Australian National Botanic Gardens

Lesson Plan

Module 3

Pollination

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

Plant Science Learning Hub

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

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

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

Module learning objectives

The following learning objectives apply to the Pollination Module

1. Understand why and how pollination occurs.
2. Explore how plants and animals interact in the pollination process and how they rely on each other for survival.
3. Identify the structural features and adaptations of pollinators and flowering plants and describe common 'pollination syndromes'.
4. Identify ways of taking action to ensure the survival of flowering plants and pollinators.

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

Contents

Lesson Two: Plant and Pollinator Relationships

LEARNING INTENTIONS

Students will be able to:

1. Identify animal pollinators and understand why we need to care for them.
2. Explore which plant structures pollinators are attracted, or not attracted to.
3. Identify adaptations plants use to attract pollinators.
4. Design a plant-pollinator partnership.

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)

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)

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)

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)

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)

CONTENT INFORMATION

Introduction to pollination

Pollination is one step in the process of sexual reproduction in seed-producing plants.

Pollination involves pollen being delivered from the male parts of a plant to the female parts. In a flower, pollen travels from the anther (part of the male reproductive system) to the stigma (part of the female reproductive system). Pollen contains male reproductive or sperm cells, which contain the plant's genetic information. Successful pollination can lead to fertilisation and the production of seeds.

Pollination can occur when pollen is moved by wind, water or animal pollinators, including birds and insects. Approximately 65% of all flowering plants, and non-flowering seed-producing plants (such as cycads and pines), rely on insects for pollination.

Why is pollination important?

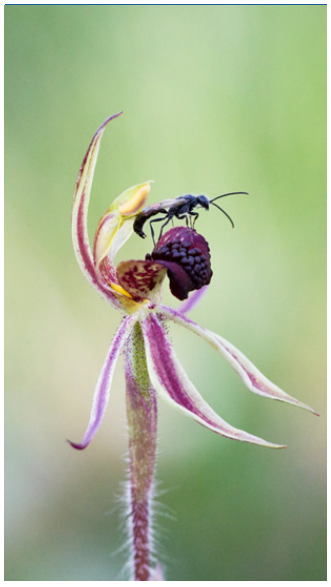
Many of the Earth's systems rely on plants; without them, food chains and ecosystems would stop functioning. This is also true for humans, as agricultural industries grow cereal crops, such as wheat and rice, and fruit and vegetable crops, such as oranges and broccoli, to provide food for us and livestock. Many of these agricultural plants require pollination to maximise the volume and quality of production, and two-thirds of Australia's crops benefit from the presence of pollinators.

Crops that require cross-pollination, such as apples and watermelons, rely on the presence of animal pollinators to produce fruit that is good enough to be sold. Wheat, corn and rice are pollinated by the wind, so do not require animal pollinators. Some crops can self-pollinate, requiring pollination to produce fruit and seeds but not relying on external pollinators.

Introduction to pollinators and pollination syndromes

A pollinator helps to move pollen from the male parts of a flower to the female parts to allow pollination to occur. There are two categories of pollinators: abiotic and biotic.

- Abiotic relates to things that are not living. Abiotic pollination includes the movement of pollen by wind or water.
- Biotic relates to things that are living. Biotic pollination refers to the movement of pollen by animals, such as birds, insects, mammals and reptiles.
- About 80% of all plant pollination is performed by animals and the remaining 20% is completed by abiotic methods.



Plants have adapted to make pollination more successful by developing a huge diversity in flower colour, form, scent, nectar reward, structure and position on a plant. This has given rise to pollination syndromes, which describe flower features that tend to occur together to maximise pollination success via a specific pollinator. Wind-pollinated plants have a wind pollination syndrome that enables their pollen to be released into the wind and carried away. In contrast, butterfly-pollinated plants have a butterfly pollination syndrome that allows them to attract butterflies with certain colours, scents and nectar.

See Pollination Teachers' Notes for specific information on pollination syndromes.

INQUIRY QUESTIONS (ENGAGE)

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

Ask the students a series of questions such as:

Do all plants need to be pollinated?

How can you tell if a flower is pollinated by animals, the wind or something else?

What is the role of animals in plant pollination? How do animals benefit from being a pollinator?

What is the difference between a honeybee and a native bee? How many types of native bees are there?

Which animals besides bees pollinate plants?

What will happen if we don't look after pollinators?

How do plants attract pollinators?

What are some unusual mechanisms flowers use to get pollinated?

What is a pollination syndrome?

How do pollinators and flowers work in partnership to ensure they both receive benefit from the pollination process?

What is biotic pollination? What is abiotic pollination?

STRATEGIES TO FACILITATE QUESTIONING AND DISCUSSION:

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

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

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

LESSON SEQUENCE (EXPLORE)

There are three activities in this lesson:

In Activity 1, students will explore different techniques plants use to attract pollinators (pollination syndromes).

In Activity 2, students will be introduced to pollinator flower preferences.

In Activity 3, students will create their own flower and pollinator to demonstrate how pollinators and plants work together for mutual benefit.

ACTIVITY 1 – PLANTS, POLLINATORS AND POLLINATION SYNDROMES

This activity is designed for students to expand on what they already know about pollination and pollinators to discover some of the amazing techniques plants use to attract animals to pollinate them. The way that a plant's characteristics match the features of its pollinator is called a pollination syndrome. There are two parts to this activity.

