3 THE PLANT KINGDOM

In this unit students learn about the plant kingdom. Students will understand that plants are very important organisms and not just decorative parts of a landscape. Plants are essential for the survival of other organisms, as we have seen in previous units. Students will be able to identify the parts of plants and how these parts relate to the vital functions. They will also find out the most common uses humans have for plants.

Objectives

LEARNING OBJECTIVES
▮ Describe the characteristics that are found in all plants.
▮ Recognise the most common plants which are typical of their taxonomic classes.
▮ Identify the most important parts of plants and describe what their functions are.
▮ Explain how plants have evolved from the beginning of life on Earth to the present day.
▮ Describe the process of autotrophic nutrition and relate it to the importance of plants for other living things.
▮ Analyse the relationship between human beings and plants.
▮ Carry out a research task.

Mixed-ability needs

In order to meet the needs of students of different abilities, a wide variety of classroom resources are provided as complements or alternatives to the work in the unit: worksheets, lesson summaries, slide show presentations with core content and curricular adaptations. Also, since science combines many skills, it is important to pair up students of mixed abilities, so that they can support each other.

The mixed-ability resources are to be used at the teacher's discretion, although each lesson contains suggestions.

Suggested Timing

This unit can be worked on over a period of four weeks (approximately 11 sessions). The number of sessions should be determined by the interest that students show for the content and by the general unit planning.

Sections	N.° of sessions
Warmer	1
1. The plant kingdom	1
2. Parts of a plant	3
3. Seedless plants	1
4. Plants with seeds	1
5. Plants and us	1
Consolidation	1
Work and experimentation techniques	1
Final task	1

UNIT LESSON PLAN		
Contents	**Assessment criteria**	**Learning outcomes**
The Plant kingdom ▮ Classification of plants ▮ The characteristics of plants	1. Identify plants according to criteria.	1.1. Classify plants according to a range of criteria. (MCST)
	2. Describe the characteristics of the Plant kingdom and its importance for other living things.	2.1. Describe the general characteristics of plants and their importance. (LC, MCST)
Parts of a plant ▮ Roots: absorption and anchoring ▮ Stem: conducting vessels ▮ Leaves: synthesising organic matter ▮ Flowers: the reproductive organs	3. Relate each part of the plant with its adaptation to the environment.	3.1. Identify the parts and the importance of the root. (LC, MCST, DC, LL, SIE)
		3.2. Identify the parts and the importance of the stem. (LC, MCST, DC, LL, SIE)
		3.3. Identify the parts and the importance of the leaf. (LC, MCST, DC, LL, SIE)
		3.4. Identify the parts and the importance of the flower. (LC, MCST, DC, LL, SIE)
Seedless plants ▮ Bryophytes: hepatic plants and mosses ▮ Pteridophytes: ferns	4. Identify the main characteristics that make seedless plants different.	4.1. Identify characteristics of bryophytes. (LC, MCST, LL, SIE)
		4.2. Identify characteristics of pteridophytes. (LC, MCST, LL, SIE)
Plants with seeds ▮ Gymnosperm plants ▮ Angiosperm plants	5. Identify the main characteristics that make plants with seeds different.	5.1. Identify characteristics of gymnosperms. (LC, MCST, LL, SIE)
		5.2. Identify characteristics of angiosperms. (LC, MCST, LL, SIE)
Plants and us ▮ Plant uses ▮ Natural and artificial vegetation	6. Value the importance of plants for humans.	6.1. Relate characteristics of plants (or parts of plants) with the uses humans have for them. (LC, MCST, DC, SIE)

LC: Linguistic communication; **MCST**: Mathematical competence and basic competences in science and technology; **DC**: Digital competence; **LL**: Learning to learn; **SIE**: Sense of initiative and entrepreneurship; **SCC**: Social and civic competence.

UNIT CONTENT MAP

STUDENT RESOURCES

Oxford investigation > > > > > >

Interactive activities > > > > > >

Talking book > > > > > >

Video 1: Introduction to plants

Weblink 1: Plant cells

Video 2: Parts of a plant
Video 3: Photosynthesis
Science experiment: Observing the different parts of a flower
Animation: Reproduction in flowering plants
Video 4: Pollination rock

Video 5: Fern: the life cycle

Weblink 2: Seed dispersal

Unit 3. The Plant kingdom

1. The plant kingdom
- 1.1. Classification of plants
- 1.2. The characteristics of plants

2. Parts of a plant
- 2.1. Roots: absorption and anchoring
- 2.2. Stem: conducting vessels
- 2.3. Leaves: synthesising organic matter
- 2.4. Flowers: the reproductive organs

3. Seedless plants
- 3.1. Bryophytes: hepatic plants and mosses
- 3.2. Pteridophytes: ferns

4. Plants with seeds
- 4.1. Gymnosperm plants
- 4.2. Angiosperm plants

TEACHER RESOURCES

Concept map
Presentation

Video 2 worksheet
Video 3 worksheet
Video 4 worksheet

Video 5 worksheet

Weblink 2 worksheet

Reinforcement worksheets > > > > > >

Curricular adaptation worksheets > > > > > >

> > > > > > Oxford investigation

> > > > > > Interactive activities

> > > > > > Talking book

Weblink 3: Plants and us

5. Plants and us
5.1. Plant uses
5.2. Natural and artificial vegetation

Consolidation

Work and experimentation techniques
The height of trees

Final task
Plants around me

Weblink 3 worksheet

Concept map
Presentation
Extension activities

Competence test
Unit tests

> > > > > > Reinforcement worksheets

> > > > > > Curricular adaptation worksheets

TEACHING SUGGESTIONS

3 THE PLANT KINGDOM

YOU WILL LEARN TO...

- Describe the characteristics that are found in all plants.
- Recognise the most common plants which are typical of their taxonomic classes.
- Identify the most important parts of plants and describe what their functions are.
- Explain how plants have evolved from the beginning of life on Earth to the present day.
- Describe the process of autotrophic nutrition, and relate it to the importance of plants for other living things.
- Analyse the relationship between human beings and plants.
- Carry out a research task.

- *What do all plants have in common?*
- *What are the three basic organs which most plants share? What are their functions?*
- *How do plants without flowers or seeds, such as ferns, reproduce?*
- *Are pine nuts, which are sold and eaten as dried nuts, really nuts?*
- *Can you think of some ways in which humans benefit from plants?*

Final task

Plants around us

If we look carefully in parks, gardens and in certain other areas of our cities and villages, we can see many plants. Most of them have been planted by people in order to get various products or to make the landscape look more attractive. However, some of these plants were already part of the landscape before human activity was involved.

In this unit, you are going to learn about the characteristics of plants that allow us to recognise and classify them.

Using some simple identification criteria, you will learn how to recognise the most common plants in your local area. You will also create a dichotomous key to identify them.

3 The plant kingdom 45

Students look at the image carefully trying to work out how many types of plants they can see. Some of the plants that can be seen in the image are ferns, mosses and other trees, which are probably conifers. Get them to work in pairs to write down as many plant names as they can. Students are allowed to write any names they know: names of fruits, flowers, herbs or any other plant-related term.

Write the terms on the board and then ask:

What makes plants different from each other?

Plants are different in many ways as we will see in this unit. The two main groups of plants are flowering and non-flowering plants.

Ask students to read the objectives in pairs or groups. When they have finished they should discuss the objectives' meanings and explore any prior knowledge they may have.

Create a spidergram on the board (or ask groups to draw their own on large pieces of paper) and allow students to contribute concepts and ideas that relate to the unit or the objectives (knowledge about living things, classification of living things, any prior knowledge of microorganisms, viruses, microscopes). Discuss as a class.

Finally, ask students to draw their own spidergram in their notebooks. This activity can be revisited at the end of the unit, for assessment. Students can add to it, using different colours each time different concepts are learned.

Before playing the following video, ask questions so that the students can think about them while watching it.

- *Where in the world are plants found?*
- *How are plants important to habitats?*

Students can share their prior knowledge of these two questions. Do not worry if they are unsure as the video will stimulate and motivate them.

Video 1: **INTRODUCTION TO PLANTS**
This video displays great footage of plants across the world.

Discuss students' understanding of the video. Have they changed their minds about where plants can be found? Discuss how plants are found everywhere on Earth and discuss the meaning of the following statement: *Plants make up the backbone of habitats.*

The following questions are designed to continue to spark student's thoughts:

- *What do all plants have in common?*

  Plants have a particular type of cells: eukaryote plant cells that have a cell wall made of cellulose. They are all multicellular organisms that perform autotrophic nutrition and perform photosynthesis. Plants have tissues.

- *What are the three basic organs which most plants share? What are their functions?*

  The roots: their main function is to absorb water and minerals from the environment as well as to anchor the plant to the

ground. The stem, which carries the water and minerals to the leaves, which in turn perform photosynthesis.

- *How do plants without flowers or seeds, such as ferns, reproduce?*

  They reproduce by using asexual spores, which are produced by the sporophyte and the gametophyte.

- *Are pine nuts, which are sold and eaten as dried nuts, really nuts?*

  No. They are the seeds of pine trees. Pine trees are gymnosperm plants and do not produce fruits, they only produce naked seeds.

- *Can you think of some ways that humans benefit from plants?*

  Humans use plants in many different ways: they are made into food, medicines, raw materials and even for ornamental purposes.

PRESENTATION

Use the slideshow presentation to show the different sections in the unit and to evaluate students´ prior knowledge. The slides can stimulate student participation, as students can be asked about certain topics before they study them. This tool can also be used as revision at the end of the unit.

Point out the **Final task** to the students: **Plants around me.** Ask them to read the text briefly, in pairs, to find out the main objectives of the investigation. Students should then explain the task to the class, using full sentences. Write some sentence openers on the board to help them if necessary:

In this investigation we will… We will also have to create….

Ask: *What type of identification criteria would we use to classify plants? Would it be objective and discriminatory? What is a dichotomous key?*

Students should remember from the previous unit the meaning of the terms just mentioned.

Explain that the steps to carry out the final task are on page 63 of the Student's book.

At the end of the first session you could introduce the vocabulary suggested in the **Study skills** section on page 61 of the Student's Book. They are: *anemophily, chloroplast, conifer, spermatophyte, stoma, phloem photosynthesis, fruit, inflorescence, nerve, vascular* and *xylem.*

As a class, read the definitions of these words or ask students to define the words themselves. Discuss which particular images could be suitable for each term. Students can scan through the unit to locate the terms as well as explore other new vocabulary. They can use the diagrams and pictures as inspiration for their visual representations.

Ask: *Which image would you use to represent the term photosynthesis? And how about a conifer?*

Discuss students' ideas. Then get them to do their own visual dictionary. When they have finished ask students to share their work with the class.

In addition, students could work in groups to create graphic organisers in their notebooks. Graphic organisers allow students to interact with the word in a variety of ways, from a variety of angles, to reach a fuller understanding of its meaning.

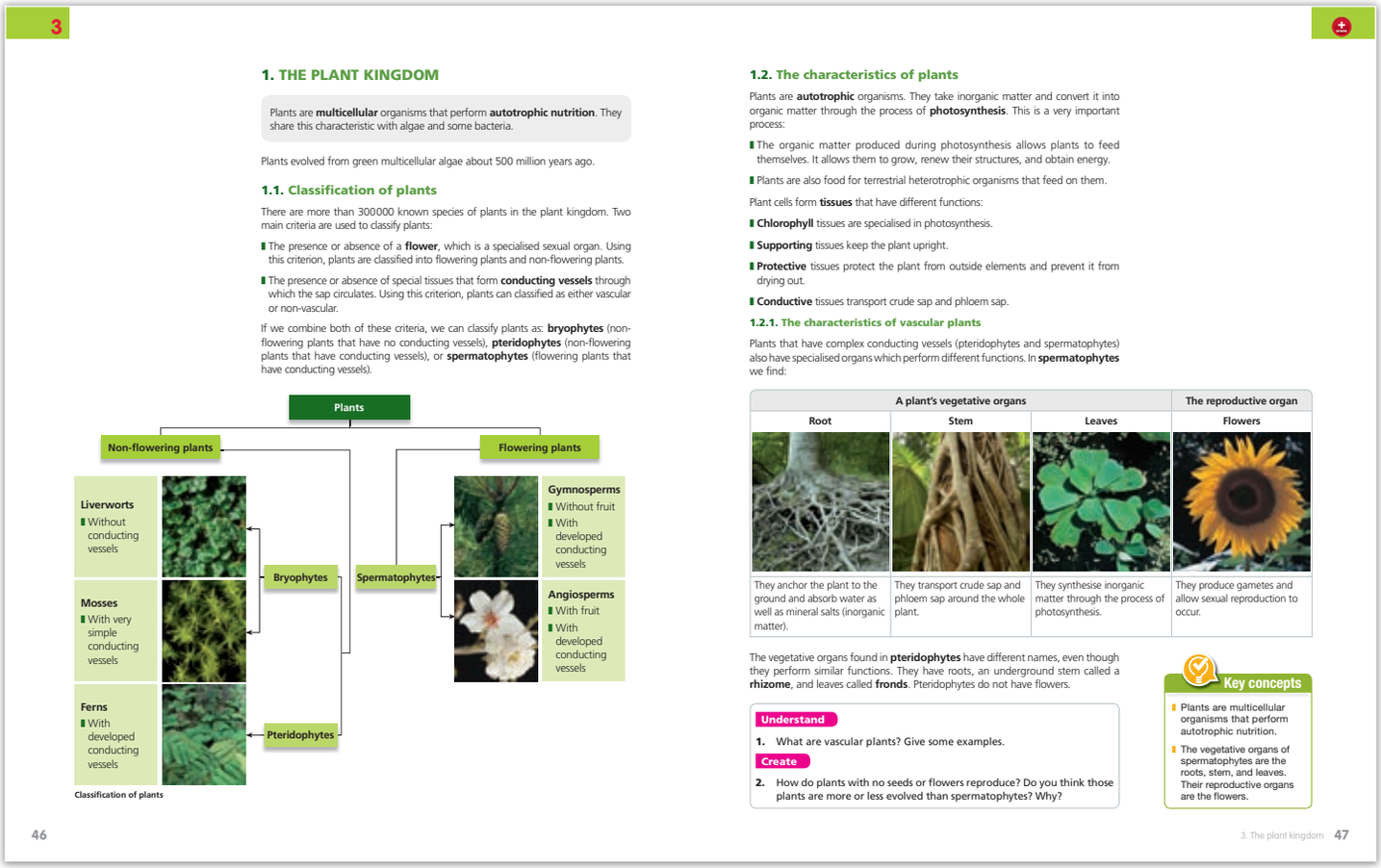
In groups, the students should write a word in the middle of a rhombus and label each corner *synonym*, *sentence*, *picture* and *definition*. They should then find or create a definition for the word; find a synonym or create a small phrase that means the same (2-5 words); put the word into a sentence and finally, create a picture that embodies its meaning.

CONCEPT MAP

To introduce the contents of the unit, you could show an incomplete concept map and ask students to complete the gaps, either in their notebook or orally with the whole group. This will help students visualise the links between the different contents of the unit. This tool can also be used as revision at the end of the unit.

OXFORD INVESTIGATION

It starts with an **introduction** of the unit with some preliminary questions and the **final task** that should be carried out after finishing the activities. The final task is normally a practical problem whose solution demands a variety of learning skills and research. Students will be given the idea that in particular activities they will learn concepts and/or the procedures that will be used to sort out the practical problem.



3

1. THE PLANT KINGDOM

Plants are **multicellular** organisms that perform **autotrophic nutrition**. They share this characteristic with algae and some bacteria.

Plants evolved from green multicellular algae about 500 million years ago.

1.1. Classification of plants

There are more than 300000 known species of plants in the plant kingdom. Two main criteria are used to classify plants:

- The presence or absence of a **flower**, which is a specialised sexual organ. Using this criterion, plants are classified into flowering plants and non-flowering plants.
- The presence or absence of special tissues that form **conducting vessels** through which the sap circulates. Using this criterion, plants can classified as either vascular or non-vascular.

