

# Macmillan Science

Teacher's Book

3

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## Preface

The Macmillan Science series is a comprehensive science course for all students in primary schools. Building on practical experience and investigation, the books follow current best practice in science education. Through engaging content and carefully graded activities and exercises, students are guided to develop a sound framework of scientific knowledge, understanding and skills.

Discussing ideas with partners and then with the whole class is central to the approach used throughout. In this way, the children acquire and improve their spoken English, but are also active learners throughout each science lesson.

There are six full-colour Pupil's Books from the level 1 to the final year of primary school. The main strands of living things (plants, animals and humans), materials, and the physical world are repeated at each grade, reinforcing ideas learnt earlier and developing these to a higher level.

Science teaching, especially when it is 'hands-on', can be highly enjoyable and rewarding for teachers and students alike. We hope that Macmillan Science will contribute both to the effectiveness of your teaching and to the pleasure that you and your class gain from studying science.

David and Penny Glover

## Components

For each level there is a Pupil's Book, Workbook and CD-ROM, accompanied by a Teacher's Book which gives clear instructions on how to plan lessons.

- The Pupil's Book contains clear illustrations and instructions for carrying out practical investigations, discussion activities and sections for the assessment of learning.
- The Workbook contains a range of different activities that enable children to review and consolidate their learning.
- The CD-ROM packaged with each Pupil's Book, provides further reinforcement and assessment of skills and concepts developed in each unit through interactive activities.

The scope and sequence is displayed at the beginning of the Pupil's Book, together with the objectives for each unit. Each of the five main areas of science is colour-coded for easy reference from one book to another.

## Teacher's Book structure

Each topic is divided into three sections: Lesson preparation, Lesson plan and After the lesson.

Lesson preparation: outlines the topic objectives, equipment needed, key words with definitions and teaching ideas and background information, linking theory with practice.

Lesson plan: detailed lesson plans including ideas for warm-up and extension activities.

After the lesson: Workbook and CD-ROM answers.

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# Introduction

## Why teach science in the primary school?

Today, the case for teaching primary science hardly needs to be stated. Science, alongside numeracy and literacy, is a core component of the primary school curriculum in schools around the world.

The reasons for teaching science at the primary level may be summarised as follows:

- investigation-based science learning develops children's curiosity, problem-solving, practical and communication skills
- basic scientific knowledge of the human body, diet, living things, the environment, materials, forces and energy contributes to children's developing awareness of themselves and their relationship to their surroundings; this knowledge will help them to make healthy choices, to keep safe and to solve problems as they move through life
- scientific values and attitudes such as respect for evidence, questioning, flexible thinking and the willingness to share knowledge and ideas are relevant in all areas of children's learning, not just science
- through science, children become aware of environmental issues and the impact that they as individuals can have on their surroundings; they develop respect for living things and their environment and become aware of the harm that simple actions such as littering, wasting energy or contaminating water supplies can cause
- in the majority of countries, science is an examination subject at the end of the final year of primary school. Children may need to perform well in science to gain a place at the secondary school of their choice
- a good knowledge of science gained in the primary school prepares children to do well in their more formal science education at secondary school. Good results in secondary school science examinations open up a wide range of career opportunities.

## Successful teaching and learning with Macmillan Science

Effective science teaching should incorporate the following components.

- 1 Plan well-resourced lessons that engage all pupils, so each one is able to participate in the discussion and the practical tasks. Most of the equipment needed for the lessons is easy to obtain, but specific measuring equipment and an assortment of containers are essential for scientific investigations.
- 2 Allow children to reflect on their prior knowledge, articulating their views about scientific ideas. Sometimes these ideas may be quite different to accepted scientific ones but are often valid from a child's point of view. They provide a key to developing scientific concepts.
- 3 Encourage children to discuss their ideas with their partners and the rest of the class so that they learn to be active learners, articulating their own ideas and listening to those of others.
- 4 Introduce the key words shown in each unit, developing a shared understanding of these and encouraging children to use them when they express their ideas. Developing working definitions for new vocabulary and using the glossary can help children to clarify meanings of scientific terms.
- 5 Try to ask 'open questions' so that children are encouraged to think through their ideas in depth rather than just recalling information. Often, inserting 'do you think' into a question can elicit a more meaningful response.
- 6 Teach scientific recording, using charts and graphic organisers. These enable comparisons to be made and reduce the amount of writing required, leaving more time for discussion and practical work.

