Collins

# Cambridge IGCSE™

# Biology

## TEACHER'S GUIDE

Sue Kearsey, Mike Smith

# B8 Transport in plants

## Introduction

In this section, students will learn about the transport systems in flowering plants, including the processes of water uptake, transpiration and translocation.

## Links to other topics

| Topics | Essential background knowledge | Useful links |
|---|---|---|
| 1 Characteristics and classification of living organisms | 1.1 Characteristics of living organisms<br>1.3 Features of organisms | |
| 2 Organisation of the organism | 2.1 Cell structure and size of specimens | |
| 3 Movement into and out of cells | 3.1 Diffusion<br>3.2 Osmosis<br>3.3 Active transport | |
| 4 Biological molecules | 4.1 Biological molecules | |
| 6 Plant nutrition | 6.1 Photosynthesis<br>6.2 Leaf structure | |
| 12 Respiration | | 12.1 Respiration<br>12.2 Aerobic respiration<br>12.3 Anaerobic respiration |
| 14 Coordination and response | | 14.4 Homeostasis<br>14.5 Tropic responses |

## Topic overview

| | |
|---|---|
| **B8.1** | **Xylem and phloem**<br>In this learning episode, students will learn about the tissues involved in transporting materials around a plant.<br>Supplement Students relate the structure of xylem vessels to their function. |
| **B8.2** | **Water uptake**<br>In this learning episode, students look at how water is gained through the root hair cells, and how it moves through the plant. |
| **B8.3** | **Transpiration**<br>Students learn about the route of water loss through leaves. There is also the opportunity to plan and carry out practical work on factors that affect the rate of transpiration from leaves.<br>Supplement Students look at the mechanism of transpiration, and explain why different factors affect transpiration rate. |
| Supplement<br>**B8.4** | **Translocation**<br>Students learn about translocation, and the roles of sources and sinks in the movement of sucrose and amino acids around a plant. |

| B8.5 | **Consolidation and summary**<br>This learning episode provides an opportunity for a quick recap on the ideas encountered in this section. Students can answer the end of topic questions in the Student Book. |
|---|---|

# Careers links

These are some scientific careers that focus on this area of biology but careers in many other fields use the knowledge and skills gained studying science. **Forestry managers** look after forests and woodland areas and need to ensure that newly planted trees will have sufficient space and water to grow. **Maple tree tappers** carefully remove some of the sap in the phloem of maple trees to produce maple syrup.

# Starting points

The Student Book section opener puts the ideas in the section into context and sets the scene. It also allows students to acknowledge and value their prior learning, and provides a benchmark against which future learning can be compared.

- The questions provide a structure for introducing the section and can be used in a number of different ways:
- You could ask students to consider the questions as an introductory homework task.
- You could put students into groups to share their own ideas and understanding and then to report back to the whole class.
- Students could be given access to the Internet, preferably with a tight timescale, to find out the information required.

You could then use a spider chart or other form of wall chart to summarise everybody's ideas.

Recording these initial ideas allows you to retain them for reference as the individual topics are developed. In this way, your students' progress in learning can be readily acknowledged.

# Learning episode B8.1 Xylem and phloem

## Learning objectives

- State the functions of xylem and phloem:
  (a) xylem – transport of water and mineral ions, and support
  (b) phloem – transport of sucrose and amino acids
- Identify in diagrams and images the position of xylem and phloem as seen in sections of roots, stems and leaves of non-woody dicotyledonous plants
- Supplement Relate the structure of xylem vessels to their function, limited to:
  (a) thick walls with lignin (details of lignification are **not** required)
  (b) no cell contents
  (c) cells joined end to end with no cross walls to form a long continuous tube

## Common misconceptions

Check that students learn the correct spelling *absorption*, as some spell it *absorbtion*.

This is a good opportunity to revise diffusion and absorption from earlier sections and check that students have not formed any misconceptions on that work.

