Australian National Botanic Gardens

Lesson Plan

Module 2

Plant Structure

We acknowledge the Traditional Owners of Country throughout Australia and recognise their continuing connection to land, waters and culture. We pay our respects to their Elders past, present and emerging.

Plant Science Learning Hub

Students need a space to learn that is fun and rewarding. The Australian National Botanic Gardens has developed a Plant Science Learning Hub that aims to inspire and engage students in plant science and the stories surrounding Australian flora. With clear links to the Australian Curriculum for school years four to six, the Plant Science Learning Hub will provide a valuable resource for students and educators.

- Plant Life Cycles
- **Plant Structure**
- Pollination
- Seeds

This series provides educators with authoritative plant science content that has a uniquely Australian perspective. The Gardens manages globally significant scientific collections of living plants and herbarium specimens of Australian native flora. We provide educational experiences for students from pre-primary to tertiary levels, leveraging our scientific collections, participation in national and international conservation projects and outreach programs to engage the community in valuing, conserving, and appreciating Australia's diverse plant heritage.

Module learning objectives

The following learning objectives apply to the Plant Structure Module.

1. Identify the basic structural elements of a generalised flowering plant.
2. Identify the structural elements of several specific Australian plants.
3. Understand the functions and parts of a flowering plant.
4. Explore links between plant structure and the physical environment.

Each lesson within the lesson plans and the field kits has individual learning intentions appropriate to the activity.

Contents

Lesson Two: Function of stem, roots and leaves

LEARNING INTENTIONS

Students will be able to:

- Explore the anatomy of plants and how they use the vascular system in their roots, stem and leaves to transport water and nutrients.
- Design an investigation to demonstrate the function of each of the structural elements of a plant.
- Consider how damage or disease to one part of the plant structure can impact the survival of the plant.
- Analyse how plants make food through photosynthesis by conducting a scientific experiment.

CURRICULUM LINKS

This material provides opportunities for students to engage in the following Australian Curriculum content descriptions **(Version 9.0)**:

Science understanding

AC9S5U01 examine how particular structural features and behaviours of living things enable their survival in specific habitats (Year 5)

AC9S6U01 investigate the physical conditions of a habitat and analyse how the growth and survival of living things is affected by changing physical conditions (Year 6)

Science as a Human Endeavour

AC9S3H02 consider how people use scientific explanations to meet a need or solve a problem (Year 3)

AC9S4H02 consider how people use scientific explanations to meet a need or solve a problem (Year 4)

AC9S4H01 examine how people use data to develop scientific explanations (Year 4)

AC9S5H01 examine why advances in science are often the result of collaboration or build on the work of others (Year 5)

AC9S5H02 investigate how scientific knowledge is used by individuals and communities to identify problems, consider responses and make decisions (Year 5)

AC9S6H01 examine why advances in science are often the result of collaboration or build on the work of others (Year 6)

AC9S6H02 investigate how scientific knowledge is used by individuals and communities to identify problems, consider responses and make decisions (Year 6)

Science Inquiry Skills

AC9S3I01 pose questions to explore observed patterns and relationships and make predictions based on observations (Year 3)

AC9S3I02 use provided scaffolds to plan and conduct investigations to answer questions or test predictions, including identifying the elements of fair tests, and considering the safe use of materials and equipment (Year 3)

AC9S3I03 follow procedures to make and record observations, including making formal measurements using familiar scaled instruments and using digital tools as appropriate (Year 3)

AC9S3I04 construct and use representations, including tables, simple column graphs and visual or physical models, to organise data and information, show simple relationships and identify patterns (Year 3)

AC9S3I05 compare findings with those of others, consider if investigations were fair, identify questions for further investigation and draw conclusions (Year 3)

AC9S3I06 write and create texts to communicate findings and ideas for identified purposes and audiences, using scientific vocabulary and digital tools as appropriate (Year 3)

AC9S4I01 pose questions to explore observed patterns and relationships and make predictions based on observations (Year 4)

AC9S4I02 use provided scaffolds to plan and conduct investigations to answer questions or test predictions, including identifying the elements of fair tests, and considering the safe use of materials and equipment (Year 4)

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AC9S4I05 compare findings with those of others, consider if investigations were fair, identify questions for further investigation and draw conclusions (Year 4)

AC9S4I06 write and create texts to communicate findings and ideas for identified purposes and audiences, using scientific vocabulary and digital tools as appropriate (Year 4)

AC9S5I01 pose investigable questions to identify patterns and test relationships and make reasoned predictions (Year 5)

AC9S5I02 plan and conduct repeatable investigations to answer questions, including, as appropriate, deciding the variables to be changed, measured and controlled in fair tests; describing potential risks; planning for the safe use of equipment and materials; and identifying required permissions to conduct investigations on Country/Place (Year 5)

AC9S5I03 use equipment to observe, measure and record data with reasonable precision, using digital tools as appropriate (Year 5)

AC9S5I04 construct and use appropriate representations, including tables, graphs and visual or physical models, to organise and process data and information and describe patterns, trends and relationships (Year 5)

AC9S5I05 compare methods and findings with those of others, recognise possible sources of error, pose questions for further investigation and select evidence to draw reasoned conclusions (Year 5)

AC9S5I06 write and create texts to communicate ideas and findings for specific purposes and audiences, including selection of language features, using digital tools as appropriate (Year 5)

