Primary**Connections**®
Linking science with literacy

Fully aligned with the Australian Curriculum

The Primary**Connections** program is supported by astronomer, Professor Brian Schmidt, Nobel Laureate

Desert survivors

Year 5

Biological sciences

Primary**Connections project**

Australian Academy of Science

Professional learning program

Primary**Connections** comprises a professional learning program supported with exemplary curriculum resources to enhance teaching and learning in science and literacy. Research shows that this combination is more effective than using each in isolation.

Professional Learning Facilitators are available throughout Australia to conduct workshops on the underpinning principles of the program: the Primary**Connections** 5Es teaching and learning model, linking science with literacy, investigating, embedded assessment and collaborative learning.

The Primary**Connections** website has contact details for state and territory Professional Learning Coordinators, as well as additional resources for this unit. Visit the website at:
www.primaryconnections.org.au

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Desert survivors

Year 5

Biological sciences



It can be hard to imagine how any form of life could survive in the extreme temperatures and dryness of a desert environment. Yet even in such places an amazing diversity of plants and animals can still be found. Their structural features and adaptations not only help them to survive, but thrive under these conditions.

The *Desert survivors* unit is an ideal way to link science with literacy in the classroom. It provides an opportunity for students to explore some of the structural features and adaptations of desert plants and animals, and to compare them with plants and animals that live in other environments. They pose questions and develop evidence-based claims supported by their reasoning. Through hands-on activities, students investigate how the structural features of desert plants and animals help them to survive in their own natural environment.

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Contents

Foreword

The Australian Academy of Science is proud of its long tradition of supporting and informing science education in Australia. 'Primary**Connections:** linking science with literacy' is its flagship primary school science program, and it is making a real difference to the teaching and learning of science in Australian schools.

The Primary**Connections** approach has been embraced by schools since its inception in 2004, and there is substantial evidence of its effectiveness in helping teachers transform their practice. It builds teacher confidence and competence in this important area, and helps teachers use their professional skills to incorporate elements of the approach into other areas of the curriculum. Beginning and pre-service teachers find the approach do-able and sustainable. Primary**Connections** students enjoy science more than in comparison classes, and Indigenous students, in particular, show significant increases in learning using the approach.

The project has several components: professional learning, curriculum resources, research and evaluation, and Indigenous perspectives. With the development of an Australian curriculum in the sciences by ACARA in December 2010, it is an exciting time for schools to engage with science, and to raise the profile of primary science education.

Students are naturally curious. Primary**Connections** provides an inquiry-based approach that helps students develop deep learning, and guides them to find scientific ways to answer their questions. The lessons include key science background information, and further science information is included on the Primary**Connections** website (www.primaryconnections.org.au).

Science education provides a foundation for a scientifically literate society, which is so important for engagement in key community debates, such as climate change, carbon emissions, and immunisation, as well as for personal decisions about health and well-being. The inquiry approach in Primary**Connections** prepares students well to participate in evidence-based discussions of these and other issues.

Primary**Connections** has been developed with the financial support of the Australian Government and has been endorsed by education authorities across the country. The Steering Committee, comprising the Department of Education, Employment and Workplace Relations and Academy representatives, and the Reference Group, which includes representatives from all stakeholder bodies including states and territories, have provided invaluable guidance and support. Before publication, the teacher background information on science is reviewed by a Fellow of the Academy. All these inputs have ensured an award-winning, quality program.

The Fellows of the Academy are committed to ongoing support for teachers of science at all levels. I commend Primary**Connections** to you and wish you well in your teaching.

Professor Suzanne Cory, AC PresAA FRS
President (2010–2013)
Australian Academy of Science

The PrimaryConnections program

Primary**Connections** is an innovative program that links the teaching of science and literacy in the primary years of schooling. It is an exciting and rewarding approach for teachers and students, with a professional learning program and supporting curriculum resources. Further information about professional learning and other curriculum support can be found on the Primary**Connections** website: (www.primaryconnections.org.au)

The PrimaryConnections teaching and learning model

This unit is one of a series designed to exemplify the Primary**Connections** teaching and learning approach, which embeds inquiry-based learning into a modified 5Es instructional model with the five phases: *Engage, Explore, Explain, Elaborate* and *Evaluate* (Bybee, 1997). The relationship between the 5Es phases, investigations, literacy products and assessment is illustrated below:

Primary**Connections 5Es teaching and learning model**

Phase	Focus	Assessment focus
ENGAGE	Engage students and elicit prior knowledge	**Diagnostic assessment**
EXPLORE	Provide hands-on experience of the phenomenon	**Formative assessment**
EXPLAIN	Develop scientific explanations for observations and represent developing conceptual understanding Consider current scientific explanations	**Formative assessment**
ELABORATE	Extend understanding to a new context or make connections to additional concepts through a student-planned investigation	**Summative assessment** of the Science Inquiry Skills
EVALUATE	Students re-represent their understanding and reflect on their learning journey, and teachers collect evidence about the achievement of outcomes	**Summative assessment** of the Science Understanding

More information on Primary**Connections** 5Es teaching and learning model can be found at: www.primaryconnections.org.au

Developing students' scientific literacy

The learning outcomes in Primary**Connections** contribute to developing students' scientific literacy. Scientific literacy is considered the main purpose of school science education and has been described as an individual's:

- scientific knowledge and use of that knowledge to identify questions, acquire new knowledge, explain scientific phenomena and draw evidence-based conclusions about science-related issues
- understanding of the characteristic features of science as a form of human knowledge and enquiry
- awareness of how science and technology shape our material, intellectual and cultural environments
- willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen (Programme for International Student Assessment & Organisation for Economic Co-operation and Development [PISA & OECD], 2009).

Linking science with literacy

Primary**Connections** has an explicit focus on developing students' knowledge, skills, understanding and capacities in science and literacy. Units employ a range of strategies to encourage students to think about and to represent science.

Primary**Connections** develops the literacies of science that students need to learn and to represent their understanding of science concepts, processes and skills. Representations in Primary**Connections** are multi-modal and include text, tables, graphs, models, drawings and embodied forms, such as gesture and role-play. Students use their everyday literacies to learn the new literacies of science. Science provides authentic contexts and meaningful purposes for literacy learning, and also provides opportunities to develop a wider range of literacies. Teaching science with literacy improves learning outcomes in both areas.

Assessment

Assessment against the year level achievement standards of the Australian Curriculum: Science (ACARA, 2014) is ongoing and embedded in Primary**Connections** units. Assessment is linked to the development of literacy practices and products. Relevant understandings and skills are highlighted at the beginning of each lesson. Different types of assessment are emphasised in different phases:

Diagnostic assessment occurs in the *Engage* phase. This assessment is to elicit students' prior knowledge so that the teacher can take account of this when planning how the *Explore* and *Explain* lessons will be implemented.

Formative assessment occurs in the *Explore and Explain* phases. This enables the teacher to monitor students' developing understanding and provide feedback that can extend and deepen students' learning.

Summative assessment of the students' achievement developed throughout the unit occurs in the *Elaborate* phase for the Science Inquiry Skills, and in the *Evaluate* phase for the Science Understanding.

Alignment with the Australian Curriculum: Science

The Australian Curriculum: Science has three interrelated strands—Science Understanding, Science as a Human Endeavour and Science Inquiry Skills—that together 'provide students with understanding, knowledge and skills through which they can develop a scientific view of the world' (ACARA, 2014).

The content of these strands is described by the Australian Curriculum as:

Science Understanding	
Biological sciences	Understanding living things
Chemical sciences	Understanding the composition and behaviour of substances
Earth and space sciences	Understanding Earth's dynamic structure and its place in the cosmos
Physical sciences	Understanding the nature of forces and motion, and matter and energy
Science as a Human Endeavour	
Nature and development of science	An appreciation of the unique nature of science and scientific knowledge.
Use and influence of science	How science knowledge and applications affect people's lives and how science is influenced by society and can be used to inform decisions and actions
Science Inquiry Skills	
Questioning and predicting	Identifying and constructing questions, proposing hypotheses and suggesting possible outcomes
Planning and conducting	Making decisions regarding how to investigate or solve a problem and carrying out an investigation, including the collection of data
Processing and analysing data and information	Representing data in meaningful and useful ways; identifying trends, patterns and relationships in data, and using evidence to justify conclusions
Evaluating	Considering the quality of available evidence and the merit or significance of a claim, proposition or conclusion with reference to that evidence
Communicating	Conveying information or ideas to others through appropriate representations, text types and modes

AC All the material in this table is sourced from the Australian Curriculum.

There will be a minimum of four Primary**Connections** units for each year of primary school from Foundation to Year 6—at least one for each Science Understanding sub-strand of the Australian Curriculum. Each unit contains detailed information about its alignment with all aspects of the Australian Curriculum: Science and its links to the Australian Curriculum: English and Mathematics.

Safety

SAFETY

Learning to use materials and equipment safely is central to working scientifically. It is important, however, for teachers to review each lesson before teaching to identify and manage safety issues specific to a group of students. A safety icon (SAFETY) is included in lessons where there is a need to pay particular attention to potential safety hazards. The following guidelines will help minimise risks:

- Be aware of the school's policy on safety in the classroom and for excursions.
- Check students' health records for allergies or other health issues.
- Be aware of potential dangers by trying out activities before students do them.
- Caution students about potential dangers before they begin an activity.
- Clean up spills immediately as slippery floors are dangerous.
- Instruct students never to taste, smell or eat anything unless they are given permission.
- Discuss and display a list of safe practices for science activities.

References

Australian Curriculum Assessment and Reporting Authority (ACARA). (2014). *Australian Curriculum: Science.* www.australiancurriculum.edu.au

Bybee, R.W. (1997). *Achieving scientific literacy: from purposes to practical action.* Portsmouth, NH: Heinemann.

Programme for International Student Assessment & Organisation for Economic Co-operation and Development. (2009). *PISA 2009 assessment framework: key competencies in reading, mathematics and science.* Paris: OECD Publishing.

Unit at a glance

Desert survivors

Phase	Lesson	At a glance
ENGAGE	**Lesson 1** Deadly deserts?	To capture students' interest and find out what they think they know about how living things have structural features and adaptations that help them to survive in their environment To elicit students' questions about how living things survive in desert environments
EXPLORE	**Lesson 2** Dodging desiccation ***Session 1*** Bagging leaves ***Session 2*** Soaking cloths ***Session 3*** Moist in the middle	To provide students with hands-on, shared experiences of how having smaller leaves can help plants avoid desiccation
	Lesson 3 Way too warm	To provide students with hands-on, shared experiences of how having a larger surface area can help animals to cool down
	Lesson 4 Colourful creatures *(Optional)* ***Session 1*** Perspicacious predators ***Session 2*** Ravishing or ridiculous?	To provide students with hands-on, shared experiences of how living things adapt to other living things through the use of colour
EXPLAIN	**Lesson 5** Ships of the desert	To support students to represent and explain their understanding of how structural features and adaptations help living things to survive in their environment To introduce current scientific views about structural features and adaptations
	Lesson 6 Species specialists	To support students to research information about the structural features and adaptations of a particular desert animal or plant
ELABORATE	**Lesson 7** Checking claims	To support students to plan and conduct an investigation of whether or not structural features of an animal are adaptations for surviving in a desert environment

Unit at a glance *Desert survivors*

Phase	Lesson	At a glance
EVALUATE	**Lesson 8** Powerful presentations	To support students to present their evidence-based claims about different structural features and adaptations for surviving in a desert environment, and to reflect on their learning during the unit
	Lesson 9 Plausible possibilities	To provide opportunities for students to represent what they know about how living things have structural features and adaptations that help them to survive in their environment, and to reflect on their learning during the unit

A unit overview can be found in Appendix 10, page 115.

Alignment with the Australian Curriculum: Science

This *Desert survivors* unit embeds all three strands of the Australian Curriculum: Science.
The table below lists sub-strands and their content for Year 5. This unit is designed to be taught in conjunction with other Year 5 units to cover the full range of the Australian Curriculum: Science content for Year 5.

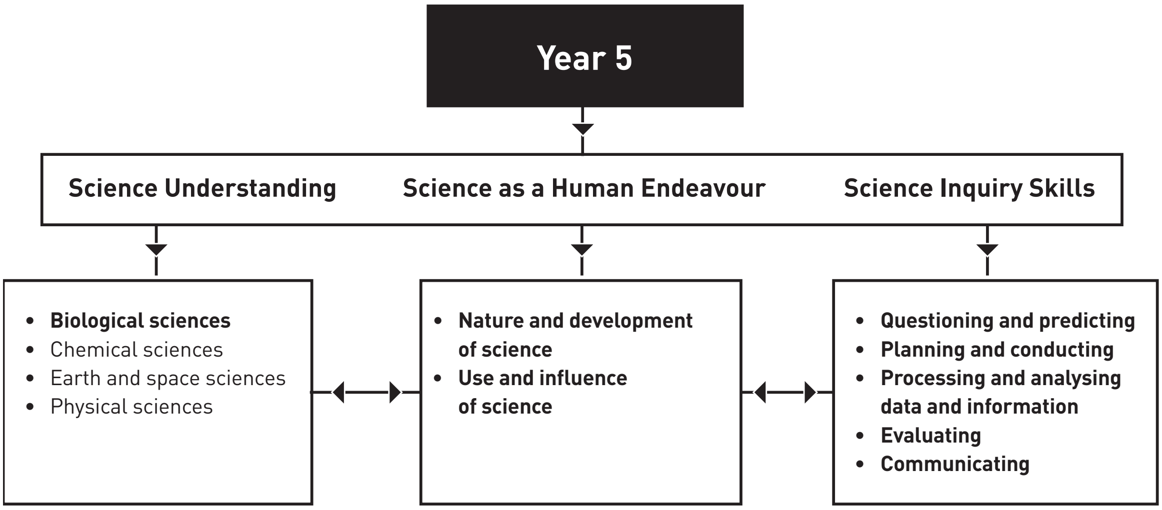
For ease of assessment the table below outlines the sub-strands and their aligned lessons.

Strand	Sub-strand	Code	Year 5 content descriptions	Lessons
Science Understanding (SU)	**Biological sciences**	ACSSU043	Living things have structural features and adaptations that help them to survive in their environment	1–9
Science as a Human Endeavour (SHE)	**Nature and development of science**	ACSHE081	Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena	2–5, 7, 9
		ACSHE082	Important contributions to the advancement of science have been made by people from a range of cultures	1
	Use and influence of science	ACSHE083	Science understandings, discoveries and inventions are used to solve problems that directly affect people's lives	1
		ACSHE217	Science knowledge is used to inform personal and community decisions	1–9
Science Inquiry Skills (SIS)	**Questioning and predicting**	ACSIS231	With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be	1–4, 6, 7
	Planning and conducting	ACSIS086	With guidance, plan appropriate investigation methods to answer questions or solve problems	6, 7
		ACSIS087	Decide which variable should be changed and measured in fair tests and accurately observe, measure and record data, using digital technologies as appropriate	2–4, 7
		ACSIS088	Use equipment and materials safely, identifying potential risks	2–4, 7
	Processing and analysing data and information	ACSIS090	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	2–4, 7
		ACSIS218	Compare data with predictions and use as evidence in developing explanations	2–4, 6–8
	Evaluating	ACSIS091	Suggest improvements to the methods used to investigate a question or solve a problem	3, 7
	Communicating	ACSIS093	Communicate ideas, explanations and processes in a variety of ways, including multi-modal texts	1–9

AC All the material in the first four columns of this table is sourced from the Australian Curriculum.

Interrelationship of the science strands

The interrelationship between the three strands—Science Understanding, Science as a Human Endeavour and Science Inquiry Skills—and their sub-strands is shown below. Sub-strands covered in this unit are in bold.



AC All the terms in this diagram are sourced from the Australian Curriculum.

Relationship to overarching ideas

In the Australian Curriculum: Science, six overarching ideas support the coherence and developmental sequence of science knowledge within and across year levels. In *Desert survivors* these overarching ideas are represented by:

Overarching idea	Incorporation in *Desert survivors*
Patterns, order and organisation	Students observe and describe similarities and differences in features of different desert-dwelling species. They recognise patterns and investigate whether specific features help plants and animals to survive in their environment. They develop criteria for classifying different structural features and behaviours as adaptations.
Form and function	Students identify structural features of desert-dwelling species and describe their form. They investigate whether this form could play a role for survival in environments. They identify relationships, for example, how increased surface area of ears can promote heat loss, which helps survival in a hot environment.
Stability and change	Students explore how structural features of animals and plants that might appear stable can slowly evolve over time to adapt to their environment and to each other.
Scale and measurement	Students discuss how evolutionary adaptations can happen over long timescales whereas behavioural adaptations can happen over short timescales. They use precise measurements of time and volume in their scientific investigations. They explore ‘surface area’ and how it influences heat loss and water retention in desert conditions.
Matter and energy	Students explore some principles of heat (energy) transfer, including how heat exchange depends on available surface areas. They investigate water evaporation (movement of matter) and relate it to surface area.
Systems	Students explore desert environments and identify them as ecosystems with many different living things. They investigate how non-living elements, such as water and heat from the Sun, affect living things.

Curriculum focus

The Australian Curriculum: Science is described by year level, but provides advice across four year groupings on the nature of learners. Each year grouping has a relevant curriculum focus.

Curriculum focus Years 3–6	Incorporation in *Desert survivors*
Recognising questions that can be investigated scientifically and investigating them	Students generate inquiry questions about adaptations of livings things to desert environments. They discuss and formulate plans of action to answer these questions, including literature reviews and conducting scientific investigations. They generate new claims based on evidence to answer their original questions. Investigations might include how surface area affects heat loss and water retention of animals and plants in desert environments.

Achievement standards

The achievement standards of the Australian Curriculum: Science indicate the quality of learning that students typically demonstrate by a particular point in their schooling, for example, at the end of a year level. These standards will be reviewed regularly by ACARA and are available from the ACARA website.

By the end of this unit, teachers will be able to make evidence-based judgments on whether the students are achieving below, at or above the Australian Curriculum: Science Year 5 achievement standard. Rubrics to help teachers make these judgements will be available on the website (www.primaryconnections.org.au)

General capabilities

The skills, behaviours and attributes that students need to succeed in life and work in the 21st century have been identified in the Australian Curriculum as general capabilities. There are seven general capabilities and they are embedded throughout the units. For further information see: www.australiancurriculum.edu.au

For examples of our unit-specific general capabilities information see the next page.

Desert survivors—Australian Curriculum general capabilities

General capabilities	Australian Curriculum description	*Desert survivors* examples
Literacy	Literacy knowledge specific to the study of science develops along with scientific understanding and skills. Primary**Connections** learning activities explicitly introduce literacy focuses and provide students with the opportunity to use them as they think about, reason and represent their understanding of science.	In *Desert survivors* the literacy focuses are: • science journals • TWLH charts • word walls • annotated drawings • tables • graphs • summaries • oral presentations.
Numeracy	Elements of numeracy are particularly evident in Science Inquiry Skills. These include practical measurement and the collection, representation and interpretation of data.	Students: • collect and interpret data in tables • represent and interpret data in simple graphs • identify trends and patterns from numerical data.
Information and communication technology (ICT) competence	ICT competence is particularly evident in Science Inquiry Skills. Students use digital technologies to investigate, create, communicate, and share ideas and results.	Students are given optional opportunities to: • use interactive resource technology to view, record and discuss information • use the internet to research further information on animals and plants • use ICT to create multimedia presentations.
Critical and creative thinking	Students develop critical and creative thinking as they speculate and solve problems through investigations, make evidence-based decisions, and analyse and evaluate information sources to draw conclusions. They develop creative questions and suggest novel solutions.	Students: • ask questions on a TWLH chart and answer them based on investigations • analyse data from investigations and use it to answer their questions • respond to questions and compare predictions with results to formulate conclusions • discuss the uses and limits of models used in an investigation to answer questions • make evidence-based claims about whether different features are adaptations to a particular environment.
Ethical behaviour	Students develop ethical behaviour as they explore principles and guidelines in gathering evidence and consider the implications of their investigations on others and the environment.	Students: • ask questions of others respecting each other's point of view.
Personal and social competence	Students develop personal and social competence as they learn to work effectively in teams, develop collaborative methods of inquiry, work safely, and use their scientific knowledge to make informed choices.	Students: • participate in discussions • work collaboratively in teams • listen to and follow instructions to safely complete investigations.
Intercultural understanding	Intercultural understanding is particularly evident in Science as a Human Endeavour. Students learn about the influence of people from a variety of cultures on the development of scientific understanding.	• cultural perspectives opportunities are highlighted where relevant. • important contributions made to science by people from a range of cultures are highlighted where relevant.

All the material in the first two columns of this table is sourced from the Australian Curriculum.

Cross-curriculum priorities

There are three cross-curriculum priorities identified by the Australian Curriculum:

- Aboriginal and Torres Strait Islander histories and cultures
- Asia and Australia's engagement with Asia
- Sustainability.

For further information see: www.australiancurriculum.edu.au

Aboriginal and Torres Strait Islander histories and cultures

The Primary**Connections** Indigenous perspectives framework supports teachers' implementation of Aboriginal and Torres Strait Islander histories and cultures in science. The framework can be accessed at: www.primaryconnections.org.au

Desert survivors focuses on the Western science way of making evidence-based claims about how living things have evolved adaptations to survive in their environment. When studying an emu, scientists seek to describe selective environmental pressures that can explain some of its structural features and adaptations. For example, they might explain that when ancestors of emus started running fast rather than flying, their wings gradually become vestigial structures that help with heat regulation.

Aboriginal and Torres Strait Islander Peoples might have other explanations for why living things have particular features, often referring to the Dreamtime. For example, some Indigenous groups might explain that the emu lost its wings because it was greedy—the wild turkey tricked the emu into cutting off its wings by saying it could eat more fish that way. Dreamtime stories can be specific to particular people or communities, or can be shared.

Primary**Connections** recommends working with Aboriginal and Torres Strait Islander community members to access local and relevant cultural perspectives. Protocols for engaging with Aboriginal and Torres Strait Islander community members are provided in state and territory education guidelines. Links to these are provided on the Primary**Connections** website.

Asia and Australia's engagement with Asia

The *Desert survivors* unit provides opportunities for students to discuss the plumage of a peacock. This is the national bird of India, chosen because of its rich religious and legendary involvement in Indian traditions. This provides a link to explore the emblems of different countries in Asia and their associated mythologies, literature and artwork.

Sustainability

In *Desert survivors*, students develop an understanding of the desert as an ecosystem, with a diversity of unique life. Through studying adaptations, they explore how some living things are uniquely adapted to survive in their environments and are unable to survive when their environment is disturbed or changed. *Desert survivors* therefore provides opportunities for students to better understand ecosystems and how human activity can affect them. This can assist them to develop knowledge, skills and values for making decisions about individual and community actions that contribute to sustainable patterns of use of the Earth's natural resources.

Alignment with the Australian Curriculum: English and Mathematics

Strand	Sub-strand	Code	Year 5 content descriptions	Lessons
English–Language	**Language for interaction**	ACELA1502	Understand how to move beyond making bare assertions and take account of differing perspectives and points of view	1–9
	Text structure and organisation	ACELA1504	Understand how texts vary in purpose, structure and topic as well as the degree of formality	1–4, 6
	Expressing and developing ideas	ACELA1512	Understand the use of vocabulary to express greater precision of meaning, and know that words can have different meanings in different contexts	1–9
English–Literacy	**Interacting with others**	ACELY1699	Clarify understanding of content as it unfolds in formal and informal situations, connecting ideas to students' own experiences and present and justify a point of view	1–9
		ACELY1796	Use interaction skills, for example paraphrasing, questioning and interpreting non-verbal cues and choose vocabulary and vocal effects appropriate for different audiences and purposes	1–9
		ACELY1700	Plan, rehearse and deliver presentations for defined audiences and purposes incorporating accurate and sequenced content and multimodal elements	8
	Interpreting, analysing, evaluating	ACELY1703	Use comprehension strategies to analyse information, integrating and linking ideas from a variety of print and digital sources	6, 8
	Creating texts	ACELY1707	Use a range of software including word processing programs with fluency to construct, edit and publish written text, and select, edit and place visual, print and audio elements	8
Mathematics–Number and Algebra	**Number and place value**	ACMNA291	Use efficient mental and written strategies and apply appropriate digital technologies to solve problems	2, 3, 7
Mathematics–Measurement and Geometry	**Using units of measurement**	ACMMG108	Choose appropriate units of measurement for length, area, volume, capacity and mass	2, 3, 7
	Shape	ACMMG111	Connect three-dimensional objects with their nets and other two-dimensional representations	2, 3
Mathematics–Statistics and Probability	**Data representation and interpretation**	ACMSP118	Pose questions and collect categorical or numerical data by observation or survey	3, 4, 7
		ACMSP119	Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies	2–4, 7, 8
		ACMSP120	Describe and interpret different data sets in context	2–4, 7, 8

All the material in the first four columns of this table is sourced from the Australian Curriculum.

Other links are highlighted at the end of lessons where possible. These links will be revised and updated on the website (www.primaryconnections.org.au).

Teacher background information

Introduction to adaptations

Survival of the 'fittest'

Looking at an animal or a plant, you can identify structural features and their probable function. For example, some animals have large eyes that allow them to see in darkness and some plants have waxy leaves that help minimise water loss. These features, which are important to the survival of an animal or plant in its native environment, are called 'adaptations'. Adaptations can also be behaviours, such as the instinct to run from danger or the unfurling of leaves when sunlight hits them.

Adaptations evolve by means of natural selection. Within populations there is variation among individuals, such as in the size of eyes and waxiness of leaves. If the conditions in the environment favour particular traits, such as larger eyes that help to see food and predators at night and waxy leaves that help slow dehydration in water-poor environments, then the individuals who have them are more likely to survive and reproduce. If offspring inherit these traits then future generations are more likely to have larger eyes and waxier leaves.

Generally, scientific adaptations are identified at a population level; one individual with a difference is a mutant who might survive better in the environment. If the individual's children inherit the trait and also survive better in the environment, then the mutation will gradually become 'normal' in the population and be considered an adaptation.

