Teacher Notes

Themes

- Relationships between microbes, fungi and plants
- Soil and soil organisms

Key learning outcomes

- Understand the concept of symbiosis (living together)
- Learn about the size scales of different forms of life, and how very small living things can help very large ones
- Learn how living things communicate without a spoken language

Key curriculum areas

- English: Language, literature, literacy
- Science: Biological sciences, Earth and space sciences
- The Arts: Making, responding
- Cross Curriculum Priority – Sustainability: Systems, world views, futures

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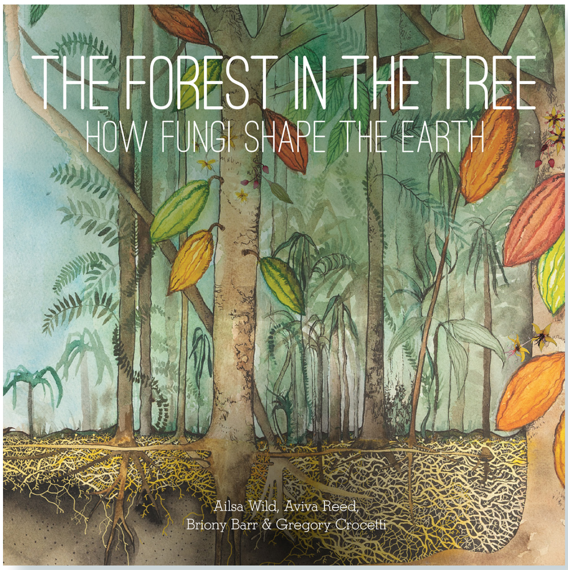
Teacher notes prepared by Dr Gregory Crocetti and Mark Hamilton



The Forest in the Tree

How Fungi Shape the Earth

Ailsa Wild, Aviva Reed, Briony Barr and Gregory Crocetti

This is a story about trees and fungi connected through a 'wood wide web' – told by one tiny fungal spore.

A little fungus meets a baby cacao tree and they learn to feed each other. They cooperate with a forest of plants and a metropolis of microbes in the soil. But when drought strikes can they work together to survive?

The fourth book in the Small Friends Books series, this science-adventure story explores the Earth-shaping partnerships between plants, fungi and bacteria.

Readers aged 8–12, teachers, librarians and parents

Co-published by CSIRO Publishing and Scale Free Network

scale free network
art–science collaborative

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About the creators

The Forest in the Tree is the creation of a team of people who work together, just like the characters in the story, to accomplish more than they could do on their own.

The story is written by Ailsa Wild, a writer–performer who creates fiction, non-fiction and physical theatre. She also wrote *The Squid, the Vibrio and the Moon*, *Zobi and the Zoox* and *Nema and the Xenos*, the first three illustrated science-adventure stories in the Small Friends Books series.

The enchanting illustrations are made by Aviva Reed, an artist and scientist who loves combining ideas and exploring concepts from multiple perspectives. She also illustrated the first three Small Friends books.

Dr Gregory Crocetti and Briony Barr, who are collaborators in the art–science collective Scale Free Network, co-author and co-publish the Small Friends Books series.

“I love being part of this deeply collaborative team,” Ailsa says. “I take the lead on the storytelling, but I really enjoy the part of the process where I’m led by other experts in the group. Gregory guides us through the scientific research, and Briony works closely with him designing a storyboard so each page reflects the story and real science. We get feedback from scientists and sometimes we’ve needed to change the story completely because my first plot wasn’t actually possible.”

“Aviva, Briony, Gregory and I often meet for hours (or days!) to go through each draft together and talk through the ideas. It’s amazing to be part of creating something together, which is far more layered and beautiful and scientifically rigorous than I could ever do if I was working alone.”

Aviva’s favourite part of the illustration process is “the eyes-closed part, the bit where I have done the research and try and put it all together in my mind’s eye, using my imagination.”

