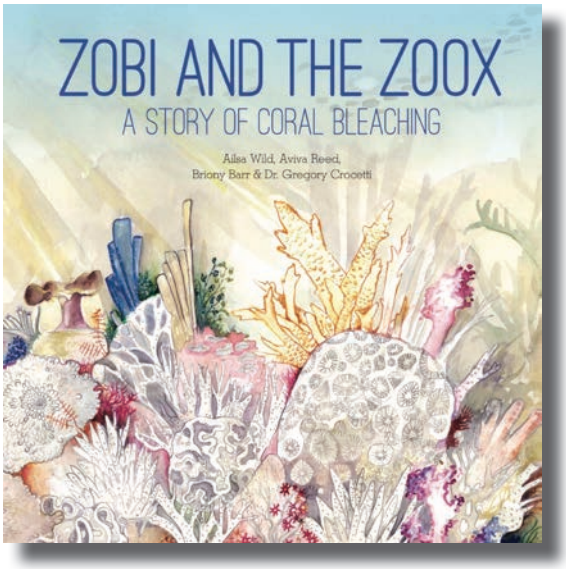
TEACHER NOTES



ZOBI AND THE ZOOX

A STORY OF CORAL BLEACHING

Ailsa Wild, Aviva Reed, Briony Barr and Gregory Crocetti

About the book

This is a story about coral bleaching, told by the tiniest creatures on the reef.

With her home under threat from a warming ocean, Zobi, a brave rhizobia bacterium, teams up with a family of slow but steady zoox (zooxanthellae). As the coral bleaches, everyone begins to starve...

Can Zobi and the zoox work together to save the day?

This beautifully illustrated science-adventure story, set on the Great Barrier Reef, was originally published in 2015, but has been extensively re-written and revised to delight and captivate primary school-aged readers.

*Zobi and the Zoox: A Story of Coral Bleaching i*s the first in the new Small Friends Books series – Stories of Partnership and Cooperation in Nature.

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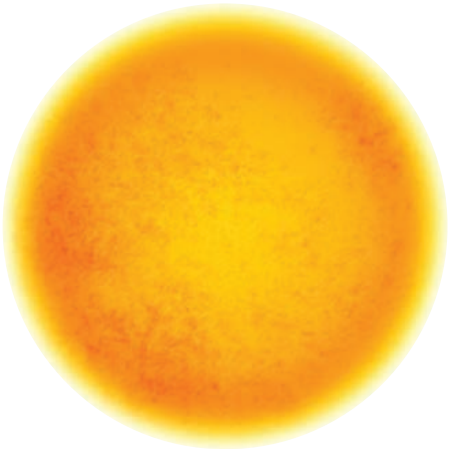
TABLE OF CONTENTS



