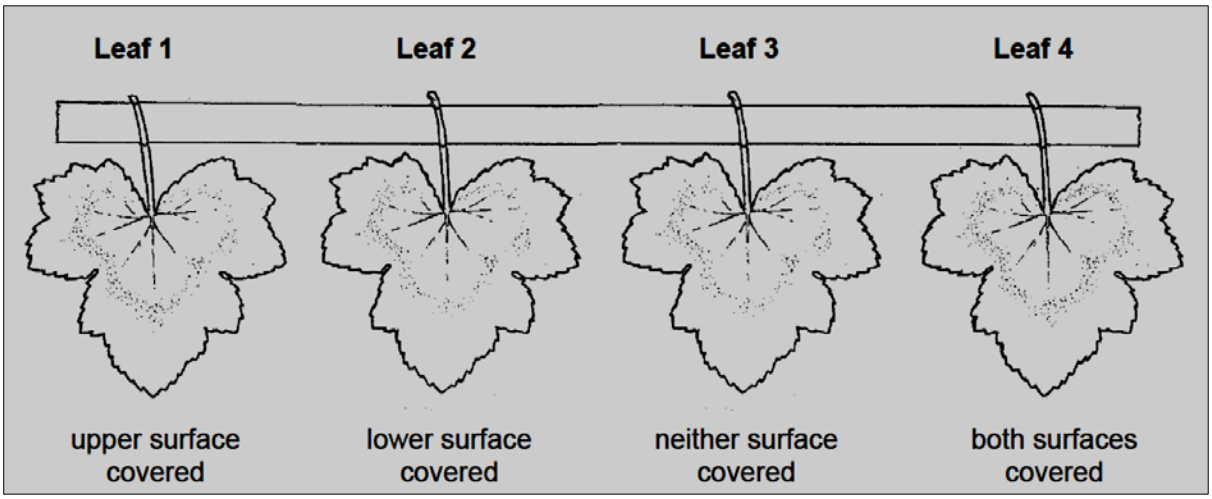
1. Cover the upper surface of the first leaf with a thin coating of vaseline. Leaf 1 is testing to see if water is lost from the lower surface of the leaf.

2. Cover the lower surface of a second leaf with a thin coating of vaseline. Leaf 2 is testing to see if water is lost from the upper surface of the leaf.

3. Leave one leaf with no Vaseline. This is Leaf 3 which is a check to see what would happen under normal conditions. It is a control.

4. Cover both surfaces of the last leaf with a thin coating of vaseline. This is Leaf 4 where no water will be lost from the upper or the lower surfaces. This leaf is also a control.

5. Tape your leaves to a sheet of paper with a label next to each leaf.



6. Leave the sheet undisturbed for three days then carefully observe each leaf. In the results table, record any changes you see.

Go to the send in exercises and complete exercise 4.1

Summary of Lesson 4

- The leaves of multicellular plants use light energy in photosynthesis to produce glucose and oxygen.
- Stomates on the surface of leaves, allow gases to enter and exit, and water to exit.
- More stomates are located on the lower side of leaves to reduce water loss by evaporation.

Go to the send in exercises and complete exercise 5.1

Send in Exercises

Exercise 1.2 Results: Draw or insert a picture using your mobile phone

Exercise 1.2

a) What do you think the coloured spots are? _____

b) How do you think they got their colour?

c) If the dye moves up the stem then what do you think is the name of these tubes?

Where do the tubes go when they reach a leaf?

_____

e) Describe the pattern of the veins in a celery leaf.

_____

f) Can you remember why leaves need water? Explain!

_____

_____

g) What is the connection between xylem tubes and leaf veins and why is this connection needed?

h) Where do the tubes go when they reach a leaf?

i) Describe the pattern of the veins in a celery leaf.

j) Can you remember why leaves need water? Explain!

k) What is the connection between xylem tubes and leaf veins and why is this connection needed?

Exercise 2.1 Complete the exercise below

Similarities	Differences	
Xylem and phloem	Xylem	Phloem

Exercise 3.1

Describe the control leaf in the experiment you just completed.

_____

_____

There are two suitable controls for this experiment:

What was your **independent variable**?

_____

What was your **dependent variable**?

_____

What are some other variables in the experiment that you need to keep the same (constant)?