## Resources

Student Book pages 143–145

B8.1 Technician's notes

Resources for demonstrations and class practicals (see Technician's notes)

## Approach

### 1. Introduction

Remind students of their work on Section 6: *Plant nutrition*, and give them a minute or so to jot down which substances the plant needs from the environment for growth. They should identify what these substances are used for, which provides an opportunity to briefly revise photosynthesis and the formation of proteins and other substances that need mineral ions from the environment. Take examples from around the class and note any weaknesses in understanding that need addressing during work on this section. Ask students which parts of the plants take in the substances they need. They should be able to answer: leaves for taking in carbon dioxide and roots for absorbing water and mineral ions.

### 2. Xylem and phloem

Students should use prepared slides of transverse sections of plant roots, stems and leaves to help identify the vascular bundles in the different plant organs. Make sure that the slides show non-woody, herbaceous, dicotyledonous plants. (If slides are not available, students could use the photomicrographs in Fig. 8.3 on page 144 of the Student Book.)

Students should draw labelled diagrams from each slide, to show the main features. This is a good opportunity to remind students how to draw plan diagrams, which outline the main areas, and then add detail only to the areas of interest, in this case the xylem and phloem. Remind students that they should use a sharp pencil, only draw what they see, and should label the key features on their diagrams. Fig. 8.2 on page 144 in the Student Book could help students identify and label the tissues correctly on their diagrams.

Students then use page 143 of the Student Book to describe the functions of each of xylem and phloem.

Supplement Explain to students that xylem vessels are made of empty columns of dead cells, whose cross walls have broken down, and outer walls have become thickened and strengthened with lignin. Ask students to think about the advantages of this structure as regards to their function. Comparing xylem vessels with drinking straws will help elucidate their transport function, and comparing them with scaffolding poles will help elucidate their support function.

### 3. Consolidation

Ask students to start a concept map on plant transport tissues, which they will add to during other activities in this section. This could be done as a group activity to encourage discussion of what should be added. They should begin with the words *Transport in plants* in the middle of the page and add any terms and knowledge they have gained from this learning episode. Save the concept maps for adding to later.

## Technician's notes

**Be sure to check the latest safety notes on these resources before proceeding.**

**The following resources are needed for task 2 on xylem and phloem:**

| |
|---|
| prepared slides of transverse sections of plant roots, stems and leaves<br>The slides should show non-woody, herbaceous, dicotyledonous plants. |

# Answers

## Page 144 Science in Context: Tree rings

In warmer years, when there was greater growth, the rings are wider than in years when it was cooler and there was less growth.

## Page 145

1. In vascular bundles that form veins throughout the roots, stems, and leaves.
2. Phloem cells link together to form continuous phloem tissue in the vascular bundles. They carry dissolved food materials, such as sucrose and amino acids.
3. **Supplement** Xylem vessels are long continuous hollow tubes formed from columns dead cells with no cross walls. This allows water and dissolved substances to pass easily through the plant.

# Learning episode B8.2 Water uptake

## Learning objectives

- Identify in diagrams and images root hair cells and state their functions
- State that the large surface area of root hairs increases the uptake of water and mineral ions
- Outline the pathway taken by water through the root, stem and leaf as: root hair cells, root cortex cells, xylem, mesophyll cells
- Investigate, using a suitable stain, the pathway of water through the above-ground parts of a plant

## Common misconceptions

Check that students learn the correct spelling *absorption*, as some spell it *absorbtion*.

This is a good opportunity to revise diffusion and absorption from earlier sections and check that students have not formed any misconceptions on that work.

Some students think that the ends of roots are open, like drinking straws. Ask students why water enters the roots – remind them of what they learned about osmosis in Section 3: *Movement into and out of cells.*

## Resources

Student Book pages 145–146

Worksheet B8.2 Water movement through plants

B8.2 Technician's notes

Resources for demonstrations and class practicals (see Technician's notes)

## Approach

### 1. Introduction

Remind students of their work on surface area and rate of diffusion from Worksheet B3.1c. If they did not carry out that practical work, present this here as a prepared demonstration (see Technician's notes).

If possible, show them a picture of a unicellular organism, such as *Paramecium* or *Amoeba*, from a slide or the internet. Ask them to apply what they learned from the practical to the diffusion of nutrients into and out of the unicellular organism. They should compare this with the problem of getting materials to and from diffusion surfaces and the external environment in larger organisms. Give them a minute or so to discuss in pairs how large/multicellular organisms, such as plants, might solve this problem. Take ideas from round the class. (If needed, remind students of their work in Section 6: *Plant nutrition,* and as then to think about which part of the plant absorbs mineral ions.) They should be able to suggest that the much-divided root system of the plant provides a large surface area for absorption.

