TEACHER GUIDE

YEAR 5 BIOLOGICAL SCIENCES

INTRODUCING ADAPTATIONS

Government of Western Australia
Department of Education

THE UNIVERSITY OF WESTERN AUSTRALIA

spice
science teachers enrichment program

ACKNOWLEDGEMENTS

Thanks to Perth Zoo, Herdsman Lake Wildlife Centre, Department of Environment and Conservation (Barna Mia sanctuary), EarthCare St Kilda and Rakali.com.

Scientific advisers: Dr Renae Hovey (Centre for Marine Futures, The University of Western Australia), Dr Victoria Cartledge, Dr Kellie McMaster and Dr Stewart Ford (School of Animal Biology, The University of Western Australia)

Designed and developed by the Centre for Learning Technology, The University of Western Australia.
Production team: Alwyn Evans, Dan Hutton, Paul Ricketts and Jodie Ween, with thanks to Jenny Gull and Michael Wheatley.

SPICE RESOURCES AND COPYRIGHT

ast1497 | Introducing adaptations (teacher guide)

Version 1.0

Web: spice.wa.edu.au

Email: spice@uwa.edu.au

Phone: (08) 6488 3917

Centre for Learning Technology (M016)
The University of Western Australia
35 Stirling Highway
Crawley WA 6009

Cover image: Animal emblem of Western Australia – the numbat.

CONTENTS

INTRODUCING ADAPTATIONS

Digital resources for *Introducing adaptations* are available on CD-ROM or USB. They include electronic copies of this teacher guide, the student workbook and audiovisual resources (presentations and videos). Files are grouped by chapter in the folder, *digital-resources*.

Part 1: Learning through story	*Bara Boodie, the burrowing bettong* *Finding the facts*
Part 2: Investigating penguins	*Emperor penguin* *Keeping warm underwater* *Staying warm on ice* *Investigation planner* *Cool penguins*
Part 3: Animal adaptations	*Animal adaptations* *Find my food* *My animal adaptations*
Part 4: Adaptations for an environment	*Featured creatures* *Adaptations in action* *Adaptations match-up*
Part 5: What adaptation is this?	*My adaptations* *Types of adaptations*
Part 6: Show what you know	*Bara Boodie, the burrowing bettong* *Show what you know*

HOW TO USE THIS RESOURCE PACKAGE

TEACHER GUIDE

This manual includes an introduction, which contains a program summary, links to additional resources and activities, and details on how this package fits within the *Australian Curriculum*.

INTRODUCTION

The teacher guide is divided into six parts, each describing a set of related activities. You don't have to complete all parts – each one stands alone.

You may wish to rearrange activities or include activities from other programs.

Suggested times for activities are included, but in general a part will take one or two lessons.

Appendices to this guide include answers to student worksheets and references.

PART 1: LEARNING THROUGH STORY

PART 2: INVESTIGATING PENGUINS

PART 3: ANIMAL ADAPTATIONS

PART 4: ADAPTATIONS FOR AN ENVIRONMENT

PART 5: WHAT ADAPTATION IS THIS?

PART 6: SHOW WHAT YOU KNOW

APPENDICES

Each part includes the following:

- **PURPOSE AND OUTCOMES** – what each lesson will help students achieve
- **ACTIVITY SUMMARY** – outline of materials needed and location of resources
- **SCIENCE BACKGROUND** – important background information on each topic
- **ACTIVITY GUIDE** – detailed instructions on how to run activities and links to student workbook materials

PURPOSE AND OUTCOMES

ACTIVITY SUMMARY

SCIENCE BACKGROUND

ACTIVITY GUIDE

STUDENT WORKBOOK

Student resource materials are available in a separate student workbook that includes fact sheets, worksheets, procedures and investigation planners.

All student workbook activities are available in digital format.

INTRODUCTION

BACKGROUND

Introducing adaptations is a resource package that addresses the Year 5 *Australian Curriculum* science content for Biological sciences. It is designed to complement and supplement a *Primary Connections* resource, *Desert survivors*.

This package emphasises Australian environments and links the conditions of these environments to plant and animal adaptations. It reveals how animals and plants fit their environment through associated physical features and behaviours, and how these enhance their ability to survive.

The activities in the package build up student knowledge, progressing from connecting an animal with its environment, to making decisions about how animal features and behaviours function to improve survival outcomes within an environment.

Literacy is accentuated in the package through storytelling, and inclusion of activities that encourage students to express their understanding of subject content creatively.

The package contains engaging activities, such as story, animation and a card game designed to encourage student participation and inquiry.

LEARNING PATHWAY

The program is structured around a constructivist model, based on the 5-Es, where teachers may:

- **Engage** students' interest in adaptations through storytelling. This is followed by an activity in which students identify scientific facts and fictitious facts within a story.
- **Explore** through classroom activities two adaptations of emperor penguins that enable them to survive the harsh conditions of Antarctica. These activities can be conducted as teacher demonstrations or student investigations.
- **Explore** the types of food animals eat and the adaptations animals have to find and eat their food. This activity links adaptations with function.
- **Explain** how adaptations enable animals and plants to survive in their environment. This activity links adaptation with function and environment.
- **Elaborate** on adaptations by introducing two types of adaptations: structural and behavioural.
- **Evaluate** student understanding of key concepts learned throughout *Introducing adaptations* by review of student created stories and creative presentation of stories.

Additional opportunities to **Evaluate** students' progress are available throughout the package.

ADDITIONAL ACTIVITIES

Interested teachers may wish to pursue this topic further by attending any of the following organisations and participating in available adaptations learning programs.

- **Kanyana Wildlife (https://www.kanyanawildlife.org.au)**

  Kanyana Wildlife Rehabilitation Centre is a not-for-profit organisation dedicated to the rehabilitation of sick and injured wildlife. Located in Lesmurdie, Perth hills, the centre is available for onsite school visits. Schools visiting Kanyana may take part in curriculum-linked education programs including *Adaptation Adventures* aimed at Year 4-5 students.

  Kanyana provides an opportunity for students to meet some of the animals featured in this resource package, including burrowing bettongs, echidnas and bilbies.

  If you can't make it to Kanyana, educators are able to visit schools.

- **Perth Zoo (http://perthzoo.wa.gov.au/learn/schools-programs/)**

  Perth Zoo offers an extensive Discovery and Learning program for primary and secondary students. Teacher professional learning opportunities are also available.

  Onsite visits to the zoo provide curriculum-linked programs. For Year 5 students *Animal Allsorts* and *African Safari* introduces students to animal adaptations.

- **Australian Wildlife Conservancy (http://www.australianwildlife.org/sanctuaries/karakamia-sanctuary/)**

  Australian Wildlife Conservancy (AWC) is a privately operated organisation dedicated to the conservation of Australian ecosystems and their plant and animal inhabitants. The organisation's approach to conservation is to purchase land and establish sanctuaries.

  Karakamia Wildlife Sanctuary, located in the Perth hills, is an AWC-owned and operated sanctuary. It is home to Australian native species such as woylies, quendas and tammar wallabies. Karakamia recently successfully reintroduced rakali (native Australian water rat) to the sanctuary.

  Karakamia is open to the general pubic for wildlife tours led by experienced educators.

PROGRAM SUMMARY

RESOURCE NAME	PURPOSE	DESCRIPTION
Part 1: Learning through story	ENGAGE	Students read a folktale about an Australian native animal, the burrowing bettong, and identify features that help them to survive.
Part 2: Investigating penguins	EXPLORE	Students investigate emperor penguin adaptations that keep them warm in Antarctica.
Part 3: Animal adaptations	EXPLORE	A card game encourages students to match animals with their food, and adaptations that help them find and eat this food.
Part 4: Adaptations for an environment	EXPLAIN	A video and accompanying activity allows students to link an animal or plant's adaptations with their survival within a particular environment.
Part 5: What adaptations is this?	ELABORATE	An animation and accompanying activity asks students to identify different types of animal adaptations: structural and behavioural.
Part 6: Show what you know	EVALUATE	Students create a folktale describing how an animal of their choosing came to develop adaptations that enables them to survive in their environment.

TECHNICAL REQUIREMENTS

The teacher guide and student workbook require Adobe Reader (version 5 or later), which is a free download from www.adobe.com.

Presentations are in HTML 5 format and will run in any modern browser such as Firefox, Chrome or Safari (PDF versions are also included). Video also uses HTML 5 format and supports MP4 and WebM video formats.

The card set is available in digital format; printed sets are also available for purchase from the Centre for Learning Technology.

Links to the *Australian curriculum*

version 8.1 © Australian Curriculum, Assessment and Reporting Authority

SCIENCE UNDERSTANDING (YEAR 5)	PARTS
Living things have structural features and adaptations that help them to survive in their environment (ACSSU043) • explaining how particular adaptations help survival such as nocturnal behaviour, silvery coloured leaves of dune plants • describing and listing adaptations of living things suited for particular Australian environments • exploring general adaptations for particular environments such as adaptations that aid water conservation in deserts	1 – 6
SCIENCE AS A HUMAN ENDEAVOUR (YEAR 5)	
Nature and development of science Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE081)	2
SCIENCE INQUIRY SKILLS (YEAR 5)	
Questioning and predicting With guidance, pose clarifying questions and make predictions about scientific investigations (ACSIS231)	2
Planning and conducting 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) Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS087)	2
Processing and analysing data and information Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS090) Compare data with predictions and use as evidence in developing explanations (ACSIS218) Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)	1, 2, 5, 6
MATHEMATICS (Year 5)	
Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies (ACMSP119) Describe and interpret different data sets in context (ACMSP120)	2
ENGLISH (Year 5)	
Understand how texts vary in purpose, structure and topic as well as the degree of formality (ACELA1504) Plan, rehearse and deliver presentations for defined audiences and purposes incorporating accurate and sequenced content and multimodal elements (ACELY1700) Plan, draft and publish imaginative, informative and persuasive print and multimodal texts, choosing text structures, language features, images and sound appropriate to purpose and audience (ACELY1704) Navigate and read texts for specific purposes applying appropriate text processing strategies, for example predicting and confirming, monitoring meaning, skimming and scanning (ACELY1702)	1, 6

PART 1

LEARNING THROUGH STORY

PURPOSE

Students **Engage** with a folktale that identifies features and behaviours, of an animal, that help it to survive.

OUTCOMES

Students:

- appreciate real life facts can be conveyed in fiction, such as folk tales;
- read a folk tale about a native Australian animal, the boodie/burrowing bettong;
- demonstrate interpretative and organisational skills by identifying and summarising facts about the animal presented in the story; and
- research the animal on the Internet to check answers and discover additional information.

ACTIVITY SUMMARY

ACTIVITY	DESCRIPTION	MATERIALS
1.1 *Storytelling*	Teacher leads discussion about storytelling as a means of communication and learning.	
1.2 *Bara Boodie, the burrowing bettong*	This folk story introduces the idea that changing environments can result in changing features and behaviours of an animal.	Story is on pages 7 – 15 of this manual and included in *digital-resources*.
1.3 *Finding the facts*	This worksheet helps students identify correct facts about burrowing bettongs in the fictitious story, *Bara Boodie, the burrowing bettong*. It also helps them to distinguish between correct facts and fictitious facts that writers invent when telling stories.	student sheet 1: Finding the facts computer access
1.4 *What's true and what's not?*	Discuss facts highlighted, also functions of features identified, and compile class list on a chart or as the first page of a class scrapbook.	chart paper or class scrapbook

SCIENCE BACKGROUND

Story a powerful learning tool

From time immemorial learning through story is the way most cultures pass on their languages, knowledge and histories. Whether in oral, written and/or pictorial form, story is one of humankind's most powerful methods of communication.

In their simplest form, we tell stories every day when we share events that happened to us or when we describe plans for the weekend … Story is a form of communication understood by all people - and it can be about anything! Science maths, history, astronomy, art … you name it.

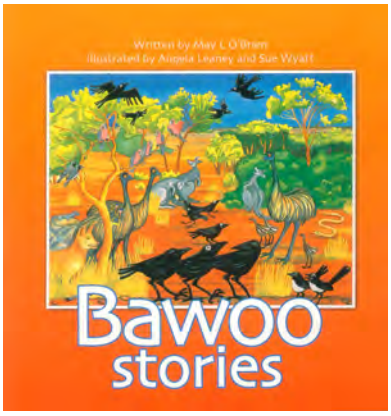
Stories about animals and their characteristics (features) abound in literature, folklore, and cultural mythology.

From Rudyard Kipling's *Just so stories* to Australian Aboriginal people's cultural stories (from their Dreamtime), and others told throughout the world, stories are handed down from generation to generation. Each culture has its own stories about why animals and environments developed characteristics we see today.

Many fictional tales about how animals came to have particular features include accurate observations about structural features of animals, and their functions.

In *How the leopard got its spots*, Kipling relates a fictitious tale of how these spots appeared. However, there's a correct fact amongst the fiction: leopards' spots help camouflage these animals.

Similarly, the evolutionary pathway of the large flightless ratite bird: the emu, is embedded in May O'Brien's retelling of her language group's (Wongutha people from the West Australian goldfields desert region) story, *Why the emu can't fly*. At one point in evolutionary history emus were flying birds but lost this feature when they no longer needed to fly. They later developed the ability to run extremely fast and to turn quickly. These features enabled them to outrun more recent predators such as dingos.



© Fremantle Arts Centre Press

The Kunwinjku language group, from Western Arnhem Land in the Northern Territory, tells a cultural story that features protective characteristics of turtles (armoured shell) and echidnas (spiked defence). It relates what happened in a battle between the two species which results in protections each wears today. It also refers to functional aspects of each feature: turtles' armoured shells provide protection against predators, as does the spiked covering of echidnas.

Stories such as these provide an excellent way to introduce young children to features of animals, their functions, and relationships of these features to the environment in which they live. There are many more stories from all over the world. *Bara Boodie, the burrowing bettong* is an original story illustrating this genre.

When writing stories, authors create imaginary 'facts'. Students need to distinguish between the two kinds of facts in stories: correct real life facts, and imaginary facts.

For instance, in *Bara Boodie, the burrowing bettong*, we're told Bara lives with her family: 'in a large cosy nest under a quandong tree'. That's an imaginary fact as there's no proof of this. A real life fact in the story is: 'Bara was only about 28 centimetres long … her father … was 40 centimetres long'. Burrowing bettongs actually measure between 28 and 40 centimetres in length.

Burrowing bettongs

Burrowing bettongs belong to the Family Potoroidae which includes rat-kangaroos, potoroos and bettongs. It's the only species known to live in burrows year round, and is considered the only burrowing kangaroo. Burrowing bettongs look like small kangaroos, and display the characteristic macropod hopping gait. They weigh up to 1.5 kg, and are omnivorous, predominantly eating plants but also foraging for insects.


Burrowing bettong feeding at night.
© The University of Western Australia

At European settlement burrowing bettongs were believed to be the most widespread of all Australian mammals, inhabiting the central, southern and western regions of the continent.

The mainland species is now extinct, and burrowing bettongs only inhabit islands off the West Australian north-western coast. Isolated island populations of burrowing bettongs are estimated in the thousands with additional populations living in various managed sanctuaries.

Agricultural practices, habitat fragmentation and introduction of feral predators, such as foxes and domestic cats, have all influenced the decline of burrowing bettong numbers. The burrowing bettong is listed as vulnerable by both Federal and West Australian governments.

Burrowing bettongs habitats are diverse, including: scrub, coastal dunes and woodlands. Their Noongar (South West WA) name is 'boodie'.

Burrowing bettong adaptations

Adaptations are characteristics, of a plant or animal, that serve a function and contribute to survival of a species in a particular environment. Adaptations are often categorised as:

- structural: physical or observable characteristics (e g strong forelegs for digging);
- physiological: cellular or system processes (e g efficient kidneys that help conserve water); and
- behavioural: actions (e g nocturnal activity and social behaviour).

Burrowing bettongs have many features or adaptations that help them survive in semi-arid and arid environments. They're social animals that live in small family groups, and are known for their burrowing behaviour. Bettongs excavate burrows with their strong forelimbs and sharp claws. Burrow systems range from simple tunnels to complex warrens with multiple chambers and tunnels. They use their fat, weakly prehensile (grasping) tails to carry nest materials into burrows. Their tails also store fat when resources are plentiful.

Burrowing bettongs are strictly nocturnal, only active after sunset, and always returning to burrows before sunrise.

They're able to survive with limited or no access to freshwater, relying on water in their food or morning dew. Their highly efficient kidneys conserve water, and living in burrows reduces evaporative water loss.

ACTIVITY 1.1

STORYTELLING DISCUSSION

WHOLE CLASS ACTIVITY

suggested time: 10 - 15 minutes

Discuss storytelling as a means of communication and learning (see details in Science background).

Discussion points may include:

- Stories may be written or oral. What are some different kinds of stories you've read or heard?
- You may not realise it, but every day we all tell the simplest kind of story to share information with others. What's a story you've told today? What information did you share in it?
- Was it true, factual information, or was it a made up story, fiction, or was there a bit of both?
- Think of a story that you enjoyed reading, write down its title and author. Now exchange what you've written with your neighbour and see if you can work out from the title whether each other's story is fact or fiction (it may be both) and discuss your answers.
- There are some stories that are fiction but also contain accurate real life facts. Can anyone think of a story like that? What's its name? What facts does it contain?
- Who's read any of Rudyard Kipling's *Just so* stories? One is called *How the elephant got its trunk*. Although it's a fictitious story it does contain real life facts, for instance the uses of an elephant's trunk. (Discuss other stories students have read.)
- Many cultures tell this kind of story, and Australian Aboriginal people have their own stories, such as May O'Brien's retelling of her language group's (Wongutha people from the West Australian goldfields desert region) story, *Why the emu can't fly*. (Discuss other such stories students may have read.)
- We're going to read an original story like this, about an Australian animal: *Bara Boodie, the burrowing bettong*.

