Australian National Botanic Gardens

Field Activities

Module 1

Plant Life Cycles

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.

1. **Plant Life Cycles**
2. **Plant Structure**
3. **Pollination**
4. **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 Module 1 Plant Life Cycles.

- **Understand the life cycle of a flowering plant.**
- **Investigate and describe the life cycle of one or more native Australian plants.**
- Identify the differences and similarities between the life cycles of flowering plants and animals.
- Recognise and describe how environmental conditions or events can trigger seed germination and affect plant life cycles.

The objectives in bold are addressed in this Field Kit.

Each Field Kit activity has individual learning intentions appropriate to the activity.

Contents of this kit

Each Field Kit contains the following sections relevant to all field activities:

Description: A brief overview of the field activity and the relevant Australian Curriculum content description, along with the learning intentions.

Content information relevant to all field activities: Often with a story to introduce the content and key information for teachers to support the activity.

Equipment list: A list of the materials needed to support all listed field activities. Students are encouraged to participate in gathering the equipment using a checklist. There may be some items that need to be prepared by the teacher prior to the field activity. This section also contains guidelines for personal safety.

Each activity within the Field Kit contains the following sections relevant to the individual activity.

Content information: This section contains content information specific to the activity that may not have been included in the kit instructions.

Equipment list: A list of the materials needed to support the specific field activity.

Activity instructions: The steps for completing the field activity. Multiple activities may be presented and each may have an equipment list. The activities use experiential learning, are hands-on and are designed to encourage a sense of curiosity.

Learning and reflecting: Discussion questions to help students reflect on and summarise their learning.

Further exploration: Extension activities for greater depth.

Field Kit activities

It is not intended that the field activities are a continuous course of learning that must be completed in a linear manner. It is not essential that they are all completed.

We know from consulting with teachers that the preferred approach is to provide a selection of learning activities and resources from which they can choose, enabling them to curate a program of learning appropriate to their student group. Teachers might be guided by availability of resources (including time), the natural environment around them and the interests of their students.

The Field Kit begins with an overarching activity: making a recycled field journal.

There are four Field Kit activities that follow:

1. Recording plant information
2. Collecting species challenge
3. Identifying plants at different life cycle stages
4. Building a tree map

Contents

ACTIVITY 2 - COLLECTING SPECIES CHALLENGE 27

ACTIVITY 3 – IDENTIFY PLANTS AT DIFFERENT LIFE CYCLE STAGES 33

CONTENT INFORMATION

What is a scientist?

What kinds of scientists are there?

What do scientists do?

How do scientists discover things?

Scientists ask questions and investigate.

Did you know there are many different types of scientists? Most of them work in three main areas of science:

- Life science - the study of all living things, including plants and animals
- Earth science - the study of planet Earth and space
- Physical science - the study of the physical objects in the world around us

All scientists like to ask questions and find answers. They investigate those questions and look for clues, recording what they see as they go, rather like detectives.

Scientists who study living things use observations and experiments to understand what has happened in the world around us and what might happen in the future.

When we go outside, we can do the same things as scientists. We can observe the smallest things we can find using a microscope. We can ask questions about what we see. We can investigate, look for clues and we can make notes in a journal.

Field journal use in Botany

"The Scott Family lived in Sydney and later on Ash Island, NSW, in the mid-19th Century. Alexander Walter Scott was a keen naturalist and entomologist (insect specialist) – interests that he encouraged in his youngest daughters, Harriet and Helena.

Alexander, Harriet and Helena spent many hours researching and documenting plants and insects. They kept detailed field notes on everything they discovered. These notes were very important, as Alexander was writing a book - Australian Lepidoptera and their Transformations. While Alexander compiled the information, all the beautiful and meticulous illustrations were completed by Harriet and Helena. Their field notes included information used in the book, but also details that helped the sisters ensure their illustrations were as accurate as possible. The illustrations in Australian Lepidoptera earned the Scott sisters an impressive reputation, and they went on to provide illustrations for many other scientific works. Some of their artworks are still used by scientists today.

The Scott family diaries and journals are now held at the Australian Museum in Sydney, and tell us much about the scientific activities of the family. Not only do they provide a record of the research undertaken by the Scott family, but they also demonstrate how involved Harriet and Helena were in the scientific process. This is an important part of the story, as 19th-century society frowned on women participating in science. Thanks to these journals we now know about the valuable contributions of these two women."

Source: Australian Museum https://australian.museum/learn/collections/museum-archives-library/scott-sisters/

What is a field journal?

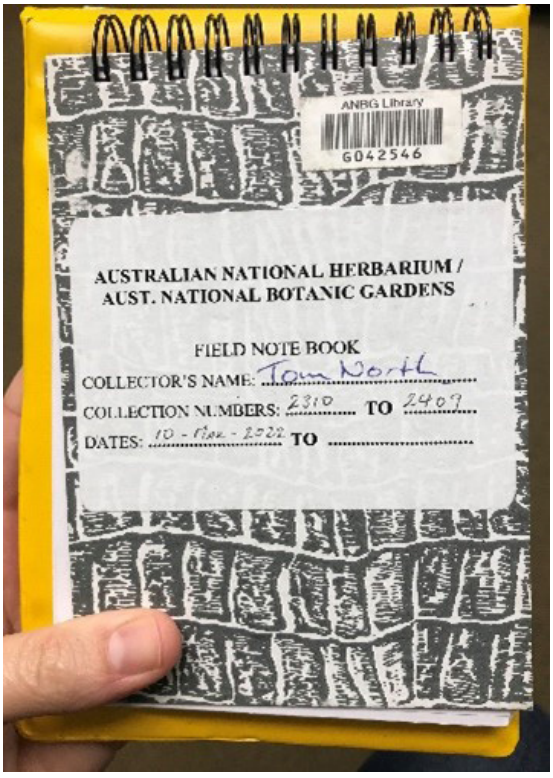
Scientists keep a field journal to record their observations and the specimens they collect. Some journals are filled with scientific information and data including measurements, charts, labels and lists. Others are filled with observations and notes, specimens and samples or drawings or paintings of what the scientist saw. There is no required format when using a field journal, and budding scientists can find a way that works for them. The important part is to visually record the information so it is remembered.

Botanists use field journals for plant identification. They will keep detailed descriptions of the location of the plant and the habitat it was found in. They record the collector's name and a collection number and once the plant is identified, the botanical name and family will be added. Nowadays the ID is often recorded and updated in a database. Botanists can record hundreds of thousands of collections in their lifetime.

Students can mirror the field journal by keeping a nature journal – a kind of scrapbook where they can record information they learn while being outside or interesting discoveries that they make. It's a good place to write questions or to explain how being in nature makes them feel. They might take leaf rubbings or flower samples to press.

When they are finished in the field, the scientist takes their field journal back to their desk or laboratory to investigate their findings. The field journal often remains property of the museum or organisation they work with so that other researchers have access to them. Sometimes scientists will look at field journals that are decades old to help with present-day investigations.

For students, the journal becomes a tool for reflection.



This is a Field Note Book completed by Tom North, a scientist at the Australian National Botanic Gardens. Once complete, it will be held in the Australian National Botanic Gardens library to be used by other scientists.

Building your Field Kit

A Field Kit contains all the equipment and items scientists need to stay safe and conduct their research when working in the field. A Field Kit generally contains the following items:

- A field note book/journal for each researcher (or student), ideally a hard cover book with blank or lined pages, but an exercise book will work just as well. Keep the book small so it is easy to carry. A waterproof pocket-sized notebook and pencil that will stand up to the wet are ideal (but not required). You can also make your own journal with the instructions in this document.
- Pencils and pens.
- Specimen collection equipment if you are collecting samples for pressing and mounting. (See Activity 2)
- Digital camera if collecting electronically (can be on a smartphone or tablet).
- Field lens/magnifying glass.
- Topographic maps and GPS (Global Positioning System) unit. These are necessary for locating your position and determining altitude. A GPS unit makes fixing an accurate latitude and longitude easy, often a mobile phone can be used for this purpose.
- Field identification manuals or keys.
- Safety equipment – see below.

Staying Safe

Science education should be fun with exciting experiments and activities that involve the use of equipment, materials, chemicals and products either in the classroom or outdoors.

Like any science classroom, teachers facilitating lessons and field activities sourced from the Australian National Botanic Gardens education materials should ensure they and their students are aware of potential hazards and take precautions to prevent accidents.

The Field Kits contain lists of safety gear as follows:

- A hat, long-sleeved shirt and long trousers to provide protection from the sun and sharp vegetation.
- A jumper and water-proof raincoat to provide protection from the rain and cold.
- Close-toed, sturdy shoes.
- A first-aid kit.
- Plenty of water for drinking as well as for washing your hands.
- Gloves - you can wear these when collecting specimens as some plants have caustic sap or other irritants and toxins. Always make sure you know what plants you are touching and wash your hands after handling.
- Food.
- A trip plan outlining your intended destination/s and expected time of return left with someone who will call for help if necessary.

Classroom and field activities may include:

- Use of potting mix
- Use of ovens and boiling water
- Knife and scalpel use
- Exposure to plants that may have caustic sap or other irritants and toxins

Where Material Safety Data Sheets (MSDS) are available (such as for potting mix), ensure you are aware of the directions for using the product safely.

Undertake risk assessments and take actions to mitigate identified risks.

General Guidance for Collecting and Exploring our Natural Environment

The general principle of 'leave no trace' applies any time we are in our natural environment. Respect the environment, take your rubbish with you, stick to paths, don't make campfires unless permitted to do so, respect wildlife by not feeding or otherwise interacting or interfering and leave what you find as you found it.