### 2. Root hair cells

Students should look at a prepared slide of a plant root showing root hairs, or an image from the internet, to identify the root hair cells. In addition they should look at Fig. 8.5 on page 145 of the Student Book, which shows the root hair cells on the outside of a root. They should identify the root hair cells as the site of absorption of water and mineral ions. This can be reinforced by explaining that if a plant is lifted out of the soil, these delicate root hairs are usually damaged. So, even if the plant is immediately replanted, it will take a few days before it can absorb water and mineral ions effectively again.

Link this work to the introductory task to help students understand the role of root hair cells in providing a much-increased surface area for absorption of water and mineral ions.

**Supplement** Ask students to suggest another surface in organisms which is adapted for absorption by having features that greatly increase its surface area. They should be able to recall the villi and microvilli of the small intestine from their work in Section 7: *Human nutrition*.

### 3. Water movement through plants

Worksheet B8.2 provides a method for investigating the transport of water through the above-ground parts of a plant. This takes a few minutes to set up, but then needs to be left for about 24 hours before looking at the results. Alternatively, this could be set up by a technician the day before the lesson.

Celery stalks work well for this, as they have large vascular bundles that can easily be removed from the stalk tissue. If celery is not available, use a plant stem that is wide and fairly transparent, such as Busy Lizzie (*Impatiens*) or just wide, such as *Coleus*. If the plant stems have flowers, ideally choose white flowers as these will more clearly show the dye in the petals. If the plant stems have leaves, ideally choose those with pale or yellow leaves.

SAFETY INFORMATION: Remind students to take care with sharp knives.

Use the information on water uptake on pages 145–146 of the Student Book to help describe the whole pathway taken by water through the plant from the root hair cells to the leaf mesophyll cells.

### 4. Consolidation

Students could develop the concept maps they started in the last learning episode, to include what they have learned in this learning episode. Alternatively ask students to write a short paragraph for a web science encyclopaedia to explain how plants are adapted to take in water and mineral ions.

## Technician's notes

**Be sure to check the latest safety notes on these resources before proceeding.**

**The following resources are needed for the introduction:**

| |
|---|
| picture / slide of a unicellular organism, such as *Paramecium* or *Amoeba* and the means to display it |

**The following resources are needed for task 2 on root hair cells, per student or group:**

| |
|---|
| prepared slide of transverse section of a plant root, showing root hair cells, or a photograph of this |

**The following resources are needed for the class practical B8.2, per group:**

| |
|---|
| stem or stalk of plant |
| 1 $cm^3$ food colouring |
| teat pipette |
| water |
| 250 $cm^3$ beaker |
| sharp knife and cutting board |
| forceps |
| hand lens |

See note above about suitable plants to use.

Keep the ends of the stalks/stems sitting in water until needed, to prevent air entering the vascular tissue.

SAFETY INFORMATION: Remind students to take care when using sharp knives.

# Answers

## Page 146

1. It enters through the root hair cells, moves through the root cortex cells to the xylem in the centre of the root. It moves through the xylem, up the stem and into the leaves. In the leaves, it moves out of the xylem into the mesophyll cells.
2. Place a stem of a plant in water containing food colouring. The colour will travel through the xylem with the water, and show where the xylem is in the stem, leaves and flowers.
3. a) osmosis
   b) active transport

# Worksheet B8.2 Water movement through plants

The movement of water through the parts of a plant that are above ground can be investigated using water containing a coloured dye, such as food colouring. As the water is taken up, it carries the dye with it. The dye stains tissues with which it comes into contact.

## Apparatus

stem or stalk of plant

food colouring

pipette

water

beaker

sharp knife and cutting board

forceps

hand lens

**SAFETY INFORMATION**

*Take care with sharp knives.*

## Method

1. Add about 1 $cm^3$ dye to half a beaker of water and mix.
2. Use the knife to cut off about 1 cm from the end of the plant stem. Discard the end and place the stem immediately into the beaker of coloured water. Leave the stem in the beaker for 24 hours.
3. After 24 hours, use the hand lens to look carefully at the stem, leaves and petals of the flower (if present). Identify where the dye has been transported. Quickly sketch and annotate a diagram to show where the dye is visible.
4. Place the stem on the cutting board, and use the sharp knife to cut across the stem about half-way up.
5. Use the hand lens to look closely at the end of the stem. Is the dye evenly distributed across the stem or concentrated in some areas more than others? Sketch and annotate a diagram to show what you see.