ACTIVITY 1.2

BARA BOODIE, THE BURROWING BETTONG

WHOLE CLASS, GROUP OR INDIVIDUAL ACTIVITY

suggested time: 10 - 15 minutes

Read *Bara Boodie, the burrowing bettong* to the class, or ask students to read it themselves, either in groups or individually.

Discuss points such as:

- Who may tell this kind of story?
- What is the purpose of the story?
- Are there any real life facts in it? What are some of these? (Ask students to name a few, as examples. They'll complete their own lists in the worksheet activity.)
- Which aspects are fictional? Can you find any 'imaginary facts' that the author has created for the story?
- Do you think it works as a story about how boodies came to have particular features? Why? Why not?

ACTIVITY 1.3

FINDING THE FACTS

INDIVIDUAL ACTIVITY

suggested time: 20 minutes


STUDENT SHEET 1
FINDING THE FACTS

student sheet 1

Ask students to highlight real life factual information in the story. They may also highlight imaginary facts using a different colour.

Then ask them to organise the real life factual information as a table, mind map or list; or under the categories listed in the workbook (student sheet 1).

When students finish ask them to research burrowing bettongs on the Internet to check their facts are correct. They may need to go to more than one site to find them all.

We recommend the following sites for extra research:

Australian wildlife conservancy - **http://www.australianwildlife.org**

Kanyana Wildlife - **http://www.kanyanawildlife.org.au/animal/burrowing-bettong/**

Welcome to Shark Bay - **http://www.sharkbay.org.au/nature-of-shark-bay/fact-sheets/boodie.aspx**

Department of Parks and Wildlife – **https://www.dpaw.wa.gov.au/plants-and-animals/animals**

Students may also write any additional facts they find in their lists.

ACTIVITY 1.4

WHAT'S TRUE AND WHAT'S NOT?

CLASS DISCUSSION

suggested time: depends on activity chosen

Discuss findings with the class. Some students may have found more or less facts. In the case of incorrect answers, discuss how to tell whether or not they're real life facts.

Discuss burrowing bettongs' features (identified as real life facts), functions of the features identified, and how they help these animals live in their environment.

Compile a class list of all correct facts about bettongs. You may like students to make their own poster, a class chart, including a photo, or a class scrapbook. Later, when students research their own animals, they may construct similar charts for each animal, or create a separate page for the class scrapbook.

Real life facts in the story, *Bara Boodie, the burrowing bettong* (add others from students' Internet research) include:

- Before European settlement burrowing bettongs lived all over Australia in all sorts of places: from shady woodlands with grasses and shrubs, to wide sandy deserts.
- They are nocturnal animals, coming out after sunset and returning to burrows before sunrise.
- Physical description: small (28 - 40 cm) kangaroo-like; short muzzle; small rounded ears; fat lightly-haired, prehensile tails with white tip; thick grey fur - some burrowing bettongs have a golden tinge.
- They have an acute sense of smell.
- Their strong back legs enable them to bound like kangaroos.
- Burrowing bettongs are the only burrowing kangaroo.
- Their burrows may be single tunnels and/or warrens.
- Burrowing bettongs make squeaks, squeals, hisses, grunts and a noise like farting.
- Their predators include wedge-tailed eagles.
- They are omnivores and eat: seeds, plants, fruit, nuts, roots, tubers, termites, and may also scavenge from carcasses.
- Quandong trees grow in deserts.
- Desert flora includes: quandongs, spinifex and grasses.
- Burrowing bettongs are social animals.

Some imaginary facts, created by the writer for the story, include:

- Burrowing bettongs don't assemble at meetings to discuss solutions to problems.
- It's likely wedge-tailed eagles evolved along with burrowing bettongs and would not have suddenly appeared in the environment.
- Bara's family lived in a large cosy nest under a quandong tree. There's no proof bettongs did this.
- There are bird species that build burrows for shelter and nesting, including owls and parrots.

ACTIVITY 1.4: WHAT'S TRUE AND WHAT'S NOT?

Potential questions to discuss:

Where bettongs used to live and where they live now?

The fictional story *Bara boodie, the burrowing bettong* depicts Bara and her family living in the Western Desert. Burrowing bettongs inhabited this area prior to colonial settlement, but have since disappeared from mainland Australia. Today, burrowing bettongs persist only on small islands off Western Australia's coast, or within managed wildlife sanctuaries.

Changes to the burrowing bettong's environment resulted in their mainland extinction. The main pressures that affected this change were land clearing, agriculture, and introduction of feral predators, namely domestic cats and red foxes.

Did burrowing bettongs decide to respond to environmental changes?

In the story burrowing bettongs respond to a new predatory threat by convening as a group and making a decision to change their behaviour to increase their chance of survival. This is a fictional element in the story.

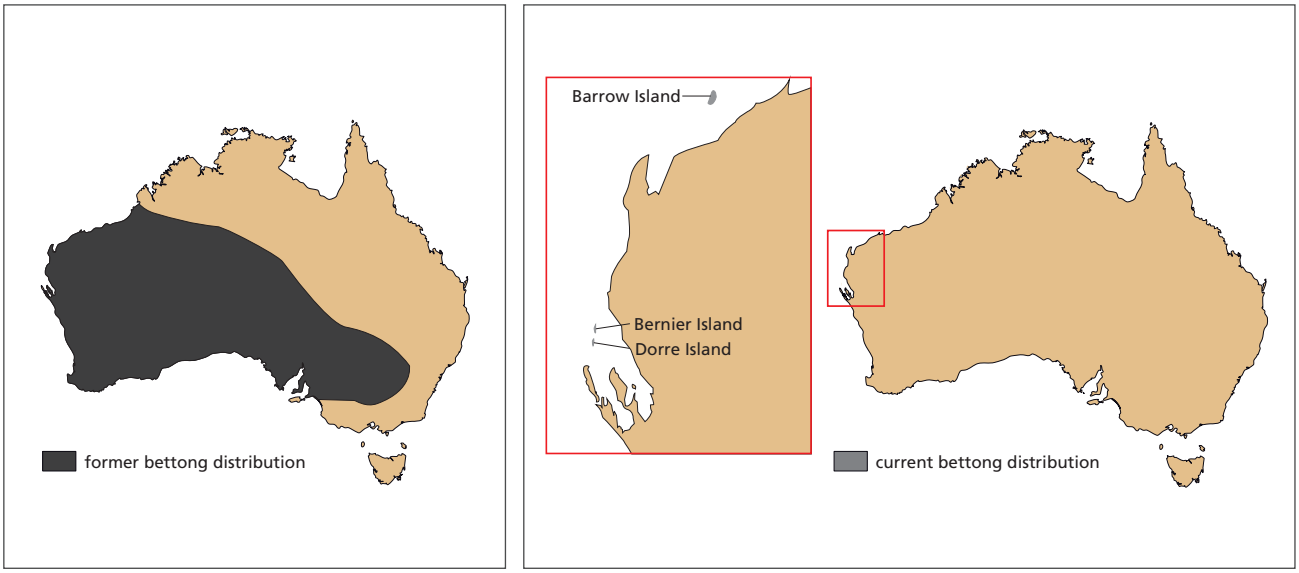
In reality animals and plants don't make decisions about what features they need to survive or deliberately acquire adaptations; rather their environment shapes these features through natural selection.

Why couldn't burrowing bettongs change to cope with colonisation and new predators?

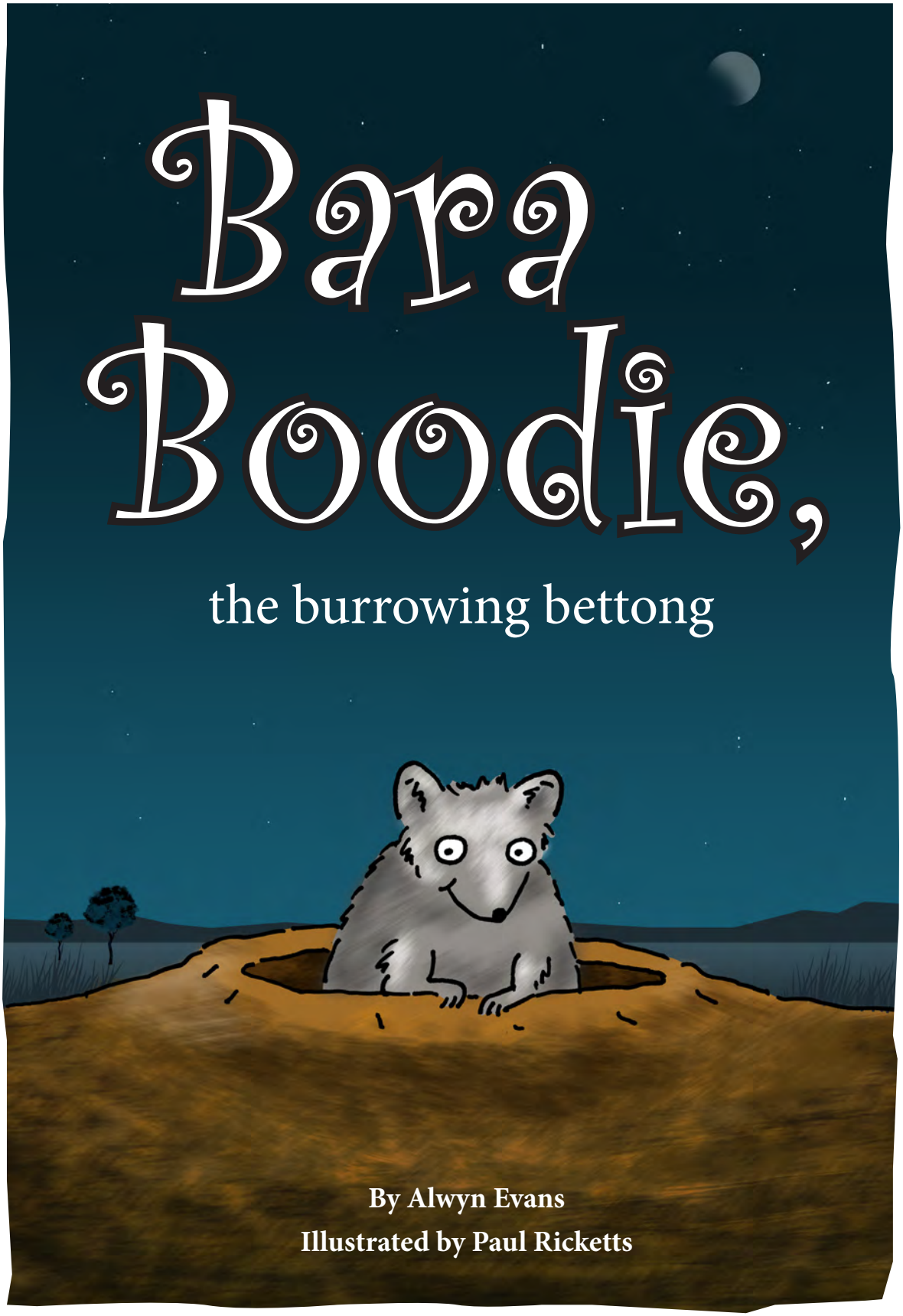
Sudden changes in an environment often result in species extinction. These changes can include new diseases or new predators and competitors. If a species cannot find refuge elsewhere it may no longer be able to reproduce and survive. Human-induced change impacts biodiversity rapidly through habitat destruction, introduction of feral animals, and pollution.

How does the environment select animals' or plants' adaptations?

Over long periods of time, millions of years, environments change, and these changes shape features of plants and animals. For instance, if an area becomes hotter and drier those plants or animals better adapted to life with less water will survive. Those that aren't will be less likely to reproduce and survive.



former and current burrowing bettong distribution


Bara Boodie,
the burrowing bettong
By Alwyn Evans
Illustrated by Paul Ricketts

A long, long time ago, boodies lived contentedly all over Australia, in all sorts of places: from shady woodlands with grasses and shrubs, to wide sandy deserts.

Actually my friend, they lived in almost any place they fancied.

Bara Boodie and her family's home was the Australian Western Desert, in Martu people's country. They lived in a large cosy nest under a quandong tree, with many friends and neighbours nearby.

Actually my friend, boodies loved to make friends with everyone.

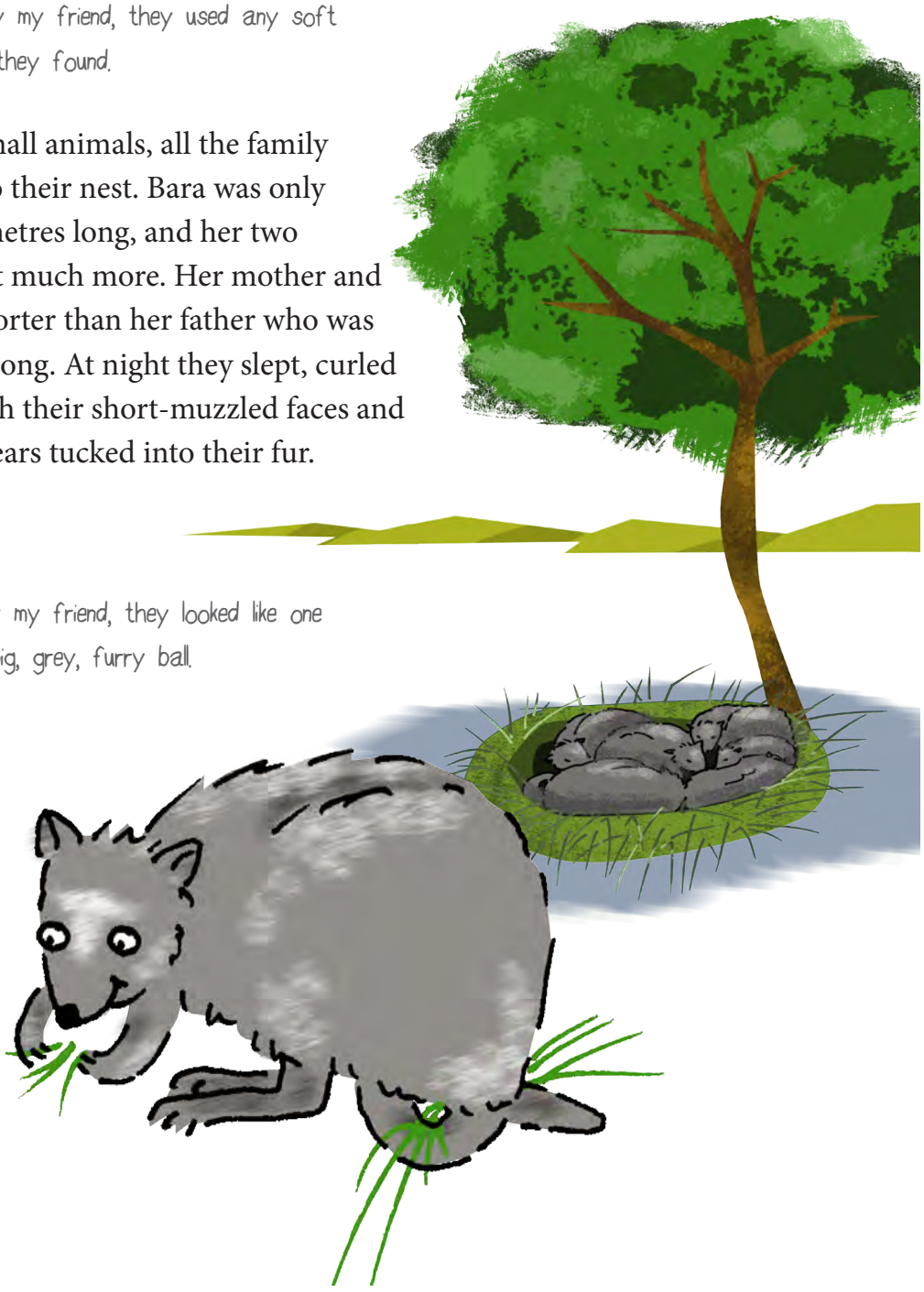
Bara Boodie, the burrowing bettong

To make their nests snug, Bara's dad, mum and aunties collected bundles of spinifex and grasses. Scampering on all fours, they carried their bundles with their fat, prehensile tails, back to their nests.

Actually my friend, they used any soft things they found.

As they were small animals, all the family fitted cosily into their nest. Bara was only about 28 centimetres long, and her two brothers weren't much more. Her mother and aunties were shorter than her father who was 40 centimetres long. At night they slept, curled up together, with their short-muzzled faces and small rounded ears tucked into their fur.

Actually my friend, they looked like one great big, grey, furry ball.



Bara Boodie, the burrowing bettong

Bara means dawn or sunrise in Martu language. Her mother gave Bara that name because she was born as the sun peeped over the horizon, and because her thick fur had a golden tinge. Dawn is also when boodies find the freshest and tastiest foods. Bara's favourites were seeds, plants, fruit and nuts - especially quandongs that dropped from their tree. Her mum also liked to eat roots, tubers and termites as well. Privately, Bara thought termites tasted erk!

Actually my friend, her greedy brothers didn't care what they ate, but gobbled up whatever they found.

Bara Boodie, the burrowing bettong

One morning, Bara was by herself foraging for food and contentedly nibbling one of her favourite foods: bush tomatoes, when the world seemed to darken. She peered skywards where she just made out a dark cloud dimming the sunlight. It wasn't like a rain cloud, and there were no other clouds in the huge blue sky.