- 7 Use the school grounds and the neighbourhood as an extension of the classroom, encouraging children to observe things that they may otherwise walk past each day.
- 8 Science is a way of thinking, not just a body of knowledge, so encourage the children to think of themselves as scientists so that they develop a wonder of the natural world and an excitement for exploring the world around them.

## Teaching a lesson

- 1 Look through the learning objectives and key words to decide how the children can be supported during the topic. The language boxes give additional ideas for how children's language needs can be addressed.
- 2 Check the resources list and ensure that there is enough equipment for all the children to participate in the practical work. Resources can be put out on each table or placed nearby so that it does not cause a distraction during the introduction to the lesson. Ideally, children should work in pairs or small groups so that each person can play an active part.
- 3 Arrange the classroom to ensure easy movement, making sure that bags and clothing are not trailing from chairs.
- 4 If an interactive white board is available, look for visual materials and video sequences that will help to reinforce vocabulary and aid concentration.
- 5 Let the children decide on their own working definitions for new vocabulary and try to develop these during the lesson, refer to the glossary for more precise meanings. Write new vocabulary and summarise children's ideas on the board to reinforce learning, especially for visual learners.
- 7 Encourage children to be active listeners, responding to the ideas of others, saying if they agree or disagree and giving reasons why. Try to develop a sense that the children are talking to each other. Get children to give reasons for their thinking rather than giving short answers to questions.
- 8 At the end of the lesson, encourage the children to reflect on their learning, saying what they found particularly interesting or perhaps difficult. Look at the objectives again and ask the class to assess whether they managed to achieve these. Invite questions about any difficulties or puzzles they may still have. Close the lesson with Check your progress.
- 9 Set the children the Workbook and CD-ROM activities as homework to consolidate their learning.

## Developing children's scientific vocabulary

To become scientifically literate, children must acquire the vocabulary they need to describe their observations and ideas. To aid with this aspect of their learning, new key words are identified in every lesson. Simple definitions for all the key words are given in the glossary at the back of the Pupil's Book, and the Teacher's Guide offers suggestions for helping children to learn these new words.

During the lesson, you could write the key words on the board as they are introduced. Children could copy the key words into their notebooks. If you print the key words on individual cards, they can be used as flashcards for reading practice. Key word cards can also be used to label displays and to play word games.

# Introduction

## General safety rules for students

Hazardous laboratory chemicals such as strong acids and alkalis should not be used in the primary school, but common household chemicals such as cleaners and paints are often introduced for various activities. These must be treated as potentially hazardous, and any safety instructions on the container followed. In general, anything which is irritating, toxic or corrosive (bleach, for example) should be handled only by the teacher.

Particular care should be taken with matches, candles and other naked flames and heat sources. In lower primary, children should not use heat sources themselves; these should only be demonstrated by the teacher. We advise against the use of spirit burners by pupils in the primary school because of the fire risk posed by fuel spills.

## Safety equipment

There is some basic safety equipment that you should have when you do an experiment. Make sure you have the following nearby:

- First Aid box. Keep your First Aid box complete at all times – if you use something up, replace it. The most important things to have in your First Aid box are First Aid instructions, plasters, small bandages, large bandages and safety pins.
- Bucket of water (with cup). Burns or chemical poisoning (either swallowed, on the skin, or in the eyes) need water. Near the water, keep a cup with which to pour the water more effectively.
- Fire blanket. A blanket should be kept for smothering fires. If someone's clothes catch fire, quickly lay the person on the floor and smother the flames with the blanket.
- Fire bucket. Fill a metal bucket with clean, dry sand and keep a long-handled scoop or ladle in it. Sand is very good for putting out fires. NEVER put out a spirit or kerosene fire with water – ALWAYS use sand.