## Handling experimental observations and data

6. Using your knowledge of the structure of a plant, explain what you have seen of the distribution of dye.
7. If you had left the stem in the water for another two days, what would you expect to have happened to the distribution of the dye? Explain your answer.
8. Use your findings to explain the importance of a transport system to plants.

# Learning episode B8.3 Transpiration

## Learning objectives

- Describe transpiration as the loss of water vapour from leaves
- State that water evaporates from the surfaces of the mesophyll cells into the air spaces and then diffuses out of the leaves through the stomata as water vapour
- Investigate and describe the effects of variation of temperature and wind speed on transpiration rate
- **Supplement** Explain how water vapour loss is related to: the large internal surface area provided by the interconnecting air spaces between mesophyll cells and the size and number of stomata
- **Supplement** Explain the mechanism by which water moves upwards in the xylem in terms of a transpiration pull that draws up a column of water molecules, held together by forces of attraction between water molecules
- **Supplement** Explain the effects on the rate of transpiration of varying the following factors: temperature, wind speed and humidity
- **Supplement** Explain how and why wilting occurs

## Common misconceptions

Sometimes, when students describe transpiration as the evaporation of water from leaves, they do not appreciate that the evaporation takes place inside the leaf and the actual loss of water from the leaves is by diffusion of water vapour through the stomata.

## Resources

Student Book pages 146–150

Worksheet B8.3 The rate of transpiration

B8.3 Technician's notes

Resources for class practicals (see Technician's notes)

## Approach

### 1. Introduction

Give students the following words and ask them to write sentences that use as many of the words as possible: *root hair cell, absorption, water, root xylem, stem xylem, osmosis, surface area, mineral ions*. Take examples from around the class and check that students have remembered all the key points from the previous learning episode.

### 2. Transpiration

On the day before you teach this section, place a potted plant in a plastic bag so that all the above-ground parts are enclosed, but the pot is not. Tie the bag loosely around the plant stem. Then place the plant in a bright place until the lesson. If the light is bright enough, and it is reasonably warm, condensation should be visible on the inside of the bag.

Show the plant in its bag to students and explain that the only water that plant has had was given to the roots. Ask them to explain as fully as they can why the condensation has formed inside the bag. They should be able to explain that the water in the pot has been absorbed by the roots and lost as water vapour from the leaves.

Introduce the term *transpiration* for the loss of water vapour from a leaf. Make sure that students identify *xylem* as the transport tissue through which water and dissolved mineral ions move through a plant.

### 3. Transpiration from leaves

Ask students to look at a transverse section of a plant leaf, either under a light microscope or displayed on a screen. Ask them to think about the movement of water, entering the leaf from the xylem that has carried the water from the roots and diffusing out of leaves as water vapour through stomata. They should identify the surfaces of the mesophyll cells from which water evaporates into the air spaces, and

the connection between the air spaces and stomata through which the water molecules diffuse. Take the opportunity to check understanding of diffusion from their work in Section 3: *Movement into and out of cells.*

Ask students to sketch an outline of a leaf and its key structures (including veins), and to annotate it to show how water moves through the leaf.

**Supplement** Students should relate the large surface area of the cells surrounding the air spaces to its effect on the rate of evaporation of water from the mesophyll cells. The rate of loss of water vapour by diffusion from the leaf is also related to the size and number of stomata.

**Supplement** **4. Transpiration pull**

Explain that there are forces of attraction between water molecules, so that they have a tendency to stick together. This means that if there is a tension ('pull') on one end of a column of water, such as when you suck on a drinking straw, the whole column of water is pulled along rather than breaking into separate drops.

Ask them to apply this concept to the movement of water through a plant from where it enters through the roots and exits through the leaves. They could annotate a cartoon, or draw a flow chart, that explains how water moves through the roots, stems and leaves.