If we combine both of these criteria, we can classify plants as: **bryophytes** (non-flowering plants that have no conducting vessels), **pteridophytes** (non-flowering plants that have conducting vessels), or **spermatophytes** (flowering plants that have conducting vessels).

Classification of plants

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1.2. The characteristics of plants

Plants are **autotrophic** organisms. They take inorganic matter and convert it into organic matter through the process of **photosynthesis**. This is a very important process:

- The organic matter produced during photosynthesis allows plants to feed themselves. It allows them to grow, renew their structures, and obtain energy.
- Plants are also food for terrestrial heterotrophic organisms that feed on them.

Plant cells form **tissues** that have different functions:

- **Chlorophyll** tissues are specialised in photosynthesis.
- **Supporting** tissues keep the plant upright.
- **Protective** tissues protect the plant from outside elements and prevent it from drying out.
- **Conductive** tissues transport crude sap and phloem sap.

1.2.1. The characteristics of vascular plants

Plants that have complex conducting vessels (pteridophytes and spermatophytes) also have specialised organs which perform different functions. In **spermatophytes** we find:

A plant's vegetative organs			The reproductive organ
Root	Stem	Leaves	Flowers
They anchor the plant to the ground and absorb water as well as mineral salts (inorganic matter).	They transport crude sap and phloem sap around the whole plant.	They synthesise inorganic matter through the process of photosynthesis.	They produce gametes and allow sexual reproduction to occur.

The vegetative organs found in **pteridophytes** have different names, even though they perform similar functions. They have roots, an underground stem called a **rhizome**, and leaves called **fronds**. Pteridophytes do not have flowers.

Understand

1. What are vascular plants? Give some examples.

Create

2. How do plants with no seeds or flowers reproduce? Do you think those plants are more or less evolved than spermatophytes? Why?

Key concepts

- Plants are multicellular organisms that perform autotrophic nutrition.
- The vegetative organs of spermatophytes are the roots, stem, and leaves. Their reproductive organs are the flowers.

3. The plant kingdom 47

1. The plant kingdom

Ask: *Can you recall any characteristics all plants share?*

Make sure students understand that they are multicellular organisms and that they perform autotrophic nutrition.

Students read the highlighted information as well as the following paragraph. Then ask the following questions:

- *When did the first plants appear on Earth?*

  500 million years ago
- *Which other multicellular organism did plants evolve from?*

  Algae
- *Can you name something plants have that algae do not have?*

  Tissues
- *Can you identify a very important process that plants and algae do?*

  Photosynthesis

1.1. Classification of plants

Ask students to guess how many known species of plants there are in the world. Take some of their guesses and then ask students to read the first paragraph to find out.

Ask: *Can you remember what type of criteria we can use to classify living things? Would you use beauty or nice smell as identification criteria?*

No, because that would be subjective criteria. The criteria used to classify plants needs to be objective and discriminatory.

Ask students to read the following two bullet points to find out two main criteria to classify plants. Ask them to discuss in pairs and then feed back to the class. Write on the board using their contributions:

- *Plants that have flowers and plants that do not have flowers.*
- *Plants that have conducting vessels and plants that do not have conducting vessels.*

Students then read the final paragraph.

Play *Who am I?* with students using the diagram that shows a general plant classification. The questions can be used in preparation for the creation of dichotomous keys, as they will be very similar.

- *I am a non-flowering plant without conducting vessels.*

  Liverwort
- *I am a spermatophyte that produces fruits.*

  Angiosperm

Let students play the same game in pairs for a few minutes, so that they become familiar with the criteria used to classify plants.

1.2. The characteristics of plants

Students should be able to recall some of the general characteristics of plants: *autotrophic nutrition*, *eukaryote cells*, *and so on*.

Draw a plant on the board (it does not matter which plant as long as it has roots, a stem and leaves). Ask the students to read the section.

Ask students to suggest ways in which we could create a diagram that shows some of the characteristics of plants: for example, label the plant diagram with the word chlorophyll and draw an arrow joining the term and the leaves of the plant.

Ask students to create their own diagrams in their notebooks, labelled with the following terms: *autotrophic, photosynthesis,*

chlorophyll, supporting tissues, protective tissues and *conductive tissues.*

When they have finished select a few students to explain their diagrams back to the class.

Use the following link to have a look at a 3-D structure of a plant cell. Students learn parts of a plant cell and learn their functions. Do the activities as a whole class using the interactive whiteboard if you have one; alternatively, students can use the link as part of their homework or on laptops/computers.

Weblink 1: **PLANT CELLS**
This interactive activity will help students explore plant cells.

1.2.1. The characteristics of vascular plants

Ask: *Can you remember the two types of plants that have developed conducting vessels?*

Establish that the plants that have conducting vessels are spermatophytes and gymnosperms.

Students read the table to find the parts that are common to spermatophytes (vegetative organs: root, stem, leaves and their reproductive organs, which are flowers). Ask students to read the paragraph below the table to find out what the vegetative organs in pteridophytes are. Then ask them:

What do we call the underground stem found in pteridophytes?

Rhizome

What do we call the leaves of pteridophytes?

Fronds

Students can add the terms rhizome and fronds to their graphic organisers.

Students complete question 1 individually. Students can complete question 2 at home as a homework activity and do some research about seedless plants.

Write the following sentences from the **Key concepts** section on the board and tell students to fill in the gaps with the key words below (write the key words on the board but not in the correct order.

- *Plants are ___ organisms that perform ___ nutrition.*
- *The vegetative organs of ___ are the roots, ___ , and leaves. Their ___ organs are the flowers.*

Answers: multicellular, autotrophic, spermatophytes, stem, reproductive

EXTRA RESOURCES
AUDIO
TALKING BOOK
PDF
REINFORCEMENT WORKSHEET 1
CURRICULAR ADAPTATION WORKSHEET 1
INTERACTIVE ACTIVITIES

Answer key

Understand

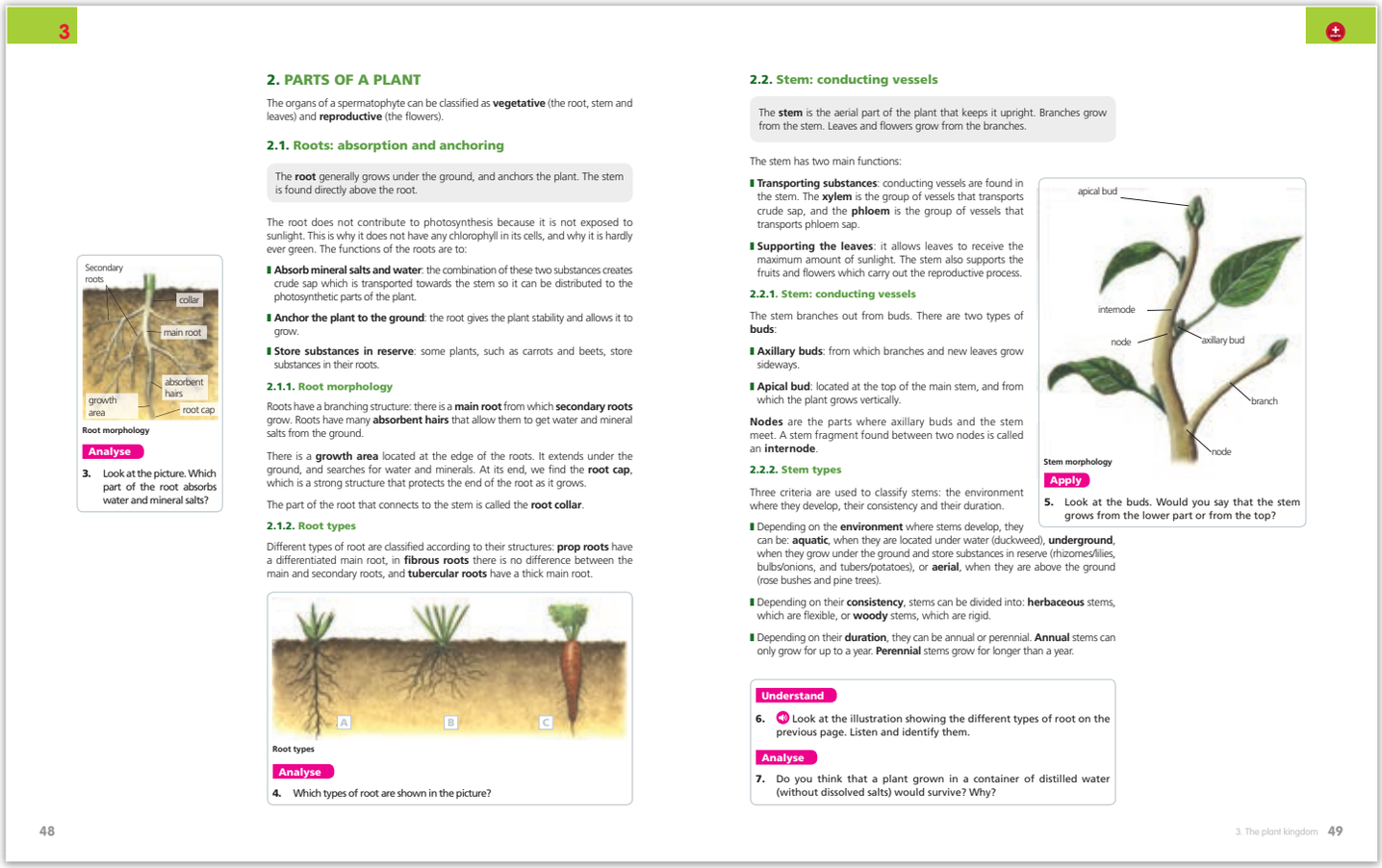
1. What are vascular plants? Give some examples.

Vascular plants have conducting vessels that carry crude or phloem sap. All flowering plants are vascular plants such as olive trees, geraniums, poppies...

Create

2. How do plants with no seeds or flowers reproduce? Do you think those plants are more or less evolved than spermatophytes? Why?

They use spores, which are specialised cells from which a new individual originates, and gametes that perform sexual reproduction; however they are never formed in a reproductive organ (flower). Instead the process takes place in a different individual (alternating life cycle). These types of plants are more primitive because the presence of flowers is an evolutionary specialisation.



3

2. PARTS OF A PLANT

The organs of a spermatophyte can be classified as **vegetative** (the root, stem and leaves) and **reproductive** (the flowers).

2.1. Roots: absorption and anchoring

The **root** generally grows under the ground, and anchors the plant. The stem is found directly above the root.

The root does not contribute to photosynthesis because it is not exposed to sunlight. This is why it does not have any chlorophyll in its cells, and why it is hardly ever green. The functions of the roots are to:

- **Absorb mineral salts and water**: the combination of these two substances creates crude sap which is transported towards the stem so it can be distributed to the photosynthetic parts of the plant.
- **Anchor the plant to the ground**: the root gives the plant stability and allows it to grow.
- **Store substances in reserve**: some plants, such as carrots and beets, store substances in their roots.

2.1.1. Root morphology

Roots have a branching structure: there is a **main root** from which **secondary roots** grow. Roots have many **absorbent hairs** that allow them to get water and mineral salts from the ground.

There is a **growth area** located at the edge of the roots. It extends under the ground, and searches for water and minerals. At its end, we find the **root cap**, which is a strong structure that protects the end of the root as it grows.

The part of the root that connects to the stem is called the **root collar**.

2.1.2. Root types

Different types of root are classified according to their structures: **prop roots** have a differentiated main root, in **fibrous roots** there is no difference between the main and secondary roots, and **tubercular roots** have a thick main root.

Secondary roots
collar
main root
absorbent hairs
growth area
root cap

Root morphology

Analyse

3. Look at the picture. Which part of the root absorbs water and mineral salts?

A B C

Root types

Analyse

4. Which types of root are shown in the picture?

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2.2. Stem: conducting vessels

The **stem** is the aerial part of the plant that keeps it upright. Branches grow from the stem. Leaves and flowers grow from the branches.

The stem has two main functions:

- **Transporting substances**: conducting vessels are found in the stem. The **xylem** is the group of vessels that transports crude sap, and the **phloem** is the group of vessels that transports phloem sap.
- **Supporting the leaves**: it allows leaves to receive the maximum amount of sunlight. The stem also supports the fruits and flowers which carry out the reproductive process.

2.2.1. Stem: conducting vessels

The stem branches out from buds. There are two types of **buds**:

- **Axillary buds**: from which branches and new leaves grow sideways.
- **Apical bud**: located at the top of the main stem, and from which the plant grows vertically.

Nodes are the parts where axillary buds and the stem meet. A stem fragment found between two nodes is called an **internode**.

2.2.2. Stem types

Three criteria are used to classify stems: the environment where they develop, their consistency and their duration.

- Depending on the **environment** where stems develop, they can be: **aquatic**, when they are located under water (duckweed), **underground**, when they grow under the ground and store substances in reserve (rhizomes/lilies, bulbs/onions, and tubers/potatoes), or **aerial**, when they are above the ground (rose bushes and pine trees).
- Depending on their **consistency**, stems can be divided into: **herbaceous** stems, which are flexible, or **woody** stems, which are rigid.
- Depending on their **duration**, they can be annual or perennial. **Annual** stems can only grow for up to a year. **Perennial** stems grow for longer than a year.

apical bud
internode
node
axillary bud
branch
node

Stem morphology

Apply

5. Look at the buds. Would you say that the stem grows from the lower part or from the top?

Understand

6. Look at the illustration showing the different types of root on the previous page. Listen and identify them.

Analyse

7. Do you think that a plant grown in a container of distilled water (without dissolved salts) would survive? Why?

3. The plant kingdom 49

2. Parts of a plant

Ask students to recall the vegetative parts of spermatophytes (roots, stem and leaves) and the name of their reproductive parts (flowers). If they are unsure, tell them to read the paragraph in their textbooks.

2.1. Roots: absorption and anchoring

Before reading this section, ask students to discuss in pairs what they already know about roots. They probably know that they absorb nutrients. Then, tell them to read the section in pairs and answer the following questions:

- *Where do roots normally grow?*

  In the soil
- *Are the roots involved in the photosynthesis process? Why?*

  No, they are not because they are not exposed to sunlight.
- *What are the functions of the roots?*

  Absorb minerals and water, anchor the plant to the ground and store substances in reserve.

Students can complete question 3 in pairs. Encourage students to look at the *Root Morphology* diagram carefully. Discuss the meaning of the word *absorbent*.

2.1.1. Root morphology

Draw a plant with a root on the board and write underneath:

Roots have a branching structure: there is a main root from which secondary roots grow.

Ask: *What is a branching structure? What does the term mean?*

It means that the roots grow like the branches of a tree but underground.

Now ask students to read the rest of the section and note down the key words in bold. Ask students to draw a simple diagram of a plant with roots. Then they should work together to locate where the different parts of the root are. When they have finished, ask a few volunteers to label the diagram on the board with the correct parts: *main roots, secondary roots, growth area, root cap* and *root collar*.

Finally ask students a few questions to check their understanding:

Why did you place the root collar there?

Because the root collar connects the stem and the root.

Why did you locate the growth area there?

Because the growth area protects the ends of the roots.

2.1.2. Root types

Write the three main types of roots on the board: *prop roots, fibrous roots* and *tubercular roots*. Draw a simple picture of each of the types or photocopy the examples in the textbook (alternatively print some pictures) and place them on the board. Do not tell students which root is which; instead get them to guess the term by listening to the definition.

Say: *This type of root has a clear main root.*

Prop root

This type of root has no difference between the main and secondary roots.

Fibrous root

This type of root has a thick main root.

Tubercular root

After students have familiarised themselves with the root types they can complete question 4. Then, they can complete question 6 as a class. First they listen to the description and then, they identify the type of root. Allow them a few seconds to discuss before they give their answers.

