PrimaryConnections®

Australian Academy of Science

Fully aligned with the Australian Curriculum

Dinosaurs and more

Year 1

Biological sciences

About this unit Dinosaurs and more

Dinosaurs lived millions of years ago alongside other fantastic prehistoric animals like giant insects, armoured fish and huge amphibians. By comparing the fossilised remains of dinosaurs to those of living animals, palaeontologists can make claims about how dinosaurs moved, what they ate and even how they behaved.

The *Dinosaurs and more* unit is an ideal way to link science with literacy in the classroom. Through hands-on activities students explore the external features of modern animals, and compare them with the skeletons of dinosaurs and other prehistoric animals. Students learn about the protective features of dinosaurs and use those ideas to design, make and appraise a 'dino shield'.

Published by the Australian Academy of Science.
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www.primaryconnections.org.au

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Print house: Daniels Printing Craftsmen
Cover images: iStockphoto.com

ISBN 978 0 85847 685 1

Acknowledgments
Thanks to the trial teachers and students of the trial schools Australia-wide and Fellows of the Australian Academy of Science who contributed to this unit.

Trial schools: Aranda Primary School, ACT; Kaleen Primary School, ACT; Richardson Primary School, ACT; Young Public School, ACT; Baulkham Hills North Public School, NSW; Ben Lomond Public School, NSW; Coledale Public School, NSW; Engadine West Public School, NSW; Melrose Park Public School, NSW; Metella Road Public School, NSW; Mount Warrigal Public School, NSW; Orange Anglican Grammar School, NSW; St James Primary School, NSW; Stuarts Point Public School, NSW; Ryde Public School, NSW; Tabulam Public School, NSW; Turramurra Public School, NSW; Weethalle Public School, NSW; Wyrallah Road Public School, NSW; Durack Primary School, NT; Nakara Primary School, NT; Mackenzie River State Primary, QLD; St Clare's Catholic School, QLD; Warwick Christian School, QLD; Mount Compass Area School, SA; St Francis de Sales College, SA; St Paul's College, SA; Avoca Primary School, TAS; Deloraine Primary School, TAS; Illawarra Primary School, TAS; Alfredton Primary School, VIC; Boolarra Primary School, VIC; Camberwell South Primary School, VIC; Karingal Heights Public School, VIC; Urquhart Park, VIC; Sydenham Hillside Public School, VIC; Toolern Vale and District Primary School, VIC; Warrnambool West Primary School, VIC; William Ruthven Primary School, VIC; Yarra Road Primary School, VIC; Bruce Rock District High School, WA; Byford Primary School, WA; East Narrogin Primary School, WA; Palmyra Primary School, WA.

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Foreword

Never has there been a more important time for science in Australia. More than ever, we need a scientifically-literate community to engage in debates about issues that affect us all. We also need imaginative thinkers to discover the opportunities in our exponentially expanding knowledge base. Teachers play a vital role in nurturing the minds of our future citizens and scientists.

The Australian Academy of Science has a long, proud history of supporting science education. Our primary education program, Primary**Connections**: linking science with literacy, now has over 15 years' experience in supporting teachers to facilitate quality learning experiences in their classrooms. Regular evaluations demonstrate the significant impact the program can have on both teacher confidence and student outcomes.

Primary**Connections** has been developed with the financial support of the Australian Government and endorsed by education authorities across the country. It has been guided by its Steering Committee, with members from the Australian Government and the Australian Academy of Science, and benefitted from input by its Reference Group, with representatives from all states and territories.

Key achievements of the program include engaging over 24,000 Australian teachers in professional learning workshops, producing multi award-winning curriculum resources, and developing an Indigenous perspective framework that acknowledges the diversity of perspectives in Australian classrooms.

The Primary**Connections** teaching and learning approach combines guided inquiry, using the 5Es model, with hands-on investigations. It encourages students to explore and test their own, and others', ideas and to use evidence to support their claims. It focuses on developing the literacies of science and fosters lasting conceptual change by encouraging students to represent and re-represent their developing understandings. Students are not only engaged in science, they feel that they can do science.

This is one of 40 curriculum units developed to provide practical advice on implementing the teaching and learning approach while meeting the requirements of the Australian Curriculum: Science. Trialled in classrooms across the country and revised based on teacher feedback, and with the accuracy of the teacher background information verified by Fellows of the Academy, the experience of many brings this unit to you today.

I commend Primary**Connections** to you and wish you well in your teaching.

Professor John Shine, AC Pres AA
President (2018–2022)
Australian Academy of Science

The Primary**Connections teaching and learning approach**

Primary**Connections** units embed inquiry-based learning into a modified 5Es instructional model. 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

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

Developing students' scientific literacy

The Primary**Connections** program supports teachers in 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.

Reference: 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.

Linking science with literacy

PrimaryConnections 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.

PrimaryConnections develops the literacies of science that students need to learn and to represent their understanding of science concepts, processes and skills. Representations in PrimaryConnections 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

Science is ongoing and embedded in PrimaryConnections 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.

Rubrics to help you make judgments against the relevant achievement standards of the Australian Curriculum are available on our website:
www.primaryconnections.org.au

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 

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 smell, taste or eat anything unless they are given permission.
- Discuss and display a list of safe practices for science activities.

Teaching to 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 2020).