**5. Factors that affect transpiration**

Worksheet B8.3 is a planning sheet on the factors that affect the rate of transpiration. It suggests equipment for producing a simple potometer, but a commercial potometer is likely to give better results if set up correctly.

If you have the equipment, consider allowing students to test their plans once you have checked them for safety and suitability. You will need to set up the potometer for them. Details are given in the Technician's notes below.

This experiment could be extended to record the movement of the bubble when leaves are removed from the stem. Ask students to predict the effect of this when the apparatus is set up, and to explain any results from this extension.

If the practical set-up is not feasible, ask students to read page 148 of the Student Book about the factors that affect the rate of transpiration. They should write a test question and answer asking how transpiration would change under different conditions (such as on a warm, still day or a cool, windy day).

Next they should exchange their question and answer with another student who should first try to answer the question, then check their answer with the one given and identify ways of improving both the question and answer.

**Supplement** Students should be expected to explain the effects of temperature, humidity and wind speed on transpiration rate using their knowledge of the effect of temperature on the kinetic energy of particles, and the effect of concentration of particles on diffusion (humidity is a measure of the concentration of water in air, and wind will move humid air away from leaves).

SAFETY INFORMATION: Wash hands thoroughly at the end of the practical. Be careful with the possibility of water being spilled close to the electrical fan.

**Supplement** **6. Wilting**

Show students a picture of a wilted plant and remind them of the effect of water loss on plant cells from Section 3: *Movement into and out of cells.*

Ask students to apply what they now know about transpiration to explain why wilting occurs

**7. Consolidation**

Students could add to their concept maps from the last two activities, to include what they have learned in this learning episode. Alternatively, ask students to write a question about plant transport tissues and transpiration, that is worth 3 or 4 marks, and the mark scheme for it.

They should exchange their question and mark scheme with another student and look for weaknesses in the other student's answer. They should suggest any amendments to improve the question or answer, then return it to the other student to discuss and change.

## Technician's notes

**Be sure to check the latest safety notes on these resources before proceeding.**

**The following resources are needed for task 2, for demonstration:**

| |
|---|
| potted plant |
| clear plastic bag |
| root section under a light microscope *or* an example displayed on a screen; transverse section of a plant leaf, either under a light microscope or displayed on a screen |

On the day before the lesson, place a potted plant in a plastic bag so that all the above-ground parts are enclosed, but the pot is not. Tie the bag loosely around the plant stem. Then place the plant in a bright place until the lesson. If the light is bright enough, and it is reasonably warm, condensation should be visible on the inside of the bag.

**The following resources are needed for the class practical B8.3, per group:**

| |
|---|
| potometer (see note above) |
| bright light (as light bank or next to bright window) |
| dim and/or dark conditions |
| light meter or sensor |
| electric fan with several settings |
| thermometer |
| access to warm area |
| access to cooler area |

If a potometer is to be set up for the demonstration or for use by students in an investigation, use the following instructions.

Use woody shoots from a bush or tree that does not have glossy leaves. Assemble the potometer underwater to prevent air bubbles entering the apparatus. (Refer to the manufacturer's instructions.) The shoot should also be cut and inserted into the potometer under water.

Allow the leaves to dry before the lesson and allow the plant to adjust to the new conditions. Just before measurement starts, insert an air bubble into the tube as described in the manufacturer's instructions, and adjust its position to sit within the scale.

If students are to carry out their plans from the worksheet, the following apparatus may be needed. However, students may suggest other apparatus. The plans should be checked to make sure that the apparatus suggested is available.

If using lamps, please note the following.

- The voltage of the bulb should not exceed the safety limits of the bench lamp. Low-energy bulbs should have some sort of protection so that they do not protrude beyond the protective metal of the bench lamp. Or they can be protected by a plastic or glass screen.
- Low-energy bulbs contain mercury and so can be hazardous if the bulb is broken.
- You should be vigilant during this practical because of water being close to electrical equipment.
- LED lights emit a very narrow range of wavelengths of light, which might not be absorbed by the plant. Halogen light sources are fine for photosynthesis, but they do get hot. A large beaker of tap water placed in front of the light source will absorb the heat.
- Potometers should be prepared in a different part of the room from the light sources.