Puzzled, she watched the cloud drawing closer. The nearer it came the more her bewilderment turned to fear. Bara scampered home making her frightened cry that sounded as though she was farting! The whole family crouched there, quivering and peering out of their nest trying to see what was happening.

Actually my friend, all other animals were in their nests, too.

Bara Boodie, the burrowing bettong

Hovering overhead, the black cloud materialised into huge birds, soaring on enormous wings. Wedge-tailed eagles, for that's what they were, descended and perched in trees surveying the surroundings. A flock covered Bara's quandong tree as her family cowered in their nest.
Then, one by one, spreading gigantic wings, the eagles took to the sky again.

Actually my friend, they circled slowly, menacingly overhead.

Suddenly Bara saw one drop like a stone, plunging onto her friend Kindilan's home. Her mother had called her Kindilan as it means happy and she wanted her daughter to be happy always. But, Bara knew she'd be anything but happy now.

Actually my friend, both Bara and Kindilan were terrified almost out of their skins.

There was a rumbustious commotion in Kindilan's nest with boodies' squeaks, hisses and grunts ringing out. Then, that demon-eagle rose clutching a squirming bundle in its claws. Everywhere boodies cowered in their nests, watching in horror as ruthless predators carted away other bundles.

Actually my friend, Bara trembled and cried pitifully so certain was she her friend had been captured!

Bara Boodie, the burrowing bettong

That night, when boodies were usually sound asleep, a crowd of them gathered under the quandong tree. Bara squeaked with delight as she caught sight of Kindilan. She hadn't been snatched away after all!

'We must do something! Twenty of our young were stolen today,' Bara's father cried.

Another voice piped up, 'But what can we do?'

'Those demons came in the day so we need to hide then,' called a voice.

There was silence.

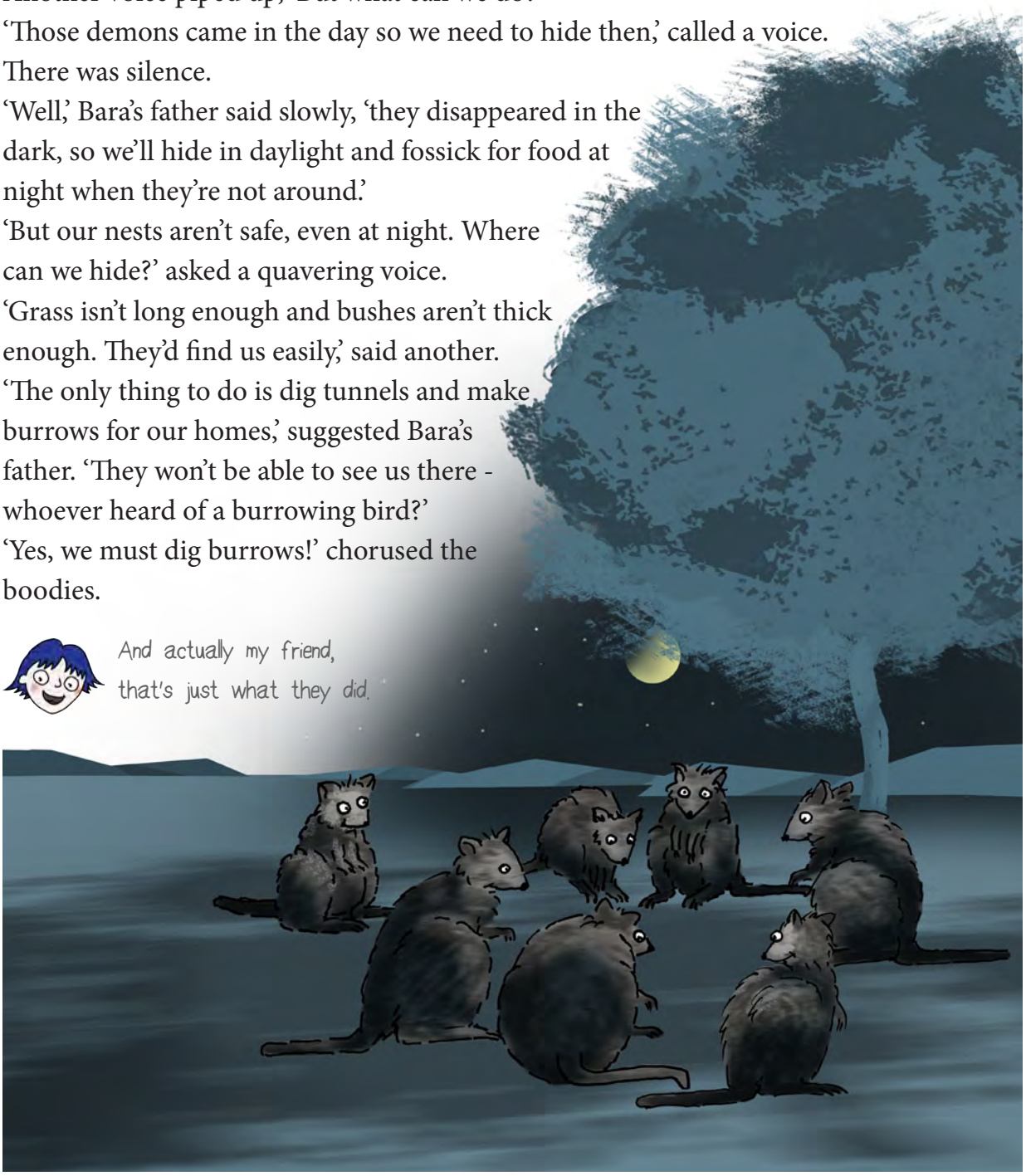
'Well,' Bara's father said slowly, 'they disappeared in the dark, so we'll hide in daylight and fossick for food at night when they're not around.'

'But our nests aren't safe, even at night. Where can we hide?' asked a quavering voice.

'Grass isn't long enough and bushes aren't thick enough. They'd find us easily,' said another.

'The only thing to do is dig tunnels and make burrows for our homes,' suggested Bara's father. 'They won't be able to see us there - whoever heard of a burrowing bird?'

'Yes, we must dig burrows!' chorused the boodies.



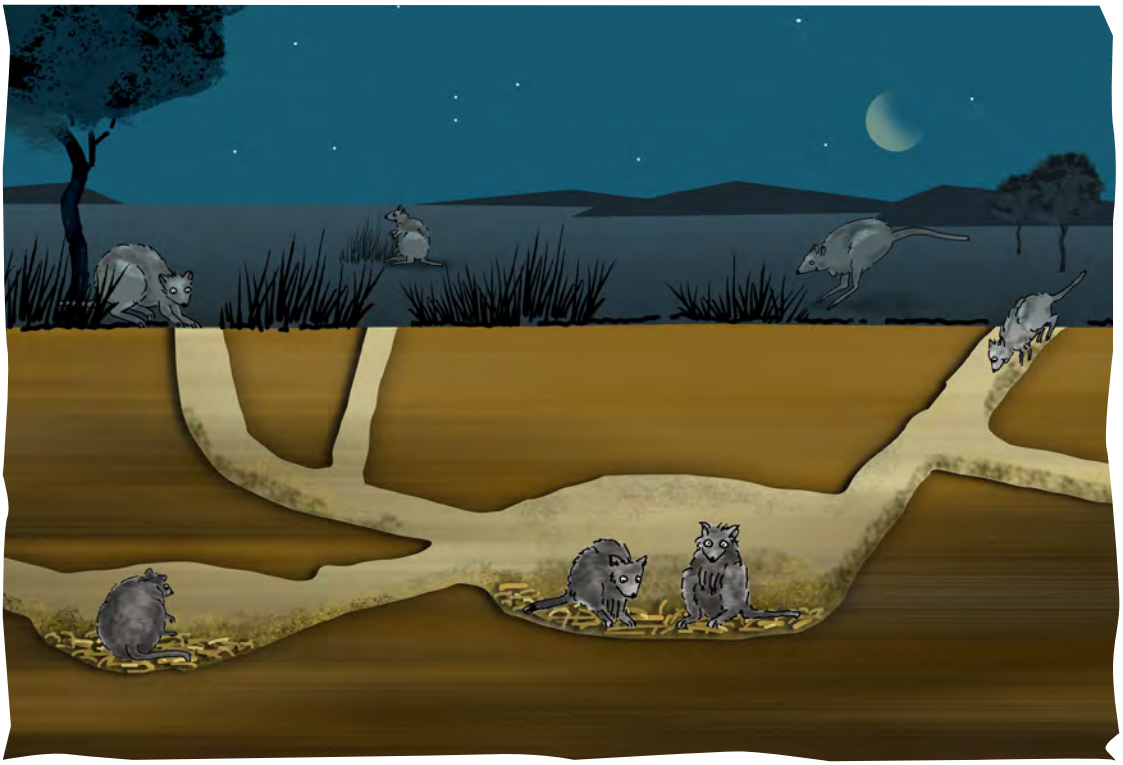
Bara Boodie, the burrowing bettong

At first, each family dug their own burrow and lined it with spinifex and grasses. Then gradually, as boodies are very social animals, they made tunnels to visit each other. Bara and Kindilan used them often. Connecting tunnels also meant they could come and go using different openings if danger was about.

Actually my friend, it often was.

As boodies love to eat, they quickly learned to fossick for food in the dark of the night. In daytime when they slept, their burrows not only protected them but also were cooler than their above-ground nests had been.

Actually my friend, they found this new arrangement to their liking.



However, boodies always remember the attack of the wedge-tailed eagles. They remain alert, and only come out of their burrows after sunset making sure to be back by sunrise.

Bara Boodie, the burrowing bettong

Over time, their sense of smell sharpened to help them find food in the dark. Their back legs grew stronger so they could bound out of harm's way, like kangaroos, instead of scampering on all fours. Their smaller front legs strengthened too, as they used them for digging.

Actually my friend, that's why boodies also became known as burrowing bettongs, the only burrowing kangaroo.

Bara Boodie, the burrowing bettong

PART 2

INVESTIGATING PENGUINS

PURPOSE

Students observe and conduct activities to **Explore** how adaptations enable emperor penguins to survive the harsh conditions of the Antarctic.

OUTCOMES

Students:

- simulate structural and behavioural adaptations of emperor penguins;
- understand these adaptations enable emperor penguins to survive in their environment; and
- recognise there are different categories of adaptation: structural and behavioural.

ACTIVITY SUMMARY

ACTIVITY	DESCRIPTION	MATERIALS
2.1 *Emperor penguins*	Students identify special characteristics of emperor penguins and their environment.	student sheet 2: Emperor penguin
2.2 *Keeping warm underwater* *Part 1*	This practical activity demonstrates how insulating fat helps warm-blooded penguins stay warm when diving underwater for food.	student sheet 3: Keeping warm underwater • 4 plastic or zip-lock bags • masking tape • vegetable shortening (softened) • basin/bucket of cold water • ice cubes • two thermometers • stopwatch
2.3 *Keeping warm underwater* *Part 2*	This practical activity allows students to experience the effects of insulation on their own hands when submerged in cold water.	student sheet 3: Keeping warm underwater • 2 plastic or zip-lock bags (extra bags may be required) • masking tape • vegetable shortening (softened) • basin/bucket cold water • ice cubes • disposable gloves, 1 pair per student • stopwatch • thermometer

ACTIVITY	DESCRIPTION	MATERIALS
2.4 *Staying warm on ice*	This practical activity demonstrates how the huddling behaviour of emperor penguins helps them stay warm during harsh winter conditions.	student sheet 5: Staying warm on ice • 8 test tubes or small glass jars • rubber bands • 2 thermometers • 2 stands or similar • 2 clamps or similar • stopwatch • source of hot water
2.5 *Emperor penguin investigation planner*	Students plan and document their own investigation into how emperor penguins stay warm underwater and on ice.	student sheet 6: Investigation planner
2.6 *Cool penguins*	A worksheet guides students through interpretation of practical activity results.	student sheet 7: Cool penguins

SCIENCE BACKGROUND

Emperor penguins (*Aptenodytes forsteri*) are the largest of seventeen species of penguin. They're well-known for breeding during the harsh Antarctic winter. Distributed around the Antarctic continent they dive for food in the Southern Ocean. Emperor penguins breed on sea ice, and breeding colonies are found around the continent.

Spending a life in one of the coldest environments on Earth requires specialised adaptations. The activities outlined in this resource are designed to allow students to explore some of these adaptations and consider how structural features and behaviours enhance emperor penguin survival.

Insulation

Emperor penguins are birds, and like all birds they're endothermic. Endotherms generate their own body heat through metabolic processes; both birds and mammals are endotherms. Birds have a higher body temperature than mammals, around 39°C. Maintaining internal body temperature is important for endothermic animals in order for optimum function of metabolic processes.

Emperor penguins have a number of adaptations to minimise heat loss to the environment, including: subcutaneous fat, specialised feathers, and processes that enable recycling of body heat.

Emperor penguins are well insulated, with four layers of feathers and a thick layer of subcutaneous fat.
photo by Glenn Grant © National Science Foundation

Water temperatures in the Southern Ocean can be as low as –1.9°C so insulation during foraging dives is important for emperor penguins. A two centimetre layer of subcutaneous fat helps them retain body heat underwater. While this layer of fat aids in thermoregulation in water, it's not as effective as the thick blubber layers of whales, so penguins need to remain active to prevent declining body temperature.

Fat stores have other important functions for emperor penguins. They provide buoyancy in water and an energy store during fasting. Male emperor penguins rely on this fat store to survive the breeding season.

Emperor penguins have four layers of feathers. Outermost feathers are waterproofed with oil produced by the uropygial gland. These feathers lie flat and are unruffled by strong Antarctic winds. Emperor penguin feathers provide excellent insulation both on land and in water.

Other adaptations of emperor penguins to cope with cold conditions include: counter-current heat exchange systems in blood vessels of feet and bill; reduced surface area of feet and bill; and small surface area to body ratio.

Huddling

Breeding during the Antarctic winter exposes emperor penguins to extreme weather conditions such as air temperatures of –40°C and wind speeds of 200 km.h^{-1}. Males fast for up to four months as they incubate a single egg.

Emperor penguins have evolved social behaviour that reduces impacts of harsh winter conditions. Huddling occurs throughout the breeding season and involves males grouping together in a tight bunch, with animals on the outside shuffling toward the centre. Measurement in the field has shown that huddling increases ambient air temperature significantly, up to 24°C.

Male emperor penguins cluster together in tight huddles to reduce heat loss.
photo by Frederique Olivier © Australian Antarctic Division

Huddling is a behavioural adaptation that allows emperor penguins to save energy and maintain their long breeding fast (four months) through the Antarctic winter.

ACTIVITY 2.1

EMPEROR PENGUINS

INDIVIDUAL ACTIVITY AND CLASS DISCUSSION

suggested time: 10 minutes

Distribute student sheet 2, *Emperor penguins*, for students to read. Ask students to suggest some key features of emperor penguins. Examples are: they live in a very cold environment, they're flightless birds, and they're warm-blooded, generating their body heat internally. Staying warm is important for all warm-blooded birds/animals, including ourselves.

The following activities focus on two adaptations of emperor penguins that enable them to minimise heat loss to the environment and maintain internal body temperature.


STUDENT SHEET 2

EMPEROR PENGUIN

(APTENODYTES FORSTERI)

There are 17 species of penguins, and all are found in the Southern Hemisphere.

Emperor penguins live around the Antarctic continent, and are one of the top predators in the Antarctic food chain. They hunt in the Southern Ocean, diving after prey such as squid, fish, and krill.

SURVIVING ANTARCTIC EXTREMES

In the Antarctic, emperor penguins live in some of the harshest conditions on the planet. Coping with extreme cold and living mainly in water means emperor penguins have many special features to help them survive. These features are known as adaptations.

Staying warm underwater

Emperor penguins dive underwater for food, where temperatures can be as low as –1.9°C. Staying warm is essential, so they have a thick layer of fat under their skins. This keeps cold out and their body heat in.

Emperor penguins also have four layers of feathers, the densest feathers of any bird on Earth. An incredible 15 feathers per square centimetre! The outer layer of feathers is waterproofed with special oil which stops icy cold water coming into contact with their skin.

While they might look awkward on land, the body shape of emperor penguins is superbly adapted for life at sea.

Emperor penguins can swim at speeds of 14.4 kilometres per hour, while the best human swimmers might reach speeds of five kilometres per hour.

The emperor penguin is the largest of all 17 penguin species.

On average 122 cm tall, and weighing between 22 - 45 kg.

student sheet 2

ACTIVITY 2.2

KEEPING WARM UNDERWATER

PART 1

TEACHER DEMONSTRATION OR STUDENT INVESTIGATION

suggested time: 15 minutes

student sheet 3

In this activity, teachers demonstrate the effect of insulation on body temperature. Alternatively students plan and conduct their own investigation using the student procedure and/or investigation planner (student sheets 3 and/or 6).

This activity explains a key structural feature or adaptation of emperor penguins: a thick subcutaneous fat layer, and its function in helping emperor penguins retain body heat in frigid Antarctic waters.

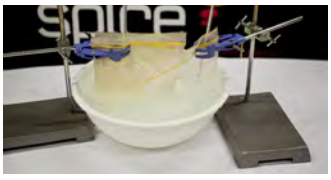
In this activity, vegetable shortening represents subcutaneous fat in emperor penguins. Two sets of plastic bags are lowered into a basin of cold water (10°C); one set contains vegetable shortening, the other is empty. Temperatures are recorded over a four-minute period. Recorded temperature will be lower in the bag without shortening, than the bag with shortening, demonstrating the insulating effect of subcutaneous fat.