AC9S6I01 pose investigable questions to identify patterns and test relationships and make reasoned predictions (Year 6)

AC9S6I02 plan and conduct repeatable investigations to answer questions, including, as appropriate, deciding the variables to be changed, measured and controlled in fair tests; describing potential risks; planning for the safe use of equipment and materials; and identifying required permissions to conduct investigations on Country/Place (Year 6)

AC9S6I03 use equipment to observe, measure and record data with reasonable precision, using digital tools as appropriate (Year 6)

AC9S6I04 construct and use appropriate representations, including tables, graphs and visual or physical models, to organise and process data and information and describe patterns, trends and relationships (Year 6)

AC9S6I05 compare methods and findings with those of others, recognise possible sources of error, pose questions for further investigation and select evidence to draw reasoned conclusions (Year 6)

AC9S6I06 write and create texts to communicate ideas and findings for specific purposes and audiences, including selection of language features, using digital tools as appropriate (Year 6)

Humanities and social sciences

AC9HS3S05/AC9HS4S05 draw conclusions based on analysis of information (Year 3/Year 4)

CONTENT INFORMATION

Root system

Image: ©M.Fagg, 2013

Roots anchor the plant and provide it with access to water, nutrients, minerals and fungi that are essential for their growth and survival. Root systems can be made up of a network of **fibrous roots** or based around one main **taproot**.

Taproot

A taproot is a dominant root that is typically straight, thick, points downwards and has a tapering shape (like a carrot), but they can grow into other shapes (like a radish). Roots grow from the sides of the taproot as well (lateral roots), but they are smaller than the taproot itself.

Scientists believe that taproots evolved from fibrous roots to allow plants to live in drier environments. Because taproots grow downwards they can provide plants in dry areas access to water deeper in the soil profile, such as groundwater. Taproots can also store food and nutrients for the plant to access during tough conditions associated with dry environments.

Taproots are found in gymnosperms (like pine trees) and dicotyledons (dicots), plants that sprout with two cotyledon leaves instead of one. You can find plants with taproots in your garden or kitchen, such as dandelions, carrots, radishes and beetroot!

Fibrous roots

Fibrous root networks generally form dense mats made up of many thin roots. Unlike taproots, fibrous roots remain relatively shallow in the soil profile, so they do not provide plants with access to deep water. As such, fibrous roots are better suited to wetter environments. The network of roots can help to hold soil together and prevent erosion of the upper soil layers, which is especially beneficial in the wetter environments they are suited to.

Fibrous root systems occur in monocotyledons (monocots), plants that sprout with just one cotyledon leaf. They are commonly found in grasses like rice and wheat, and other plants like bananas, asparagus and onions.

Stems

Stems provide support for leaves, flowers and fruits and allow nutrients, minerals and water to travel around the plant. Some stems are soft and **herbaceous** (e.g. in herbs) and others are hard and woody, like the stems in trees and shrubs. Stems can also be **unbranched** (single stem) or **branched** (divisions and side stems). Palm trees and cycads have unbranched stems, whereas tomato vines and pine trees have branched stems.

Stem types

Stems are categorised according to where they grow: **underground**, **aerial** or **subaerial**.

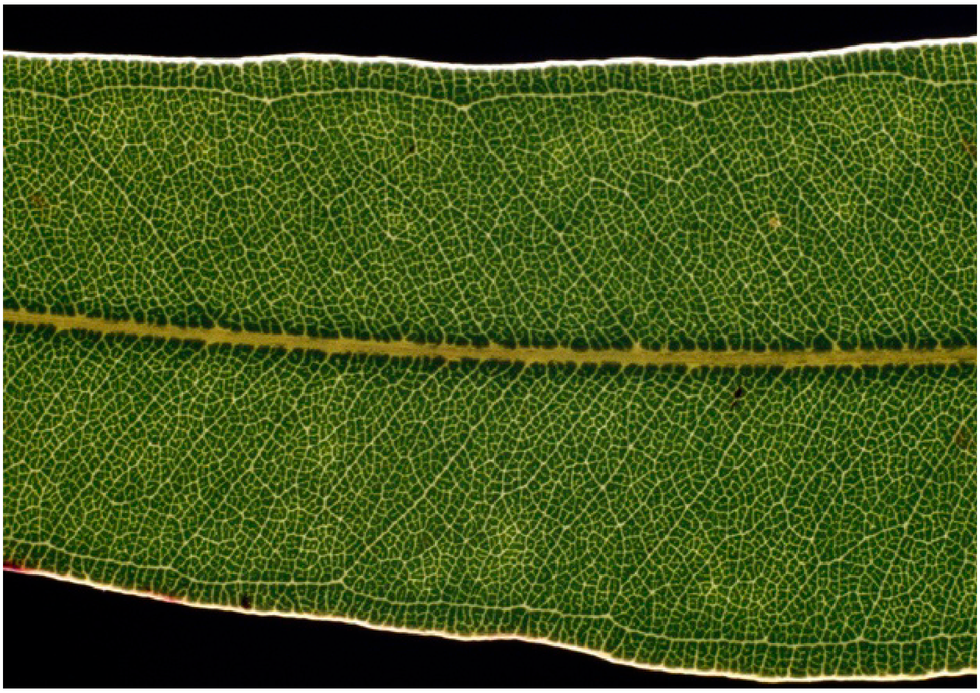
Underground stems remain under the ground, store food and nutrients and are often capable of **asexual reproduction** (genetic cloning). Rhizomes, tubers and corms are different types of underground roots; in many kitchens you can find tubers in the form of potatoes and rhizomes in the form of ginger.