Part 1: Am I a pollinator? checks existing knowledge and raises awareness of the role of pollinators in the environment.

Part 2: Pollination syndromes allows students to see the connection between the features of plants and their pollinators by exploring unique Australian pollination syndromes.

To do this, you will need:

- Images from Resource: Pollinator Fact Sheet
- Resource: See, Think, Wonder Worksheet for each student
- Students' science journals

Instructions

Part 1: Am I a pollinator?

1. Introduce the activity by showing the class the images from the Resource: Pollinator Fact Sheet and ask the students to identify if the pollination method is biotic (involving animals) or abiotic (involving wind or water). You may also wish to show the class other pollinator images that you find online.
2. Discuss key focus questions:

   What is a pollinator?

   What does a pollinator do?

   Why do we need to care for pollinators?
3. It is estimated that 70% of animal, plant and fungi species in Australia have not yet been documented. Explain that one way of supporting pollinators is to identify them, because if we don't know what they are, we can't protect them!

Part 2: Pollination syndromes

1. Introduce the concept of a pollination syndrome to students:
   A pollination syndrome describes the parts of a plant that have adapted to suit a specific type of pollinator. For example, a bird like a honeyeater has a long beak that can reach into a tube-shaped flower to drink nectar from the bottom. While it reaches its beak into the flower, it touches the flower's pollen with its head. The bird receives food (nectar) and the plant has its pollen moved away from the flower (attached to the bird). The flower and bird both benefit from this interaction and evolved together to be a perfect match.
2. Hand out the Resource: See, Think, Wonder Worksheets to each student or have them create this in their science journal. Explain how to participate in the See, Think, Wonder thinking routine if students haven't done so before.
   a) In the 'see' section students explain what they can see in the videos and photos.
   b) In the 'think' section students explain what they think the videos and photos are showing. Students might be able to reproduce some of the new vocabulary in these responses, such as 'I think the bird is drinking nectar and pollinating the flower', 'I think the bee is attracted to the flower and collecting pollen from it'.
   c) In the 'I wonder' section students record anything that the videos and photos make them wonder, such as 'I wonder why the bee likes this flower?'
3. Watch the Pollination video produced by the Australian National Botanic Gardens, this can be found by searching on the Plant Science Learning Hub and encourage the class to hypothesise what a pollination syndrome is. Ask the students to:
   a) identify a pollinator
   b) identify a pollination syndrome
   c) discuss the reasons why the plant may have developed this adaptation

Explain some of the factors that influence the way plants adapt to survive and reproduce, including:

- Plants have adapted to make pollination more successful by developing a huge diversity in flower colour, form, scent, nectar reward, structure and position on a plant.
- This has given rise to pollination syndromes, which describe flower features that tend to occur together to maximise pollination success from a specific pollinator.
- Animal pollinators have co-evolved with plants so their features 'match' these pollination syndromes.
- The plant and pollinator both benefit from this interaction (symbiotic/mutualistic relationship).
- For example: In Australia, beaks of honeyeater birds have evolved to be narrow and curved enough to successfully extract nectar from a spiny grevillea flower. This adaptation enables honeyeaters to access nectar efficiently. Some grevillea plants have developed a pollination syndrome that matches the honeyeater's narrow beak. Its modified stigma holds pollen in a position that means it brushes against the honeyeater as it is foraging for nectar. This ensures that the bird transports pollen to the next flower and allows pollination to happen. This shows a symbiotic/mutualistic relationship between honeyeaters and grevilleas.

Discussion points:

How does the plant's survival rely on the plant and the pollinator working together?

Why do you think the plant has adapted this way? Does its pollinator have a trait that suits this?

Does this feature help in attracting a pollinator?

Does environment and/or weather affect this?

If you were to design a different kind of pollination syndrome, what might it be?

RESOURCE – SEE, THINK, WONDER WORKSHEET

SEE - WHAT DO YOU SEE?

THINK - WHAT DO YOU THINK ABOUT THAT?

WONDER - WHAT DOES IT MAKE YOU WONDER?

ACTIVITY 2 – MEET THE POLLINATORS

This activity allows students to gain insight into specific pollinators and the pollination syndromes that attract them. We also look at what happens if we don't look after pollinators.

To do this, you will need:

- Resource: Pollinator Fact Sheet for each group/student
- Resource: Pollinator Summary Sheet for each group
- Resource: Pollination Syndrome Posters (can be printed as A3 size if desired). Spread these around the room on walls/tables etc. but make sure students can write on them.
- Resource: Flower Profiles

Instructions

1. Remind students of what a pollination syndrome is.
2. Explain the activity to students then divide them into six groups (one for each pollinator).
    - Each group will be given a Pollinator Fact Sheet about one pollinator.
    - Students will read the fact sheet and summarise the information on the Pollinator Summary Sheet as a group.
    - Groups will then visit each Pollination Syndrome Poster (spread around the room on walls/tables) and fill in the information about their pollinator. The topics include general information, flower colour, flower shape, flowering time and flower smell.
    - On completion of the activity, the class will have created posters that summarise the pollination syndromes that attract different pollinators.
3. Bring the class back together. Now you have created posters of different pollination syndromes, you can use this information to look at flowers and predict what their pollinator is. Look through each of the Flower Profiles and ask students to vote on which pollinator they think would pollinate each flower. Refer to the Pollination Syndrome Posters and allow students to discuss/debate which pollinator best matches the flower's pollination syndrome – in nature, many flowers are pollinated by multiple pollinators, so it is OK if the students decide the answer is more than one pollinator!