After teachers demonstrate the activity individual students may participate in part 2 of the activity.

Procedure

1. Ask students to predict which will stay warmest in icy water: a plastic bag insulated with vegetable shortening or an empty plastic bag? They write answers in their workbook or investigation planner.
2. Fill one plastic bag with one cup softened vegetable shortening.
3. Insert a second plastic bag inside bag containing shortening. Shortening should be sandwiched evenly between the two bags. Place a thermometer inside the inner bag.

4. Take another two bags and place one inside the other with no shortening. Place a thermometer inside the inner bag.
5. Fill basin with cold water. Place thermometer in water.
6. Add ice until temperature is around 10°C.
7. Record water temperature.
8. Secure each pair of bags with masking tape or using zip-lock feature. It is important water does not enter bags.
9. Suspend both in water basin.



10. Record temperatures inside the bags at two minutes, and at four minutes.

Sample data

Room temperature: 20°C, water temperature: 10°C

Table 1: temperatures in insulated plastic bag and empty plastic bag over a four minute time period.

TIME (MINUTES)	GLOVE 1 (INSULATION) TEMPERATURE (°C)	GLOVE 2 (NO INSULATION) TEMPERATURE (°C)
2	21	14
4	20.5	14

ACTIVITY 2.3

KEEPING WARM UNDERWATER

PART 2

INDIVIDUAL ACTIVITY

suggested time: 20 minutes

student sheet 4

Part 2 of the activity allows individual students to experience the benefits of insulation on their own body temperature. Alternatively students plan and conduct their own investigation using the student procedure and/or investigation planner (student sheet 4 and/or 6).

Students immerse an unprotected hand in cold water and compare the sensation with a hand protected by insulation (vegetable shortening).

Students should not extend the time, beyond reasonable limits, of holding their gloved hand underwater. We recommend less than a minute. Extended exposure to very cold water can result in pain and reddening of the skin. Skin temperatures below 10°C result in dilation of blood vessels to warm the area.

You may wish to set up multiple basins of cold water to ensure all students have the opportunity to observe the effects of insulation.

To minimise amount of vegetable shortening required prepare one or more sets of insulated gloves for students to test.

Procedure

1. Ask students to predict which hand will stay warmest in icy water: the one insulated with vegetable shortening or the one inside a glove with no shortening? They write answers in their workbook or investigation planner.
2. Put on pair of disposable gloves.
3. Fill basin with cold water. Place thermometer in water.
4. Add ice until temperature is around 10°C.
5. Record water temperature.
6. Add 1 cup of vegetable shortening (softened) to first plastic bag. Second plastic bag contains no vegetable shortening.
7. Place a gloved hand inside plastic bag with shortening, and seal bag.
8. Place other gloved hand into second plastic bag. Secure bags so no water leaks into them. (Make sure shortening is evenly distributed around hand in plastic bag.)
9. Start timer
10. Submerge both hands into water.
11. Observe, for each hand, how long it takes for cold to become intense. Remove hand immediately.
12. Students use the accompanying workbook or investigation planner to document their observations of the activity.

ACTIVITY 2.4

STAYING WARM ON ICE

TEACHER DEMONSTRATION OR STUDENT INVESTIGATION

suggested time: 30 minutes

In this activity, teachers demonstrate advantages of social huddling amongst male emperor penguins, through a simulation. Alternatively students plan and conduct their own investigation using the student procedure and/or investigation planner (student sheet 5 and/or 6).

Test tubes or jars of hot water represent penguins. Clustering test tubes or jars results in lower temperature declines when compared with temperature declines of single test tubes or jars of hot water.

Collected data may be affected by ambient air temperature, operation of fans, air conditioning, or heating. Under warm room conditions temperature of the single test tube may rise. In these instances teachers may decide to turn off cooling or heating appliances.


STUDENT SHEET 5

STAYING WARM ON ICE

student sheet 5

Procedure

1. Ask students to predict which test tubes or jars will stay the warmest: the tube at the centre of the group, or a single test tube? Students write answer in workbook or investigation planner.
2. Fasten seven test tubes or jars together using rubber bands.
3. Attach group of test tubes to stand using clamp.
4. Attach single remaining test tube or jar to separate stand using clamp.
5. Fill all test tubes or jars with hot water. Take care handling hot water.
6. Place one thermometer in central tube of group of test tubes.
7. Place second thermometer in single test tube or jar.
8. Record initial temperature of each test tube or jar, then take readings of both test tubes at two-minute intervals over a 10 minute period.
9. Record temperatures in workbook or use the investigation planner.

Sample data

room temperature 24°C

Table 2: temperatures of test tubes simulating huddling and non-huddling behaviour.

TIME (MINUTES)	SINGLE TEST TUBE TEMPERATURE (°C)	GROUPED TEST TUBES TEMPERATURE (°C)
0	59	59
2	48	55
4	41	50
6	36	47
8	33	45
10	31	43
total change in temperature	28	16

ACTIVITY 2.5

INVESTIGATION PLANNER

INDIVIDUAL OR GROUP ACTIVITY

suggested time: 50 minutes

As an alternative to teacher demonstrated activities, students as a class, group or individuals use an investigation planner (student sheet 6) to plan and conduct their own emperor penguin investigation.

Ask students to investigate either or both of the following questions:

- How do emperor penguins stay warm when they dive underwater for food?
- How do emperor penguins stay warm during winter when they gather on sea ice to breed?


STUDENT SHEET 6
INVESTIGATION PLANNER
1. What are you going to investigate?
2. What do you think will happen? Explain why.
3. Which variables are you going to:
• change?
• measure?
• keep the same?
4. How will you make it a fair test?
5. What equipment will you need?

student sheet 6

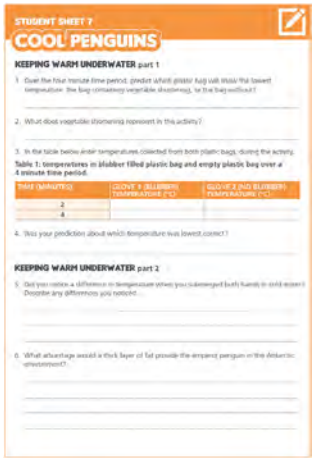
ACTIVITY 2.6

COOL PENGUINS

INDIVIDUAL ACTIVITY

suggested time: 20 minutes

Students complete workbook activity (student sheet 7) answering questions, documenting and interpreting observations, and reporting activity results.


STUDENT SHEET 7
COOL PENGUINS
KEEPING WARM UNDERWATER part 1
KEEPING WARM UNDERWATER part 2

student sheet 7

PART 3

ANIMAL ADAPTATIONS

PURPOSE

This resource encourages students to **Explore** adaptations of ten Australian animals. It also **Explains** how adaptations help animals find and eat their food.

OUTCOMES

Students:

- consider structural adaptations of different Australian animals;
- recognise structural adaptations have a function (e g acquiring food);
- discover that different animals may share similar adaptations; and
- understand adaptations help animals survive.

ACTIVITY SUMMARY

ACTIVITY	DESCRIPTION	MATERIALS
3.1 *Animal adaptations*	This presentation introduces ten Australian animals, their environments, main food sources, and adaptations that help them acquire this food.	*Animal adaptations* presentation in *digital-resources*
3.2 *Find my food*	Using a card set, *Find my food*, students match animals, food, and adaptations. Game 1, Animal sets, requires students to sort cards into sets of four: an animal, its main food source, and two adaptations that help it find and eat their food. Game 2, *Happy hunting*, is an extension card game, without the scaffolding provide in the previous game. It requires students to apply what they've learned and may be used to evaluate student understanding of concepts in this resource.	*Find my food* card game in *digital-resources* (printed cards are available for purchase) • pack of 40 playing cards • game rules • answer sheet
3.3 *My animal adaptations*	This workbook contains a review activity related to the card game, as well as additional research activities.	student sheet 8: My animal adaptations

SCIENCE BACKGROUND

An adaptation is a trait or characteristic of an organism that performs a function in its environment and increases chances of survival.

All plants and animals have adaptations that help them survive in their environment. Adaptations result from the process of natural selection, and are acquired over long periods of evolutionary time. Adaptations are: inherited, fulfil a specific function within a population, and improve the chance of species survival in their environment.

Adaptations can be categorised as structural, behavioural, or physiological. A structural adaptation is a physical or anatomical feature, of an organism, that increases chances of survival. For instance, protective thorns of plants reduce the risk of predation, and the long tail and powerful hindquarters of kangaroos are used in locomotion.

Behavioural adaptations are actions that improve an animal's chance of success in its environment. For instance, nocturnal behaviour is a behavioural adaptation for many species that reduces the risk of predation.

Physiological adaptations are processes occurring within body systems or cells that improve chances of survival. For instance, many desert animals have physiological adaptations that enable them to conserve water in desert environments, such as highly efficient kidneys.

At this level, only physical and behavioural adaptations will be introduced to students.

The western grey kangaroo is nocturnal, well equipped for energy efficient locomotion, and is able to survive with limited access to water.
© The University of Western Australia

Different perceptions about adaptations

Adaptations are the result of natural selection. Natural selection is a process, where environmental pressures/ circumstances favour some genes over others.

Genetic variation occurs naturally in populations. If genetic variants are more successful in a particular environment these traits (adaptations) are passed on to future generations.

For instance, if a colour variant in an insect population aids camouflage then over time camouflaged insects will suffer less predation, reproduce more, and survive in greater numbers.

There's a popular perception that natural selection results from an organism's efforts to survive. In reality, selection of particular traits in a plant or animal over others results from pressures in the surrounding environment.

This isn't how natural selection works.

Convergent evolution

Many animals are unrelated but share similar environments and/or similar diets, and evolve similar adaptations. These adaptations are the result of convergent evolution and evolved independently in separate lineages.

Convergent evolution of long sticky tongue for collecting insects in two different animal lineages.
Numbat © Mike Freeth - Echidna © Perth Zoo

For instance, the numbat and short-beaked echidna are not closely related but have both evolved long sticky tongues to collect insect prey. Bats and birds also demonstrate convergence in the evolution of wings for flight.

Other animals that inhabit similar environments, such as aquatic, also share similar traits or adaptations. For instance, sharks, whales and crocodiles have all evolved powerful swimming aids independent of each other.

Australian animal adaptations

This resource presents ten Australian animals and their adaptations. These animals represent the following broader groups: placental (eutherian) mammal, marsupial, monotreme, reptile, fish, and bird.

Each animal has specialised adaptations. This resource focuses on adaptations that function to help each animal acquire food. The featured adaptations are structural: physical characteristics or features of the animal that can be readily seen and identified.

ACTIVITY 3.1

ANIMAL ADAPTATIONS PRESENTATION

WHOLE CLASS ACTIVITY

suggested time: 10 minutes

The presentation, *Animal adaptations*, introduces the idea that adaptations perform a function and improve an animal's chances of survival. It focuses on body form and function, specifically diet and adaptations.

The presentation introduces students to ten Australian animals, diets of these animals, and adaptations that help them acquire their food.

Slide 1

For survival all animals must find food.

Discuss what different animals eat and what adaptations they have to help find food.

Emphasise the idea that different animals have different adaptations in order to find their particular foods.

Image 1: Great egret – carnivore: eats fish, shrimp, molluscs, and insects. Adaptations for finding food include long legs for wading, sharp beak for stabbing prey, excellent eyesight to spot prey.

Image 2: Tasmanian devil – carnivore: eats meat, including carrion. Adaptations for finding food include keen sense of smell, strong claws for tearing apart prey, sharp teeth.

Image 3: Quokka – herbivore: eats grasses, leaves and shoots. Adaptations for finding food include grasping forepaws, grinding molars to crush plant material, ability to climb trees in search of food.

Image 4: Bilby – omnivore: eats insects, fruit, seeds, and plants. Adaptations for finding food include excellent hearing and sense of smell, strong legs and sharp claws for digging up insects.

Slide 2-21

Introduction to the ten animals featured in the card game *Find my food*.

Ask students what they know about each animal. *E g carnivore, herbivore, predator, fish, mammal.*

Where they live? *E g water, terrestrial, underground, forest.*

After each animal is introduced ask students what they eat. Discuss student responses before moving to the next slide. To reveal answers click on the ? on each slide.

Ask students what adaptation helps each animal to find and eat their food. *E g vision, smell, claws, teeth, wings.*

This section allows students to express their own ideas about animal adaptations. Through guided instruction they begin to understand that adaptations fulfil a function, improving an animal's chance of survival.

ACTIVITY 3.1: ANIMAL ADAPTATIONS PRESENTATION

Slide 2

Great white sharks are a large predatory fish found globally in temperate marine environments. Female great white sharks can reach up to six metres in length and weigh up to 3000 kilograms.

Slide 3

What do they eat?

Great whites are carnivores: fish and seals are primary food sources. Others include: stingrays, other sharks, and crustaceans, such as crabs.

What adaptations help them catch and eat food?

Teeth of the great white, adapted for a carnivorous diet, are serrated and sharp allowing grasping and tearing of prey. They've multiple rows of teeth, which can regrow throughout their lives.

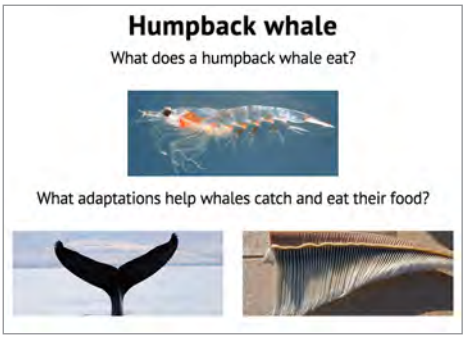
They are migratory animals, and can travel long distances in search of food. Their powerful tails aid in propulsion, and streamlined bodies reduce drag in water.

Sharks have acute senses to help locate and capture food. These include: keen sense of smell, excellent vision, and ability to detect electrical signals emitted by prey.

Slide 4

Humpback whales are large aquatic mammals. Like all whales they are carnivorous.

Slide 5



What do they eat?

Humpback whales' main food is some of the tiniest animals in the oceans: krill. These are small crustaceans which are the main prey for many baleen whales. Other food sources include fish.

What adaptations help them catch and eat their food?

Humpback whales don't have teeth; they feed by scooping up large amounts of water, which is filtered through rigid baleen plates in their mouths. The baleen traps krill. Baleen is formed of keratin, the same protein that makes up fingernails, hair, and horns. Humpbacks also feed on fish and other small marine creatures.

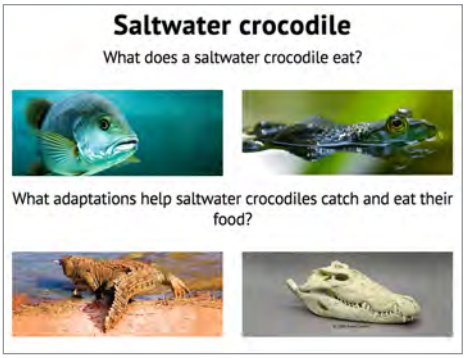
Humpback whales migrate across the world's oceans in search of food and warm calm calving grounds. They are well adapted for swimming long distances, with strong powerful tails and long pectoral fins. Humpback whales use sonar to communicate; their songs carry long distances underwater.

ACTIVITY 3.1: ANIMAL ADAPTATIONS PRESENTATION

Slide 6

Saltwater crocodiles are the largest reptilian species in the world, males can reach over six metres in length and weigh over 1000 kilograms. Saltwater crocodiles are found in northern Australia and south-east Asia. They reproduce via eggs, and like all reptiles are cold-blooded (ectothermic).

Slide 7



What do they eat?

Crocodiles are carnivorous. Their primary food source is fish. They also hunt and eat crabs and frogs. Large crocodiles will take mammal prey, such as goats or cattle. They're opportunistic hunters, and also scavenge from carcasses.

What adaptations help them catch and eat their food?

Crocodile teeth are adapted to grip and puncture, not to cut; crocodiles twist and turn, while gripping onto prey, to tear away chunks of flesh. With large heads, long teeth, and large jaw muscles and tendons, these animals have a powerful biting force.

Saltwater crocodiles have many adaptations for an aquatic lifestyle. Their webbed feet and powerful tails aid swimming, allowing them to travel long distances. Their eyes and nostrils positioned on top of their heads allowing them to submerge and await prey. Their patterned skin provides superb camouflage underwater and along waterway edges.

Slide 8

Dingoes are Australia's wild dogs and the largest mammalian predator on the continent. They're also found in parts of south-east Asia. They are placental (eutherian) mammals.

Slide 9

What do they eat?

Dingoes are carnivores. Prey includes kangaroos, wallabies, and smaller animals, including: bandicoots, lizards and mice. They also eat introduced animals, such as rabbits.

What adaptations help them catch and eat their food?

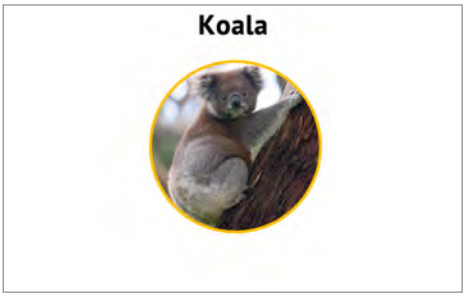
Dingoes' muzzles and teeth are adapted for a carnivorous lifestyle. Their jaws are long and tapered with serrated teeth for cutting and tearing. Canine teeth of dingoes are much longer than those of domestic dogs. Their canines are adapted for gripping live prey, while their molars are modified to form carnassial, or shearing teeth, for cutting and tearing flesh.