SAFETY INFORMATION: Wash hands thoroughly after handling the plants and ventilate the room after the activity.

# Answers

## Pages 148–149 Developing Practical Skills

1. In each case you would need two potometers set up as identically as possible, or run the investigation twice with the same equipment.
   a) Take measurements at a low temperature, and also at a higher temperature (for example, with a heater nearby, but below 40 °C, when damage may start to occur to proteins/enzymes), keeping all other conditions identical.
   b) Take measurements in still air conditions, and also in windy conditions (such as using a fan), keeping all other conditions identical.
2. a) moving air/sunlight with hot/moving air/sunlight so that heat/temperature is the only factor that differs
   b)still air/sunlight compared with moving air/sunlight, or still air/dark cupboard compared with moving air/dark cupboard, because light intensity is the same in both and only the factor of wind speed differs
3. a) The rate of transpiration increases with higher temperature because the bubble moved 5 cm much more quickly (54 seconds for hot/moving/sunlight compared with 75 seconds with normal/moving/sunlight).
   b) The rate of transpiration is faster when wind speed is greater because the bubble moved 5 cm much more quickly (light: 75 seconds in moving air compared with 135 seconds in still air; dark: 122 seconds in moving air compared with 257 seconds in still air).
4. As water is transpired from the leaf, more water is drawn into the leaf from the stem, and more water is then drawn into the stem from the capillary tubing. The bubble moves with the water, so the movement of the bubble indicates how much water has been taken up by the shoot.
5. Apart from a fault in the connection between the shoot and the tubing, some water is used in photosynthesis in the leaves. (But this is usually minimal over the time of the experiment.)
6. The conclusions are based on comparing two results in each case. Carrying out repeats with the same shoot, and with shoots from the same plant, in each set of conditions would make it possible to identify any anomalous results and take averages of results, to produce more reliable conclusions.

## Page 150

1. Evaporation from the surfaces of a plant, particularly from the stomata of a leaf into the air.
2. Diagram should include annotations like the following, at the appropriate point: water molecules evaporate from surfaces of spongy mesophyll cells into air spaces; water molecules from air spaces move into and out through stomata into the air – diffusion (net movement) usually from inside leaf to outside; osmosis causes water molecules to move from xylem into neighbouring cells until they reach a palisade cell or a spongy mesophyll cell; transpiration is the evaporation of water from a leaf.
3. **Supplement** Closing stomata reduces diffusion of water molecules out of the leaf. At night, carbon dioxide is not needed for photosynthesis, so keeping stomata open would lose water unnecessarily.
4. **Supplement** a) When temperature is higher, particles move faster, so water molecules will diffuse out of the leaf more quickly.
   **Supplement** b) When air humidity is lower, there is a lower concentration of water molecules in the air outside the leaf. This increases the concentration gradient between the inside of the leaf and the outside air. This means the rate of diffusion will be faster.
5. **Supplement** Forces of attraction between water molecules means they stick to each other. So as water moves out of the xylem in the leaves, down its potential gradient into the spongy mesophyll cells, more water molecules are drawn up the xylem tube through the plant because of the forces of attraction between water molecules. This causes a water potential gradient between the root cortex cells and the xylem in the root, causing more water to enter the xylem.

# Worksheet B8.3 The rate of transpiration

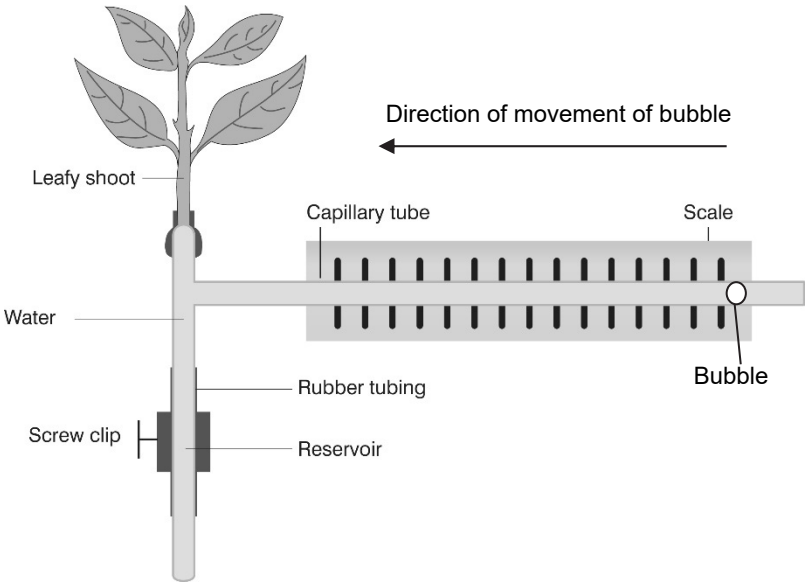
Transpiration is the loss of water vapour from the leaves of a plant. The rate of transpiration from the leaves of a plant shoot can be measured using a potometer.