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 including how current knowledge has developed over time through the actions of many people
Use and influence of science	How science knowledge and applications affect people's lives, including their work, 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 about 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 this 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

Above material is sourced from the Australian Curriculum: Australian Curriculum Assessment and Reporting Authority (ACARA. (2020). *Australian Curriculum: Science*. www.australiancurriculum.edu.au

Primary**Connections** has units to support teachers to teach each Science Understanding detailed in the Australian Curriculum: Science from Foundation to Year 6. Units also develop students' skills and knowledge of the Science as a Human Endeavour and Science Inquiry Skills sub-strands, as well as specific sub-strands within the Australian Curriculum: English and Mathematics. Detailed information about its alignment with the Australian Curriculum is provided in each unit.

Unit at a glance — *Dinosaurs and more*

Phase	Lesson	At a glance
ENGAGE	**Lesson 1** Hear it roar!	To capture students' interest and find out what they think they know about how living things have a variety of external features and live in different places where their needs are met. To elicit students' questions about dinosaurs and their relatives.
EXPLORE	**Lesson 2** Legs, fins and wings ***Session 1*** Creature features ***Session 2*** Skeleton clues	To provide students with hands-on, shared experiences of comparing the external features of modern and prehistoric animals.
	Lesson 3 Open wide! ***Session 1*** Testing teeth ***Session 2*** Juxtaposing jaws	To provide students with hands-on, shared experiences of how animals have different types of teeth to eat different types of food.
	Lesson 4 Finding food	To provide students with hands-on, shared experiences of the features of ferns and the environments in which this prehistoric food source could be found.
EXPLAIN	**Lesson 5** Making models	To support students to represent and explain their understanding of the external features of prehistoric animals and where they lived. To introduce current scientific views about features of dinosaurs.
ELABORATE	**Lesson 6** Dinosaur defence ***Session 1*** Defensive designs ***Session 2*** Construction time	To support students to design and make a shield inspired by the features that helped dinosaurs to defend themselves.
EVALUATE	**Lesson 7** Like a palaeontologist	To provide opportunities for students to represent what they know about how living things have a variety of external features and live in different places where their needs are met, and to reflect on their learning during the unit.

A unit overview can be found in Appendix 6, page 64.

Dinosaurs and more—Alignment with the Australian Curriculum

Dinosaurs and more is written to align to the Year 1 level of the Australian Curriculum: Science. The Science Understanding, Science Inquiry Skills, and Science as a Human Endeavour strands are interrelated and embedded throughout the unit (see page xi for further details). This unit focuses on the Biological sciences sub-strand.

Year 1 Science Understanding for the Biological Sciences:	**Living things have a variety of external features (ACSSU017)** **Living things live in different places where their needs are met (ACSSU211)**
Incorporation in *Dinosaurs and more*:	Students use their senses to observe and describe the features of modern and prehistoric living things. They make comparisons and claims about where animals might live, what they might eat and how they might move. Students' questions and ideas about prehistoric animals are explored and tested.

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

Year 1 Achievement Standard

The Australian Curriculum: Science Year 1 achievement standard indicates the quality of learning that students should demonstrate by the end of Year 1.

By the end of Year 1, students describe objects and events that they encounter in their everyday lives, and the effects of interacting with materials and objects. They describe changes in their local environment and how different places meet the needs of living things.

Students respond to questions, make predictions, and participate in guided investigations of everyday phenomena. They follow instructions to record and sort their observations and share them with others.

The sections relevant to *Dinosaurs and more* are bolded above. By the end of the unit, teachers will be able to make evidence-based judgments on whether the students are achieving below, at or above the achievement standard for the sections bolded above.

Dinosaurs and more—Australian Curriculum: Key ideas

In the Australian Curriculum: Science, there are six key ideas that represent key aspects of a scientific view of the world and bridge knowledge and understanding across the disciplines of science. The below table explains how these are represented in Changes all around.

Overarching idea	Incorporation in *Dinosaurs and more*
Patterns, order and organisation	Students recognise some similarities of features between animals that live in similar habits and/or eat similar things and use this to make claims about prehistoric animals.
Form and function	Students explore how different types of teeth are better suited for different functions, for example, flat molars for grinding and sharp canines for tearing.
Stability and change	Students identify that many prehistoric animals had very different features and are no longer alive today. They also identify that some species have remained relatively stable in appearance to the modern era, for example, ferns.
Scale and measurement	Students are introduced to a simple scale to help them identify the size of prehistoric animals: the silhouette of an adult human provides a point of comparison that is related to their everyday lives.
Matter and energy	Students discuss different modes of feeding, or acquiring energy, of animals. This builds the basis of understanding food pyramids in later years.
Systems	Students make links between the external features of living things and their habitats.

Dinosaurs and more—Australian Curriculum: Science

Dinosaurs and more embeds all three strands of the Australian Curriculum: Science. For ease of reference, the table below outlines the sub-strands covered in *Dinosaurs and more*, the content descriptions for Year 1 and the aligned lessons.