Dingoes are lightweight with long legs to enable them to travel long distances in search of prey. Their claws are strong and sharp, to assist in tearing flesh from prey.

ACTIVITY 3.1: ANIMAL ADAPTATIONS PRESENTATION

Slide 10

Koalas are specialised marsupials that live in eastern Australia. They are nocturnal and spend most of their lives in trees (arboreal).



Slide 11

What do they eat?

Koalas are herbivores. They mainly eat eucalyptus leaves, but are also known to eat other native plants, such as acacia and melaleuca. There are over 600 eucalyptus species but koalas are fussy, preferring to eat leaves and shoots of around only 30 eucalypt species. Eucalyptus leaves are toxic but koalas have unique gut bacteria capable of breaking down toxins released by ingested leaves. Their digestive system is extremely large to aid digestion.

What adaptations help them reach and eat their food?

Strong claws and powerful legs help koalas climb in search of food. Koalas' teeth are adapted for tough fibrous leaves: incisors clip leaves that large molars grind into finer particles. Koalas also have cheek pouches where they store food prior to chewing and digestion.

Slide 12

Echidnas are monotremes: a mammal that lays eggs. This lineage is represented by only one other surviving species, the platypus. Short-beaked echidnas are found across Australia and in parts of New Guinea.

Slide 13

What do they eat?

Echidnas are specialised carnivores known as insectivores: they eat only insects. Their primary food sources are ants and termites.

What adaptations help them find and eat their food?

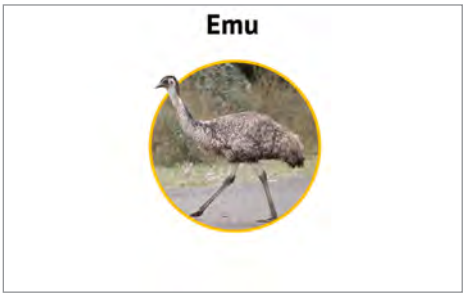
Echidnas have short strong legs and powerful digging claws to excavate insect nests. Echidnas don't have teeth, but they've a long sticky tongue that helps them collect food.

A distinctive adaptation of echidnas is long spines which provide protection against predators. Echidnas hibernate during winter, entering a state of torpor where body temperatures and metabolic rates are significantly lower, to conserve energy.

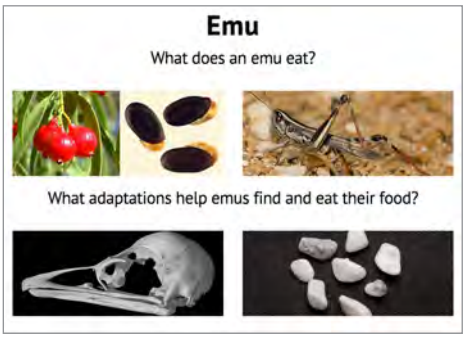
ACTIVITY 3.1: ANIMAL ADAPTATIONS PRESENTATION

Slide 14

Emus are Australia's large flightless birds, standing up to two metres tall. They're adapted for travelling long distances in order to exploit seasonal food supplies.



Slide 15



What do they eat?

Emus are omnivorous, with a flexible and varied diet that includes plants, fruit, seeds and insects.

What adaptations help them catch and eat their food?

Emus don't have teeth, but their beaks are adapted for collecting grasses, shoots and insects.

As they don't chew food, their modified stomach forms a gizzard in the hind region. This digestive adaptation is a muscular portion of the stomach found in all birds and some reptiles.

Like many other birds, emus swallow small stones that are stored in their gizzard where they help to grind food. Gizzard stones are known as gastroliths.

They have well-developed legs, adapted for travel and sprinting, and can reach speeds of over 40 kilometres per hour. They also have powerful claws capable of disabling predators.

Slide 16

Grey-headed flying foxes live in eastern Australia. They're placental mammals (eutherian) and Australia's largest bat species.

Slide 17

What do they eat?

Flying foxes are herbivores, but may be referred to as nectarivores (nectar eaters) or frugivores (fruit eaters) as they eat nectar, pollen and fruit.

What adaptations help them find and eat their food?

Flying foxes' wings are modified forelimbs allowing them to travel long distances to find food as they rely on a diet of seasonal fruit and flowering plants.

Flying foxes' teeth are sharp and powerful, adapted to crush flowers and penetrate tough fruit skin.

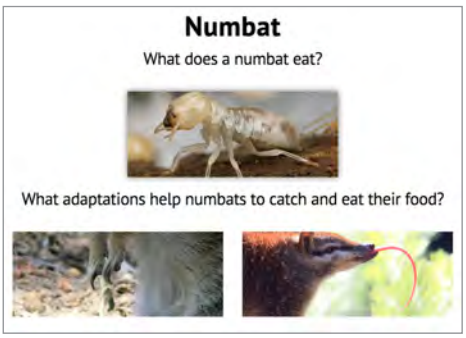
They're social animals, gathering in large roost sites during the day to sleep, and foraging at night. This bat species does not use echolocation for navigation (microbats), instead they rely on excellent vision to find food.

ACTIVITY 3.1: ANIMAL ADAPTATIONS PRESENTATION

Slide 18

Numbats are small marsupials found in the south-west of Western Australia. Their habitat has been reduced considerably since Australian settlement with only a few small populations remaining in the wild.

Slide 19



What do they eat?

Numbats are specialised carnivores known as insectivores. They survive on termites, exclusively.

What adaptations help them find and eat their food?

Numbats have strong sharp claws to help dig out termite nests. They've reduced/remnant teeth due to their soft insect diet, instead relying on their long sticky tongues to scoop up insects.

Numbats hunt in the day, using their keen eyesight and sense of smell to locate termites. Numbats' teeth are non-functional due to their soft diet of termites.

Numbats don't have pouches.

Slide 20

Western grey kangaroos are found across southern Australia.

Slide 21

What do they eat?

Western greys are herbivores eating grass, leaves and shrubs.

What adaptations help them find and eat their food?

Their teeth are adapted for an herbivorous diet: incisors clip vegetation, and large molars grind plant material. Western grey kangaroos have a complex chambered digestive system full of microorganisms to breakdown vegetation.

They often travel long distances to find food. Their powerful muscular tail helps them cover long distances without using much energy.

ACTIVITY 3.1: ANIMAL ADAPTATIONS PRESENTATION

Slide 22

Introduction to card game, *Find my food.*

Explain the object of the game described in the procedure, or present students with a copy of the procedure.

Tasmanian devils are discussed as an example animal.

They're found only in Tasmania, and are currently listed as endangered. Their conservation status has been impacted by devil facial tumour disease, a transmissible form of cancer that has decimated wild populations.

They're carnivores and their diet includes: wallabies, bettongs, mice, reptiles, frogs and often carrion from road kill.

They're nocturnal, and well equipped for a carnivorous lifestyle. Sharp meat-cutting teeth, help them rip and tear flesh, and strong molars crush bones. Their large heads and strong necks provide a powerful biting force. They also have long, sharp claws to grip and tear food.

Tasmanian devils rely on excellent hearing and sense of smell to locate prey.

ACTIVITY 3.2

FIND MY FOOD CARD GAME

SMALL GROUP ACTIVITY

suggested time: 20 minutes

Form groups of four or five students. You may explain rules of the game to groups, or distribute one copy of the procedure guide per group.

During the game, review students' selections correcting any errors. Return to presentation images to resolve problems.

After playing the game ask students to group animals according to similar diets.

Explore students' ideas about diet and adaptations.

Do students understand animals sharing similar diets also share adaptations? For instance, insectivores such as numbats and echidnas both have adaptations to find and eat insects.

Ask students to group animals according to their environment.

Explore their ideas about environment and adaptations.

Do students understand animals sharing similar environments also share adaptations? For instance, aquatic animals such as whales, sharks and crocodiles all have swimming adaptations.

ACTIVITY 3.2: FIND MY FOOD CARD GAME

This procedure sheet outlines playing instructions for two card games.

This pack contains 40 cards: 10 show Australian animals, 10 show each animal's main source of food, and 20 show adaptations that help these animals find their food.

There are 10 sets of four cards. Each set relates to one of the 10 animals.

Each card is marked with a letter indicating the category to which it belongs: animal, food or adaptation. (Note there are two adaptations for each animal.)

A. animal **B. food** **C. adaptation 1** **D. adaptation 2**

GAME 1: ANIMAL SETS

The object of this game is to build 10 sets of cards. A set contains four cards: an animal, its main food, and two adaptations that help the animal find and/or eat its food.

1. Form groups of four or five.
2. Distribute one pack of cards to each group.
3. Find the 10 animal cards (Category A) and arrange them in a row.
4. Find each animal's main food source (Category B) and place under the relevant animal card.
5. Find each animal's two adaptations (Categories C and D) that help it find and eat this food.
6. Once you've completed the 10 sets, use the answer guide to check them.

Activity 1: Foods in common

1. Sort animals into groups according to the type of food they eat: plants, insects/animals.
2. Identify adaptations each group has in common.

Activity 2: Where do you live?

1. Sort animals into groups according to the type of environment in which they live. These may be aquatic, land-dwelling or tree-dwellers.
2. Identify adaptations each group has in common.

ACTIVITY 3.2: FIND MY FOOD CARD GAME

GAME 2: HAPPY HUNTING

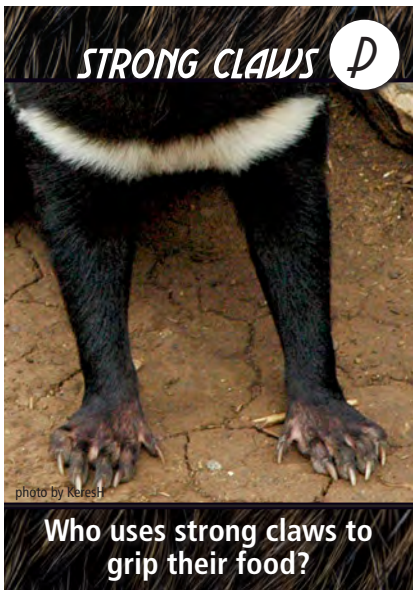
This extension activity is for students able to play a more advanced version of the *Find my food* card game.

In groups of two, three or four, students play *Happy hunting*, competing against each other to be first to complete two sets of animal adaptation cards.

Teachers may explain game rules to students or distribute a copy of the game procedure to each group.

We recommend students have on hand a copy of the *Find my food* answer guide to facilitate the game.

The object of this game is to collect three cards from one animal set. Collect the animal (Category A), and two of the other three cards in the set (Categories B, C or D).



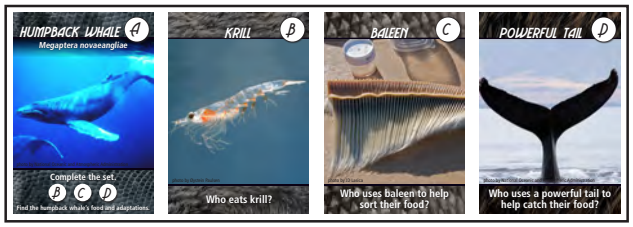
1. Form groups of two to four.
2. Distribute one pack of cards to each group.
3. Deal five cards, face down, to each player (keep them hidden).
4. Turn the remaining cards face down in the centre. This is the draw deck.
5. Turn the top card of the draw deck face up beside it. This is the discard pile.
6. The first player either picks up the top card from the discard pile, or top card from the draw deck.
7. The player checks their hand to see if they have a set of animal cards.
8. If the player has three cards that form a set, they lay it face up on the table. To complete this play, the first player discards a card onto the discard pile, face up.
9. If the player doesn't have a set of cards they discard one card onto the discard pile. This completes their turn.
10. Play continues in a clockwise direction.
11. Play continues until a player has no more cards. This player wins.

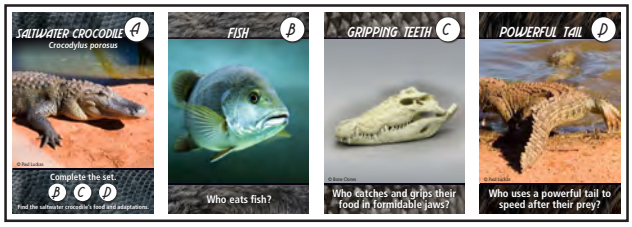
Note: If the draw deck runs out, shuffle the discard pile and use as the draw deck. Remember to turn the final card on the pile face up next to it.

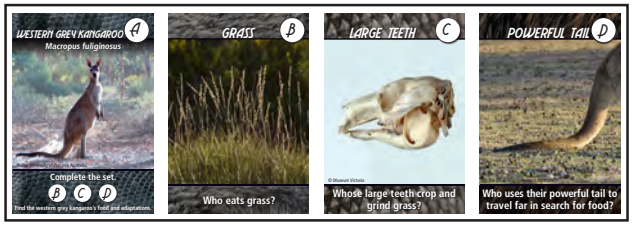
Use the answer guide to check completed sets.

ACTIVITY 3.2: FIND MY FOOD CARD GAME

ANSWERS







ACTIVITY 3.3

MY ANIMAL ADAPTATIONS

Teachers allocate an animal to each student, or a student chooses one and explores it in more detail. In the workbook (student sheet 8), students draw their animal and label any adaptations. They may also undertake more research on their chosen animal.

If research is encouraged we recommend the following websites:

http://australianmuseum.net.au/wild-kids

http://www.abc.net.au/tveducation/animals/default.htm

http://ngkids.com.au/


STUDENT SHEET 8

MY ANIMAL ADAPTATIONS

Investigate an animal from the card game *Find my food* in more detail.

1. Choose an animal from the card set.

2. Draw your animal in the space provided below. Label any adaptations of your chosen animal.

3. Write a short paragraph about your animal based on what you have learned from the game *Find my food* or by researching your animal on the internet.

student sheet 8

PART 4

ADAPTATIONS FOR AN ENVIRONMENT

PURPOSE

This resource **Explains** how adaptations help plants and animals to function successfully in their environment.

OUTCOMES

Students:

- consider conditions found in three environments and discuss types of animals and plants that might live there;
- are introduced to three organisms and the environments they inhabit: rakali in rivers, water-holding frogs in deserts, and seagrasses in oceans;
- discover adaptations that allow these organisms to survive in their environments; and
- make connections between environment and adaptations.

ACTIVITY SUMMARY

ACTIVITY	DESCRIPTION	MATERIALS
4.1 *Featured creatures*	This presentation may be used to introduce three environments and unusual organisms in them.	*Featured creatures* presentation in digital-resources
4.2 *Adaptations in action*	A video describes specialised adaptations of rakali, water-holding frogs and seagrasses that enable them to survive in particular environments.	*Adaptations in action* video in *digital-resources* or www.youtube.com/watch?v=wEDxThDINgQ
4.3 *Adaptations match-up*	Students match adaptations to the correct organism.	student sheet 9: Adaptations match-up • scissors (one pair per student) • glue stick/sticky tape (one per group/table) • workbook/blank A4 paper (3 sheets per student or group)

SCIENCE BACKGROUND

Previous activities in this resource have examined animals' specialised structures and behaviours that help them survive in a harsh environment; and adaptations that help an animal find its food.

Activities in this part of the resource look at adaptations in relation to specific environments. Students consider three common environments and adaptations of two animals and a plant that they might not expect to find there:

- rats in rivers;
- frogs in deserts; and
- flowering plants in oceans.

Relationship between environment and adaptation

All plants and animals survive in environments that meet their basic requirements for food, shelter and reproduction. Adaptations mean plants and animals essentially 'fit' their habitat.

The three species featured in this resource have adaptations to overcome particular challenges within their environments. They provide examples of how natural selection, or environmental pressures, shaped the evolution of features that enable their survival. These adaptations have evolved over many generations, and are inherited by offspring.

RAKALI, AUSTRALIAN WATER RAT *(HYDROMYS CHRYSOGASTER)*

Rakali is a native rodent that inhabits Australian freshwater systems where it's one of the top predators. It's Australia's largest rodent, with a body length of around 40 cm and a tail almost as long. The largest specimen recorded weighed an impressive 1.12 kg.

Their habitats include creeks, rivers, estuaries, wetlands and farm dams. They are also found in brackish environments, including mangroves of New Guinea. In Western Australia they are found in the Canning River, Perth metropolitan lakes, and the Bremer River.

© The University of Western Australia

Rakali are predominantly carnivorous and opportunistic, so their diet is highly varied. Many aquatic organisms are on the menu: particularly insects, worms, spiders and crustaceans. They also dine on fish, frogs, tortoise, small mammals and waterbirds. Rakali prefer to take their meals on land, visiting favourite feeding platforms called middens.

Rakali adaptations

Rakali have adaptations to survive in a semi-aquatic environment. They swim and dive to find food and have specialised features for underwater hunting.

- Their body is streamlined to reduce drag in water.
- Their feet are partially webbed, increasing surface area and providing propulsion when swimming.
- The long tail is used for steering and balance when swimming.
- Rakali have long sensitive whiskers that are used to locate prey underwater. This is especially useful in murky water.
- They've small ears that are retractable to keep water out and reduce heat loss.
- Rakali have two layers of fur, a fine layer close to the skin traps air and keeps them warm, while a thick, waterproof, top layer of hair keeps them dry.
- Rakali's teeth are adapted to a diet of crustaceans and fish: their molars have smooth surfaces, perfect for crushing the shells of underwater prey.

© Andrew McCutcheon

© Andrew McCutcheon

© Andrew McCutcheon

WATER-HOLDING FROG (CYCLORANA PLATYCEPHALA)

The water-holding frog is one of many Australian frog species capable of surviving in an arid environment. From southern Queensland to central Western Australia, these arid survivors inhabit some of Australia's major deserts, including the Great and Little Sandy Deserts, Gibson Desert and Simpson Desert. Despite inhabiting arid areas, the water-holding frog lives where there's water, even if it's only seasonal. They're found in ponds, streams, claypans and even ditches. Water-holding frogs rely on water in which to find most of their food, and of course it's here they lay their eggs.