2.2. Stem: conducting vessels

Ask students to read the highlighted information that defines the stem. Get them to discuss any words that they do not understand. Discuss the meaning of the words aerial, upright and branches.

Before students read the text, ask them to discuss in pairs what they already know about stems. Write students' ideas on the board. Then, get them to read the two bullet points explaining the stem's functions: transporting substances and supporting the leaves.

Explain that inside spermatophytes we find well-developed conducting vessels that carry the sap. These are like very small tubes inside the stem that reach the leaves. Ask students to find out the meaning of xylem and phloem in their books. Students should add new terms to their graphic organisers.

2.2.1. Stem: conducting vessels

Draw the diagram found in question 5 (unlabelled) on the board and explain to the students that they are going to be stem detectives. Say:

I am going to describe a part of the stem and name it. Then you will have to decide where this particular part is.

Write the names of the stem parts onto pieces of card so students can place them on the board: axillary bud, apical bud, node and internode.

1. *These parts of the stem are called axillary buds. They are located where branches and leaves grow sideways.*
2. *This part is called the apical bud. It is located at the top of the main stem.*
3. *These parts are called nodes. They are located when the axillary buds and the stem meet.*
4. *This part is called the internode. It is a smaller stem found between two nodes.*

Students discuss in pairs or small groups and then decide where the parts are located. They can bring the cards with the key words to the front and stick them on the right area of the stem. When finished, students can complete question 5 individually.

2.2.2. Stem types

Ask students to read the different criteria used to classify stems:

What do they mean by 'the environment where they develop'? What does the word 'consistency' mean? And how about 'duration'?

Students read the section to find out. Encourage students to form full sentences. The environment where they develop refers to where the stems are found, for example stems can be aquatic, underground or aerial. Consistency refers to what the stem feels like, for example herbaceous stems are flexible and woody stems are rigid.

Discuss the different criteria used to classify stems. Start making a spidergram on the board. Write stems in the middle and draw three lines. At the end of the lines, write: *environment where stems are found; consistency and duration.*

Students finish completing the spidergram in their books. If possible allow students to watch the following video for them to continue adding information to their spidergram. Students can add pictures of each type of stem or draw their own.

Video 2: PARTS OF A PLANT

Interesting video with detailed information about plants. Ask students to do the Video 2 Worksheet.

Finally, ask students to do question 7. They should discuss in pairs what they think would happen to the plant, then share their ideas with the rest of the class.

EXTRA RESOURCES

AUDIO
TALKING BOOK
PDF
REINFORCEMENT WORKSHEET 2
CURRICULAR ADAPTATION WORKSHEET 2
INTERACTIVE ACTIVITIES

Answer key

Analyse

3. Look at the picture. Which part of the root absorbs water and minerals?

Mostly this process happens in the part of the roots rich in absorbent hairs.

4. Which types of root are shown in the pictures?

a) prop root; **b)** fibrous root; **c)** tubercular root

Apply

5. Look at the buds. Would you say that the stem grows from the lower part or from the top?

The stem grows from the top, from the apical bud upwards.

Understand

6. Look at the illustration showing the different types of root on the previous page. Listen and identify them.

a) This type of root has one very thick root from which very small roots branch out.

Tubercular root

b) This type of root has a long and thin main root from which smaller secondary roots branch out. It is difficult to identify the main root.

Prop root

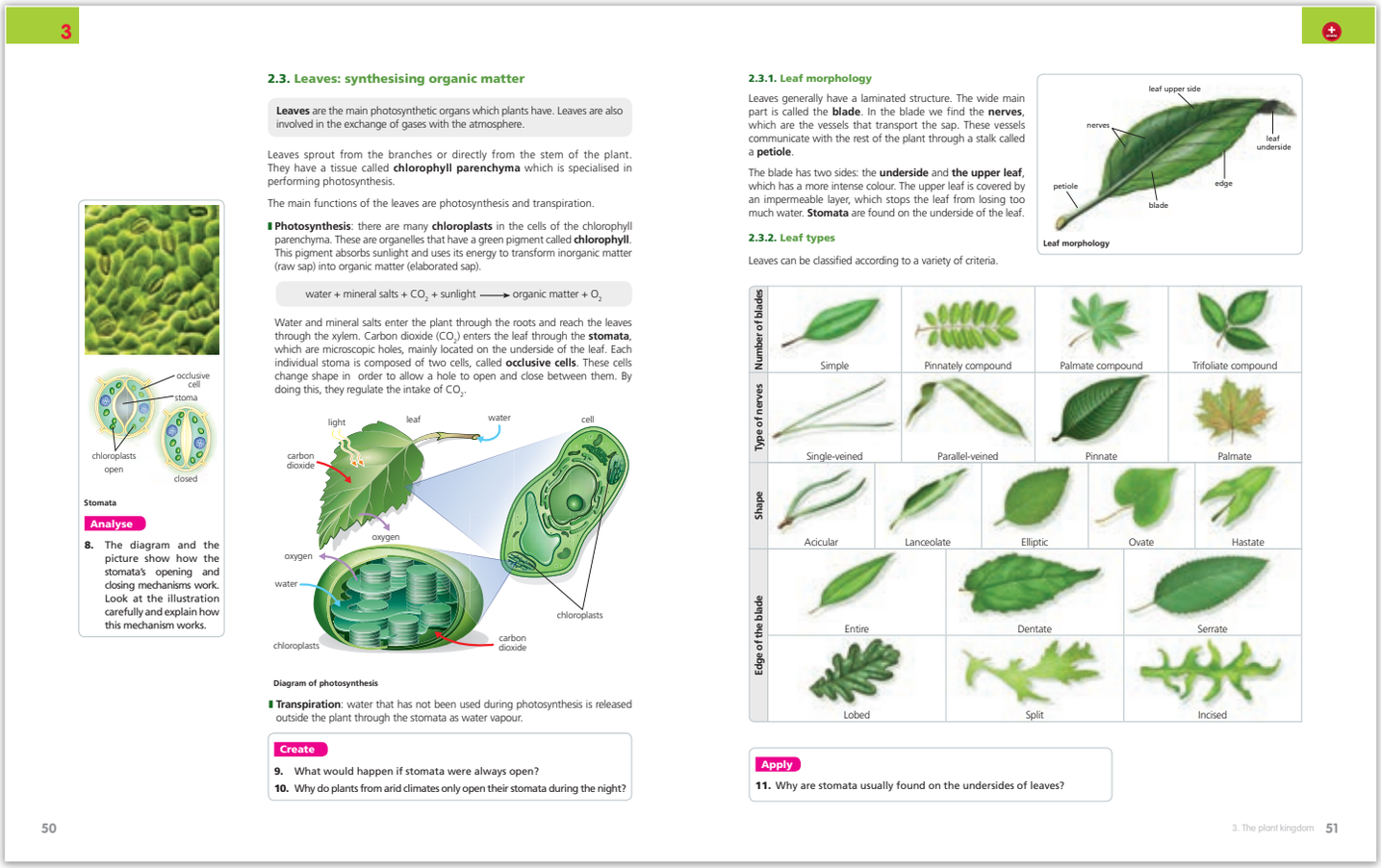
c) In this type of root there is no difference between primary roots and secondary roots.

Fibrous root

Analyse

7. Do you think that a plant grown in a container of distilled water (without dissolved salts) would survive? Why?

No, because the minerals found in soil are the nutrients the plant needs. Distilled water has no minerals in it, so the plant will die.



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2.3. Leaves: synthesising organic matter

Leaves are the main photosynthetic organs which plants have. Leaves are also involved in the exchange of gases with the atmosphere.

Leaves sprout from the branches or directly from the stem of the plant. They have a tissue called **chlorophyll parenchyma** which is specialised in performing photosynthesis.

The main functions of the leaves are photosynthesis and transpiration.

Photosynthesis: there are many **chloroplasts** in the cells of the chlorophyll parenchyma. These are organelles that have a green pigment called **chlorophyll**. This pigment absorbs sunlight and uses its energy to transform inorganic matter (raw sap) into organic matter (elaborated sap).

water + mineral salts + CO_2 + sunlight ⟶ organic matter + O_2

Water and mineral salts enter the plant through the roots and reach the leaves through the xylem. Carbon dioxide (CO_2) enters the leaf through the **stomata**, which are microscopic holes, mainly located on the underside of the leaf. Each individual stoma is composed of two cells, called **occlusive cells**. These cells change shape in order to allow a hole to open and close between them. By doing this, they regulate the intake of CO_2.

Analyse

8. The diagram and the picture show how the stomata's opening and closing mechanisms work. Look at the illustration carefully and explain how this mechanism works.

Transpiration: water that has not been used during photosynthesis is released outside the plant through the stomata as water vapour.

Create

9. What would happen if stomata were always open?
10. Why do plants from arid climates only open their stomata during the night?

50

2.3.1. Leaf morphology

Leaves generally have a laminated structure. The wide main part is called the **blade**. In the blade we find the **nerves**, which are the vessels that transport the sap. These vessels communicate with the rest of the plant through a stalk called a **petiole**.

The blade has two sides: the **underside** and **the upper leaf**, which has a more intense colour. The upper leaf is covered by an impermeable layer, which stops the leaf from losing too much water. **Stomata** are found on the underside of the leaf.

2.3.2. Leaf types

Leaves can be classified according to a variety of criteria.

Apply

11. Why are stomata usually found on the undersides of leaves?

3. The plant kingdom 51

2.3. Leaves: synthesising organic matter

At the beginning of this lesson place a plant with water inside a transparent plastic bag and put it in direct sunlight. Later on students will be able to see droplets of water accumulating in the bag. In this way students will be able to see the process of transpiration first hand.

Students discuss what they already know about leaves as well as the photosynthesis process. Then tell them to read the highlighted information. Ask:

What is the function of photosynthetic organs?

They perform photosynthesis.

For the next section that describes the functions of leaves, put students into small groups and ask them to play a few rounds of *Just a minute*. Explain that they will have to describe the two main functions of leaves in detail using diagrams and a few notes, but not just reading the information in their textbooks.

Make sure that the students have some time to prepare, 10 to 15 minutes should be enough. During this time they should read the information, take notes and make diagrams to support their explanations. Once they have prepared, time all groups (1 minute each) as they describe photosynthesis and transpiration without repetition or hesitation.

In order to support their presentations write the following questions on the board:

- *What is chlorophyll parenchyma?*

  A tissue specialised in performing photosynthesis

- *Where are the chloroplasts located?*

  In the cells of chlorophyll parenchyma

- *What are stomata? How do they work?*

  Stomata are microscopic holes that are composed of two cells, called occlusive cells. These cells regulate the intake of CO_2.

- *What is the process of transpiration?*

  Water that has not been used during photosynthesis is released outside the plant through the stomata as water vapour.

The teacher and students should award points to each group.

They should take into consideration how clear the presentation was (no repetition or hesitation) as well as how well the group answered the questions on the board.

To end this section, show the following video and ask students to complete the worksheet.

Video 3: **PHOTOSYNTHESIS**
Animation that explains the process of photosynthesis. Ask students to do the Video 3 Worksheet.

2.3.1. Leaf morphology

Students read the information about the different parts of the leaf in pairs. Explain that they are going to have five minutes to read the two paragraphs looking at the diagram on the right hand side. Explain that as they read about the different parts of the leaf they need to look at the diagram to locate the different parts of the leaf.

As the students read the information draw a leaf (like the one in the textbook) and draw lines pointing to the parts being studied. Do not label the leaf, but instead write all the parts next to the diagram: *leaf upper side, nerves, petiole, blade, edge* and *leaf underside*.

Students draw a diagram like the one on the board (books closed now!) and locate the different parts of the leaf. To simplify the activity tell students to work in pairs.

When they are finished ask some students to come to the front to finish labelling the diagram on the board. Students correct any mistakes in their books using a different colour. Get students to discuss why stomata are located on the underside of the leaf. If they get stuck prompt them by reminding them that the upper leaf has an impermeable layer to stop it from losing water. Then they can complete question 9, question 10 and question 11 in pairs, using the information on the previous page to help them.

Students could collect a range of leaves so they can actually label the real thing. This could be done as a plenary, once they are familiar with the parts of the leaf or perhaps, as a homework activity.

2.3.2. Leaf types

Explain to students that just like stems, leaves can be classified according to different set of criteria. Ask students to recall the different parts of the leaf studied before, so that they refresh their minds about their names. Make sure they understand that we can use the parts of the leaf as classification criteria to classify leaves.

Students look at the table displaying different types of leaves. Ask them to find out what types of criteria were used. Students should be able to realise that the table classifies leaves according to the number of blades, type of nerves, their shape or the edge of the blade.

Explain to students that they are going to play a guessing game. They will have to use questions in order to find out the type of leaf. Get students to practise creating questions that have a Yes or No answer (in the style of a dichotomous key):

- *Are you classified according to the number of blades?*

  No.
- *Are you classified according to the type of nerves?*

  No.
- *Are you classified according to your shape?*

  Yes.
- *Do you have a long, thin blade?*

  No.
- *Is your blade heart shaped?*

  Yes.
- *Are you an ovate leaf?*

  Yes!

Ask some students to come to the front using their textbooks whilst the rest of the class creates questions to find out the mysterious leaves. Repeat this process as many times as possible. In this way students will become familiar with the names of the parts of the leaf as well as understand the different leaf types better. If possible use real leaves so that the students can actually practise classifying real leaves found in their local area.

EXTRA RESOURCES

AUDIO
TALKING BOOK
PDF
REINFORCEMENT WORKSHEET 3
CURRICULAR ADAPTATION WORKSHEET 3
INTERACTIVE ACTIVITIES

Answer key

Analyse

8. **The diagram and the picture show how the stomata's opening and closing mechanisms work. Look at the illustration carefully and explain how this mechanism works.**

The process takes place when the two occlusive cells that form the orifice of the stomata change shape, accumulating water, opening and closing the entrance and exit's orifices respectively.

Understand

9. **What would happen if stomata were always open?**

The plant would lose too much water (water vapour) because it would be completing the transpiration process constantly.