Strand	Sub-strand	Code	Year 1 content descriptions	Lessons
Science Understanding	**Biological sciences**	ACSSU017	Living things have a variety of external features	1–7
		ACSSU211	Living things live in different places where their needs are met	1–7
Science as a Human Endeavour	**Nature and development of science**	ACSHE021	Science involves observing, asking questions about, and describing changes in, objects and events	1–5
	Use and influence of science	ACSHE022	People use science in their daily lives, including when caring for their environment and living things	2–4
Science Inquiry Skills	**Questioning and predicting**	ACSIS024	Pose and respond to questions, and make predictions about familiar objects and events	1–7
	Planning and conducting	ACSIS025	Participate in guided investigations to explore and answer questions	2–4, 6
		ACSIS026	Use informal measurements to collect and record observations, using digital technologies as appropriate	1–7
	Processing and analysing data and information	ACSIS027	Use a range of methods to sort information, including drawings and provided tables through discussion, compare observations with predictions	1–7
	Evaluating	ACSIS213	Compare observations with those of others	1–7
	Communicating	ACSIS029	Represent and communicate observations and ideas in a variety of ways	1–7

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

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

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

Dinosaurs and more—Australian Curriculum general capabilities

General capabilities	Australian Curriculum description	*Dinosaurs and more* examples
Literacy	Literacy knowledge specific to the study of science develops along with scientific understanding and skills. PrimaryConnections 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 *Dinosaurs and more* the literacy focuses are: • science journals • annotated drawings • word walls • T-charts • tables • labelled diagrams.
 **Numeracy**	Elements of numeracy are particularly evident in Science Inquiry Skills. These include practical measurement and the collection, representation and interpretation of data.	Students: • interpret relative sizes of dinosaurs using a simple scale.
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: • view and discuss relevant videos • create 'Blabberize' animation.
 **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 and answer questions, describe and explain their ideas, make suggestions and join in discussions • make predictions • make comparisons between the external features of modern and prehistoric animals • plan and follow a design process • reflect on learning.
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 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. • Important contributions made to science by people from a range of cultures are highlighted.

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

Dinosaurs and more—Australian Curriculum: English

Strand	Sub-strand	Code	Year 1 content descriptions	Lessons
Language	**Text structure and organisation**	ACELA1447	Understand that the purposes texts serve shape their structure in predictable ways	2–7
Literature	**Responding to literature**	ACELA1583	Express preferences for specific texts and authors and listen to the opinions of others	1–7
	Creating literature	ACELA1586	Recreate texts imaginatively using drawing, writing, performance and digital forms of communication	7
Literacy	**Interacting with others**	ACELY1656	Engage in conversations and discussions, using active listening behaviours, showing interest, and contributing ideas, information and questions	1–7
		ACELY1788	Use interaction skills including turn-taking, recognising the contributions of others, speaking clearly and using appropriate volume and pace	1–7
	Creating texts	ACELY1661	Create short imaginative and informative texts that show emerging use of appropriate text structure, sentence-level grammar, word choice, spelling, punctuation and appropriate multimodal elements, for example illustrations and diagrams	1–7
		ACELY1662	Re-read student's own texts and discuss possible changes to improve meaning, spelling and punctuation	5–7

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

Dinosaurs and more—Australian Curriculum: Mathematics

Strand	Sub-strand	Code	Year 1 content descriptions	Lessons
Measurement and Geometry	**Shape**	ACMMG022	Recognise and classify familiar two-dimensional shapes and three-dimensional objects using obvious features	2–4

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

Dinosaurs and more—Australian Curriculum: Design and Technologies

Strand	Code	Foundation–Year 2 content descriptions	Lessons
Knowledge and Understanding	ACTDEK001	Identify how people design and produce familiar products, services and environments and consider sustainability to meet personal and local community needs	6
	ACTDEK004	Explore the characteristics and properties of materials and components that are used to produce designed solutions	6
Processes and Production Skills	ACTDEP005	Explore needs or opportunities for designing, and the technologies needed to realise designed solutions	6
	ACTDEP006	Generate, develop and record design ideas through describing, drawing and modelling	1, 2, 4–7
	ACTDEP007	Use materials, components, tools, equipment and techniques to safely make designed solutions	6
	ACTDEP008	Use personal preferences to evaluate the success of design ideas, processes and solutions including their care for environment	6

All the material in the first four 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.

Two of these are embedded within *Dinosaurs and more*, as described below.

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

Dinosaurs and more focuses on the Western science method of relating the use of external body parts to their function, such as legs for moving and teeth for feeding, and how living things live in places where their needs are met, such as on land or in water.

Aboriginal and Torres Strait Islander Peoples might have other explanations for the external features of animals and plants and the places where they live.

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.

Sustainability

The *Dinosaurs and more* unit provides opportunities for students to develop an understanding of how animals and plants meet their needs in their environment and can therefore be affected by changing environmental conditions. This can help students 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.

Teacher background information

This information is intended as teacher information only. It provides teachers with information relevant to the science concept so they can feel more confident and competent to teach each lesson. The content and vocabulary of this information is at a more detailed and advanced level than what is required for students.

Introduction to living things and the places they live

Animals and plants live in places where there is access to what they need. All living things are heavily reliant on their environment, and so it is possible to learn a lot about living things based on the area they occupy. For example, by knowing that one type of kangaroo lives in Central Australia while another lives in the Snowy Mountains, it is possible to infer which kangaroo is more likely to be coloured red (for camouflage amongst red dirt and rocks), and which one is more likely to be grey (for camouflage in gum tree forests and snow).

The areas where living things spend most of their time are referred to as habitats. Different living things are supported by different types of habitats depending on their individual requirements for food, water, air, light, shelter and temperature. Most ferns, for example, are dependent on a plentiful supply of water, and so they establish well in a rainforest habitat where there is a high amount of rainfall and humidity.