Aerial stems grow above the ground, often vertically, and are the most familiar stem form. Modifications to aerial stems include **tendrils**, **thorns**, **bulbils** and **cladodes.** Thorns can be seen on rose bushes and tendrils on passionfruit vines. Bulbils are modified buds that can drop to the ground and grow into a new plant, such as those on agave succulents. Cladodes (or phylloclades) are specialised aerial stems that occur in some dry-adapted plants. To minimise water loss these plants have very small or absent leaves and the phylloclades undertake photosynthesis instead. Many cacti have cladodes (pads) which can grow into a new plant if they become detached. Many acacia species (wattles) have phyllodes which are modified leaf stems. Phyllodes look and function like leaves.

Thorns on a Vachellia nilotica subsp. Indica. Note this is not a native Australian plant species.
Image: ©M.Fagg, 2013

Subaerial stems grow just above the ground and include **runners**, **offsets**, **stolons** and **suckers**. Runners grow parallel to the ground and can help a plant to spread by putting down roots. Offsets, stolons and suckers function similarly to runners but grow at different orientations to the main stem. These structures allow a plant to reproduce asexually.

Leaves



The leaf of a *Eucalypt* with veins clearly visible.
Image:Brooker and Kleinig©ANBG

Leaves are attached directly to stems or via a 'leaf stem' called a **petiole**. Vascular tissues (**xylem** and **phloem**) run through the veins of the leaf, providing structural support and allowing nutrients and water to move through the leaf. The main functions of leaves include **photosynthesis**, **transpiration**, storage, **guttation** and plant defence.

Leaves are green due to a substance called **chlorophyll** which plays a vital role in photosynthesis. Chlorophyll allows leaves to combine energy from the sun, carbon dioxide and water to produce sugar and oxygen. This provides food for the plant, allowing it to grow and produce flowers and fruit.

When leaves open their stomata (pores) to acquire gases for photosynthesis a lot of water is lost to the atmosphere. This process is called transpiration, and a plant can lose up to 99% of the water taken up by their roots in this way. Dry-adapted plant species have developed ways of reducing water loss by transpiration, such as:

- having hairy, thick or waxy leaf **cuticles** (surfaces),
- being a lighter colour,
- having small leaves, and
- having no leaves and photosynthesising through specialised leaf or stem structures instead (e.g. cladodes).

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INQUIRY QUESTIONS (ENGAGE)

Explain the learning intentions for the lesson and introduce the topic to the students.

Ask the students a series of questions such as:

What existing knowledge do we have about how plants transport water and nutrients? When you were younger you may have done an experiment to see how coloured water can change the colour of a white flower? Why does this happen?

What function does a leaf have?

If a plant had no roots could it survive?

If a plant had no stem how would it stand up?

If one part of a plant is damaged (through disease, fire or poor growing conditions), can the plant still survive?

Animals (including people) grow because they eat food, which provides energy and nutrients to build body mass. How does a plant grow if it doesn't eat food? Would you believe that their 'food' comes from the sun and air?

If plants and people are both living things, why can plants make their own food and people can't? How are they different?

How exactly does photosynthesis happen through the leaves of a plant? Are there things we don't know about this process? Why is it relevant to us?

STRATEGIES TO FACILITATE QUESTIONING AND DISCUSSION:

- Talk with a partner (turn and talk).
- [1]Think, Pair, Share. (Project Zero Thinking Routine).
- KWL Chart to track what a student knows (K), wants to know (W) and has learned (L) about a topic, can be used before during and after research projects.
- Write in journal and share with others.
- Individual student writing.
- Drawing.

Record students' answers and wonderings on the board or a flipchart.

LESSON SEQUENCE (EXPLORE)

There are three activities in this lesson:

In activity 1, students will explore the vascular structure of a flowering plant through planning a scientific investigation and undertaking an experiment.

In Activity 2, students explore the process of photosynthesis and conduct an experiment.

In Activity 3, students look at case studies and examples of damage to plants.

[1] The Think, Pair Share thinking routine was developed by Project Zero, a research center at the Harvard Graduate School of Education. Project Zero adapted this routine from Frank Lyman: Lyman, F. T. (1981). The Responsive Classroom Discussion: The Inclusion of All Students. In A. Anderson (Ed.), Mainstreaming Digest (pp. 109-113). College Park: University of Maryland Press.

ACTIVITY 1 – EXPLORE THE VASCULAR SYSTEM OF A PLANT

In this activity, students will explore the vascular structure of a flowering plant through planning a scientific investigation and undertaking an experiment.