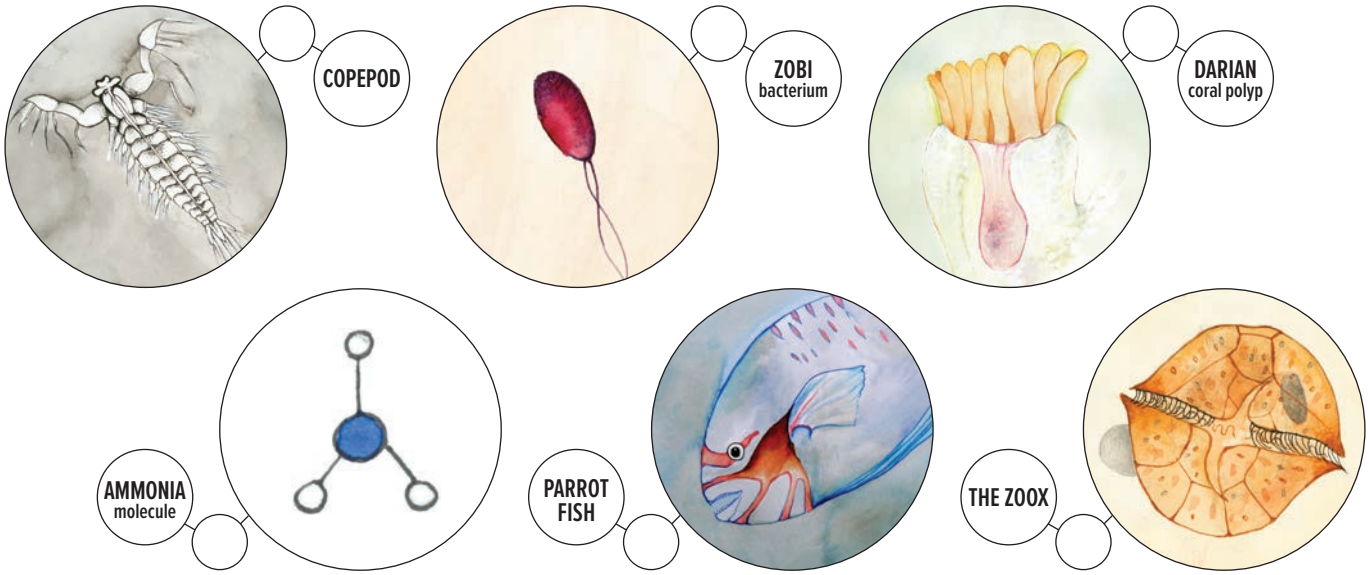
KEY LEARNING OUTCOMES

- Compare the relative sizes and behaviours of creatures living in a coral reef ecosystem.
- Understand and reflect on the concept of symbiosis (living together).
- Comprehend important natural chemical processes such as photosynthesis.
- Interpret story themes using creative writing and drawing tasks.

THE QUIZ: QUESTIONS

RELATIVE SIZES

1. Here are six characters in the story.
Can you number them from smallest to biggest in size? (1 = smallest, 6 = biggest)



SYMBIOSIS

2. In the story, how did Zobi help Dini?

_____

_____

3. In the story, how do the zoox (including Dini) normally help Darian (the coral polyp in which they live)?

_____

_____

4. The relationship between Zobi, Dini, and the other Zoox and the coral polyp is called 'symbiosis' – that is, where two or more different life forms work together to help each other.
Can you think of other examples of symbiosis in nature?

_____

_____

5. Are there any relationships in your life, which you could maybe describe as symbiotic?

_____

_____

6. All coral polyps have a massive number of friendly microorganisms like bacteria and zooxanthellae living on and inside them.
How many? (circle one)

a) Millions (1,000,000+)
b) Billions (1,000,000,000+)
c) Trillions (1,000,000,000,000+)

THE QUIZ: QUESTIONS

REFLECTION

7. Describe the climax of the story in your own words.

8. Was there a moment you felt nervous in the story? Why?

CHEMICAL REACTIONS (advanced)

9. Rhizobia bacteria (such as Zobi) are able to make ammonia.
What are the two (2) main ingredients they use to do this?

10. Dini and the other Zoox are able to make sugar and oxygen, like plants.
What are the three (3) ingredients they use to do this?

What scientific word is used to describe this process?

11. In the story, the big Zoox are making too many toxic molecules 'nasties'.
How do these toxic molecules harm the coral?

THE QUIZ: ANSWERS

RELATIVE SIZES

1. The six characters, from smallest to biggest are (see Meet the Characters on p2/3):

A: 1. Ammonia (molecule)
2. Zobi (bacterium)
3. The Zoox
4. Copepod
5. Darian (coral polyp)
6. Parrotfish

SYMBIOSIS

(see p30 for a simplified diagram of the main symbiotic relationships in the story)

2. In the story, how did Zobi help Dini?

A: Towards the end of the story (p25) Zobi starts making ammonia for Dini, and then spreads the message to other Rhizobia bacteria to make ammonia for Dini and the other zoox.

3. In the story, how do the zoox (including Dini) normally help Darian (the coral polyp which they live in?

A: Dini – like all zoox – makes and shares sugar (p17 "those big zoox used to feed Darian lots of sugar, and he needs it to build our home.")

4. Can you think of any other symbiotic relationships in nature – that is, where two different life forms work together to help each other? How do they help each other?

A:
- *Clownfish and sea anemones. Clownfish (think 'Finding Nemo') clean sea anemones, and in return are protected from predators.*
- *Flowering plants (e.g. tomatoes) & bees. Flowers provide nectar for bees, who in return spread the flower's pollen to help them reproduce.*
- *Cleaner shrimp and large fish. Cleaner shrimp eat the parasites from large fish as a food source. This service also helps keep the large fish clean and healthy.*
- *Humans and gut microbes. Humans feed the microbes living in their large instestine (gut), who in return provide extra nutrients and vitamins to their human host.*

5. Are there any relationships in your life, which you could maybe describe as symbiotic?

A:
- *Humans and dogs (human provides food, dog provides safety)*
- *Humans and cats (humans provides food, cat usually catches mice)*
- *Does anyone have grandparents living at their home? How do you help each other?*

6. All coral polyps have an massive number of different friendly microorganisms like bacteria and zooxanthellae living on and inside them. How many?

A: c) Trillions (1,000,000,000,000+)
(See p5 of the story to read the answer)

REFLECTION

7. Describe the climax of the story in your own words.

A: Answer is relative to the learner.

8. Was there a moment you felt nervous in the story? Why?

A: Answer is relative to the learner.