Key features of animals

All animals are able to move themselves from place to place at least during one stage of their lives. For example, the larvae of oysters swim before the animal fixes itself on to a hard surface. This capacity for independent movement is a key difference from plants and has resulted in a wide array of features to accommodate different types of movement, such as fins for gliding through water, legs to walk or to jump and wings to glide. Modes of movement can provide clear clues to the habitats in which prehistoric creatures lived.

Animals also differ from plants in that they need to eat other living things in order to survive. This means animals have a range of features to help them locate, catch and eat food. Bats have well developed ears to help them locate prey using sound (echolocation), dogs have noses that can pick up an amazing array of scents and some snakes have special organs (pit organs) to help them sense a prey's body heat.

There is usually a strong link between the form and function of specific features. For example, the shape and size of an animal's teeth relates to the type of food the animal eats: herbivores have large molars to help grind down cellulose fibres in plants and carnivores have sharp canines to rip flesh. Different honeyeaters and finches have different-shaped beaks depending on the types of flowers and insects they rely on for food. Predators often have a pair of eyes on the front of their head for accurate vision and depth perception for hunting, whereas the eyes of prey are usually on the sides of the head, providing a large field of view to help detect predators and then flee in the opposite direction.

There are other external features used by predators and prey for attack or defence, such as body plates, spines and spikes. Hair, fur and feathers are another group of external features that enable animals to cope in harsh environments and prevent heat loss. In some cases, these features are also used for communication, such as birds' brightly coloured feathers, or the moving patterns on a chameleon's scales.

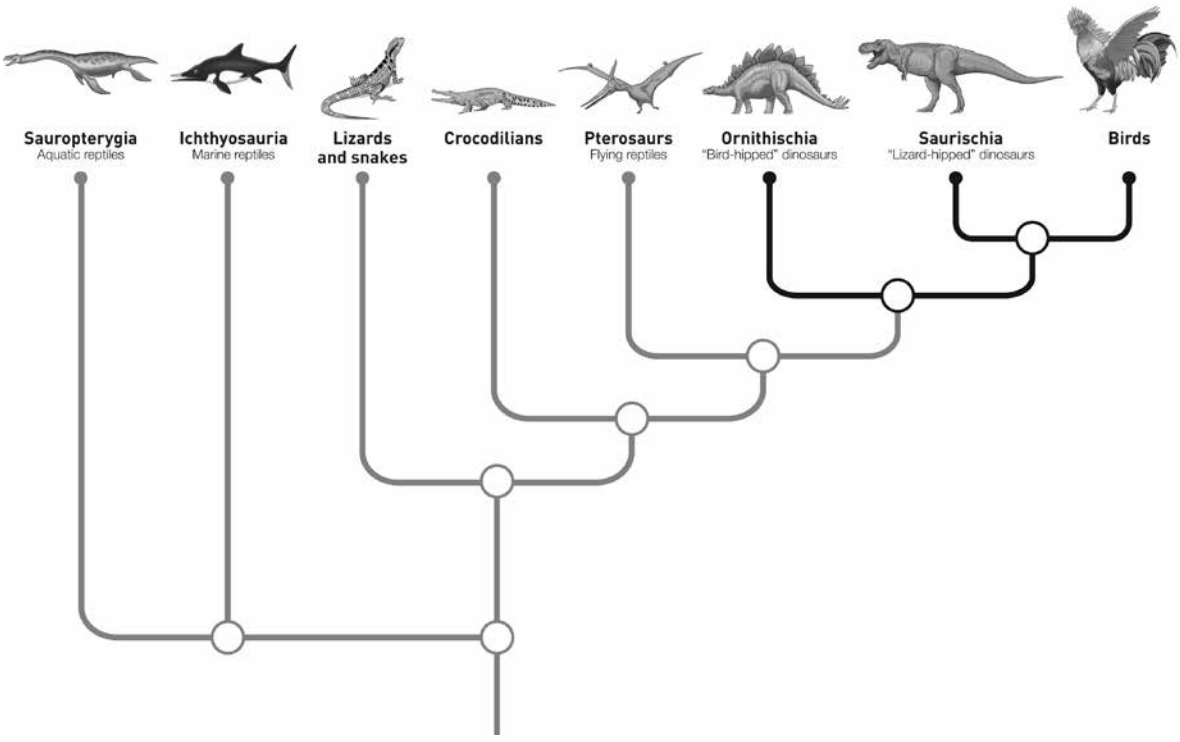
Scientists define dinosaurs as a very specific group of animals

The common term for 'dinosaurs' is quite different from the scientific term *Dinosauria*. Most people, young students included, consider all large prehistoric animals as dinosaurs, but animals commonly called dinosaurs, such as Pterosaurs, Ichthyiosaurs, Plesiosaurs, and crocodiles, are not part of *Dinosauria*. Perhaps surprising to some young students is that birds are part of *Dinosauria* and are therefore dinosaurs. *Dinosauria* is part of a group of reptiles called Archosaurs that evolved from earlier reptiles in the Triassic (about 220 million years ago), following the Permian mass extinction.