Many of our activities ask students to use real specimens or examples they have collected from the field. In some places you will need to seek permission or apply for a permit to collect material from the environment.

- For private property, contact the landowner.
- For government managed property, contact the managing authority.

You will not need a permit to collect material from the school grounds. However, the area around your school is still an environment that provides habitat for many plant and animal species. To limit the impact of your collecting on the organisms that live there, do not take material unnecessarily and only take a sample equivalent to about 5% of the plant.

CREATING YOUR FIELD JOURNAL

You can use any small notebook for your field journal, but it can be fun to make your own using recycled paper. You can use the instructions below to either make pages for your field journal, or just to make a special cover.

Making recycled paper:

Equipment

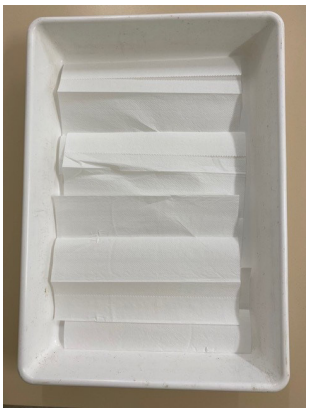
- Picture frame (if using)
- Insect screen or fine fabric (e.g. muslin) that will allow the water to drain through from the paper mix
- Old paper for recycling. Try to avoid too much glossy paper e.g. magazines. Remember that the paper you make will be thicker than the original, so you'll need several starting sheets per sheet you intend to create. Coloured paper and pictures will add colour to the finished product – either add these for effect or avoid them if you want light coloured paper at the end.
- Blender
- Large bowl
- Paper towels, tea towels or piece of material

Method

1. Tear the paper into small pieces and soak in water for 24 hours (if possible).
2. If you are using a picture frame, cut the insect screen or fabric to the size of the frame and attach to the back using a staple gun or hot-glue gun. Alternatively, you can just use screen.

3. Add water and soggy paper to the blender. About 2 handfuls of soggy paper to 2 cups of water. Blend on high speed until mostly smooth. Add water until it is smooth with no chunky bits. The finer the pulp, the smoother your paper will be.

4. Pour the pulp into the large bowl.
5. Cover the bottom of the tray with a towel, tea towel or newspaper. Lay the frame screen-side down inside the tray, or the screen by itself if not using the frame. Scoop paper pulp into the frame and spread out, covering any gaps, until there is a thin layer of pulp across the screen.



6. Shape it into a rectangle that you will be able to fold in half to make a card.
7. Lay a tea towel (or paper towel) over the top of the pulp and press down to compress the pulp and absorb the water. With the tea towel still over the pulp, use a sponge or towel to absorb as much water as possible. The drier the better.

8. Alternatively, put a piece of cloth over the paper on the screen and use the rolling pin to squeeze out the excess water.

9. Tip out onto a flat surface or leave to dry on the screen.
10. Let it dry for one to two days.

Binding your journal

You can bind your journal simply by using staples. Alternatively, fold all the pieces of paper in half and make a small tear (1-2cm) along the tops and bottoms of the folds. Lay the pages on top of one another. Take a piece of string and lay it along the fold, tucking it into the tears at the top and bottom to hold it in place. Tie it at the back of the bundle.

DISCUSSION AND REFLECTION QUESTIONS THAT CAN BE USED TO SUPPORT THIS ACTIVITY:

How does recycling help the environment?
What is paper made from?

USING THE FIELD JOURNAL/NOTEBOOK

Scientists like to have journals that are waterproof and with a hard cover. Students could laminate the journal cover and keep it in a plastic document box or lunchbox to protect it from the elements.

It can be a good idea to write on only the left-hand page of the journal so that the right-hand side becomes a place for reflection.

CAN WE RECORD ELECTRONICALLY?

Yes! There are plenty of apps available as tools to support collection and identification, however there are clear benefits to keeping a hard copy journal. It's something students can touch and feel and interact with. If you do choose to use technology, you could look at apps like Inaturalist or their junior version Seek. These enable students to engage with experts to identify plants correctly, and their images can contribute to the scientific community.

Activity 1 – Locate and record information about Australian native plants

LEARNING INTENTIONS

Students will be able to:

- Describe what a plant is.
- Collect and record information about plants in a field journal using keywords and descriptors.
- Understand that plants have common and scientific names.

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 inquiry

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)

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)

AC9S4I03 follow procedures to make and record observations, including making formal measurements using familiar scaled instruments and using digital tools as appropriate (Year 4)

AC9S4I04 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 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)

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)

INQUIRY QUESTIONS

Which plants are around us?

What are the differences between Australian plants and non-Australian plants?

Why is each part of the plant important?

Do you know what a plant family is?

Why do we use a field journal?

Which words can we use to describe the features of plants?

Which features in a plant's habitat are important?

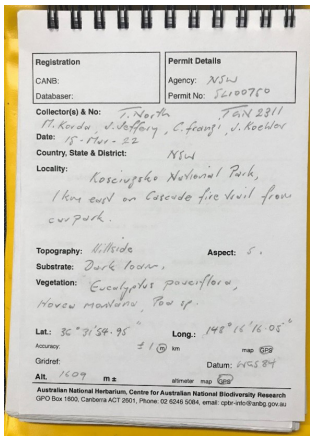
CONTENT INFORMATION

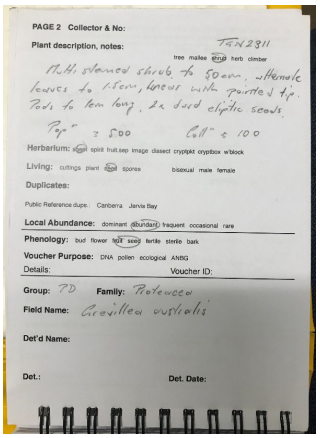
Once we have a field journal, we can start using it! The journal is where you record information on what you have observed. It can help sharpen your observation skills and provides a permanent record of what you found in the field as we don't always remember all the details of what we have seen.

COLLECTING AND RECORDING INFORMATION ABOUT PLANTS

The following information about plants is usually recorded:

Collection date	*Today's date*
The name of the collector	*Your name*
Collection number	*If this is your first field journal, start with 1*
Country, State	*Where the specimen was found*
Locality description	*The specific location (e.g. distance along a road from a known point, such as the town post office). Write enough detail to enable someone else to find the place again without your help.*
GPS coordinates	*If you have access to Google Maps or a GPS device, you can record this information in the field*
Plant identification	*Scientific name of plant and common name(s)*
Plant description	*Describe the plant, including details such as:* • bark colour/texture • plant height • trunk diameter • leaf colour/shape/texture • whether fruits or flowers are present • flower colour/shape/texture • fruit colour/shape/texture • scent of bark/leaf/flower/fruit • Is it a herb, tree, ground-cover, shrub or vine?
Habitat	*Can you describe:* • *Soil type?* • *Topography?* • *Sunlight?* • *Streams or lakes nearby?* • *Other plants in the area?*





Tom North is a scientist who works at the National Seed Bank in Canberra. This field journal entry was made on a trip to Kosciuszko National Park in New South Wales.

DESCRIBING PLANTS

Scientists identify specimens of unknown plants by using:

- Taxonomic keys and floras – detailed descriptions of plants and their features and ways to tell them apart.
- Comparing plants – to books, photographs or specimens whose identity is known.
- Expert determination – asking someone who knows a lot about plants.

The more information you have about the plant the easier it will be to identify it later. For example, if you can describe the colour, shape and texture of the bark, leaves and/or flowers of the plant, you can compare these characteristics to plant lists or books and work out its family, genus and species. In general, before collecting a plant you should make a note of anything that is not obvious from the specimen or that might change during the preservation process. For example, the height of a tree or the persistence of bark on its trunk will not be obvious from a single branchlet, and flower colour may fade during drying.

Look for:

- Habit (the type of plant - tree, shrub, creeper, herb)
- Leaves (shape, size, arrangement)
- Bark (colour, texture)
- Flowers (colour, shape, size, arrangement, scent)
- Fruit and/or seeds (size, colour, smell, texture, number, arrangement)

Feature	Questions to ask
Habit	What type of plant is this - how does it grow? How tall and wide is it? (Measure if you can)
Leaves	What does the edge of the leaf look and feel like? How long and wide is the leaf? Where is the widest point? What shape are the tip and the base? How are the leaves arranged on the stem? What pattern do the veins make? What texture is the surface of the leaf (top and underneath)?

Bark	What colour(s) is the bark? What texture is the bark? Does the bark persist on the trunk and all the branches or just part-way? If the bark is shed, how does this happen (e.g. in flakes, in ribbons)?
Flowers, fruits and seeds	What size, shape and colour are they? Do the flowers have petals? How many? Is there a scent? How are they arranged on the branch or stem? Are the fruits hard or soft? Do the fruits have an 'attachment' that could help them to be transported?
Habitat	What landscape features are nearby? What is the soil like? How much sunlight reaches this plant? What other plants are growing nearby?

Habit

This is the 'type' of plant – whether it is a tall spreading tree or a soft herb.
Some common examples are listed below:

Tree	A large plant with one or two main stems (trunks) that are woody. You should describe the shape of a tree's canopy (the top of its leaves grouped together) – is it rounded, conical, rectangular or weeping (drooping)?
Shrub	A plant that is woody but is small and has many branching stems rather than one or two distinct trunks.
Vine	A plant that creeps across the ground and/or climbs up other objects.
Herb	A small soft plant that is not woody (e.g. a dandelion or paper daisy).
Grass or grass-like plants	A plant with long, narrow, strappy leaves. Grasses can grow in upright clumps or spread across the ground (like a lawn).
Palm	A single stem topped by large fan-like leaves. The new leaves grow from the very top of the stem.
Fern	A plant with fronds that unfurl as they grow. Ferns do not produce flowers or fruits but reproduce using spores which are held in little raised sacs on the underside of the fronds.