To do this, you will need:

Teacher Preparation:

- Copies of Resource: Investigation Planning Worksheet for each student
- Straws, chopsticks and rubber bands
- Clear containers
- White flowers or celery sticks
- Water
- Spoons/sticks for stirring
- Food colouring
- Students' science journals

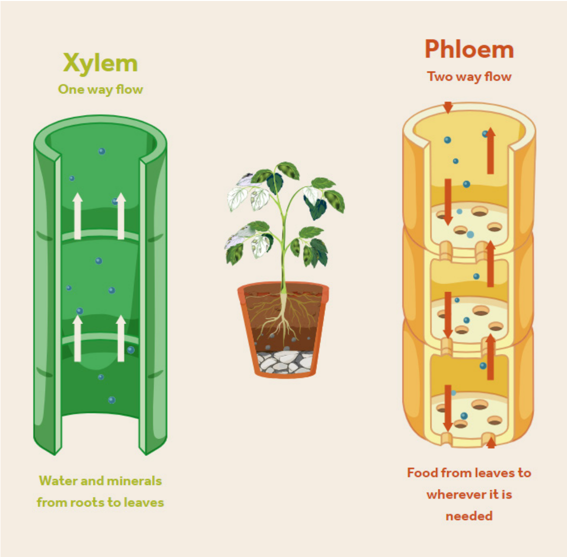
Instructions

Part 1 -Visualise the vascular structure

1. Introduce the lesson intentions and discuss the inquiry questions. Review anchor chart from Plant Structure Lesson 1, word wall and existing knowledge as a class group.
2. Explain that all living things need water to survive. *How does water get distributed through a plant?*

   Roots take in water that travels through the stem and into the leaves. The water evaporates from the leaves in a process called transpiration. This system of transport is called a **vascular system**.

   Humans have a vascular system. In humans and animals the circulatory or vascular system consists of arteries and veins and in plants is the **xylem** (pronounced zy-lem) and **phloem** (pronounced flow-em).



3. Students will be aware that they have a heart to pump their blood around their bodies. *How do plants pump water around without a heart?*

   Plants move water around their 'body' using a process called capillary action. In a smooth, narrow space like a xylem vessel, water molecules stick together with no gaps between them due to electrical forces. This means that water molecules 'creep' up xylem vessels, like liquids moving through a straw. This allows xylem vessels to transport water around a plant, from the soil all the way up to its leaves.

Imagine a string of water molecules reaching from the tip of a root to a leaf on the top of a tree: when one molecule is evaporated from the leaf, one more molecule is sucked up by the root tip to keep the string a constant length.

Not all the vascular system vessels carry water up – some bring it back down again. Xylem vessels transport water and nutrients from the roots to different parts of the plant and provide structural support in the stem.

Phloem vessels transports food from the site of photosynthesis (the leaf) to other parts of the plant. Sap is what we commonly call the substance being transported in both the xylem and the phloem. The xylem and phloem always lie next to each other in a **vascular bundle**. Wood is made up of xylem and the inner layer of bark is made of phloem.

How can we remember that water travels up the plant in the xylem and to other part of the plant through the phloem? There are lots of good ways to remember this, such as:

- *zooming up through xylem and flowing out through phloem*
- *water zips up the xylem and food flows down the phloem*
- *xy goes up high, phlo goes down low*
- *phloem with a ph sounds like f and it transports food (not water)*

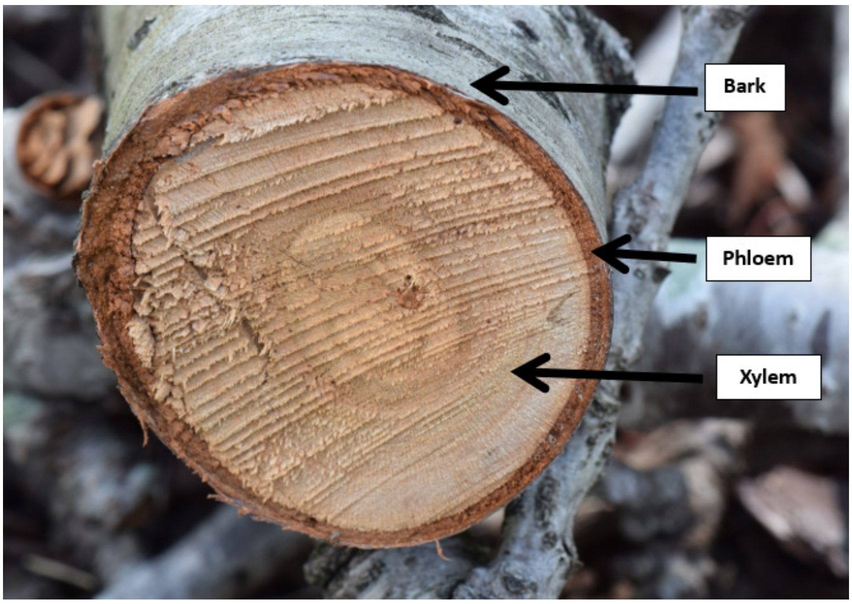


Image:©PumpkinSky, CC BY-SA 4.0 via Wikimedia Commons

4. Help students visualise the vascular structure of plants by using drinking straws and chopsticks.

   Put a rubber band around an equal number of straws and chopsticks (or skewers) to represent a plant stem. The straws are the xylem vessels and the chopsticks or skewers are the phloem vessels. The rubber band represents the tissue on the outside of the stem. You could also wrap a sheet of paper or cardboard tube around the bundle. Demonstrate for the class and/or have students pass the bundle around.

   If you trying to drink a smoothie through this plant stem, would the smoothie rise through all straws at the same rate? (Probably not. Some can be more efficient than others.)