© Kellie McMaster

Water-holding frogs are opportunistic predators. Food on the menu includes invertebrates (especially insects), aquatic arthropods and even other frogs. These creatures are strong, muscular, and formidable hunters in water.

Water-holding frogs' reproduction depends on rainfall, so they reproduce from spring to late summer. Females lay hundreds of eggs in clumps in available water sources. Tadpoles emerge about 14 days later. The tadpole stage lasts about 30 days.

Water-holding frog adaptations

Water-holding frogs are amphibians: cold-blooded animals that rely on external heat to survive. Amphibian skin is highly permeable to water and in many species it provides a surface for gas exchange. The skin requires protection from the environment and needs to be kept moist to avoid desiccation. It has two layers: a thick outer layer called the epidermis to prevent water loss; and a thinner inner layer, the dermis, which is important in gas exchange. The epidermis is shed regularly, sloughing off the old skin, which is replaced with a new layer of skin cells.

During dry periods water-holding frogs aestivate. Aestivation is similar to hibernation, but while hibernation is a response to cold conditions, aestivation is a response to arid conditions.

At the start of aestivation water-holding frogs burrow underground. The epidermal skin layer is not shed, instead it builds up to form a cocoon that prevents evaporative water loss. During aestivation water-holding frogs store water in a super-sized bladder that's large enough to hold sufficient water to last the frog for three years. This is the only water source available to the frog once the cocoon is formed.

Water-holding frogs have specialised ridges on their hind feet to dig burrows. These ridges operate much like a spade and are an important digging adaptation.

Water-holding frogs have many adaptations for an aquatic lifestyle when sufficient water is available.

- Eyes are positioned on top of their heads to maximise vision, help avoid predators and hunt prey.
- They're efficient underwater hunters with webbed feet to help with propulsion, and strong muscular legs for swimming.
- Their camouflaged skin colour matches surroundings, helping water-holding frogs avoid predators such as snakes and birds of prey.

© Victoria Cartledge

© Montana Fish, Wildlife & Parks

© Kellie McMaster

SEAGRASS (*POSIDONIA AUSTRALIS*)

Seagrasses are flowering plants (Angiosperms) that have adaptations for life in a marine environment. The genus Posidonia includes nine species, of which eight are found in Australia. Seagrasses from this genus are often called strapweed or ribbon weed because of their long flat leaves. *Posidonia australis* is one of Australia's most recognisable seagrasses.

© Renae Hovey

Seagrasses usually grow in shallow coastal waters. Most species like to remain submerged, so they inhabit the subtidal zone (1 – 12 m deep) that's rarely exposed by low tides. They grow best in sandy or muddy sediments, although some species colonise rocky regions. In suitable conditions seagrasses cover vast areas, forming extensive underwater meadows.

Seagrasses provide an important habitat for marine animals; they're home to many fish and crustacean species, along with sea worms, sea squirts and razor clams. In Australia they're nursery grounds for economically important species such as prawns, lobster and fish. They're also a principal source of food for animals such as dugongs and turtles.

Seagrasses aren't seaweeds. Seaweed is actually a common name for algae. Algae don't have the same features as land plants or seagrasses: they lack veins and a root system and reproduce by spores, rather than seeds and fruits.

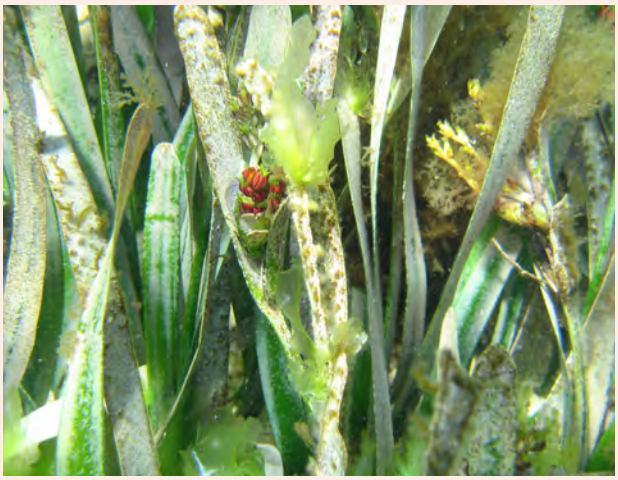
Seagrass adaptations

Seagrasses require nutrients and oxygen to perform all cellular functions. Most plants get these chemicals from soil or sediments, but ocean sediments contain little or no oxygen. Seagrasses contain, in their leaves and roots, networks of airspaces known as lacunae. Oxygen manufactured in leaves during photosynthesis is transported through lacunae to the roots via diffusion. This ensures roots can perform all necessary functions, such as the uptake of nutrients.

Seagrasses are flexible and buoyant: they float within the water column and flexible cell walls minimise damage from tidal and wave action. As marine sediments are often unstable, seagrasses have extensive root systems to anchor them in place.

As a flowering plant, seagrasses rely on dispersal of pollen for sexual reproduction. Seagrass pollen grains are long and filamentous. These pollen grains float and are easily carried by waves and currents, increasing chances of reproductive success.

© Renae Hovey



© Renae Hovey

ACTIVITY 4.1

FEATURED CREATURES

CLASS PRESENTATION AND DISCUSSION

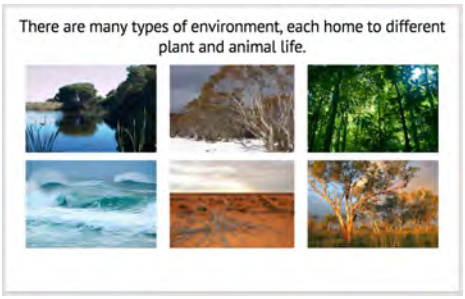
suggested time: 20 minutes

Use the presentation, *Featured creatures*, to discuss with students what animals and plants need to survive in their environment.

Slide 1

Each environment has its own specialised plant and animal life.

Discuss with students, characteristics of pictured environments, and animals and plants that might live there.



Slide 2

Adaptations are features of plants and animals that improve their chance of survival in a particular environment.

Discuss with students, examples of adaptations that help plants and animals to survive.

- grass trees: They've long thin leaves, with a waxy coating, that limit water loss.
- oystercatcher: It has a long sharp beak that helps collect food, and its wings enable flight.
- red kangaroo: It stays cool in the heat of the day, and travels long distances.
- emu: It can reach high speeds to avoid predators.
- koala: It has climbing limbs, and specialised digestion to eat eucalyptus leaves.
- boab tree: It stores water in spongy trunks, and sheds leaves in dry seasons.

Slide 3

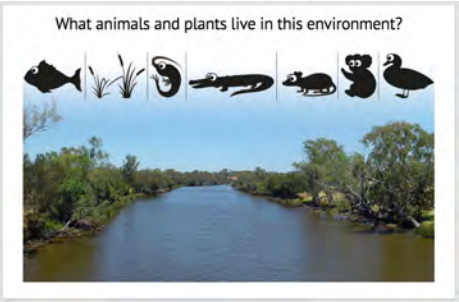
Survival means: finding food and water; shelter; defence against predators; and finding a mate.

Discuss with students pictured adaptations:

- superb lyrebird: Male lyrebirds perform an elaborate courtship dance, on top of a mound they build, to attract a mate.
- acacia: Their thorns prevent fragile leaves from being eaten by herbivores.
- microbat: Wings help them get around to find food, and echolocation helps them find insect prey.
- Carnaby cockatoo: Their strong hooked beaks are perfect for opening marri and jarrah nuts to get at seeds inside.
- lizard: Camouflage means these lizards are barely visible against rocky backdrops, protecting them from predators and helping them sneak up on prey.
- wombat: They've powerful limbs and long sharp claws for digging burrows for shelter. They're nocturnal, and use their burrows in daylight and forage at night.

ACTIVITY 4.1: FEATURED CREATURES

Slide 4



Environment 1: freshwater/estuarine

What conditions are found in this environment?

water, murky, wet, cold

Discuss with class, which animals and plants (illustrated by icons) might live in this environment. Make decisions as a group.

Slide 5

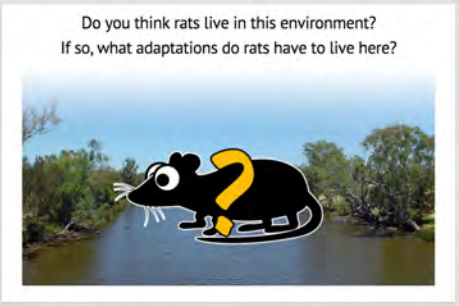
Use this slide to reveal animals and plants that live in freshwater/estuarine environments.

Grass/reeds, fish, shrimp/prawns, ducks and crocodiles live in freshwater/estuarine environments.

Koalas don't live in freshwater/estuarine environments.

Use the next slide to consider if rats live in freshwater/estuarine environments.

Slide 6



Do rats live in freshwater/estuarine environments?

Discuss with students, environments in which they'd expect to find rats.

cities, gardens, forests, sewers, landfill

Why are rats found in these environments?

They've everything they need: shelter, food and other rats.

What adaptations would a rat need to live in a river environment?

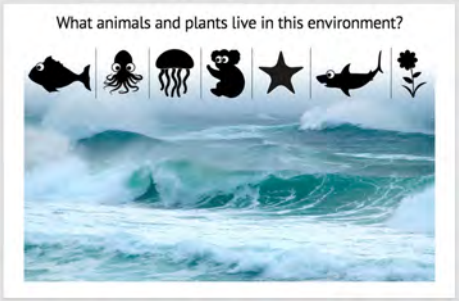
- *adaptations to swim*
- *adaptations to hunt underwater*
- *adaptations to keep warm*

Slide 7

Introduce students to rakali, Australian water rat, a native rodent that has adaptations to help it survive in rivers, lakes and estuaries.

ACTIVITY 4.1: FEATURED CREATURES

Slide 8



Environment 2: marine

What conditions are found in this environment?

salty, wet, cold, less sunlight

Discuss with class, which animals and plants live in this environment. Make decisions as a group.

Slide 9

Use this slide to reveal which animals and plants live in marine environments.

Sharks, octopus, jellyfish, fish and starfish live in this environment.

Koalas don't live in marine environments.

Use the next slide to discuss if flowering plants live in marine environments.

Slide 10

Ask students if flowering plants live in marine environments.

Discuss with students, environments in which they expect to find flowering plants.

gardens, forests, desert, bush

Why are plants found in these environments?

They've everything they need: sunlight, soil, nutrients, and freshwater.

What adaptations would flowering plants need to live in the ocean?

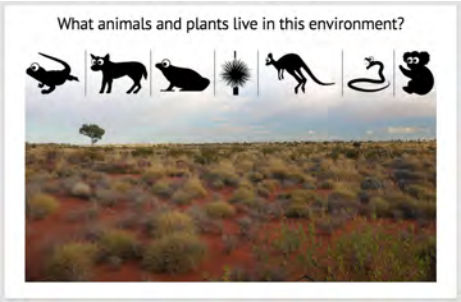
- *adaptations to obtain oxygen and nutrients underwater*
- *adaptations to acquire sunlight underwater*
- *adaptations to reproduce underwater*
- *adaptations to cope with high levels of salt*

Slide 11

Introduce students to seagrass, a flowering plant that lives underwater in coastal areas around the world.

ACTIVITY 4.1: FEATURED CREATURES

Slide 12



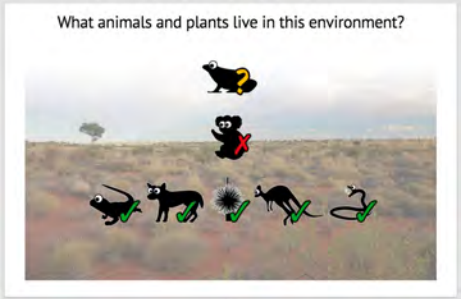
Environment 3: desert

What conditions are found in this environment?

hot, dry, arid, limited water, food and shelter

Discuss with class, which animals and plants live in desert environments. Make decisions as a group.

Slide 13



Use this slide to reveal which animals and plants live in desert environments.

Lizards, dingos, grasstrees, kangaroos and snakes all live in desert environments.

Koalas don't live in desert environments.

Use the next slide to discuss if frogs live in desert environments.

Slide 14

Ask students if frogs live in desert environments?

Discuss with students, environments in which they would expect to find frogs.

rivers, lakes, ponds and wetlands

Why are frogs found in these environments?

They've everything they need: water, place to lay eggs, food, and other frogs to reproduce.

What adaptations would frogs need to live in the desert?

- *adaptations to prevent water loss*
- *adaptations to survive drought*
- *adaptations to find food and shelter*

Introduce students to the water-holding frog, a native frog that lives in Australian deserts.

Discussion topics following the presentation

Are you surprised that featured animals and plants live in the environments shown?

Why are you surprised?

How do adaptations help these animals and plants live in the environments shown?

ACTIVITY 4.2

ADAPTATIONS IN ACTION

CLASS VIDEO AND DISCUSSION

suggested time: 20 minutes

Students watch and discuss the video, *Adaptations in action*. This video explains how adaptations help plants and animals to survive in their environment. It focuses on structural adaptations of the three organisms introduced in Activity 3.1.

Encourage students to associate animal or plant adaptations with specific functions and environment conditions.

Some concepts presented in the video may require explanation to students.

TERM	EXPLANATION
thermal conductivity	Thermal conductivity is a measure of how easily heat is transferred between objects. This is important for warm-blooded animals living in a cold environment, as they must maintain a stable core body temperature for normal bodily functions. Water has a greater thermal conductivity than air, which means heat is lost more readily to the environment. Adaptations to prevent heat loss include a thick layer of fat in emperor penguins and rakalis' insulating fur. Insulating fur traps air next to the skin and prevents cold water contacting the skin. Fur's only effective in aquatic and semi-aquatic mammals if it's well kept; these animals spend a lot of time grooming to maintain their fur coats.
aestivation	Aestivation is dormancy induced by hot climatic conditions. It's similar to hibernation (dormancy stimulated by cold conditions). Some invertebrates (insects) and vertebrates (amphibians, reptiles, fish and mammals) undergo aestivation. During aestivation animals become inactive and metabolic activity is greatly reduced to use less energy. Warm-blooded animals often reduce their body temperature during aestivation. Aestivation in amphibians is triggered by: warm dry conditions, and limited food and water resources. Heavy rain stimulates amphibians to emerge from periods of aestivation.
permeable skin of amphibians	Amphibian skin is smooth, thin and delicate. It's permeable, so water molecules and gas can pass through the skin. This allows amphibians to 'breathe' (respire) through their skin; but skin must remain moist to enable efficient gas exchange. Permeable skin leaves amphibians at risk of desiccation (drying out) as they can lose too much water to their environment. Most amphibians solve this problem by living in damp or wet places.
gas exchange in plants	Plants rely on gases (oxygen and carbon dioxide) for survival, just as animals do. Seagrasses live in ocean sediments where oxygen levels are often low. To obtain sufficient oxygen for cellular processes, seagrasses rely on networks of air spaces called lacunae. Lacunae transfer oxygen, produced in leaves, to the root system.

Discussion topics after viewing the video

What did the video teach you about how animals and plants survive in these environments?

How are animal and plant adaptations related to environments they inhabit?

List other plants and animals you know about that live in unexpected environments.

ACTIVITY 4.3

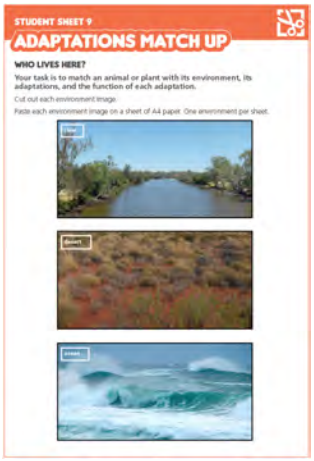
ADAPTATIONS MATCH-UP

INDIVIDUAL OR SMALL GROUP ACTIVITY

suggested time: 30 minutes

Students complete the workbook activity, *Adaptations match-up* (student sheet 9). Based on information provided in the presentation and video, this activity encourages students to associate animal and plant adaptations with their environment. Students are also asked to match an adaptation with its function. This review activity emphasises key adaptations of rakali, water-holding frogs and seagrasses.

Note: if you choose to print the images (on student sheet 9), the four pages of water marks won't be required.


STUDENT SHEET 9

ADAPTATIONS MATCH UP

WHO LIVES HERE?

Your task is to match an animal or plant with its environment, its adaptations, and the function of each adaptation.

Cut out each environment image.

Paste each environment image on a sheet of A4 paper. One environment per sheet.

student sheet 9

Students may complete the activity individually or in groups of three.

- step 1: Students choose an environment, cut out the photo, and paste it into their workbook or on a blank A3 page. Alternatively, they may use a separate A4 page for each environment.
- step 2: Students cut out the animal or plant that lives in this environment and paste it beneath the environment photo.
- step 3: Students find all adaptations belonging to their animal or plant, cut them out and paste them with the relevant animal or plant.
- step 4: Students find the function of each adaptation and paste them beneath the correct adaptations.

Students may write a short paragraph on each featured plant and animal species describing how they survive in their environment. This activity demonstrates understanding of how adaptations serve a function in a particular environment.

PART 5

WHAT ADAPTATION IS THIS?

PURPOSE

To **Elaborate** on student knowledge of adaptations by considering different types of adaptation: structural and behavioural.