    You can mention that even when the pollination syndrome of a plant matches a particular pollinator/s it doesn't mean that other pollinators won't visit it. Pollination syndromes relate to pollinator preferences but do not capture the whole picture of where a pollinator travels.

4. Finish this activity by asking each group to think about what might happen to humans and the environment if pollinators became endangered or extinct. What are some ways we can protect pollinators? Read the Conserving pollinators in your local area fact sheet as a class and discuss the points raised and how they relate to your home and school gardens. Fill out the Resource: Pollinator conservation poster and add it to the other posters the class has created. Ask questions such as:

Do you think you can do any of these things at your house?

Do you think we can do this at school?

What can you do differently to help our pollinators?

Optional extra:

Play a quick game of pollinator 'Heads Up' as a review activity.

1. Write, or use the image of each of the pollinators and flower profiles on a card, phone or tablet.
2. The goal is to guess the word that appears without looking at it. One player holds the pollinator/flower against their forehead while their teammates will provide clues to them either as charades or verbal cues.
3. Write familiar and new words on a word wall.

Discussion points

Is the relationship between plants and pollinators more complicated than you thought? Why or why not?

How do pollinators affect your everyday life?

What is a way you can improve your environment (school/home garden) for pollinators?

What would happen if a plant's only pollinator became endangered? What would happen if it became extinct?

What are some of the threats to pollinators?

Are there any pollinators you would like to learn more about?

ACTIVITY 3 – DESIGNING A POLLINATOR-PLANT PARTNERSHIP

In this activity, students will design an imaginary pollinator for a real flower, an imaginary flower for a real pollinator or both! This activity encourages students to draw on their knowledge of the process of pollination, the characteristics and structures of flowers, how plants attract pollinators and asks them to think about the unique characteristics their pollinator will have. It is a hands-on craft activity designed to spark students' imaginations.

To do this, you will need:

- Pollination/flower anatomy reference materials
- Paper for students to make a fact card
- A variety of craft materials such as pipe cleaners, cardboard, fabric, egg cartons, straws, natural materials, sponges, newspaper, glue, wool, cardboard tubes, rubber bands or similar. You may also like to draw this activity.

Instructions

1. Review the features of pollinators and flowers that support pollination. More information on this can be found in Lesson Plan 1 of this module (Pollination) and in the Pollination Teachers' Notes.
2. Explain to students that they will be designing a pollinator and a flower that will work in partnership to facilitate pollination. The emphasis is on the relationship between the plant and its pollinator. Introduce the concepts of co-evolution and mutualism:
    - Co-evolution – when organisms evolve and adapt to each other over time. Flowering plants have evolved with their pollinators over millions of years.
    - Mutualism – a relationship between two organisms where both receive a benefit. In pollination, the plant benefits because its pollen is moved to another flower by the pollinator, which means that the plant can reproduce. The pollinator benefits because it can get to the food in the flower (pollen and nectar) easily with less competition from other pollinators that are not specially adapted to do so. Each partner depends on and benefits from the other, but they each act their own interest and survival.
3. Encourage students to be imaginative and have fun with this task, noting that any characteristics they develop will need to be justified and will need to relate to the partnership as much as possible. The fact card should show how the flower and pollinator have 'matching' designs to increase the chances of pollination and what they each receive from the interaction. Scientific accuracy does not need to be the focus, for example:

Flower-bat partnership

"*I have designed a large lounge shaped white flower with fruit flavoured nectar. It is white so the bat can see the flower and all bats love fruit, so they will be strongly attracted. The lounge has a number of tiny anthers that produce pollen on the back rest and the stigma is located in the cushion that the bat sits on. The bat can lounge in the flower and eat fruit nectar and when they lie down on the lounge after their big meal they get pollen from the back rest that they leave in the cushion stigma of the next flower.*"

In this example, the benefit for the bat is food and rest, and the benefit for the flower is pollination.

Flower-fly partnership

"My flower has a super-speed pollen booster and the nectar smells like rotten bananas. A hairy fly

lands on the flower and drinks the nectar when suddenly the flower uses a gust of wind to blow a puff of pollen onto the fly. The fly gets blinded and confused and stumbles around, landing on the sticky stigma. The fly then moves to another flower and the same thing happens: when the fly runs into the stigma, the pollen becomes stuck to it."

In this example the benefit for the flower is pollination and for the fly it is nectar.

4. Allow time for students to consider and draw their designs before they start construction. Students can record their design decisions and keep notes to create a fact card later.

Ensure that each design includes:

- A reason that the pollinator is attracted to the flower
- Anther
- Stigma
- How the pollen gets on the living pollinator or is moved by wind or water
- How the pollen is transferred to the next flower
- Adaptations that the pollinator has to ensure the pollen is transferred to the next flower (e.g. long beak, spiky tongue, pollen sacks, fur).