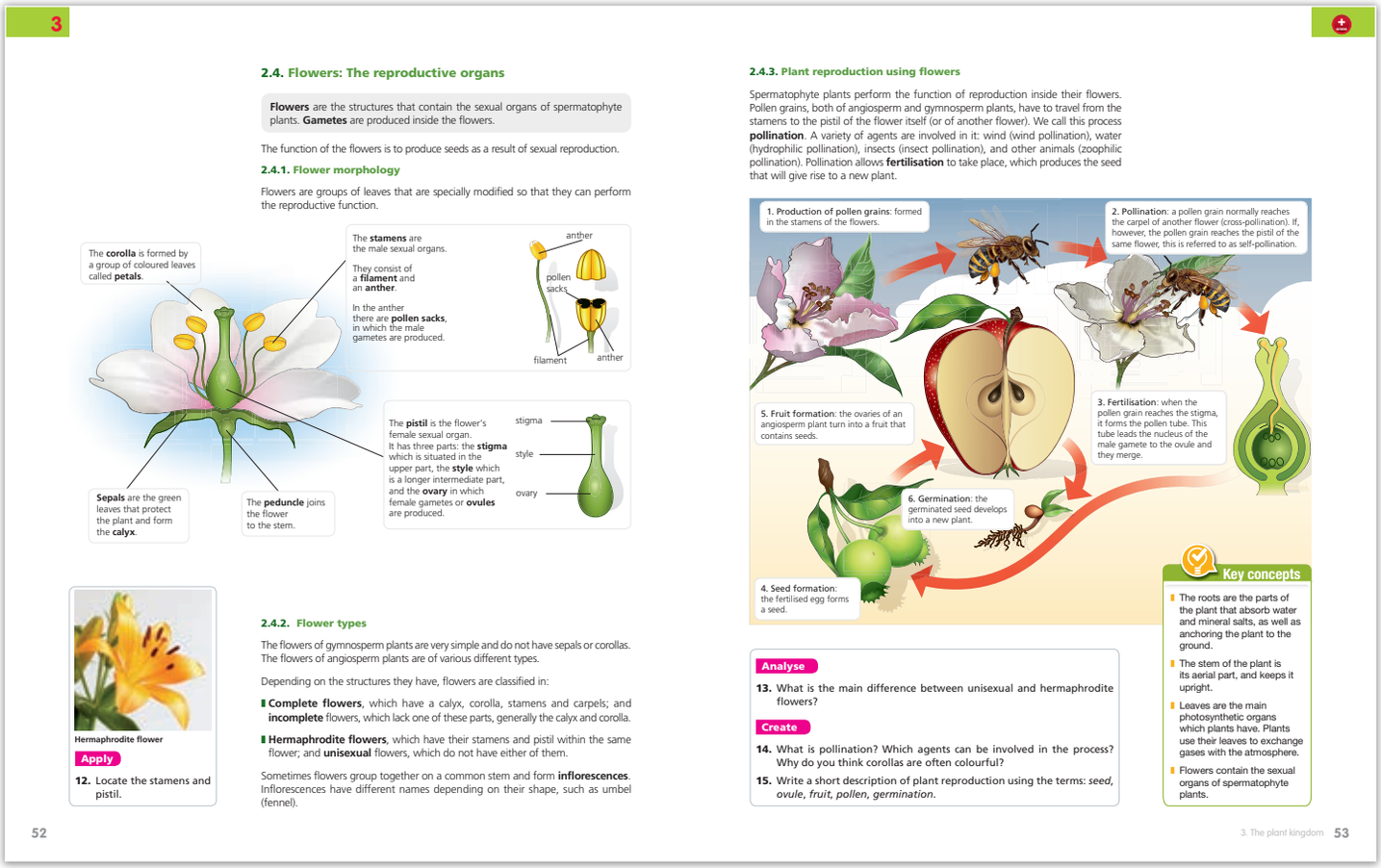
10. **Why do plants from arid climates only open their stomata during the night?**

In order to stop the transpiration process, otherwise they would lose too much water and die.

Apply

11. **Why are stomata usually found on the underside of leaves?**

In order to make sure that they do not lose too much water, otherwise sunlight will evaporate more water.



3

2.4. Flowers: The reproductive organs

Flowers are the structures that contain the sexual organs of spermatophyte plants. **Gametes** are produced inside the flowers.

The function of the flowers is to produce seeds as a result of sexual reproduction.

2.4.1. Flower morphology

Flowers are groups of leaves that are specially modified so that they can perform the reproductive function.

The **corolla** is formed by a group of coloured leaves called **petals**.

The **stamens** are the male sexual organs.

They consist of a **filament** and an **anther**.

In the anther there are **pollen sacks**, in which the male gametes are produced.

anther
pollen sacks
filament
anther

The **pistil** is the flower's female sexual organ. It has three parts: the **stigma** which is situated in the upper part, the **style** which is a longer intermediate part, and the **ovary** in which female gametes or **ovules** are produced.

stigma
style
ovary

Sepals are the green leaves that protect the plant and form the **calyx**.

The **peduncle** joins the flower to the stem.

Hermaphrodite flower

Apply

12. Locate the stamens and pistil.

2.4.2. Flower types

The flowers of gymnosperm plants are very simple and do not have sepals or corollas. The flowers of angiosperm plants are of various different types.

Depending on the structures they have, flowers are classified in:

- **Complete flowers**, which have a calyx, corolla, stamens and carpels; and **incomplete** flowers, which lack one of these parts, generally the calyx and corolla.
- **Hermaphrodite flowers**, which have their stamens and pistil within the same flower; and **unisexual** flowers, which do not have either of them.

Sometimes flowers group together on a common stem and form **inflorescences**. Inflorescences have different names depending on their shape, such as umbel (fennel).

52

2.4.3. Plant reproduction using flowers

Spermatophyte plants perform the function of reproduction inside their flowers. Pollen grains, both of angiosperm and gymnosperm plants, have to travel from the stamens to the pistil of the flower itself (or of another flower). We call this process **pollination**. A variety of agents are involved in it: wind (wind pollination), water (hydrophilic pollination), insects (insect pollination), and other animals (zoophilic pollination). Pollination allows **fertilisation** to take place, which produces the seed that will give rise to a new plant.

1. **Production of pollen grains**: formed in the stamens of the flowers.

2. **Pollination**: a pollen grain normally reaches the carpel of another flower (cross-pollination). If, however, the pollen grain reaches the pistil of the same flower, this is referred to as self-pollination.

3. **Fertilisation**: when the pollen grain reaches the stigma, it forms the pollen tube. This tube leads the nucleus of the male gamete to the ovule and they merge.

4. **Seed formation**: the fertilised egg forms a seed.

5. **Fruit formation**: the ovaries of an angiosperm plant turn into a fruit that contains seeds.

6. **Germination**: the germinated seed develops into a new plant.

Key concepts

- The roots are the parts of the plant that absorb water and mineral salts, as well as anchoring the plant to the ground.
- The stem of the plant is its aerial part, and keeps it upright.
- Leaves are the main photosynthetic organs which plants have. Plants use their leaves to exchange gases with the atmosphere.
- Flowers contain the sexual organs of spermatophyte plants.

Analyse

13. What is the main difference between unisexual and hermaphrodite flowers?

Create

14. What is pollination? Which agents can be involved in the process? Why do you think corollas are often colourful?

15. Write a short description of plant reproduction using the terms: *seed, ovule, fruit, pollen, germination*.

3. The plant kingdom 53

2.4. Flowers: the reproductive organs

Students read the two paragraphs. Ask:

Why do some plants have flowers? What is their function?

Gymnosperm plants have flowers to reproduce. Flowers produce seeds that then make a new plant.

2.4.1. Flower morphology

To introduce this section, elicit students' prior knowledge and focus their attention on flower morphology, ask students the following question:

Can you name the different parts of a flower?

As this is a warm-up question, don't correct any mistaken answers students may give, instead encourage them to describe as many different parts of flowers they can think of, using any language, scientific or not.

Once students can't think of any more answers, ask them to read the information on the diagram. If they hadn't mentioned some of the flower's parts before, ask them to tell you about them.

To help student remember and see for themselves the different parts of flowers, ask them to complete the science experiment below.

Science experiment: OBSERVING THE DIFFERENT PARTS OF A FLOWER

By carrying out this science experiment students will be able to see in detail and in real life the structure of plants. They will also have the chance to use a binocular microscope.

When students have finished, they can complete question 12 individually as they should have a good understanding of the anatomy of a flower after completing the science experiment.

2.4.2. Flower types

Students read the section to find out how flowers are classified. If needed, recap on the different parts of the flower, so they understand fully which parts are found in complete, incomplete, hermaphrodite and unisexual flowers. Discuss the meaning of the word *inflorescence*. When they have finished they can complete question 13 in pairs. Encourage them to form full sentences.

2.4.3. Plant reproduction using flowers

Ask students to read the text describing flower reproduction and to answer the following questions forming full sentences:

- *Where do pollen grains start their journey? What is the pollen grains' destination?*

  Pollen grains start their journey in the stamens of a flower and they end their journey when they reach the pistil of the same or another flower.

- *How do pollen grains travel?*

  Pollen grains travel in a variety of ways. The different agents involved in pollination are wind, water, insects and other animals.

- *What happens after pollination is complete?*

  After pollination is complete fertilisation takes place. Fertilisation produces the seed/s that will generate a new plant.

Next, students do a role-play to explain how plants with flowers reproduce. Put students into groups of five and give them some time to think how they are going to act out the process.

Perhaps they could use the models created in the previous section or they could just get creative: they could use one of the students in the group to narrate the process whilst the other four represent the flower, the pollination agent/s, the formation of the fruit and the creation of a new plant!

When finished, students can complete questions 14 and 15 in pairs. Then, they should try to explain in their own words what pollination is and how plant reproduction works.

Animation: REPRODUCTION IN FLOWERING PLANTS

This animation shows the different phases of reproduction in plants with flowers. It can be used as a summary to visually support students learning.

Video 4: POLLINATION ROCK

Song and animation that explains pollination and fertilisation. Ask students to do the Video 4 Worksheet.

Write the following sentences from the **Key concepts** section on the board for students to practise identifying key vocabulary and key facts regarding the parts of flowering plants:

- *The roots are the parts of the plant that ___ water and mineral salts, as well as ___ the plant to the ground.*
- *The stem of the plant is its ___ part, and keeps it ___ .*
- *Leaves are the main ___ organs which plants have. Plants use their leaves to exchange ___ with the atmosphere.*
- *Flowers contain the ___ organs of ___ plants.*

Answers: absorb, anchoring, aerial, upright, photosynthetic, gases, sexual, spermatophyte.

EXTRA RESOURCES

AUDIO
TALKING BOOK
PDF
REINFORCEMENT WORKSHEET 4
CURRICULAR ADAPTATION WORKSHEET 4
INTERACTIVE ACTIVITIES

Answer key

Apply

12. Locate the stamens and the pistil.

Analyse

13. What is the main difference between unisexual and hermaphrodite flowers?

Unisexual flowers only have masculine or feminine organs (stamens or carpel), whilst hermaphrodite flowers have both organs.

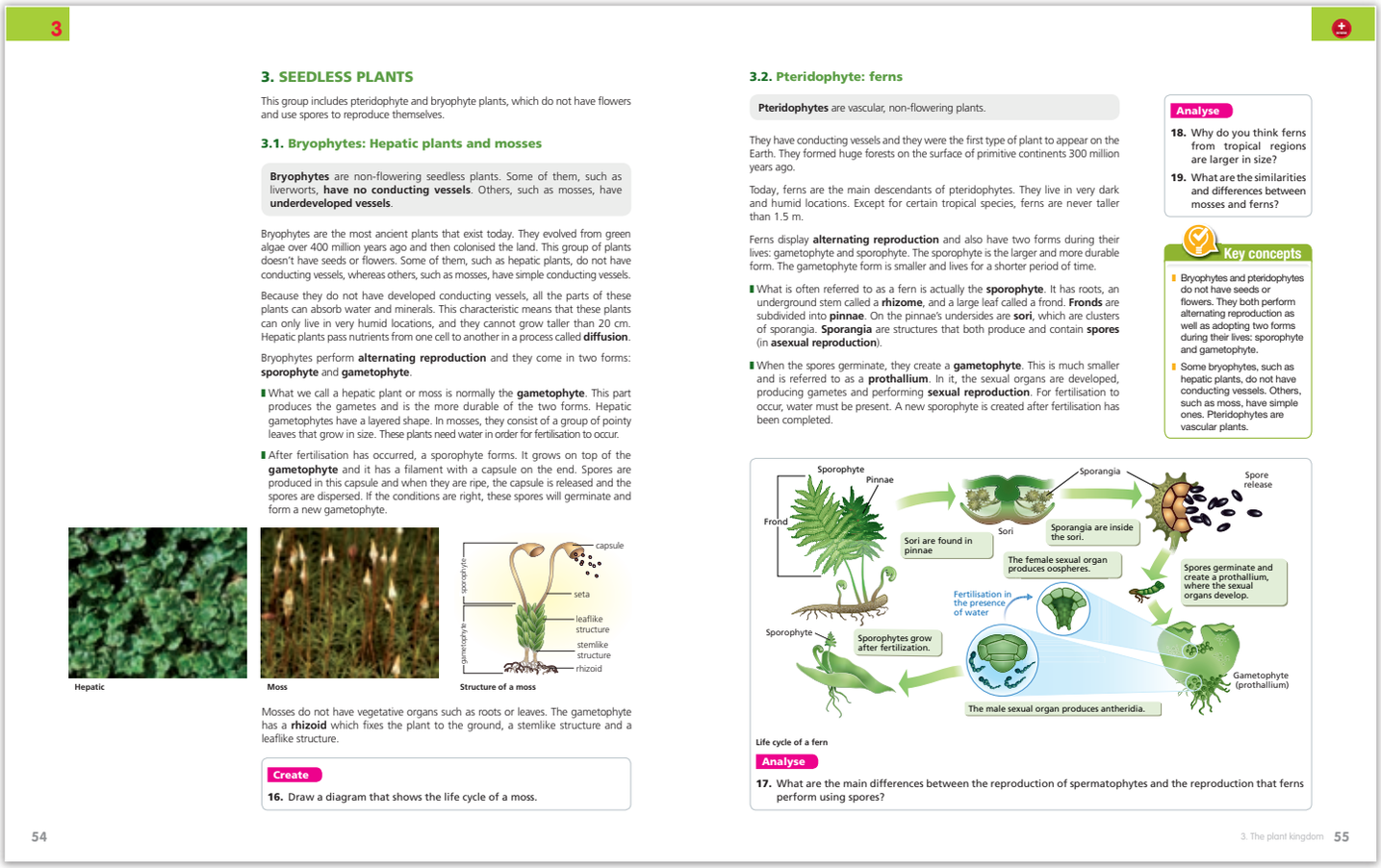
Create

14. What is pollination? Which agents can be involved in the process? Why do you think corollas are often colourful?

Pollination is the process by which the pollen of one flower travels to the carpel of the same flower or to another flower's carpel. This process is carried out by a pollination agent (wind, insects, water and other animals). Corollas are often colourful because they need to attract insects.

15. Write a short description of plant reproduction using the terms: *seed, ovule, fruit, pollen, germination.*

Open response, however students need to describe the process of sexual reproduction found in angiosperms (plants with flowers and fruits). Encourage students to use the diagram to support their answers (page 53 of the Student's book).



3

3. SEEDLESS PLANTS

This group includes pteridophyte and bryophyte plants, which do not have flowers and use spores to reproduce themselves.

3.1. Bryophytes: Hepatic plants and mosses

Bryophytes are non-flowering seedless plants. Some of them, such as liverworts, **have no conducting vessels**. Others, such as mosses, have **underdeveloped vessels**.

Bryophytes are the most ancient plants that exist today. They evolved from green algae over 400 million years ago and then colonised the land. This group of plants doesn't have seeds or flowers. Some of them, such as hepatic plants, do not have conducting vessels, whereas others, such as mosses, have simple conducting vessels.

Because they do not have developed conducting vessels, all the parts of these plants can absorb water and minerals. This characteristic means that these plants can only live in very humid locations, and they cannot grow taller than 20 cm. Hepatic plants pass nutrients from one cell to another in a process called **diffusion**.

Bryophytes perform **alternating reproduction** and they come in two forms: **sporophyte** and **gametophyte**.

- What we call a hepatic plant or moss is normally the **gametophyte**. This part produces the gametes and is the more durable of the two forms. Hepatic gametophytes have a layered shape. In mosses, they consist of a group of pointy leaves that grow in size. These plants need water in order for fertilisation to occur.
- After fertilisation has occurred, a sporophyte forms. It grows on top of the **gametophyte** and it has a filament with a capsule on the end. Spores are produced in this capsule and when they are ripe, the capsule is released and the spores are dispersed. If the conditions are right, these spores will germinate and form a new gametophyte.

Hepatic

Moss

Structure of a moss

Mosses do not have vegetative organs such as roots or leaves. The gametophyte has a **rhizoid** which fixes the plant to the ground, a stemlike structure and a leaflike structure.

Create

16. Draw a diagram that shows the life cycle of a moss.

54

3.2. Pteridophyte: ferns

Pteridophytes are vascular, non-flowering plants.

They have conducting vessels and they were the first type of plant to appear on the Earth. They formed huge forests on the surface of primitive continents 300 million years ago.

Today, ferns are the main descendants of pteridophytes. They live in very dark and humid locations. Except for certain tropical species, ferns are never taller than 1.5 m.

Ferns display **alternating reproduction** and also have two forms during their lives: gametophyte and sporophyte. The sporophyte is the larger and more durable form. The gametophyte form is smaller and lives for a shorter period of time.