## Field work and visits

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Nothing is as effective as first-hand experience in promoting curiosity and developing understanding of the natural world. As with any learning experience, preparation is the key to a successful field trip.

- Visit the site yourself in advance to explore what it has to offer
- If there is a warden or an education officer, discuss what he or she will show the children on the day of the visit. Brief them about the topics the children have been studying in recent lessons
- It is often helpful to prepare worksheets for the trip. These should prompt the children to find and answer questions about the important specimens/features you want them to see and understand
- Make a safety assessment before committing yourself to the trip. How many adults will you need to accompany the class? Are there any particular hazards at the site?
- Follow up the trip with a lesson in which children talk and write about their experiences.

## Lesson preparation

### OBJECTIVES

- ✓ explain what science is
- ✓ describe some of the things that scientists do to understand the world

### EQUIPMENT

#### What is science? Warm up

familiar objects such as stones, seeds or pieces of wood

#### What is science? Extension

for each child: a magnifying glass, everyday objects

### BACKGROUND INFORMATION

The children started to learn about being a scientist in levels 1 and 2. In this topic children are introduced to some of the key scientific skills that are used when carrying out investigations. Scientists, like children doing science, need to observe, question, hypothesise and experiment. It is important to convey to the children that they are behaving in the same way as real scientists, and that their findings are equally valid. Some of the most important discoveries have arisen from seemingly simple observations, such as the invention of Velcro or our understanding of gravity.

Bringing in everyday natural and manmade artefacts for children to observe and experiment with will help the children to understand how new ideas can come about and how real science works.

When children carry out practical tasks it is helpful to highlight the scientific skills they are using. Although it may seem obvious that we need to observe things carefully, this needs to be taught and practised by giving children familiar and new objects to investigate. Children naturally ask questions, so it is usually just a case of allowing them to do this. Formulating a hypothesis may be relatively new and children may need to have this type of thinking modelled for them.

It is important that children verbalise their thinking processes as they plan and carry out investigations, working.

### Language support

Key word	Elicitation ideas	Quick concept check
discoveries (n)	Show a picture of a famous scientist and their discovery.	Did they do experiments? (Yes)
experiment (n)	Show a picture of children doing an experiment.	Are they playing? (No) Are they investigating? (Yes)
hypothesise (v)	Tell children this is a set of ideas about what might happen in an experiment.	Are these sometimes good guesses? (Yes)
observe (v)	Show a picture of children watching an experiment.	Are they watching carefully? (Yes)
question (n)	Put a question mark on the board.	Do we ask these all the time in science? (Yes)

# Being a scientist

## Lesson plan

### What is science? p4

#### Warm up

Find out what the children's ideas are about what science involves by asking *What do scientists do? If you could watch a scientist working, what would they be doing? How is science different to other jobs, such as being a teacher? Do you think being a scientist is an important job?* Record some of the main ideas on the board.

Ask the children to be scientists. Give each group a familiar object such as a stone, a seed, or a piece of wood. Ask them to make three observations, to ask three questions and to think an experiment they could do to find out more about their object. Experiments might include dropping it, hitting it, or putting it in water.

#### Activity 1 p5

**Work with a partner. Read the story of the invention of Velcro. Then answer the questions. What observation did George de Mestral make? What question did he ask? How did he answer his question? What invention did his discovery lead to?**

[text to come]

#### Extension

Ask the children to devise a simple investigation in which they learn to observe, question, hypothesise and experiment. They could try one of the following:

1 What kind of tube rolls well?

Ask *Which tubes will roll best? Empty ones, half full ones or full ones?*

In fact, the half full tubes will stop on the slope as the rice settles, which may cause quite a surprise and should generate plenty of questions and discussion.