5. Have students construct their pollinator and flower out of craft materials and complete their fact card.

These images show a constructed pollination partnership between an imaginary flower and a butterfly.

A butterfly, constructed out of craft materials: ribbon, string, paper, sticky tape and packing paper.

A brightly coloured flower, to attract butterflies, with a unique, central, multi-stranded stamen full of pollen.

The butterfly has a very wide, tubular proboscis, to match the flower's stamen. It also has a furry body, which helps to pick up pollen.

The butterfly at rest, before flying to another flower and using its large proboscis and body to cross-pollinate.

6. On completion of the activity, the groups can present their designs and fact cards to the class group. Encourage discussion on how the pollinator and plant are in partnership and encourage creative responses.
7. You may wish to have a class exhibition to display the students' designs.

Discussion points

What were the most effective examples of plants and pollinators working together in your classmates' projects?

Were there examples where there wasn't mutual benefit for the plant and pollinator? Did the pollinator or the flower receive more benefit than the other? What could this mean for the plant or the pollinator if it happened in nature?

Do you think it is better for the plant and the pollinator to have an exclusive relationship? i.e. a pollinator only visits one species of flower and a flower is highly attractive to only one type of pollinator? Why or why not?

CONCEPTS EXPLAINED AND VOCABULARY DEFINED (EXPLAIN)

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

- Pollination Teachers' Notes (found in the Pollination section of the Plant Science Learning Hub)
- Pollination Video. The Pollination video discusses pollination, why it is important, what it is and how it occurs, as well as visiting the National Herbarium to further explore pollination. The video is appropriate for use through any of the Pollination Module. It can be used to engage students at the beginning of a lesson or to summarise key information at the end. This video can be found in the Pollination Resources section of the Plant Science Learning Hub.
- Word Bank

APPLYING AND EXTENDING THE LEARNING (ELABORATE)

Applying the learning

Which came first, the flower or the bee? Apply the analogy about whether the chicken or the egg evolved first to plants and pollination and hold a class debate.

Did you know plants have sexual diversity? Flowers can be female only, male only or have both sexes in one flower. Some species will have male flowers on one plant and female flowers on a separate plant. How does this affect pollination? Research and present your findings.

Identify pollinators in your local area. Use the Atlas of Living Australia or iNaturalist websites to see which pollinators are in your local area. Have you seen any around? How can you encourage them to visit your home or school environment?

Write a pollinator story. Write a creative story about 'a day in the life' of a flower or a pollinator. Write it from their point of view or from that of someone watching them.

Categorising pollinators. Using the fact sheets about pollinators, categorise the pollinators discussed based on whether they are flying or non-flying, night or day feeders. Do further research to see if there are more pollinators you can add to this list.

Explore other flowers and their pollinators. Using the plant cards and flowers from Module 1: Plant Life Cycles show students pictures of flowers they haven't seen in this lesson. Challenge students to guess which pollinators might visit each flower. Allow student to create insects with adaptations suited to pollinate each of these new flowers and compare with the flowers' real pollinators.

Flowers that change the taste of honey. Does honey take on the flavour of the plants and flowers bees were feasting on at the time they made it? When bees forage mostly on one type of plant, the honey they produce is called 'monofloral' and has a more consistent taste than when they find many different flowering plants in their immediate area. Taste test some different honeys and compare their flavours. Do they all taste the same? Try to find some monofloral honeys flavoured by Australian native plants and compare the flavours. Which one do you like the most?

Take a virtual tour of CSIRO's Australian National Insect Collection. The Australian National Insect Collection at CSIRO is the largest collection of Australian insects in the world, housing more than 12 million specimens! Take a tour of the collection from the comfort of your classroom or home at https://blog.csiro.au/virtual-tour-insect-collection/.

Extension ideas for further research

Learn about moths at CSIRO. There are many things that scientists do not yet understand about moths. Visit the Australian Moths Online database from CSIRO's Australian National Insect Collection to explore the diversity of Australian moths, available at https://moths.csiro.au/.

Read more about Australian native bees. Visit the CSIRO blog, 'Can you beelieve?! Our guide to native bees', to learn more about Australia's fascinating native bees, available at https://blog.csiro.au/can-you-beelieve-our-guide-to-native-bees/.

What does an entomologist do? Research this intriguing profession and share your findings with your class, school or family. What do you think are the best parts of the job? What do you think is important about their work? Would you like to be an entomologist?

Learn more about insects and invertebrates. Learn more about Australia's intriguing invertebrates using the key made by CSIRO, available at https://www.ento.csiro.au/education/index.html, or by exploring the Atlas of Living Australia's Iconic Invertebrate List, available at https://lists.ala.org.au/iconic-species?fq=kvp%20group:Invertebrates.

Insect anatomy. Experience what it is like to be a scientist studying insect pollinators. Look at basic insect anatomy under a microscope or view slides and microscope images from the Australian National Insect Collection available at https://www.csiro.au/en/about/facilities-collections/collections/anic.

- Which insects are pollinators? How can you tell?
- What scientific study could you do to gather information about which plants the pollinators visit or where they nest?
- Look at their mouth parts and discuss whether you think they are pollen or nectar feeding.
- Observe the hairs on their body that hold pollen, allowing them to transport it long distances.
- If you are looking at a bee, observe its flat legs that allow it to carry pollen.