CHEMICAL REACTIONS (advanced)

9. Rhizobia bacteria (such as Zobi) are able to make ammonia. What are the two main ingredients they use to do this?

A: Nitrogen (N_2) and hydrogen (H_2)

10. Dini and the other Zoox are able to make sugar and oxygen, like plants. What are the three (3) ingredients they use to do this?

A: Sunlight, carbon dioxide (CO_2) and water (H_2O)
What is the scientific word used to describe this process?

A: Photosynthesis

11. In the story, the big Zoox are making too many toxic molecules.
How do these molecules harm the coral?

A: These molecules can damage and destroy DNA and proteins (p15 "A tiny toxic molecule zooms past Zobi and smashes up a protein. Wham! Another breaks a strand of DNA.").

DRAWING ACTIVITY

In the space below, or on a separate page, draw a scene from the story...

QUESTIONS TO DISCUSS

Q: The word 'Symbiosis' is often used to describe two or more different life forms, which live closely together. However, not all symbioses are to the benefit of everyone. Do you know the name of a symbiotic partner that takes advantage of the other partner, but causes harm? (In other words – something living inside or on the skin of another thing, often causing sickness).

A: A parasite

Q: Can you think of any examples of parasites?

A: Viruses, nits, lice, ticks, leeches, hookworms. (Be warned – new scientific research is showing hidden benefits from many 'parasites')!

Q: Trillions of Bacteria live inside the guts of humans (that is, our large intestines). Is this a symbiosis?

A: Yes, bacteria help humans break down (decompose) many parts of our food, creating new vitamins, hormones, antibiotics and more. They also help support our immune system and affect our brain and mood. (Sure, some rogue bacteria can occasionally make us ill, but that's a small price to pay for our overall health).

Q: Can you figure out where the names of the main characters 'Dini' & 'Zobi' came from?

*A: Zobi is simply taken from within the common name – Rhizobia – for all bacteria from the Order Rhi**zobi**ales (see p39). However you need to look closely on p37 to find the name Dini within the genus Symbio**dini**um.*

Q: In the book, the bacteria (Zobi and Cy) talk to each other. Do you think they can actually talk to one another? If so, how?

A: No, not with words. However, Bacteria can communicate with each other using molecules.

Q: Other than talking, what other ways can humans communicate with each other?

A: Using other senses:
- *seeing (sign language/body language);*
- *feeling (braille);*
- *smelling (pheromones, odours)*

Q: If coral polyps could speak in words, what advice do you think they could give to humans about living and working together in a symbiotic community?

A: Answer is relative to the learner.

Q: Corals, like all animals make mucus. And lots of it! How does the mucus help coral?

A: In the book, it's described as a "snotty, protective blanket". Mucus contains lots of molecules (chemicals) which encourage helpful/friendly bacteria (e.g. recycling and swapping molecules, and making weapons to defend Darian from deadly microbes). It can also help trap invading unwanted microbes (such as bacteria and viruses). The same applies to humans.

Q: Can you think of a time when your body has made lots of mucus?

A: When you catch a cold, your body recruits more and more white blood cells to the nose to fight the virus, and the colour of your mucus (snot) changes from clear to yellow to green. This is because these cells carry green iron-containing enzymes. The greener the colour, the stronger the immune response.

Q: Advanced Research Question: Can you find out how mucus helps the human body during a cold or flu infection?

Q: Other than the nose, what other parts of the (human) body make mucus?

A: Lungs, eyes, mouth, stomach, intestines, penis, vagina and anus.

ADDITIONAL ACTIVITIES

SIMPLE WRITING ACTIVITIES

- Tell a story from the perspective of a Copepod, trying to avoid being harpooned by coral polyps in the seawater around the reef.
- Write a short story describing what happens to Cy the Cyanobacteria after the end of this story.

ADVANCED ACTIVITIES

Draw a symbiosis

- Find an example of another kind of symbiosis,
- Identify each partner and the benefits to each,
- Then draw a sequence of pictures which symbolises the symbiotic relationship.

For example:

Symbiotic Partner 1: *Flower (containing pollen & nectar)*
Symbiotic Partner 2: *Bee*
Benefits: *Pollination and Nectar*
(more pollination means more flowers which means more nectar which feeds more bees which means more pollination...)

Write about a story inspired by scientific facts

- Choose an environment (e.g. ocean, forest, mountain, lake, desert, city, wetland, tree etc.)
- Research and collect some scientific facts about this environment.
- Write a fictional story set there, in which your main characters are not human.
- Try to weave at least three scientific facts into the story, so that they are an important part of the plot.