Modern birds (sometimes called by the scientific names Aves or Avian) are considered part of the *Dinosauria* group, as there is strong evidence that birds shared a common ancestor with the Saurischia—the 'lizard-hipped' dinosaurs and not as initially thought with the 'bird-hipped' Ornithischia—as their feet share a remarkably similar skeleton structure. Modern-day crocodiles (*Crocodilia*) are a part of *Archosauria*, sharing features like ankle joints, which flex in a different way from those of other reptiles.

The *Archosauria* were very diverse. This group included *Dinosauria*, *Crocodilia*, and Pterosaurs, and this diversity provides a useful platform for investigating the external features of living things and how their needs were met in the places they lived:

- Non-Avian *Dinosauria*, such as Stegosaurus and Tyrannosaurus, were exclusively land-dwelling and had their legs placed beneath their bodies.
- Pterosaurs were winged reptiles that flew.
- Ichthyiosaurs (Ichthyosauria) and Plesiosaurs (Sauropterygia) were cousins of the *Archosauria* and were swimming reptiles with fins.



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.

Many students have non-scientific ideas about what an animal is, and their concept of an animal is limited to common mammals only—in particular cats, dogs and cows—and does not include humans, insects or fish.

Students will most likely regularly use the term 'dinosaur' as it is commonly understood, even though it is not technically correct from a scientific viewpoint. Students can be encouraged to instead use the word archosaurs (when talking about pterosaurs, crocodiles and dinosaurs), or perhaps the easier and all-encompassing 'prehistoric animals'.

Similarly, young students might consider megafauna, such as the 'Woolly mammoth' and 'Sabre-tooth cat', to be dinosaurs. They also consider Australian Megafauna, such as *Diprotodon* and *Thylacaleo*, as dinosaurs. The term 'Megafauna' is used to describe large animals (mostly mammals) that evolved after dinosaurs and co-existed with humans.

Students might believe that humans and dinosaurs walked on Earth together. However, humans evolved approximately 62 million years after most dinosaurs became extinct.

Younger students might believe that animals chose their features depending on the environment and can change them. For example, they might believe a snow leopard actively decides to be white as a camouflage strategy. The ancestors of the snow leopard that had lighter pelts were more likely to survive in their arctic environments. So, it was born with white fur that it is now unable to change even if there is no snow and it is highly visible against grass or a dark landscape.

Students commonly hold anthropomorphic views of animals, attributing human motivation, features or behaviour to animals. These views are often perpetuated in storybooks and films.

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

Ideas for teaching science: Years P–8 Animals. Deakin University: http://www.deakin.edu.au/arts-ed/education/sci-enviro-ed/early-years/pdfs/animals.pdf

To access more in-depth science information in the form of text, diagrams and animations, refer to the Primary**Connections** Science Background Resource, available on the Primary**Connections** website: www.primaryconnections.org.au.

Lesson 1 Hear it roar!

AT A GLANCE

To capture students' interest and find out what they think they know about how living things have a variety of external features and live in different places where their needs are met.

To elicit students' questions about dinosaurs and their relatives.

Students:

- listen to a scientifically recreated recording of a dinosaur roar
- draw and annotate what they think a dinosaur might have looked like and where it lived.

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 a variety of external features
- living things live in different places where their needs are met.

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

Key lesson outcomes

Science

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

- discuss their existing ideas about the external features of animals
- discuss their existing ideas about dinosaurs and where they lived.

Literacy

Students will be able to:

- engage in conversations and discussions
- create an annotated drawing
- share and compare ideas with a partner.

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

ENGAGE

Teacher background information

Dinosaur sounds

Most of the sounds used to represent dinosaurs in animated clips are produced by living animals, such as crocodiles, which produce a range of sounds including rumbles, snorts, hisses, squeaks, groans and growls. Crocodiles can also use their body to vibrate water and make splashing noises. Similarly, amphibians are capable of producing creaks, croaks, squeaks and hoots, using air stored in sacs under their chin to amplify the sounds.

The best evidence of a 'real' dinosaur sound is from the skull of a *Parasaurolophus tubicen*, a duck-billed hadrosaur with a large crest on its head. A special structure within the crest directs airflow across a hole in a similar manner to blowing a note on a flute or across the neck of a bottle. Computer models show that it can produce sounds over a range of frequencies, depending on how hard air is pushed through the structure.

Equipment

FOR THE CLASS

- class science journal
- word wall
- scientific recording of dinosaurs roaring (see 'Preparation')

FOR EACH STUDENT

- science journal

Preparation

- Source a scientific recording of presumed dinosaur roaring sounds. For example, see: 'Dino soundbite' www.sandia.gov/media/dinosaur.htm (click 'Dino soundbite' located in bar on left of screen).
- Read 'How to use a science journal' (Appendix 2).
- Read 'How to use a word wall' (Appendix 3).
- Prepare a page in the class science journal with the heading 'Our questions about dinosaurs'.
- Start collecting materials for future lessons, including mirrors for Lesson 3, ferns for Lesson 4 and materials to make shields for Lesson 6, such as large paper plates, egg cartons, straws, margarine containers, tissue boxes, cardboard tubes, yoghurt containers, aluminium foil, string, wire, popsticks and cardboard boxes.

Lesson steps

1 Ask students to close their eyes. Play presumed sounds of dinosaurs (see 'Preparation') and ask students to think about:

- What might be making that sound?
- Where might you be when you hear that sound?
- What does that place look like?