   What if we had one big straw instead of a group of smaller straws? Would that work better? (Probably not – one big straw would take a lot of work to get the liquid through it, it would be less efficient. Just because a vessel is wider doesn't mean it works better).

   Does it rise through the chopsticks? (Of course not! These represent the phloem vessels which take water and food back down to the roots).

   Are the straws arranged neatly and organised in a particular way in the stem? Does it make a difference? (They are probably random, but in plants they can be organised in different ways depending on the type of plant).

5. Add any new learnings to the anchor chart and words to the word wall.

Part 2 – Plan a scientific investigation

1. Explain to students how and why scientists use investigations. The purpose of a scientific investigation is to generate knowledge and create explanations for things that happen in the world around us. It's not just something we do at school!

Scientific investigations follow this process:

1. Make initial observations.
2. Come up with a question of interest that is based on the observations.
3. Develop a hypothesis or prediction to accompany the question.
4. Experiment and test.
5. Gather and record results of tests and experiments and draw conclusions.
6. Share and discuss results.

Make observations → **Ask a question** → **Form a hypothesis or prediction** → **Experiment and test** → **Draw conclusions** → **Share and discuss results**

Common practices in science include modelling, hypothesising, predicting, analysing, sampling and including a controlled variable. While these are important practices, not all are used in every context. They all require reflecting on the data and evidence that is collected through observation.

Scientists then share the results of their investigations with their peers. They do this through:

- writing and publishing research papers
- sharing information at conferences and events where they present their work and discuss their results and conclusions
- attending events where they display data, diagrams and results in poster format for other scientists to see and discuss.

2. Students will plan and conduct an investigation to demonstrate how the vascular system of a plant works using the Resource: Investigation Planning Worksheet. Use the planning worksheet to work through the following questions:

PLAN

What are you going to investigate? (Write it as a question)

How are you going to investigate this? (What procedure will you follow?)

How will you ensure it is a fair test?

What equipment/resources will you need?

HYPOTHESISE AND MAKE PREDICTIONS

What do you think you will find out? (Give scientific explanations for your predictions).

What are the variables to consider?

PROCEDURE

What method and process will you use?

What are the safety rules you need to adhere to?

RESULTS

What were the results of your investigation?

How can you represent these results in a way that others can easily understand?

CONCLUSIONS

What conclusions can you draw?

What data and evidence do you have to support your conclusions?

What other experiments might help to prove or disprove your conclusions? (Part of the scientific process is recommending further work on areas of uncertainty).

EVALUATION

Share and discuss your results with your peers. Can you modify the experiment for next time? Do your peers have suggestions?

3. As an extension, students can write a report on the investigation using the Resource: Report Writing Template. The report follows the format of:

- Title
- Introduction
- Sub-heading 1
- Sub-heading 2
- Sub-heading 3
- Labelled picture
- Summary
- Closing sentence
- Reference list

Part 3 – Conducting a scientific investigation

1. This investigation shows the vascular system at work, as the flowers or celery take in coloured water through their xylem and show a colour change in their petals or leaves. Comparing the results of the coloured water to a control of uncoloured water will allow students to undertake a fair test.

   Flowers from the Asteraceae family (e.g. daisies) work well for this experiment, with many native and non-native options available (e.g. paper daises, gerberas, carnations). White flowers will show the colour change best. Celery will show a colour change in its leaves.

   This activity is best undertaken in the morning or across multiple days as the colour change can be slow.

a) Break students into small groups.

b) Provide each group with at least two clear containers and half fill them with water.

c) Allow students to put 10 drops of food colouring in one or more of the containers, ensuring that one container still has clear water in it (this will be the control). Stir until mixed.

d) Put the flowers or celery into the water.

e) Make observations about their appearance throughout the day and/or across multiple days.

Discussion:

What have your results shown?

How can this information be used?

How could this experiment be improved?

How did you ensure it was a 'fair test'?

ACTIVITY 2– PHOTOSYNTHESIS: HOW DO PLANTS MAKE FOOD?

In this activity, students will look at the process of photosynthesis and conduct an experiment. They will explore the functions of leaves and how the plant makes its food through photosynthesis. On completion of the experiment students can write a report to help them develop report-writing skills. Alternatively, students can answer questions as part of a class discussion, in groups that present to the class or individually in their science journals.

To do this, you will need:

- Presentation explaining function of each plant part
- Access to online videos
- Fresh leaves
- Clear container, cup or glass
- Water
- A weight such as small rocks
- Magnifying glass or hand lens
- Science journal

Instructions

1. Introduce the activity by revisiting one of the inquiry questions:

   Animals (including people) grow because they eat food, which provides energy and nutrients to build body mass. How does a plant grow if it doesn't eat food? Would you believe that their 'food' comes from the sun and air?

2. Explore with students whether they think this is possible. Some questions to consider:

   Take a deep breath, what are we breathing in and where did it come from?

   Humans and animals breathe air, but they can't survive on air as a food source.

   Humans and most other animals also need light like plants do, but we don't 'eat' light and can't survive on it.

   If a plant 'eats' the soil (a common misconception), why doesn't the amount of soil around the plant reduce?

   Is there a difference between 'eating food' and 'making food'?

   If plants take in carbon dioxide and give out oxygen, does that mean they breathe? How can they do that without lungs?