Bees with backpacks. Do you bring a backpack to school? Do you know of any insects that carry them? The Bees with Backpacks project has put tiny micro-senser 'backpacks' on the backs of more than half a million bees around the world to track their movements outside their hives. Research this project and share what you learned with your class. Project information available at https://blog.csiro.au/bees-with-backpacks-fly-into-schools/.

Explore co-evolution through research. Challenge students to research pollinators and find out how they have co-evolved with flowers to produce highly specialised pollination syndromes. Read about the Hawkmoth that Charles Darwin predicted would pollinate a flower in Madagascar before it had even been discovered.

Pollinator technology WebQuest. Undertake a critical thinking WebQuest to explore the technology behind robotic bees and RoboFly. What technology does it use? How could it be useful to farming, environmental science and conservation? In what ways will it impact our future? Approach this investigation from the perspective of a politician, farmer, scientist or conservationist. Share your research with your class, school or community.

Flower models. Students with skills and/or interest in engineering and construction can design and build working models of the trick mechanisms used by some flowers to deposit pollen on a pollinator. Examples can be seen on pages 26-28 of Volume 17(1 of Botanic Gardens Conservation International's Roots magazine, available at https://www.bgci.org/resources/bgci-tools-and-resources/roots/.

Bry the Fly Guy. Dr Bryan Lessard (a.k.a. Bry the Fly Guy) is an entomologist and author of the kids book Eyes on Flies. Bry discovered the curious world of flies as an undergraduate student, learning about the use of maggots to help solve crimes and heal patients in hospital. He has named 50 new species and now works at the Australian Biological Resources Study – the national species authority – where he continues to discover, classify and names new species of flies. Discover amazing fly facts and more at his website https://brytheflyguy.com/.

QUESTIONS AND ACTIVITIES FOR REFLECTION (EVALUATE)

Students review and reflect on their learning journey by:

Revisiting the learning intentions and original inquiry questions:

Do all plants need to be pollinated?

How can you tell if a flower is pollinated by animals, the wind or something else?

What is the role of animals in plant pollination? How do animals benefit from being a pollinator?

What is the difference between a honeybee and a native bee? How many types of native bees are there?

Which animals besides bees pollinate plants?

What will happen if we don't look after pollinators?

How do plants attract pollinators?

What are some unusual mechanisms flowers use to get pollinated?

What is a pollination syndrome?

How do pollinators and flowers work in partnership to ensure they both receive benefit from the pollination process?

What is biotic pollination? What is abiotic pollination?

Identifying further questions.

What questions haven't I had answered yet?

Identifying what they learned from others and their own research.

What new knowledge do I have about pollination that I didn't have before?

RESOURCE – WORD BANK

pollinator	**pollination syndrome**	**biotic**	**abiotic**
invertebrate	**adaptation**	**co-evolution**	**mutualism**
proboscis	**nectar**		

RESOURCE – SEE, THINK, WONDER WORKSHEET

SEE - WHAT DO YOU SEE?

THINK - WHAT DO YOU THINK ABOUT THAT?

WONDER - WHAT DOES IT MAKE YOU WONDER?

RESOURCE – POLLINATION SYNDROME POSTERS

Birds

The flowers of *Pimelia physodes* and the beak of the Red Wattle Bird.
Image: ©G.Gall, 2019

1.

2.

3.

Bats

A flying fox feeding on nectar from a *Banksia* cone.
Image:©Steve Parish

1.

2.

3.

Bees

A native Blue-banded Bee buzz pollinating a flower.
Image: ©S.B.Rogers, 2018

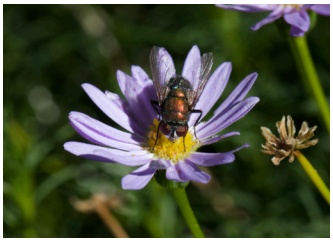
1.

2.

3.

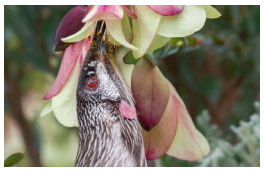
RESOURCE – POLLINATION SYNDROME POSTERS

Wind	
 Themeda grasses. Image: ©M.Fagg,1999	1. 2. 3.

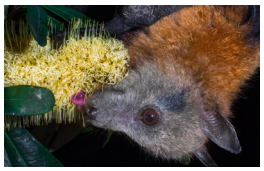
Flies	
 A Lucilia fly on a Brachyscome mutifida daisy. Image: ©B.Lessard, 2022	1. 2. 3.

Butterflies	
 A Red-spotted Jezebel butterfly pollinating flowers of a Pimelea species. Image: ©S.B.Rogers	1. 2. 3.

RESOURCE – POLLINATOR CONSERVATION

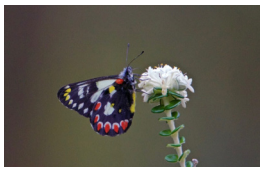


The flowers of *Pimelia physodes* and the beak of the Red Wattle Bird.
Image: ©G.Gall, 2019



A flying fox feeding on nectar from a *Banksia* cone.
Image:©Steve Parish

A native Blue-banded Bee buzz pollinating a flower.
Image: ©S.B.Rogers, 2018



A Red-spotted Jezebel butterfly pollinating flowers of a *Pimelea* species. Image: ©S.B.Rogers

A Lucilia fly on a *Brachyscome mutifida* daisy.
Image: ©B.Lessard, 2022

How we can conserve pollinators

1.