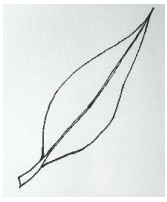
Leaves

When describing leaves, make sure you are looking at a healthy one. A leaf that has been chewed by insects won't help you identify a plant.

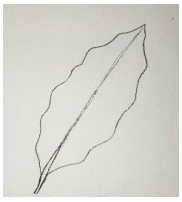
Leaves vary by shape, colour, arrangement and size. For most Australian natives, leaves are present year-round, making them an important feature to study. There are several details that scientists look at when studying leaves. There is specific scientific language that describes leaf shapes, these words are outlined below, however you can use your own describing words if you with. When you are looking at leaves you should ask the following questions:

Leaf edges

What does the edge of the leaf look (and feel) like? Is it smooth, bumpy or spiky? How far apart are the spikes?

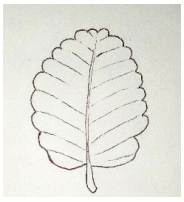


Smooth (entire)

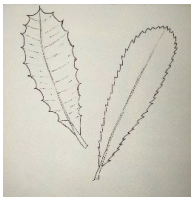


Wavy (undulate)

Lobed



Bumpy (crenate)



Toothed (dentate, serrate)

Leaf shapes

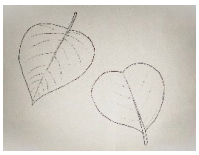
Scientists identify specimens of unknown plants by considering:

What is the overall shape of the leaf? Is it long and thin or round? Use your ruler to measure the length and width of the leaf – is it longer than it is wide, wider than it is long or about equal?

Where is the widest point – near the stem, in the middle or near the tip?

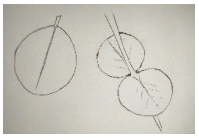
What shape are the tip and base (near the stem) - are they pointy? Indented? Round?

Acicular (needle shaped)



Cordate (heart shaped with stem in 'indent') or obcordate (if stem is at the tip)

Elliptic

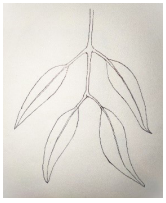


Orbicular (circular)

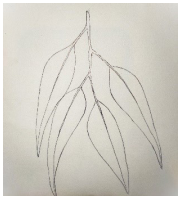
Lanceolate (lance shaped) or oblanceolate (lance shaped with the point at the base)

Leaf arrangement

How are the leaves arranged on the stem? Are they growing opposite each other, are they all at the same level in a whor or do they 'take turns' (alternate) around the stem?



Opposite

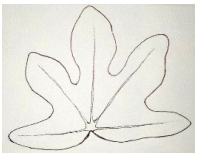


Alternate

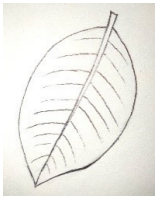
Whorl

Veins

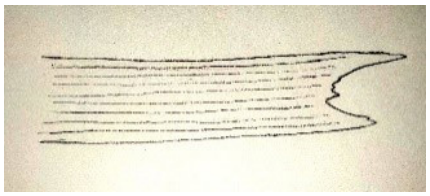
What pattern do the veins make? Are they parallel or do they branch out like a tree?



Palmate



Branching



Parallel

Leaf type. The two main types of leaves are 'simple' and 'compound'. The key to telling the difference is to find something called the 'axillary bud' - this is a tiny bud found at the point where the leaf grows out of the stem. You'll have to look closely to find it – a magnifying glass may help.

Simple	Compound
A single whole leaf growing from its own axillary bud.	Compound leaves may look like multiple leaves but each one is actually a collection of 'leaflets' growing from a single axillary bud. You should record the number of leaflets in your journal, as this can help identify the plant

Bark

Bark texture and colour is often important in identifying trees – especially eucalypts (gum trees). When looking at bark, ask the following questions:

- *What colour(s) is the bark?*
- *What texture is the bark?*
- *Does it persist on the trunk and branches or is it shed fully or in part?*

Below are some words that might help you describe the bark of trees:

Smooth	Stringy	Scaly	Flaky
Corky	Fissured	Papery	Bumpy
Peeling	Cracked	Spiky	Wrinkly

Flowers

Image: A.Lyne©ANBG, 2001

Image: G.McEwin©ANBG, 1976

Image: ©M.Fagg, 2018

Flowers of many Australian native plants look a bit different from a 'typical' flower. The flowers of *Eucalyptus* species, some of which are also known as gum trees, don't have any petals, but instead have long soft filaments (the male part of the flower with an anther containing pollen on the end). The second picture above shows the brightly-coloured filaments of *Eucalyptus macrocarpa.*
They often have a sweet scent. When looking at flowers, ask the following questions:

- *Can I see any petals? How many?*
- *Does this look like one flower or many?*
- *Is there a scent?*
- *What colour is it?*

Fruits and seeds

Image: Brooker & Kleinig©ANBG

Not all fruits are edible! The fruits of some native plants are hard and woody to protect their seeds, while others are soft and fleshy. When looking at fruits ask the following questions:

- *What texture is it?*
- *What size is it?*
- *Are there many fruits clustered together or are they spread out?*
- *Does it have any 'attachments' - e.g. prickles that will stick to clothing or an animal's fur?*

Be careful when handling fruits – some are poisonous or can irritate or stain your skin.
Always wear gloves and wash your hands afterwards.

Describing habitats

Many species of plant will only grow in a specific habitat. This is because they develop adaptations that help them thrive in certain environments, but not in others. Describing a habitat can narrow down the species that are likely to be found there, helping us to identify a plant.

Many features make up a plant's habitat. These include:

Topography	Landscape features like hilltops, slopes, valleys and plains. Describe where in the landscape your plant is growing. Is there any water nearby, such as a stream or a lake?
Soil	Many plants prefer a certain soil type, as the soil affects how much water and nutrients are available. Is the soil sandy or fine sticky clay? Can you see any 'organic matter' (broken down plants, like compost)? Is it moist or dry? What colour is it?
Sunlight	Some plants need full sun, while others grow happily in the shade. Make note of whether the plant is growing in a sunny or shaded spot (e.g. under another plant or sheltered by a rock, building or hill).
Surrounding vegetation	Like people, plants often live in 'communities' with certain other species. The plants growing nearby can help us identify the vegetation type that we are studying. This can allow us to define the plants that might grow there.

Habitat types

There are some broad terms that we can use to describe a landscape:

Coastal	Beaches and sand dunes next to the ocean.
Rainforest	Wet, dense forests that receive very high rainfall. Rainforest trees often have tall, straight trunks and leaves that grow so closely together that they almost completely block out the sky. Many plants have large, dark green leaves.
Woodland	Trees (usually *Eucalyptus* species, some of which are also known as gum trees) are spaced out with shrubs and grasses growing in between.
Grassland	Natural grassy areas with few or no trees.
Wet or dry forest	Tall, close-growing trees, but drier and less dark than a rainforest. Trees in wet forests tend to grow closer together and sometimes overlap branches, while trees in dry forests will be more spaced out and let more light reach the ground.
Mountain/Alpine	Mountain environments, including areas above the treeline.
Wetland	Freshwater swamps, bogs and floodplains.
Riparian	Next to a river or creek.
Arid	Desert environments. Very dry, with plants widely spaced. Plants are usually small, with small leaves.
Urban	Town and city environments.

NAMING PLANTS

Common names

Common names are easy to say and remember but are not always helpful for identification. This is because the same common name is often used for multiple different species of plant. Likewise, the same species of plant can have several common names! For example, the name 'White Gum' can refer to any number of *Eucalyptus* species with smooth white bark.

First Nations plant names

Australia's First Nations people have had names for native plants and animals for thousands of years. See if you can find out the First Nations names for some native plants that grow where you live.

Scientific names

These are the names given to plants by scientists. Scientific names are useful because, unlike common names, they are unique to a single species. The same scientific name is used all over the world and in every language.

Scientific names are usually written in two parts – the genus, followed by the species. When typing the scientific name should be written in italics (unless the main body text is italics); if handwritten it should be underlined. The genus name always starts with a capital letter, and the species always uses lower case. For example:

Scientific name (*Genus species*)	*Microseris lanceolata*
Common names	Yam Daisy, Murnong
First Nations name example	Dharaban (in Ngunnawal language of ACT and NSW; many other names also exist in other languages)

Source: Australian Capital Territory (2014). *Ngunnawal Plant Use: A traditional Aboriginal plant use guide for the ACT region*. ACT Government, Canberra.

GATHERING YOUR SUPPLIES

Equipment

- Field journal
- Pens or pencils
- Camera, if taking photographs
- GPS, if available. Some smartphone mapping applications will be able to give you GPS coordinates
- Resource: Native Plant Cards
- Resource: Journal Template

ACTIVITY INSTRUCTIONS

Method

1. Head out into the field with each student equipped with a field journal. The field can be a location of choice: the school premises, a local park, a plant nursery or even a botanic gardens in your state or territory.
2. Working in small groups, in pairs or individually, students look for Australian native plants and record their observations in their field journal. Where Australian native plants are hard to find, other plants can be used.
3. Make copies of the Resource: Plant Cards for each individual, pair or group either as a worksheet or by cutting them into cards. This will help students to identify native plants. The plant cards can be found at the end of this document.
4. Find and sketch the plants found in the field using the Resource: Journal template provided at the end of this document.
5. Once you have spent time in the field, try to identify the plants found. Check your school or local library for books on plant identification or ask an expert.