“Every work I make, I visualise the image in my mind before I start,” Aviva says. “I seek to visualise the composition and palette before I start to try and capture a story.”

Pre-reading activity: Contemplating trees

Equipment needed: none

Take students outside and find a group of trees. Ask the students to sit or stand quietly and use their senses to contemplate the trees and their surrounding ecosystem for three minutes. What can they see? What can they hear? What do they smell? What can they feel? Don't taste though! Allow them to close their eyes if they wish to. As a group, ask the students to describe what they learned or what they experienced.

Ask students:

- How old do you think the trees are?
- Can you predict how deep and wide a tree's roots are?
- What might live on, in or around the tree? Guide students to look at:
  - leaves (insects living on leaves)
  - branches (bird nests)
  - the trunk/bark (spiders and insects)
  - the base of the tree (ants, mushrooms, etc)
  - the soil underneath the tree (consider visible things such as worms, mites, centipedes, but also invisible things, such as fungal hyphae, bacteria, etc)

For discussion

1. Thinking about trees

Key curriculum areas – Science: Biological sciences, Earth and space sciences

Ask students to break up into small groups to write down some ideas in response to these questions. They can reflect on their pre-reading 'Contemplating trees' activity to help them come up with their ideas.

- Did any of the trees you observed look to be much older than the others? Could they be a mother tree?
- Can you predict how deep and wide the roots are?
- What do you think is bigger or wider, the roots of the tree or the web of mycorrhizal threads? Discuss.
  - This fungal web is also called the mycelium.
- What do you think is bigger, a forest of trees or the mycorrhizal network underneath them? Discuss.

- Can you imagine the web of connections under the ground between trees?
  – Take students back to the group of trees they observed previously. Look for fungal threads in the leaf and bark litter around the base (keep in mind not to disturb the surface too much or trample around the base of the tree too much, as this can hurt fungi).
- What do you think might happen to the fungi if the tree dies?
- How do you think the fungi will be affected if the ground between two trees is excavated?

Then come back together as a class to discuss.

2. Thinking sustainably about soil

Key curriculum area – Sustainability

Synthetic pesticides are chemicals designed to kill or block creatures from causing damage to crops. However, these chemicals often have unintended consequences. For example, many insecticides kill beneficial insects like honeybees and ladybird beetles.

1. Some farmers spray fungicides onto fruit trees to help protect the fruit from rotting on the tree before it can be picked and packed.
   – After reading the story, can you imagine any other impacts this might have on the tree and the surrounding soil...?
2. Some farmers plough (till) the soil in a field before they sow seeds of a new crop.
   – Can you imagine any impacts this might have on any creatures living in the soil?
3. Some farmers feed antibiotics to livestock (such as cows, sheep and chickens) to help them grow more quickly. However, these chemicals often have unintended consequences. Research and compare the uses, benefits and negative impacts of antibiotics in livestock/farming.

   Further prompts:
   – How could manure from livestock (containing antibiotics) affect soil microbes?
   – What unintended consequences might the overuse of antibiotics have on human health?

3. Symbiosis Q&A

Key curriculum area – Science: Biological sciences

There are different types of symbiotic relationships, depending on whether both species benefit or only one. One of the main themes in the book is the symbiotic relationship between Broma, the cacao tree, and Glomus, the mycorrhizal fungi that live around her roots.

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Q. How do the Glomus fungi benefit from being directly connected to Broma's roots?

A. As a type of plant, Broma is able to perform photosynthesis, transforming energy from sunlight into chemical energy, in the form of sugars. Broma shares some of these sugars through her roots with underground partners, such as mycorrhizal fungi like Glomus.

Q. Does Broma benefit from allowing Glomus fungi to connect into her roots? If so, how?

A. Glomus fungi share water and nutrients with Broma. The tiny threads (hyphae) of fungi are much better suited to finding water and (mineral) nutrients in between all the little pockets and pathways that make up soil.