2 Encourage students to share descriptions of what they think was making the sounds. Ask questions such as:

- What do you know about dinosaurs?
- What did dinosaurs look like? How do you know?
- Where did dinosaurs live? What did they eat there?
- How did they move?
- Have you ever seen a living dinosaur? Why do you think that?

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

3 Introduce the class science journal and discuss its purpose and features. Record students' thoughts about dinosaurs.

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.

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.

4 Ask students to make an annotated drawing in their science journal of what they think a dinosaur might have looked like and where it lived. Discuss the purpose and features of an annotated drawing.

Literacy focus

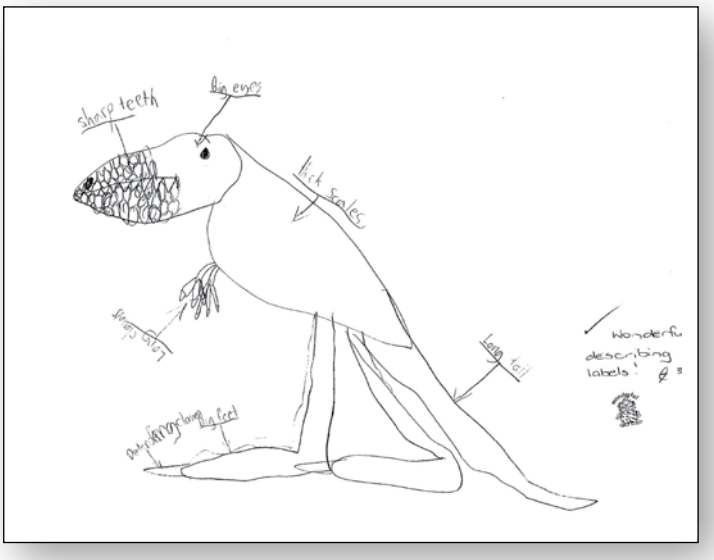
Why do we use an annotated drawing?

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.

5 Ask students to include words about the body parts of their dinosaur.



Work sample of an annotated drawing of a dinosaur

6 Ask students to share their annotated drawing with a partner. Ask pairs to compare what is the same and what is different about their drawings.

7 Explain that the class will be looking at dinosaurs and other animals that lived a long, long time ago.

8 Show students the prepared page in the class science journal (see 'Preparation'). Ask questions such as:

- What questions do you have about what dinosaurs looked like?
- What questions do you have about where dinosaurs lived?

9 Show students the prepared word wall. Discuss the purpose and features of a word wall.

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.

10 Ask students what words from today's lesson they would like added to the word wall.

Curriculum links

Science

- Organise a dinosaur dig to create a dinosaur skeleton.

The Arts

- Make clay or plasticine sculptures of dinosaurs to display.

Lesson 2 Legs, fins and wings

AT A GLANCE

To provide students with hands-on, shared experiences of comparing the external features of modern and prehistoric animals.

Session 1 Creature features

Students:

- discuss features of modern animals
- work in teams to identify the features of a prehistoric animal.

Session 2 Skeleton clues

Students:

- match skeletons of modern animals with their images.

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 how:

- living things have a variety of external features, such as legs, fins and wings.

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

Key lesson outcomes

Science

Students will be able to:

- identify external features of animals
- recognise the features of a dinosaur
- identify where prehistoric animals lived according to their features
- match an animal to its skeleton by identifying features.

Literacy

Students will be able to:

- use a T-chart to sort animals
- sort and match images
- engage in conversations and discussions.

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

Teacher background information

Skeletons provide the framework that supports the bodies of vertebrate animals, including dinosaurs and their relatives. Although skeletons are internal body structures, they provide clues about external features. For example, terrestrial vertebrates have sturdy leg and feet bones, aquatic vertebrates have flexible fin rays (these can be partially cartilaginous) and no feet, and flying vertebrates have elongated arm bones that imply wings and very thin hollow bones to minimise mass.

Scientists also know a lot about how muscles attach to skeletons. By looking at skulls they can infer the size and strength of jaw muscles. Eye sockets provide clues about size and shape of eyes and therefore the animal's ability to see. There are even clues about the age of animals in their bones, for example, the tusks of elephants and mammoths have growth rings.

Skeletons, however, do not generally provide information about external features such as feathers, hair, fur or wing membranes like those in bat wings. Occasionally, palaeontologists uncover a rare fossil that has not only a skeleton but also the imprint of the animal, including of its skin. Scientists have known for decades that the dinosaur *Archaeopteryx* had feathers because imprints of feathers were found with a skeleton.

A difficulty palaeontologists face is that not all skeletons are discovered complete, for example, to date an intact *Brontosaurus* skull has not been found attached to the rest of the skeleton. This led to a debate about whether it might actually be the same animal as *Apatosaurus*. The most recent published theory, which used computer software to analyse differences in the features of other species, claims that *Brontosaurus* did in fact exist.

In this lesson, students will sort prehistoric animals into 'Dinosaurs' or 'Other prehistoric animals'. Unlike modern birds, the extinct Dinosaurs (for example *Stegosaurus* and *Tyrannosaurus*) were exclusively land-dwelling animals and had their legs placed beneath their bodies, like chickens (see page xvii). They did not fly, swim or have legs bent out to the side like a crocodile.