OUTCOMES

Students:

- discover different types of adaptations: structural and behavioural;
- interpret visual and written information about functions of adaptations;
- make decisions about types of adaptations featured in examples; and
- demonstrate understanding of the function of an adaptation and its relationship to environment.

ACTIVITY SUMMARY

ACTIVITY	DESCRIPTION	MATERIALS
5.1 *What adaptation is this?*	Discuss with students different types of adaptations: structural and behavioural.	
5.2 *My adaptations*	A series of visually engaging fact sheets feature six Australian animals and highlight both structural and behavioural adaptations that enable them to survive in their environment. Students interpret information presented in these fact sheets and organise the information in any way they choose.	student sheet 10: My adaptations student sheet 11: Types of adaptations

SCIENCE BACKGROUND

Adaptations are features of plants or animals that improve functioning in their environment. These traits or features increase chances of species' survival. Adaptations always serve a function and are always inherited.

Adaptations take many forms. They're often categorised as structural, behavioural, or physiological.

These categories are somewhat arbitrary, and there's often overlap. For instance, hibernation can be considered both a behavioural and physiological adaptation.

TYPES OF ADAPTATIONS

Structural adaptations

Structural adaptations refer to physical characteristics or anatomical structures that aid survival. Structural adaptations can be internal or external. For instance, the enlarged bladder in water-holding frogs is an internal structural adaptation for water storage, while the long tail of kangaroos is an external structural adaptation providing balance during locomotion. At year five level external structures remain the focus.

All plants and animals display physical traits that suit their environment. For instance, eucalyptus species show extraordinary diversity in their leaf anatomy. These variants are related to their environment. Eucalyptus species inhabiting arid regions have a number of structural adaptations to reduce water loss, including: increased epidermis thickness, thick waxy cuticle, and leaves that hang vertically.

Vertical leaves are an adaptation of many eucalyptus trees.
photo by Ethel Aardvark

Spot the reptile!
© Paul Ricketts

In animals a recognisable structural adaptation is camouflage. This is a structural adaptation of both predators and prey. Predators, such as Australian death adders, use camouflage to conceal themselves from prey. Similarly, prey animals, including many insects, use camouflage to hide from potential predators.

Behavioural adaptations

Behavioural adaptations are actions that help animals survive. Animals inherit behavioural adaptations, such as territorial and reproductive displays: mating rituals of many bird species are obvious examples. Behavioural adaptations are also learned. For instance, tool use amongst vertebrates, such as chimpanzees and crows, is considered a learned behavioural adaptation.

Behavioural adaptations include nocturnal behaviour of many species, such as bilbies and brushtail possums. Nocturnal behaviour serves numerous functions, allowing animals to avoid daylight predators, and also harsh climatic conditions.

Nocturnal behaviour is an adaptation of the brushtail possum.
© The University of Western Australia

Hibernation, torpor and aestivation, in which animals avoid summer or winter conditions by becoming inactive, are also considered behavioural adaptations, despite associated physiological changes.

Physiological adaptations

Physiological adaptations refer to body systems that perform specific biochemical functions. They're processes in the body, or cells of the body, that improve plants' or animals' chances of survival. At year five level physiological adaptations are not featured.

All plants and animals have physiological adaptations to aid survival in their environment. For instance spinifex hopping mice inhabit arid areas of Australia. One of their physiological adaptations is incredibly efficient kidneys that produce concentrated urine, limiting water loss in their harsh environment.

Samphires are plants growing in saline habitats other plants find inhospitable. Excess salt is detrimental to plants, upsetting osmotic balance within cells. One physiological adaptation of samphires is their specialised cells that allow them to store and remove excess salt.

Samphires are adapted to survive salty extremes.
© The University of Western Australia

Adaptations, evolution and natural selection

The central principle of evolutionary theory is that all life on earth descended from a common ancestor. Evolution means all life forms are related. Over time, descent with modification has resulted in the fantastic diversity of life found on Earth. As lineages diverge from one another, modifications are passed down through generations.

Evolution is the result of a number of processes: natural selection, genetic drift, mutation, and migration. Natural selection is often considered the most important.

Natural selection, a main force behind evolution, is the process that results in adaptations: features and functions of organisms within their environment.

What is natural selection?

To answer this question we accept a basic premise: environments favour or discriminate against traits of organisms. There's always genetic variation within a population, and reproduction amongst organisms differs. However, if one genetic variant results in more offspring, a trait to reflect this will become dominant within a population.

For instance, a population of beetles may include both grey and brown beetles. However, changes to the environment, such as a volcanic eruption, may change the local habitat, and favour one colour over the other. In time, grey beetles may be more likely to survive than brown beetles. Natural selection selects the most favourable trait for that environment.

All adaptations have a genetic basis and all are passed down through generations.

ACTIVITY 5.1

WHAT ADAPTATION IS THIS?

WHOLE CLASS

suggested time: 15 minutes

This class discussion introduces the concept that there's more than one type of adaptation: structural and behavioural.

Structural adaptations are anatomical or physical features of an animal or plant

Behavioural adaptations are traits or actions of an animal.

To be considered an adaptation a feature or behaviour of an animal or plant needs to have a demonstrable function. The function of an adaptation improves animals and plants chances of survival.

For instance, bilbies are nocturnal; nocturnal behaviour allows bilbies to find more food and avoid predators, improving their chances of survival.

Geckos have camouflaged skin that matches their surroundin gs; camouflage is a structural adaptation that allows geckos to catch food and avoid predators, increasing their chances of survival.

Adaptations are the result of evolution and develop over long periods of time. Modifications to the features or behaviours of animals and plants that improve the chances of survival are inherited, passed on from generation to generation.

Further discussion questions may include:

Do all types of adaptations have a function?

Yes, to be considered an adaptation a feature/characteristic must have a demonstrable function.

ACTIVITY 5.1: WHAT ADAPTATION IS THIS?

What do different types of adaptations achieve animals?

All adaptations improve animals' chances of survival.

What is evolution?

Evolution is the modification of features in life forms, over time. These characteristics are inherited. They occur in plants and animals due to natural processes.

What types of adaptations are there?

Two types are highlighted: structural and behavioural.

How do plants and animals acquire adaptations?

Adaptations are the result of evolution, specifically natural selection. Adaptations are inherited; they're passed from generation to generation.

ACTIVITY 5.2
MY ADAPTATIONS

INDIVIDUAL OR SMALL GROUPS

suggested time: 30 minutes

After the discussion students explore adaptations of featured animals by reviewing the fact sheet series, *My adaptations* (student sheet 10).

Distribute one or more *My adaptations* fact sheets to students/groups.

The fact sheets use text and imagery to present information about an animal, its environment, and its structural and behavioural adaptations. Students interpret this information and organise/present it in a form of their choice, (e g a mind map, chart, diagram or table).

Students may use the layout provided in the student workbook *Types of adaptations* (student sheet 11).

This activity demonstrates students' understanding of different types of adaptations, functions of these adaptations, and relationship to an animal's environment.

The activity also allows students to display skills in interpreting visual and written information.

Teachers can review student answers as part of an evaluation component.

student sheet 10

student sheet 11

PART 6

SHOW WHAT YOU KNOW

PURPOSE

Students demonstrate understanding of key concepts learned throughout *Introducing adaptations* by writing their own folk story featuring an Australian animal and describing how this animal came to have particular adaptation(s).

OUTCOMES

Students:

- demonstrate understanding of key adaptation concepts: adaptations have a function; adaptations help an organism fit their environment; and adaptations increase the chance of species' survival;
- communicate, through story, understanding of adaptations in relation to an animal's environment;
- practise online research skills, discovering, assimilating and recording information about an Australian animal;
- create a fictional story demonstrating conceptual understanding of adaptations; and
- plan and write a structured narrative that interweaves fact and fiction.

ACTIVITY SUMMARY

ACTIVITY	DESCRIPTION	MATERIALS
6.1 *Bara Boodie, the burrowing bettong*	This folk story introduces burrowing bettongs, and adaptations that help them survive in changing environments, ensuring survival of the species.	Story is on pages 7 – 15 of this manual and included in *digital-resources*.
6.2 *Show what you know*	Students: identify an Australian animal; research this animal; identify adaptations that allow it to thrive in its environment; and write a fictitious narrative that describes how these adaptations were acquired.	student sheet 12: Show what you know
6.3 *Present your story*	Students present their original adaptation story in a creative format: audio, visual, printed, oral or theatrical.	

SCIENCE BACKGROUND

Story writing can provide a useful summative evaluation tool. In this activity, students are required to write a folk story that introduces relevant facts within fiction. Teachers may analyse these stories to assess whether students understand key concepts that are the focus of this unit of work: adaptations and their functions, and how these help to ensure organisms' continued existence in their relevant environments.

Rubrics at the end of this section provide one way for teachers to record students' skills and understandings. There are extra rows for teachers to include their own criteria.

Evaluations may be shared with students to enable them to appreciate their own learning.

Ideas for completed stories

Students may exchange completed stories: read each other's story and identify the animal in them, adaptations described, their functions and other factual information.

Factual information may be added to a class chart or scrapbook. Stories may be presented to the class as a PowerPoint or another oral form of presentation. If possible, present stories to a wider audience. Written stories may be collated to compile a class book of stories to share. If you have the software, stories may be converted into an eBook or other digital form.

ACTIVITY 6.1

REVIEW BARA BOODIE, THE BURROWING BETTONG

WHOLE CLASS, GROUP OR INDIVIDUAL

suggested time: 10 minutes

Re-read *Bara Boodie, the burrowing bettong*, noting adaptations of burrowing bettongs and functions of these adaptations in its environment. Review any lists, word walls, or KWL charts created in earlier lessons.

Remind students of the central premise of this story: how burrowing bettongs came to burrow.

Revisit major themes of the story:

- Environmental changes resulted in changes to burrowing bettong behaviour and their physical features.
- Arrival of wedge-tailed eagles into the bettongs' environment threatened their survival, resulting in bettongs' changed behaviours: digging burrows for shelter, and adopting a nocturnal lifestyle.
- This behaviour change reduced chances of predation and increased chances of burrowing bettongs surviving. Adopting an underground lifestyle also resulted in changes to physical features: their forelimbs grew stronger and their claws longer in order to excavate burrows.

Discuss how adaptations were woven into the folk tale, and review factual and fictitious elements presented in the story.

Remind students of the meaning of adaptation: an adaptation has a function, an adaptation increases the likelihood of survival, and adaptations help an organism fit its environment. Despite the theme of the story, adaptations are not chosen by an animal or plant. Adaptations are the result of evolution due to natural selection and are shaped by pressures in the surrounding environment.

ACTIVITY 6.2

SHOW WHAT YOU KNOW

INDIVIDUAL ACTIVITY

suggested time: 60 minutes

Outline the evaluation task to students:

- pick an Australian animal;
- conduct your own research on this animal; and
- write your own adaptation folk tale on this animal featuring one or more of its adaptations.

Encourage students to choose an Australian animal. They may wish to feature an animal that has appeared in other resources within *Introducing adaptations*, such as: *Find my food* card game, *Featured creatures* presentation, *Adaptations in action* video or *What adaptation is this?*

Echidna
photo by Barry Thomas

Numbat
© Mike Freeth

Mountain pygmy possum
© The University of Western Australia

Water holding frog
© James Ward

Students use the Internet or other sources to discover information about their chosen animal. We recommend the following websites:

- http://australianmuseum.net.au/wild-kids
- http://www.abc.net.au/tveducation/animals/default.htm
- http://ngkids.com.au/

ACTIVITY 6.2: SHOW WHAT YOU KNOW

Students use student sheet 12, *Show what you know*, to guide them through information collection. They may list factual information about their chosen animal, including adaptations and their function, under headings provided on the worksheet. From this list students choose at least one adaptation to feature in a fictitious story.


STUDENT SHEET 12

SHOW WHAT YOU KNOW

student sheet 12

Students plan and write their own adaptation folk tale about an Australian animal. Students may consider the narrative framework of *Bara Boodie, the burrowing bettong*, paying attention to how and where factual information is included within the story.

Students plan a story outline that shows:

- how the plot develops through imaginary events;
- where their chosen animals' adaptations and functions are introduced; and
- uses the narrative framework to organise content for their story.

Students write their first draft using their plan or outline as a guide. Encourage extension of/changes to their plans where necessary to include additional ideas, changes in sequence, extra events, and other ideas where relevant.

Students edit their stories, check their facts, and when satisfied, write their final copy.

ACTIVITY 6.3

PRESENT YOUR STORY

INDIVIDUAL, GROUPS OR CLASS

suggested time: 30 minutes

Students decide on the final form in which they wish to present their stories. Creative suggestions and ideas are included in the workbook (student sheet 12), but students may come up with their own.

Students may also exchange stories with a partner, read each other's story and identify the animal; its adaptations and their functions; its environment; and other factual information.

This activity has the potential for oral presentation and class discussion of completed stories.

EVALUATION – WRITTEN

Student name:..... **Date:**.....

WRITTEN PRESENTATION			
Organisation	Story has limited structure and is hard to follow.	Story has partial structure but facts are not presented consistently within the narrative form, nor drawn together in a conclusion.	Story uses narrative structure effectively to introduce facts through fiction, and effectively draws them together in a conclusion.
Sequencing and clarity	Story has little cohesion, events are randomly presented, and facts seldom relate to the story.	Story's events are mainly sequential but with a few exceptions. Facts are sometimes included in unrelated sections.	Story is clearly sequenced with events and facts presented in logical order, and summarised in an effective conclusion.
CONTENT			
Facts	Facts included are often inaccurate. They are difficult to distinguish from the fiction.	Some appropriate facts are presented in relevant parts of the story.	Facts are accurately identified and consistently presented in relevant parts of the story.
	The plot is confused, events are difficult to follow and contain few facts.	The plot is reasonably coherent and combines some facts with fiction.	The plot is well developed and coherently presents facts within the fiction.
SCIENCE CONCEPTS			
Adaptations	Features chosen are not adaptations.	Most adaptations are accurately identified.	Adaptations are consistently identified accurately.
Functions of adaptations	Functions identified often do not relate to the adaptation described.	Sometimes, relevant functions are matched to adaptations described.	Functions of adaptations presented are consistently accurate.
Environment	Environment described is not appropriate.	Environment is not described consistently.	An appropriate environment is described accurately and consistently.
Adaptations and environment	Adaptations do not relate to the animal's environment.	Some presented adaptations relate to the animal's environment.	Adaptations relate directly to the animal's environment.

EVALUATION – ORAL PRESENTATION

Organisation	Student presents with no logical sequence of information making it hard to understand.	Student sometimes strays from the topic which makes it hard for the audience to follow the presentation at all times.	Student presents information in a logical and interesting sequence which the audience can follow throughout.
Subject knowledge	Student does not have a grasp of the information and cannot answer questions about the subject.	Student is not confident with information and can answer only basic questions.	Student demonstrates knowledge by answering all questions with explanations and elaborations.
Graphics	Student uses irrelevant graphics, or none at all.	Student uses graphics but occasionally they fail to support the text and presentation.	Student's graphics relate to the topic and also explain and reinforce the text and overall presentation.
Language	Student's presentation has five or more errors: spelling and/or grammatical.	Presentation has two or three errors: spelling and/or grammatical.	Presentation has no errors: spelling or grammatical.
Eye contact	Student reads the presentation with no eye contact with audience.	Student occasionally uses eye contact, but reads most of the presentation.	Student maintains eye contact with audience, seldom referring to notes.
Speech	Student mumbles, incorrectly pronounces words, and speaks too quickly and quietly for all to hear.	Student pronounces most words correctly, but voice is difficult to hear at all times.	Student speaks clearly with correct, pronunciation so that all audience members can hear the presentation.

PART 7

APPENDICES

STUDENT SHEET 1: FINDING THE FACTS — ANSWERS

1. After you've read the story, *Bara Boodie, the burrowing bettong*, organise all the real life facts about boodies you can find in it. (Hint: Stories' illustrations may add details that don't appear in the text.) Present your facts as a table, a mind map, or a diagram.

Students' answers may differ. Final class discussion will clarify this.

Sample organisation of information in the story.

Physical features:
They are small (28 - 40 cm), kangaroo-like animals with short muzzle; small rounded ears; fat, prehensile tails with white tip; and thick grey fur. Some boodies have a golden tinge in their fur.

Habitat, in the past and in the story:
They used to live all over Australia in all sorts of places: from shady woodlands with grasses and shrubs, to wide sandy deserts. In the story Bara lives in Western Australia's Western Desert.

Location of Bara's home and the type of home she lived in:
She lived with her family in the Australian Western Desert, in Martu people's country. Their home was a nest, under a quandong tree. Now, remaining boodies live in burrows single tunnels or warrens.

Food:
Boodies eat seeds, plants, bush tomatoes, fruit and nuts, quandongs, roots, tubers and termites. Dawn is when they find the freshest food.

Sounds boodies make:
Squeaks, hisses, grunts, and a noise like farting when they're frightened.

Behaviours and reasons for these:
Over time boodies came to bound fast like kangaroos, to escape predators. Other behaviours include: collecting bundles of spinifex and grasses to line their nests; digging burrows and tunnels to connect to those of other boodies as they are social animals; sniffing out and foraging for food at night to avoid predators; and returning to their burrows to sleep in the day and avoid predators.

Predators:
wedge-tailed eagles
(Note: additional research will uncover more including dingoes, cats, and dogs.)

Other information in the story:

They are called both boodies (their Aboriginal name) and burrowing bettongs.

They are the only burrowing kangaroos.

They have an acute sense of smell that helps to find food in the dark.