- What is often referred to as a fern is actually the **sporophyte**. It has roots, an underground stem called a **rhizome**, and a large leaf called a frond. **Fronds** are subdivided into **pinnae**. On the pinnae's undersides are **sori**, which are clusters of sporangia. **Sporangia** are structures that both produce and contain **spores** (in **asexual reproduction**).
- When the spores germinate, they create a **gametophyte**. This is much smaller and is referred to as a **prothallium**. In it, the sexual organs are developed, producing gametes and performing **sexual reproduction**. For fertilisation to occur, water must be present. A new sporophyte is created after fertilisation has been completed.

Analyse

18. Why do you think ferns from tropical regions are larger in size?

19. What are the similarities and differences between mosses and ferns?

Key concepts

- Bryophytes and pteridophytes do not have seeds or flowers. They both perform alternating reproduction as well as adopting two forms during their lives: sporophyte and gametophyte.
- Some bryophytes, such as hepatic plants, do not have conducting vessels. Others, such as moss, have simple ones. Pteridophytes are vascular plants.

Life cycle of a fern

Analyse

17. What are the main differences between the reproduction of spermatophytes and the reproduction that ferns perform using spores?

3. The plant kingdom 55

3. Seedless plants

Ask: *Do you think seedless plants are less or more evolved than plants with seeds? Why?*

Discuss students' prior knowledge and what they remember from the beginning of the unit. Establish that seedless plants are less evolved than plants with seeds.

Explain that bryophytes and pteridophytes are seedless plants. They are less evolved and more primitive than spermatophytes. Remind students that plants evolved from green algae and that the first terrestrial plants could not be very big and needed humid conditions to live in.

3.1. Bryophytes: hepatic plants and mosses

3.2. Pteridophytes: ferns

If needed re-visit the diagram on page 46 of the Student's book showing flowering and non-flowering plants. Make sure students understand that non-flowering plants are also seedless. Write *bryophytes* and *pteridophytes* on the board. Next to them write liverworts, ferns and mosses. Ask students to use the diagram to link the terms: *Liverworts and mosses are bryophytes* and *ferns are pteridophytes*.

Read the information about bryophytes and pteridophytes (3.1 and 3.2) as a whole class. You could use the talking book to help with pronunciation of some of the terms. Whilst reading ask students to think of questions that relate to the information found in the text. As students come up with the questions write them on the board.

Explain that later on they will create a presentation in groups and that the questions will help them structure their work. The following questions can be used as a model in case students struggle to structure their work.

BRYOPHYTES

- *What are bryophytes?*
- *What is special about bryophites?*
- *Describe the morphology of bryophites.*
- *How do bryophites reproduce?*
- *What is a gametophyte and a sporophyte?*

PTERIDOPHYTES

- *What are pteridophytes?*
- *What is special about pteridophytes?*
- *Describe the morphology of pteridophytes.*
- *How do pteridophytes reproduce?*
- *What is a gametophyte and a sporophyte?*

Now, after reading the text and discussing the main themes, put students into groups of five students (6 groups). Allocate bryophyte plants to three groups and pteridophyte plants to the other three groups. Explain that they need to create a presentation that answers the questions they have written down (remember that the questions we have provided are just an example, the students should create their own). They should add diagrams and pictures in order to make their presentations effective.

Tell students to work in their groups for 20-30 minutes to complete their presentations. When they are finished have students present their work in two big groups: *Mosses and Ferns*.

After the presentations are complete have a *Speed debate* in which students argue which are best, pteridophytes or bryophites.

Students could debate aspects such as the sizes of hepatic plants, mosses and ferns, their morphology and how they reproduce.

Divide the class in half (use the groups from the previous activity). Let the three groups that studied bryophytes outline their arguments and do the same with the groups who studied pteridophytes.

Then students get into pairs (one student representing pteridophyte plants and the other one bryophyte plants). Students take turns to debate (1-2 minutes each).

After the debate and presentations, students should be able to find the similarities and differences between mosses and ferns with ease. They should also be able to complete question 17. Students can complete question 16 and 18 in pairs. In order to complete their diagram they could use the one on page 55 of the Student's book as inspiration, but making sure that they show a moss and not a fern. When finished, complete activity 19 as a whole class. Write their contributions on the board.

In addition, discuss the meaning of the **Key concepts** box, which includes some of the similarities between bryophytes and pteridophytes as well as their differences.

As a final activity, show the following videos. Some students could narrate the video.

Video 5: **FERN: THE LIFE CYCLE**
An animation of the life cycle of a fern. Ask students to do Video 5 Worksheet.

EXTRA RESOURCES
AUDIO
TALKING BOOK
PDF
REINFORCEMENT WORKSHEET 5
CURRICULAR ADAPTATION WORKSHEET 5
INTERACTIVE ACTIVITIES

Answer key

Create

16. Draw a diagram that shows the life cycle of a moss.

Open response. It is important that students indicate the sporophyte stage and the gametophyte stage (the diagram needs to show an alternating life cycle). Students should also mention the spores, gametes and zygote formation.

Analyse

17. What are the main differences between the reproduction of spermatophytes and the reproduction that ferns perform using spores?

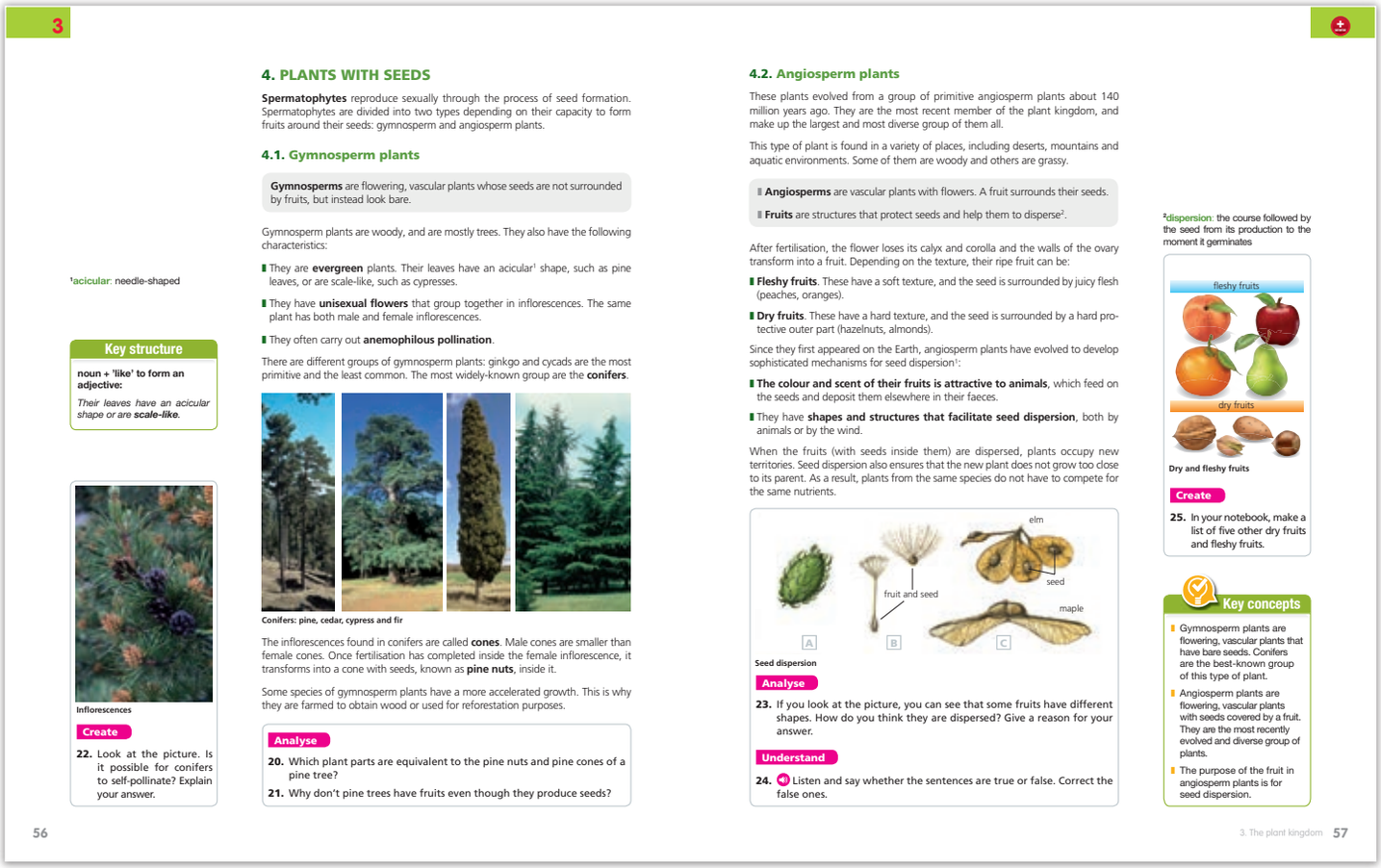
The main difference is that there are two individuals in the life cycle of a fern (gametophyte and sporophyte), whilst spermatophytes only have one individual.

18. Why do you think ferns from tropical regions are larger in size?

Because they live in humid conditions, the higher quantities of water allow them to grow very large.

19. What are the similarities and differences between mosses and ferns?

Both mosses and ferns do not have flowers or seeds and they need humid conditions to survive. The main difference between mosses and ferns is that ferns have developed conducting vessels.



3

4. PLANTS WITH SEEDS

Spermatophytes reproduce sexually through the process of seed formation. Spermatophytes are divided into two types depending on their capacity to form fruits around their seeds: gymnosperm and angiosperm plants.

4.1. Gymnosperm plants

Gymnosperms are flowering, vascular plants whose seeds are not surrounded by fruits, but instead look bare.

Gymnosperm plants are woody, and are mostly trees. They also have the following characteristics:

- They are **evergreen** plants. Their leaves have an acicular[1] shape, such as pine leaves, or are scale-like, such as cypresses.
- They have **unisexual flowers** that group together in inflorescences. The same plant has both male and female inflorescences.
- They often carry out **anemophilous pollination**.

There are different groups of gymnosperm plants: ginkgo and cycads are the most primitive and the least common. The most widely-known group are the **conifers**.

Conifers: pine, cedar, cypress and fir

The inflorescences found in conifers are called **cones**. Male cones are smaller than female cones. Once fertilisation has completed inside the female inflorescence, it transforms into a cone with seeds, known as **pine nuts**, inside it.

Some species of gymnosperm plants have a more accelerated growth. This is why they are farmed to obtain wood or used for reforestation purposes.

Analyse

20. Which plant parts are equivalent to the pine nuts and pine cones of a pine tree?
21. Why don't pine trees have fruits even though they produce seeds?

[1]acicular: needle-shaped

Key structure

noun + 'like' to form an adjective:

*Their leaves have an acicular shape or are **scale-like**.*

Inflorescences

Create

22. Look at the picture. Is it possible for conifers to self-pollinate? Explain your answer.

56

4.2. Angiosperm plants

These plants evolved from a group of primitive angiosperm plants about 140 million years ago. They are the most recent member of the plant kingdom, and make up the largest and most diverse group of them all.

This type of plant is found in a variety of places, including deserts, mountains and aquatic environments. Some of them are woody and others are grassy.

- **Angiosperms** are vascular plants with flowers. A fruit surrounds their seeds.
- **Fruits** are structures that protect seeds and help them to disperse[2].

After fertilisation, the flower loses its calyx and corolla and the walls of the ovary transform into a fruit. Depending on the texture, their ripe fruit can be:

- **Fleshy fruits**. These have a soft texture, and the seed is surrounded by juicy flesh (peaches, oranges).
- **Dry fruits**. These have a hard texture, and the seed is surrounded by a hard protective outer part (hazelnuts, almonds).

Since they first appeared on the Earth, angiosperm plants have evolved to develop sophisticated mechanisms for seed dispersion[1]:

- **The colour and scent of their fruits is attractive to animals**, which feed on the seeds and deposit them elsewhere in their faeces.
- They have **shapes and structures that facilitate seed dispersion**, both by animals or by the wind.

When the fruits (with seeds inside them) are dispersed, plants occupy new territories. Seed dispersion also ensures that the new plant does not grow too close to its parent. As a result, plants from the same species do not have to compete for the same nutrients.

Seed dispersion

Analyse

23. If you look at the picture, you can see that some fruits have different shapes. How do you think they are dispersed? Give a reason for your answer.

Understand

24. Listen and say whether the sentences are true or false. Correct the false ones.

[2]dispersion: the course followed by the seed from its production to the moment it germinates

Dry and fleshy fruits

Create

25. In your notebook, make a list of five other dry fruits and fleshy fruits.

Key concepts

- Gymnosperm plants are flowering, vascular plants that have bare seeds. Conifers are the best-known group of this type of plant.
- Angiosperm plants are flowering, vascular plants with seeds covered by a fruit. They are the most recently evolved and diverse group of plants.
- The purpose of the fruit in angiosperm plants is for seed dispersion.

3. The plant kingdom 57

4. Plants with seeds

Start this section by describing the characteristics of spermatophytes. Remind students that the term refers to all flowering plants. Also explain that these plants are more evolved than plants without seeds, also known as non-flowering plants.

Say: *Spermatophytes are subdivided into two groups. Read the text to find out their names.*

Gymnosperms and angiosperms.

Establish that the difference between these two groups is that angiosperm plants have a seed that is enveloped by a fruit.

4.1. Gymnosperm plants

Ask students to read the information in this section in pairs, making notes about some of the main characteristics of this group of plants: *anemophilous pollination, unisexual flowers, evergreen plants* and so on. Make sure that students understand that anemophilous pollination refers to pollination in which the wind is the pollination agent.

Establish that conifers are the most well known type of gymnosperm. Students look at the four pictures of gymnosperm plants on page 56 of the Student's book. Ask:

What do you think the term evergreen means?

It means that they do not lose their leaves during winter and that they always stay green.

Students complete questions 20 and 21 in pairs. Then do question 22 as a whole class activity, first asking students what they can see in the picture.

4.2. Angiosperm plants

Before you start this section, ask the students to name some fruits. Then ask:

Are nuts, such as almonds, fruits?

Yes, they are dry fruits.

If students are unsure, say they will find out in this section.

Write the following questions on the board:

- *Where can we find angiosperm plants?*

  A variety of places, including deserts, mountains and aquatic environments
- *Which part of a flower becomes the fruit?*

  The ovary
- *What are the two types of fruit?*

  Fleshy fruits and dry fruits
- *Why is seed dispersion important?*

  So the new plants occupy new territories and do not grow to close to the parents.

Students read the section in pairs and answer the questions in their notebooks. Check their answers as a whole class.

Use the weblink below on the whiteboard so that students can see different examples of seed dispersal.

Weblink 2: **SEED DISPERSAL**

This weblink shows animations involving different types of seed dispersion (wind, bursting, shakers, water, catching a lift, animal food and drop and roll). Ask students to do the Weblink 2 Worksheet.

Students then complete question 23 in pairs. Complete activities 24 and 25 as a whole class. During the listening activity (question 24) students can stand up if they think the statement is true, and they remain sitting down if they think the statement is incorrect. They need to be prepared to explain why they think the statement. is incorrect.

EXTRA RESOURCES

AUDIO
TALKING BOOK
PDF
REINFORCEMENT WORKSHEET 6
CURRICULAR ADAPTATION WORKSHEET 6
INTERACTIVE ACTIVITIES

Answer key

Analyse

20. Which plant parts are equivalent to the pine nuts and pine cones of a pine tree?

Pine nuts are the seeds, whilst the pine cones are the inflorescences where the feminine parts of the plant are found.

21. Why don't pine trees have fruits even though they produce seeds?

Because they are gymnosperm plants. Gymnosperm flowers do not transform into fruits that envelop and protect the seeds; instead, they form inflorescences, in which the naked seed forms directly from a fertilised ovule.

Understand

22. Look at the picture. Is it possible for conifers to self-pollinate? Explain your answer.

Yes, because the male inflorescences are really close to the female inflorescences: it is easy for the male flowers to fertilise the female flowers of the same plant.