Dinosaurs	**Other prehistoric animals**
Archaeopteryx *(ark-ee-OP-ter-iks)*	Plesiosaurus *(plee-see-uh-SORE-us)*
Stegosaurus *(STEG-uh-SORE-us)*	Ichthyosaurus *(IKH-thee-oh-SORE-us)*
Brontosaurus *(Bron-te-SORE-us)*	Pteranodon *(teh-RANN-oh-don)*
Tyrannosaurs *(tye-RAN-uh-SORE-us)*	
Muttaburrasaurus *(mut-tah-BUR-rah-SORE-us)*	
Velociraptor *(Veh-less-ih-RAP-tor)*	

Students' conceptions

Most students believe that bones are not living tissue. Bones are a living network of cells and have a blood supply that grows as an organism matures.

Young students believe that the role of the skeleton is to hold the body together. Rather, skeletons provide support, while skin is usually considered to be an organ that holds the body together.

Students might believe that prehistoric reptiles such as Pteranodons are *Dinosauria*, due to their common depiction in dinosaur-themed shows and exhibits. The scientific definition of dinosaurs, however, is much narrower than the popular definition.

Session 1 Creature features

Equipment

FOR THE CLASS

- class science journal
- word wall
- team roles chart
- team skills chart
- 1 enlarged copy of 'Animal features' (Resource sheet 1)
- 1 enlarged copy of 'Prehistoric animals' (Resource sheet 2)

FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Manager and Speaker
- enlarged image from 'Prehistoric animals' (Resource sheet 2) per student (see 'Preparation')

Preparation

- Prepare an enlarged 'Animal features' (Resource sheet 1) and cut out the individual animals.
- Prepare an image of a prehistoric animal for each team by photocopying enough copies of 'Prehistoric animals' (Resource sheet 2). Cut out individual pictures for distribution.

- Prepare a T-chart in the class science journal as follows:

Dinosaurs	Other prehistoric animals

- *Optional:* Display 'Animal features' (Resource sheet 1) and 'Prehistoric animals' (Resource sheet 2) in a digital format.

Lesson steps

1 Review the previous lesson by asking students what body parts they included on their annotated drawing of a dinosaur. Explain that body parts are called 'features'. Add 'features' to the word wall.

2 Ask students if they know what a palaeontologist does. Explain that palaeontologists find out about prehistoric animals that are no longer alive today. Explain that palaeontologists also use clues from present-day animals to understand what prehistoric animals looked like and how they lived.

3 Introduce the enlarged copy of 'Animal features' (Resource sheet 1). Brainstorm common features of animals. Encourage students to name specific features, such as 'long legs' or 'sharp teeth'. Record a list in the class science journal.

4 Place the enlarged images of the animals (see 'Preparation') around the room for students to consult later.

5 Introduce the enlarged copy of 'Prehistoric animals' (Resource sheet 2) (see 'Preparation'). Discuss how the picture of the person helps us to see how big each animal was.

6 Explain that students will be working in collaborative learning teams to discuss the features of one of the prehistoric animals. They will choose which of the modern-day animals around the room most resembles their prehistoric animal and stand next to the image. For example, students might identify that *Tyrannosaurus rex* shares the most features with an eastern grey kangaroo as they both have long legs and short legs.

Note: There is no correct scientific answer for this activity. Its aim is to encourage discussions and comparisons of external features.

7 Form teams and allocate roles. Ask Managers to collect their team's picture of a prehistoric animal. Allow time for teams to complete the activity.

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 wear role wristbands or badges to help them (and you) know which role each team member should be doing.

Matching modern day animals with prehistoric animals

8 Once all teams are standing next to their chosen animal, ask Speakers to share what features their prehistoric animal shares with the modern animal they have chosen.

9 Explain that palaeontologists use clues from present-day animals to find out where prehistoric animals might have lived and how they might have moved. Discuss which features might provide clues, for example, having fins might mean the animal lived in water.

10 Ask teams questions such as:

- Which team thinks that its prehistoric animal might have lived in water and swam? Why do you think that? (It has fins like a fish.)
- Which team thinks that its prehistoric animal might have flown through the air? Why do you think that? (It has wings like a bird.)
- Which team thinks that its prehistoric animal might have walked, run or jumped around where it lived? Why do you think that? (It has legs like a cat.)

11 Explain that palaeontologists identify dinosaurs as prehistoric reptiles that all lived on land and had legs directly beneath their bodies (like chickens). They did not fly, swim or have bent legs like a crocodile.

12 Ask teams if they think their prehistoric animal would be identified as a dinosaur by palaeontologists.

13 Show students the T-chart on the prepared page in the class science journal (see 'Preparation'). Discuss the purpose and features of a T-chart.