There are many designs of potometer, but the diagram shows a simple version. A shoot is inserted into the apparatus and sealed so that there are no air leaks.

A bubble is introduced to the side-arm of the apparatus. The movement of this bubble is used as a measure of the amount of water lost by transpiration.

At first the screw clip is left open to let the shoot adjust to the new conditions. When the experiment begins, the screw clip is closed and the bubble's rate of movement over a fixed distance is measured.

The shoot can be exposed to different conditions to test their effect on the rate of transpiration.




## Apparatus

| | |
|---|---|
| potometer | bright light (as light bank or next to bright window) |
| dim and/or dark conditions | light meter or sensor |
| electric fan with several settings | thermometer |
| access to warm area | access to cooler area |

**SAFETY INFORMATION**

*Wash hands thoroughly at the end of the practical.*

## Planning and evaluating investigations

1. You are going to plan an investigation, using this apparatus, to test the effect of different factors on the rate of transpiration.

You will need to consider:

- which factors you will test
- how you should set up the equipment to test each of the factors
- how you will adjust each factor and what you will measure in each test
- which other factors you will need to control and how to control them
- what risks there may be in carrying out your tests and how these can be managed
- how the limitations of the method suggested will affect the conclusions you could draw from any results.

2. Write out your plan for each factor, and make a prediction for each one.

3. Show your plan to your teacher. Your teacher will tell you whether you can now carry out your plan.

# Supplement Learning episode B8.4 Translocation

## Learning objectives

- Supplement Describe translocation as the movement of sucrose and amino acids in phloem from sources to sinks
- Supplement Describe:
  (a) sources as the parts of plants that release sucrose or amino acids
  (b) sinks as the parts of plants that use or store sucrose or amino acids
- Supplement Explain why some parts of a plant may act as a source and a sink at different times

## Common misconceptions

Students may confuse the terms *transpiration* and *translocation*. Encourage them to find a way of remembering the difference, such as relating translocation to 'moving location/place' and transpiration to inspiration and expiration in human breathing. (Avoid linking it to *respiration*, as this could reinforce the misconception that respiration means breathing.)

## Resources

Student Book pages 150–151

## Approach

### 1. Introduction

Ask students what all plant cells need for growth. From earlier sections, they should be able to answer that they need the building blocks for making new substances such as proteins, large carbohydrates and fats and oils, as well as a source of energy. Then ask where these substances come from, and to suggest how they reach all cells. Students should identify the need for a transport system that is separate from xylem, and may suggest phloem as that system.

### 2. Translocation, sources and sinks

Introduce the term *translocation* as the transport of substances other than water and dissolved mineral ions around a plant. Ask students to suggest which substances might be translocated. Lead students to answers such as sucrose (produced from glucose made during photosynthesis) and amino acids (made by converting carbohydrates using nitrogen from nitrate ions absorbed from the soil).

Introduce the terms *source* and *sink* and give students a few minutes to consider where these substances may be made in a plant (their *sources*) and where they might be needed and for what purpose (their *sinks*). Provide hints such as 'growth', 'storage' and 'respiration', to help them do this. Students could use page 151 of the Student Book to help with this.

Students should consider how sources and sinks may change at different times of the year, and identify how translocation of substances may change in different seasons. Provide examples, such as the production of leaves in spring, and formation of storage organs during the autumn, for students to interpret.

### 3. Consolidation

Students complete their concept maps from the previous activities, to include what they have learned in this learning episode.