DISCUSSION ACTIVITY – FOR OLDER CHILDREN

In *Zobi and the Zoox* we chose to create a mostly positive ending to this story about coral bleaching (although many other surrounding corals did not recover). Does an environmental story with a positive ending engage an audience better than one with a tragic ending? Imagine and write a new ending to *Zobi and the Zoox*, which ends in tragedy. Discuss how the different endings might engage and affect readers.

RESEARCH PROJECT

Research and make a drawing of a food web around the coral reef, starting with primary producers (such as algae and cyanobacteria) at the bottom, all the way up to sharks and whales at the top – including the characters from this story.

IMAGINING ACTIVITY

Close your eyes and relax.

Imagine you're sitting at the back of a boat, where steps descend into the lapping ocean. Your wetsuit is tight across your shoulders and your feet feel huge and awkward in the flippers. You pull the mask across your eyes, bite the mouthpiece and now your breath sounds loud through the snorkel.

You push into the water and feel the cold wash over you, trickling into your wetsuit. You float in the sudden silence, gazing down. The world is blue and shadowy with mounds and caverns and wavering shapes in the distance. A school of tiny, bright yellow fish swim past you, flickering in the sunbeams. You swim towards the nearest mound. It's covered with different kinds of coral, some sticking out like twigs and fingers and branches, others round and brain-shaped. Some coral is soft and wavering, bright reds and yellows, with what looks like tiny, gentle hairs, trembling in the current.

Everywhere dart different sizes and colours of fish. One bright fish with a beak just like a parrot is fluttering beside a twig of coral. You hear a scrape, scrape, scrape noise and realise the fish is biting coral with its beak.

Away in the distance a huge turtle floats past, a dark blue shadow against the deep.

You turn back to the busy world of the coral community and focus on one sharp branch. You realise your eyes are growing stronger and stronger. They are amazing, like powerful microscopes and you can see much more detail now. Everywhere you turn, it looks like a city of tiny, busy creatures, moving and pulsing and interacting with each other.

What is happening?

What do you see?

What feeling does it give you?'

(pause for reflection with eyes closed)

Open your eyes, then write or illustrate what you think happens next...

AUSTRALIAN CURRICULUM LINKS

YEAR LEVEL	LEARNING AREA: SCIENCE	Other Learning Areas
Year 1/2	**Science Understanding: Biological Sciences** • Living things have a variety of external features. ACSSU017 • Living things live in different places where their needs are met. ACSSU211 **Science as a Human Endeavour** • People use science in their daily lives, including when caring for their environment and living things. ACSHE022 and ACSHE035 **Science Inquiry Skills** • Use a range of methods to sort information, including drawings and provided tables and through discussion, compare observations with predictions. ACSIS027 • Compare observations with those of others. ACSIS213 • Represent and communicate observations and ideas in a variety of ways. ACSIS029	**English** • Create short imaginative and informative texts that show emerging use of appropriate text structure, sentence-level grammar, word choice, spelling, punctuation and appropriate multimodal elements, for example illustrations and diagrams. ACELY1661 • Create short imaginative, informative and persuasive texts using growing knowledge of text structures and language features for familiar and some less familiar audiences, selecting print and multimodal elements appropriate to the audience and purpose. ACELY1671 **The Arts: Visual Arts** • Use and experiment with different materials, techniques, technologies and processes to make artworks. ACAVAM107 • Create and display artworks to communicate ideas to an audience. ACAVAM108
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 depend on each other and the environment to survive. ACSSU073 **Science as a Human Endeavour** • Science involves making predictions and describing patterns and relationships. ACSHE050 and ACSHE061 • Science knowledge helps people to understand the effect of their actions. ACSHE051 and 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. ACSIS065 • Represent and communicate observations, ideas and findings using formal and informal representations. ACSIS060	**English** • Draw connections between personal experiences and the worlds of texts, and share responses with others. ACELT1596 • Learn extended and technical vocabulary and ways of expressing opinion including modal verbs and adverbs. ACELA1484 • Discuss literary experiences with others, sharing responses and expressing a point of view. ACELT1603 • Incorporate new vocabulary from a range of sources into students' own texts including vocabulary encountered in research. ACELA1498 **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
Year 5/6	**Science Understanding: Biological Sciences** • The growth and survival of living things are affected by the physical conditions of their environment. ACSSU094 **Science as a Human Endeavour** • Scientific knowledge is used to solve problems and inform personal and community decisions. ACSHE100 **Science Inquiry Skills** • With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment. ACSIS090	**English** • Use comprehension strategies to analyse information, integrating and linking ideas from a variety of print and digital sources. ACELY1703 • Create literary texts that adapt or combine aspects of texts students have experienced in innovative ways. ACELT1618 **The Arts: Visual Arts** • Develop and apply techniques and processes when making their artworks. ACAVAM115