Q. Is this relationship benefiting both? What type of symbiosis is this classified as?

A. Yes, both species benefit. It is a type of symbiosis called **mutualism**. Scientists have found that most plants strictly enforce the sharing exchange, cutting off their supply of sugars if their fungal partners don't share enough nutrients and water!

Q. Are there any other examples of **mutualism** in the story?

A. Yes. Glomus shares sugars from Broma with the Tilis (*Bacillus subtilis* bacteria), in exchange for phosphorus they are able to extract (mine) from the phosphate rock. The relationship between the Azoes and Monas (bacteria) living around Broma's roots could also be described as mutualism. Both types of bacteria benefit from the sugars Broma releases into the soil around her roots, and in return they provide valuable assistance in the form of nutrients (Azoes) and protection (Monas). However, because these relationships are not essential for the survival of the plant or bacteria – in the same way that Broma and Glomus need each other – some scientists describe these symbiotic partnerships as commensalism.

Another type of symbiosis is known as **commensalism**. This means that one species benefits but the other is neither hurt nor particularly helped. For example, one creature may use another one for transportation or for housing.

Q. Can you think of any examples?

A. Examples include hermit crabs using old shells to protect their bodies, birds living in tree hollows, spiders building webs on plants.

A third type of symbiosis is known as **parasitism**. This means that one species (called a parasite) benefits, while the second species, called the host, is harmed or sometimes even killed.

Q. Is there an example of parasitism in the story?

A. No examples of parasitism are described in the story. However, some types of soil bacteria and fungi can infect plant roots, potentially causing disease and death. This is likely why plants share so much of their energy with protective bacteria such as the Monas through their roots! The Monas help to crowd out any harmful bacteria from getting too close.

Q. Can you think of any other examples of parasitism? (Hint: You may have had parasites living on your head at some stage in your life, and your dog or cat may also have some!)

A. Head lice are parasites that live on humans. They won't kill you, but they do suck your blood. Your dog or cat may have fleas or ticks. Viruses (e.g. measles, influenza and the common cold) are also examples of parasites.

4. Looking at emotive language

Key curriculum area – English

The book uses emotive language to convey how the characters might be feeling and behaving, as if they were able to have feelings and behave in a similar way to humans. Here are some examples:

- "We touch. It's like destiny. It's like melting. Our skins soften, and we swap parts of ourselves."
- "Whenever nasty microbes approach, the multitudes of Monas block their way, preventing attacks."
- "We work with the friendly bacteria, making the soil sticky and good to eat."
- "The delighted Tilis give us phosphorus for Broma's babies and they tumble over themselves to feast on our sugar."
- "But they need more water. Weeks pass. We're starting to feel desperate."
- "We, Glomus, hold her. With the whole forest web, we hold her in a vast, tangled embrace."
- "We feel tree roots take the rain, gratefully quenching their thirst."

Q. What are the emotive words used in these sentences that convey feelings or behaviours that you might think of as human?

A. Answers will vary in the discussion. For instance, in the first example, the tree has "skin", which is a term used for the human body. "Good to eat" implies that microbes have tastebuds and enjoy their food. "Desperate" implies a great deal of worry and makes the reader feel sorry for the fungi.

Q. Why do the authors use this type of emotive language in a narrative, non-fiction science book?

A. Answers will vary in the discussion but will likely include the theme of making the characters seem more human to the reader, which makes the reader care about the characters and be more interested in the story. Hopefully, it also makes the reader care more about these plants and creatures in real life. This leads to people taking more care of the natural environment, once they understand how important each living thing is, and how important the interactions between them are to enable a healthy, sustainable environment for us all.

5. Extension questions to research

Key curriculum areas – Science: Biological sciences, Sustainability

How stuff is made: Chocolate

In the story, we meet Broma, a *Theobroma cacao* tree growing on the edge of a forest in the Amazon. *Theobroma cacao* trees are grown across many equatorial regions around the globe, with their beans used to make chocolate.