The 'environment' for a population is the physical habitat, for example, a desert, and also the community of other livings things in which it lives. For example, the abilities of predators determine the adaptations of prey: if a species' main predator has eyes that primarily detect motion then the instinct to freeze when spotted is an adaptation to that 'environment'.

Beyond survival

The ability to survive in an environment is only one thing that determines what features are common in a population. Other examples include the following possibilities:

- The necessity to reproduce to pass on genes. If individuals selectively choose their mating partners then traits might evolve due to preference. For example, if female birds prefer red chests then the population might evolve red chests. If there is competition to mate then males might develop special characteristics for fighting even if these make it harder to survive. For example, some species of stags fight each other with antlers and therefore have large antlers which can make it harder to walk around in a forest.
- If all individuals have the exact same genes for a particular feature then it will not change or disappear even if it can hinder survival. For example, even if it might be advantageous to have red fur, if all the individuals of the population have black fur then that feature cannot evolve unless the right mutation occurs.
- A mutant might have a structural feature that makes it more difficult to survive, but if the other individuals die from an unexpected event, for example, an avalanche, then the population might end up with that feature.

- Sometimes it doesn't matter either way—structural features and instincts might not affect an individual's ability to survive. In that case the population might end up sharing a structural feature or behaviour because of chance.

Science therefore seeks to justify with evidence and reasoning why features or behaviours can be considered adaptations to an environment. The desert environment is good for studying adaptations to survive because it is so harsh and so it is rare to find features and behaviours that don't help a population's survival. Many desert species are 'specialists' (adapted to live in the specific conditions of the desert, for example, the thorny devil) rather than generalists (adapted to live in most environments with varying degrees of success, for example, common rats).

Species might have very different adaptations to the same environment, and not all these adaptations might be the 'best' adaptation. The adaptations that living things can evolve are constrained by traits they cannot change because they are integral to their development, such as plants not being able to develop muscles to walk to a water source and amphibians not being able to evolve fish scales. They are also constrained by traits that are not variable, for example, there might not be any individuals in the population with the ability to store fat in a hump, so even if it is a remarkable adaptation for camels it might not be an adaptation that other species will adopt.

Students' conceptions

Taking account of students' existing ideas is important in planning effective teaching approaches that help students learn science. Students develop their own ideas during their experiences in everyday life and might hold more than one idea about an event or phenomenon.

Students might believe that individuals adapt to their environment in their lifetime and pass this ability to their offspring. Certain animals, for example, humans, can change their behaviours in new situations and teach this to their offspring. However, the adaptation of species' instincts and structural features, such as longer legs, smaller leaves or camouflage, is not something that happens at an individual level. It is the relative ability of an individual to survive with the structural features and instincts inherited from their parents that determines whether its genes are passed on and, therefore, which features and instincts are more prevalent in the population.

Students might believe that animals choose their adaptations based on their environment. However, adaptations are not a conscious choice by individuals. It is the success of the individual with the structural features and behaviours inherited from its parents in a particular environment that determines which adaptations are 'chosen' genetically. Even the learning of new behaviours is often not a conscious choice, but parents that have adopted them are more likely to survive and teach them to their children (or the population).

Students might think it is easy to change environments, for example, if food becomes unavailable. The ability to survive in new environments depends on what structural features the population has upon arrival and whether it is 'competitive' compared to other populations already present. Desert species are often 'specialists', that is, they have a lot of structural features and behaviours that allow them to thrive relative to other species in their desert environment.

References

Frosehauer, Linda (2010). ‘Editor’s Note—Approaching Adaptation’, *Science and Children* 47(5) p. 6.

Fries-Gaither, Jessica (2009). ‘Common Misconceptions about Biomes and Ecosystems’, *Beyond Penguins and Polar Bears*, an online professional development magazine, Ohio State University project.

Skamp, K. (Ed.) (2012). *Teaching primary science constructively* (4th Edn). South Melbourne: Cengage Learning Australia.

To access more in-depth science information in the form of text, diagrams and animations, refer to the Primary**Connections** Science Background Resource which has now been loaded on the Primary**Connections** website: www.primaryconnections.org.au/science-background-resource/

Note: This background information is intended for the teacher only.

Lesson 1 Deadly deserts?

ENGAGE

AT A GLANCE

To capture students' interest and find out what they think they know about how living things have structural features and adaptations that help them to survive in their environment.

To elicit students' questions about how living things survive in desert environments.

Students:

- discuss Burke and Wills' exploration of Australia
- identify features of desert environments
- explain what structural features they think help living things survive in a desert.

Lesson focus

The focus of the *Engage* phase is to spark students' interest, stimulate their curiosity, raise questions for inquiry and elicit their existing beliefs about the topic. These existing ideas can then be taken account of in future lessons.

Assessment focus

Diagnostic assessment is an important aspect of the *Engage* phase. In this lesson you will elicit what students already know and understand about:

- how living things have different structural features and adaptations that help them to survive in a desert environment
- the contribution that Indigenous peoples of Australia have made to our knowledge of desert flora and fauna
- how to communicate and represent their ideas.

You will also monitor their developing science inquiry skills (see page 4).

ENGAGE

Key lesson outcomes

Science

Students will be able to represent their current understanding as they:

- explain their existing ideas about desert environments that early explorers might have visited
- identify challenges for survival in desert environments and pose questions to clarify their understanding.

Literacy

Students will be able to:

- contribute to class discussions about possible adaptations of plants and animals to desert environments
- use talk to share their ideas
- contribute to the class TWLH chart and word wall
- understand the purpose and features of a science journal, TWLH chart and word wall.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 6).

Teacher background information

Deserts

Deserts are primarily characterised by their lack of water: their 'dryness' or 'aridity'. The Köppen climate classification uses annual rainfall and temperatures to distinguish between different climates. Arid and semi-arid climates are distinguished by having much less rainfall per year than 'normal' green plants would require (calculated based on the average annual temperature and when the rains fall).

Australia has many arid and semi-arid climates; they cover four fifths of the continent. These areas are generally hot, that is, they can record high temperatures during the day but cool down significantly during the night. The fluctuation between temperatures is partly due to the absence of water, which has a moderating effect on climate. Not all deserts are hot; there are some cold, foggy deserts in the world that experience clouds and fog but very little rain.

Deserts generally receive an extremely low amount of precipitation. Rain can come suddenly in the form of intense storms that can cause flash floods, often in late summer/early autumn. Living things in the desert therefore have to adapt to conditions of unpredictable surface-water supply that ranges from very low to non-existent most of the year.

Humans surviving in a desert

Humans have the ability to learn about their world and choose new behaviours. We also seek to modify environments to suit our needs and think ahead, which is why explorers would take supplies and equipment with them. They did not have the extensive local knowledge of the flora, fauna and environment of Indigenous people of the region. Therefore, some early explorers died from factors like malnutrition or lack of water in areas where they might have survived had they had that knowledge.

Dark skin is identified as a human adaptation to environments with high-UV indexes, including Australian deserts. The colour is due to a pigment called melanin, which shields the skin from cancer-inducing rays. The concentration of melanin pigments increases in all skin types when exposed to the Sun, but is naturally high in people from tropical and desert regions around the world. However, some northwest European skins have almost lost the ability to produce melanin and their skins burn and peel in the Sun. In a low-UV environment lighter skin allows more sunlight to be absorbed, ensuring adequate vitamin D. However, in high-UV environments it is linked to a much higher rate of skin cancer. Some animals in deserts are heavily pigmented as protection from the UV of the Sun, but others have lighter colours that have the advantage of camouflaging them.

Burke and Wills

The theme of early exploration of the interior of Australia was chosen for several reasons:

- It links closely to the Australian Curriculum: History descriptor.
- It is about early exploration of harsh desert environments for which the European explorers were sometimes inadequately prepared.
- Early explorers described the desert and the plants and animals they found in great detail.
- Local Indigenous people helped on expeditions, providing knowledge and sometimes saving the lives of the explorers.

Students' conceptions

Some students might believe that almost nothing lives in a desert. Compared to a tropical environment there are fewer species in a desert ecosystem, but there are still many different plants and animals, such as crustaceans (shrimps), amphibians (frogs), insects (termites), birds (budgerigars), mammals (bilbies) and reptiles (goannas).

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart
- 1 enlarged copy of 'Australia's red heart' (Resource sheet 1)
- multimedia resources (see 'Preparation')
- *optional:* cards or paper strips for word wall labels

FOR EACH STUDENT

- science journal
- *optional:* waterproof marking pen

ENGAGE

Preparation

- Read ‘How to use a science journal’ (Appendix 2).
- Read ‘How to use a word wall’ (Appendix 3).
- Read ‘How to use a TWLH chart’ (Appendix 4) and prepare a four-column chart for the class with the following headings:

Surviving in a desert

What we **think** we know	What we **want** to learn	What we **learned**	**How** we came to that conclusion

- Prepare an enlarged copy of ‘Australia’s red heart’ (Resource sheet 1).
- Collect multimedia resources, including books, maps, pictures and videos that evoke the conditions of central Australia and/or the early European explorers, such as:
  — www.aso.gov.au/titles/tv/peachs-explorers-east-to-west
  — www.youtube.com/watch?v=GPjfQh-IjSU (Central Australia: The Eighth Wonder with Ted Egan Preview)
- **Note:** Do not introduce students to resources that describe and explain the structural features and adaptations of living things in the desert, as the purpose of this lesson is to elicit their existing ideas so you can take account of these when planning subsequent lessons.
- *Optional:* Display the class science journal, the TWLH chart and ‘Australia’s red heart’ (Resource sheet 1) on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed (www.primaryconnections.org.au).
- Begin collecting thermometers for Lesson 3.
- This unit focuses on structural features and adaptations that help living things survive in their environment. If you have contact with local Indigenous community members and/or Indigenous Education Officers invite them to discuss what they know about the observable structural features and survival of local living things.

Lesson steps

1 Introduce the multimedia resources (see 'Preparation') and discuss with students how early explorers, such as Burke and Wills, ventured into the interior of Australia. Ask questions, such as:

- What kinds of environments, such as deserts, grasslands, rivers and lakes, forests, woodland, do you think explorers would have encountered?
- What plants and animals do you think they might have seen?
- What conditions, such as temperature and weather, do you think early explorers would have had to face? (eg, cold and heat, drought and flood)
- What do you think the explorers would have needed to take with them when exploring deserts? (eg, water, food, maps, compass, suitable clothing)
- If you were going into the desert what would you take with you?

Remind students that this was 'exploration' from a Eurocentric perspective. Many early explorers and scientists were helped by Aboriginal nations who would supply food, biological specimens and information. The vital role they played was often not publically acknowledged at the time.

2 Introduce the science journal and discuss its purpose and features.

Literacy focus

Why do we use a science journal?

We use a **science journal** to record what we see, hear, feel and think so that we can look at it later to help us with our claims and evidence.

What does a science journal include?

A **science journal** includes dates and times. It might include written text, drawings, measurements, labelled diagrams, photographs, tables and graphs.

Record students' ideas about the explorations to the interior of Australia in the class science journal, in particular, the environment and plants and animals.

Note: In the *Engage* phase, do not provide any formal definitions or correct students' answers as the purpose is to elicit students' prior knowledge.

3 Introduce the TWLH chart and discuss its purpose and features

Literacy focus

Why do we use a TWLH chart?

We use a **TWLH chart** to show our thoughts and ideas about a topic before, during and after an investigation or activity.

What does a TWLH chart include?

A **TWLH chart** includes four sections with the headings: What we **T**hink we know, What we **W**ant to learn, What we **L**earned, and **H**ow we know. Words or pictures can be used to show our thoughts and ideas.

ENGAGE

4 Introduce the title and first column of the TWLH chart ('What we **T**hink we know'). Invite students to contribute ideas about Australian deserts, what they might look like and what plants and animals might be found there. Focus on the structural features and adaptations of plants and animals that they think help them survive and why. Ask questions, such as:

- What do we think we know about … ?
- How do you think it survives the conditions?
- What challenges would plants face in the desert?
- What challenges would animals face in the desert?
- What structural features might help them survive?
- What behaviours might help them survive?

Optional: Create rows on the TWLH chart to organise students' ideas, for example, 'What we think we know about plants'.

5 Introduce the second column of the TWLH chart ('What we **W**ant to learn') and ask students to suggest questions they have about surviving in desert environments.

Note: Students will have the opportunity to research specific plants and animals in the *Explain* lesson. If students ask an interesting and relevant question that leads to a feasible investigation, consider adding an *Explore* lesson to investigate it or suggest ways students could investigate outside class time.

6 Introduce the enlarged copy of 'Australia's red heart' (Resource sheet 1). Read through with students, highlighting unfamiliar words or passages.

7 Identify desert characteristics mentioned in 'Australia's red heart' (Resource sheet 1) and record them in the class science journal. Explain that in this unit students will explore plants and animals that survive in Australian deserts, and investigate what helps them to survive.

Note: A good understanding of desert environments is necessary for students to understand how living things adapt to them. If students have unanswered questions about desert environments, develop plans of action to answer them, such as looking on the web, in resource books or by asking a suitable person.

8 Draw students' attention to the word wall and discuss its purpose and features.

Literacy focus

Why do we use a word wall?

We use a **word wall** to record words we know or learn about a topic. We display the word wall in the classroom so that we can look up words we are learning about and see how they are spelled.

What does a word wall include?

A **word wall** includes a topic title or picture and words that we have seen or heard about the topic.

Ask students what words from today's lesson would be useful to place on the word wall.

Invite students to contribute words from different languages to the word wall, including local Indigenous names of animals and plants if possible, and discuss different communication systems of different languages.

Curriculum links

English

- Ask students to read and compare the diary entries of Burke and Wills for the same day, 26th/28th June 1861.The original diary entries can be found at: www.burkeandwills.net.au
- Ask students to write narratives about the story of Burke and Wills from different viewpoints.

History

- Discuss the history of the exploration of the interior of Australia and discuss its political and scientific effects on the colonies.

Geography

- Identify locations of deserts in the world using maps.

Australia's red heart

In England in the early 1900s, a homesick Dorothea Mackellar wrote a famous poem, 'My Country', about Australia with the stanza:

'I love a sunburnt country,
A land of sweeping plains,
Of ragged mountain ranges,
Of droughts and flooding rains.'

Dorothea Mackellar was describing the interior of Australia, also known as the 'outback'. Almost half of Australia receives so little rain that it is classified as desert or 'arid' country. Some deserts in Australia are sandy, but others are full of rocks.

Not all deserts are hot, but in Australia the daytime temperatures can rise so high you could cook an egg on the rocks. However, they are not hot all the time. Neither are they dry all the time. Deserts do receive some rain that can suddenly come down in a thunderstorm and cause floods. Much of this water evaporates and after some weeks it is as if the rains had never fallen.

The explorer Captain Charles Sturt made many observations about the desert during his expedition into central Australia in 1844:

'The heat now became so great that it was almost unbearable, the thermometer every day rose to 42°C or 47°C in the shade, whilst in the direct rays of the sun from 60°C to 66°C, however, the night was so bitterly cold that we were glad to put on anything to keep us warm.'

Note: the original text uses degrees Fahrenheit.

'As we descended from the ranges I observed that all the water I had seen glittering on the plains had disappeared.'

'The stillness of death reigned around us, no living creature was to be heard; nothing visible inhabited that dreary desert but the ant. Even the fly shunned it, and yet its yielding surface was marked all over with the tracks of native dogs. The only trees growing in this terrible place were a few acacias in the hollows, and some shrubs, all of low growth; there was no grass, neither were the few herbs that grew on the hollows such as the horse would eat.'

Sturt, C. 1848-49. Narrative of an expedition into central Australia, performed under the authority of Her Majesty's Government, during the years 1844, 5, and 6: together with a notice of the province of South Australia, in 1847. London: T. and W. Boone.

Because of the harshness of the conditions, it is difficult for living things to survive in a desert. The explorers might have been disappointed as they couldn't feed their horses, but there are plants in the Australian desert, such as spinifex and acacia.

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Lesson 2 Dodging desiccation

AT A GLANCE

To provide students with hands-on, shared experiences of how having smaller leaves can help plants avoid desiccation.

Session 1 Bagging leaves

Students:

- explore how plants lose water through their leaves.

Session 2 Soaking cloths

Students:

- work in teams to investigate if cloths with smaller surface areas lose less water.

Session 3 Moist in the middle

Students:

- display their results using a graph and use it to make predictions
- make evidence-based claims on whether having smaller leaves helps plants to survive in deserts.

EXPLORE

Lesson focus

The *Explore* phase is designed to provide students with hands-on experiences of the science phenomenon. Students explore ideas, collect evidence, discuss their observations and keep records, such as science journal entries. The *Explore* phase ensures all students have a shared experience that can be discussed and explained in the *Explain* phase.

Assessment focus

Formative assessment is an ongoing aspect of the *Explore* phase. It involves monitoring students' developing understanding and giving feedback that extends their learning. In this lesson you will monitor students' developing understanding of:

- structural features that help plants survive in a desert environment
- how to compare their results with predictions to develop explanations of phenomena.

You will also monitor their developing science inquiry skills (see page 4).

Key lesson outcomes

Science

Students will be able to:

- plan an investigation, with teacher support
- make predictions about which cloth will dry out fastest
- observe, record and interpret the results of their investigation
- identify that cloths with smaller surface areas retain water for longer
- make evidence-based claims about whether having smaller leaves can help plants survive in the desert.

Literacy

Students will be able to:

- understand the purpose and features of a table
- follow a procedural text to complete an investigation
- use oral, written and visual language to record and discuss investigation results
- understand the purpose and features of a graph
- engage in discussion to compare claims.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 6).

Teacher background information

Leaves of plants

Animals circulate water and nutrients through their bodies using circulatory systems and organs, such as hearts and blood vessels.

Plants also circulate water. Plants have stomata (small openings) in their leaves through which water can evaporate. Most plants have stomata that close during the heat of the day. This helps to prevent a too rapid loss of water that might lead to the leaves wilting. Some desert plants have stomata that only open at night.

Having smaller and fewer leaves decreases the number of stomata and, therefore, the amount of water lost. Other leaf adaptations include:

- waxy cuticles (leaf covering) to help stop water from escaping
- light-coloured pigments or hairs that help to reflect the Sun's heat
- dropping leaves during dry seasons
- storing water inside the leaves.

Desiccation

In biology, desiccation is the removal of water from the cells of the organism.

In desert conditions the dryness of the air can result in the loss of water from cells of living things. Therefore desiccation tolerance (ability to withstand water loss below optimal cell water content levels) is one mechanism of survival. Some organisms in a dry (fully desiccated) state can survive for a very long time; a *Nelumbo nucifera* seed (sacred lotus, a native in tropical Asian countries and Queensland) was successfully germinated after over a thousand years in a dry state in an ancient lakebed of China.

Surface area

The term 'smaller' is ambiguous in science. The term 'surface area' is a measure of how much of an object is in contact with the outside world, for example, the air. In this session students fold a cloth to reduce its contact with the air. The volume of the object remains the same but its surface area changes.

Students might say that the folded cloth stays wet because it is 'thicker'. While this is not incorrect it is important for students to realise that there is the same amount (mass) of cloth.

Using damp cloths as a model

Measuring water loss of leaves requires precise instruments, as the water mass lost might be a small percentage of the actual mass of the leaves.

Absorbent cloths are used in this investigation, since they can absorb enough water for water-loss differences to be measurable in the classroom with simple digital scales. Folding one multiple times exaggerates surface-area difference, making measurement easier. However, there are many differences between a cloth and a leaf. For example, cloths lose water uniformly over the surface in contact with the air, whereas leaves might have waxy surfaces and only lose water through stomata.

EXPLORE

Session 1 Bagging leaves

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart
- team skills chart
- team roles chart
- permanent marking pen

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 2 plastic bags
- a leafy branch (see 'Preparation')
- *optional:* 1 waterproof marking pen

Preparation

- Conduct Session 1 the day before Session 2.
- Read 'How to organise collaborative learning teams (Appendix 1). Display an enlarged copy of the team skills chart and the team roles chart in the classroom. Prepare role wristbands or badges.
- Collect one small branch with leaves for each team of three students (see photo in Session 2). Alternatively, students can enclose leaves on a plant in the school grounds, sealing it firmly with tape.

Lesson steps

1 Review the previous lesson using the class science journal and the TWLH chart, focusing students' attention on how having enough water is critical to the survival of living things, including plants, especially in desert environments.

2 Explain that students will be working in collaborative learning teams to investigate how plants have adapted to desert environments.

3 Show students one of the leafy branches and ask what they think might happen if the leaves are enclosed in a plastic bag, and explain why they think that. Record their predictions and reasons in the class science journal, completing the first two sections of a 'PROE' table:

PREDICT			
REASON			
OBSERVE			
EXPLAIN			

The remaining two sections will be completed in Session 2.

4 Explain that students will work in teams to seal a plastic bag over a branch with leaves. Explain that they will observe any changes in the next session. Discuss how they will need to compare it with an empty plastic bag.

Ask students to:

- Use the permanent marking pen to label their bags with their team names.
- Label the first bag 'Bag 1—leaves'.
- Label the second bag 'Bag 2—no leaves'.

Ask students to put leaves in Bag 1, and no leaves in bag 2, and seal the bags.

5 Form teams and allocate roles. Ask Managers to collect team equipment. If students are using collaborative learning teams for the first time, introduce and explain the team skills chart and the team roles chart. Explain that students will use role wristbands or badges to help them (and you) know which role each member has.

6 Ask students to record the appearance of bag contents in their science journal using an annotated drawing, recording the date and time of observation. Discuss the purpose and features of an annotated drawing.

Literacy focus

Why do we use an annotated drawing?

We use an **annotated drawing** to show an idea or object.

What does an annotated drawing include?

An **annotated drawing** includes a picture and words or descriptions about the idea or object.

Optional: take a photograph of bags over branches for use in recording and discussing results in class journal.

7 Store the samples for Session 2 on the next day.

8 Update the word wall with words and images.

EXPLORE

EXPLORE

Session 2 Soaking cloths

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart
- team skills chart
- team roles chart
- 1 enlarged copy of 'Comparing plants and animals' (Resource sheet 2)
- 1 enlarged copy of 'Surface drying investigation planner' (Resource sheet 3)
- water
- at least 1 pair of digital scales (see 'Preparation')
- 1 timing device (eg, a class clock)
- *optional:* leaves from different species (see 'Preparation')

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- each team's sample plastic bags from Session 1
- 1 copy of 'Surface drying investigation planner' (Resource sheet 3)
- 2 absorbent cloths (eg, 36 cm x 36 cm)
- 2 paper clips
- *optional:* 1 waterproof marking pen

Preparation

- Plan to conduct this session in the morning, and preferably Session 3 the next morning or the afternoon of the same day if you only have students once a week.
- Read 'How to write questions for investigation' (Appendix 5).
- Read 'How to conduct a fair test' (Appendix 6).
- Collect digital scales that can record centigrams to ensure students will record a difference in mass. It is preferable for each team, or pair of teams, to have access to a scale to help ensure quick measurements.
- *Optional:* Bring in leaves from Australian desert species, for example, the Mulga tree, and leaves from European forest species, for example, the oak.
- Prepare an enlarged copy of 'Comparing plants and animals' (Resource sheet 2).
- Prepare an enlarged copy of 'Surface drying investigation planner' (Resource sheet 3).
- *Optional:* Display 'Comparing plants and animals' (Resource sheet 2) and 'Surface drying investigation planner' (Resource sheet 3) on an interactive whiteboard. Check the PrimaryConnections website to see if an accompanying interactive resource has been developed (www.primaryconnections.org.au).

Lesson steps

1 Introduce the enlarged copy of 'Comparing plants and animals' (Resource sheet 2). Read through with the class, discussing and comparing the structural features that might help survival in a desert environment. Focus students' attention on the pictures of a desert plant with small leaves and a forest plant with large leaves. Discuss with students the similarities and differences between the two types of leaves.

Optional: Ask students to examine leaf samples (see 'Preparation').

2 Discuss with students possible reasons for plants having smaller leaves in the desert. Discuss how the term 'smaller' is ambiguous and introduce the term 'smaller surface area' (see 'Teacher background information'). Record an agreed description of 'surface area' in the class science journal.

3 Explain that students are going to work in collaborative learning teams from Session 1 to explore 'Whether the surface area of leaves affects water retention in plants' to determine what plants are better equipped to survive in the desert and why.

4 Form teams and allocate roles. Ask Managers to collect their team's plastic bags from Session 1, and observe the changes. Ask students where they think the water condensing in the bag around the plant came from (the plant). Ask why they think it came from the plant (the only thing different in the two bags is the plant). Explain that plants lose a lot of water from their leaves (see 'Teacher background information'). Complete the remaining two sections of the 'PROE' table started in the class science journal in Session 1.

Condensation in a bag with leaves compared to a bag without leaves

5 Discuss that since it is difficult to measure water loss in leaves without special equipment students will use absorbent cloths as models for leaves. Explain that absorbent cloths can absorb enough water for water-loss differences to be measured in the classroom with simple digital scales. Discuss with students the advantages and disadvantages of using models.

EXPLORE

6 Brainstorm things that might affect the evaporation of water from cloths. Use students' answers to make a list in the class science journal, such as:

- the amount of water in the cloth
- the amount of material
- the type of material
- the colour of the material
- the surface area of the cloth
- the temperature of the air
- the humidity of the air
- whether the cloth is in sunlight or shade.

7 Introduce the term 'variables' and discuss that in an investigation these are things that can be changed, measured or kept the same. Ask students why it is important to keep some things the same when measuring the changes (to make the test fair, and so we know what caused the observed changes). Explain that when a variable is kept the same it is said to be 'controlled'.

8 Introduce students to the process of writing questions for investigation (see Appendix 5). Model how to develop a question, such as:

- What happens to the amount of water in the cloth over time when we change the surface area of the cloth?
- What happens to the amount of water in the cloth when we change the type of cloth?
- What happens to the amount of water in the cloth when we change the colour of the cloth?