2 Fill a balloon with water and freeze it (an ice balloon). Invite questions and observations. Ask the children to think of experiments they can carry out. Ask *Will it float in water? How long will it take to melt?*

## After the lesson

### Check your progress

#### Answers

- 1 Scientists observe the things in our world. Sometimes observations lead to new discoveries and inventions.
- 2 Science is a practical way of understanding the world and everything in it. Scientists observe, question, hypothesise and experiment. Sometimes scientists make discoveries that are important for society.
- 3 George de Mestral observed that some spiny seeds fastened themselves to his trousers and dog's fur. He invented 'Velcro'.

## Lesson preparation

### OBJECTIVES

- ✓ identify some dangers in being a scientist
- ✓ explain how to do science safely

### BACKGROUND INFORMATION

As children progress through the course, science will involve more practical work, so it is important that they develop safe working practices. These include keeping the working area clear and ensuring that equipment is distributed so that children do not crowd into one area of the room. Children need to be shown how to use equipment such as scissors and knives in a safe way. Sources of heat such as candles or kettles can be used under careful adult supervision. Wherever possible, glass containers should be avoided and plastic ones used instead. Discussing some of the possible hazards shown in this section will help children to identify possible dangers for themselves and to act accordingly.

### Language support

Key word	Elicitation ideas	Quick concept check
dangers (n)	Show a picture of a lab with Bunsen burners, gas taps, etc.	Can it hurt you? (Yes)
laboratory (n)	Show a picture of a school science lab.	Is it where you do science? (Yes)
laboratory rules (n)	Point to lab rules on the wall or board. Sample marketing text © Macmillan Publishers LTD	Do they tell you what to do and not do in the lab? (Yes)
safety (n)	Show pictures of children in lab coats and goggles in a lab.	Are they safe? (Yes) Are they in danger? (No)

## Lesson plan

### Dangers in science p6

#### Warm up

Find out about the children's ideas of possible dangers in science by asking *Do you think science is dangerous?* Ask the children to talk in pairs about their ideas, giving examples of possible dangers. Record some of the ideas. Ask *Do you think doing science in school is dangerous? What can we do about it?*

#### Activity 1 p6

**Talk about the dangers in these pictures. Say how the different things could hurt you. Discuss what you should do to avoid danger in each case.**

Tell the children to look at the pictures on page 6. Ask them to talk in pairs about each picture, saying what they think the potential danger is for each item shown.

## Answers

- a kettle: the danger of boiling water causing burns or scalds. There can also be a danger caused by a trailing flex, causing the kettle to tip. Ask an adult to pour hot water and make sure that the flex is not trailing.
- b candle: this can cause burns, especially if left unattended or if someone has trailing clothes or loose hair when bending over. Candles should be at a safe distance and secured in a stand or holder, preferably in a tray of sand.
- c heavy weights can cause serious injury if dropped. They should be kept on a work surface or used on the floor.
- d a scalpel may be needed to cut things, but should only be used by an adult, as they are very sharp.
- e a needle can cause injury and needs to be handled carefully, so it is important to make sure that they are collected in after each activity as they are difficult to see if dropped.
- f scissors should be used with caution, especially if trying to cut something that is difficult to cut. They need to be stored carefully, preferably in a stand designed for the purpose. Cutting resistant materials needs to be carried out by an adult.
- g household chemicals and cleaners need to be avoided. They can cause poisoning. It is important not to taste any unknown substances. Only use safe kitchen substances in school science.

## Activity 2 p7

**Work in a group. Write a list of laboratory rules for practical work in science. Illustrate your work by making a safety poster.**

Ask the children to think of their own ideas before discussing these with the group. Ask the groups to agree on an idea and to present this to the rest of the class, and then make their poster.

Ask the group to write up their rules. It may be a good idea to limit these to five or six so that they can be read easily.

Discuss with the children the merits of posters that work well. They need to have a simple and clear illustration and legible text.

## Extension

Ask the children to work in small groups, to develop a small drama or role play about an accident that happened in science.