Analyse

23. If you look at the picture, you can see that some fruits have different shapes. How do you think they are dispersed? Give a reason for your answer.

A: sticking itself to the fur or skin of an animal.

B and C: floating in the air and transported by the wind. In the case of C, it spins just like a helicopter.

Understand

24. Listen and say whether the sentences are true or false. Correct the false ones.

a) Angiosperm plants are the most recent member of the plant kingdom, and make up the largest and most diverse group of them all.

True

b) Fruits and seed are the same thing.

False, fruits are structures that protect seeds and help them to disperse and seeds are plants' fertilised eggs.

c) All seeds are covered by fruits.

False, no. Angiosperm plants' seeds are covered by a fruit but Gymnosperm plants' seeds are bare.

Create

25. In your notebook, make a list of five other dry fruits and fleshy fruits.

Open answer. Examples of fleshy fruits are peaches, grapes, plums, melon or bananas; hazelnuts, peanuts, pistachio nuts or sunflower seeds are dried fruits.

3

5. PLANTS AND US

Plants are essential for terrestrial ecosystems to exist. This is because they provide the **oxygen** and **organic matter** which heterotrophic organisms need to survive.

As humans, we have always tried to benefit from the invaluable resources that plants provide. When we first existed as a species, we collected fruit, seeds, roots, and leaves to feed ourselves.

In the Neolithic period, we learned how to cultivate plants, and selected certain species in order to start farming. Farming has had an enormous influence both on human history and on the evolution of landscapes and terrestrial ecosystems.

5.1. Plant uses

In addition to the food plants give us, there are other reasons why humans have been attracted to plants over the course of history. Uses of plants include:

Food. Plants are an essential part of our diet. They are a source of very important nutrients, such as sugars, unsaturated fats, and vitamins. Cereals, fruits, and vegetables form the base of the food pyramid. The lack of plants in our diet can increase the chances of contracting various diseases such as colon cancer, immune system failures, and digestive disorders.

Ornamental. Due to their beauty, plants are used to represent our feelings or to decorate landscapes. Parks and gardens often have a combination of many different plants, which can create a pleasant environment.

Medicinal. Many plants, such as aloe vera, produce substances that help to prevent and cure diseases. Many drugs come from plants.

Forest resource. Some plants are used as raw material for various industries. Wood from certain trees is used to make houses, furniture, or paper. Other plants are used in the clothing industry to make fibres and fabrics.

Natural resource. Plants are essential for the existence of diverse ecosystems, so it is extremely important that we conserve and protect their environments. In our country, we have many natural spaces that are protected due to their beauty or the uniqueness of the plants that you can find there.

58

5.2. Natural and artificial vegetation

In nature, we can find different types of natural vegetation, such as forests, jungles, and prairies. However, humans are continually transforming vegetation for their own purposes. In fact, every year, around 10 million hectares of forest are destroyed. The existing vegetation is often destroyed in order to convert land for crops and pasture. The vegetation that replaces it has been artificially introduced and it favours the growth of one or a few plant species at the expense of the rest which disappear. This process endangers native species from the original ecosystem.

Field crops (left) and intensive crops (right)

Analyse

26. What are the main differences between the two types of crop? Which one do you think is more productive? Which one do you think uses local species?

Create

28. Describe some of the uses of the following plants and trees: oak, linden, holm oak, cotton, pine and eucalyptus.

Understan

29. Listen and say why forests are important.

Analyse

30. Do some research on the most important crops in your region. Are they field crops or intensively farmed crops?

5.2.1. Mediterranean grasslands

Grasslands are an artificial type of vegetation. Large grasslands are found in the centre, east, and south east of the Iberian Peninsula. They are composed of a modified Mediterranean forest used for livestock and farming purposes.

The modification of the forest involves the removal of bushes and trees, leaving only **scattered trees**. As a result, the terrain becomes more open, allowing grazing areas with herbaceous plants to flourish. Grasslands are used to feed cows, goats, sheep, and the Iberian pig.

Iberian grassland

Evaluate

27. Why aren't all the trees removed from the grassland? Why are the remaining trees important?

Key concepts

- Plants are essential to terrestrial ecosystems.
- We use plants as food or medicines, as natural and forest resources, and for ornamental purposes.
- Humans modify existing vegetation to obtain land for livestock and agriculture.
- Grassland is an artificial type of vegetation with only a few characteristics of the original forest preserved.

3. The plant kingdom 59

5. Plants and us

After studying plants throughout the unit get students to discuss in pairs, why plants are so useful to us humans. In addition, prompt students to think why plants are also essential in all environments. Students should already have many ideas about this particular topic. Write them on the board. Students read the first section to find out what the first use for plants was.

5.1. Plant uses

Students read the main uses of plants: *ornamental, natural resource, forest resource, food* and *medicinal*. Discuss these with students. Then ask students to make posters about the uses of plants. Put students into groups of five and provide them with materials such as magazines, to look for pictures.

Their posters should outline the many uses plants have and in addition, it should encourage people to look after them. Encourage students to think about how they use plants. To find some more ideas, the groups could use the weblink below.

Weblink 3: PLANTS AND US

This is an excellent web page that explores the essential role of plants in our life. It expands on the information provided in the textbook by explaining other ways in which plants are important as well as providing examples. Ask students to do Weblink 3 Worksheet.

5.2. Natural and artificial vegetation

On the board make a table with the headings: *Natural* and *Artificial*. Students read the information in the paragraph in pairs.

Ask some students to write examples from the text on the board. Encourage them to think of more examples. When finished ask them to describe natural and artificial vegetation in their own words.

Then complete question 26. Students discuss in pairs what are the main differences between the two types of crop. Ask them to think which type of crop respects natural vegetation more.

5.2.1. Mediterranean grasslands

Students read the information in this section. Ask:

What are Mediterranean grasslands like?

Grasslands with scattered trees

What are they used for?

Feeding cows, goats sheep and the Iberian pig

Ask if there are any Mediterranean grasslands in the local area.

Students complete question 27 in pairs. Students complete question 28 at home by doing independent research about the plants and trees mentioned in the question.

Students complete question 29 in pairs. Play the audio once. Then pairs try to recall the reasons without any notes or support. Allow a few pairs to try and if no pairs can answer play the audio again and repeat the process.

Activity 30 could be done as part of their homework as they will have to research local crops. Alternatively select some materials regarding local crops so students can complete the activity in class.

EXTRA RESOURCES

AUDIO
TALKING BOOK
PDF
REINFORCEMENT WORKSHEET 7
CURRICULAR ADAPTATION WORKSHEET 7
INTERACTIVE ACTIVITIES

Answer key

Analyse

26. What are the main differences between the two types of crop? Which one do you think is more productive? Which one do you think uses local species?

The image on the left has a more traditional type of crop and on the one on the right we can see modern mechanised agriculture, which allows farmers to work in very large areas and in a more efficient way. Mechanised agriculture is more productive (it uses machinery, chemical products...). On the other hand traditional agriculture uses local species.

Evaluate

27. Why aren't all the trees removed from the grassland? Why are the remaining trees important?

Some of the trees are kept because they produce food for livestock (acorns), resources such as wood or cork and they provide shade for livestock too.

Create

28. Describe some of the uses of the following plants and trees: oak, linden, holm oak, cotton, pine and eucalyptus.

- Oak: wood used for construction and decorative purposes.
- Linden: its flowers and leaves are used in medicines.
- Holm oak: its fruits are excellent food for livestock, especially pigs; its wood is widely use as firewood.
- Cotton: widely used in the clothes industry to make fabrics.
- Pine: mainly used for construction and decorative purposes, as well as to obtain pine nuts.
- Eucalyptus: its leaves are used in medicines.

Understand

29. Listen and say why forests are important.

- By cutting down forests we reduce plant biodiversity on Earth.

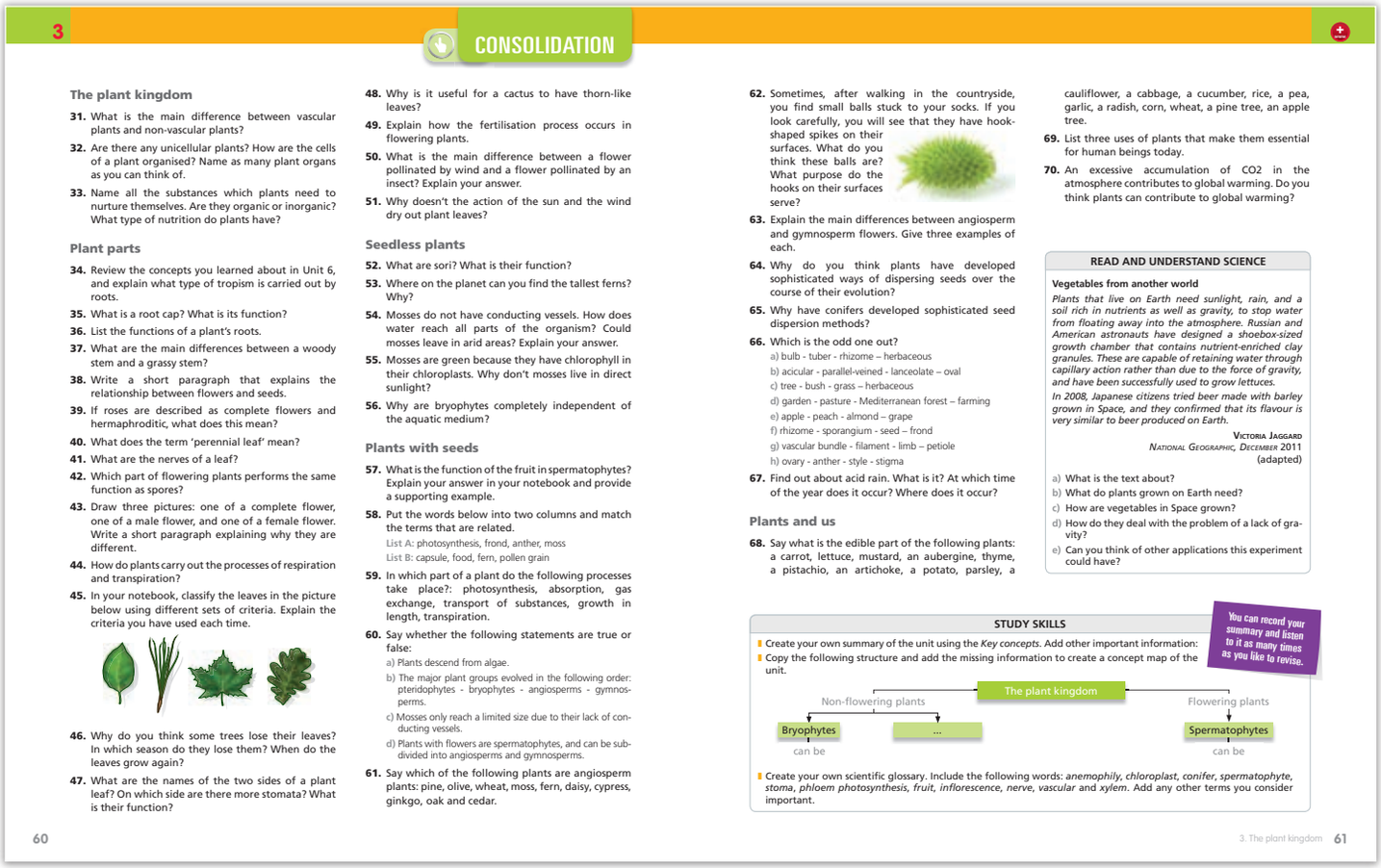
  For humans, this means it will get harder for us to discover new sources of nutrition and to make new medicines.
- Animals would also suffer, as different animals depend on different forest plants. If forests are cut down, these animals would suffer and could even become extinct. Other animals up the food chain could also suffer and become extinct.
- Finally, forests turn carbon dioxide into oxygen. The more forests we cut down the less oxygen will be produced. All living things will suffer as we all need oxygen to survive.

Answers should repeat what is said in the audio track. To further help students understand why forests are important ask them to develop their answers. Can they come up with any other reasons?

Analyse

30. Do some research on the most important crops in your region. Are they field crops or intensively farmed crops?

Open answer dependent on the region.



3 CONSOLIDATION

The plant kingdom

31. What is the main difference between vascular plants and non-vascular plants?

32. Are there any unicellular plants? How are the cells of a plant organised? Name as many plant organs as you can think of.

33. Name all the substances which plants need to nurture themselves. Are they organic or inorganic? What type of nutrition do plants have?

Plant parts

34. Review the concepts you learned about in Unit 6, and explain what type of tropism is carried out by roots.

35. What is a root cap? What is its function?

36. List the functions of a plant's roots.

37. What are the main differences between a woody stem and a grassy stem?

38. Write a short paragraph that explains the relationship between flowers and seeds.

39. If roses are described as complete flowers and hermaphroditic, what does this mean?

40. What does the term 'perennial leaf' mean?

41. What are the nerves of a leaf?

42. Which part of flowering plants performs the same function as spores?

43. Draw three pictures: one of a complete flower, one of a male flower, and one of a female flower. Write a short paragraph explaining why they are different.

44. How do plants carry out the processes of respiration and transpiration?

45. In your notebook, classify the leaves in the picture below using different sets of criteria. Explain the criteria you have used each time.

46. Why do you think some trees lose their leaves? In which season do they lose them? When do the leaves grow again?

47. What are the names of the two sides of a plant leaf? On which side are there more stomata? What is their function?

48. Why is it useful for a cactus to have thorn-like leaves?

49. Explain how the fertilisation process occurs in flowering plants.

50. What is the main difference between a flower pollinated by wind and a flower pollinated by an insect? Explain your answer.

51. Why doesn't the action of the sun and the wind dry out plant leaves?

Seedless plants

52. What are sori? What is their function?

53. Where on the planet can you find the tallest ferns? Why?

54. Mosses do not have conducting vessels. How does water reach all parts of the organism? Could mosses leave in arid areas? Explain your answer.

55. Mosses are green because they have chlorophyll in their chloroplasts. Why don't mosses live in direct sunlight?

56. Why are bryophytes completely independent of the aquatic medium?

Plants with seeds

57. What is the function of the fruit in spermatophytes? Explain your answer in your notebook and provide a supporting example.

58. Put the words below into two columns and match the terms that are related.
List A: photosynthesis, frond, anther, moss
List B: capsule, food, fern, pollen grain

59. In which part of a plant do the following processes take place?: photosynthesis, absorption, gas exchange, transport of substances, growth in length, transpiration.

60. Say whether the following statements are true or false:
a) Plants descend from algae.
b) The major plant groups evolved in the following order: pteridophytes - bryophytes - angiosperms - gymnosperms.
c) Mosses only reach a limited size due to their lack of conducting vessels.
d) Plants with flowers are spermatophytes, and can be subdivided into angiosperms and gymnosperms.

61. Say which of the following plants are angiosperm plants: pine, olive, wheat, moss, fern, daisy, cypress, ginkgo, oak and cedar.

62. Sometimes, after walking in the countryside, you find small balls stuck to your socks. If you look carefully, you will see that they have hook-shaped spikes on their surfaces. What do you think these balls are? What purpose do the hooks on their surfaces serve?

63. Explain the main differences between angiosperm and gymnosperm flowers. Give three examples of each.

64. Why do you think plants have developed sophisticated ways of dispersing seeds over the course of their evolution?

65. Why have conifers developed sophisticated seed dispersion methods?

66. Which is the odd one out?
a) bulb - tuber - rhizome – herbaceous
b) acicular - parallel-veined - lanceolate – oval
c) tree - bush - grass – herbaceous
d) garden - pasture - Mediterranean forest – farming
e) apple - peach - almond – grape
f) rhizome - sporangium - seed – frond
g) vascular bundle - filament - limb – petiole
h) ovary - anther - style - stigma

67. Find out about acid rain. What is it? At which time of the year does it occur? Where does it occur?

Plants and us

68. Say what is the edible part of the following plants: a carrot, lettuce, mustard, an aubergine, thyme, a pistachio, an artichoke, a potato, parsley, a cauliflower, a cabbage, a cucumber, rice, a pea, garlic, a radish, corn, wheat, a pine tree, an apple tree.