9 Introduce the enlarged copy of 'Surface drying investigation planner' (Resource sheet 3) and explain that in order to find out 'Whether having leaves with smaller surface areas helps plants to retain water longer' students will be investigating the question:

- 'What happens to the amount of water in the cloth when we change the surface area of the cloth?'

Model how to record these on the enlarged planner under 'What are you trying to find out?' and 'What is your question for investigation?'

10 As a class, discuss and record on the enlarged planner what teams will:

- **change:** the exposed surface area of the cloth
- **measure/observe:** how much water is in the cloth over time
- **keep the same:** the type of cloth, the original size of the cloth, the starting amount of water in the cloth, the temperature of the room, where the samples are placed.

11 Ask students to suggest how to change the exposed area of the cloth. For example, fold the second cloth in half four times and fix it together with a binder clip. The first cloth will stay flat with a binder clip attached. Discuss why. Discuss why the amount of water in each cloth needs to be consistent. Discuss how to have the same amount of

EXPLORE

water in each cloth, such as by squeezing water out until they weigh about the same or by measuring how much water to put on them.

12 Discuss how to measure the amount of water in the cloth over time, by measuring its mass when wet and subtracting the mass when dry. Remind students to leave the binder clips attached at all times so that the clip is consistently included in the mass. Model how to use digital scales if students are unfamiliar with their use.

Optional: Discuss how to calculate the remaining water in the cloth as a fraction of the water originally in the cloth. This will allow students to have easily comparable results even if the starting weights of their water-saturated cloth are not the same.

13 Ask students to predict what will happen to the cloth in four hours, such as:

- Cloth with a big surface area will have more water in 4 hours.
- Both cloths will have the same amount of water in 4 hours.
- Cloth with a small surface area will have more water in 4 hours.

Remind students to discuss their predictions in their team, record them on their copy of the 'Surface drying investigation planner' (Resource sheet 3) and provide reasons for their prediction before commencing their investigation.

14 Introduce the 'Recording results' section of the enlarged copy of 'Surface drying investigation planner' (Resource sheet 3). Discuss the purpose and features of a table.

Literacy focus

Why do we use a table?

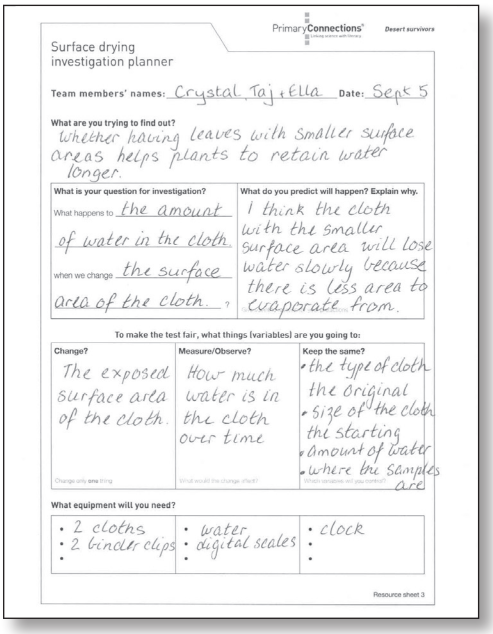
We use a **table** to organise information so that we can understand it more easily.

What does a table include?

A **table** includes a title, columns with headings and information organised under each heading.

15 Discuss why more than one measurement will be taken over time (to see the changes and how quickly they appear).

16 If students have had limited opportunities planning an investigation, model on the class planner how to complete the equipment sections and the 'What are you going to do?' section of the planner. For experienced students, this can be completed independently in teams.



PrimaryConnections Desert survivors

Surface drying investigation planner

Team members' names: Crystal, Taj + Ella Date: Sept 5

What are you trying to find out?
Whether having leaves with smaller surface areas helps plants to retain water longer.

What is your question for investigation?	What do you predict will happen? Explain why.
What happens to the amount of water in the cloth when we change the surface area of the cloth?	I think the cloth with the smaller surface area will lose water slowly because there is less area to evaporate from.

To make the test fair, what things (variables) are you going to:

Change?	Measure/Observe?	Keep the same?
The exposed surface area of the cloth.	How much water is in the cloth over time	• the type of cloth the original • size of the cloth the starting • amount of water • where the samples are

What equipment will you need?

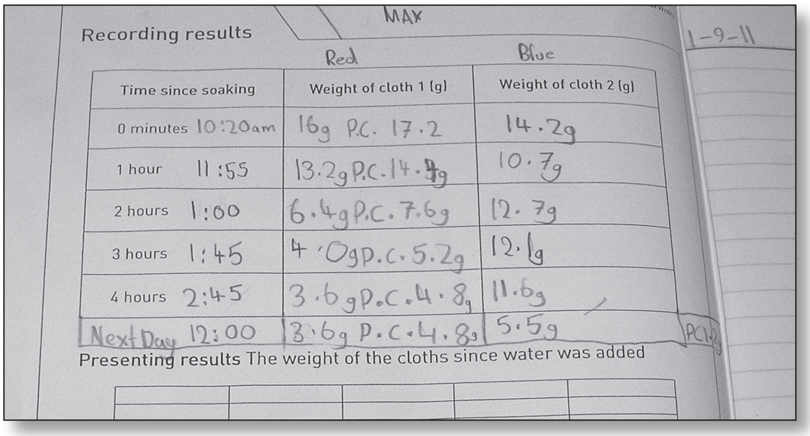
• 2 cloths • 2 binder clips	• water • digital scales	• clock

Resource sheet 3

Student work sample of 'Surface drying investigation planner' (Resource sheet 3)

17 Form teams and allocate roles. Ask teams to complete the planning section of their investigation planner, recording their predictions and what they will do using diagrams and drawings if needed.

18 Ask Managers to collect team equipment. Allow time for students to conduct the investigation and record their results.



Recording results MAX 1-9-11

Time since soaking	Weight of cloth 1 (g) Red	Weight of cloth 2 (g) Blue
0 minutes 10:20am	16g P.C. 17.2	14.2g
1 hour 11:55	13.2g P.C. 14.4g	10.7g
2 hours 1:00	6.4g P.C. 7.6g	12.7g
3 hours 1:45	4.0g P.C. 5.2g	12.1g
4 hours 2:45	3.6g P.C. 4.8g	11.6g
Next Day 12:00	3.6g P.C. 4.8g	5.5g

Presenting results The weight of the cloths since water was added

Student work sample of recorded results

Note: Ask students to leave their investigation set up overnight when they have finished collecting their results so that a further measurement can be taken.

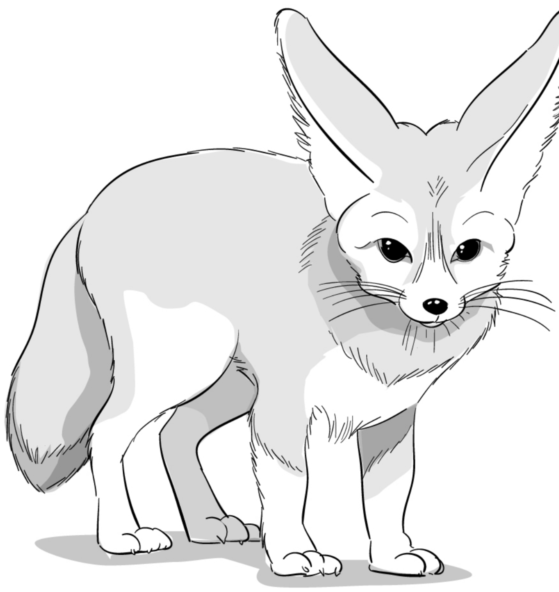
19 Explain that the class will discuss their results in the next session.

20 Update the word wall with words and images.

Comparing plants and animals

The desert might appear empty during the day, but animals such as the bilby wait for the cool of night to emerge from their burrows.

Compare this nocturnal fox from a desert in North Africa with this Bilby from a desert in Australia. Can you spot structural features these animals have in common? Why might that be?

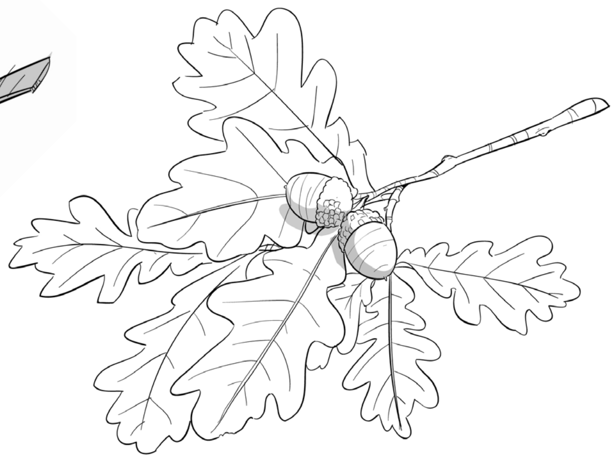


Fennec fox *(Vulpes zerda)*
Desert of North Africa

Greater bilby *(Macrotis lagotis)*
Desert of Australia

Compare the leaves of this acacia (desert plant) and this oak tree (forest plant). How are the leaves of these two plants different? Why might that be?

Leaves of the Mulga tree *(Acacia aneura)*
Desert of Australia



Leaves of an Oak tree *(Quercus robur)*
Forest of Europe

 ISBN 978 0 85847 328 7

Surface drying investigation planner

Team members' names: ______________________ **Date:** __________

What are you trying to find out?

What is your question for investigation?	**What do you predict will happen? Explain why.**
What happens to ______________________ ______________________ when we change ______________________ ______________________ ?	Give scientific reasons for your predictions

To make the test fair, what things (variables) are you going to:

Change?	**Measure/Observe?**	**Keep the same?**
Change only **one** thing	What would the change affect?	Which variables will you control?

What equipment will you need?

• • •	• • •	• • •

 ISBN 978 0 85847 328 7

Surface drying investigation planner

What are you going to do?

Recording results

Time since soaking	Mass of cloth 1 (g)	Mass of cloth 2 (g)
Before water added (dry)		
0 minutes		

Explaining results

Which cloth kept water the longest? Why do you think that happened?

 ISBN 978 0 85847 328 7

Session 3 Moist in the middle

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart
- team skills chart
- team roles chart
- 1 enlarged copy of 'Surface drying investigation planner' (Resource sheet 3) from Session 2
- 1 enlarged piece of graph paper

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- copy of 'Surface drying investigation planner' (Resource sheet 3) from Session 2
- cloths from Session 2
- 1 piece of graph paper

Preparation

- Read 'How to facilitate evidence-based discussions' (Appendix 7).
- Read 'How to construct and use a graph' (Appendix 8).
- *Optional:* Create graphs on an interactive whiteboard. Check the PrimaryConnections website to see if an accompanying interactive resource has been developed (www.primaryconnections.org.au).

Lesson steps

1. Review the previous session using the enlarged copy of 'Surface drying investigation planner' (Resource sheet 3). Explain that students will graph and discuss yesterday's results before making a prediction of today's results and weighing their cloths again.
2. Discuss how representing results in a graph can help us see patterns. Discuss the purpose and features of a line graph.

Literacy focus

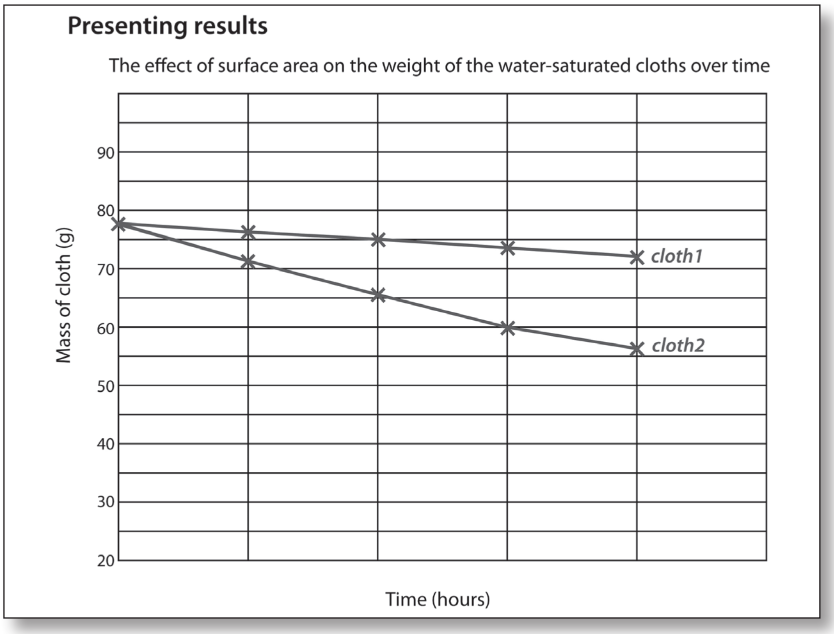
Why do we use a graph?

We use a **graph** to organise information so we can look for patterns. We use different types of graphs, such as picture, column or line graphs, for different purposes.

What does a graph include?

A **graph** includes a title, axes with labels on them and the units of measurement.

Discuss with students the conventions of constructing a scientific graph. The vertical axis usually represents the variable we measure and the horizontal axis represents the variable that we change.



Work sample of a line graph of the surface drying investigation

3 Introduce the enlarged graph paper and model how to draw the two axes. Discuss what scale to use on the Y-axis, for example, one box represents 10 g. Model how to construct a line graph to visually represent the information recorded during the investigation.

4 Explain that teams will construct two lines on their line graph in different colours, one for each cloth. Model how to record which cloth corresponds to which colour on the graphs using a key. Discuss how drawing two lines allows you to compare what is happening in each cloth.

5 Form teams and allocate roles. Allow time for students to complete their graphs using their data.

6 Analyse and compare graphs to look for patterns and relationships, asking questions, such as:

- What is the story of the graph?
- Which cloth lost more water after four hours?
- Was that what you predicted?
- Why do you think the result was different from your prediction?
- Do you still agree with the reasons you provided with your predictions?

Ask students to question each other using the 'Science question starters' (see Appendix 7), listening and responding to others' ideas, and comparing data and evidence.

7 Discuss how many hours have passed since the start of the investigation. Ask students to predict how heavy they think their cloths will be now using their results.

8 Allow time for students to weigh their cloths again and record their results.

9 Allow time for students to compare their predictions and findings, reasoning about evidence and modifying ideas in the light of evidence if needed.

10 As a class, create a summary of their findings. Discuss the purpose and features of a summary.

Literacy focus

Why do we use a summary?

We use a **summary** to present the main points of a topic or text.

What does a summary include?

A **summary** includes a concise description of the main points of a topic or text.

Record a summary of results in the class science journal. Ask students to suggest what claim could be made, such as ‘Cloths with smaller surface areas keep water for longer.’ Also record their reason, such as ‘We think this is because there is less surface for water to evaporate from.’

11 Remind students that the cloths were originally used as models to help find out ‘Whether the surface area of leaves affects water retention in plants.’ Ask students what claims they might make based on their collected evidence about the structural features and adaptations of plants that might help prevent water loss, such as ‘Having leaves with a smaller surface area helps plants to retain water for longer.’ Explain that the claims need to be conditional (using the word could—see Step 12 below) since the results are for cloths in classroom conditions as a model of plants in desert conditions. Record students’ claims and reasoning in the class science journal.

12 Explain that since the results of this test seem to support the claim ‘Having leaves with smaller surface area could help plants survive because they would lose less water’, scientists would continue to devise tests to check the accuracy of the claim. Remind students of their ideas about why desert plants might have smaller leaves recorded in the science journal (see Session 2) and discuss how this is one of several possible claims.

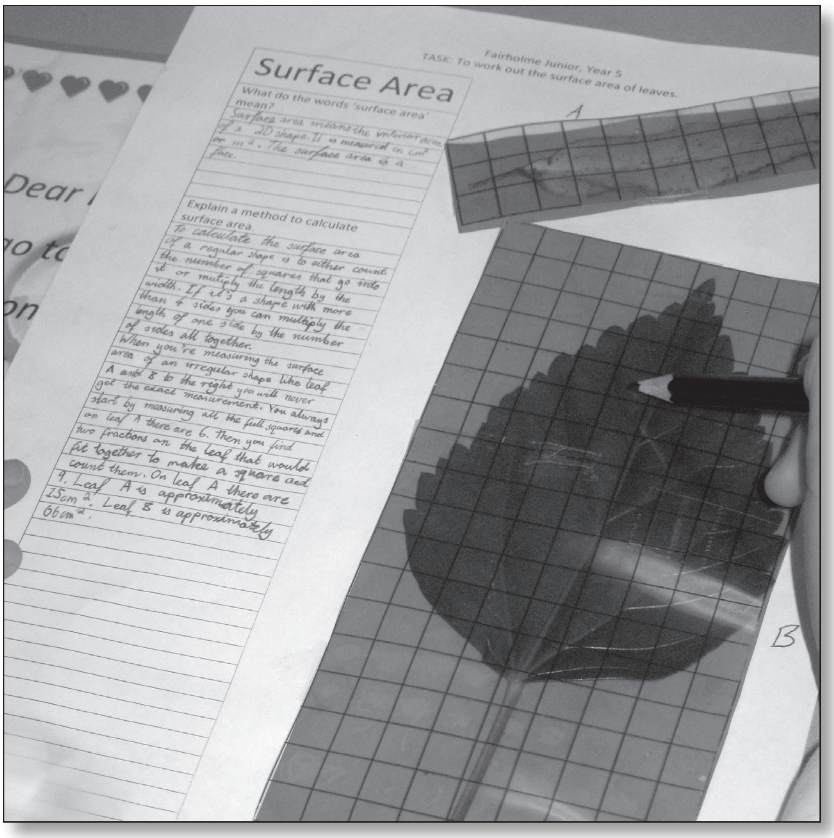
13 Review the TWLH chart. Record what students have learned and answer any questions that can be answered.

14 Update the word wall with words and images.

Curriculum links

Mathematics

- Calculate surface areas of different leaves.



Student calculating the surface area of two different leaves

EXPLORE

Lesson 3 Way too warm

EXPLORE

AT A GLANCE

To provide students with hands-on, shared experiences of how having a larger surface area can help animals to cool down.

Students:

- work in teams to investigate whether increasing surface area increases heat loss
- discuss and compare their results from the investigation.

Lesson focus

The *Explore* phase is designed to provide students with hands-on experiences of the science phenomenon. Students explore ideas, collect evidence, discuss their observations and keep records, such as science journal entries. The *Explore* phase ensures all students have a shared experience that can be discussed and explained in the *Explain* phase.

Assessment focus

Formative assessment is an ongoing aspect of the *Explore* phase. It involves monitoring students' developing understanding and giving feedback that extends their learning. In this lesson you will monitor students' developing understanding of:

- structural features that help animals survive in a desert environment
- comparing their results with predictions to develop explanations of phenomena.

You will also monitor their developing science inquiry skills (see page 4).

Key lesson outcomes

Science

Students will be able to:

- plan and conduct an investigation of the effect of surface area on heat loss
- make predictions about which pool of water will lose heat fastest
- observe, record and interpret the results of their investigation
- identify that pools of water with larger surface areas lose heat faster
- make evidence-based claims about whether having larger ears can help animals survive in the desert.

Literacy

Students will be able to:

- use oral, written and visual language to record and discuss investigation results
- record data in a table and represent it in a graph to interpret findings
- engage in discussion to compare claims
- demonstrate understanding of how to identify adaptations using science journal entries.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 6).

Teacher background information

Larger ears

If you dip your hand into a bucket of water and then let it dry in the air, your hand will feel cold. This is because the evaporation of water consumes energy (heat). Similarly, sweating helps to cool the body through this process. However, it also uses a lot of water that animals cannot afford to lose in the desert. Another way of losing heat in the desert is to use heat exchange: if the blood of an animal is warmer than the air outside, then heat will diffuse into the surrounding air. Increasing the surface area of ears, filled with small capillaries where blood is close to the surface, can help an animal lose heat but only if their blood is warmer than the air. Since deserts have pockets of warmer and cooler air (for example, in the shade) this adaptation can therefore help animals survive.

Larger ears also have other advantages to explain why they might have evolved, for example, they might help an animal capture sounds better. This can be important at night when visibility is low, or even during the day in an environment where bright sunlight makes vision difficult and many animals are camouflaged.

Relative surface area

As discussed in Lesson 2, surface area relative to volume is an important measure in biology. Making body parts thin and large increases their relative surface area, rather like taking a pastry ball and rolling it out on the table. For the same amount of dough, the rolled out pastry has more contact with the air. The water on a plate is more spread out than water in a cup, which gives it a larger zone for heat exchange similar to larger ears.

Using water in open containers as a model

Using pools of water as a model for animals is designed to represent the heat loss that happens from blood circulated in capillaries close to the skin. However, capillaries are not in direct contact with the air, and the primary loss of heat is by heat exchange. As it requires heat for water to become water vapour, heat can also be lost through evaporation, which is why we sweat. However, not all animals sweat, in particular in the desert, since this causes greater water loss.

In the example provided in 'Preparation', the water is losing heat through both evaporation and heat exchange with the air. A closer model to that of the ear would be to have closed containers with thermometers integrated, for example, by covering both containers with material of a similar type. The proposed investigation was chosen for simplicity and measurable results; the trend is still observable if you use covered containers but it requires more materials and can make taking temperatures more difficult.

EXPLORE

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart
- team skills chart
- team roles chart
- 1 enlarged copy of 'Comparing plants and animals' (Resource sheet 2) from Lesson 2, Session 2
- 1 enlarged copy of 'Surface cooling investigation planner' (Resource sheet 4)
- hot water (<50°C)

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 copy of 'Surface cooling investigation planner' (Resource sheet 4)
- a cup and a plate of similar material with high sides (see 'Preparation')
- 1 timing device (eg, a stopwatch or a watch with a second hand)
- 1 thermometer
- 500 mL hot water
- 1 x 250 mL measure

Preparation

- Read 'How to write questions for investigation' (Appendix 5).
- Collect two containers of similar material but very different shapes for each team, such as a ceramic cup and saucer or a plastic cup and plate. Each container should hold 250 mL of water
- Obtain a thermometer for each team, such as from school supplies or school catalogues. Digital thermometers are preferred. If, however, the thermometers are not digital, consider how to introduce the students to reading temperatures. Note also that thermometers that are intended to check human temperatures only have a range between 32°C and 42°C.

SAFETY

Do not use mercury thermometers because breakages will expose students to harmful mercury vapour.

- Set up a safety zone where you can prepare the hot water. Decide on a class safety procedure for students to collect the hot water, for example, students collect water that the teacher prepares and pours.

SAFETY Keep water temperature below 50°C, for example, by mixing almost boiled water with equal parts of cold water.

- Prepare an enlarged copy of 'Surface cooling investigation planner' (Resource sheet 4).
- *Optional:* Collect images of desert animals with larger ears and similar non-desert animals (with ears that are not so pronounced) to display for students. Use these images to compare desert to non-desert animals.
- *Optional:* Display 'Surface cooling investigation planner' (Resource sheet 4) on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed (www.primaryconnections.org.au).

EXPLORE

Lesson steps

1 Review the previous lessons using the class science journal and the TWLH chart, focusing students' attention on how hot desert environments can get and how animals and plants need to avoid overheating and losing moisture.

2 Ask students what they do when they are hot (take clothes off) and when they are cold (put warm clothes on). Discuss with students how animals lose heat through their skin, which humans try to regulate with clothes.

3 Review the enlarged copy of 'Comparing plants and animals' (Resource sheet 2), focusing students' attention on the pictures of two desert animals. Discuss with students the similarities and differences between the two animals.

4 Ask students to suggest why they think the two desert-dwelling animals might have larger ears. Record students' responses in the class science journal.

5 Explain that students are going to work in collaborative learning teams to explore 'Whether the surface area of an animal's ears has an impact on them keeping cool in the desert' Explain that since animals have a lot of water in their bodies, students are going to use pools of water as a model for the ears (see 'Teacher background information'). Review with students the advantages and disadvantages of using models.

6 Ask students how to modify the surface area of water (by changing the shape of the container the water is in). Discuss how water that is 'spread out' on a plate has more surface area in contact with the air than water in a cup. Discuss which modification would best represent the ear of the desert animal and which modification would best represent a smaller/thicker non-desert animal ear.

EXPLORE

7 Brainstorm variables that might affect how quickly a pool of water cools down and record a list in the class science journal, such as:

- the amount of water
- the shape of the container in which the water is held
- the surface area of water
- the initial temperature of the water
- the location of the water
- the material of the container in which the water is held
- movement of the surrounding air (wind)

8 Review with students the process of writing questions for investigation (see Appendix 5) and ask students to suggest possible questions for investigation. For example, 'What happens to the temperature of water over time when we change the shape of the container?'

9 Introduce the enlarged copy of 'Surface cooling investigation planner' (Resource sheet 4). Record in the section 'What are you trying to find out?' the following statement: 'Whether the surface area of an animal's ears has an impact on it keeping cool in the desert.'

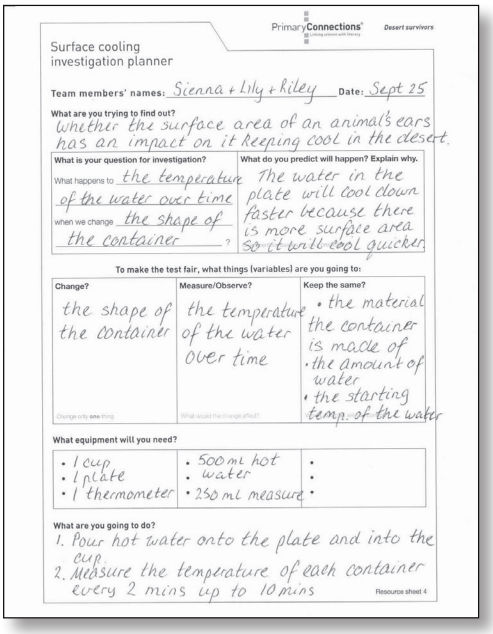
10 As a class discuss and record on the enlarged planner what teams will:

- **change:** the shape of the container (and therefore the surface area of the water)
- **measure/observe:** the temperature of the water over time
- **keep the same:** the material the container is made of, the amount of water, the starting temperature of the water, the temperature of the room the water is in.