3. Ask students if they know that plants are one of the only living things that can make their own food? Share with students how they do this:

   *Plants are **autotrophic** organisms because they make their own food (auto means 'self' and trophic means 'food'). Humans are **heterotrophic** organisms because we don't make our own food (hetero means 'other').*

   Photosynthesis is the process by which plants make their own food. During photosynthesis plants convert sunlight, water and carbon dioxide (CO_2) into sugar, which provides them with energy (food). Plants release oxygen (O_2) as a waste product during this process.

   The basic chemical formula for photosynthesis is:

   $6CO_2 + 6H_2O$ + sunlight ----> $C_6H_{12}O_6 + 6O_2$

Humans breathe in oxygen and breathe out carbon dioxide, whereas plants take in carbon dioxide and release oxygen.

This is a perfect example of how we need each other to survive! This is why we sometimes hear people say that the trees and forests are 'the lungs of the Earth'.

Without the carbon dioxide in the air there wouldn't be the 300,000 species of flowering plants we see today!

1. As leaves photosynthesise and make food they produce oxygen. Conduct an experiment to see the rate at which a leaf produces oxygen. This experiment illustrates the photosynthesis process and allows students to see a plant producing oxygen.

   Break students into groups or conduct the experiment as a class.

   Place a leaf in a clear container, cup or glass and weigh it down so it sits on the bottom (but don't completely cover the leaf).. Fill with water.

   Repeat this process so that you have several leaves in different containers of water.

   Place some of the leaves in a sunny place and some of the leaves in a dark place.

   After about 30 minutes you will see bubbles forming on the leaves that are situated in the sun. Observe with a magnifying glass or hand lens. Explain to the students that the leaves are undergoing the process of photosynthesis and converting sunlight, water and carbon dioxide into food. During this process the leaves release oxygen into the air, or in this case, into the water. This is what is contained in the bubbles that students can see.

   Compare the leaves in the sunny location with the leaves in the dark location. Note if there are any differences and discuss why.

2. Once the experiment is finished, write a report using the Resource: Report writing guide

   or answer the following questions:

Looking at your results, write down...

Can you explain why....

What problems or challenges did you have in doing this experiment?

How could you improve this experiment? (Think about fairness and accuracy.)

Discussion:

What happened?

What did you observe?

How long did it take?

Can you explain why it happened?

What problems or challenges did you have in doing this experiment?

How could you improve this experiment (think about fairness and accuracy)?

ACTIVITY 3 – DAMAGED PLANT CASE STUDIES

This activity builds on students' knowledge of plant parts and their functions. Students will consider what happens if a plant part is damaged or affected by predators and diseases.

To do this, you will need:

- Copies of Resource: Damaged Plant Scenarios and Problem Solving

Instructions:

1. Review learning so far in this unit by referring to the anchor chart created in Plant Structure Lesson 1, word wall and activities completed so far.
2. Explain to students that there are many things that can cause damage to plant structures, including environmental events like fire and flood, pests, invasive species (weeds), diseases, and environmental conditions. *Do you know of any examples of these issues happening locally?*
3. Explain that scientists need to understand how damage occurs so that they can properly care for and conserve plants.
4. Ask students to complete the Resource: Damaged Plant Scenarios and Problem Solving worksheet. There are three case studies provided.
5. As they work, encourage students to think about what can be done to minimise damage to plants and how they can raise awareness in their community. If time allows, you could support further research about introduced species (plants and animals) and how they have impacted native plants in your area.
6. On completion of the Banksia Garden activity, read the news article at https://www.canberratimes.com.au/story/6978882/expect-the-unexpected-in-the-australian-national-botanic-gardens-new-banksia-garden/ to see the solutions the Gardens' scientists implemented! You can also watch an Australian National Botanic Gardens video at at https://www.youtube.com/watch?v=QV8G9ZCCce8
7. Add new words to the word wall (see the word bank for examples of vocabulary).
8. Encourage students to add their learning and reflections to their science journal (see Resource: Student Reflections).

Discussion:

Have you noticed any invasive plants in our area?

What other threats might native plants in our area face?

Should people take action to protect plants from these threats?

What can we do as individuals or as a school to help?

CONCEPTS EXPLAINED AND VOCABULARY DEFINED (EXPLAIN)

The following resources are provided to assist teachers to facilitate a class session to explain concepts and terms that have been introduced to students through the activities.

- Plant Structure Teachers' Notes (these can be found by searching in the Plant Science
- Learning Hub).
- Plant Structure Video. If you have not already shown the video produced by the Australian National Botanic Gardens in a previous lesson, you could use this to engage students. The Plant Structure video uses botanical illustration, along with a visit to the National Herbarium and the Australian National Botanic Gardens to engage students.
- Word wall
- Discussion questions

APPLYING AND EXTENDING THE LEARNING (ELABORATE)

Applying the learning

Leaf skeletons. Leaves have veins that you can see if you look closely. These also help with the movement of nutrients and water. There are activities on the internet that show you how to remove the outer green layer and soft part of the leaf so that only the 'skeleton' (vascular system) remains. This is an interesting way to take a closer look at leaf structures.