Research how chocolate is made. Think about:

- How and where is cacao grown?
- How is cacao turned into chocolate?
- Where is it made and who makes it?
- How does a block of chocolate end up in your local shop?

Write a story, draw a flow chart or illustrate a diagram representing the stages of how chocolate is made and how it eventually ends up in your mouth!

Plants vs trees

The story initially describes Broma as a plant, and then as a tree. Research the difference between plants and trees, considering their potential differences in size, lifespan, nutrition and diversity.

Finally, consider the statement, "All trees are plants, but not all plants are trees". Is this statement true? Why/why not?

Fertile soil

Fertile soil contains lots of nutrients to help plants grow and thrive. Most nutrients in fertile soil come from the decay of dead plants and animals.

- Why does soil quickly become less fertile if it is used to grow crops that are repeatedly harvested or cleared of vegetation?
- What are some of the problems that might occur when farmers use large amounts of fertiliser to make up for the lack of fertile soil? (Hint: Think beyond the farm into the wider environment. Where does the fertiliser eventually end up?)
- What are some natural* ways to increase the fertility of soil? (*avoiding synthetic fertiliser)

Quiz questions

1. The four main characters in the story are drawn below.
   Can you number them from smallest to biggest in size? (1 = smallest, 4 = biggest)

Tilis bacteria

____

Water molecule

____

Broma

____

Fungal spore

____

Part 1

2. At the start of the story, how does the spore know what direction to go to find the plant?

____

____

3. What part of the tree does the fungal spore connect to?

____

____

4. How does Broma help the fungus (Glomus)?

____

____

5. How does the Glomus fungus help Broma?

____

____

Part 2

1. What do the Tilis bacteria share with Glomus to help Broma's babies?

2. What does Glomus give the Tilis in exchange for phosphorus?

3. What is the main threat in the story that threatens to kill the trees?

Bacterial characters

1. Can you remember how many different types of bacteria are mentioned in the story?

2. Can you remember the name of one type of bacteria and what they were doing?

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Quiz answers

1. The four main characters – from smallest to biggest – are:
   – Water molecule (280 pm long)
   – Tilis bacteria (3 μm long)
   – Fungal spore (100 μm diameter)
   – Broma (5 m tall)

For more information on relative sizes, see pages 46 and 47 of the book.

Part 1

2. The plant releases message molecules (chemicals called strigolactones).
3. Mycorrhizal fungi connect to plant roots.
4. Broma shares some of her sugar (energy) with Glomus.
5. Glomus finds and shares nutrients (nitrogen and phosphorus) and water with Broma.

Part 2

1. Phosphorus (in the form of phosphate PO_4).
2. Glomus shares some of Broma's sugar in exchange for phosphorus from the Tilis.
3. The trees are suffering from a lack of water (drought) – after the summer rains don't come.

Bacterial characters

1. Four (4) = Tilis, Azoes, Monas and Actins.
2. The names of the bacteria in the story and what they did are:
   – Tilis release phosphorus from the soil.
   – Azoes take nitrogen from the air, which they turn into ammonium.
   – Monas protect Broma's roots from attack.
   – Actins make the soil sticky and good to eat.

Activities

Writing activity 1: The words within the story

Consider the use of words, names and perspectives used in the story, either individually, in groups or as a whole class.