69. List three uses of plants that make them essential for human beings today.

70. An excessive accumulation of CO2 in the atmosphere contributes to global warming. Do you think plants can contribute to global warming?

READ AND UNDERSTAND SCIENCE

Vegetables from another world

Plants that live on Earth need sunlight, rain, and a soil rich in nutrients as well as gravity, to stop water from floating away into the atmosphere. Russian and American astronauts have designed a shoebox-sized growth chamber that contains nutrient-enriched clay granules. These are capable of retaining water through capillary action rather than due to the force of gravity, and have been successfully used to grow lettuces.

In 2008, Japanese citizens tried beer made with barley grown in Space, and they confirmed that its flavour is very similar to beer produced on Earth.

Victoria Jaggard
National Geographic, December 2011
(adapted)

a) What is the text about?
b) What do plants grown on Earth need?
c) How are vegetables in Space grown?
d) How do they deal with the problem of a lack of gravity?
e) Can you think of other applications this experiment could have?

STUDY SKILLS

You can record your summary and listen to it as many times as you like to revise.

- Create your own summary of the unit using the *Key concepts*. Add other important information:
- Copy the following structure and add the missing information to create a concept map of the unit.

The plant kingdom
- Non-flowering plants
  - Bryophytes — can be
  - ...
- Flowering plants
  - Spermatophytes — can be

- Create your own scientific glossary. Include the following words: *anemophily, chloroplast, conifer, spermatophyte, stoma, phloem photosynthesis, fruit, inflorescence, nerve, vascular* and *xylem*. Add any other terms you consider important.

60 3. The plant kingdom 61

The plant kingdom

31. What is the main difference between vascular plants and non-vascular plants?

Vascular plants have conducting vessels that carry the sap.

32. Are there any unicellular plants? How are the cells of a plant organised? Name as many plant organs as you can think of.

All plants are multicellular organisms. Their cells are organised into tissues that perform specialised functions. The vegetative parts of a plant are the roots, stem and leaves as well as the flower if they have them.

33. Name all the substances which plants need to nurture themselves. Are they organic or inorganic? What type of nutrition do plants have?

Plants need water and minerals as well as sunlight. These substances are inorganic, so plant nutrition is autotrophic.

Plant parts

34. Review the concepts you learned about in Unit 1, and explain what type of tropism is carried out by roots.

Negative phototropism (grows away from light) and positive geotropism (grows towards gravity).

35. What is a root cap? What is its function?

The root cap is a strong structure that envelops the root. It performs a protective function.

36. List the functions of a plant's roots.

Absorb water and minerals from the ground.

Anchoring the plant to the ground.

Accumulate substances as a reserve. This is the case of certain plants such as carrots.

37. What are the main differences between a woody stem and a grassy stem?

Their consistency: woody stems are strong and rigid whilst grassy (herbaceous) stems are flexible.

38. Write a short paragraph that explains the relationship between flowers and seeds.

Flowers are the reproductive organs of plants, in which gametes are located (female ovule and male grain of pollen). When the ovule is fertilised by the grain of pollen, it transforms into a seed that will grow into a new plant when it germinates.

39. If roses are described as complete flowers and hermaphroditic, what does this mean?

Complete means that they have all the flower structures (calix, corollas, stamen and carpel). This is why they are hermaphrodite given that they have both male and female organs.

40. What does the term 'perennial leaf' mean?

The term perennial refers to the plants that have leaves all year round.

41. What are the nerves of a leaf?

They are the conducting vessels that help circulate the sap inside the leaves.

42. Which part of flowering plants performs the same function as spores?

Seeds, which are the female ovule fertilised by the grain of pollen.

43. **Draw three pictures: one of a complete flower, one of a male flower, and one of a female flower. Write a short paragraph explaining why they are different.**

The main differences between these flowers are the reproductive organs that they have. The complete flower has stamens and pistil, the male flower only has stamens and the female flower only has a pistil.

44. **How do plants carry out the processes of respiration and transpiration?**

Transpiration is the process by which plants release oxygen and water vapour into the atmosphere as the by-product of photosynthesis. Respiration takes place inside individual plant cells.

45. **In your notebook, classify the leaves in the picture below using different sets of criteria. Explain the criteria you have used each time.**

	N.º OF BLADES	TYPE OF NERVES	SHAPE	EDGE OF THE BLADE
A	Simple	Pinnate	Elliptic	Entire
B	Simple	Single veined	Acicular	Entire
C	Simple	Palmate	Ovate	Dentate
D	Simple	Pinnate	Elliptic	Lobbed

46. **Why do you think some trees lose their leaves? In which season do they lose them? When do the leaves grow again?**

Certain trees lose their leaves in order to save energy during the autumn and winter because there is not much sunlight. In spring the leaves grow again, ready for the increase in sunlight.

47. **What are the names of the two sides of a plant leaf? On which side are there more stomata? What is their function?**

The names are upper side and underside of the leaf. There are more stomata on the underside of the leaf. Stomata are used in the transpiration process and they are located on the underside of the leaf in order to stop the plant from losing too much water.

48. **Why is it useful for a cactus to have thorn-like leaves?**

It is useful because the leaves are the smallest possible size and therefore they lose very little water.

49. **Explain how the fertilisation process occurs in flowering plants.**

The fertilisation of a flower takes place when a grain of pollen (male) reaches the ovule (female) of the same or another flower. The pollination process can be carried out by a range of agents, such as wind, bees, water, ...

50. **What is the main difference between a flower pollinated by wind and a flower pollinated by an insect? Explain your answer.**

Flowers pollinated by the wind have long stamens that release the pollen when the wind moves them; they have corollas with small petals that are not very colourful. Flowers pollinated by insects tend to be very colourful and have large corollas. Their stamens are hidden and produce nectar (a sweet liquid that insects like).

51. **Why doesn't the action of the sun and the wind dry out plant leaves?**

Because inside the plants there is water and minerals in the form of crude sap that prevents the leaves drying out.

Seedless plants

52. **What are sori? What is their function?**

Sori are bumps in which the sporangia of ferns can be found. They are located on the underside of their fronds and in them spores are produced.

53. **Where on the planet can you find the tallest ferns? Why?**

The tallest ferns are found in tropical regions because they have very humid conditions and low light, which are the perfect conditions for ferns to grow.

54. **Mosses do not have conducting vessels. How does water reach all parts of the organism? Could mosses live in arid areas? Explain your answer.**

Mosses have underdeveloped conducting vessels that stop them from growing taller than 2 cm (this is the tallest height the water can reach in a plant without developed conducting vessels). This is why mosses cannot live in arid, dry conditions, because they need a very humid environment to live in.

55. **Mosses are green because they have chlorophyll in their chloroplasts. Why don't mosses live in direct sunlight?**

Because humidity will be less in direct sunlight and the mosses will be unable to survive in those conditions.

56. **Why are bryophytes completely dependent on the aquatic medium?**

Because they have underdeveloped conducting vessels and they need a very humid environment in order to survive.

Plants with seeds

57. **What is the function of the fruit in spermatophytes? Explain your answer in your notebook and provide a supporting example.**

The function of fruits is to disperse the seeds. The fruit protects the seeds, stopping them from being damaged by the elements; fruits help seed dispersion in many different ways.

For example, the fruit we, humans and other animals, eat make us carry the seeds in our digestive system. Then, the seeds are deposited in a new location when the excrement is released.

58. **Put the words below into two columns and match the terms that are related.**

List A: photosynthesis, frond, anther, moss

List B: capsule, food, fern, pollen grain

photosynthesis → food

frond → fern

anther → pollen grain

moss → capsule

59. In which part of a plant do the following processes take place? *Photosynthesis, absorption, gas exchange, transport of substances, growth in length, transpiration.*

Photosynthesis (leaves), absorption (roots), gas exchange (leaves), transport of substances (stem), growth in length (stem), transpiration (leaves).

60. Say whether the following statements are true or false:

a) Plants descend from algae.

True, plants evolved from algae 500 million years ago.

b) The major plant groups evolved in the following order: pteridophytes - bryophytes - angiosperms - gymnosperms.

False, the correct order is bryophytes, pteridophytes, angiosperms and gymnosperms.

c) Mosses only reach a limited size due to their lack of conducting vessels.

True, because they can only grow up to 2cm.

d) Plants with flowers are spermatophytes, and can be subdivided into angiosperms and gymnosperms.

True.

61. Say which of the following plants are angiosperm plants: pine, olive, wheat, moss, fern, daisy, cypress, ginkgo, oak and cedar.

Olive, wheat, daisy and oak.

62. Sometimes, after walking in the countryside, you find small balls stuck to your socks. If you look carefully, you will see that they have hook-shaped spikes on their surfaces. What do you think these balls are? What purpose do the hooks on their surfaces serve?

The balls are seeds and their purpose is to hook onto a person or animal so they can be dispersed far away from the parent plant.

63. Explain the main differences between angiosperm and gymnosperm flowers. Give three examples of each.

Gymnosperms have unisexual flowers (one sex only), always group into inflorescences and the ovule is always exposed.

Angiosperms have complete/hermaphrodite flowers that tend to be on their own (although they sometimes group into inflorescences in certain species) their ovules are enclosed in an ovary that after being fertilised will become fruits.

Examples:

Gymnosperms: pine, cypress and fir

Angiosperms: peach, apple and almond trees

64. Why do you think plants have developed sophisticated ways of dispersing seeds over the course of their evolution?

Because seed dispersion is a very sophisticated mechanism that plants need because they cannot move from one place to another. In this way they can colonise new territories and avoid the competition that living close by involves.

65. Why have conifers developed sophisticated seed dispersion methods?

Because conifers use anemophilous pollination (wind).

66. Which is the odd one out?

a) bulb - tuber - rhizome – herbaceous

herbaceous

b) acicular - parallel-veined - lanceolate – oval

parallel-veined

c) tree - bush - grass – herbaceous

herbaceous

d) garden - pasture - Mediterranean forest – farming

Mediterranean forest

e) apple - peach - almond – grape

almond

f) rhizome - sporangium - seed – frond

seed

g) vascular bundle - filament - limb – petiole

filament

h) ovary - anther - style – stigma

anther

67. Find out about acid rain. What is it? At which time of the year does it occur? Where does it occur?

Acid rain is rainfall made so acidic by atmospheric pollution that it causes environmental harm mainly to forests and lakes. It is mainly caused by the industrial burning of coal and other fossil fuels. These create waste gases containing sulphur and nitrogen oxides which mix with atmospheric water to form acid rain.

Acid rain is more typical during the months where there is more humidity in the air, as waste gases mix in with the water in the atmosphere, and happen in areas surrounding coal and other fossil fuel burning industries.

Plants and us

68. Say what is the edible part of the following plants:

a carrot: root

lettuce: leaves

mustard: seeds

an eggplant: fruit

thyme: leaves

a pistachio: fruit

an artichoke: inflorescence

a potato: stem (tuber)

parsley: leaves

a cauliflower: inflorescence

a cabbage: leaves

a cucumber: fruit

rice: seeds

a pea: seeds

garlic: stem (bulbous)

a radish: root

corn: seeds

wheat: seeds

a pine tree: seeds

an apple tree: fruits

69. List three uses of plants that make them essential for human beings today.

- They are used as food.
- They are used to create many medicines.
- They are used to create raw materials.

70. An excessive accumulation of CO_2 in the atmosphere contributes to global warming. Do you think plants can contribute to global warming?

They can contribute positively as they use CO_2 during the photosynthesis in order to make organic matter. This is why plants are the best way to store CO_2 and remove it from the atmosphere.

READ AND UNDERSTAND SCIENCE

a) What is the text about?

The text describes crops in space, under zero gravity conditions.

b) What do plants grown on Earth need?

Plants need sunlight, rain and a soil rich in minerals as well as gravity to stop water floating away.

c) How are vegetables in Space grown?

In a shoebox-sized growth chamber.

d) How do they deal with the problem of a lack of gravity?

Using nutrient enriched clay granules that retain water through capillary action.

e) Can you think of other applications this experiment could have?

They could have larger crops in space, if the Earth starts to have less fertile land.

STUDY SKILLS

Open answer

EXTRA RESOURCES

PDF
COMPETENCE TEST
CONCEPT MAP
EXTENSION WORKSHEET
UNIT TESTS
INTERACTIVE ACTIVITIES
PRESENTATION

3 WORK AND EXPERIMENTATION TECHNIQUES

The height of trees

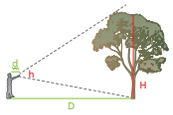
Different trees can reach different heights, from 3 m to more than 100 m, depending on their species. In this experiment, you will learn how to measure the height of trees easily. You will apply your mathematical knowledge and use simple instruments, such as a pencil and a measuring tape.

Materials

- Pencil
- Measuring tape

Procedure

1. Measure and make a note of the length of the pencil (*h*).
2. Stretch out your arm while holding the pencil, as shown in the diagram



3. Looking through one eye only, line up the flat end of the pencil with the base of the tree and the top of the pencil with the top of the tree.
4. Measure the distance between you and the tree (*D*).
5. Measure the length of your stretched-out arm (*d*).
6. Make a note of the measurements and draw a diagram.
7. Calculate the length of the tree (*H*) by using the following method: $H = h \cdot \frac{D}{d}$
8. Repeat the procedure with a range of trees.

Analysis of results:

To analyse your results, copy the following table and complete it using data from three different trees.

Name of the tree	Length of pencil (h)	Length of stretched-out arm (d)	Distance from the tree (D)	Height of the tree (H)
...	...	...	...	...

1. What is the height of each tree?
2. Is the height related to the distance between your position and the tree?
3. Would the height be different if the width of the pencil was different?
4. Calculate the circumference of the trunk of each tree. Does it have any relationship to the height of the tree?
5. Draw your own conclusions from the experiment you have just carried out, and suggest an experiment for calculating the height of some important buildings in your local area.

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FINAL TASK

Plants around me

The aim of this task is to do some research on the criteria used to classify plants. In addition, you will be practising the use of keys and guides in order to identify plants in your local area. You will write a scientific article as well as creating a dichotomous key to present your results.

1. Research

a) Which criterion is used to classify plants depending on their stems? And which criterion is used depending on their leaves?
b) What is a dichotomous key?
c) How are identification keys used?
d) Do all the plants in your local area have flowers?
e) How tall are the plants which you have studied?
f) In what season of the year do spermatophyte plants bloom in your local area? How do they disperse their seeds?
g) What types of fruit have you observed in angiosperm plants?

Procedure

In order to carry out this research task, follow these steps:

Research

- Use a plant guide to identify the names of plants in your local area. Find out which group they belong to and make a note of their characteristics.
- Review what a dichotomous key is and how to make one. Find a completed dichotomous key that is ready to use, and familiarise yourself with it.
- Look at a website for your local area and find information about its natural spaces and flora.
- Make sure you write down all of your sources for the bibliography.

Organise the information

- Make a map of the area you have studied and locate the trees observed in it.
- Before writing the article, make sure you plan it first.
- Answer all the questions in the *Investigate* section.

Draw conclusions and check your research

- Check your answers. Make sure your conclusions are consistent with the content from this unit and that you have answered all the questions above.

2. Tasks

a) For the research task, you will have to write a scientific paper. Use photos or drawings of the plants to illustrate it.
b) Another aim of this research task is to produce a dichotomous key:
- Find objective characteristics that you can use to identify the plants you have studied.
- Create questions that only have two possible answers.
- Check that it is possible to identify the selected plants using your dichotomous key.