LEARNING AND REFLECTING

Discussion questions to help students reflect on or summarise their learning.

What did you discover?

Where did you find the plants?

Which plants did you see most/least?

Which plant features were the most/least common?

Did any plants have similar features?

FURTHER EXPLORATION

Extension activities for greater depth

Present

- Ask each student to do a small presentation on their findings.
- Include interesting facts/stories and information from their research.

Share

- As a class or in smaller groups share the plants recorded in their journals.
- Have students try to identify as many Australian plants as they can and sort them into family groups.
- Discover interesting ways to share the information, perhaps by displaying open journals in the classroom or creating posters or tables summarising their findings.

Reflect

- Have students reflect on what they found. by writing a poem or song that captures what they saw, heard, felt and smelled during the process.

Repeat!

- Repeat the exercise again. Find more plants on another occasion. Visit in a different season, after rainfall or go to a different location where there are different species to find.

Activity 2 - Collecting species challenge

Note: This activity works best during the flowering season.

LEARNING INTENTIONS

Students will be able to:

- Recognise names of some common Australian native plants.
- Identify features and characteristics of plants found in the local area.

CURRICULUM LINKS

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

Science understanding

AC9S3U01 compare characteristics of living and non-living things and examine the differences between the life cycles of plants and animals (Year 3)

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 inquiry

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

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

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

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

INQUIRY QUESTIONS

What types of plants can we see around us?

How many Australian plants can we name?

What do we mean when we say 'Australian native flora'?

Why is it important to learn about Australian native plants?

CONTENT INFORMATION

When James Cook sailed into Botany Bay on the *Endeavour* in April 1770, two botanists were with him: Sir Joseph Banks and Dr Daniel Charles Solander. Together, they made the first scientific collections of Australian flora. The specimens they collected were sketched by Sydney Parkinson.

Over the six days they spent in Botany Bay Banks and Solander collected 132 plant specimens and Parkinson made drawings of 84 of them. These plants were all new to European science. They continued along the coast from Botany Bay collecting more specimens and making more drawings, stopping at the Great Barrier Reef.

The UK Natural History Museum holds all of the surviving botanical artwork from Captain James Cook's first Pacific voyage. The *Endeavour* voyage (1768-1771) greatly expanded Western scientific knowledge of the South Pacific. The scale of discoveries recorded by the natural history illustrators on board set a precedent for including artists on future voyages.

Explore original botanical drawings and engravings prepared by Sydney Parkinson aboard the *Endeavour*, as well as those completed after his death by artists back in England under the patronage of Sir Joseph Banks.

https://www.nhm.ac.uk/discover/endeavour/search?country=Australia&page=1

Sir Joseph Banks (1743-1820)

©https://www.nhm.ac.uk/discover/joseph-banks-scientist-explorer-botanist.html

Dr D. C. Solander (1736-1782)

©https://www.nhm.ac.uk/discover/daniel-solander-a-linnaean-disciple-on-hms-endeavour.html

IDENTIFYING AUSTRALIAN NATIVE PLANT TYPES

Botanists group different species of plants together according to their characteristics. This is called *classification* and there are different levels of classification that tell us different information about a plant and its relatives. We use the three lowest levels of classification - family, genus and species - most often.

For example, a Brittle Gum and a Lemon Bottlebrush are in the same family, but a different genus. This means that they have some features in common, but still differ in a variety of ways.

Family: Myrtaceae	**Family**: Myrtaceae
Genus: *Eucalyptus*	**Genus**: *Callistemon*
Species: *mannifera*	**Species**: *pallidus*
Common name: Brittle Gum	**Common name**: Lemon Bottlebrush

Knowing about the many plant groups can help us grow and care for them. It also helps us to understand how plants have evolved, and how environments have changed over time.

The task is to identify different types of Australian native plants in the field. When students find each plant they will check it off a bingo card. The field can be a location of your choice: the school premises, a local park, a plant nursery or even a botanic gardens in your state or territory. If you choose to visit a nursery or botanic gardens, you will be limited in your ability to collect specimens from plants and would need to take photographs or create drawings instead. If you visit a National Park, you will likely require a permit from an authority to collect specimens. See section above on general guidance for collecting and exploring out natural environment.

- For private property, contact the landowner.
- For government managed property, contact the managing authority.

When planning this activity, think about the life cycles of plants in your area. *What time of year do you see the most flowers? When do plants produce fruit?* Flowers are an important feature when identifying Australian natives, so you might like to run this activity during the peak flowering season (between September – November across much of Australia).

Think of some questions that may help you get started: *What do I see around me? Do I see anything that surprises me?*

The Resource: Plant Cards (found in the Resource section at the end of this document) has images of Australian native plants that are easily identifiable and commonly found across Australia.

GATHERING YOUR SUPPLIES

Equipment

- Field journal
- Pens/pencils
- Camera/tablet for taking photos
- Student copies of Resource: Plant bingo cards
- Teacher Support PowerPoint presentation or print out of Resource: Teacher Support PowerPoint Presentation Slides

ACTIVITY 2 – PLANT BINGO CARDS

Method

1. Using the images in the Teacher Support PowerPoint presentation (or printed images from Resource: Teacher Support PowerPoint Presentation Slides) introduce the Australian plants to be explored in this activity: acacias, banksia, eucalypts, grevilleas and callistemons. Photographs of the flowers, leaves, fruits and overall shape of each plant type are provided, highlighting the diversity of these plant parts. This also introduces students to a sample of Australia's iconic native flora. Use discussion questions to engage the students.

- *What do you notice about these plants?*
- *How are they similar?*
- *How are they different?*
- *Have you seen them before?*
- *Do they grow at school, at home, in a park, in nature reserves or in the bush around our town/city?*

2. Go to your field location (school grounds, nature reserve etc.) and provide each student with a copy of the Resource: Bingo Card. Give them about 30 minutes to locate the different plant parts listed on the bingo card and check them off. Once completed the bingo cards can be glued in their field journals. Students can take photos of what they find in the field to compare with what other students find and the photo examples in the Teacher Support PowerPoint presentation. Printing and displaying student photos in the classroom can serve as an ongoing resource for understanding the native flora in your area.

   If you know that students will not be able to find the plants shown on the plant cards in the field, print the images from the Resource: Teacher Support PowerPoint Presentation Slides and put them around the field area for students to find instead. This can be done with all the species or just those that don't grow in the field area.

3. Students share and discuss their findings as a class. Show the images in the Teacher Support PowerPoint presentation again to help students discuss what they observed.

- Did the whole class find all the plants on their bingo cards?
- Was this affected by where you looked?

- Which plants and plant parts were not found? Why do you think that is?
- Did you find more than one of some of these plants? Which ones? Why do you think that is?
- Were some harder to find than others? Why do you think that is?
- Do you think the time of year affects the success of this activity?

LEARNING AND REFLECTING

Discussion questions to help students reflect on or summarise their learning.

What did you discover?

Which stages of the life cycle did you find?

Where did you find the plants?

Which features of the plants were most interesting or different?

Did any plants have features in common? Do you think any of these plants might be related?

FURTHER EXPLORATION

Extension activities for greater depth.

Research facts about different Australian native plants.

Using your research resources (books or the internet), look up interesting facts about Wattles (*Acacia* species), Gum Trees (*Eucalyptus* species), Kangaroo Paws (*Anigozanthos* species), Paperbarks (*Melaleuca* species), Tea Trees (from the family Myrtaceae, including *Leptospermum* and *Kunzea* species) and Emu Bushes (*Eremophila* species). Present and share your facts with the class.

Visit the Atlas of Living Australia.

Explore the lists of iconic species of plants and animals here in Australia by visiting https://lists.ala.org.au/iconic-species. Explore your local area by entering an address or location to find the species that have been recorded nearby. You can set the size of the search area and download the results. https://www.ala.org.au/explore-by-location/

Explore the Knowing Plants site from the National Museum of Australia.

"Discover Indigenous perspectives and facts about native plants collected during Endeavour's 1770 voyage. Australia's First Peoples have a much older knowledge of these plants, many of which were previously unknown in Europe. Learn about plants through creation stories, how they mark the seasons and provide food, medicine and materials for making everyday items. See videos, hear plant names spoken in Indigenous languages and more."
https://www.nma.gov.au/explore/features/knowing-australian-plants

What are some common Australian plant families?

Access the Australian National Botanic Gardens Resource called *'Alive with Learning: Australian Plant Families'*. This activity uses group work to research and source examples from the common

Australian plant families: Asteraceae, Lamiaceae, Mimosaceae, Myrtaceae, Proteaceae and Rutaceae.

Research and report

Using books and the internet, research the plants that were not found in the field area you visited. Try to work out why they weren't growing in the area you visited, using species distribution maps and climate information for your local town/city to help you understand. Create a poster, write a report or present to the class to communicate your findings.

Activity 3 – Identify plants at different life cycle stages

LEARNING INTENTIONS

Students will be able to:

- Identify the life cycle stages of a flowering plant.
- Collect and record information from the field about plant life cycles.