SAFETY

Discuss with students the safety procedures for handling hot water.

11 Form teams and allocate roles. Ask Managers to collect a copy of 'Surface cooling investigation planner' (Resource sheet 4) and record their planning.



PrimaryConnections — Desert survivors

Surface cooling investigation planner

Team members' names: Sienna + Lily + Riley Date: Sept 25

What are you trying to find out?
Whether the surface area of an animal's ears has an impact on it keeping cool in the desert.

What is your question for investigation?	What do you predict will happen? Explain why.
What happens to the temperature of the water over time when we change the shape of the container?	The water in the plate will cool down faster because there is more surface area so it will cool quicker.

To make the test fair, what things (variables) are you going to:

Change?	Measure/Observe?	Keep the same?
the shape of the container	the temperature of the water over time	• the material the container is made of • the amount of water • the starting temp. of the water
Change only one thing	What would the change affect?	

What equipment will you need?

• 1 cup • 1 plate • 1 thermometer	• 500 ml hot water • 250 ml measure	•

What are you going to do?
1. Pour hot water onto the plate and into the cup.
2. Measure the temperature of each container every 2 mins up to 10 mins

Resource sheet 4

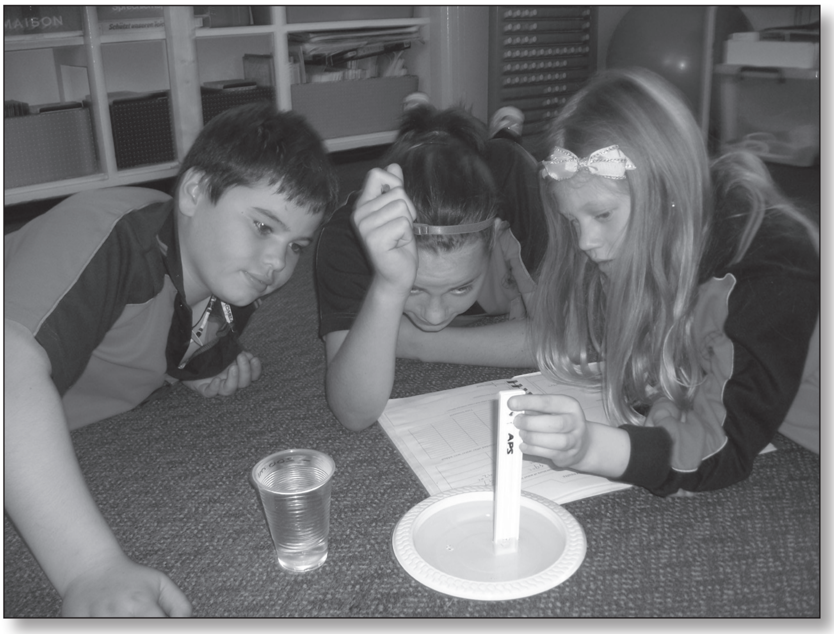
Student work sample of 'Surface cooling investigation planner' (Resource sheet 4)

12 Ask students to predict what will happen to the water temperature over the first 10 minutes:

- The water in the plate (with a big surface area) will cool down faster.
- The water in each container will cool down at the same speed.
- The water in the cup (with a small surface area) will cool down faster.

Ask students to discuss their predictions in their team and record them on their copy of the 'Surface cooling investigation planner' (Resource sheet 4), providing reasons for their prediction.

13 Ask Managers to collect team equipment. Allow time for students to conduct the investigation and record their results.



Students measuring the temperature of the water

14 Ask teams to construct a line graph using their data so the patterns in the data can be seen more clearly and easily. Discuss what scale to use on the Y-axis, for example, each box represents 1°C (in order to identify small differences). Explain that the scale should start at a temperature that is lower than the lowest reading, for example, 30°C if the lowest reading is 32°C.

EXPLORE

Student work sample of a line graph of the surface-cooling investigation

EXPLORE

15 Ask teams to analyse and compare their graphs to look for patterns and relationships, asking questions, such as:

- What is the story of the graph?
- Which surface area cooled down the fastest?
- Was that what you predicted?
- Why do you think the result was the same as or different from your prediction?
- Do you still agree with the reasons you provided for your predictions?

Optional: Calculate the class average for each time. Discuss why replication is necessary to produce reliable results and list possible reasons for variation, for example, the temperatures might not have been taken at the same second. Ask questions, such as:

- Do you think it will happen the same way every time?
- How will that affect the result?
- How will that affect what we think?

16 Record a summary of the findings of the class in the class science journal. Ask students if they experienced any difficulties while doing the investigation and ask them to suggest ways to improve the investigation.

17 Remind students that the water was used as a model for an animal's body to help find out to 'Whether the surface area of an animals' ears has an impact on them keeping cool in the desert.' Discuss the limitations of this model, in particular that body fluids aren't directly exposed to air and cooled by evaporation (see 'Teacher Background Information'). Ask students what conditional claims they can make based on their collected evidence. Record students' claims and reasoning in the class science journal. Ask students to review their initial ideas on why animals might have larger ears in the desert and discuss whether they still think that and why.

18 Ask students to consider the claim 'Having ears with a larger surface area can help animals survive in the desert.' Ask questions, such as:

- Do you agree? Why? Why not?
- How might larger ears help animals survive in the desert?
- What evidence do we have to support that claim?
- Is there evidence that we might gather to help us assess the claim?

19 Explain that since the results of this test seem to support the claim 'Having ears with larger surface area could help animals survive because they might cool down faster', scientists would continue to devise tests to check the accuracy of the claim. As a class, brainstorm ideas of different investigations that might also be useful to help scientists judge the validity of that claim, for example, re-doing the experiment with closed containers whose cooling process would match those of the ear more closely (see 'Teacher background information').

20 Review the TWLH chart. Record what students have learned and answer any questions that can be answered.

21 Update the word wall with words and images.

Surface cooling investigation planner

Team members' names: ______________________ **Date:** __________

What are you trying to find out?

What is your question for investigation?	**What do you predict will happen? Explain why.**
What happens to ______________ ______________ when we change ______________ ______________ ?	Give scientific reasons for your predictions

To make the test fair, what things (variables) are you going to:

Change?	**Measure/Observe?**	**Keep the same?**
Change only **one** thing	What would the change affect?	Which variables will you control?

What equipment will you need?

• • •	• • •	• • •

What are you going to do?

 ISBN 978 0 85847 328 7

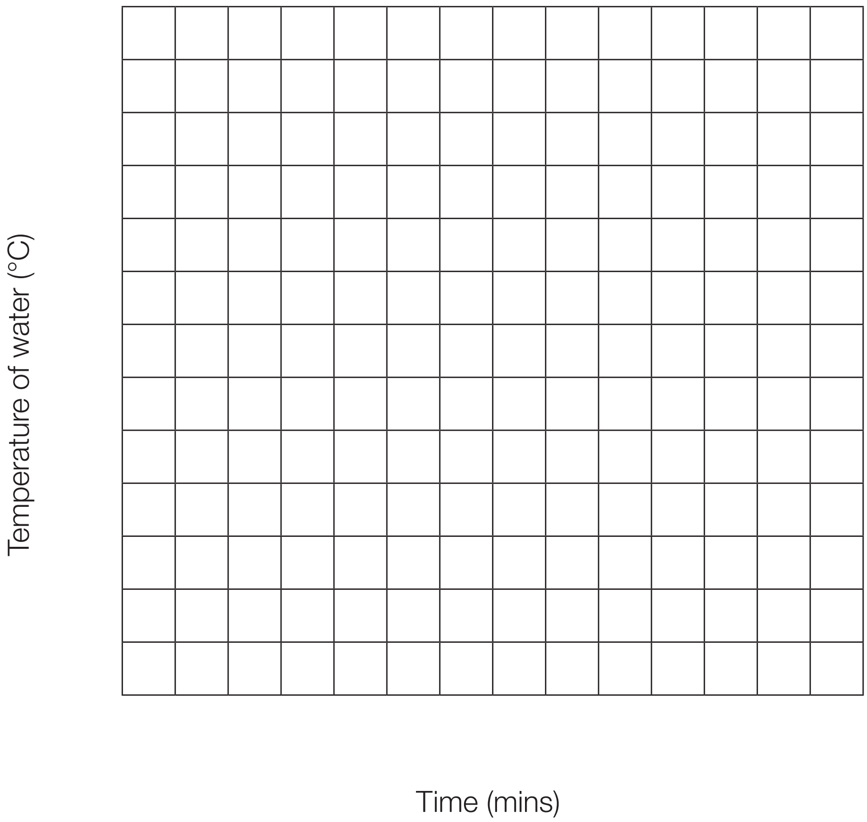
Surface cooling investigation planner

Recording results

Time	Temperature of water in cup (°C)	Temperature of water in plate (°C)
0 minutes		

Presenting results

The effect of time on water temperature for different surface areas



Explaining results

Which size surface area cooled down the water the fastest? Why do you think that happened?

 ISBN 978 0 85847 328 7

Lesson 4 Colourful creatures *(Optional)*

EXPLORE

AT A GLANCE

To provide students with hands-on, shared experiences of how living things adapt to other living things through the use of colour.

Session 1 Perspicacious predators

Students:

- work in teams to investigate whether being camouflaged helps living things survive in deserts
- discuss and compare their results to make evidence-based claims.

Session 2 Ravishing or ridiculous?

Students:

- discuss claims explaining why some animals are not camouflaged.

Lesson focus

The *Explore* phase is designed to provide students with hands-on experiences of the science phenomenon. Students explore ideas, collect evidence, discuss their observations and keep records, such as science journal entries. The *Explore* phase ensures all students have a shared experience that can be discussed and explained in the *Explain* phase.

Assessment focus

Formative assessment is an ongoing aspect of the *Explore* phase. It involves monitoring students' developing understanding and giving feedback that extends their learning. In this lesson you will monitor students' developing understanding of:

- structural features that help living things survive in their environment
- how to compare results with predictions to develop explanations of phenomena.

You will also monitor their developing science inquiry skills (see page 4).

Key lesson outcomes

Science

Students will be able to:

- plan and conduct an investigation of the effect of camouflage on predation
- use confetti to make predictions about how camouflage can affect the visibility of an object
- observe, record and interpret the results of their investigation
- make evidence-based claims about whether being camouflaged can help animals survive in the desert
- identify that there are different selective pressures which can influence the appearance of an animal, including choice of mate.

Literacy

Students will be able to:

- use oral, written and visual language to record and discuss investigation results
- record data in a table and represent it in a graph to interpret findings
- engage in discussion to compare claims and develop understanding about how different factors can influence the structural features of an animal
- demonstrate understanding of how to identify adaptations using science journal entries.

EXPLORE

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 6).

Session 1 Perspicacious predators

Teacher background information

Hiding in plain sight

Living things adapt to their environment through the process of evolution. However, the 'environment' is not just the physical properties of the external environment, such as heat and temperature. Living things are part of a complex ecosystem that includes other living things, and they adapt to them as well. An intuitive example of this is the evolution of camouflage. Camouflage allows an animal to blend into its environment and is far too prevalent in the animal kingdom to assume that it always happens by accident.

Camouflage helps animals survive by protecting them from the eyes of other animals. For example, it can help a prey go undetected by a predator. It might also help a predator go undetected by their prey, increasing their chances of eating. Either way camouflage depends on the eyesight of the other animal. A predator that hunts a blind prey would not get much advantage from being camouflaged, nor would a camouflaged prey have much protection against a predator such as a snake that can sense the heat radiating from their bodies.

The peppered moth evolution

Camouflage also depends on the environment. In this lesson students will change the background on which they spot confetti. The experiment is a simple one reflecting a case that is often discussed as an example of evolution: a two-hundred year study of the peppered moth (*Biston betularia*) in Britain. The peppered moth can be either white or black depending on its genes. Early insect collectors valued the black moth as they were very rare. However, during the 1800s black moths became common around city areas.

In their natural habitat, moths land on white-barked trees. The white moths are less visible against the bark than the black ones. However, during the 1800s, the Industrial Revolution polluted the environment around cities and the tree trunks became black. Therefore, the black moths were the ones that were camouflaged and the white moths became more visible. Experiments showed that birds have more difficulty finding and eating colour-camouflaged moths, supporting the claim that the observed changes in relative numbers of black and white moth types was due to natural selection by bird predators.

In this example, the population did not acquire new genes, nor did individual moths choose to change their colour. Both colours were initially present in the population and natural selection changed the relative numbers of each type. The moths are also eaten by bats but those predators do not discriminate between the two different colours, so it is unlikely that bats played a part in the observed change in relative numbers of the different colours of moths. The conclusion that the changes in moth populations were due to natural selection is reinforced by the increase in light-coloured moths since pollution was controlled.

Using confetti as a model

Although it might seem evident that camouflage helps make prey more difficult to see, investigations provide evidence to justify any claims. Since it is not ethical to do such experiments with animals in the classroom, students will test their own abilities as predators. Confetti was chosen because it is relatively easy to produce almost identical pieces in large numbers. Camouflage does not guarantee that you will not be spotted, but it will reduce your chances. The main challenge in this investigation is that students should try and act as a predator working on instincts. Since they know the reason for the investigation and have predicted an outcome, they might subconsciously try to support their prediction. They might also use techniques such as systematically searching from one edge of the sheet. A short time limit with a focus on getting the most confetti possible is intended to help students have results that reflect life more realistically. However, the different strategies adopted also provide a point of discussion about how predators might act differently and the different effect this has on the survival chances of camouflaged prey.

Students' conceptions

Students might think that animals live independently of each other. However, living things interact in a variety of ways; from direct, for example, birds eating moths; to indirect, for example, plant types changing the soil acidity, which changes the soil ecosystem, which affects the animals living in the soil, which affects the birds that feed off those animals. Evolution is a dynamic process because the living things are constantly changing, and therefore the environment of living things (the ecosystem) is also changing.

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart
- team skills chart
- team roles chart
- 1 enlarged copy of 'Camouflage investigation planner' (Resource sheet 5)

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 copy of 'Camouflage investigation planner' (Resource sheet 5)
- 1 A3 piece of white paper
- 1 A3 piece of newspaper
- piece of newspaper to make confetti
- piece of white paper to make confetti
- 1 hole punch
- 1 timing device (eg, a stopwatch or a watch with a second hand)

Preparation

- Consider how you will conduct the investigation in a way that best suits your class. Possible variations include:
  - Make the confetti pieces for the students prior to the lesson.
  - Use coloured paper if you do not intend to discuss the moths example and coloured paper is easily available. Do not use red and green, as students who are colour-blind will not be able to distinguish them.
- Enlarge a copy of 'Camouflage investigation planner' (Resource sheet 5). After the modelling in earlier lessons, most students will now be able to complete the investigation planner and conduct the investigation independently. Decide the level of support needed and adjust lesson steps accordingly.
- *Optional:* Display 'Camouflage investigation planner'(Resource sheet 5) on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed (www.primaryconnections.org.au).

EXPLORE

Lesson steps

1. Review the previous lessons using the class science journal and the TWLH chart, including the description of deserts. Discuss why it might be hard to see plants and animals in the desert. Discuss the meaning of 'camouflaged'.
2. Discuss whether being camouflaged could be beneficial to surviving in the desert. Ask students to record their ideas in their science journal, and then share their ideas with the class, justifying their ideas with evidence and reasoning if possible.
3. Explain that one idea scientists might have is that being camouflaged helps things to survive because their predators might find it harder to see them.
4. Explain that students are going to work in teams to investigate that claim by taking turns at being predators that spot confetti on a background. Discuss how students will model the activity of predators trying to 'catch' as much prey as possible.
5. Brainstorm variables that might affect how quickly the confetti are spotted, such as:
   - the colour of the confetti compared to the background
   - the size of the confetti, their shape,
   - whether they are damaged
   - the ability of the spotter
   - how they are distributed.

   Record students' answers in the class science journal.
6. Review how to develop a question for investigation and ask students to suggest questions, such as:
   - What happens to the number of confetti pieces spotted when we change the size of the confetti?
   - What happens to the number of confetti pieces spotted when we change the colour of the confetti?
   - What happens to the number of confetti pieces spotted when we change the colour of the background they are sprinkled on?

   Discuss how these questions for investigation will help them find out 'Whether being camouflaged could be beneficial to surviving in the desert.'

   Note: The remainder of this lesson describes investigating the third question. Depending on the science investigations skills of the students, teams could choose which question to investigate, and how independently they work.
7. Introduce the enlarged copy of 'Camouflage investigation planner' (Resource sheet 5). Discuss and record 'What are you trying to find out?' ('Whether being camouflaged could be beneficial to surviving in the desert') and the question for investigation ('What happens to the number of confetti pieces spotted when we change the colour of the background they are sprinkled on?')

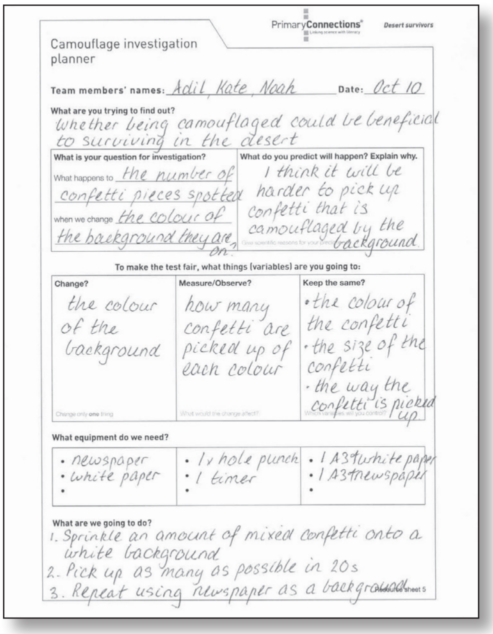
8 As a class brainstorm and record on the enlarged planner what teams will:

- **change:** the colour of the background
- **measure/observe:** how many confetti of different types are found
- **keep the same:** the colour of the confetti, the size of the confetti, the way the confetti is distributed.

9 Discuss how to set up the investigation, such as:

- Sprinkle a certain amount of mixed confetti (white and newspaper) onto a white background and ask one team member to act as a predator and pick up as many confetti as they can in a limited time, for example, 20 seconds.
- Repeat the activity on a newspaper background.

Remind students they are modelling the activity of predators, and that they are trying to 'catch' as much prey as possible rather than playing a strategy game. Discuss the advantages and limits of using this model to gather evidence (see 'Teacher background information').


PrimaryConnections® Linking science with literacy — Desert survivors

Camouflage investigation planner

Team members' names: Adil, Kate, Noah **Date:** Oct 10

What are you trying to find out?
Whether being camouflaged could be beneficial to surviving in the desert

What is your question for investigation?	What do you predict will happen? Explain why.
What happens to the number of confetti pieces spotted when we change the colour of the background they are on?	I think it will be harder to pick up confetti that is camouflaged by the background. Give scientific reasons for your prediction.

To make the test fair, what things (variables) are you going to:

Change?	Measure/Observe?	Keep the same?
the colour of the background	how many confetti are picked up of each colour	• the colour of the confetti • the size of the confetti • the way the confetti is picked up
Change only **one** thing	What would the change affect?	Which variables will you control?

What equipment do we need?

• newspaper • white paper •	• 1x hole punch • 1 timer •	• 1 A3 white paper • 1 A3 newspaper •

What are we going to do?
1. Sprinkle an amount of mixed confetti onto a white background
2. Pick up as many as possible in 20s
3. Repeat using newspaper as a background

Resource sheet 5

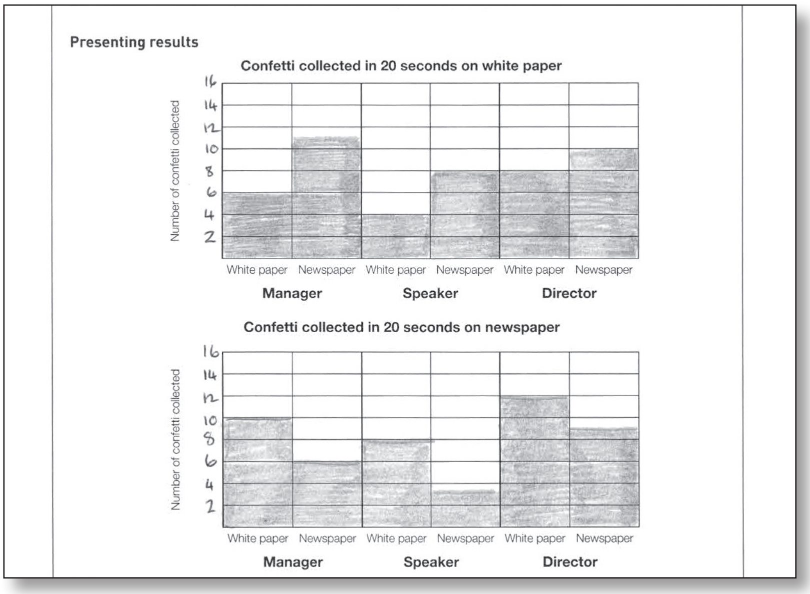
Student work sample of 'Camouflage investigation planner' (Resource sheet 5)

10 Discuss why replication is necessary to produce reliable results, and list possible reasons for variation, for example, the confetti was dispersed differently. Ask questions, such as:

- Do you think it will happen the same way every time?
- How will that affect the result?
- How will that affect what we think?

Explain that each member of the team will take a turn at collecting the confetti and record their results in the table on the 'Camouflage investigation planner' (Resource sheet 5). Discuss how to create a column graph (see Appendix 8), and explain that students will be completing a column graph to compare each person's trial. Model how to complete the graph on the enlarged copy of the planner.

EXPLORE



Student work sample of a column graph

EXPLORE

11 Form teams and allocate roles. Ask Managers to collect team equipment.

12 Allow time for students to conduct the investigation and record their results. Ask teams to analyse and compare their graphs after constructing them.

13 Ask teams to present their analysis and comparison to the class. Encourage students to question each other using the 'Science question starters' (see Appendix 7).
Ask questions, such as:

- Do you agree with what this team said? Why or why not?
- Why do you think different students collected different numbers, for example, because the person collecting the confetti changed?

14 Remind students that they were picking up confetti to help determine 'Whether being camouflaged could be beneficial to surviving in the desert.' Discuss that the students could be seen to be acting as a predator and the confetti was the prey. Ask students what claims they can now make based on their collected evidence. Record students' claims and reasoning in the class science journal.

15 As a class, discuss the investigation, asking questions such as:

- What did we learn from the investigation?
- What did we find that we didn't expect? Why was it surprising?
- What did we find that confirmed what we thought? What did we learn from that?
- What went well with our investigation?
- What didn't go well? How could we have done it better?
- What are you still wondering about?

Record students' thoughts in the class science journal.

16 Review the TWLH chart. Record what students have learned and answer any questions that can be answered.

17 Update the word wall with words and images.

Camouflage investigation planner

Team members' names: ______________________________ **Date:** __________

What are you trying to find out?

What is your question for investigation?	**What do you predict will happen? Explain why.**
What happens to ______________________ ______________________ when we change ______________________ ______________________ ?	Give scientific reasons for your predictions

To make the test fair, what things (variables) are you going to:

Change?	**Measure/Observe?**	**Keep the same?**
Change only **one** thing	What would the change affect?	Which variables will you control?

What equipment do we need?

• • •	• • •	• • •

What are we going to do?

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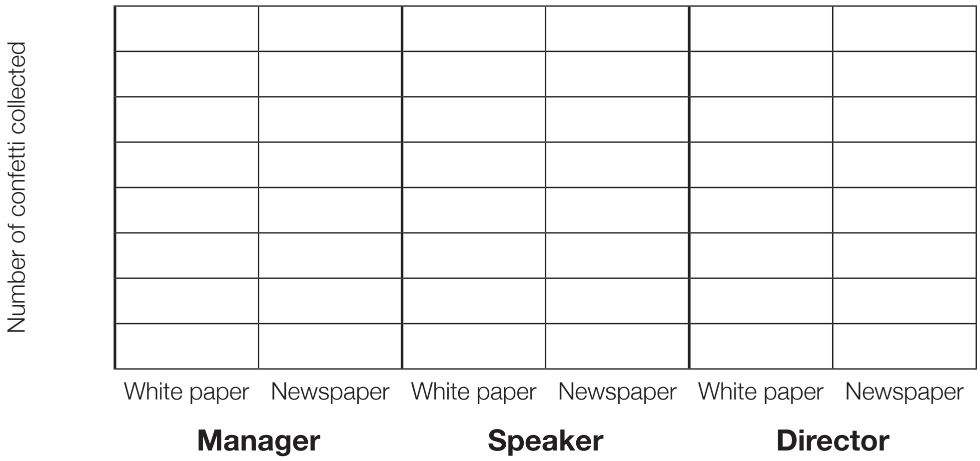
Camouflage investigation planner

Recording results

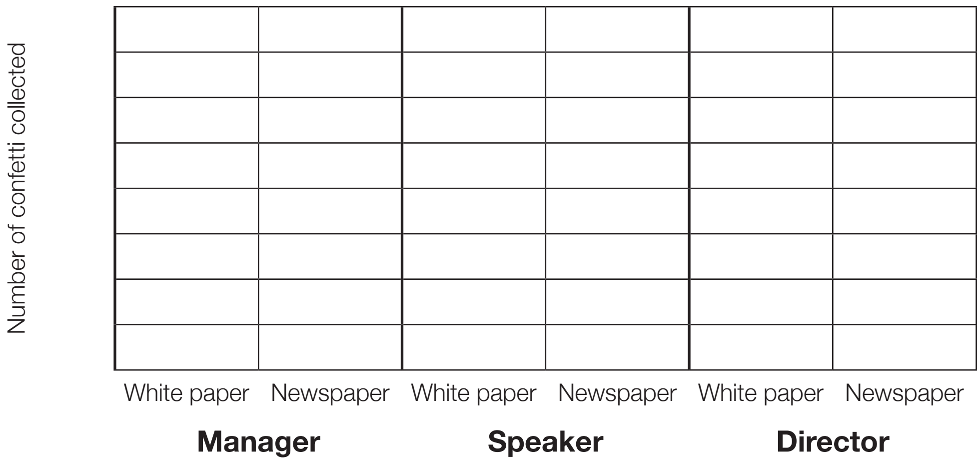
Person picking up the confetti pieces	Background paper	Number of white pieces of confetti collected	Number of newspaper pieces of confetti collected
Manager (**M**)	White		
	Newspaper		
Speaker (**S**)	White		
	Newspaper		
Director (**D**)	White		
	Newspaper		

Presenting results

Confetti collected in 20 seconds on white paper



Confetti collected in 20 seconds on newspaper



Explaining results

Summarise your results and answer the following questions:

- Which confetti was the most collected on the white paper? Why?
- Which confetti was the most collected on newspaper? Why?