## Check your progress

### Answers

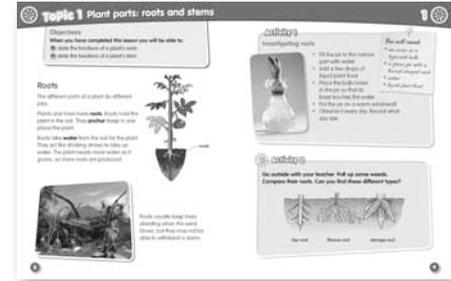
- 1 Scientists carry out experiments in a science laboratory. There may be dangers when performing experiments. When working in the laboratory you must follow the laboratory rules. The rules are designed for the safety of everyone.
- 2 a hot flame, a hot kettle; sharp scissors, a sharp knife; a heavy weight
- 3 a to keep hair away from the experiments and so you can see well, b to keep your eyes safe



# Plants

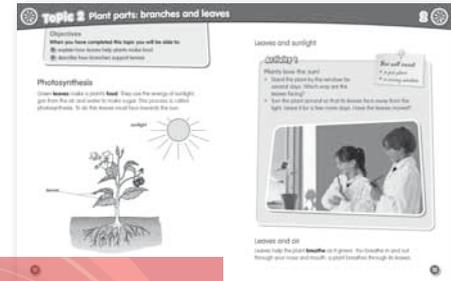
## Topic 1 Plant parts: roots and stems PB p8-11

- State the functions of a plant's roots
- State the functions of a plant's stem



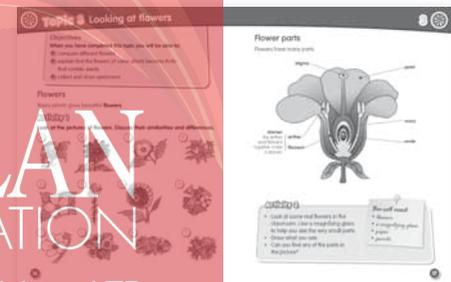
## Topic 2 Plant parts: branches and leaves PB p12-15

- Explain how leaves help plants make food
- Describe how branches support leaves



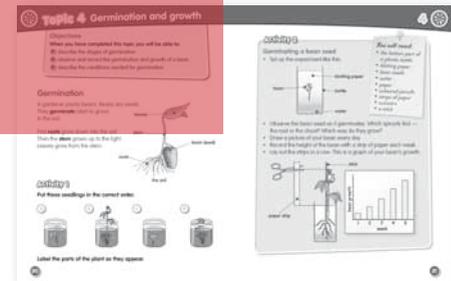
## Topic 3 Looking at flowers PB p16-19

- Compare different flowers
- Explain that the flowers of some plants become fruits that contain seeds
- Collect and draw specimens



## Topic 4 Germination and growth PB p20-23

- Describe the stages of germination
- Observe and record the germination and growth of a bean
- Describe the conditions needed for germination



## Review questions PB p24-25

### Level 1

- Topic 1 The things around us
- Topic 2 Plants and their parts
- Topic 3 The importance of plants
- Topic 4 Seeds

### Level 2

- Topic 1 Plant life
- Topic 2 Plants we eat
- Topic 3 Making things from plants
- Topic 4 How do plants grow?

# Topic 1 Plant parts: roots and stems

## Lesson preparation

### OBJECTIVES

- state the functions of a plant's roots
- state the functions of a plant's stem

### EQUIPMENT

#### Roots Warm up

pot plants, a weed or small plant

#### Activity 1

for each group: an onion or hyacinth bulb, a glass jar with a funnel-shaped neck, water, liquid plant food

#### Roots Extension

a camera, a plant that has been in its pot for several years

#### Activity 3

white flowers, a tomato plant, food colouring, jars, a knife, a teaspoon, water, a magnifying glass

### BACKGROUND INFORMATION

Children have been introduced to the parts of a plant in levels 1 and 2, so should have some basic knowledge of this topic already. The roots of plants tend to be hidden from view unless trees are uprooted in a storm, or plants are pulled out of a pot or the ground. The parts of a plant underground can be just as extensive as the branches and leaves above ground. The roots of most common deciduous trees spread just as far underground as the canopy spreads above ground. On the other hand, palm trees tend to have thin roots and a fairly small root ball. This explains why they are often planted close to paving and pools.