SELF-ASSESSMENT

Answer the following questions to assess your work:

1. Did you answer all the questions in the *Investigate* section?
2. How many plants in your local area did you identify? Did you know any of them beforehand?
3. Did you check that your answers appear in different sources?
4. Did you actively participate in the creation of the presentation?
5. Did you take part in the oral presentation?
6. Give your research task a score from 1 to 5.

3. The plant kingdom 63

The height of trees

This science experiment complements the contents studied in section 4. Students will expand their knowledge of *5.1. Identify characteristics of gymnosperms* and *5.2. Identify characteristics of angiosperms.*

Spermatophytes are plants that become trees and the purpose of this investigation is to find out how tall they can be. In addition, students will use mathematical formulae and apply it in a biological context.

Model how to carry out the investigation using all of the materials and following all of the steps mentioned in the **Procedure** section. Ask some students to support you. If possible, show students how to find out the height of a tree in the playground (if there is one). Ask students to estimate the height of the tree before actually measuring it using the mathematical formula.

By doing this science experiment students will achieve the following key competences:

- **Mathematical competence and basic competences in science and technology (MCST)**
- **Learning to learn (LL)**

Answer key

1. What is the height of each tree?

Student's own answers

2. Is the height of the tree related to the distance between your position and the tree?

No, the height of the tree is always the same, however as we change the distance we are from it (D), the value of h (length of the pencil) changes.

3. Would the height be different if the width of the pencil was different?

No, because what we use is the length of the pencil not the width.

4. Calculate the circumference of the trunk of each tree. Does it have any relationship to the height of the tree?

Student's own answers.

The relationship between height and circumference indicates age in trees of the same species.

5. Draw your own conclusions from the experiment you have just carried out, and suggest an experiment for calculating the height of some important buildings in your local area.

The conclusion of this investigation is that we can measure trees in an indirect way, as we have done during this investigation. In order to measure buildings we could use a very similar methodology as we should be able to measure buildings indirectly, like we did with the trees.

Plants around me

This investigation project aims to familiarise students with the plants found in their local environments. In this way, students will get to know their names, how they are classified and some of their most important characteristics.

In addition, students will become more familiar with dichotomous keys, which are an excellent way of classifying living things in an objective and discriminatory way. It is important that you review some of the main characteristic of plants.

Transform the diagram found on page 46 of the Student's book into a dichotomous key. Practise creating questions that are objective and discriminatory as well as follow the criteria studied in the unit.

- *Does it have flowers?*
- *Does it have conducting vessels?*
- *Does it have fruits?*

Show students how to make a dichotomous key using the information on page 46.

Make sure the students understand that they have to create a dichotomous key as well as a scientific paper.

On page 45 of the Student's Book we introduce the final task to the students.

On page 63 we explain how to produce the **dichotomous key** and the **scientific paper**.

- In the **Research** section there are questions aimed at enhancing students' understanding of dichotomous keys as well as plant classification. In addition, the questions will give the investigation a structure.
- The **Presentation** section gives students guidance on how to make a dichotomous key as well as other tips on how to complete their scientific paper.
- The **Procedure** section indicates the steps needed to complete the research, organise data and how to draw conclusions as well as how to check your sources.
- The **Self-assessment** at the end of the page will make them think about their work and the development of the final task.

The learning outcome that will be reinforced during this task is:

4.1. *Classify plants according to different criteria.*

An example of how to assess the final task is shown here:

0 = not handed in 1 = very basic 2 = well done 3 = excellent

	0	1	2	3
DICHOTOMOUS KEY AND SCIENTIFIC PAPER				
The format of the scientific paper is suitable.				
The paper has a clear introduction.				
The methodology section is clear.				
Results are presented in a clear manner.				
Results are accompanied by data and images that support them.				
The paper uses the correct terminology.				
The dichotomous key is clear and easy to use.				
Students are able to respond to the questions of other students and the teacher.				
It includes a list of sources.				

LEARNING OUTCOMES RUBRIC

Evaluable learning outcomes	Assessment tools	Excellent 3	Satisfactory 2	In process 1	Not achieved 0	Score
1.1. Classify plants according to a range of criteria.	1, 2, 4, 41	Identifies criteria correctly and resolves all the activities correctly	Identifies most criteria correctly and resolves most activities correctly.	Identifies few criteria correctly and resolves the activities but making quite a lot of mistakes.	Answers in an incorrect way or does not answer.	
2.1. Differentiate the general characteristics of plants and their importance.	3, 43, 44, 71	Identifies all the important characteristics.	Identifies quite a lot of the important characteristics.	Identifies few important characteristics.	Answers in an incorrect way or does not answer.	
3.1. Identify the parts and the importance of the root.	5, 6, 8, 10, 44, 45, 46, 54, 70	Resolves all the activities correctly.	Resolves most of the activities correctly with mistakes in a few of them.	Resolves the activities but making quite a lot of mistakes.	Answers in an incorrect way or does not answer.	
3.2. Identify the parts and the importance of the stem.	7, 9, 11, 47, 70, 77	Resolves all the activities correctly.	Resolves most of the activities correctly with mistakes in a few of them.	Resolves the activities but making quite a lot of mistakes.	Answers in an incorrect way or does not answer.	
3.3. Identify the parts and the importance of the leaf.	12, 13, 14, 15, 16, 17, 50, 51, 55, 56, 57, 58, 59, 62, 69, 70, 77	Resolves all the activities correctly.	Resolves most of the activities correctly with mistakes in a few of them.	Resolves the activities but making quite a lot of mistakes.	Answers in an incorrect way or does not answer.	
3.4. Identify the parts and the importance of the flower.	18, 19, 20, 21, 22, 48, 49, 52, 53, 60, 61, 69, 70, 77	Resolves all the activities correctly.	Resolves most of the activities correctly with mistakes in a few of them.	Resolves the activities but making quite a lot of mistakes.	Answers in an incorrect way or does not answer.	
4.1. Identify the characteristics of bryophytes.	23, 24, 65, 66, 67, 69	Identifies all the important characteristics.	Identifies quite a lot of the important characteristics.	Identifies few important characteristics.	Answers in an incorrect way or does not answer.	
4.2. Identify the characteristics of pteridophytes.	25, 26, 27, 28, 63, 64, 69, 77	Identifies all the important characteristics.	Identifies quite a lot of the important characteristics.	Identifies few important characteristics.	Answers in an incorrect way or does not answer.	
5.1. Identify the characteristics of gymnosperms.	29, 30, 31, 32, 68, 74, 76	Identifies all the important characteristics.	Identifies quite a lot of the important characteristics.	Identifies few important characteristics.	Answers in an incorrect way or does not answer.	
5.2. Identify the characteristics of angiosperms.	33, 34, 35, 72, 73, 74, 75, 77, 78	Identifies all the important characteristics.	Identifies quite a lot of the important characteristics.	Identifies few important characteristics.	Answers in an incorrect way or does not answer.	
6.1. Relate characteristics of plants (or plants' parts) with the uses humans give them.	36, 37, 38, 39, 40, 77, 79, 80, 81, 82	Resolves all the activities correctly.	Resolves most activities correctly.	Resolves the activities but making quite a lot of mistakes.	Answers incorrectly or does not answer.	

Objectives, contents and methodology

TYPES OF RESOURCES AND METHODOLOGY USED TO MEET OBJECTIVES	
●	Interactive activities. Elaboration and verification of a hypothesis.
❍	Search for information on the Internet.
▶	Watch videos.
❑	Analyse images.
■	Analyse texts (news articles, scientific articles...).

SECTIONS	OBJECTIVES AND CONTENTS	METHODOLOGY	
The parts of a plant	Identify the different parts that make up a plant.	❑	❍
	Analyse the daily functions of a plant	❍	
	Concepts: Root, absorbent hairs, stem, buds, leaf, petiole, leaf upper side, leaf underside, nerves		
Photosynthesis	Find out how photosynthesis occurs and what the necessary elements are.	●	
	Analyse the function of photosynthesis.	●	▶
	Concepts: Photosynthesis, chloroplasts, stomata		
Flower morphology	Identify the different parts of a flower.	❑	❍
	Analyse the functions of each part of the flower.	❍	
	Concepts: Flower, petals, calyx, peduncle, stamen, filament, anther, carpel, stigma, style, ovary		
Plant reproduction	Analyse the sequence of processes involved in sexual reproduction in flowering plants.	●	❑
	Analyse the role of the flower and its transformation in the process of reproduction.	❑	❍
	Concepts: Pollination, fertilisation, formation of fruit and seed		
Investigation	Identify and classify different types of plants.	❍	❑

1. Describe the differences between the following concepts:

a) Apical bud and axillary bud.

Axillary buds allow the plant to grow side branches and leaves whilst the apical bud helps the plant grow upwards.

b) Leaf upper side and leaf underside.

The upper side of the leaf is the top part and the underside is the part underneath.

c) Calyx and corolla.

The calyx is green and the corolla tends to have brighter colours.

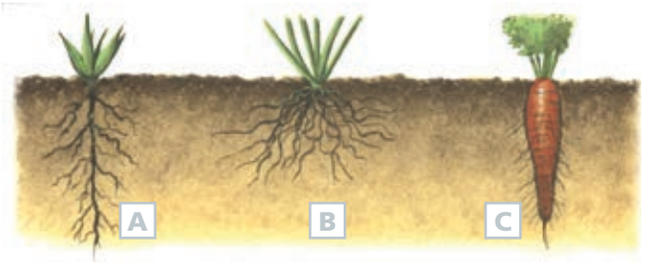
2. Create a classification of plants and use the presence of conducting vessels as classification criteria.

Without conducting vessels	-	Hepatic
Simple conducting vessels	-	Mosses
Developed conducting vessels	-	Ferns, gymnosperms and angiosperms

3. Which plants have flowers?

Spermatophyte plants have flowers

4. The following diagram displays three types of roots. Identify their names.



A: Prop root.

B: Fibrous root.

C: Tubercular root.

5. Explain the process of photosynthesis and answer the following question:

Photosynthesis involves transforming inorganic matter that plants take from the environment (water, minerals and carbon dioxide) into organic matter using sunlight.

Which part of the plant is responsible for exchanging gases with the atmosphere?

Stomata are responsible for exchanging gases with the atmosphere.

6. Decide if the following statements are true or false. Correct the false statements.

a) Stomata are located on the upper leaf.

False. Stomata are located on the underside.

b) A leaf can be simple and compound.

False. A leaf can either be simple (one blade) or compound (several blades).

c) The underside of the leaf has a lighter colour that the upper leaf.

True

d) An individual stoma is formed by two cells.

True

7. Identify the part of a plant being described:

a) Formed by a filament and an anther.

Stamen

b) A group of sepals.

Calyx

c) Often formed by coloured petals.

Corolla

d) It is divided into stigma, style and ovary.

Pistil

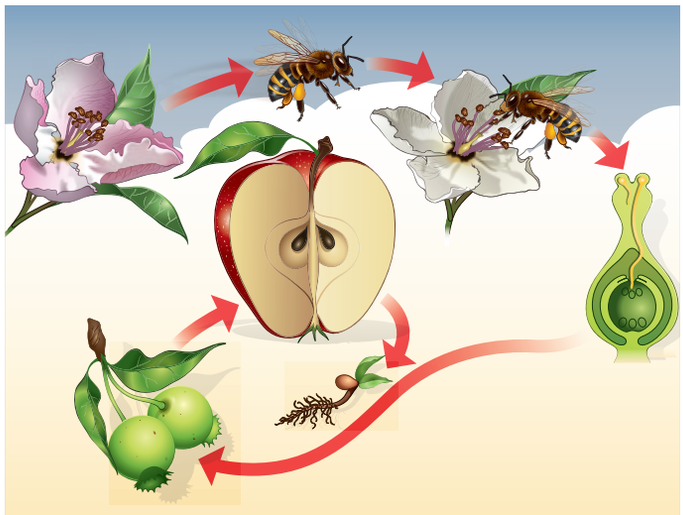
8. Why are bryophyte plants important in the history of terrestrial plants?

Because bryophytes were the first terrestrial plants. They evolved from green algae 500 million years ago.

9. Identify ways in which plants are important for us.

Plants are key for terrestrial ecosystems to exist. Plants are very important for us because we have used them for many purposes since ancient times. Nowadays plants are used for food, to make medicines, as forest and natural resources or for ornamental purposes.

10. Look at the following image and explain how pollination takes place.



Spermatophyte plants perform the function of reproduction inside their flowers. Pollen grains, both of angiosperm and gymnosperm plants, have to travel from the stamens to the pistil of the flower itself (or of another flower). We call this process pollination. A variety of agents can be involved in it: wind (wind pollination), water (hydrophilic pollination), insects (insect pollination), and other animals (zoophilic pollination). Pollination allows fertilisation to take place, which produces the seed that will lead to a new plant.

1. Identify similarities and differences between pteridophytes and bryophytes.

Similarities: bryophytes and pteridophytes do not have flowers and do not reproduce using seeds.

Differences: bryophytes have no conducting vessels or they have very simple ones. Pteridophytes, on the other hand, have developed conducting vessels. Also, pteridophytes are larger than bryophytes.

2. Relate the following terms with the plant types:

Angiosperms	a) Seed	b) Capsule
Gymnosperms	c) Fruit	d) Spores
Pteridophytes	e) Frond	f) Cones
Bryophytes	g) Rhizoid	h) Sori

Angiosperms: a, c

Gymnosperms: a, f

Pteridophytes: d, e, h

Bryophytes: b, d, g

3. Look at the following diagram and describe the dispersion mechanism used by the elm and maple trees.

They have a winged seed that the wind disperses.

4. Create a diagram that displays the different types of leaves according to the number of blades

The drawing should be similar to the first row found in the *Leaf types* diagram (page 51 of the Student's book). It should include the following types: simple, pinnately compound, palmate compound and trifoliate compound.

5. Explain if the following statements are true or false:

a) The ovary in gymnosperm flowers transforms into a fruit.

False. Angiosperm plants have ovaries that transform into fruits.

b) Bryophytes are very small plants.

True

c) Ferns are not spermatophytes because they do not have conducting vessels.

False. Ferns are not spermatophytes because they do not have flowers.

d) Many angiosperm plants have colourful flowers.

True.

6. Answer the following questions, and justify your answers:

a) Can a complete flower be unisexual?

No, because if it is complete it has to be hermaphrodite.

b) Do hermaphrodite flowers have stamens and pistil within the same flower?

Yes and they are able to fertilise themselves.

c) Which parts of the flower do gymnosperm plants not have?

Calyx and corolla

7. Draw two occlusive cells and explain how the transpiration works.

Use the diagram found in page 50 of the Student's book.

When water vapour is going to be released the occlusive cells separate creating an orifice (stoma). Gas is released through the stoma. When the plant does not want to release gas the stomata close.

8. What are grasslands and what are they used for?

Grasslands are an artificial type of vegetation that are used for agricultural purposes.

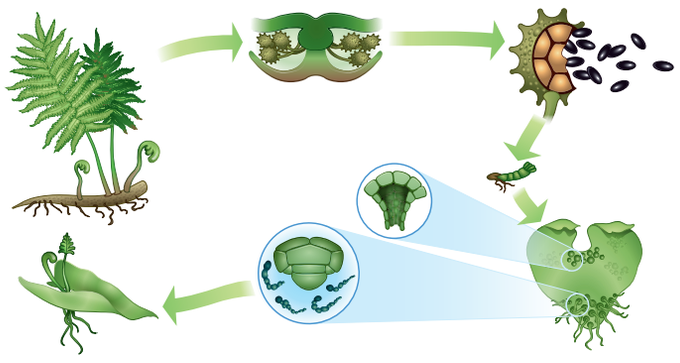
9. Identify the functions of the vegetative organs in vascular plants.

The roots absorb water and minerals as well as anchor the plant.

The stem keeps the plant upright and carries nutrients to the leaves.

The leaves perform photosynthesis and transpiration processes.

10. Look at the diagram and explain the life cycle of a fern.



Students explain what they learned by studying the diagram on page 55.