_____

_____

Results:

Leaf branch	Number of bubbles on	
	upper side of leaves	lower side of leaves
1		
2		

3		

Conclusion:

_____

_____

_____

_____

Discussion:

(Answer the following questions to form a discussion)

1. Bubbles indicate the presence of stomates. What could you suggest if more bubbles appear on the lower surface of the leaf?

_____

_____

2. How does using three different types of plants make your results better or more reliable?

_____

_____

3. Describe a safety precaution taken in the investigation and justify (give a reason) for its use.

_____

_____

_____

Conclusion:

(Complete the following sentence to make a conclusion statement that refers back to the aim and is supported by your results. Cross out the incorrect underlined word).

There appears to be more/ fewer stomates on the lower / upper surface of leaves.

_____

_____

Exercise 4.1

Results: Table – Appearance of leaves after three days

Leaf	Observations – wilted / dry or firm / spongy
1 upper surface covered	
2 lower surface covered	
3 neither surface covered	
4 both surfaces covered	

Discussion:

Analyse the results by answering the following questions.

1. Which leaves do not have vaseline on their:

(a) upper surfaces? _____

(b) lower surfaces? _____

2. Which leaf lost the most water? _____

Explain why. _____

_____

3. Which leaf lost the least water? _____

Explain why. _____

_____

4. Which test leaf lost more water? _____

Conclusion:

_____

_____

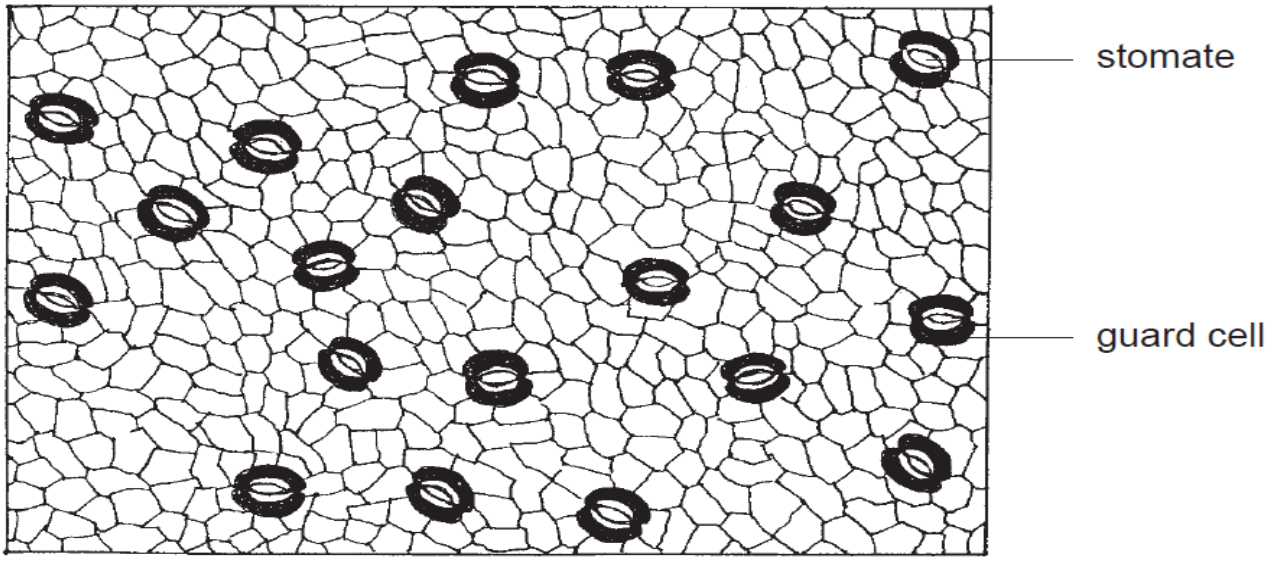
_____

When plants lose too much water, they wilt and die. Having more stomates on the lower surface reduces water loss because this surface is cooler and water will evaporate more slowly from the stomates.

Exercise 4.2

In a piece of leaf, size 1 mm^2, a plant can have many stomates. The diagram below shows the stomates on the upper surface of a piece of geranium leaf 1 mm^2.

Upper surface of a geranium leaf 1 mm^2 (magnification x 1000)



1. Count the number of stomates in the diagram and add your answer to the table on the next page.

Table: The number of stomates in a piece of leaf 1 mm^2

Name of plant	Number of stomates in upper surface	Number of stomates in lower surface
geranium		59
maize	52	68
nasturtium	0	130
sunflower	85	156

- ✓ From the table above, you should be able to see the variation in the number of stomates on the leaves of different plants.