CURRICULUM LINKS

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

Science understanding

AC9S3U01 compare characteristics of living and non-living things and examine the differences between the life cycles of plants and animals (Year 3)

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 inquiry

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)

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)

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)

AC9S4I03 follow procedures to make and record observations, including making formal measurements using familiar scaled instruments and using digital tools as appropriate (Year 4)

AC9S4I04 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 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)

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)

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)

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)

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)

INQUIRY QUESTIONS

What is a life cycle?

What are the six major stages of a flowering plant's life cycle?

Which parts of a plant can you see? which parts can't you see?

How do plants grow and change?

CONTENT INFORMATION

All living things are classified into five kingdoms: Monera, Protista, Fungi, Plantae and Animalia. Humans are part of the Kingdom Animalia and plants are part of **Kingdom Plantae**.

One distinguishing feature of members of the plant kingdom is their life cycle.

A **life cycle** is a series of stages all living organisms (both plants and animals) go through from the beginning of their life until the end. For plants, this is from seed to mature plant or, for plants like ferns that don't produce seeds, from spores to mature plant. Animals may start as an egg or undergo a live birth, later reaching maturity and death.

Life cycles repeat again and again.

Image: ©S.Sonntag, 2022

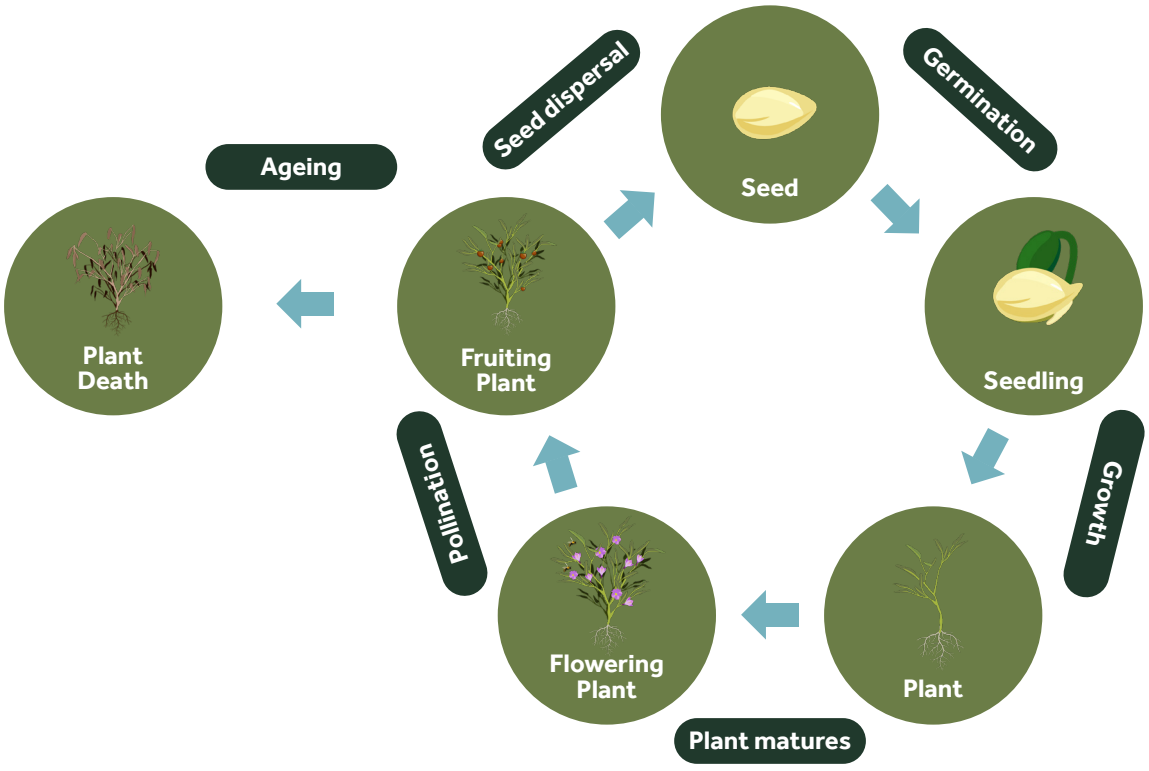
COLLECTING AND RECORDING INFORMATION ABOUT PLANTS AT DIFFERENT LIFE CYCLE STAGES

Scientists who study plants, observe them growing and collect plant samples are called botanists. Botanists may work in a laboratory, examining how plants grow and how environmental conditions affect plant life cycles (like rainfall, soil, nutrients and more). They may also undertake field work and plant growth trials. There can be a lot of research involved!

There are many good reasons to research plants including conservation and agriculture, as well as to improve our understanding of how the natural world works. If we understand how plants grow and the environment they grow best in, we can use this knowledge to ensure that species don't die out (become extinct). Farmers also use this information to help them identify the best methods to grow their crops so that we all have enough food to eat. Understanding plants has even inspired inventors and engineers to create products that we use every day.

The life cycle stages of a generalised flowering plant include **seed, seedling, plant, flowering plant, fruiting plant and plant death**, which depend on the intervening processes of **germination, growth, maturation, pollination, seed dispersal and ageing.** These stages and processes are elaborated below.

The stages and processes are best represented as a cycle as follows:



1. Seed

A flowering plant's life begins as a **seed**. Once dispersed, seeds of some species will germinate straight away, assuming that temperatures and light and water availability are good enough. Seeds of other species have evolved ways to postpone germination until they experience very specific conditions. They do this by having dormancy mechanisms or very particular germination requirements (or both). For example, some seeds only germinate when they experience specific temperatures, light conditions, rain events or a bushfire - or sometimes a special combination of factors! Some seeds may remain for years in the soil seed bank until conditions are just right for germination. Once the seed experiences dormancy alleviation, or receives the right cues for germination, it will take in water through its outer layer, causing the **seed coat** to expand and crack open. The **embryo** inside is made up of a shoot and a root that emerge from inside the seed and begin to grow.

Can you find any examples of seeds either about to sprout or already sprouting? You could look for seeds that have fallen to the ground, or try to find some tiny cotyledons (the first leaves to shoot out from the seed), which are evidence that seed has recently sprouted.

See if you can find examples of seeds that are ready for dispersal. Examples are:

Image: ©M.Fagg, 2009

Image: ©M.Fagg, 2009

Image: ©E.Cheney, 2022

2. Seedling

Once a seed has germinated it begins to grow into a **seedling**. Its roots grow down into the soil and its shoot grows upwards towards the sun, even if the seed is upside down in the soil. The shoot develops into a stem with either one or two 'leaves'. These first leaves are called **cotyledons** and

are not considered 'true leaves'. They provide the developing seedling with nutrients until it grows true leaves that can produce food through **photosynthesis**.

See if you can find examples of roots and stems and leaves. Hint: pull up a weed to view the roots rather than our native plants! Use a tool such as a trowel or weeder to avoid damaging the roots.

Examples to look for are:

Image: ©E.Cheney, 2022

Image: ©E.Cheney, 2022

3. Plant

Over days, weeks, months or years the seedling matures into a **plant**. Its roots, stems and branches grow thicker and stronger, allowing it to support the growing plant and structures such as leaves and flowers.

Mature plants make their own food through **photosynthesis**, using the green pigment **chlorophyll** in their leaves to combine energy from the sun, carbon dioxide and water to make sugar, while releasing oxygen as a by-product. The sugar produced in the leaves is called **glucose**, but the plant can convert this to other **carbohydrates** to store it, such as **fructose**, **sucrose**, **starch** or **cellulose**. The roots, seeds, stems and fruits can be storage sites for these carbohydrates, allowing the plant to produce sweet nectar rewards in flowers, sweet flesh in their fruits and to have access to food stores when environmental conditions are tough.

Can find any examples of plants at this stage? Look for roots, stems and branches that are able to support the growing plant, as well as leaves. Look for leaves and flowers as the plant matures.

4. Flowering plant

When the plant is ready to reproduce it produces **flowers**. The male part of the flower is called the **stamen**, comprised of the filament and anther, and the female part is called the **pistil**, comprised of the stigma, style, and ovary. Some flowers have only male parts, some have only female parts, and some have both male and female parts together.

Pollination occurs when the pollen (the male cell) that is produced in the anther moves to the stigma (female part). When this happens on a single plant it is called self-pollination. When it moves to another plant it is called cross-pollination.

Pollination occurs either via animals (notably insects), water or by the wind. Native bees, flies, butterflies, moths, birds and even flying foxes all help our Australian native plants to reproduce.

Can you find examples of the parts of a flower that are ready for pollination?

Examples to look for are:

Image: ©S.Sonntag, 2022

Image: N.Lamb©ANBG, 1972

5. Fruiting plant

Once pollen lands on the stigma of the flower, **fertilisation** can occur. This process involves the male **gametes** (reproductive cells) from the pollen grain mixing with the female gametes (**ovules**) contained in the **ovary**. When the ovule has been fertilised it can develop into a **seed**.

The ovary wall then develops into a **fruit** that surrounds and protects the newly formed seed. Some fruits contain just one seed, such as *Macadamia integrifolia* and many *Syzygium* (Lily Pilly) species, but most fruits contain many seeds, such as *Eucalyptus* and *Banksia* species.

Fruits come in many colours, shapes and sizes! Some fruits are **fleshy** and sweet to attract animals to eat them and spread the seeds contained inside. Other fruits are tough, like *Macadamia* 'nuts', and others are leathery or dry, like *Acacia* pods. Fruits can be woody, spiky, juicy, sticky, large or small, and their different properties allow them to protect and spread their seeds in different ways.