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Session 2 Ravishing or ridiculous?

Teacher background information

Coloured plants

Colouration of plants can serve essential functions, for example, pigments such as chlorophyll (which makes leaves look green) help plants capture energy from the Sun.

Therefore, there are strong evolutionary pressures for plants to keep their colouring and they are less likely to evolve camouflage. (An exception is the 'living stones' (*Lithops*) of southern Africa, desert plants that blend in with stones and soil when they are not flowering.) Desert plants might have slightly different colouration to forest plants, for example, some have lighter-coloured leaves that help reduce overheating. They might also have more spikes and tough leaves to help limit predation.

The bright colours of some flowering plants are interesting. If a plant has large, coloured flowers it is generally pollinated by insects (or other animals), whereas wind-pollinated flowers are generally small and nondescript. This would suggest that colours play an important part in attracting pollinators. However, not all insects have eyes that can detect the colours in question.

Some scientists claim that the colours might also help to foil the camouflage of insects that feed off the plant. The plants gain an advantage of having fewer herbivores because the herbivore's predators can see them more easily ('The enemy of my enemy is my friend').

Coloured animals

Given the apparent advantages of camouflage, it might be surprising to see the numbers of animals that are not camouflaged in their environment. Possible explanations for this include:

- **Sexual selection:** If there is non-random mating (partners choose each other) then this can lead to the evolution of sexual dimorphism (the two sexes don't look the same). This is the case of the peacock, the red-breasted robin or the regent bower bird, where the males are brightly coloured and the females are generally duller. It is the females that choose their mate and it is thought that this choice has driven this evolution, particularly when the choice is shown to be instinctive (passed down from mothers to daughters). Scientists are studying whether a female's choice of a brightly coloured male is in fact adaptive, for example, by choosing a brightly coloured male she might in fact be choosing a male that is particularly healthy, because he can still avoid predators that can see him and will therefore pass these good survival genes to her offspring.
- **Advertising poison:** Some prey produce poison to help protect them from predators, and advertise this fact with bright colours. A bird that eats a brightly coloured insect and then is violently sick will avoid similarly coloured insects. This adaptation depends on having predators who avoid eating a prey with such colours (either through instinct or learned behaviour). A prey that does not produce poison might evolve to look like one that predators in its environment are avoiding ('mimicry'). The peacock is unlikely to be a mimic because there is nothing in its environment that it could be mimicking.

- **No pressure:** If there are no environmental pressures, such as no predators/prey, no female choice and no physical advantages, for example, protection from UV, then an animal's colouring might evolve randomly. However, bright colours do require more internal resources and energy. Therefore, colours and structures like the peacock's tail will tend to disappear unless they are under positive selection by the environment.
- **No variation:** Natural selection can only select between individuals. So if all individuals are of the same colour then there can be no change for that feature. Blackbirds were introduced to Australia in the 1850s and are now considered a pest in the southern areas. Their dark plumage is very visible in their new environment. However when the blackbird evolved in the ancient forests of Europe it nested in the roots of overturned trees. The soil of the forest was very dark and nest predation was high, so the dark colours of the bird were a camouflage. Since leaving the environment, populations do not have variations in colour that can be selected (although they do have higher albinism rates), so the blackbird remains black.

EXPLORE

Peacocks

Peacocks were chosen for this lesson because they are one of the clearest examples of sexual selection in the scientific literature. Numerous studies have been conducted to confirm the hypothesis, for example, varying lengths of tail to gauge the female's reaction. Although it is not a native Australian animal, many students are familiar with it. Those that are not will still find it a fascinating bird if introduced to it through pictures and videos.

Equipment

FOR THE CLASS	FOR EACH STUDENT
• class science journal • word wall • TWLH chart • 1 enlarged copy of 'Peacock tales' (Resource sheet 6) • 5 x A4 sheets of paper (see 'Preparation') • *optional:* photos of animals (see 'Preparation')	• science journal

Preparation

- Prepare an enlarged copy of 'Peacock tales' (Resource sheet 6).
- Prepare five A4 signs with the headings 'It doesn't matter', 'It looks poisonous', 'It used to be camouflage', 'The females find it attractive' and 'Unsure'.
- *Optional:* Find photos of animals camouflaged in their environment and photos of a peacock (male and female) and other animals that are distinctly coloured, such as the *Agama sinaita* lizard, regent bower bird, lyrebird or eastern water dragon.

- *Optional:* Display photos and 'Peacock tales' (Resource sheet 6) on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed (www.primaryconnections.org.au).

Lesson steps

1 Review the previous session using the class science journal and the TWLH chart. Focus students' attention on their previous investigation and their results of 'Whether being camouflaged could be beneficial to surviving in the desert.'

Optional: Show students pictures of animals camouflaged in the environment and ask students to spot the camouflaged animals.

2 Ask students whether they think plants can use colour to camouflage themselves similar to animals, ask questions, such as:

- Can you think of plants that are camouflaged?
- What colours are plants usually?
- Why are leaves generally green? (To capture light from the Sun.)

Explain that plants have other structural features that help to protect them from predators, for example, by producing toxins and tannins (see 'Teacher background information').

3 Ask students if they can think of animals that are not camouflaged.

Optional: Show students pictures of animals that are brightly coloured and don't blend into the environment, including a peacock.

4 Introduce the enlarged copy of 'Peacock tales' (Resource sheet 6). Read through with students highlighting unfamiliar words or passages.

Optional: display photos/images of peacocks (see 'Preparation').

5 Draw students' attention to the four claims presented in 'Peacock tales' (Resource sheet 6). Ask students to consider that if there is evidence supporting each claim to decide which they agree with more.

6 Place the signs (see 'Preparation') at separate parts of the rooms and ask students to stand in front of their answer. Ask students to discuss with other students in front of the sign why they chose that answer.

EXPLORE

Students with their chosen claim

EXPLORE

7 Ask each group to share their reasons and evidence for choosing that claim. Record each group's answers in the class science journal.

8 Explain that scientists continue to debate why some animals are not camouflaged and that all of the claims on 'Peacock tales' (Resource sheet 6) are currently accepted claims for different animals. Discuss how in science there isn't always a right or wrong answer, and that uncertainty is part of dealing with ideas in science.

9 Draw students' attention to the following on 'Peacock tales' (Resource sheet 6):

- only the male has the bright colouring and train
- the bright colour and train only appears after they are two years old
- males dance in front of females with the feathers erect.

Explain that scientists think these are indications to believe that the patterns might be connected with getting a mate (see 'Teacher background information').

10 Discuss what evidence scientists might need to collect to support their claims. Ask students to suggest possible questions for investigation if time and resources are available, such as:

- Do females choose males with longer trains and brighter colouration?
- Do males with longer trains find it harder to escape from predators?

11 Explain that through observation and fair testing scientists have found that females do prefer males with longer trains and brighter colours. They have also shown a possible link between longer trains and brighter colours and being generally healthy. However, the research continues, as not everything is yet explained.

12 Explain that although this is more spectacular in forest species, for example peacocks, scientists have found that some desert species have the same type of selection, for example, the males of the *Agama sinaita* lizard in the desert around the Red Sea turn electric blue during mating season.

Optional: Show images of the Agama sinaita lizard and the electric blue colouring. Discuss.

Optional: show images of male eastern water dragon (*Physignathus leseurii*) to show how colour change can be present in Australian lizards also, with the breast of the male turning red.

13 In the class science journal, review the claims from previous lessons about how particular structural features and adaptations help living things survive in their environment. Discuss how not all structural features and behaviours of animals necessarily help them to survive in their environment and that the four claims suggested to explain the peacock's tail are also possible claims for features (see 'Teacher background information).

14 Review the TWLH chart. Record what students have learned and answer any questions that can be answered.

15 Update the word wall with words and images.

EXPLORE

Curriculum links

English

- Examine texts about peacocks from different cultures, including those from South Asia, and identify different moral attributes assigned to the birds, such as nobility, vanity and pride.

Mathematics

- Discuss the investigation results by comparing them to chance outcomes and represent probabilities using fractions.

Asia and Australia's engagement with Asia

- The peacock is the national emblem of India. Examine emblems of countries in South Asia, including their associated mythologies, literature and artwork.

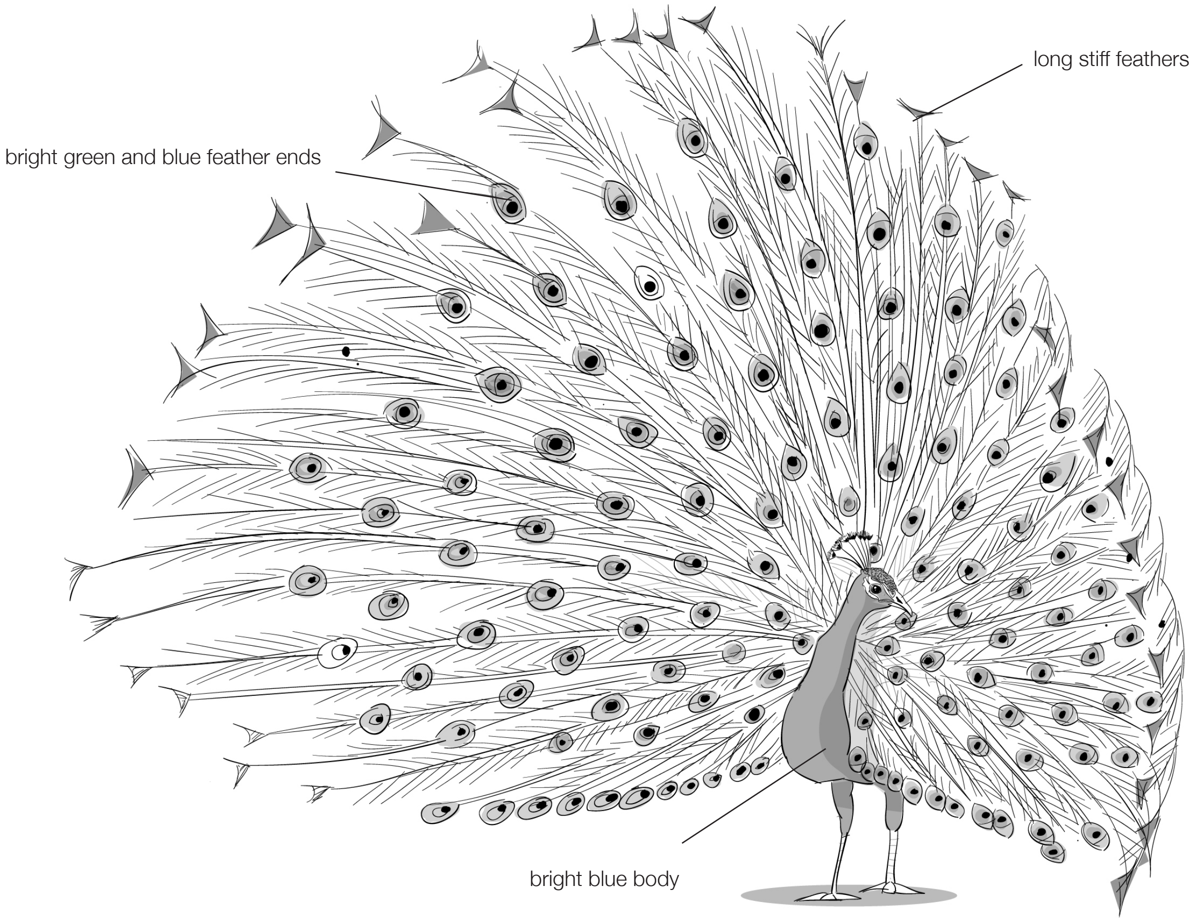
Sustainability

- Discuss measures taken to protect peacocks in their native culture, including tests to determine if feathers were shed naturally or plucked.

Peacock tales

Have you heard of the peacock? It is a most extraordinary bird. It comes from South Asia and is the national bird of India. It has been introduced into many other countries, including Australia.

The body of the male peacock is a bright, vibrant blue. It has a very long train made of long, stiff feathers with colourful patterns. The train is longer than the peacock's body and juts out behind it like a tail. When courting a female, the male holds the train up like a fan and dances in front of her.



The female peacock's feathers are mostly dull brown and she doesn't have a train. Young peacocks and peahens are also both dull coloured. Males only start to grow trains and become blue after they are two years old.

Peacocks originally lived in forests. They forage for food on the ground. They fly up into trees at night to roost, or to high rocks. They also fly to try to escape predators, however, they are still ambushed by leopards.

Being so colourful makes male peacocks easier to see. The long, stiff train can make flying and running more difficult. So why do male peacocks look like they do?

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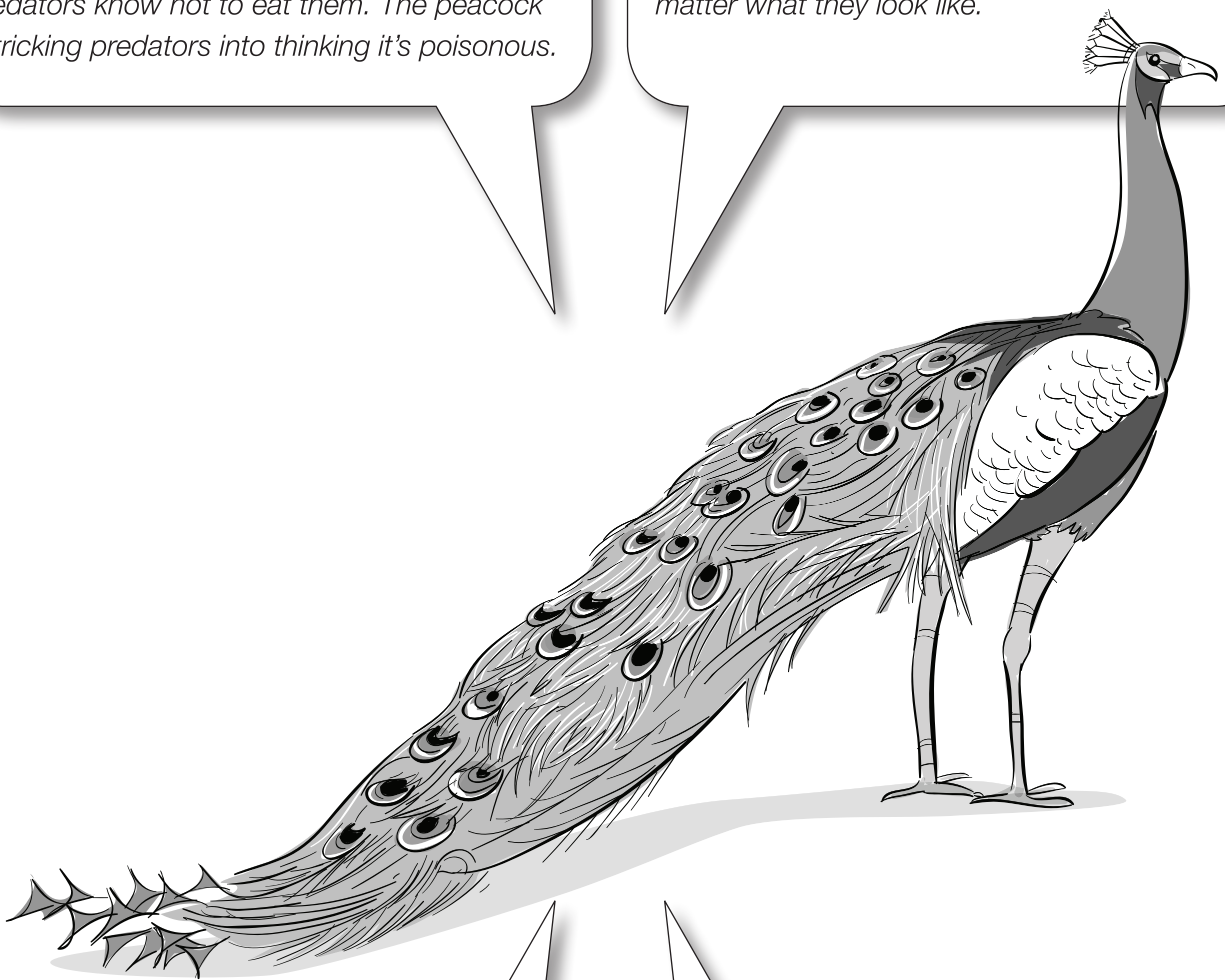
Why do male peacocks look like they do?

It looks poisonous
Poisonous animals are brightly coloured so predators know not to eat them. The peacock is tricking predators into thinking it's poisonous.

It doesn't matter
Peacocks are so fast and strong that it doesn't matter what they look like.



It used to be camouflage
Peacocks used to live in forests where being bright blue and green was good camouflage. Now they can't change back.

The females find it attractive
The train is a nuisance, but if you want to get a female interested you need one—the bigger and brighter the better.

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Lesson 5 Ships of the desert

AT A GLANCE

To support students to represent and explain their understanding of how structural features and adaptations help living things to survive in their environment.

To introduce current scientific views about physical and behavioural adaptations.

Students:

- identify why camels were used for explorations of Central Australia
- make claims about which structural features help camels to survive in desert environments
- discuss behavioural and structural adaptations.

EXPLAIN

Lesson focus

In the *Explain* phase students develop a literacy product to represent their developing understanding. They discuss and identify patterns and relationships within their observations. Students consider the current views of scientists and deepen their own understanding.

Assessment focus

Formative assessment is an ongoing aspect of the *Explain* phase. It involves monitoring students' developing understanding and giving feedback that extends their learning. In this lesson you will monitor students' developing understanding of:

- how living things, such as camels have structural features and adaptations that help them to survive in a desert environment
- how to gather evidence to develop explanations about adaptations.

You will also monitor their developing science inquiry skills (see page 4).

You are also able to look for evidence of students' use of appropriate ways to represent what they know and understand about structural features and adaptations, and give them feedback on how they can improve their representations.

Key lesson outcomes

Science

Students will be able to:

- review their understanding of how plants and animals survive in desert environments
- identify structural features and adaptations that help camels to survive in a desert environment
- identify the difference between physical and behavioural adaptations.

Literacy

Students will be able to:

- use written and oral language to demonstrate their understanding of adaptations
- use scientific language to describe different types of adaptations
- contribute to class discussions about structural features and adaptations that help camels to survive in a desert environment.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 6).

Teacher background information

Camels are called 'ships of the desert' because of their gait and their importance for transporting humans and goods across the desert. They have many structural features that help them to survive in the sandy deserts in which they evolved. Many of these structural features help camels to survive in the new environments in Australia, to which they have been introduced.

An adaptation is a feature that has *evolved to help an animal survive and reproduce in its environment.* Calling a certain feature an adaptation is a scientific claim that needs to be supported with evidence and reasoning. It is easy to imagine how structural features might help an animal to survive, but that does mean that they evolved for that reason. For example, furry ears might help keep sand and dirt out of ears. But they might also be the result of having fur everywhere else on the body and furry ears happened to be a by-product of that adaptation. Long legs might keep a camel off the ground, but they also might simply be something the camel inherited from non-desert ancestors and it hasn't varied since.

Camels adapted to the sandy deserts of Asia and were imported to Australia. Given the similarities between the environments, many of the camels' structural features were pre-adapted to their new environment. Each of the structural features listed on 'Camel features' (Resource sheet 8) has the potential to be labelled as a 'structural adaptation.' The other category of adaptation is a 'behavioural adaptation', such as staying in the shade during the day to avoid the heat of the Sun or plants' leaves turning to avoid the Sun.

Sturt Stony Desert shares many similarities with the sandy deserts of Asia in that it can reach very high temperatures during the day and become cold at night. It also has paucity of available water—water sources are intermittent and occasionally plentiful. However, the desert is hard and stony; Charles Sturt remarked in 1844 that the stones caused the horses to limp and wore down the hooves of the cattle and sheep.

Equipment

FOR THE CLASS	FOR EACH TEAM
• class science journal • word wall • TWLH chart • team roles chart • team skills chart • 1 enlarged copy of 'Our ideas' (Resource sheet 7) • 1 enlarged copy of 'Camel features' (Resource sheet 8)	• role wristbands or badges for Director, Manager and Speaker • each team member's science journal • 1 copy of 'Our ideas' (Resource sheet 7) • 1 copy of 'Camel features' (Resource sheet 8)

Preparation

- Enlarge a copy of 'Our ideas' (Resource sheet 7).
- Enlarge a copy of 'Camel features' (Resource sheet 8).
- *Optional:* Display 'Camel features' (Resource sheet 8) on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed (www.primaryconnections.org.au).
- Review 'How to use a TWLH chart' (Appendix 4) and 'How to facilitate evidence-based discussions' (Appendix 7) for how to support students' reasoning.

EXPLAIN

Lesson steps

1 Review the previous lessons using the class science journal and the TWLH chart, asking questions, such as:

- What do we know about desert environments?
- What do we know about how plants survive in the desert?
- What do we know about how animals survive in the desert?
- How do we know these things?

2 Using the class science journal, remind students of their initial ideas of what they would take into a desert if they were explorers (see Lesson 1). Explain that early explorers took all their supplies with them because they didn't always know enough about the environment to survive there.

3 Explain that the explorers brought animals to carry their water and food for them, for example, camels that they imported from India. Ask students questions, such as:

- Why do you think they brought camels with them?
- Can you think of any Australian animals that they could have used to transport food and water?

- What structural features of camels makes them useful for carrying water and food?
- What structural features of camels might help them survive in desert environments?

4 Explain that students will represent what they know and have learned about plants and animals in the Australian desert. Introduce the enlarged copy of 'Our ideas' (Resource sheet 7) and explain that they will be working in teams to record their ideas. They will take turns to draw a plant structural feature characteristic of desert environments on the sheet. Then pass to the next student and continue until all ideas are recorded. Then they will take turns to choose one structural feature of camels that helps them survive in the desert and add a label explaining why, then pass it on. Repeat for the plants they have drawn.

5 Form teams and allocate roles. Ask Managers to collect a copy of 'Our ideas' (Resource sheet 7). Allow time for students to complete the task.

6 Select teams to share their representations and explanations. Encourage students to compare different ideas and reasoning about how ideas fit with evidence about survival in deserts.

7 Ask teams to generate a title for their recording which explains what it is about, for example, 'Plant and animal survival in the desert.'

8 Discuss how different structural features of a camel might be more suitable for survival in a hard, stony desert compared to a sandy desert. Discuss which structural features would be suitable in either type of desert.

9 Explain that students are going to work in collaborative learning teams to classify the structural features of a camel as either:

- structural features that help the camel survive in the Sturt Desert
- structural features that make it more difficult to survive in the Sturt Desert
- structural features that do not help but make it more difficult.

Discuss how to represent their classification, for example by circling the claims with different colours and writing a legend.

Remind students of the importance of providing evidence and reasoning to support their claims.

10 Ask Managers to collect a copy of 'Camel features' (Resource sheet 8). Allow time for students to complete the task.

11 Ask Speakers to share their team's claims, evidence and reasoning. Encourage students to question each other using the 'Science question starters' (see Appendix 7). Discuss what further evidence might be useful to justify a claim. Allow time for students to compare the ideas of other groups, and reason with others about how different ideas fit with evidence. Allow students time to modify their ideas to fit with evidence if needed.

12 Ask teams to revisit 'Our ideas' (Resource sheet 7) and annotate to add new things they have learned, or to add further annotations to justify their claims.

EXPLAIN

13 Introduce the term 'adaptation' and ask students what they think it means. Record students' ideas in the class science journal. Explain that scientists define an adaptation as a structural feature that has evolved to help an animal survive and reproduce in its environment.

14 Explain that for scientists an animal is therefore adapted for an environment in which it has evolved. As evolution takes time and the camel only recently arrived in Australia, scientists would say it is adapted to survive in the sandy deserts of its origin. Since deserts in Australia have many similar characteristics, camels were therefore pre-adapted to live there.

15 Discuss how the adaptations for desert conditions, such as hot, dry environments, and sparse water and food supplies, help the camel survive in Central Australia. However, the adaptations for sandy deserts are not necessarily adaptations for stony deserts, such as:

- small and furry ears are not necessarily important for survival when there is no sand to stop from blowing in
- large feet with a cushioned pad help stop camels from sinking into sand but can make it difficult to walk on a hard, stony surface.

Optional: Ask students in what other habitats the camel might survive, such as forests, cities, coral reefs, mountainous areas, swamps or snow fields. Ask students to justify their claim with reasoning about structural features that might help it survive.

16 Discuss how humans (and explorers) change their behaviours in the desert. Examples include bringing more water and wearing different clothes. Explain that adaptations can be 'physical' or 'behavioural' (see 'Teacher background information'). Discuss how behaviours can sometimes be learned and passed down, whereas structural features depend a lot more on what you are born with and tend to evolve more slowly.

Optional: Explain that the ability to learn new behaviours quickly is an adaptation that has helped animals such as humans survive in many diverse and changing environments.

17 Review the TWLH chart. Record what students have learned and answer any questions that can be answered.

18 Update the word wall with words and images.

Curriculum links

Science

- Discuss the mechanisms of adaptation, for example, using the 'Survival of the butterfly (cake)' activity (www.csiro.au/resources/butterfly-survival-activity.html).