2.

3.

4.

What we can do at school to help them

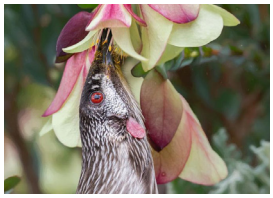
1.

2.

3.

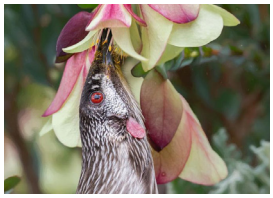
4.

RESOURCE – FLOWER COLOUR

Birds	Bats	Bees
 The flowers of *Pimelia physodes* and the beak of the Red Wattle Bird. Image: ©G.Gall, 2019	 A flying fox feeding on nectar from a *Banksia* cone. Image:©Steve Parish	 A native Blue-banded Bee buzz pollinating a flower. Image: ©S.B.Rogers, 2018
Wind	**Flies**	**Butterflies**
 *Themeda* grasses. Image: ©M.Fagg,1999	 A Lucilia fly on a *Brachyscome mutifida* daisy. Image: ©B.Lessard, 2022	 A Red-spotted Jezebel butterfly pollinating flowers of a *Pimelea* species. Image: ©S.B.Rogers

Key

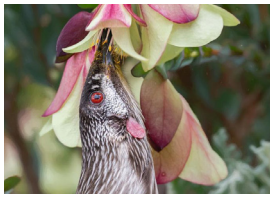
RESOURCE – FLOWER SHAPE

Birds	Bats	Bees
 The flowers of *Pimelia physodes* and the beak of the Red Wattle Bird. Image: ©G.Gall, 2019	 A flying fox feeding on nectar from a *Banksia* cone. Image:©Steve Parish	 A native Blue-banded Bee buzz pollinating a flower. Image: ©S.B.Rogers, 2018
Wind	**Flies**	**Butterflies**
 *Themeda* grasses. Image: ©M.Fagg,1999	 A Lucilia fly on a *Brachyscome mutifida* daisy. Image: ©B.Lessard, 2022	 A Red-spotted Jezebel butterfly pollinating flowers of a P*imelea* species. Image: ©S.B.Rogers

Key

Open	Flat	Brush shaped	Small	Large	Obvious
Tube shaped	Showy	Shallow	Bowl shaped	Not obvious	Bell shaped

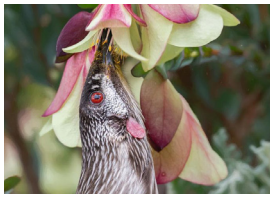
RESOURCE – FLOWERING TIME

Birds	Bats	Bees
 The flowers of *Pimelia physodes* and the beak of the Red Wattle Bird. Image: ©G.Gall, 2019	 A flying fox feeding on nectar from a *Banksia* cone. Image:©Steve Parish	 A native Blue-banded Bee buzz pollinating a flower. Image: ©S.B.Rogers, 2018
Wind	**Flies**	**Butterflies**
 *Themeda* grasses. Image: ©M.Fagg,1999	 A Lucilia fly on a *Brachyscome mutifida* daisy. Image: ©B.Lessard, 2022	 A Red-spotted Jezebel butterfly pollinating flowers of a *Pimelea* species. Image: ©S.B.Rogers

Key

Day Night Day and night

RESOURCE – FLOWER SMELL

Birds	Bats	Bees
 The flowers of *Pimelia physodes* and the beak of the Red Wattle Bird. Image: ©G.Gall, 2019	 A flying fox feeding on nectar from a *Banksia* cone. Image:©Steve Parish	 A native Blue-banded Bee buzz pollinating a flower. Image: ©S.B.Rogers, 2018
Wind	**Flies**	**Butterflies**
 *Themeda* grasses. Image: ©M.Fagg,1999	 A Lucilia fly on a *Brachyscome mutifida* daisy. Image: ©B.Lessard, 2022	 A Red-spotted Jezebel butterfly pollinating flowers of a *Pimelea* species. Image: ©S.B.Rogers

Key

Rotting	Sweet	Strong	None	Minty	Nighttime
Fruity	Daytime	Pungent			

RESOURCE – POLLINATOR SUMMARY SHEET

Pollinator name:	
Three interesting facts about your pollinator	1. 2. 3.
Pollination Syndrome: **Flower Colour** Which colour does your pollinator prefer?	
Pollination Syndrome: **Flower Shape** Which shape does your pollinator prefer?	
Pollination Syndrome: **Flowering Time** Which time does your pollinator prefer?	
Pollination Syndrome: **Flower Smell** Which smell does your pollinator prefer?	

RESOURCE – POLLINATOR FACT SHEETS

POLLINATOR PROFILE: BIRDS

Honeyeaters are the most common bird pollinators in Australia, followed by lorikeets, sunbirds and parrots. Birds are major pollinators for many native plants, including bottlebrushes, grevilleas, kangaroo paws and banksias. Birds are efficient pollinators because they can visit lots of flowers in a short time.