1. Study the table carefully and make one observation which is true for all four plants.

2. Suggest an explanation for the observation you have made in Question 2.

Now look more closely at the numbers in the table.

3. Which plant has roughly the same number of stomates on the upper surface as it has on the lower surface?

4. The leaves of the plant in Question 4 bend over and hang vertically, not horizontally as in most plants. Keeping this in mind, explain why it has roughly the same number of stomates on both the upper and lower surfaces of its leaves.

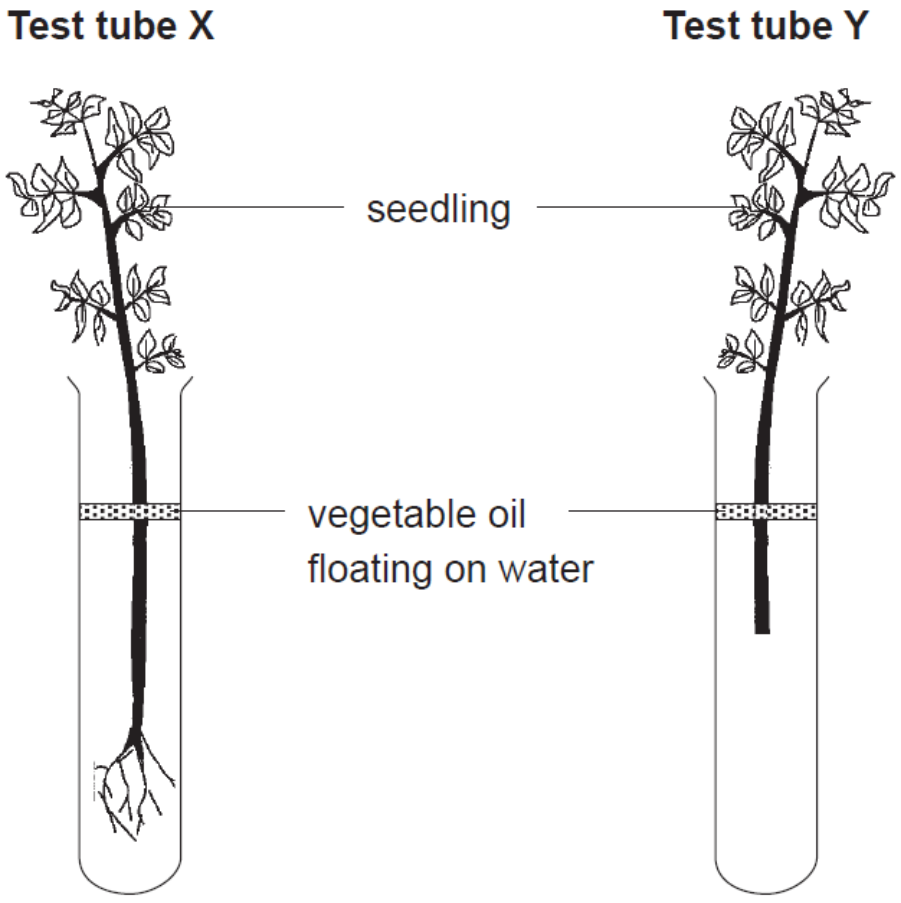
5. Which plant has three times as many stomates on the lower surface compared with the upper surface of the leaf?

6. Which plant has approximately twice as many stomates on the lower surface as compared with the upper surface?

7. Which plant has the stomates best arranged so as to reduce water loss from the leaves? Explain your selection.

Exercise 5.2

Kavita has noticed that cut flowers in a vase also use up water.
They do not have roots but they still seem to absorb water.
She would like to test if a plant with roots absorbs more water
than a plant without roots. The diagram below shows an experiment she planned. Study the diagram then answer the questions below.



1. What are five controlled variables in this experiment?

-
-
-
-

•

2. What is the independent variable in this experiment?

_____

3. What is the dependent variable in this experiment?

_____

4. How long do you think Kavita should leave the plants in the test tubes before she collects her results? _____ Why?_____

_____

5. Write a plan for Kavita's experiment.
(Describe what she would do in steps.)

6. Suggest how Kavita could present her results to her class.

_____

_____