The seeds contained in the fruits need to be **dispersed** to allow the plant life cycle to start again. Seed dispersal can happen with help from animals, wind, water or gravity, and different fruits are adapted to different methods of dispersal.

Can you find different kinds of fruits growing on plants? If possible, cut the fruit open and see if you can find the seeds inside. (Remember, this may not be allowed in some places such as botanic gardens – always ask permission first).

Image: ©S.Sonntag, 2022

Image: ©E.Cheney, 2022

Image: ©E.Cheney, 2022

6. Plant death

Life cycles can repeat again and again, however eventually the plant will age and die. Depending on the species of plant, plant death could occur after one or hundreds of seed-producing cycles. Plants can also die from other causes, such as pests, diseases, extreme events (droughts, floods, bushfires) or changes in environmental conditions.

Can find any plants that are starting to die or have already died? Do they have any leaves? What colour are they? What does the stem/trunk look and feel like? Are they still standing? Are any animals living in/on them? What do you think caused them to die?

GATHERING YOUR SUPPLIES

Equipment

- Field journal
- Pens/pencils
- Camera/tablet, if taking photographs
- Student copies of Resource: Life cycles data collection worksheet

ACTIVITY INSTRUCTIONS

Method

1. Head out into the field with each student equipped with a field journal. The field can be a location of choice: the school premises, a local park, a plant nursery or even a botanic gardens in your state or territory.
2. Working in small groups, in a pair or individually, students look for Australian native plants at different stages of their life cycle as outlined above and record their observations in their field journal. Where Australian natives are hard to find, other plants can be used.
3. The worksheet provided includes prompts for information to be recorded including space for a drawing. Students can also record:

- Observations
- Questions they have
- A tally of the number of specimens they find

Example images can be shown to students prior to going into the field. Students should copy the data collection fields from the worksheet into their journals, or you can provide a printed copy to glue in.

It is also possible to use cameras/tablets if available instead of the field journal.

WHAT TO DO WITH THE LIFE CYCLE INFORMATION ONCE OBTAINED?

At the end of the field activity, have students compare notes on what they found. This could be in the form of a presentation, discussion groups or by creating a class 'life cycle wall' where each student or group displays their discoveries for the different life cycle stages.

LEARNING AND REFLECTING

Discussion questions to help students reflect on or summarise their learning.

What did you discover?

Which stages of the life cycle did you find?

Where did you find the plant?

Which plants did we you most/least?

Did the life cycle stages look different in different plants, or the same?

What season/weather is it currently? Could this affect which life cycle stages you found?

FURTHER EXPLORATION

Extension activities for greater depth.

Scientific drawing

- Identify an Australian plant in flower. Draw and label the flower and plant parts.
- Look at 'Floral Emblems' on the Australian National Botanic Gardens website. A poster is also available here.
- Use microscopes or magnifying glasses to examine the finer detail of the plant parts and label accordingly, e.g. stomata, fine hairs – some of these can be a challenge to see.
- Follow Top Draw activities to learn more about botanical and scientific drawing.

Plant cells

- Delve deeper and use a microscope to look at the cells within a plant. There are many resources online that can assist with observing plants at a cellular level.

Research and present

- Break students into groups.
- Assign each group a life cycle stage.
- Ask each group to research and do a small presentation on their life cycle stage.
- Include interesting facts/stories and information from their research.

Scavenger hunt

- As a class or in smaller groups start a collection of Australian native plant families.
- Collect and identify as many Australian native plants as you can and try to sort them into family groups.
- Discover interesting ways to display them. Hint – you can research museums, botanic gardens and cultural institutions for ideas on plant displays.

Activity 4 - Build a tree map

LEARNING INTENTIONS

Students will be able to:

- Identify the life stages of a tree.
- Collect and record information from the field about trees.

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 inquiry

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)

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)

AC9S4I03 follow procedures to make and record observations, including making formal measurements using familiar scaled instruments and using digital tools as appropriate (Year 4)

AC9S4I04 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 4)

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

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

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

INQUIRY QUESTIONS

What is a tree map?

How can you tell what stage of growth a tree is at? Juvenile, semi-mature, mature?

What stage of the life cycle is a tree at when it flowers?

How does the environment affect the way a tree grows?

CONTENT INFORMATION

Tree mapping helps to study the vegetation of an area by providing complete information about particular tree types. Tree maps can provide information about how climate change and land management impact upon the growth of trees. It is a way to educate the community and create awareness about environmental and heritage protection, and also helps governments look after important trees.

THE TALLEST FLOWERING PLANTS IN THE WORLD

When we think about flowering plants we often think about shrubs or flowers in a vase. But trees have flowers too. Australia is home to the world's tallest flowering plant, a eucalypt commonly known as the Mountain Ash (also known as the Tasmanian Oak, Stringy Gum or Victorian Ash). Its scientific name is *Eucalyptus regnans*.

Eucalyptus regnans grows only in south-eastern Australia (Tasmania and Victoria) and the tallest example is in Tasmania near the Tahune Airwalk canopy bridge. This tree was given the name 'Centurion'. please delete 'and when' it was measured in 2018 with laser technology and was found to be 100.5 metres tall! It can grow up to a metre each year so it may be a few metres taller now.

Botanists were concerned when a bushfire went through the area in 2019 and the base of the tree was burned, but Centurion survived. Eucalypts can live up to 500 years before they die of old age (similar to people - although we don't live for 500 years!).

Image: ©M.Fagg, 1988

THE LIFE OF A TREE

Different species of trees live for very different lengths of time. Some wattles (*Acacia* species) live 5–10 years, while many eucalypts live for hundreds of years. The local conditions (where a tree lives) can also affect how long it lives for.

TREE REGISTERS AND MAPS

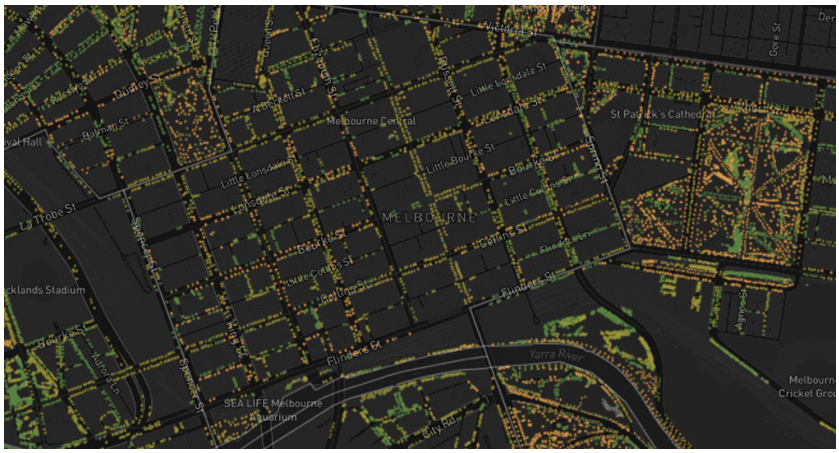
Tree maps are an important tool. Knowing where trees are located, and the type and condition of the tree, can help scientists better manage forests. They help local councils plant the correct trees for the area, and to manage them properly as they age.

Tree registers can also provide a way for people to connect with their environment, even from far away. As part of its tree mapping project, the Melbourne City Council set up email addresses for thousands of individual trees so that the public could report any problems, such as dangerous branches or damage from storms. Instead, people used the emails to send letters to their favourite trees. Do you have a favourite tree? Why not write it a letter or poem explaining why it's your favourite?

The National Trusts of Australia have a Register of Significant Trees which is constantly evolving. They have over 2,000 tree records in the register. Anyone can nominate a tree for registration at https://www.nationaltrust.org.au/services/significant-tree-register/.

- species identification, if possible
- tree height
- tree canopy spread
- tree trunk circumference
- tree age estimate
- photos: whole tree, bark, foliage, nuts/fruits/flowers (if any)
- location details
- historical information about the tree, if known

In additional to the National Trust register, many local governments in Australia have their own tree registers. Do an internet search, or ask your local council, to find out whether your area has a tree register.



An image from the City of Melbourne Urban Forest Visual map. Each coloured dot represents a different tree and its location. http://melbourneurbanforestvisual.com.au/#mapexplore.

GATHERING YOUR SUPPLIES

For this activity you will need:

- A field journal for each student
- Pencils / pens
- A measuring tape (ideally 5–10m length) for each group (groups of 3 recommended for this activity). Alternatively, have students use string and measure the length afterwards.
- A ruler for each group
- Large piece of paper (e.g. poster or butchers paper) for creating a tree map

ACTIVITY INSTRUCTIONS

For this activity, we are going to map and measure trees. Head into the field with your field journal and a measuring tape. The field can be a location of choice: the school premises, a local park, a plant nursery or even a botanic gardens in your state or territory.

Working in small groups, look for Australian native trees in the area.

1: Select one of the trees. It must be a tree with a single stem, not multiple stems like in the photo below.

2: In your field journal, draw a simple map of the area and mark the location of the tree.

3: Observe the tree. Record any information you can see in your field journal, such as:

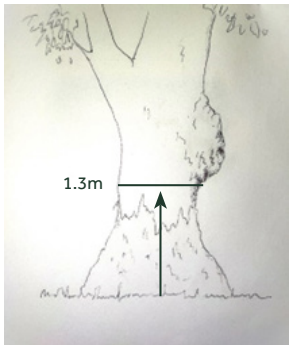
- Are there any markings on the tree that could indicate it has been used to give directions or to make equipment?
- Does the tree look healthy?
- Does it look like anything has happened to this tree – marks from fire, broken branches, any signs of animals damaging it?
- What stage of its life cycle is this tree at?
- What shape is the canopy?
- Does the tree have flowers? What do they look like?
- Do you know the name of the tree?
- Do you have any questions about this tree – about its appearance or history?