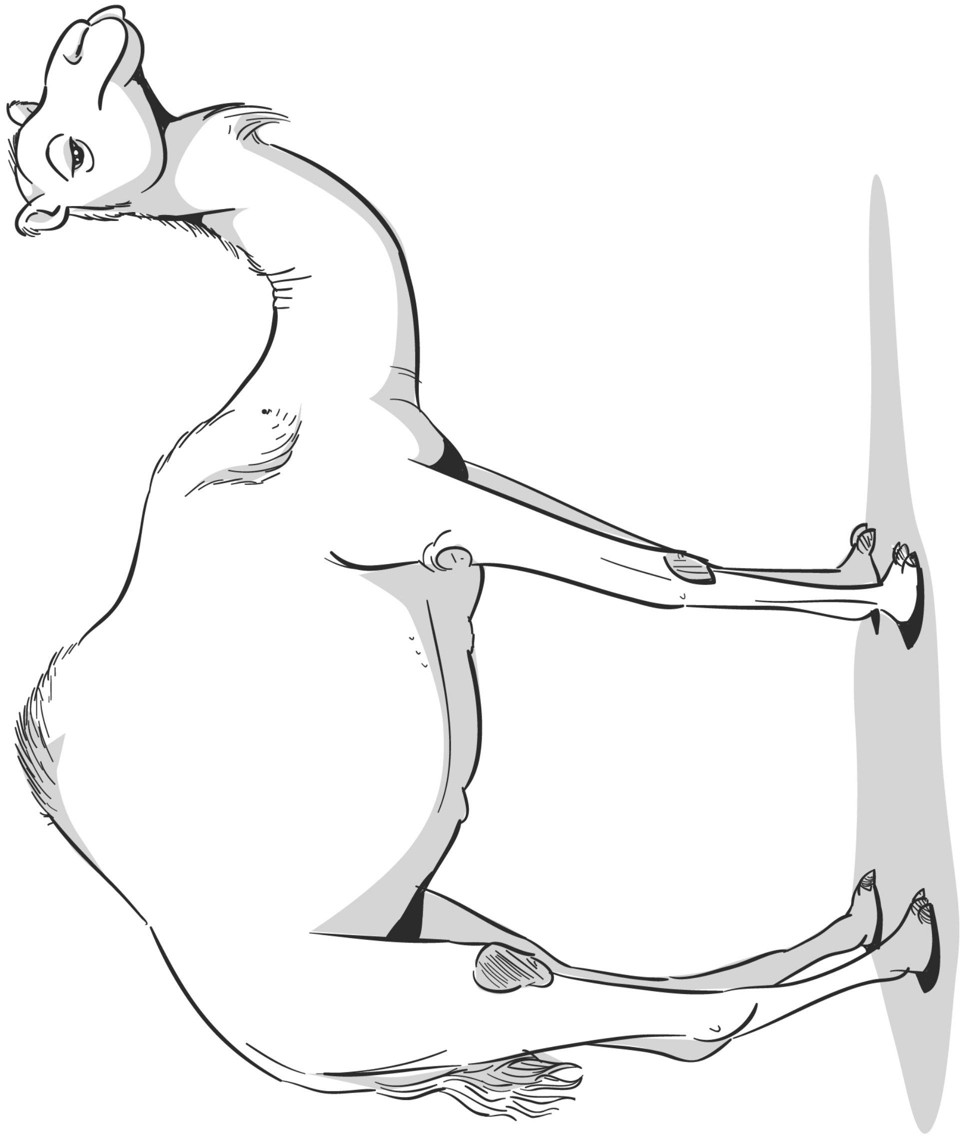
Indigenous perspectives

- Western scientists seek to understand structural features of living things in terms of functions, such as adaptation in the context of evolution. Indigenous people might have their own way of explaining the origins of structural features of living things around them (see page 7). Contact local Indigenous community members and/or Indigenous Education Officers to access relevant, local Indigenous knowledge.
- Primary**Connections** recommends working with Aboriginal and Torres Strait Islander community members to access local and relevant cultural perspectives. Protocols for engaging with Aboriginal and Torres Strait Islander community members are provided in state and territory education guidelines. Links to these are provided on the Primary**Connections** website (www.primaryconnections.org.au).

Sustainability

- Discuss the 'Camel plague' in Outback Australia (www.abc.net.au/btn/story/s2639922.htm).

Our ideas



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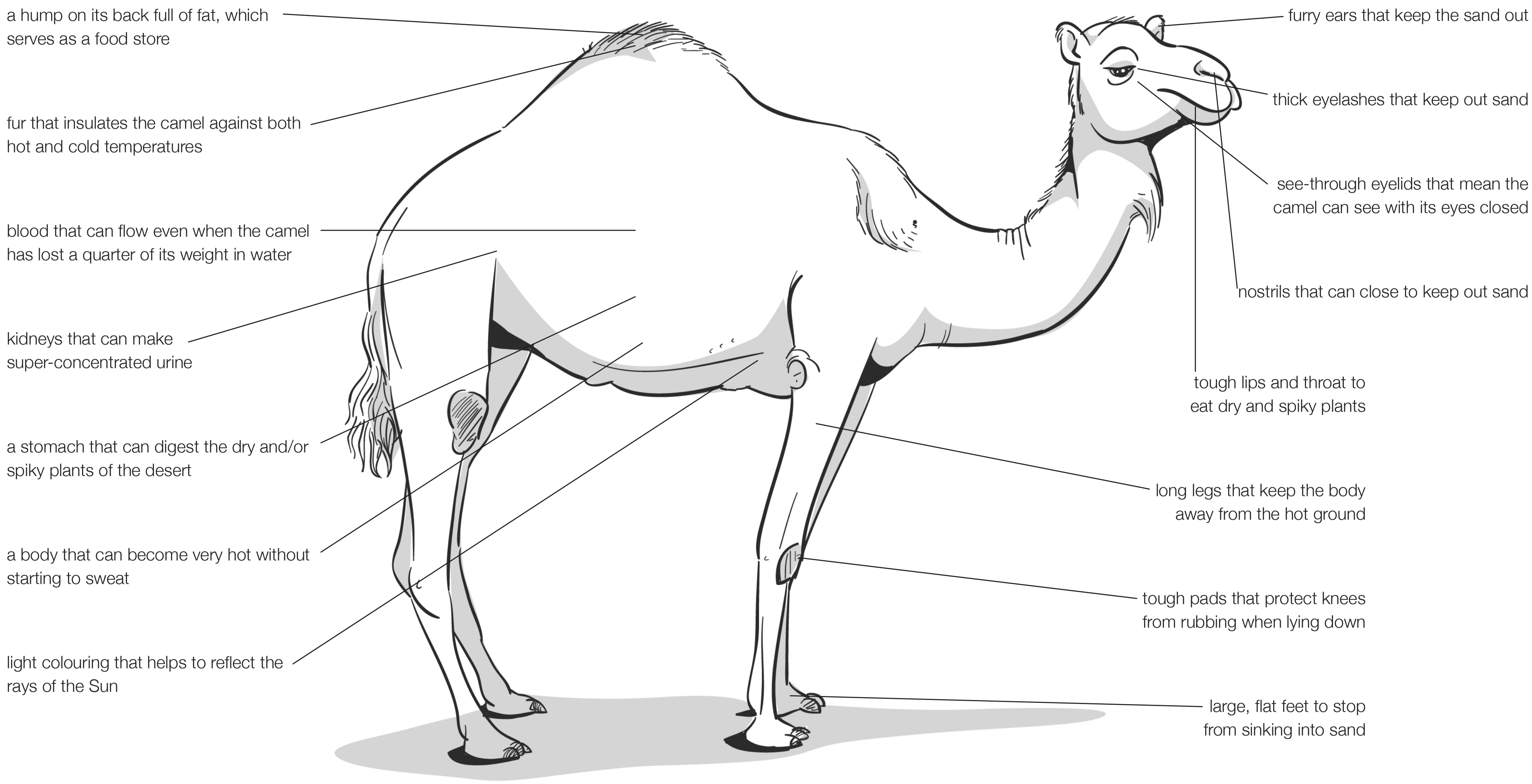
Camel features

Burke and Wills knew they were possibly heading into deserts similar to ones described by previous explorers, with very little water, plants that horses did not like to eat and extreme heat. They chose to take camels with them. What structural features of this camel might help them to survive in a sandy desert of Australia? What about a desert with sharp rocks and lots of tough, spiky plants like the Sturt Desert?



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Lesson 6 Species specialists

AT A GLANCE

To support students to research information about the structural features and adaptations of a particular desert animal or plant.

Students:

- work in teams to plan and conduct research into a particular desert species
- consider how to make evidence-based claims about desert adaptations.

Lesson focus

In the *Explain* phase students develop a literacy product to represent their developing understanding. They discuss and identify patterns and relationships within their observations. Students consider the current views of scientists and deepen their own understanding.

EXPLAIN

Assessment focus

Formative assessment is an ongoing aspect of the *Explain* phase. It involves monitoring students' developing understanding and giving feedback that extends their learning. In this lesson you will monitor students' developing understanding of:

- how living things, such as camels have structural features and adaptations that help them to survive in a desert environment
- how to gather evidence to develop explanations about adaptations.

You will also monitor their developing science inquiry skills (see page 4).

Key lesson outcomes

Science

Students will be able to:

- research information about a particular desert species
- interpret evidence to identify if certain structural features can be considered adaptations
- identify and describe key adaptations of a desert species.

Literacy

Students will be able to:

- participate in collaborative learning teams to collect information on a particular desert species
- read and analyse information on desert adaptations
- identify the purpose and features of an annotated diagram.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 6).

Teacher background information

Species to investigate

Australia has a great diversity of living things that are adapted to the desert. To ensure that students are introduced to a diverse set of adaptations to the desert environment, ask groups to investigate the following species:

- The Australian Mulga *(Acacia aneura)* that has oily, thin, sometimes hairy leaves and a long taproot.
- Old Man Saltbush *(Atriplex nummularia)* that has small succulent grey leaves, can tolerate high levels of salt and has wide-spreading roots.
- Sturt's Desert Pea *(Swainsona formosus)* that only flowers in favourable conditions and has seeds that can survive in harsh conditions for years.
- The Greater Bilby *(Macrotis lagotis)* that has large ears and concentrated urine.
- Spencer's Burrowing Frog *(Opisthodon spenceri,* formerly *Limnodynastes spenceri)* that hides in damp burrows during the dry season.
- The Thorny Devil *(Moloch horridus)* that is camouflaged and channels water on its body to its mouth.
- Budgerigars *(Melopsittacus undulatus)* that migrate out of the desert when conditions become too dry.

These have all been chosen because it is relatively easy to find information on the species (either by searching with the Latin name or with the common name). Other species of interest might include:

- The Boab tree *(Adansonia gregorii)* that has a bottle-shaped trunk that stores water and loses its leaves in extreme dryness.
- Spinifex grass, for example, *Triodia wiseana* that are sharp and spiny and conserve water through their shape.
- The Spinifex Hopping Mouse *(Notomys alexis)* that is nocturnal.
- Shield shrimps *(Triops australiensis)* that are tiny crustaceans that go from hatching to reproduction in the ephemeral pools that form after the rains.
- The Barking Spider *(Selenocosmia stirlingi*)* that is an Australian tarantula which also stays in moist burrows and feeds in the wet.
- Termites, for example, *Nasutitermes triodiae** that build large mounds in the desert that are optimised for desert conditions.
- Witchetty grubs, for example, *Endoxyla leucomochla** that are the larvae of moths that feed on plant roots and are an important source of food for Indigenous populations.
- A desert snail, for example, *Sinumelon pedasum** that estivate (pass summer in a dormant state) in their shell.

*These species names are given as indications. They have been suggested as they will help students become more familiar with the diversity of types of living things in the desert. However, there is not as much information readily available on them, and students might need to research the genus as whole, for example, search for *'Sinumelon'* rather than *'Sinumelon pedasum'*.

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart
- team skills chart
- team roles chart
- 1 enlarged copy of 'Camel features' (Resource sheet 8) from Lesson 5
- 1 hat or box (see 'Preparation')

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- resources to do research on structural features of different species in deserts of Australia

Preparation

EXPLAIN

- Choose enough species for each collaborative learning team to have a different one (see 'Teacher background information'). Write each species' name on a separate piece of paper and place in the box or hat to be drawn out by teams.
- If you have contact with local Indigenous community members and/or Indigenous Education Officers (see page 7) invite them to discuss what they know about the observable features and behaviours of each team's species with the team.
- This lesson involves a research project. Depending on students' research skills, time will need to be allocated to complete this group task. Resources that might be required include internet and library access. You might also choose to ask your students to complete part of this task at home.
- *Optional:* This task is designed to be conducted in collaborative learning teams. However, you might choose to ask students to complete it as an individual task.

Lesson steps

1 Review the previous lessons using the class science journal and the TWLH chart. Ask questions, such as:

- What is an adaptation?
- What adaptations do we know help plants/animals survive in the desert?
- What adaptations do we think help plants/animals survive in the desert?
- Do animals have structural features that do not help them survive in their environment? Why?

2 Write the question 'What are key adaptations that help living things survive in the desert?' in the class science journal. Discuss what the class could do to find answers for that question.

3 Explain that students will work in collaborative learning teams to research the features and behaviours of a particular species and make claims about key adaptations that help them survive in their desert environment.

Optional: students work individually.

4 Remind students of the importance of recording evidence to support their claims. Explain that for this investigation they will summarise the relevant information they found and record where that information came from. Review the purpose and features of a summary (see Lesson 2, Session 3).

5 Explain that students will prepare an oral presentation with supporting resources, such as a poster or slides, to present their findings to the class. Discuss the purpose and features of an oral presentation.

Literacy focus

Why do we use an oral presentation?

We use an **oral presentation** to entertain or provide information for an audience.

What does an oral presentation include?

An **oral presentation** is a speech that has an introduction, main part and conclusion.

It might be serious or funny depending on the topic and audience.

EXPLAIN

6 Explain that teams will:

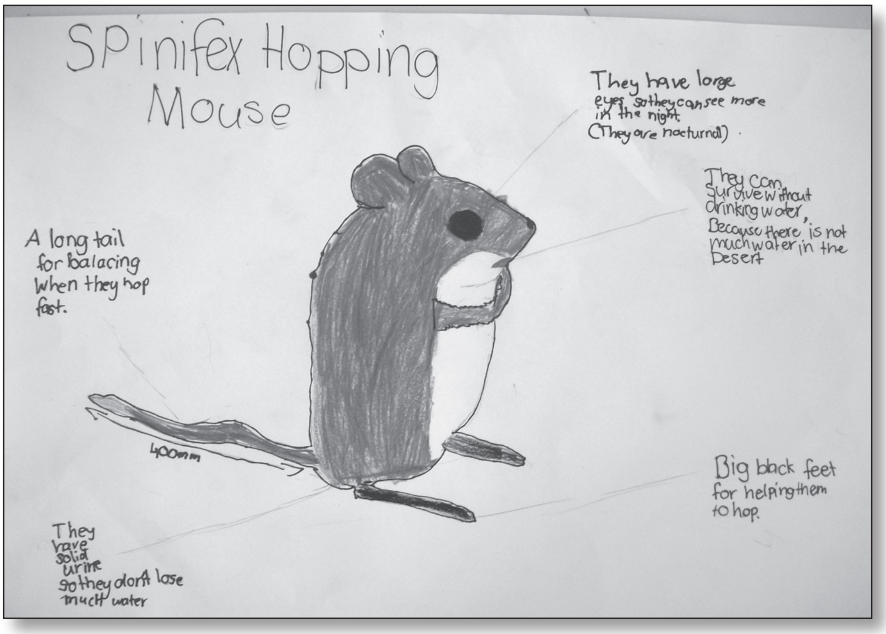
- describe the desert environment to which the species is adapted
- describe the structural features and behaviour of the species
- make claims about which are key adaptations that help the species survive.

7 Describe the features that make good-quality presentations:

- well-organised information
- clear, concise communication
- use of evidence and reasoning to support claims
- quality/creative visual aids.

Optional: View oral presentations by scientists on adaptations, for example: (www.qm.qld.gov.au/Find+out+about/Behind+the+Scenes/Museum+Experts).

8 Ask students to create an annotated drawing to present during their oral presentation, similar to the one on 'Camel features' (Resource sheet 8). Review the purpose and features of an annotated drawing discussed in Lesson 2, Session 1.



Student work sample of an annotated drawing

9 Explain that students will be presenting their findings in Lesson 8, and tell them what date that is.

10 Form teams and allocate roles. Ask Managers to come and draw which species they will be studying from the hat (see 'Preparation').

11 Allow time for teams to start their research.

Optional: Ask students to continue to research as a home task (see 'Preparation').

EXPLAIN

Lesson 7 Checking claims

AT A GLANCE

To support students to plan and conduct an investigation of whether or not a structural feature of an animal is an adaptation for surviving in a desert environment.

Students:

- identify questions for investigation and gather evidence about adaptations to desert environments
- work in teams to plan and conduct their investigation
- observe, record and share the results of their investigation.

Lesson focus

In the *Elaborate* phase students plan and conduct an open investigation to apply and extend their new conceptual understanding in a new context. It is designed to challenge and extend students' science understanding and science inquiry skills.

Assessment focus

Summative assessment of the Science Inquiry Skills is an important focus of the *Elaborate* phase (see page 4). Rubrics will be available on the website to help you monitor students' inquiry skills.

Key lesson outcomes

Science

Students will be able to:

- formulate a question for investigation to gather evidence about adaptations
- plan and conduct a fair test to test their ideas
- make and record observations
- construct and identify patterns in a graph
- provide evidence to support their conclusions.

Literacy

Students will be able to:

- represent results to interpret them and compare them to their predictions
- summarise their findings and relate them to the context of desert adaptations
- engage in discussion to compare ideas and provide relevant arguments to support their conclusions.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 6).

ELABORATE

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart
- team skills chart
- team roles chart
- 1 enlarged copy of 'Adaptation investigation planner' (Resource sheet 9)

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 copy of 'Adaptation investigation planner (Resource sheet 9)
- equipment for an open investigation (see 'Preparation')

Preparation

- Collect equipment for students to conduct investigations modified from the investigations of Lesson 2 and Lesson 3, including:
  - — thermometers
  - — a hot water station
  - — cloths of different thickness, materials and colours
  - — scales
  - — scissors
  - — containers of different sizes, shapes and colours
  - — water.
- Prepare an enlarged copy of 'Adaptation investigation planner' (Resource sheet 9).
- *Optional:* Display the 'Adaptation investigation planner' (Resource sheet 9) on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed (www.primaryconnections.org.au).

Lesson steps

1 Review the previous lessons using the class science journal and the TWLH chart, focusing students' attention on their current research claims about how their species is adapted to desert conditions. Ask questions, such as:

- How can we have confidence in a claim?
- How do we know that the authors provide reliable information?
- How can we argue that a structural feature helps living things survive for that reason?

2 Explain that students are going to work in collaborative learning teams to decide on a question for investigation and gather evidence about one claim about an adaptation, such as:

- Lighter colours help living things keep cool by reflecting the Sun. (Could place water in two different-coloured cups and measure temperature.)

- Having fat helps keep living things cool by stopping the heat being absorbed. (Could place water and fat in two cups and see if they heat up differently.)

Note: In order to see if things keep cool, students could modify the 'Surface cooling investigation planner' (Resource sheet 4), for example, by using cold water in containers and investigating which stays coldest the longest.

3 Present the equipment (see 'Preparation') and explain that students will plan an investigation. Encourage students to use their 'Surface drying investigation planner' (Resource sheet 3) or 'Surface cooling investigation planner' (Resource sheet 4) as starting points for planning their investigation.

4 Review the variables that students identified might affect those investigations, such as colour, size of containers, shapes of cloths, etc. Ask students which variables they could change with the available materials. Review the process of writing questions for investigation.

5 Form teams and allocate roles. Ask Managers to collect their team's copy of 'Adaptation investigation planner' (Resource sheet 9).

6 Allow time for teams to decide what investigation they will plan. Ask questions, such as:

- That's interesting, have you thought about … ?
- Do you think that will be possible with our equipment?
- What will you change and what will you keep the same?

7 Ask teams to plan and record their investigation and discuss it with you before conducting their investigation. Ask students how they will keep their test fair (by only changing one thing and keeping the rest the same).

8 Ask Managers to collect the material for their investigation, based on their completed planner. Allow time for students to conduct the investigation and record their results.

Student studying the effect of colour on heating of water

ELABORATE

9 Discuss with teams whether it is possible to graph their results to more easily see the patterns in their findings and what variables should be on which axis. Ask teams to represent their results and complete their copy of 'Adaptation investigation planner' (Resource sheet 9).

10 Ask Speakers to share their team's results and conclusion with the class. Encourage students to question each other using the 'Science question starters' (see Appendix 7).

11 Ask teams to share if they had any difficulties with their investigation, and what they would change if they were to do it again. Ask questions, such as:

- What went well with your investigation?
- What didn't go well? How might you change it to improve it?

12 Discuss what ideas students have for another investigation. Ask students to record these in the 'Evaluating the investigation' section of their planner.

13 Revise the science inquiry skills on page 2 with students, and review their progress in developing these skills and identify areas for improvement.

14 Update the TWLH chart and word wall with words and images.

Adaptation investigation planner

Team members' names: ______________________________ **Date:** ____________

What are you trying to find out?

What is your question for investigation?	**What do you predict will happen? Explain why.**
What happens to ______________________ ______________________________ when we change ______________________ ______________________________ ?	Give scientific reasons for your predictions

To make the test fair, what things (variables) are you going to:

Change?	**Measure/Observe?**	**Keep the same?**
Change only **one** thing	What would the change affect?	Which variables will you control?

What equipment will you need?

• • •	• • •	• • •

What are you going to do?

 ISBN 978 0 85847 328 7

Adaptation investigation planner

Recording results

Presenting results

Title: ____________________________________

____

Explaining results

How would you summarise your results?
Did your results match your prediction? Why?

Evaluating the investigation

What problems did you have? How might you improve the investigation (fairness, accuracy)?

Lesson 8 Powerful presentations

AT A GLANCE

To support students to present their evidence-based claims about different structural features and adaptations for surviving in a desert environment, and to reflect on their learning during the unit.

Students:

- present evidence-based claims about adaptation to desert environments
- compare and discuss results to draw conclusions about patterns of adaptation.

Lesson focus

In the *Evaluate* phase students reflect on their learning journey and create a literacy product to re-represent their conceptual understanding.

Assessment focus

Summative assessment of the Science Understanding descriptions is an important aspect of the *Evaluate* phase. In this lesson you will be looking for evidence of the extent to which students understand:

- how living things have structural features and adaptations that help them to survive in a desert environment
- how to use evidence to develop explanations about which animals might have a greater chance for survival in a desert environment.

Literacy products in this lesson provide useful work samples for assessment using the rubrics provided on the Primary**Connections** website.

Key lesson outcomes

Science

Students will be able to:

- interpret data to make claims about key adaptations of desert species
- provide evidence to support their identification of adaptations
- identify adaptations of different species living in desert environments.

Literacy

Students will be able to:

- understand the purpose and features of an oral presentation
- use talk and an annotated diagram to communicate their findings
- contribute to a class discussion to compare adaptations of different species to Australian deserts.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 6).

Teacher background information

'Strategies' for desert survival

When biologists study adaptations of living things to an environment they sometimes classify groups of adaptations into 'strategies'. The term comes from the mathematical modelling used and does not mean that species are deliberately choosing their evolutionary path. Rather, it is a set of adaptations that are part of the same outcome. Desert 'strategies' include:

Aridity avoiders who avoid the driest and hottest months:

- by producing seeds or eggs that don't germinate or hatch until the rains and then grow very quickly and reproduce before the dry season again; also called 'expiring'.
- by migrating
- by estivating underground (passing summer in a dormant state, such as in the form of a bulb or in a burrow like the frog) and storing food and water during rainy seasons; also called 'evading'.

Aridity endurers who live in the desert all year:

- by staying underground during the heat of the day
- by evolving adaptations to survive a desert by day, including heat regulation, water retention and gathering nutrients and energy.

These classifications are a useful way to think about 'types' of adaptations and how they might co-evolve. For example, if a plant has adaptations to only live for a brief amount of time it might not evolve waxy leaves but it might evolve better seed casings. However, different people might choose to classify things differently depending on what they are investigating.

Equipment

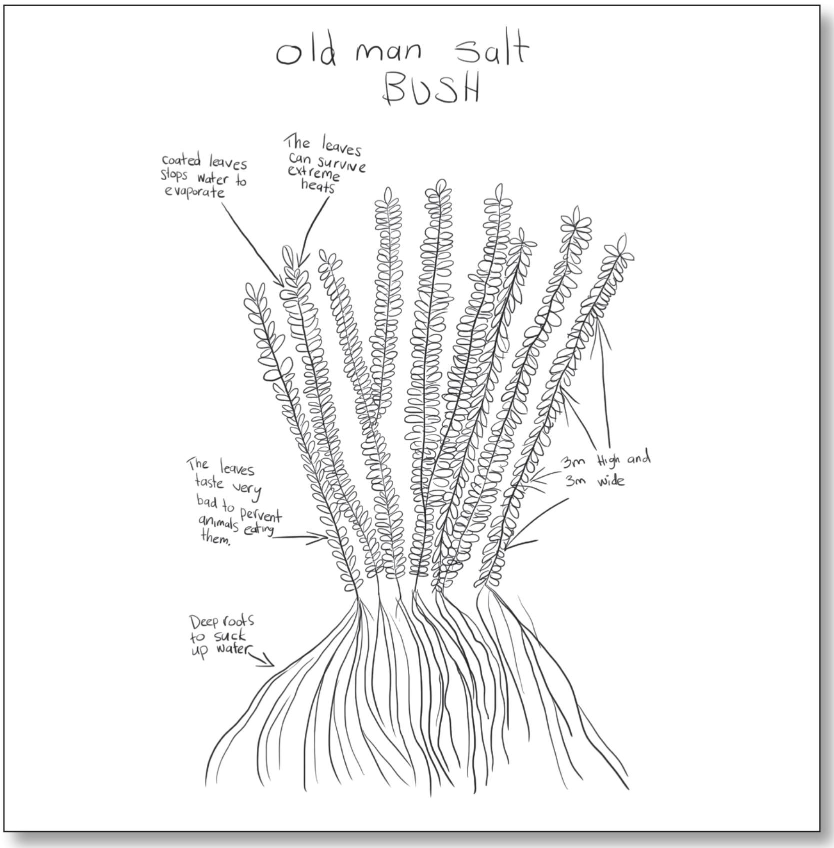
FOR THE CLASS	FOR EACH TEAM
• class science journal • word wall • TWLH chart • team skills chart • team roles chart	• role wristbands or badges for Director, Manager and Speaker • each team member's science journal • 1 copy of 'Adaptation investigation planner (Resource sheet 9) • equipment for an open investigation (see 'Preparation') • equipment to make and present visual aids for an oral presentation.