Names and vocabulary

- The words earth/Earth are spelled differently in the story on pages 21 and 32.
  - Why do you think this is the case? (Hint p. 33 black/white circles)
- Where does the name *Broma* come from?
  - *Theo**broma** cacao*
- What do you think the title 'The Forest in the Tree' means?
  - It's a play on the phrase 'The Tree in the Forest' and refers to the 'forest' of tiny fungal 'trees' that grow inside individual trees.
  - Networks of mycorrhizal fungi are often referred to as the 'wood wide web'. Why do you think this is?
- Explore the meaning of the word *mycorrhizae*.
  - Pronounced 'Mike-O-Rye-Zee'.
  - The term mycorrhiza comes from the Greek words *mykes* (fungus) and *rhiza* (root) and is used to describe the mutually beneficial symbiotic partnership between a fungus and a plant.
  - Discuss the use of morphemes (prefixes, roots and suffixes) in the book and in related science, e.g. photosynthesis, microbiology, symbiosis, antibiotic, biodiversity, pesticide, fungicide.
  - Late in the story, the trees "are facing death" (p. 28). Consider what this phrase means.
  - At one stage, the story switches from describing Broma as a plant to a tree. Why do you think the writers chose to do this?

Different perspectives

Consider the perspectives of the different characters in the story, such as:

- Who narrates the story?
- Why does the narrator switch from using 'I' to 'we' part-way through the story?
- Are any other points of view represented during the story?

Writing activity 2: Imagining yourself as a spore

Write a story from the perspective of a fungal spore, considering:

- How did you get there?
- Where do you land?
- You have three chances to send out fungal threads. What/who do you find?

Fungal spores are microscopic particles that allow fungi to be reproduced, similar to seeds in the plant world. A fungal spore can be understood as the beginning and end of a fungal life cycle. Like plant seeds, fungal spores can lay dormant (with their metabolism slowed down) for long periods until awoken. Fungal spores come in a wide variety of sizes, shapes, colours and methods of release. Some fungi have evolved above-ground structures (such as mushrooms) to help spread their spores more widely through the wind and rain, while some fungi (such as truffles) use strong smells to attract animals to feed on them, with their spores arriving in a new home in a fresh deposit of poo. Fungi spread either by forming reproductive spores that are carried on wind and rain or by growing and extending their hyphae. Hyphae are thread-like strands of cells and grow as new cells form at the tips. Over time each fungus grows out into the soil, creating a network of branching hyphae, called a mycelium (plural mycelia).

"I'm a tiny fungal spore and I'm carrying fats and sugars. These are my survival rations … but they'll only last a few days." (p. 2)

The *Glomus* fungi in our story spend their entire lives underground, producing big spores containing a supply of fats and sugars – rich energy sources to power their hyphal threads to travel through the soil. The story dramatises the question of whether the spore has enough energy to find a suitable plant partner.

"I grow a fine thread out into the soil, with my energy gathered at the tip." (p. 2)

Most fungi (such as the one in our story) grow as hyphae: long, thin, thread-like, tubular structures, chains of elongated cells containing many nuclei which can extend for many kilometres through the tiny pores within soil. The direction and rate of growth of each hypha is coordinated by tiny structures at their tip, called Spitzenkörper (German for *pointed body*).

"And then, there's something … a molecule … ? A message molecule!" (p. 5)

Mycorrhizal fungi can detect special chemical signals (message molecules called strigolactones) released by plant roots. These signals attract the mycorrhizal fungi towards the plant.

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"I send out greetings to the tree. 'Hello?' I call. 'Hello … can I come in?' 'Yes, yes!' the tree replies. 'I'll make some space.'" (p. 7)

In response to the signals from the plant, mycorrhizal fungi secrete their own chemical signals (called lipochitooligosaccharides or 'Myc factors'). If the plant recognises the signals as friendly, it will create a passage allowing the fungi to enter the root.

Writing activity 3: Different stories

Consider alternative endings or different scenarios to what happened in the story, such as:

- What might have happened if the growing spore travelled in a different direction?
- What would it be like for Glomus (the fungus) if Broma (the cacao tree) had been chopped down in the middle of the story?
- What if all of the babies had died during the drought?
- What if Glomus met a different type of fungus (e.g. a decomposing fungus)?
- What if, instead of a drought, there had been too much rainfall?
- What if the setting was different (such as a farm, backyard or park); how would the fungi and plants interact?