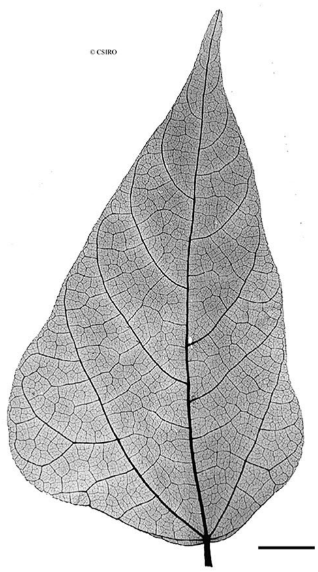


Image: ©CANBR

Survey. Carry out a survey of plant leaf shape in your home garden, school grounds or local nature reserve. Record the different shapes you find and the ways they are arranged on plants. Put them into groups or categories and use a key to identify the different types.

Extension ideas for further research

Research non-vascular plants. How do plants without a vascular system, like mosses, transport water and nutrients? Design and conduct an experiment to show the difference between water absorption in vascular and non-vascular plants. Share your research.

Investigate how plants are essential for human survival. Explore food production in Australia. Our native plants are better suited to our environment than introduced plants so how could our knowledge of plant needs and structural features be used to create more sustainable food sources in Australia?

Soil salinity is a big problem in dryland areas. According to the WA Department of Agriculture, more than 1 million hectares of agricultural land in the south-west of Western Australia (WA) is severely affected by salt. The lost agricultural productivity from salinity damage is estimated to be worth at least $519 million per year. What is soil salinity? How does soil salinity impact plants? Which plants are being used to help solve the problem?

Research mangroves and the conditions in which they live. Why are mangroves key weapons in the fight against climate change? Why are they under threat? What can we do to help protect them?

Investigate water stress. Water stress is the physiological stress experienced by a plant when there's a lack of available moisture. The Bureau of Meteorology provides information and statistics on the water situation in Australia. Research how this impacts our native plants.

Identify a problem in your local area and investigate. Is there an invasive species that is presenting a problem? Perhaps there's a disease that is impacting plants. Explore the issue and devise solutions.

Investigate Pitcher plants. These plants can smell like rotting meat to attract insects and are filled with liquid that drowns or digests the insects that fall inside. Research how the plant structures allow it to capture and eat insect prey.

Investigate Sundews. Sundews are small plants with leaves that have sticky 'fingers' to trap insects. Hairs on the leaf hold the insect victim and the whole leaf then curls around it until digestive juices secreted by the leaf have done their work. Research how the plant structures allow it to capture and eat insect prey.

Image: ©M.Fagg, 2015

QUESTIONS AND ACTIVITIES FOR REFLECTION (EVALUATE)

Students review and reflect on their learning journey by:

- Revisiting the learning intentions and original inquiry questions:

  What existing knowledge do we have about how plants transport water and nutrients? When you were younger you may have done experiment to see how coloured water can change the colour of a white flower? Why does this happen?

  What function does a leaf have? If a plant had no roots could it survive? If a plant had no stem how would it stand up?

  If one part of a plant is damaged (through disease, fire or poor growing conditions), can the plant still survive?

  Animals (including people) grow because they eat food, which provides energy and nutrients to build body mass. How does a plant grow if it doesn't eat food? Would you believe that their 'food' comes from the sun and air?

  If plants and people are both living things, why can plants make their own food and people can't? How are they different?

  How exactly does photosynthesis happen through the leaves of a plant? Are there things we don't know about this process? Why is it relevant to us?

- Identifying further questions.

  What questions haven't I had answered yet?

- Identifying what they learned from others and their own research.

  What new knowledge do I have about plant parts and their functions that didn't have before?

RESOURCE – WORD BANK

vascular system	**transpiration**	**xylem vessels**	**phloem vessels**
photosynthesis	**monocot**	**dicot**	**cotyledon**
taxonomy	**hypothesis**	**prediction**	**invasive species**
autotroph	**heterotroph**	**independent variable**	**dependent variable**
controlled variable			

RESOURCE – INVESTIGATION PLANNING WORKSHEET

What do you want to find out?

I am going to investigate...

Hypothesis

A hypothesis is an idea or prediction that I can test to find out if it is true. I can write my hypothesis in the form of an "If.................. then................" statement, using my dependent and independent variables to fill in the gaps.

For example, "If (dependent variable) then (independent variable)."

Often scientists think about their variables before they write their hypothesis.

Independent variables	Dependent variables	Controlled variables
These are the things I will change during the experiment to affect the outcome.	*This is the variable being tested or measured during the experiment.*	*These are the things I am going to keep the same during the experiment.*

To ensure my experiment is a 'fair test', I will...

A fair test is a test that controls all but one variable. Only changing one variable allows me to know that no other variable has affected the results.

Risk assessment

These are the hazards I need to manage during my experiment.

Diagram
Drawn a diagram (if relevant)

Materials (What equipment do I need?)
The equipment I need is:

Method (How am I going to carry out the experiment?)

The steps I will carry out are:

Results table

Write the headings that are relevant to your investigation.

*				
*				
*				
*				
*				
*				
*				

Review and reflection

Looking at my results, I can see that...

I think this is because...

What problems or challenges did I have in doing this experiment?	*How could I improve this experiment? (Think about fairness and accuracy).*

RESOURCE – DAMAGED PLANT SCENARIOS AND PROBLEMS TO BE SOLVED

Damaged Plant Scenario 1

Eeerpppp, it's a lerp!