Roots take in water and also help to anchor the plant or tree into the ground. In addition to water, roots also take in vital trace minerals that are essential for cell growth and for the formation of chlorophyll.

Stems support the plant and, depending on the type of plant, they are green and fairly soft, or hard and woody. In both cases, stems are fairly flexible and are able to bend without breaking when it is windy. Palm trees are particularly flexible and can bend over in a storm, whereas trees with thicker trunks such as oaks or conifers may break in storm force winds.

Plant stems perform two basic functions: they support the leaves and flowers, and they carry water and food from one place to another in the plant. The main stem of a plant continues to grow throughout the life of the plant.

### Language support

Key word	Elicitation ideas	Quick concept check
anchor (v)	Show a picture of a ship's anchor.	Does it keep the boat in one place? (Yes) Does it hold it down? (Yes)
phloem (n)	Show a cross-section of a plant or tree and point out the phloem.	Does it carry food to the plant? (Yes) Is it alive? (Yes)



roots (n)	Show a plant with obvious roots, eg an orchid.	Is it living? (Yes) Is it anchored in the ground? (Yes)
stem (n)	Show a plant with a stem.	Does it hold the plant up? (Yes)
supports (v)	Show the stem again, and how it holds the plant up.	Does the plant need the stem? (Yes) Does it hold it up? (Yes)
trunk (n)	Show a picture of a tree trunk.	Does it hold the tree up? (Yes) Is it strong? (Yes)
veins (n)	Show the veins on a plant leaf.	Do they carry water? (Yes) Does the plant need them? (Yes)
water (n)	Run a tap or show a picture of water running.	Do plants need it? (Yes) Do we need it to live? (Yes)
xylem (n)	Show a cross-section of a tree or plant.	Does it carry water? (Yes) Is this part alive? (No)

## Lesson plan

### Roots p8

#### Warm up

Show the children some pot plants or go outside to look at a variety of plants and trees. Ask *What are the parts of a plant for?* In pairs, ask the children to tell you what the different parts of a plant are for. Explain that they are going to find out more about stems and roots.

Pull a weed or small plant out of the soil so that its roots are visible. Ask the children to make a quick sketch of a plant with both roots and stem. Ask *Can you annotate your drawing, saying what you think the stem and root are for?* Ask the children to explain their drawings to their partner.

Collect the ideas held by the class and display these on the board as radial maps – one for roots and the other for stems.

Tell the children to look at page 8. Read to the children the text about roots. Compare the information here with the children's ideas displayed on the board. Check for any vocabulary that may be unfamiliar and clarify the meanings of any new words.

#### Activity 1 p9

##### Investigating roots

Ask each group to fill a glass jar with water and add a few drops of plant food. Ask them to place the onion or hyacinth bulb so that it touches the water, and put it on a warm windowsill. Help the children to remember to observe their bulb or onion each day, and to record what they see.

#### Activity 2 p9

**Go outside with your teacher. Pull up some weeds. Compare their roots. Can you find these different types?**

Take the class outside to pull up some weeds. It may be a good idea to water the soil first so that the roots do not break off from the plants. Ask the children to carefully pull up some different sorts of weeds, shake off excess soil and lay the weeds on some paper. Try to find some tap roots, fibrous roots and storage roots.



Ask the children to take some of the roots back to the classroom and compare them to the pictures of tap, fibrous and storage roots shown on page 9. You could ask the children to photograph or sketch some of the root samples.

### Extension

Take the children to look around a park or the school grounds for roots that are showing above ground. Photograph some of these to show the variety of roots that can be found.