Write a story from the point of view of the main character(s) using one of the differences listed above. Or, re-tell the story from the perspective of either a baby tree or one of the populations of bacteria living in the soil around Broma's roots. Consider a challenge you are faced with … and how you resolve it (or not).

Art activities:

Collaborative portrait of a soil micropolis

The underground soil-scape contains everything from plant roots and mineral particles (e.g. sand) to earthworms, nematodes, springtails, mycorrhizal fungi and diverse populations of bacteria. These life forms are in a continual state of birth, death and decay, always surrounded by lots of different molecules, especially pockets of air (oxygen, carbon dioxide, nitrogen) and water.

Drawing is one of the best ways to truly observe and get to know a form or object. Drawing creatures in the context of a soil micro-environment can help bring insight into the ecology of these creatures and the soil environment.

Collect a library of images to represent a wide diversity of soil creatures, soil shapes, bacteria and fungi as a reference for drawing.

Work as a group to create a collaborative portrait – collectively visualising this invisible world through an embodied, parallel process of sharing space and resources. Art materials could include mud and soil, charcoal, pastel and graphite.

Imagining underground networks

Draw a picture with a group of trees, showing the root systems. This can be an individual or large format collaborative drawing.

Using a different colour (or colours), add branching lines to represent the mycorrhizal networks connecting all the trees.

Drawings of decay

Fallen leaves feed an army of waiting bacteria, fungi, earthworms and invertebrates who decompose (decay) and recycle each leaf into soil organic matter, which ultimately helps to feed plants through their roots – with the help of mycorrhizal fungi.

Draw a sequence of images of a leaf, showing the different stages of decomposition. One good source of inspiration is to go outside and look under a tree for examples of a single type of leaf in various states of decay.

Drawing your favourite moment

Draw a picture of your favourite moment from the story or write and illustrate a short comic showing the most exciting part of the story.

Science activity: Word hide and seek

Some of the scientific language in the story is *hidden* as labels in the illustrations.

Here are five challenge questions for readers with a keen eye to seek out!

1. Soil is made up of **three types of mineral particles**.

Can you find them in the story illustrations? (Hint: they are near the beginning).

Answer: **Sand, silt and clay.**

All three particles feature briefly in illustrations at the start of the story, with two of them (sand, p. 2, and clay, p. 5) mentioned in the story text.

2. There are **four different groups of bacteria** described in the story. What are the names for each group?

Answer: **Tilis** (p. 4), **Monas** (pp. 18 and 19), **Azoes** (pp. 18 and 19), **Actins** (pp. 20 and 21).

3. Which character produces the **message molecule** and which character produces the **greeting molecule**?

Answer: Broma the cacao plant/tree produces the **message** molecule (pp. 5 and 6). **Glomus** the fungus makes the **greeting** molecule (p. 7).

4. The story uses the term '**thread**' to describe the growing arms of Glomus the fungal spore as they extend through the soil. What's the more technical term for these threads? (Hint: there is a label in one of the more technical illustrations in part 1).

Answer: Hyphae (p. 10).

5. When farmers and scientists talk about the nutrients needed by plants to grow, they usually describe them in terms of their central elements (such as carbon or nitrogen). However, in reality, these elements (atoms) are usually combined with other atoms in the form of molecules. The story uses the elements '**phosphorus**' and '**nitrogen**' to describe two of the most important plant nutrients. What molecules are used to represent phosphorus and nitrogen in the story?

Answer: Phosphorus (P) atoms are commonly found surrounded by four oxygen atoms as **phosphate molecules (PO_4)** – see p. 23. Nitrogen atoms are often found with four hydrogen atoms attached – in the form of **ammonium molecules (NH_4)** – see pp. 18 and 19.