Read the scenario and answer the questions below.

A lerp is what we call a young psyllid insect that has covered itself with a waxy covering. Lerps suck the sap from the leaves of a variety of native plants, particularly eucalypts. They munch on leaves and cause, bronzing of leaves and death of the plant tissue. They produce honeydew, which encourages the growth of sooty mould. When there is a lot of lerps on a tree, leaves can turn brown and drop prematurely. Too many lerps can lead to plant death.

Predators like spiders, birds and insects eat the lerps.

Image: ©M.Fagg, 2008

Image: ©M.Fagg, 2008

Q1. Which part of the plant is damaged and what is its function?

Q2. What impact on will this damage have on the rest of the plant?

Q3. How will this impact the overall health of the plant?

Q4. How can people help prevent this from happening or reduce its impact and conserve Australian native plants?

Q5. Lerps can provide food for many animals, if there are only a few lerps, is this a problem? When do lerps become a problem for the tree? What if there were no lerps?

RESOURCE – DAMAGED PLANT SCENARIOS AND PROBLEMS TO BE SOLVED

Damaged Plant Scenario 2

Attack of the vines!

Read the scenario and answer the questions below.

Bridal Creeper (Asparagus asparagoides) is a highly invasive environmental weed, destroying large areas of native vegetation in southern Australia. Native to Ethiopia, Swaziland and South Africa, this plant was introduced to Australia as a garden plant during the 1870s.

Bridal Creeper was often grown as an ornamental plant. It proved popular in floral arrangements and in particular bridal bouquets, giving rise to its common name, and was also grown in hanging baskets.

When walking through bushland in South Australia, you come across the scene below of large areas of native plants covered in Bridal Creeper.

Image: ©M.Fagg, 2008

Image: C. G. Wilson©DCCEEW, 2000

Q1. Which part of the plant is damaged and what is its function?

Q2. What impact will this damage have on the rest of the plant?

Q3. How will this impact on the overall health of the plant?

Q4. How can people help prevent this from happening or reduce its impact and conserve Australian native plants?

RESOURCE – DAMAGED PLANT SCENARIOS AND PROBLEMS TO BE SOLVED

Problem to be solved

Help the scientists to explore solutions to challenges in the Banksia Garden

Members of the horticultural team at the Australian National Botanic Gardens have constructed a Banksia Garden on their site in Canberra. The new garden hosts more than 70 different types of banksias from around Australia.

Weird and wonderful species have been collected from the Nullarbor Plain in South and Western Australia, from the east coast of the country and even in the Top End.

The problem is that banksias grow in different climates and environments around Australia and the climate in Canberra is different to a lot of those regions. Canberra is one of Australia's sunniest capital cities. The city is known for clear blue skies and clean air. It has four seasons that are quite different from each other, and winters can get very cold with overnight frosts.

A plant that grows in the Northern Territory may not grow in Canberra. A plant that grows in Western Australia may not grow in Canberra.

How does the Gardens keep the following plants alive?

- Tropical Banksia (Banksia dentata), collected from Kakadu National Parkneeds a lot of sun and can't withstand the cold.
- Western Australian banksia species are very susceptible to root rotting diseases. Canberra has clay soils that tend to retain moisture, whereas many WA banksias grow in sandy soils that drain well.

Can you think of ways that these plants could live in Canberra?

RESOURCE – REPORT WRITING GUIDE

Title:

Introduction: (What is this report about?)

Sub-heading 1: (Idea/Question you are answering e.g. characteristics)

Paragraph 1: Description and pictures

Sub-heading 2:

Paragraph 2: Description and pictures

Sub-Heading 3:

Paragraph 3: Description and pictures

RESOURCE – REPORT WRITING GUIDE

Labelled picture:

Summary/closing sentence:

References:

RESOURCE: STUDENT REFLECTIONS

Consider displaying sentence starters or questions, such as below, in the classroom. Alternatively they could be turned into laminated thought bubbles that are directly passed to students. Students could choose two or three to complete in their journal then share their responses with the class.

End of lesson reflections	
Today I discovered … I want to know more about … Something new I found out was … I am excited about … Something I am finding interesting is … The most challenging thing was …	I am most proud of … I feel confident about … I am enjoying … because … I am confused by … Today I asked … A question I have is …

Guiding students to reflect on their own thinking	
I am starting to think differently about … I got stuck when … and I got back on track by … I figured out that … I solved a problem by … I first thought … but then I realised that …	This idea is useful for … Some things I didn't understand are … To help me understand better I will … Before I didn't know … Now I realise/know …

Reflecting on stewardship and taking action	
This information can make a difference by … It is important to know about this because … Something I will now do as a result of my learning is … Something I want to do next is …	Something I will now help others understand is … I can make a difference by … An action I/we can take is … If we don't … the consequences could be … It is important to … because …

End of unit reflections – where I was and where I am now	
I used to think … Now I know … This causes me to (re)think/ wonder … I didn't know how to … Now I can … In the future I will …	**Revisit** your first journal entry. What do you understand now that you didn't back then? **Review** your work so far. What has been the biggest discovery/learning/ challenge? **Reconsider** your initial ideas. Have your ideas changed? If so how?

Australian National Botanic Gardens