Martu people live in the Western Desert.

Quandong trees, spinifex and bush tomatoes grow in the desert.

Wedge-tailed eagles carry off boodies if they find them outside during the day.

Burrows protect boodies and are cooler than above ground nests.

2. Do you think any or all of the facts you've listed are correct? Why do you think this?

Answers will vary. Examples may include: 'I've read/watched a documentary about boodies that showed some facts are correct' to 'I don't know'.

All facts above are correct.

STUDENT SHEET 1: FINDING THE FACTS — ANSWERS

3. Explain how some features and behaviours you've listed help boodies live in their environment.

Structural features:

- *tails act as a fat store,*
- *prehensile tail for carrying nesting materials,*
- *strong back legs for hopping motion,*
- *long claws and strong forelimbs for digging burrows, and*
- *acute sense of smell to locate food.*

Behavioural features:

- *collecting nesting material to line burrows,*
- *nocturnal behaviour to avoid predators,*
- *building burrows to avoid predators and hot conditions, and*
- *social behaviour, living in small groups for protection against predators.*

4. Research burrowing bettongs (boodies) on the Internet or in your library, and tick each of the facts in your list that are correct.

All above facts are correct.

5. Write any other facts about boodies you discovered in your research.

Answers will vary.

STUDENT SHEET 7: COOL PENGUINS — ANSWERS

KEEPING WARM UNDERWATER PART 1

1. Over the four minute time period, predict which plastic bag will show the lowest temperature: the bag containing vegetable shortening, or the bag without?

Answers will vary.

2. What does vegetable shortening represent in this activity?

Vegetable shortening represents the thick layer of fat found beneath the emperor penguin's skin.

3. In the table below enter temperatures collected from both plastic bags, during the activity.

Table 1: temperatures in insulated plastic bag and empty plastic bag over a 4 minute time period.

TIME (MINUTES)	GLOVE 1 (INSULATION) TEMPERATURE (°C)	GLOVE 2 (NO INSULATION) TEMPERATURE (°C)
2	*21*	*14*
4	*20.5*	*14*

4. Was your prediction about which temperature was lowest correct?

Answers will vary.

KEEPING WARM UNDERWATER PART 2

5. Did you notice a difference in temperature when you submerged both hands in cold water? Describe any differences you noticed.

Answers will vary. Students should note the hand protected by shortening will stay warm longer, whilst their unprotected hand will cool quickly.

6. What advantage would a thick layer of fat provide the emperor penguin in the Antarctic environment?

The Antarctic is a very cold environment and emperor penguins need to stay warm, especially when they dive underwater to find food. The thick layer of fat beneath their skin acts as an insulator, reducing heat loss to the environment.

STAYING WARM ON ICE

1. Predict which test tube, filled with hot water, will cool down fastest: the test tube in the centre of the group, or the single test tube.

Answers will vary.

2. In the table below enter temperatures collected from both the group of test tubes and single test tube.

Table 2: temperature of grouped test tubes and single test tubes.

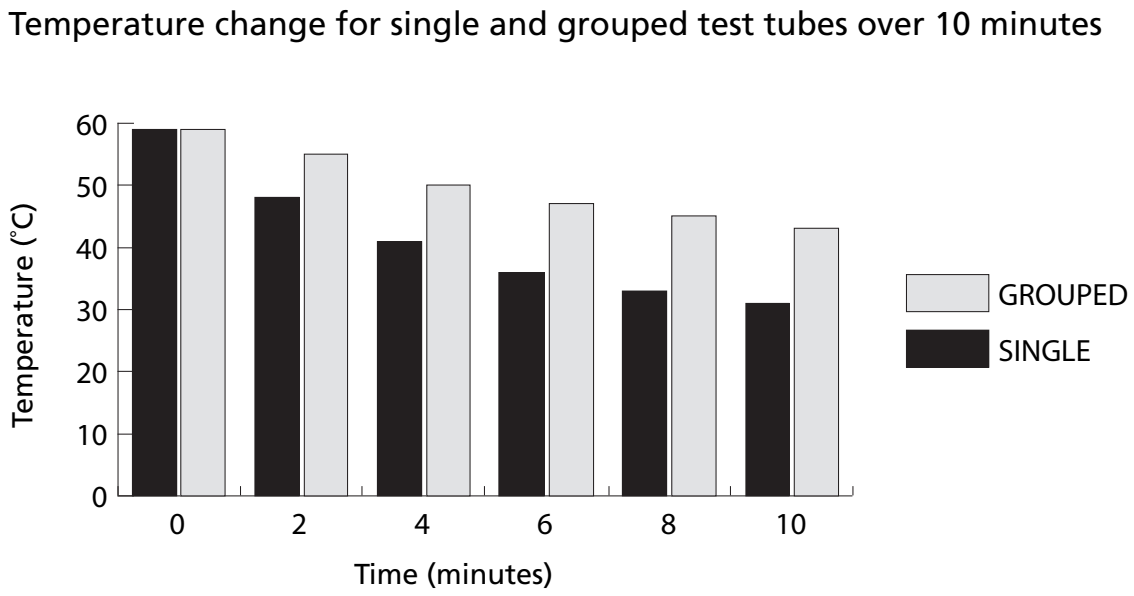
TIME (MINUTES)	SINGLE TEST TUBE TEMPERATURE (°C)	GROUPED TEST TUBES TEMPERATURE (°C)
0	*59*	*59*
2	*48*	*55*
4	*41*	*50*
6	*36*	*47*
8	*33*	*45*
10	*31*	*43*
total drop in temperature	*28*	*16*

3. Calculate, using subtraction, the total change in temperature from 0 minutes to 10 minutes for both single test tube and grouped test tubes.

Answers will vary. Sample data is provided above. The single test tube should reveal a larger temperature change than the grouped test tubes.

4. Present results from the table in a column graph using the grid below. Display both the single test tube and grouped test tube results in your chart.

Sample graph provided below.



5. Was your prediction about which test tube would cool down quickest correct?

Answers will vary.

6. How does huddling together help emperor penguins stay warm?

By huddling together during severe weather emperor penguins reduce the amount of body heat lost to the environment, this saves energy, and helps them survive their long winter fast.

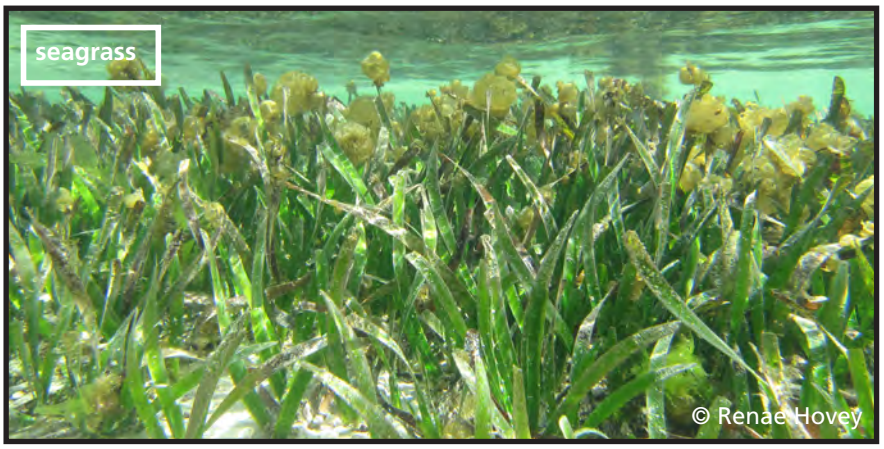
7. Fill in the missing words.

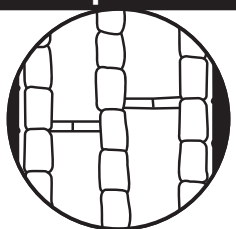
*Huddling behaviour and insulating fat are both **adaptations** of the emperor penguin that help it **survive** in the Antarctic.*

8. Write down any other information you might know or research about emperor penguins and their adaptations for life in Antarctica.

Answers will vary.

STUDENT SHEET 9: ADAPTATIONS MATCH-UP ANSWERS



Adaptation	Adaptation	Adaptation	Adaptation
			
flowers	air spaces	flexible leaves	strong roots
Function:	**Function:**	**Function:**	**Function:**
to help me to reproduce.	to move gas around.	to help my leaves bend with the waves.	to anchor me to the sea floor.

STUDENT SHEET 9: ADAPTATIONS MATCH-UP ANSWERS

Adaptation

grinding teeth

Function:

to help me crush prey.

Adaptation

whiskers

Function:

to help me sense prey underwater.

Adaptation

streamlined body

Function:

to reduce drag when swimming.

Adaptation

waterproof fur

Function:

to keep me warm.

Adaptation

long tail

Function:

to act as a rudder.

Adaptation

retractable ears

Function:

to keep water out.

Adaptation

webbed feet

Function:

to help me swim.

STUDENT SHEET 9: ADAPTATIONS MATCH-UP — ANSWERS

Adaptation

eyes on the top of head

Function:

to help me keep an eye out for food.

Adaptation

cocoon

Function:

to stop me drying out.

Adaptation

grey-green skin

Function:

to blend in with the environment.

Adaptation

digging tool

Function:

to help me dig burrows.

Adaptation

webbed feet

Function:

to help me swim.

STUDENT SHEET 11: TYPES OF ADAPTATIONS — ANSWERS

Name *Velvet gecko*

My structural adaptations are:

- *camouflage, and*
- *suction cup feet.*

My behavioural adaptations are:

- *being nocturnal,*
- *camouflage, and*
- *dropping my tail when under attack.*

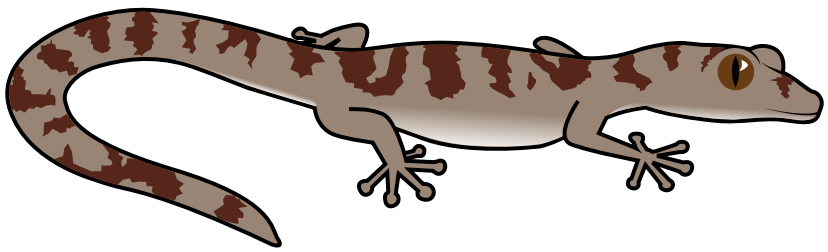
My structural adaptations help me survive by:

- *protecting me from predators,*
- *helping me sneak up on prey, and*
- *allowing me to stick to almost any surface.*

My behavioural adaptations help me survive by:

- *finding food at night,*
- *avoiding predation, and*
- *escaping predators.*

Draw your animal.



My environment has shaped my adaptations because it has:

• places to hide, • colours which my skin matches, and • predators.

STUDENT SHEET 11: TYPES OF ADAPTATIONS — ANSWERS

Name *Mountain pygmy possum*

My structural adaptations are:

- *pouch, and*
- *long grasping tail.*

My behavioural adaptations are:

- *hibernating,*
- *building a nest, and*
- *being nocturnal.*

My structural adaptations help me survive by:

- *providing a safe place to raise young, and*
- *helping me collect nesting materials.*

My behavioural adaptations help me survive by:

- *keeping me warm in winter,*
- *keeping my young warm and safe,*
- *avoiding predators, and*
- *finding food, like moths.*

Draw your animal.

My environment has shaped my adaptations because it has:

- *places to hide,*
- *places to hibernate,*
- *very cold winters, and*
- *predators.*

STUDENT SHEET 11: TYPES OF ADAPTATIONS — ANSWERS

Name *Bilby*

My structural adaptations are:

- *large ears,*
- *strong legs, and*
- *sharp claws.*

My behavioural adaptations are:

- *burrowing, and*
- *being nocturnal.*

My structural adaptations help me survive by:

- *listening for insect prey,*
- *listening for predators, and*
- *digging.*

My behavioural adaptations help me survive by:

- *providing a place to stay cool in the heat, and*
- *avoiding predators.*

Draw your animal.

My environment has shaped my adaptations because it has:

- *extreme heat,*
- *underground insects, and*
- *predators.*

STUDENT SHEET 11: TYPES OF ADAPTATIONS — ANSWERS

Name *Forest red-tailed cockatoo*

My structural adaptations are:

- *powerful beak, and*
- *wings.*

My behavioural adaptations are:

- *nesting in tree hollows, and*
- *courtship displays.*

My structural adaptations help me survive by:

- *helping me break open nuts and seeds,*
- *defending myself against threats, and*
- *travelling to find food.*

My behavioural adaptations help me survive by:

- *keeping my young safe from predators, and*
- *attracting potential mates.*

Draw your animal.

My environment has shaped my adaptations because it has:

- *very tall trees,*
- *hard tough seeds and nuts, and*
- *predators.*

STUDENT SHEET 11: TYPES OF ADAPTATIONS — ANSWERS

Name *Platypus*

My structural adaptations are:

- *webbed feet, and*
- *flat tail.*

My behavioural adaptations are:

- *burrowing,*
- *building a nest, and*
- *being nocturnal.*

My structural adaptations help me survive by:

- *swimming, and*
- *steering underwater.*

My behavioural adaptations help me survive by:

- *having a safe place to sleep,*
- *having a safe place to raise my young, and*
- *avoiding predators.*

Draw your animal.

My environment has shaped my adaptations because it has:

- *water,*
- *underwater food sources, and*
- *predators.*

STUDENT SHEET 11: TYPES OF ADAPTATIONS — ANSWERS

Name *Goliath stick insect*

My structural adaptations are:

- *camouflage, and*
- *colourful patterns.*

My behavioural adaptations are:

- *being nocturnal, and*
- *defensive display.*

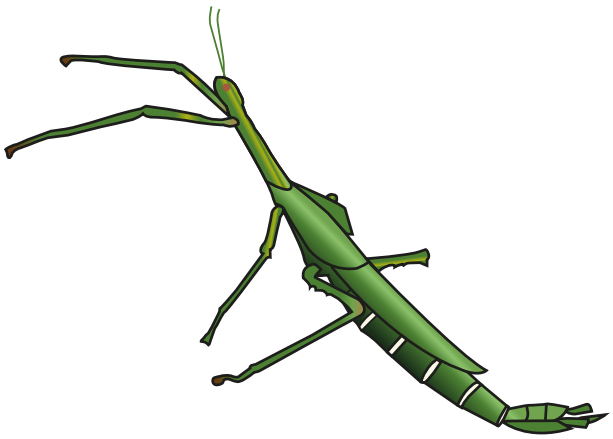
My structural adaptations help me survive by:

- *hiding from predators, and*
- *threatening predators.*

My behavioural adaptations help me survive by:

- *avoiding predators like birds, and*
- *threatening potential predators.*

Draw your animal.



My environment has shaped my adaptations because it has:

• trees and shrubs, • colours that my body markings match, and • predators.

SELECTED REFERENCES

Cartledge, V. A., Withers, P. C. and S. Don Bradshaw (2008). Water balance and Arginine Vasotocin in the Cocooning Frog *Cyclorana platycephala* (Hylidae). *Physiological and Biochemical Zoology*, Vol. 81, No. 1, pp. 43-53. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/18040971

Chanet, Bruno and François Lusignan (2008). Teaching Evolution in Primary Schools: An Example in French Classrooms. *Evolution Education and Outreach* 2: 136-140. Retrieved from http://link.springer.com/article/10.1007%2Fs12052-008-0095-y

Department of the Environment (2016). Species Profile and Threats Database. Australian Government. http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl

Endreny, Anna Henderson (2006) Children's Ideas About Animal Adaptations: An Action Research Project. *Journal of Elementary Science Education*, Vol. 18, No. 1, pp. 33-42. Retrieved from http://eric.ed.gov/?id=EJ798821

Hackling, Mark (2005). Working Scientifically: Implementing and Assessing Open Investigation Work in Science. Department of Education and Training, Western Australia

Myers, P., R. Espinosa, C. S. Parr, T. Jones, G. S. Hammond, and T. A. Dewey. 2016. The Animal Diversity Web (online). http://animaldiversity.org.

Noble, James C., Müller, Warren J., Detling, James K. and Gilbert H. Pfitzner (2007). Landscape ecology of the burrowing bettong: Warren distribution and patch dynamics in semiarid eastern Australia. *Austral Ecology*, 32, 326-337. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1442-9993.2007.01698.x/abstract

Short, Jeff and Bruce Turner (1993). The Distribution and Abundance of the Burrowing Bettong (Marsupialia: Macropodoidea). *Wildlife Research*, 20, 525-34. Retrieved from http://www.publish.csiro.au/?act=view_file&file_id=WR9930525.pdf

Short, Jeff and Bruce Turner (1999). Ecology of burrowing bettongs, *Bettongia lesueur* (Marsupialia: Potoroidae), on Dorre and Bernier Islands, Western Australia. *Wildlife Research*, 26, 651-669. Retrieved from http://www.publish.csiro.au/paper/WR98039.htm

Smart, C., Speldewinde, P.C. & H.R. Mills (2011). Influence of habitat characteristics on the distribution of the water-rat (*Hydromys chrysogaster*) in the greater Perth region, Western Australia. *Journal of the Royal Society of Western Australia*, 94:533-539. Retrieved from http://www.rswa.org.au/publications/Journal/94%284%29/ROY%20SOC%2094.4%20SMART%20533-539.pdf

Speldewinde P.C., Close, P., Weybury, M. and S. Come (2013). Habitat preference of the Australian water rat (*Hydromys chrysogaster*) in a coastal and wetland stream, Two Peoples Bay, south-western Australia. *Australian Mammology* 35(2) 188-194. Retrieved from http://www.publish.csiro.au/paper/AM12001.htm

Understanding evolution. 2016. University of California Museum of Palaeontology. http://evolution.berkeley.edu/evolibrary/home.php