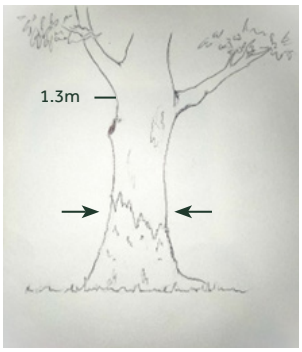
4: Measure the **circumference** of the tree. This is the distance right around the trunk. To measure the circumference you must measure above ground level, because many big trees are wider at the base.

- Measure 1.3 metres from the ground.
- Using your tape measure, measure the circumference of the tree at the narrowest point

between the ground and 1.3 metres high. You can also use a long piece of string and measure the length that was wrapped around the tree.

- Record the measurement in your journal.





5: Measure the tree **height**. This can be tricky, as some trees are very tall. Scientists use special instruments to measure tree height, but there are ways of estimating height using only a ruler and tape measure. One method is outlined below. Record the measurement in your journal.

- Working in groups of 2 or more, have Person 1 stand beside the tree.
- Holding a ruler vertically at arm's length, Person 2 walks backwards until the top and bottom of the ruler line up with the top and bottom of the tree. Tip: Try closing one eye when lining up the ruler and the tree.
- Still holding the ruler at arm's length, Person 2 now turns the ruler horizontally, so that one end of the ruler lines up with the base of the tree and the other points out sideways.
- Person 1 walks sideways, away from the tree, in the direction the ruler is pointing. When they are in line with the far end of the ruler, Person 2 calls out, "Stop!"
- Measure the distance between Person 1 and the tree. This is the tree's height.

7: Measure the **canopy spread**. Have one person stand on each side of the tree at the point where the branches are widest. Measure the distance between each person. Record the measurement.

Once all students have recorded information about their trees, this information can be compiled into a tree map of the area. Draw a rough map of the survey area on the poster or butchers' paper, and have students mark the location of their trees on the map.

Image: Brooker and Kleinig©ANBG, 1984

Image: R. Hotchkiss ©ANBG, 1985

Look for a tree like the image on the right, with a single stem. The trees on the left have multiple stems – these are not appropriate for measuring with this technique.

For a repeat activity, return to the survey area a few months later and in a different season and have students record any differences in the appearance of their tree or its surroundings.

LEARNING AND REFLECTING

Discussion questions to help students reflect on or summarise their learning.

What did you discover?

Which stages of the life cycle did you find?

Where did you find the tree?

Which trees did we see most/least?

Does the tree's environment affect the way it grows?

Did the appearance of the trees tell you anything about the history of this environment?

FURTHER EXPLORATION

Extension activities for greater depth.

Map specimens

Map the specimens found on a map of the school or field area. Draw a map or download a map from Google Maps. Number the tree and mark the location on the map. Develop a legend for the different types of trees. Use GPS coordinates.

Collate

Collate all the class' findings on one large tree map. Include photographs.

Revisit

For smaller trees, revisit the tree later in the year. How much have they grown?

Make a school tree register

Do you have a big tree at your school? Record it and make your own school tree register.

Bark and leaf rubbings

Take bark and leaf rubbings— sketch the tree and describe it in detail.

Use a magnifying glass and explore aspects of the tree in detail. What other living things are using it for shelter? Record observations.

Research

Research the effects of climate change on our trees and what this means for the animals who rely on the trees for shelter.

Trees in your area

Research trees that are threatened in your area.

RESOURCE: JOURNAL TEMPLATE

Collector's name:

Collection date:

Specimen number:

Sample type: (circle one) Cutting | Photo | Drawing

Plant name:

Country, state & district:

Specific location:

Latitude:

Altitude: Longitude:

Habitat description

Topography (landscape):

Soil:

Nearby Vegetation:

Sunlight: (circle one) Full Sun | Part Shade | Full Shade

RESOURCE – PLANT CARDS

Common name: Wallum Banksia
Scientific name: *Banksia aemula*

Image: ©M.Fagg, 2008

Plant facts

Grows in swampy coastal heath (Wallum), southern Queensland to central New South Wales.

Height: to about 3 metres.

Flowers: Yes - hundreds on a vertical flower spike.

Common name: Waratah
Scientific name: *Telopea speciosissima*

Image: ©M.Fagg, 2007

Plant facts

Floral emblem of New South Wales.

One of five waratah species that grow from NSW to Tasmania.

Grows in deep sandy soils.

Height: To about 4 metres.

Flowers: Yes - each inflorescence has up to 250 separate flowers.

Common name: Tropical Banksia
Scientific name: *Banksia dentata*

Image: J.W.Wrigley ©ANBG, 1980

Plant facts

Grows in tropical savannah grassland.

Only banksia to grow outside Australia (Eastern Indonesia and New Guinea).

Height: To about 7 metres.

Flowers: Yes.

Resprouts after fire from woody stems (lignotubers).

Common name: Golden Wattle
Scientific name: *Acacia pycnantha*

Image: ©M.Fagg, 1986

Plant facts

Floral emblem of Australia. One of more than 1,000 wattle species in Australia.

Grows naturally in southeast Australia.

Height: Shrub 3-8 metres.

Flowers: Yes - 40-80 bright yellow ball-shaped inflorescences, each one containing 40-100 tiny flowers.

Common name: Red & Green Kangaroo Paw
Scientific name: *Anigozanthos manglesii*

Image: ©M.Fagg, 2009

Plant facts

Floral emblem of Western Australia.

Grows only in Western Australia, on sand plains from Perth to Shark Bay.

Height: A single stalk up to 120 cm.

Flowers: Yes - red and green velvet textured. The flower brushes pollen on to the heads of long-billed birds like Honeyeaters.

Common name: Omeo or Rock Grevillea
Scientific name: *Grevillea willisii*

Image: ©M.Fagg, 1981

Plant facts

One of more than 350 Grevilleas across Australia.

Grows in a restricted sub-alpine ecosystem near Omeo in Victoria.

Height: To about 2 metres.

Flowers: Yes - white and resembling a toothbrush.

Common name: Gymea Lilley
Scientific name: *Doryanthes excelsa*

Image: ©M.Fagg, 1980

Plant facts

Grows in woodlands in the Sydney region of New South Wales, in soils derived from sandstone.

Height: Large sword shaped leaves and an enormous flower spike up to 6 metres tall.

Flowers: Yes - a bright red globular head of nectar-rich flowers.

Common name: Alpine Bottlebrush
Scientific name: *Callistemon pityoides*

Image: A.Lyne ©ANBG, 1992

Plant facts

Grows from about 900 metres up to the Snowy Mts, around bogs and swamps and along rivers in Queensland, New South Wales and Victoria.

Height: Grows in thickets to about 2 metres tall.

Flowers: Yes - creamy-yellow on a dense flower spike.

Common name: Royal Bluebell
Scientific name: *Wahlenbergia gloriosa*

Image: ©M.Fagg, 1995

Plant facts

Floral emblem of the Australian Capital Territory.

Grows in herbfields and grasslands in rocky alpine ecosystems in the Australian Capital Territory, New South Wales and Victoria.

Height: Up to 30 cm tall.

Flowers: Yes - five petals on each flower.

Common name: Sturt's Desert Rose
Scientific name: *Gossypium sturtianum*

Image: ©M.Fagg, 2016

Plant facts

Floral emblem of the Northern Territory.

Related to cotton. Grows as a shrub in arid areas of inland Australia.

Very deep roots to reach deep underground water.

Flowers: Yes - purple, hibiscus-like.

Common name: Cooktown Orchid
Scientific name: *Dendrobium bigibbum*

Image: ©M.Fagg, 1977

Plant facts

Floral emblem of Queensland.

A tropical epiphytic orchid that grows on paperbark tree trunks and in vine thickets.

Height: To about 80 cm.

Flowers: Yes - bright pink, shaped like a moth.

Common name: Tasmanian Blue Gum
Scientific name: *Eucalyptus globulus*

Image: ©M.Fagg, 2009

Plant facts

Floral emblem of Tasmania.

Millions planted for timber in Africa, Asia and North and South America.

Height: 45 metres.

Flowers: Yes - large cream inflorescences. Blue Gum nectar is rich food for endangered Swift Parrots.

Common name: Common Heath
Scientific name: *Epacris impressa*

Image: ©M.Fagg, 2008

Plant facts

Floral emblem of Victoria but also grows in South Australia, Tasmania & New South Wales.

Height: Up to 1.5 metres.

Flowers: Yes - pink to bright red, tubular, trumpet-shaped.

Common name: Wee Jasper Grevillea
Scientific name: *Grevillea iaspicula*

Image: ©M.Fagg, 2011

Plant facts

One of Australia's rarest plants – about 100 survive in southern New South Wales where they can't be reached by grazing goats and sheep.

Height: 1.3 metres.

Flowers: Yes - a 'spider flower' type of grevillea – cream to green with red style (female flower part).

Common name: Mountain Ash
Scientific name: *Eucalyptus regnans*

Image: ©M.Fagg,2001

Plant facts

Grows in Victoria & Tasmania in wet forests.

Height: Tree up to 90 metres.

Flowers: Yes – This is the world's tallest flowering plant

Common name: Bunya Pine
Scientific name: *Araucaria bidwillii*

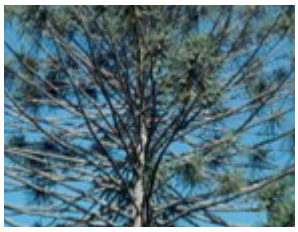


Image: ©M.Fagg,1997

Plant facts

Grows in Queensland

Height: Tree averaging 40 metres.