Birds prefer different flower shapes based on their beak shape. They can be attracted to tube, cup or brush shaped flowers. Flowers that attract birds often have their petals bent backwards, with their nectar deep inside. This forces the birds to come as close as possible to the flower and have pollen brush onto their bodies. Bird-attracting plants need strong branches for birds to perch on while they eat.

Birds are attracted to flowers that produce lots of nectar and don't really mind how it smells. They feed on nectar during the day and are usually attracted to flowers that are bright red, yellow or orange.

RESOURCE – POLLINATOR FACT SHEETS

POLLINATOR PROFILE: BEES

Bees are the most common pollinator in Australia. There are native and non-native bees that perform pollination – and there are 2000-3000 species of native Australian bee!

Blue-banded Bees are an important native pollinator and some do a special type of pollination called buzz pollination. Bees that buzz pollinate can clamp onto a flower with their legs and bang their head against it very quickly, so the flower vibrates and releases its pollen.

Bees can't generally see red, so they are attracted to blue, yellow, purple, cream or white coloured flowers. Because bees can see ultraviolet (UV) light, they can see special landing strips on some flowers that guide them to where the nectar is. These nectar guides are invisible to most creatures, including humans!

Bees like shallow, tube-shaped flowers, that provide a landing platform. Bees are attracted to sweet and minty flower scents and visit flowers during the day.

RESOURCE – POLLINATOR FACT SHEETS

POLLINATOR PROFILE: BATS

Bats are nocturnal, so usually pollinate flowers that are open at night. Feeding at night means they have less competition from pollinators who feed on flowers during the day. Bats eat nectar, fruits, flower parts and even insects inside the flowers.

Bats are constantly on the move, making them very good at pollinating lots of flowers in one night. Pollen sticks to their furry bodies and they transfer it as they move between flowers. Bats often have good memories and will revisit flowers that they know produce lots of nectar.

Bats are attracted to flowers that are pale white, green or purple. These colours tend to be easier to see at night. They enjoy eating nectar out of bell or bowl-shaped flowers. Bats are attracted to flowers that produce a lot of fragrance at night.

RESOURCE – POLLINATOR FACT SHEETS

POLLINATOR PROFILE: BUTTERFLIES

Image: ©S.B.Rogers

Butterflies use their proboscis to drink nectar from flowers. A proboscis is a long, thin tube at the front of their head, a bit like a straw. Butterflies are attracted to sweet smelling flowers and can detect these scents with their antennae.

Butterflies are cold-blooded so need the help of the sun to get moving. They usually can't fly well when temperatures are below 15°C, as their body temperature needs to be higher, which means they only visit flowers during the day.

Butterflies are attracted to native trees such as eucalypts, acacias and banksias, as the leaves, seeds and flowers of these plants provide food for their young (larvae). They are attracted to flowers that grow in groups.

Butterflies are attracted to bright red, magenta or pink flowers that are narrow and tube-shaped, which they drink nectar from using their proboscis. They also like flowers that have a landing pad.

RESOURCE – POLLINATOR FACT SHEETS

POLLINATOR PROFILE: FLIES

Image: ©B.Lessard, 2022

Flies are the second most common pollinator after bees. They are usually attracted to flowers that have a pungent or rotten smell, like the dead animals and dung they often visit.

Some plants make their flowers hot, so they can spread their rotting smell further and attract more fly pollinators.

Flies prefer dull white, brown or yellow flowers. They are attracted to flowers that are shallow, funnel- or trap-shaped. Flies access flowers during the day and at night.

RESOURCE – POLLINATOR FACT SHEETS

POLLINATOR PROFILE: WIND

Wind pollinated plants do not need to attract a pollinator, as the wind blows on them regardless of how they look and smell! They're usually small, not brightly coloured, don't have a smell and don't contain nectar. Many grasses are wind pollinated.

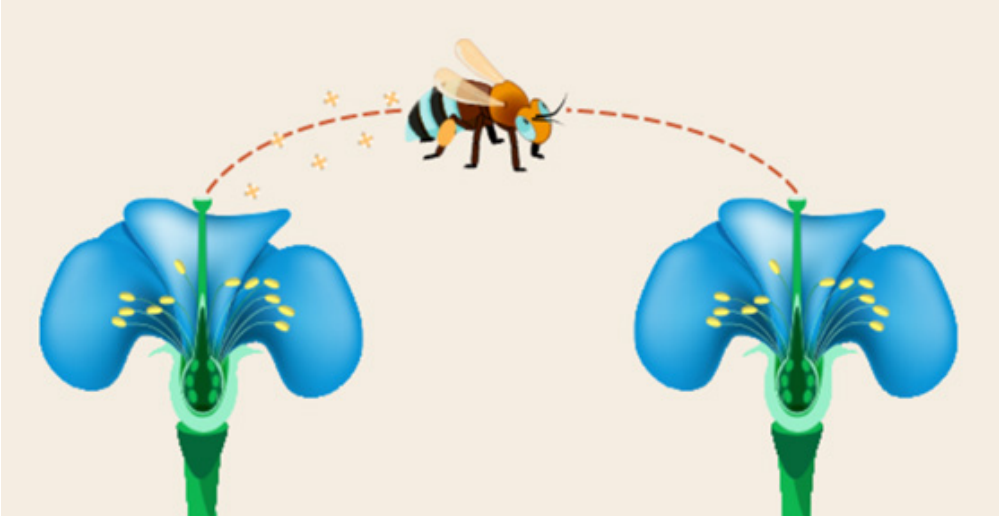
Wind pollinated flowers generally have no petals or only a small number, so they don't get in the way when the wind blows pollen on them.