Teaching links

- **Junior Landcare**: https://juniorlandcare.org.au/
- **FAO – Forests as Classrooms** Teaching and Learning guides: http://www.fao.org/publications/highlights-detail/en/c/1186245/
- **Food Web Education**: https://www.foodwebeducation.com/
- **Smithsonian Institution – The Secrets of Soil**: https://forces.si.edu/soils/

YouTube Animations & Explanations of Mycorrhizal Fungi

- https://youtu.be/7kHZ0a_6TxY
- https://youtu.be/v88gbtKBTv4
- https://www.youtube.com/watch?v=0oyqPZJj-2w
- https://youtu.be/WWD_1Nq6iwQ
- https://www.youtube.com/watch?v=SsJSzABM-K0
- https://www.youtube.com/watch?v=dibKZHhij6k&t=88s
- https://www.youtube.com/watch?v=bxABOiay6oA&t=6s
- https://youtu.be/R3XmQgyvDHY

Teacher Notes

Australian Curriculum Links

Year level	Learning area: science	Other learning areas
Year 3/4	**Science Understanding: Biological sciences** • Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044) • Living things have life cycles (ACSSU072) **Science Understanding: Earth and space sciences** • Earth's surface changes over time as a result of natural processes and human activity (ACSSU075) **Science as a Human Endeavour** • Science knowledge helps people to understand the effect of their actions (ACSHE051, ACSHE062) **Science Inquiry Skills** • With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment (ACSIS054, ACSIS065) • Represent and communicate observations, ideas and findings using formal and informal representations (ACSIS060, ACSIS071)	**English** • Discuss texts in which characters, events and settings are portrayed in different ways, and speculate on the authors' reasons (ACELT1594) • Create literary texts that explore students' own experiences and imagining (ACELT1607) **The Arts: Visual Arts** • Use materials, techniques and processes to explore visual conventions when making artworks (ACAVAM111) • Present artworks and describe how they have used visual conventions to represent their ideas (ACAVAM112) **Cross Curriculum priority: Sustainability** OI.1 The biosphere is a dynamic system providing conditions that sustain life on Earth. OI.2 All life forms, including human life, are connected through ecosystems on which they depend for their wellbeing and survival. OI.3 Sustainable patterns of living rely on the interdependence of healthy social, economic and ecological systems. OI.4 World views that recognise the dependence of living things on healthy ecosystems, and value diversity and social justice, are essential for achieving sustainability. OI.7 Actions for a more sustainable future reflect values of care, respect and responsibility, and require us to explore and understand environments.
Year 5/6	**Science Understanding: Biological sciences** • Living things have structural features and adaptations that help them to survive in their environment (ACSSU043) • The growth and survival of living things are affected by physical conditions of their environment (ACSSU094) • Sudden geological changes and extreme weather events can affect Earth's surface (ACSSU096) **Science as a Human Endeavour** • Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083, ACSHE100) **Science Inquiry Skills** • Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS086, ACSIS103)	**English** • Understand, interpret and experiment with sound devices and imagery, including simile, metaphor and personification, in narratives, shape poetry, songs, anthems and odes (ACELT1611) • Create literary texts using realistic and fantasy settings and characters that draw on the worlds represented in texts students have experienced (ACELT1612) **The Arts: Visual Arts** • Develop and apply techniques and processes when making their artworks (ACAVAM115) **Cross Curriculum priority: Sustainability** OI.1 The biosphere is a dynamic system providing conditions that sustain life on Earth. OI.2 All life forms, including human life, are connected through ecosystems on which they depend for their wellbeing and survival. OI.3 Sustainable patterns of living rely on the interdependence of healthy social, economic and ecological systems. OI.4 World views that recognise the dependence of living things on healthy ecosystems, and value diversity and social justice, are essential for achieving sustainability. OI.7 Actions for a more sustainable future reflect values of care, respect and responsibility, and require us to explore and understand environments.

Related books from CSIRO Publishing

Nema and the Xenos (2019)
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