# Answers

## Supplement Page 151

1. phloem
2. sucrose and amino acids
3. A source is a part of a plant where a substance is formed e.g. sucrose is made in leaf cells. A sink is a part of a plant where the substance leaves or is converted into something else, e.g. cells in the root or fruit may be sinks for sucrose.

# Learning episode B8.5 Consolidation and summary

## Learning aims

- Review the learning points of the topic summarised in the end of topic checklist
- Test understanding of the topic content by answering the end of topic questions

## Resources

Student Book pages 152–154

## Approach

### Introduce the learning episode

Ask students to work with a partner to make a list of key words from this topic. They could then work together to produce a spider diagram showing how the different concepts are linked. They could compare their list with the list of key terms given on page 152 of the Student Book. Discuss the checklist on pages 152–153 and use questioning to see how much of the content they are comfortable with.

Students could make flashcards of the key content and then use the flashcards to quiz each other on the information.

### Develop the learning episode

Ask students to work individually through the end of topic questions on page 154 of the Student Book without looking at the text. As they work, walk around the classroom observing their answers and asking questions as necessary to find out which questions are causing difficulties.

### Finish the learning episode

After a set period, ask the students to stop working and discuss any areas of difficulty you observed as you walked round the class. Students should complete any unanswered questions for homework, but you should stress that they should try to answer the questions without looking at the text, so that they can see how much they have remembered.

# Answers

## End of topic questions mark scheme

The marks available for a question can indicate the level of detail you need to provide in your answer.

| Question | Correct answer | Marks |
|---|---|---|
| 1 | C | 1 mark |
| 2 | Clearly drawn, and fully labelled, plan diagrams for stem, root and leaf sections based on the photomicrographs in Fig. 8.3 on page 144 of the Student Book<br>(1 mark for clear drawing, 1 mark for labelling, 1 mark for correctly labelling phloem or xylem per diagram.) | 9 marks |
| 3 | They place the plant stem in water that contains soluble colouring.<br>Water is lost from the leaves of the plant due to transpiration.<br>This draws water out of the xylem in the leaves, which causes more water to be drawn up the xylem in the stem from the bottom of the stem. | 1 mark<br>1 mark<br>1 mark<br>1 mark |

| Question | Correct answer | Marks |
|---|---|---|
| | The soluble colouring is carried with the water up the xylem and into the petals. | |
| Supplement 4 | The leaves of the plant on the windowsill receive more light than those on the shelf,<br>so the stomata in the leaves of the windowsill plant will be open wider so that photosynthesis can continue as quickly as possible.<br>Wide stomata allow water molecules to diffuse out of the air spaces in the leaves more quickly.<br>If the rate at which water is lost from the leaves is greater than the rate at which water is taken in from the soil, the cells in the plant will become flaccid, causing the plant to wilt.<br>(The temperature of the air around the windowsill plant and the temperature of its leaves are also likely to be higher than for the shaded plant, increasing the rate of transpiration for the light plant compared with the shaded plant.) | 1 mark<br>1 mark<br>1 mark<br>1 mark |
| Supplement 5 | It is cooler at night<br>and transpiration rate is slower when the temperature is lower.<br>So only opening the stomata at night means the cactus loses much less water through transpiration than if the stomata opened during the hot day.<br>This increases the chance of the plant surviving in the very dry conditions. | 1 mark<br>1 mark<br>1 mark<br>1 mark |
| Supplement 6 | In the spring, the shoots and roots are growing rapidly, and new leaves develop. These parts of the plant are the main sinks at this time,<br>needing sucrose to produce glucose in cells where needed for respiration and to build the substances needed in the new tissue.<br>In spring and summer, photosynthesising leaves are the main sources.<br>In the summer, when the plant is flowering and reproducing, the flowers become a major sink for sucrose.<br>In the autumn, the leaves may be lost for winter and carbohydrates stored as starch in stems and special structures such as tubers, so these storage areas become the major sink for sucrose.<br>Next spring, the storage areas act as sources providing sucrose for growing roots, shoots and leaves. | 1 mark<br>1 mark<br>1 mark<br>1 mark<br>1 mark<br>1 mark |
| | Total: | 28 marks |