Lesson steps

1 Review Lesson 6 and the research task assigned to teams. Explain that in this lesson, teams will be giving their oral presentations. Discuss the features that make good-quality presentations:

- well-organised information
- clear, concise communication
- use of evidence and reasoning to support claims
- quality/creative visual aids.

Review the purpose and features of an annotated drawing.



Student work sample of an annotated drawing

EVALUATE

Optional: View oral presentations by scientists on adaptations, for example: **www.qm.qld.gov.au/Find+out+about/Behind+the+Scenes/Museum+Experts**

2 Allocate each team a partner team to conduct a peer assessment. Ask students to watch their partner team's presentation and record constructive notes on where they went well and where they could improve.

3 Ask teams to share their oral presentations with the class. Ask students in the audience to use the 'Science question starters' (see Appendix 7) to ask each team about their evidence and reasoning. Encourage dialogue between students using questions, such as:

- Do you agree with what this team said? Why or why not?
- Is there any more evidence that would help to support that claim?

4 After discussion, record teams' claims and their supporting evidence on the TWLH chart.

5 Ask students to reflect on their investigation, asking questions, such as:

- Are you satisfied with the amount of information that you found?
- Is there anything you would have liked further evidence for?
- What are you still wondering about?
- Are you satisfied with how you presented the information?
- What might you improve if you presented it again?

Record students' answers in the class science journal.

6 Ask students to group with their partner teams to see if their perceived strengths and weaknesses matched where the other team thought their strengths and weaknesses lay.

7 Review the different adaptations recorded on the TWLH chart and ask students questions, such as:

- Why are there so many different adaptations? (Because there are many different forms of life.)
- Is it possible to group the types of adaptations?
- Is it possible to group the different species depending on their types of adaptations?

Optional: Ask students to organise the different species they have investigated into categories based on their adaptations using a Venn diagram.

8 Introduce the terms 'Aridity avoiders' and 'Aridity endurers' (see 'Teacher background information'), and discuss how to classify the species that students have studied into these categories. Ask students to record their classification, giving reasons, in their science journal.

9 Reinforce that living things do not choose their adaptations (other than recent behaviour changes) and that their adaptations are the result of evolution in their environment.

10 Update the TWLH chart and word wall with words and images.

Lesson 9 Plausible possibilities

AT A GLANCE

To provide opportunities for students to represent what they know about how living things have structural features and adaptations that help them to survive in their environment, and to reflect on their learning during the unit.

Students:

- describe the hypothetical adaptation of a new animal to a desert environment
- participate in a class discussion to reflect on their learning during the unit.

Lesson focus

In the *Evaluate* phase students reflect on their learning journey and create a literacy product to re-represent their conceptual understanding.

Assessment focus

Summative assessment of the Science Understanding descriptions is an important aspect of the *Evaluate* phase. In this lesson you will be looking for evidence of the extent to which students understand:

- how living things have structural features and adaptations that help them to survive in a desert environment
- how to use evidence to develop explanations about which animals might have a greater chance for survival in a desert environment.

Key lesson outcomes

Science

Students will be able to:

- identify adaptations of different desert species
- explain their ideas about which structural features of animals might help them survive in a desert environment
- discuss and compare their ideas.

Literacy

Students will be able to:

- use oral, written and visual forms to present their understanding of adaptations
- reflect on their learning in a science journal entry.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 6).

Teacher background information

In this lesson students are asked to choose which monkey they think has a good chance of surviving in a desert environment. You are looking for evidence of students' understanding of adaptations and use of evidence-based reasoning. There is no 'correct' answer, however, there are appropriate claims and assertions about particular features and behaviours and whether they are adaptations.

Structural feature or behaviour	Possible claims
Light-coloured fur*	It is camouflage in some deserts during the day. It helps reflect the rays of the Sun.
Dark-coloured fur*	It helps absorb UV and protects from the Sun. It is camouflage at night.
Big ears*	It allows animals to diffuse heat. It helps animals hear noises.
Small ears*	Means that less dust and sand get in.
Big feet	It stops the monkey sinking into the soil. It helps to dig.
Small feet	It is easier to fit into confined spaces like burrows.
Prefers eating tough plants	There are lots of plants like acacia and spinifex that they could eat.
Prefers eating insects and succulent plants	Those foods are rarer but have a lot of water.
Very active during the day without sweating too much	The monkey will find it easier to find food during the day.
Stays in the shade, active at dusk	The monkey saves water and doesn't heat up as much.
Has a lot of fur	Lots of fur can help insulate against the heat and the cold. Monkeys without lots of fur might burn in the rays of the Sun.

* These are structural features that students have studied during the unit and they can be encouraged to provide evidence and reasoning. Through the research task in the Explain phase and the student-led investigation in the Elaborate phase they will also have evidence for the other claims.

	Fur colour	Fur	Ear size	Leg size	Eating	Activity
Monkey 1	Light	Thick	Big	Long	Plants	Day
Monkey 2	Light	Thin	Small	Short	Plants	Night
Monkey 3	Dark	Thin	Small	Long	Insects	Day
Monkey 4	Dark	Thick	Big	Short	Insects	Night

EVALUATE

Based on the chart:

- Monkey 1 seems very well adapted to day life in the desert.
- Monkey 4 seems very well adapted to twilight life in the desert.
- Monkeys 2 and 3 have thin fur that would mean they are less insulated against temperature extremes and the rays of the Sun. However, if students consider other structural features or behaviours as being more important, then these factors might be selected.

Chance and random variation play such a part in evolution that it is very hard to predict what might happen when a species is introduced to a new environment, for example, it is hard to know which species will become invasive.

Equipment

FOR THE CLASS

- class science journal
- word wall
- TWLH chart
- 1 enlarged copy of 'Many monkeys' (Resource sheet 10)
- 4 A4 pieces of paper (see 'Preparation')

FOR EACH TEAM

- science journal
- 1 copy of 'Many monkeys' (Resource sheet 10)
- 1 copy of 'Choosing monkeys' (Resource sheet 11)

Preparation

- Prepare four A4 signs with the headings 'Monkey 1', 'Monkey 2', 'Monkey 3' and 'Monkey 4'.
- *Optional:* Place enlarged pictures of each monkey under the relevant sign.
- Prepare an enlarged copy of 'Many monkeys' (Resource sheet 10).
- Prepare an enlarged copy of 'Choosing monkeys (Resource sheet 11)
- *Optional:* Display 'Many monkeys' (Resource sheet 10) and 'Choosing monkeys' (Resource sheet 11) on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed (www.primaryconnections.org.au).

EVALUATE

Lesson steps

1 Review the previous lessons using the class science journal and the TWLH chart. Ask questions, such as:

- What structural features help living things (plants and animals) survive in the desert?
- Are all structural features of a living thing an adaptation?
- Can living things choose which structural features they would like to have? (No, because it is the product of evolution.)

2 Introduce the enlarged copy of 'Many monkeys' and ask students to imagine that a small population of this imaginary monkey-like creature was stranded in an Australian desert. Explain that students are going to choose which type of monkey they think will survive the best in the new environment.

3 Distribute 'Many monkeys' (Resource sheet 10) and 'Choosing monkeys' (Resource sheet 11). Ask students to record reasons and explanations for their choice on 'Choosing monkeys' (Resource sheet 11), using evidence that they have investigated throughout the unit. Discuss with students what things they might consider when making their choice, such as physical and behavioural adaptations.

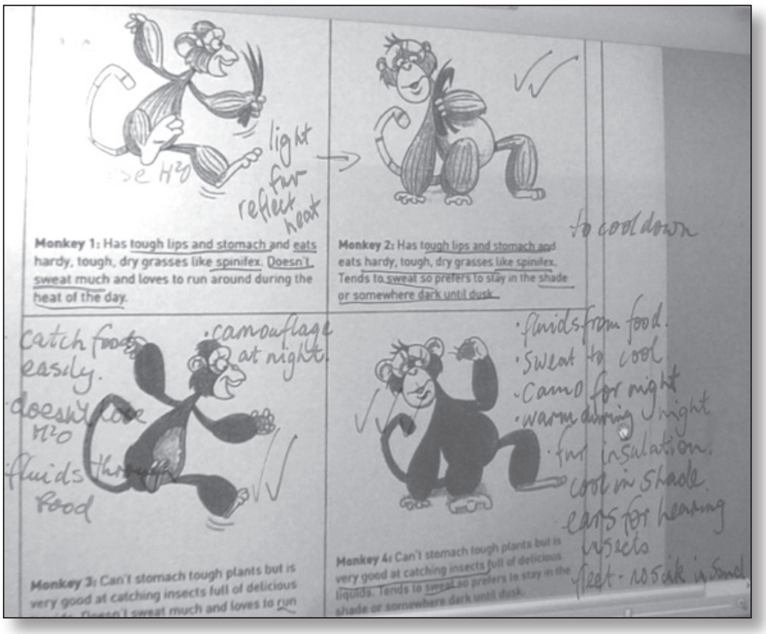
4 Allow time for students to complete their copy of 'Choosing monkeys' (Resource sheet 11).

5 Place the signs (see 'Preparation') in different parts of the room and ask students to stand in front of their answer. Ask students to discuss with other students in front of the sign why they chose that answer.

6 Ask students to find someone who chose a different answer and exchange their ideas and reasons.

7 Ask students to share with the class what they think now. Ask questions, such as:

- Did your discussions make you change your ideas? Why? Why not?
- Why do you think we have different ideas? (Because there are many different adaptations and it is hard to predict which will have the most influence on survival.)



Class record of discussion of 'Many monkeys' (Resource sheet 10)

EVALUATE

8 Ask students to reflect on their learning during the unit using their science journals, the class science journal, the TWLH chart and the completed resource sheets. Ask questions, such as:

- What did you think about … at the start of the unit? (Examples can include deserts, how plants/animals survive in deserts, adaptations.)
- What did we want to find out about … ?
- What have you learned about ... ? Why do you think that now?
- How did you find out about … ?
- What activity did you enjoy most? Why?
- What activity did you find the most challenging? Why?
- What are you still wondering about?

Many monkeys

This is an imaginary animal that is very similar to a monkey. It is adapted to living in the forest eating fruit, leaves and insects. It has dark fur to camouflage it in the shade of trees, although some individuals have lighter fur, and has a tail to help it swing through the trees. Imagine that a small population of them were stranded in an Australian desert.

Look at the structural features of each monkey and read its description below. Which type of monkey do you think has a better chance of surviving in the new environment?

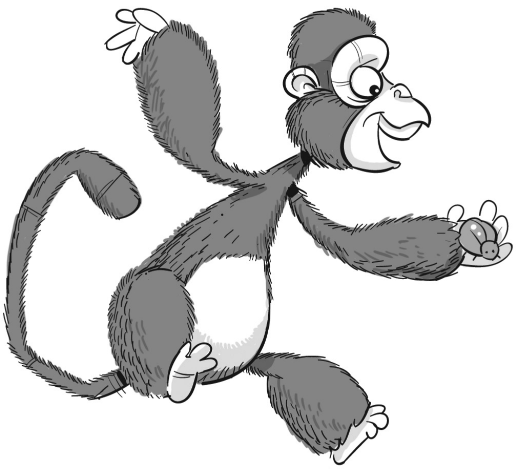
Monkey 1

Has tough lips and stomach and eats hardy, tough, dry grasses like spinifex. Doesn't sweat much and loves to run around during the heat of the day.

Monkey 2

Has tough lips and stomach and eats hardy, tough, dry grasses like spinifex. Tends to sweat so prefers to stay in the shade or somewhere dark until dusk.

Monkey 3



Can't stomach tough plants but is very good at catching insects full of delicious liquids. Doesn't sweat much and loves to run around during the heat of the day.

Monkey 4

Can't stomach tough plants but is very good at catching insects full of delicious liquids. Tends to sweat so prefers to stay in the shade or somewhere dark until dusk.

Choosing monkeys

Name: ______________________ **Date:** ______________________

I think monkey …… has a better chance of surviving in the desert.
A key adaptation of the monkey I chose is …
It might help it to survive because …

My evidence for this claim is ...

Another adaptation of the monkey I chose is …
It might help it to survive because …

My evidence for this claim is …

Another adaptation of the monkey I chose is …
It might help it to survive because …

My evidence for this claim is …

Another adaptation of the monkey I chose is …
It might help it to survive because …

My evidence for this claim is …

Appendix 1
How to organise collaborative learning teams (Year 3–Year 6)

Introduction

Students working in collaborative teams is a key feature of the Primary**Connections** inquiry-based program. By working in collaborative teams students are able to:

- communicate and compare their ideas with one another
- build on one another's ideas
- discuss and debate these ideas
- revise and rethink their reasoning
- present their final team understanding through multi-modal representations.

Opportunities for working in collaborative learning teams are highlighted throughout the unit.

Students need to be taught how to work collaboratively. They need to work together regularly to develop effective group learning skills.

The development of these collaborative skills aligns to descriptions in the Australian Curriculum: English. See page 8.

Team structure

The first step towards teaching students to work collaboratively is to organise the team composition, roles and skills. Use the following ideas when planning collaborative learning with your class:

- Assign students to teams rather than allowing them to choose partners.
- Vary the composition of each team. Give students opportunities to work with others who might be of a different ability level, gender or cultural background.
- Keep teams together for two or more lessons so that students have enough time to learn to work together successfully.
- If you cannot divide the students in your class into teams of three, form two teams of two students rather than one team of four. It is difficult for students to work together effectively in larger groups.
- Keep a record of the students who have worked together as a team so that by the end of the year each student has worked with as many others as possible.

Team roles

Students are assigned roles within their team (see below). Each team member has a specific role but all members share leadership responsibilities. Each member is accountable for the performance of the team and should be able to explain how the team obtained its results. Students must therefore be concerned with the performance of all team members. It is important to rotate team jobs each time a team works together so that all students have an opportunity to perform different roles.

For Year 3–Year 6, the teams consist of three students—Director, Manager and Speaker. (For Foundation–Year 2, teams consist of two students—Manager and Speaker.)

Each member of the team should wear something that identifies them as belonging to that role, such as a wristband, badge, or colour-coded peg. This makes it easier for you to identify which role each student is doing and it is easier for the students to remember what they and their team mates should be doing.

Manager

The Manager is responsible for collecting and returning the team's equipment. The Manager also tells the teacher if any equipment is damaged or broken. All team members are responsible for clearing up after an activity and getting the equipment ready to return to the equipment table.

Speaker

The Speaker is responsible for asking the teacher or another team's Speaker for help. If the team cannot resolve a question or decide how to follow a procedure, the Speaker is the only person who may leave the team and seek help. The Speaker shares any information they obtain with team members. The teacher may speak to all team members, not just to the Speaker. The Speaker is not the only person who reports to the class; each team member should be able to report on the team's results.

Director (Year 3–Year 6)

The Director is responsible for making sure that the team understands the team investigation and helps team members focus on each step. The Director is also responsible for offering encouragement and support. When the team has finished, the Director helps team members check that they have accomplished the investigation successfully. The Director provides guidance but is not the team leader.

Team skills

Primary**Connections** focuses on social skills that will help students work in collaborative teams and communicate more effectively.

Students will practise the following team skills throughout the year:

- Move into your teams quickly and quietly.
- Speak softly.
- Stay with your team.
- Take turns.
- Perform your role.

To help reinforce these skills, display enlarged copies of the team skills chart (see the end of this Appendix) in a prominent place in the classroom.

Supporting equity

In science lessons, there can be a tendency for boys to manipulate materials and girls to record results. Primary**Connections** tries to avoid traditional social stereotyping by encouraging all students, irrespective of their gender, to maximise their learning potential. Collaborative learning encourages each student to participate in all aspects of team activities, including handling the equipment and taking intellectual risks.

Observe students when they are working in their collaborative teams and ensure that both girls and boys are participating in the hands-on activities.

TEAM ROLES

Manager
Collects and returns all materials the team needs

Speaker
Asks the teacher and other team speakers for help

Director
Make sure that the team understands the team investigation and completes each step

TEAM SKILLS

1 Move into your teams quickly and quietly

2 Speak softly

3 Stay with your team

4 Take turns

5 Perform your role

Appendix 2
How to use a science journal

Introduction

A science journal is a record of observations, experiences and reflections. It contains a series of dated, chronological entries. It can include written text, drawings, labelled diagrams, photographs, tables and graphs.

Using a science journal provides an opportunity for students to be engaged in a real science situation as they keep a record of their observations, ideas and thoughts about science activities. Students can use their science journals as a useful self-assessment tool as they reflect on their learning and how their ideas have changed and developed during a unit.

Monitoring students' journals allows you to identify students' alternative conceptions, find evidence of students' learning and plan future learning activities in science and literacy.

Keeping a science journal aligns to descriptions in the Australian Curriculum: Science and English. See pages 3 and 8.

Using a science journal

1. At the start of the year, or before starting a science unit, provide each student with a notebook or exercise book for their science journal or use an electronic format. Tailor the type of journal to fit the needs of your classroom. Explain to students that they will use their journals to keep a record of their observations, ideas and thoughts about science activities. Emphasise the importance of including pictorial representations as well as written entries.
2. Use a large project book or A3 paper to make a class science journal. This can be used at all year levels to model journal entries. With younger students, the class science journal can be used more frequently than individual journals and can take the place of individual journals.
3. Make time to use the science journal. Provide opportunities for students to plan procedures and record predictions, and their reasons for predictions, before an activity. Use the journal to record observations during an activity and reflect afterwards, including comparing ideas and findings with initial predictions and reasons. It is important to encourage students to provide evidence that supports their ideas, reasons and reflections.
4. Provide guidelines in the form of questions and headings and facilitate discussion about recording strategies, such as note-making, lists, tables and concept maps. Use the class science journal to show students how they can modify and improve their recording strategies.
5. Science journal entries can include narrative, poetry and prose as students represent their ideas in a range of styles and forms.

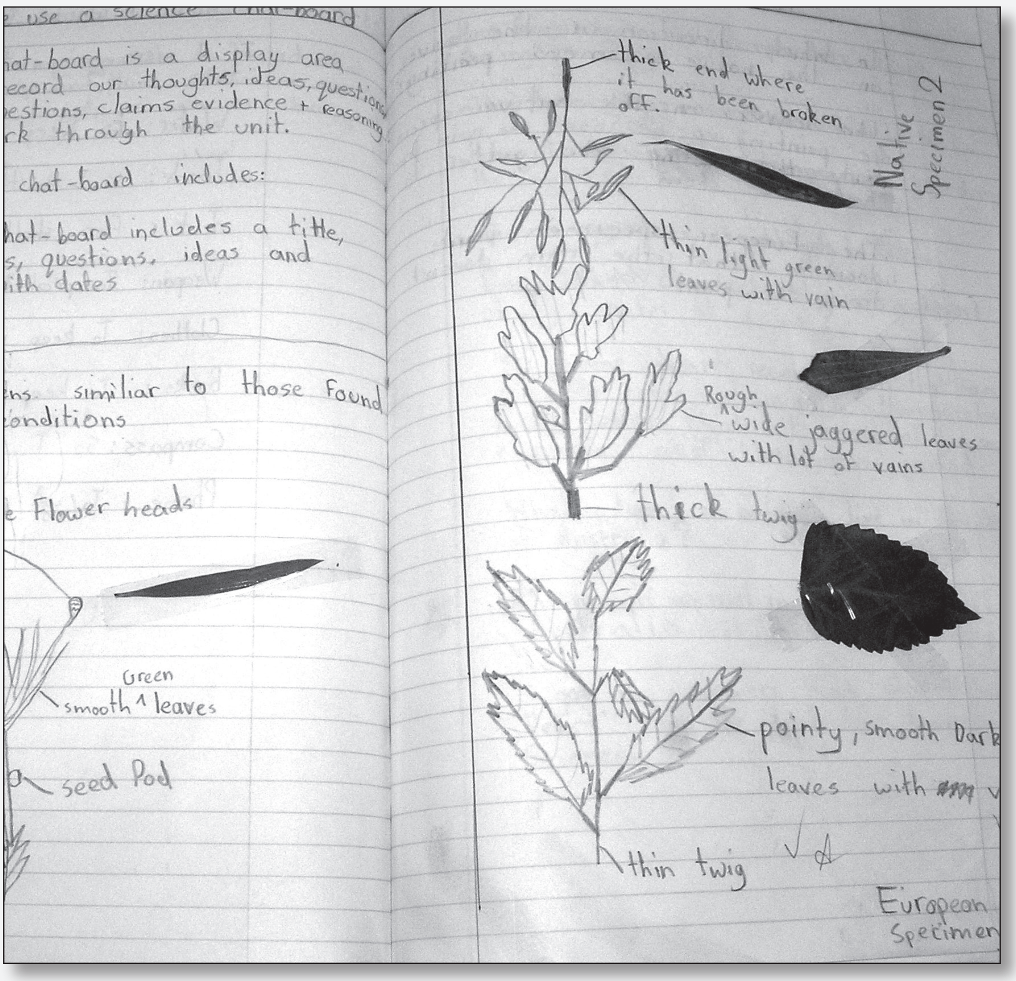
6 In science journal work, you can refer students to display charts, pictures, diagrams, word walls and phrases about the topic displayed around the classroom. Revisit and revise this material during the unit. Explore the vocabulary, visual texts and ideas that have developed from the science unit, and encourage students to use them in their science journals.

7 Combine the use of resource sheets with journal entries. After students have pasted their completed resource sheets in their journal, they might like to add their own drawings and reflections.

8 Use the science journal to assess student learning in both science and literacy. For example, during the *Engage* phase, use journal entries for diagnostic assessment as you determine students' prior knowledge.

9 Discuss the importance of entries in the science journal during the *Explain* and *Evaluate* phases. Demonstrate how the information in the journal will help students develop literacy products, such as posters, brochures, letters and oral or written presentations.

Desert survivors **science journal**



Appendix 3
How to use a word wall

Introduction

A word wall is an organised collection of words and images displayed in the classroom. It supports the development of vocabulary related to a particular topic and provides a reference for students. The content of the word wall can be words that students see, hear and use in their reading, writing, speaking, listening and viewing.

The use of a word wall, including words from regional dialects and other languages, aligns to descriptions in the Australian Curriculum: English. See page 8.

Goals in using a word wall

A word wall can be used to:

- support science and literacy experiences of reading, viewing, writing and speaking
- provide support for students during literacy activities across all key learning areas
- promote independence in students as they develop their literacy skills
- provide a visual representation to help students see patterns in words and decode them
- develop a growing bank of words that students can spell, read and/or use in writing tasks
- provide ongoing support for the various levels of academic ability in the class
- teach the strategy of using word sources as a real-life strategy.

Organisation

Position the word wall so that students have easy access to the words. They need to be able to see, remove and return word cards to the wall. A classroom could have one main word wall and two or three smaller ones, each with a different focus, for example, high-frequency words.

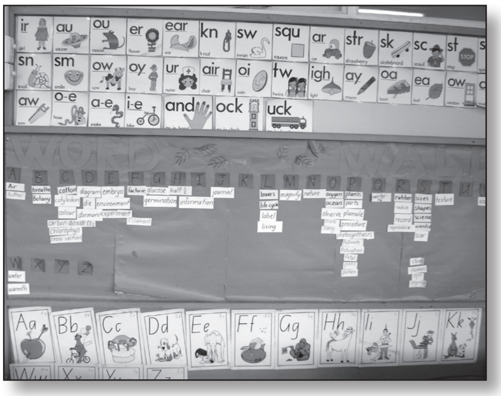
Choose robust material for the word cards. Write or type words on cardboard and perhaps laminate them. Consider covering the wall with felt-type material and backing each word card with a self-adhesive dot to make it easy for students to remove and replace word cards.

Word walls do not need to be confined to a wall. Use a portable wall, display screen, shower curtain or window curtain. Consider a cardboard shape that fits with the unit, for example, a cactus in a desert for an adaptation unit.

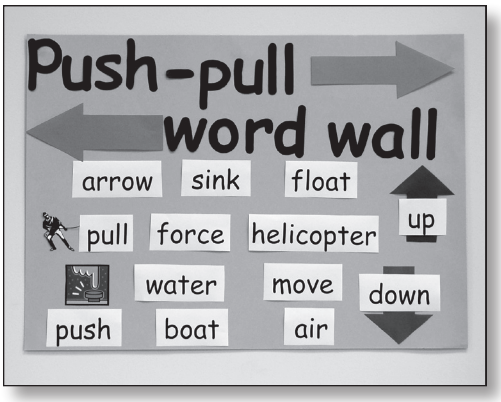
The purpose is for students to be exposed to a print-rich environment that supports their science and literacy experiences.

Organise the words on the wall in a variety of ways. Place them alphabetically, or put them in word groups or groups suggested by the unit topic, for example, words for a *Desert survivors* unit might be organised using headings, such as ‘Plants’, ‘Animals’ and ‘Deserts’.

Invite students to contribute different words from different languages to the word wall. Group words about the same thing, for example, plant adaptations and animal adaptations on the word wall so that the students can make the connections. Identify the different languages used, for example, by using different-coloured cards or pens to record the words.