Flowers: No. The very large seeds grow in the female cones. These cones are as heavy as a pineapple.

Common name: Hyacinth Orchid
Scientific name: *Dipodium roseum*

Image: ©M.Fagg,2018

Plant facts

Grows in eastern and southeast Australia, from southern Queensland to Victoria.

Height: Up to 80 cm.

Flowers: Yes, up to 50 bright pink flowers on a long, leafless stem.

Common name: Sturt's Desert Pea
Scientific name: *Swainsona formosa*

Image: ©M.Fagg,2009

Plant facts

A desert plant from South Australia, Northern Territory and Western Australia.

Height: Up to 75 cm tall.

Flowers: Yes, big and bright red, about 9 cm long, growing from stems close to ground.

Common name: Sphagnum Moss
Scientific name: *Sphagnum cristatum*

Image: ©M.Fagg,2012

Plant facts

Grows in very wet areas like alpine bogs and rainforests in many parts of Australia.

Height: Very low, grows like a green carpet on forest floors, on rocks and on other living plants.

Flowers: No – reproduces via spores, not seeds.

Common name: Leafy Liverwort
Scientific name: *Heteroscyphus fissistipus*

Image: ©H.Lepp

Plant facts

Grows on soil, bark, leaves and rocks in wet habitats along the east coast of Australia.

Height: Very low. Leafy liverworts hug the ground. They are similar to mosses.

Flowers: No – reproduces via spores, not seeds.

Common name: Rock-shield Lichen
Scientific name: *Xanthoparmelia substrigosa*

Image: ©M.Fagg,1997

Plant facts

Not a plant at all! Lichen are in the fungal kingdom.

Lichens grow worldwide. There are 3,000 species in Australia. This species in Widespread in non-tropical Australia.

A lichen is a co-operative association between a fungus and an alga or a cyanobacterium.

Flowers: No.

Common name: Rounded Earthstar Fungus
Scientific name: *Geastrum saccatum*

Image: ©M.Fagg,2003

Plant facts

Not a plant at all! Fungi are in their own kingdom.

Grow in every Australian habitat. This species is found in eastern Australia, South Australia and Western Australia.

Fungi don't make their own food and may get nutrients by feeding on dead or living organisms or by a mutually beneficial relationship with another organism.

Flowers: No.

Common name: Bitter Cryptandra
Scientific name: *Cryptandra amara*

Image: ©M.Fagg,2021

Plant facts

Grows in eastern Australia – Queensland to Tasmania.

Height: 35 cm.

Flowers: Yes – small, white, fragrant and bell-shaped flowers.

Common name: Low Bush Pea
Scientific name: *Pultenaea subspicata*

Image: ©M.Fagg,2011

Plant facts

Grows in southeastern Australia – rocky dry woodlands

Height: Low to the ground, can grow up to 15 cm.

Flowers: Yes – yellow and orange pea flowers.

Common name: Yam Daisy
Scientific name: *Microseris walteri*

Image: ©M.Fagg, 2014

Plant facts

Tubers were prepared and eaten as a vegetable by First Nations People.

Grows in a range of habitats in most states.

Height: Up to 50 cm.

Flowers: Yes – yellow daisy on 40 cm stem.

Common name: Celery
Scientific name: *Apium graveolens*

Image: ©Tiia Monto, CC BY-SA 3.0, via Wikimedia Commons

Plant facts

A common cultivated vegetable. Leaves, stalk, and root can all be eaten.

Wild celery grows in salty marshlands in Europe.

Height: Up to 60 cm.

Flowers: Yes.

Common name: Broad-leaf Parakeelya
Scientific name: *Calandrinia balonensis*

Image: ©M.Fagg,2017

Plant facts

This is a succulent plant.

Grows in arid and semi-arid areas of Australia.

Height: Leafy flower stems grow to 30 cm.

Flowers: Yes. Vivid dark pink or purple.

Common name: Round-leaved Pigface
Scientific name: *Disphyma crassifolium*

Image: ©M.Fagg,2019

Plant facts

A succulent plant of southern Australia.

Grows by the sea in salty soil and on sandy dunes.

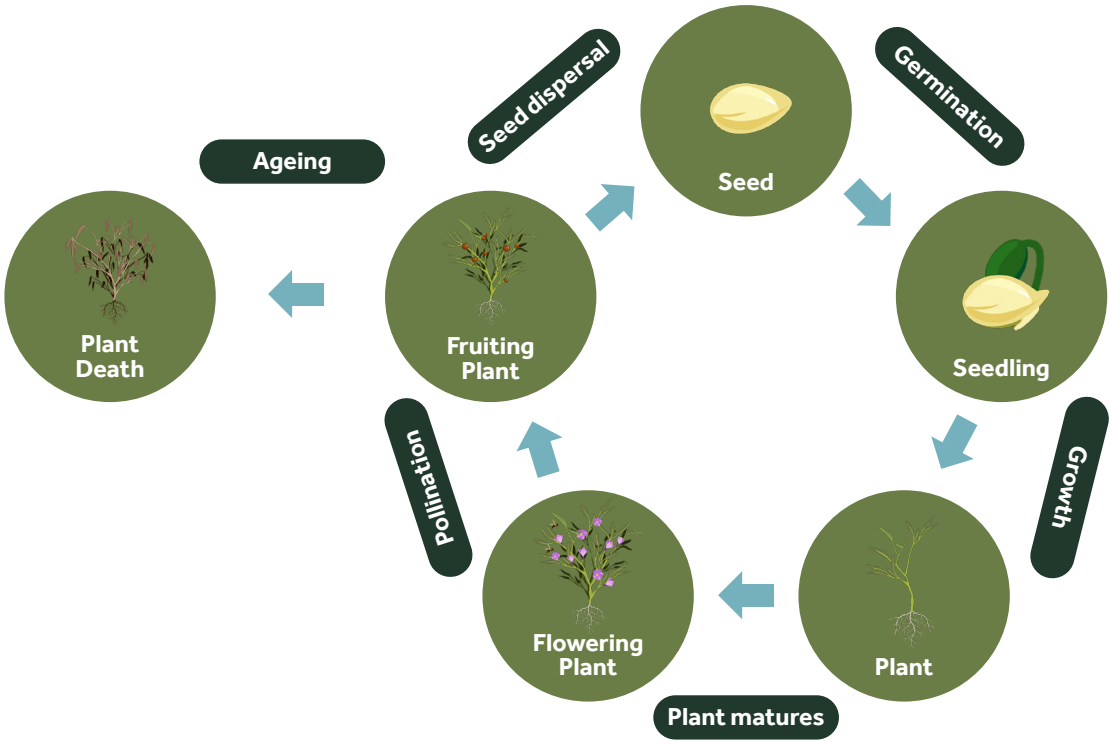
Height: Grows on the ground with long straggling branches.

Flowers: Yes. Deep purple.

RESOURCE: LIFE CYCLES DATA COLLECTION TABLE

Life cycles challenge

Look for evidence of each life cycle stage and process and draw a picture of what you see.



STAGE: SEED TO SEEDLING
PROCESS: GERMINATION

What type of seed is it? Is it a seed or already sprouting? Where did you find it? Can you tell which plant is the parent of this seed/seedling? How far away from the parent plant is it? How do you think this seed was dispersed?	***Draw a picture here.***

STAGE: SEEDLING TO PLANT
PROCESS: GROWTH

What part of the plant is it?

What type of plant is it from?

Where did you find it?

What shape is it?

Draw a picture here.

STAGE: PLANT TO FLOWERING PLANT
PROCESS: MATURATION

What plant is it?

Where did you find it?

How do you know the plant has reached maturity?

Draw a picture here.

STAGE: FLOWERING PLANT TO FRUITING PLANT
PROCESS: POLLINATION

What flower is it?

Where did you find it?

Can you see the pollen on this flower?

What do you think pollinates this flower?

Where did you find the fruit?

Is it soft or hard?

Can you find the seeds inside the fruit?

What type of plant is it from?

Draw a picture here.

STAGE: FRUITING PLANT TO SEED
PROCESS: SEED DISPERSAL

What type of seed is it?

Where did you find it?

Can you tell which plant is the parent of this seed?

How far away from the parent plant is it?

How do you think this seed was dispersed?

Draw a picture here.

STAGE: FRUITING PLANT TO PLANT DEATH
PROCESS: AGEING

What plant is it?

Where did you find it?

Can you see any of this plant's offspring nearby?

How do you know it's dying or already dead?

What do you think caused it to get sick or die?

Draw a picture here.

RESOURCE – PLANT BINGO CARD

Eucalypt (Gum) tree 	Grevillea fruit 	Grevillea flower 	Callistemon (Bottlebrush) leaf 
Banksia tree/shrub 	Acacia (Wattle) leaf 	Callistemon (Bottlebrush) flower 	Eucalypt fruit (Gum nut) 
Grevillea leaf 	Banksia flower 	Eucalypt flower (Gum blossom) 	Acacia (Wattle) tree/shrub 
Acacia fruit (Wattle seed pod) 	Callistemon (Bottlebrush) tree/shrub 	Acacia (Wattle) flower 	Callistemon (Bottlebrush) fruit 
Banksia fruit 	Eucalypt (Gum) leaf 	Banksia leaf 	Grevillea tree/shrub 

Australian National
Botanic Gardens