Bring in a plant that has been in its pot for several years for the children to look at. Gently tip it out. The roots probably fill the pot and may have begun to curl round the edge of the pot. Tell the children that ideally a plant like this should be put into a larger pot so that its roots can continue to grow.

## Stems p10

### Warm up

Water is taken in at the roots by a process called osmosis. Osmosis is the movement of a substance through a membrane. Water moves because the amount of water in the soil is more than the amount of water in the roots. The water travels up through the xylem of the root and stem into the leaves of the plant. Cutting through a stem dipped in food colour helps to highlight the bundles of phloem and xylem. Alternatively, these can be seen as strings in bananas or felt as veins on leaves.

Ask *Have you ever watered plants in your home or garden? Usually we say we water the plant, but actually, we mainly water the ground. How do you think the water goes into the plant?* Ask the children to discuss ideas in pairs and then share these with the class.

Tell the children to look at page 10 and read about stems. Check for any vocabulary that may be unfamiliar and clarify the meanings of any new words. Compare the information here with the children's ideas about stems.

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### Activity 3 p11

#### Investigating stems

This is an experiment to show that water travels up through the stem to the flower. By adding colour to the water, the children can see the white flowers change colour once the coloured water reaches them.

Ask the children to take a fresh white flower. Cut through the stem at the base with a knife for them. Ask them to place the stem in some water containing food colouring and leave it in a warm place overnight. Look at the flowers together in the morning and discuss what has happened. The flowers should change colour as the water containing food colouring is drawn up the stem. Encourage the children to think of their own explanations of why the flowers change colour. Ask them to talk in pairs explaining their idea to their partner.

Repeat the experiment with a soft-stemmed plant such as a tomato plant. Cut through the stem and it should be possible to see the tubes (xylem and phloem) that carry the water inside the stem, coloured by the food colouring.

### Extension

Ask the children to use the internet to find out about some amazing stems such as the giant Redwoods in California (Sequoia) or really tall bamboo.

Ask the children to look at websites for botanical gardens such as Kew Gardens in London, England; The Walter Sisulu National Botanic Garden, South Africa or the Botanic Garden in Aswan, Egypt. Ask the children to find out more about some of the amazing plants growing there.



## Check your progress p11

### Answers

- 1 A plant's roots anchor it in the soil. A plant's stem supports the branches and leaves. The roots take water from the soil. Water travels through veins in leaves.
- 2 Children label the roots and stem of the plant.
- 3 B

## After the lesson

### Workbook p4-7

### Answers

- 1 roots: take water from the soil, anchor the plant; stem: carries water to leaves and flowers, supports branches and leaves
- 2 a false, b true, c false, d true
- 3 The children should demonstrate what happens to the coloured water by drawing arrows to show how it travels up the stem.
- 4 a tap, b fibrous, c storage
- 5 6 years, 9 years, 11 years
- 6 a soil, b ground, c veins, d leaves
- 7 Stem: carries water to leaves, supports plant; Roots: anchor plant, take up water
- 8 Children read the text and choose the plant part: roots, stem

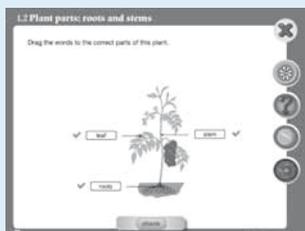
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### CD-ROM

Children complete topic 1 of the CD-ROM.

### Answers

1. 1 **Drag the words to the correct gaps to make sentences.**
  - 1 A plant's roots **anchor** it in the soil.
  - 2 The roots take **water** from the soil.
  - 3 A plant's **stem** supports its leaves and branches.
  - 4 Water travels through tiny tubes called **veins** inside a plant.
1. 2 **Drag the words to the correct parts of this plant.**



1. 3 **Drag the correct root types to each picture.**
  - 1 (picture of tap root) tap root
  - 2 (picture of tap fibrous root) fibrous root

Overmatter at the end of the file.  
We need to cut 6 lines.