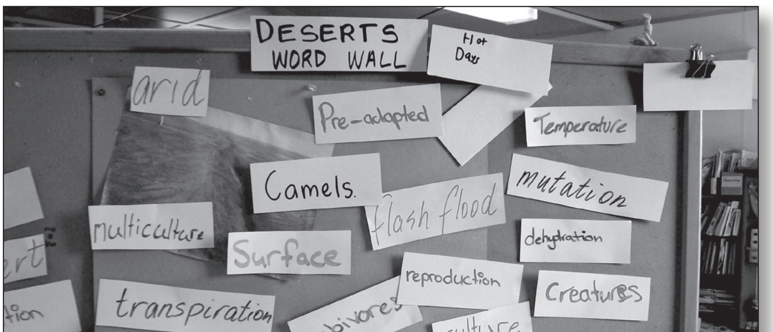
***Plants in action* word wall**



***Push pull* word wall**

Using a word wall

1. Limit the number of words to those needed to support the science and literacy experiences in the classroom.
2. Add words gradually, and include images where possible, such as drawings, diagrams or photographs. Build up the number of words on the word wall as students are introduced to the scientific vocabulary of the unit.
3. Encourage students to interact with the word wall. Practise using the words with students by reading them and playing word games. Refer to the words during science and literacy experiences and direct students to the wall when they need a word for writing. Encourage students to use the word wall to spell words correctly.
4. Use the word wall with the whole class, small groups and individual students during literacy experiences. Organise multi-level activities to cater for the individual needs of students.



***Desert survivors* word wall**

Appendix 4
How to use a TWLH chart

Introduction

A learning tool commonly used in classrooms is the KWL chart. It is used to elicit students' prior **K**nowledge, determine questions students **W**ant to know answers to, and document what has been **L**earned.

Primary**Connections** has developed an adaptation called the **TWLH** chart.

T – 'What we **think** we know' is used to elicit students' background knowledge and document existing understanding and beliefs. It acknowledges that what we 'know' might not be the currently accepted scientific understanding.

W – 'What we **want** to learn' encourages students to list questions for investigation. Further questions can be added as students develop their understanding.

L – 'What we **learned**' is introduced as students develop explanations for their observations. These become documented as 'claims'.

H – '**How** we know' or 'How we came to our conclusion' is used in conjunction with the third column and encourages students to record the evidence and reasoning that lead to their new claim, which is a key characteristic of science. This last question requires students to reflect on their investigations and learning, and to justify their claims.

As students reflect on their observations and understandings to complete the third and fourth columns, ideas recorded in the first column should be reconsidered and possibly confirmed, amended or discarded, depending on the investigation findings.

Desert survivors TWLH chart

What we **think** we know	What we **want** to learn	What we **learned**	**How** we know
We think that thick fur would keep animals too warm in a desert. →	Why do some desert animals have fur? →	Thick fur can slow down the heating of animals during the day and keep them warm at night when the desert is cold. →	We conducted fair tests using cans of water to model animal bodies and wrapped them in different fabrics. The cans of water with thick material did not heat up faster than those with thin material.

Appendix 5
How to write questions for investigation

Introduction

Scientific inquiry and investigation are focused on and driven by questions. Some questions are open to scientific investigation, while others are not. Students often experience difficulty in developing their own questions for investigation.

This appendix explains the structure of questions and how they are related to variables in a scientific investigation. It describes an approach to developing questions for investigation and provides a guide for constructing investigable questions with your students. Developing their own questions for investigation helps students to have ownership of their investigation and is an important component of scientific literacy.

The structure of questions for investigation

The way that a question is posed in a scientific investigation affects the type of investigation that is carried out and the way information is collected. Examples of different types of questions for investigation include:

- How does/do …
- What effect does …
- Which type of …
- What happens to …

All science investigations involve. Variables are things that can be changed, measured or kept the same (controlled) in an investigation.

- The **independent variable** is the thing that is changed during the investigation.
- The **dependent variable** is the thing that is affected by the independent variable, and is measured or observed.
- **Controlled variables** are all the other things in an investigation that could change but are kept the same to make it a fair test.

An example of the way students can structure questions for investigation in is:

What happens to ______________________when we change ________________________?

dependent variable **independent variable**

Q1: What happens to the amount of water in the cloth when we change the surface area of the cloth?

In this question, *the amount of water in the cloth* depends on *the surface area of the cloth.* The surface area of the cloth is the thing that is **changed** (independent variable) and the amount of water in the cloth is the thing that is **measured or observed** (dependent variable).

Q2: What happens to the amount of water in the cloth when we change the type of cloth?

In this question, *the amount of water in the cloth* depends on *the type of cloth*. The type of cloth is the thing that is **changed** (independent variable) and the amount of water in the cloth is the thing that is **measured or observed** (dependent variable).

Developing questions for investigation

The process of developing questions for investigation in *Desert survivors* is to:

- Provide a context and reason for investigating.
- Pose a general focus question in the form of:
  'What things might affect ___________ (**dependent variable**)?'.
  For example, 'What things might affect the numbers of confetti pieces picked up?'.
- Use questioning to elicit the things **(independent variables)** students think might affect the **dependent variable**, such as the colour of the confetti compared to the background, the size of the confetti, their shape, whether they are damaged, the ability of the spotter, how they are distributed.
- Each of the **independent variables** can be developed into a question for investigation, for example, the shape of the confetti. These are the things that might be changed **(independent variables)**, which students think will affect the thing that is measured or observed **(dependent variable)**.
- Use the scaffold 'What happens to ___________ when we change __________?' to help students develop specific questions for their investigation, for example, 'What happens to the number of confetti pieces when we change the size of the confetti?'.
- Ask students to review their question for investigation after they have conducted their investigation and collected and analysed their information.
- Encouraging students to review their question will help them to understand the relationship between what was changed and what was measured in their investigation. It also helps students to see how the information they collected relates to their prediction.

Appendix 6
How to conduct a fair test

Introduction

Scientific investigations involve posing questions, testing predictions, planning and conducting tests, interpreting and representing evidence, drawing conclusions and communicating findings.

Planning a fair test

In *Desert survivors*, students investigate things that affect the rate of cooling of water and things that affect the rate of evaporation of water from cloths.

Will changing the colour of the container affect the rate of cooling?

Will available surface area affect the rate of cooling?

Will the amount of water affect the rate of cooling?

All scientific investigations involve variables. Variables are things that can be changed (independent), measured/observed (dependent) or kept the same (controlled) in an investigation. When planning an investigation, to make it a fair test, we need to identify the variables.

It is only by conducting a fair test that students can be sure that what they have changed in their investigation has affected what is being measured/observed.

'**C**ows **M**oo **S**oftly' is a useful scaffold to remind students how to plan a fair test:

Cows: **Change** one thing (independent variable)

Moo: **Measure/Observe** another thing (dependent variable) and

Softly: keep the other things (controlled variables) the **Same**.

To investigate whether lighter-coloured leaves help a plant survive in a desert by keeping it cool, students could use the model of a can wrapped in different-coloured fabrics and:

CHANGE	the colour of the fabric	Independent variable
MEASURE/OBSERVE	the temperature of the water over time	Dependent variable
KEEP THE **SAME**	the amount of water, the shape and colour of the container, the size of the container, where the container is placed, the position of the water, the amount of fabric, the materials the fabric is made of, the thickness of the fabric, the initial temperature of the water.	Controlled variable

Appendix 7
How to facilitate evidence-based discussions

Introduction

Argumentation is at the heart of what scientists do; they pose questions, make claims, collect evidence, debate with other scientists and compare their ideas with others in the field.

In the primary science classroom, argumentation is about students:

- articulating and communicating their thinking and understanding to others
- sharing information and insights
- presenting their ideas and evidence
- receiving feedback (and giving feedback to others)
- finding flaws in their own and others' reasoning
- reflecting on how their ideas have changed.

It is through articulating, communicating and debating their ideas and arguments that students are able to develop a deep understanding of science content.

Establish norms

Introduce norms before starting a science discussion activity. For example,

- Listen when others speak.
- Ask questions of each other.
- Criticise ideas not people.
- Listen to and discuss all ideas before selecting one.

Claim, Evidence and Reasoning

In science, arguments that make claims are supported by evidence. Sophisticated arguments follow the QCER process:

Q What **question** are you trying to answer? For example, 'Does having ears with a larger surface area help animals survive in the desert by helping them keep cooler?'

C The **claim**, for example, 'Having bigger ears in the desert increases surface area of skin and therefore might help keep animals cooler in the desert.'

E The **evidence**, for example, 'We used water as a model for animal bodies. We changed available surface area and measured how long it took for hot water to cool down. The water with a larger surface area cooled down faster.'

R The **reasoning:** saying how the evidence supports the claim, for example, 'Since the only thing that changed in the test was the available surface area, the quicker cooling was due to increased surface area. Water is a suitable model for animals since they have a lot of water in their bodies.'

Students need to be encouraged to move from making claims only, to citing evidence to support their claims. Older students develop full conclusions that include a claim, evidence and reasoning. This is an important characteristic of the nature of science and an aspect of scientific literacy. Using science question starters (see next section) helps to promote evidence-based discussion in the classroom.

Science question starters

Science question starters can be used to model the way to discuss a claim and evidence for students. Teachers encourage team members to ask these questions of each other when preparing their claim and evidence. They might also be used by audience members when a team is presenting its results. (See Primary**Connections** 5Es DVD, Chapter 5).

Science question starters

Question type	Question starter
Asking for evidence	I have a question about ______________________________ . How does your evidence support your claim? What other evidence do you have to support your claim?
Agreeing	I agree with ___________ because ______________________.
Disagreeing	I disagree with _______________ because _______________. One difference between my idea and yours is _____________.
Questioning further	I wonder what would happen if _______________________? I have a question about ______________________________ . I wonder why _____________________________________? What caused ______________________________________? How would it be different if ___________________________? What do you think will happen if _______________________?
Clarifying	I'm not sure what you meant there. Could you explain your thinking to me again?

Appendix 8
How to construct and use a graph

Introduction

A graph organises, represents and summarises information so that patterns and relationships can be identified. Understanding the conventions of constructing and using graphs is an important aspect of scientific literacy.

During a scientific investigation, observations and measurements are made and measurements are usually recorded in a table. Graphs can be used to organise the data to identify patterns, which help answer the research question and communicate findings from the investigation.

Once you have decided to construct a graph, two decisions need to be made:

- What type of graph? and
- Which variable goes on each axis of the graph?

What type of graph?

The Australian Curriculum: Mathematics describes data representation and interpretation for Year 6 as follows:

- Interpret and compare a range of data displays, including side-by-side column graphs for two categorical variables.
- Interpret secondary data presented in digital media and elsewhere.

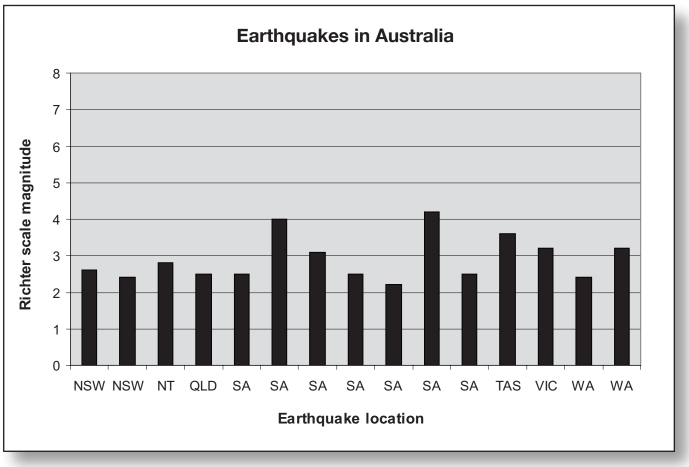
Column graph

Where data for one of the variables are in **categories** (that is, we use **words** to describe it, for example, earthquake location) a **column graph** is used. In *Earthquake explorers*, students analyse and compare secondary data. Students use their understanding of earthquakes to explain the patterns in the data. Graph A below shows the magnitude of earthquakes in Australian states and territories **(data in categories)** and is presented as a **column graph**.

Table A: The effect of location on earthquake magnitude: Australia—October and November 2008

Earthquake magnitude (Richter scale)	Australia
2.6	NSW
2.4	NSW
2.8	NT
2.5	QLD
2.5	SA
4.0	SA
3.1	SA
2.5	SA
2.2	SA
4.2	SA
2.5	SA
3.6	TAS
3.2	VIC
2.4	WA
3.2	WA

Graph A: The effect of location on earthquake magnitude: Australia—October and November 2008



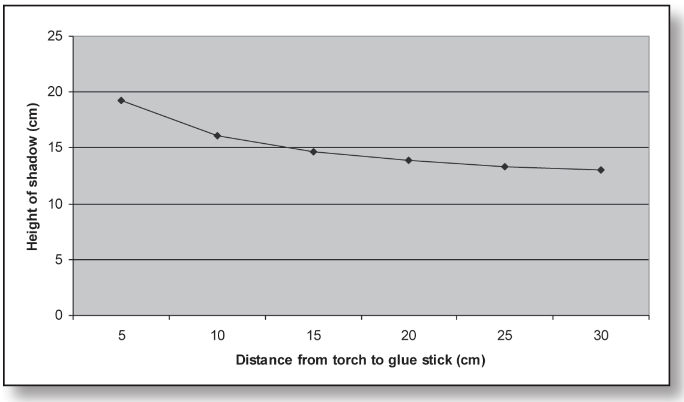
Line graph

Where the data for both variables are **continuous** (that is, we use **numbers** that can be recorded on a measurement scale, such as length in centimetres or mass in grams), a **line graph** is usually constructed. Graph B below shows how the results from an investigation of the effect of distance from a light source **(continuous data)** on the shadow height of an object **(continuous data)** have been constructed as a **line graph**.

Table B: The effect of distance from a torch on the shadow height of a glue stick.

Distance from torch to glue stick (cm)	Height of shadow (cm)
5	19.3
10	16.1
15	14.7
20	13.9
25	13.3
30	13

Graph B: The effect of distance from a torch on the shadow height of a glue stick.



Which variable goes on each axis?

It is conventional in science to plot the variable that has been changed on the horizontal axis (X axis) and the variable that has been measured/observed on the vertical axis (Y axis) of the graph.

Graph titles and labels

Graphs have titles and each variable is labelled on the graph axes, including the units of measurement. The title of the graph is usually in the form of 'The effect of one variable on the other variable'. For example, 'The effect of distance from a torch on the shadow height of a glue stick' (Graph B).

Steps in analysing and interpreting data

Step 1— Organise the data (for example, construct a graph) so you can see the pattern in data or the relationship between data for the variables (things that we change, measure/observe, or keep the same).

Step 2— Identify and describe the pattern or relationship in the data.

Step 3— Explain the pattern or relationship using science concepts.

Questioning for analysis

Teachers use effective questioning to assist students to develop skills in interrogating and analysing data represented in graphs. Such as:

- What is the story of your graph?
- Do the data in your graph reveal any patterns?
- Is this what you expected? Why?
- Can you explain the pattern? Why did this happen?
- What do you think the pattern would be if you continued the line of the graph?
- How certain are you of your results?

Analysis

Analysis of Graph B shows that the further the distance from the torch the shorter the height of the glue stick's shadow. This is because as light travels in straight lines, the closer the object to a light source, the more light it blocks out and therefore the bigger the shadow.

Appendix 9
Desert survivors equipment list

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	2	3	4	4	5	6	7	8	9
		SESSION		1	2	3		1	2					
Equipment and materials														
250 mL measure	1 per team						•							
A3 piece of newspaper	2 per team							•						
A3 piece of white paper	2 per team							•						
A4 sheet of paper	5 per class								•					
A4 sheet of paper	4 per class													•
absorbent cloths (eg, 36 cm x 36 cm)	2 per team				•	•								
cards or paper strips for word wall labels *optional*	ongoing		•											
cup and plate of similar material with high sides	1 per team						•							
digital scales	at least 1 per class				•									
equipment for an open investigation	1 per team											•	•	
equipment to make and present visual aids for an oral presentation	1 per team												•	
hat or box	1 per class										•			
hole punch	1 per team							•						
hot water (<50°C)	500 mL per team						•							
leafy branch	1 per team			•										
leaves from different species *optional*	1 per class				•									
multimedia resources	1 per class		•											
paper clips	2 per team				•									

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	2	3	4	4	5	6	7	8	9
		SESSION		1	2	3		1	2					
Equipment and materials														
permanent marking pen	1 per class			•										
photos of animals *optional*	1 per class								•					
piece of graph paper	1 per team					•								
piece of graph paper, enlarged	1 per class					•								
piece of newspaper to make confetti	1 per team							•						
piece of white paper to make confetti	1 per team							•						
plastic bags	2 per team			•										
resources to do research on structural features of different species in deserts of Australia	1 per team										•			
thermometer	1 per team						•							
timing device (eg, a class clock)	1 per class				•									
timing device (eg, a stopwatch or a watch with second hand)	1 per team						•	•						
water	1 per class				•									
waterproof marking pen *optional*	1 per team			•	•									

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	2	3	4	4	5	6	7	8	9
		SESSION		1	2	3		1	2					
Resource sheets														
‘Australia's red heart’ (RS1), enlarged	1 per class		●											
‘Comparing plants and animals’ (RS2), enlarged	1 per class				●		●							
‘Surface drying investigation planner’ (RS3), enlarged	1 per class				●	●								
‘Surface drying investigation planner' (RS3)	1 per team				●	●								
‘Surface cooling investigation planner' (RS4), enlarged	1 per class						●							
‘Surface cooling investigation planner’ (RS4)	1 per team						●							
‘Camouflage investigation planner' (RS5), enlarged	1 per class							●						
‘Camouflage investigation planner' (RS5)	1 per team							●						
‘Peacock tales’ (RS6), enlarged	1 per class								●					
‘Our ideas’ (RS7), enlarged	1 per class									●				
‘Our ideas’ (RS7)	1 per team									●				
‘Camel features’ (RS8), enlarged	1 per class									●	●			
‘Camel features’ (RS8)	1 per team									●				
‘Adaptation investigation planner’ (RS9), enlarged	1 per class											●		
‘Adaptation investigation planner’ (RS9)	1 per team											●		
‘Many monkeys' (RS10), enlarged	1 per class													●
‘Many monkeys' (RS10)	1 per student													●
‘Choosing monkeys’ (RS11)	1 per student													●

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	2	3	4	4	5	6	7	8	9
		SESSION		1	2	3		1	2					
Teaching tools														
class science journal	1 per class		•	•	•	•	•	•	•	•	•	•	•	•
role wristbands or badges for Director, Manager and Speaker	1 set per team			•	•	•	•	•		•	•	•	•	
student science journal	1 per student		•	•	•	•	•	•	•	•	•	•	•	•
team roles chart	1 per class			•	•	•	•	•		•	•	•	•	
team skills chart	1 per class			•	•	•	•	•		•	•	•	•	
TWLH chart	1 per class		•	•	•	•	•	•	•	•	•	•	•	•
word wall	1 per class		•	•	•	•	•	•	•	•	•	•	•	•

Appendix 10
Desert survivors unit overview

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to represent their current understanding as they:	Students will be able to:	Students:	
ENGAGE	**Lesson 1** Deadly deserts?	• explain their existing ideas about desert environments that early explorers might have visited • identify challenges for survival in desert environments and pose questions to clarify their understanding.	• contribute to class discussions about possible adaptations of plants and animals to desert environments • use talk to share their ideas • contribute to the class TWLH chart and word wall • understand the purpose and features of a science journal, TWLH chart and word wall.	• discuss Burke and Wills' exploration of Australia • identify structural features of desert environments • explain what structural features they think help living things survive in a desert.	**Diagnostic assessment** • Science journal entries • Class discussions • TWLH chart contributions

* These lesson outcomes are aligned to relevant descriptions of the Australian Curriculum. See page 3 for Science and page 8 for English and Mathematics.

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students:	
EXPLORE	**Lesson 2** Dodging desiccation ***Session 1*** Bagging leaves ***Session 2*** Soaking cloths ***Session 3*** Moist in the middle	• plan an investigation, with teacher support • make predictions about which cloth will dry out fastest • observe, record and interpret the results of their investigation • identify that cloths with smaller surface areas retain water for longer • make evidence-based claims about whether having smaller leaves can help plants survive in the desert.	• understand the purpose and features of a table • follow a procedural text to complete an investigation • use oral, written and visual language to record and discuss investigation results • understand the purpose and features of a graph • engage in discussion to compare claims.	***Session 1*** Bagging leaves • explore how plants lose water through their leaves ***Session 2*** Soaking cloths • work in teams to investigate if cloths with smaller surface areas lose less water ***Session 3*** Moist in the middle • display their results using a graph and use it to make predictions • make evidence-based claims on whether having smaller leaves helps plants to survive in deserts.	**Formative assessment** • Science journal entries • Class discussions • TWLH chart contributions • Annotated drawings • ‘Comparing plants and animals’ (Resource sheet 2) • ‘Surface drying investigation planner’ (Resource sheet 3)

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		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students:	
EXPLORE	**Lesson 3** Way too warm	• plan and conduct an investigation of the effect of surface area on heat loss • make predictions about which pool of water will loose heat fastest • observe, record and interpret the results of their investigation • identify that pools of water with larger surface areas lose heat faster • make evidence-based claims about whether having larger ears can help animals survive in the desert.	• use oral, written and visual language to record and discuss investigation results • record data in a table and represent it in a graph to interpret findings • engage in discussion to compare claims • demonstrate understanding of how to identify adaptations using science journal entries.	• work in teams to investigate whether increasing surface area increases heat loss • discuss and compare their results from the investigation.	**Formative assessment** • Science journal entries • Class discussions • TWLH chart contributions • 'Comparing plants and animals' (Resource sheet 2) • 'Surface cooling investigation planner' (Resource sheet 4)
EXPLORE	**Lesson 4** Colourful creatures ***Session 1*** Perspicacious predators ***Session 2*** Ravishing or ridiculous?	• plan and conduct an investigation of the effect of camouflage on predation • use confetti to make predictions about how camouflage can affect the visibility of an object • observe, record and interpret the results of their investigation • make evidence-based claims about whether being camouflaged can help animals survive in the desert • identify that there are different selective pressures which can influence the appearance of an animal, including choice of mate.	• use oral, written and visual language to record and discuss investigation results • record data in a table and represent it in a graph to interpret findings • engage in discussion to compare claims and develop understanding about how different factors can influence the structural features of an animal • demonstrate understanding of how to identify adaptations using science journal entries.	***Session 1*** Perpicacious predators • work in teams to investigate whether being camouflaged helps living things survive in deserts • discuss and compare their results to make evidence-based claims. ***Session 2*** Ravishing or ridiculous? • discuss claims explaining why some animals are not camouflaged.	**Formative assessment** • Science journal entries • Class discussions • TWLH chart contributions • Camouflage investigation planner' (Resource sheet 5) • 'Peacock tales' (Resource sheet 6)

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		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students:	
EXPLAIN	**Lesson 5** Ships of the desert	• review their understanding of how plants and animals survive in desert environments • identify structural features and adaptations that help camels to survive in a desert environment • identify the difference between physical and behavioural adaptations.	• use written and oral language to demonstrate their understanding of adaptations • use scientific language to describe different types of adaptations • contribute to class discussions about structural features and adaptations that help camels to survive in a desert environment.	• identify why camels were used for explorations of Central Australia • make claims about which structural features help camels to survive in desert environments • discuss behavioural and structural adaptations.	**Formative assessment** • Science journal entries • Class discussions • TWLH chart contributions • 'Our ideas' (Resource sheet 7) • 'Camel features' (Resource sheet 8)
	Lesson 6 Species specialists	• research information about a particular desert species • interpret evidence to identify if certain strucutral features can be considered adaptations • identify and describe key adaptations of a desert species.	• participate in collaborative learning teams to collect information on a particular desert species • read and analyse information on desert adaptations • identify the purpose and features of an annotated diagram.	• work in teams to plan and conduct research into a particular desert species • consider how to make evidence-based claims about desert adaptations.	**Formative assessment** • Science journal entries • Class discussions • TWLH chart contributions • annotated drawings

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		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students:	
ELABORATE	**Lesson 7** Checking claims	• formulate a question for investigation to gather evidence about adaptations • plan and conduct a fair test to test their ideas • make and record observations • construct and identify patterns in a graph • provide evidence to support their conclusions.	• represent results to interpret them and compare them to their predictions • summarise their findings and relate them to the context of desert adaptations • engage in discussion to compare ideas and provide relevant arguments to support their conclusions.	• identify questions for investigation and gather evidence about adaptations to desert environments • work in teams to plan and conduct their investigation • observe, record and share the results of their investigation.	**Summative assessment** of Science Inquiry Skills • Science journal entries • Class discussions • TWLH chart contributions • 'Adaptation investigation planner (Resource sheet 9)
EVALUATE	**Lesson 8** Powerful presentations	• interpret data to make claims about key adaptations of desert species • provide evidence to support their identification of adaptations • identify adaptations of different species living in desert environments.	• understand the purpose and features of an oral presentation • use talk and an annotated diagram to communicate their findings • contribute to a class discussion to compare adaptations of different species to Australian deserts.	• present evidence-based claims about adaptation to desert environments • compare and discuss results to draw conclusions about patterns of adaptation.	**Summative assessment** of Science Understanding • Science journal entries • Class discussions • TWLH chart contributions • oral presentations

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		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students:	
EVALUATE	**Lesson 9** Plausible possibilities	• identify adaptations of different desert species • explain their ideas about which structural features of animals might help them survive in a desert environment • discuss and compare their ideas.	• use oral, written and visual forms to present their understanding of adaptations • reflect on their learning in a science journal entry.	• describe the hypothetical adaptation of a new animal to a desert environment • participate in a class discussion to reflect on their learning during the unit.	**Summative assessment** of Science Understanding • Science journal entries • Class discussions • TWLH chart contributions • 'Many monkeys' (Resource sheet 10) • 'Choosing monkey's' (Resource sheet 11)

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