Wind-pollinated flowers produce lots of lightweight pollen that can be carried hundreds of kilometres by the wind. Much of this pollen never meets another flower on its journey, so a lot is wasted.

The wind blows at any time of the day, so wind pollinated flowers are open during the day and at night.

RESOURCE – POLLINATOR FACT SHEETS

CONSERVING POLLINATORS IN YOUR LOCAL AREA



Native plants: plant a variety of native plants, especially plants that are local to your area.

Flower diversity: include different flower types to attract different pollinators.

Water: provide a water source. Make it accessible to smaller animals and insects by having a stick or rock poking out the top.

Habitat: provide habitat for pollinators by keeping undergrowth, rocks and fallen logs in some garden areas.

Go organic: avoid the use of chemicals, including herbicides and pesticides, as these affect pollinators as well.

Keep pets at home: keep pets like dogs and cats away from wildlife areas.

Spread the word: the more awareness people have the more they will care about our unique Australian environment, so spread the word about our amazing pollinators!

RESOURCE – FLOWER PROFILES

WHO POLLINATES ME?

Epacris longiflora

Fuchsia Heath

Epacris longiflora ©M.Fagg, 2006

Plant: small shrub, woody branches

Flower shape: long, narrow, tube-shaped

Nectar: yes

Flower colour: pink/red and white

Flowering time: open day and night

WHO POLLINATES ME?

Craspedia variabilis

Billy Buttons

©M.Fagg, 2014

©M.Fagg, 2008

Plant: small plant, not woody

Flower shape: round, flat, open

Nectar: yes

Flower colour: yellow

Flowering time: open day and night

RESOURCE – FLOWER PROFILES

WHO POLLINATES ME?

Angophora costata

Sydney Red Gum

©M.Fagg, 2012

J.R Connors©CANBR, 1998

Plant: tall tree, woody

Flower shape: open, cup-shaped

Nectar: yes

Flower colour: white or cream

Flowering time: open day and night

WHO POLLINATES ME?

Casuarina cunninghamiana

River She-oak

Image: ©M.Fagg, 2013

Plant: tall tree, woody

Flower shape: small, not obvious

Nectar: no

Flower colour: red

Flowering time: open day and night

RESOURCE – FLOWER PROFILES

WHO POLLINATES ME?

Callistemon viminalis

Weeping Bottlebrush

©M.Fagg, 2011

©M.Fagg, 1989

Plant: medium shrub/tree, woody

Flower shape: long, brush-shaped

Nectar: yes

Flower colour: red

Flowering time: open day and night

WHO POLLINATES ME?

Brachyscome multifida

'Amethyst'

©M.Fagg, 2016

Plant: small plant, not woody

Flower shape: small, open, flat

Nectar: yes

Flower colour: purple

Flowering time: open during the day

RESOURCE – FLOWER PROFILES

WHO POLLINATES ME?

Grevillea barklyana

Large Grevillea

©M.Fagg, 2007

Plant: medium shrub/tree, woody

Flower shape: long, brush-shaped

Nectar: yes

Flower colour: pink

Flowering time: open day and night

WHO POLLINATES ME?

Xerochrysum viscosum

Sticky Paper Daisy

©M.Fagg, 2008

Plant: small plant, not woody

Flower shape: open, flat

Nectar: yes

Flower colour: yellow

Flowering time: open during the day

RESOURCE – FLOWER PROFILES

WHO POLLINATES ME?

Juncus usitatus

Common Rush

©M.Fagg, 2008

©M.Fagg, 2008

Plant: small plant, not woody

Flower shape: small, not obvious

Nectar: no

Flower colour: green to brown

Flowering time: open day and night

WHO POLLINATES ME?

Banksia menziesii

Firewood Banksia

©M.Fagg, 2021

Plant: medium shrub/tree, woody

Flower shape: long, brush-shaped

Nectar: yes

Flower colour: red

Flowering time: open day and night

RESOURCE – FLOWER PROFILES

WHO POLLINATES ME?

Scaevola albida 'Pink Ribbon'

Fan Flower

©M.Fagg, 2012

Plant: small plant, not woody

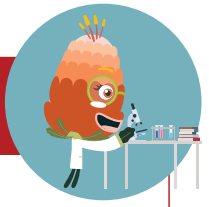
Flower shape: open, flat

Nectar: yes

Flower colour: pink

Flowering time: open day and night

RESOURCE: STUDENT REFLECTIONS



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

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

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

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

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

Source: Adapted from the *Animal adaptations: year 5 Australian science curriculum focus, 2016, by the Great Barrier Reef Marine Park Authority, licenced under Creative Commons licence CC-BY-NC-SA from: http://hdl.handle.net/11017/2990'.*

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