Literacy focus

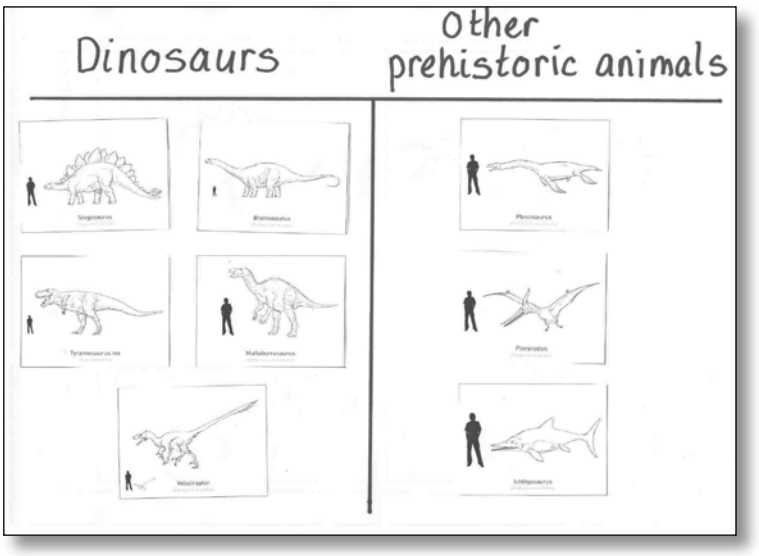
Why do we use a T-chart?

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

What does a T-chart include?

A **T-chart** includes two columns with headings. Information is put into the columns based on the headings.

Ask teams to place their image in the matching column.



Work sample of class T-chart

14 *Optional:* Ask teams to sort images from 'Prehistoric animals' (Resource sheet 2) into a class T-chart.

15 Review students' questions to see if any have been answered. Update the word wall with words and images.

Curriculum links

The Arts

- Make silhouettes/shadows of body parts, such as hands and legs.

Indigenous perspectives

- Discuss local names and knowledge about the features of the Australian animals featured.
- PrimaryConnections 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 PrimaryConnections website (www.primaryconnections.org.au).

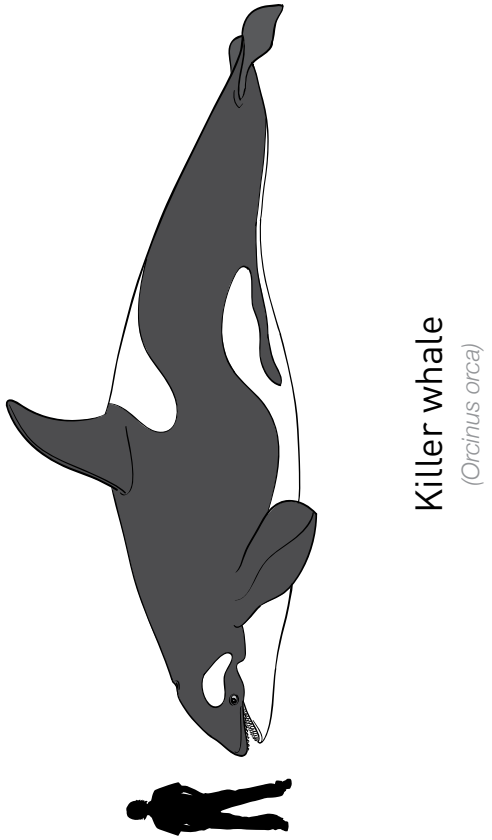
Animal features

Rooster

(Gallus gallus domesticus)

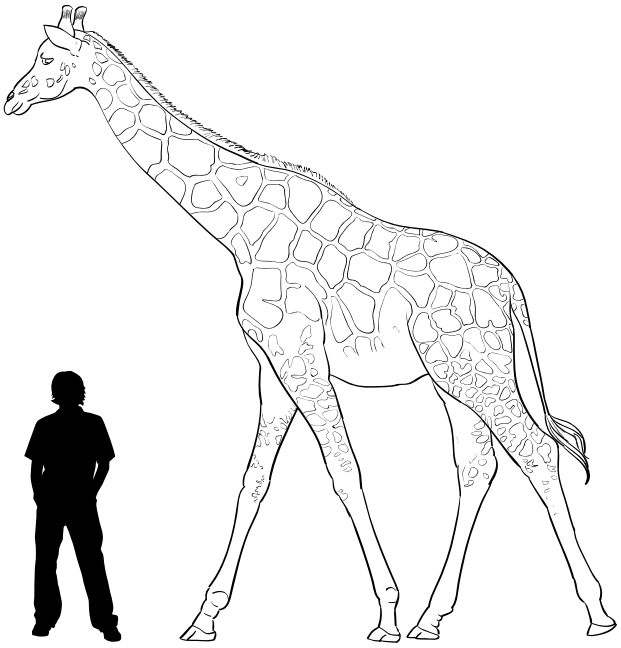
Lion

(Panthera leo)



Killer whale

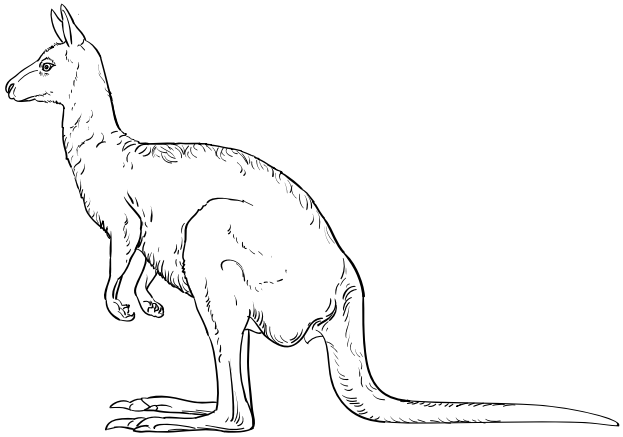
(Orcinus orca)

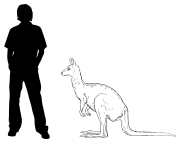


Giraffe

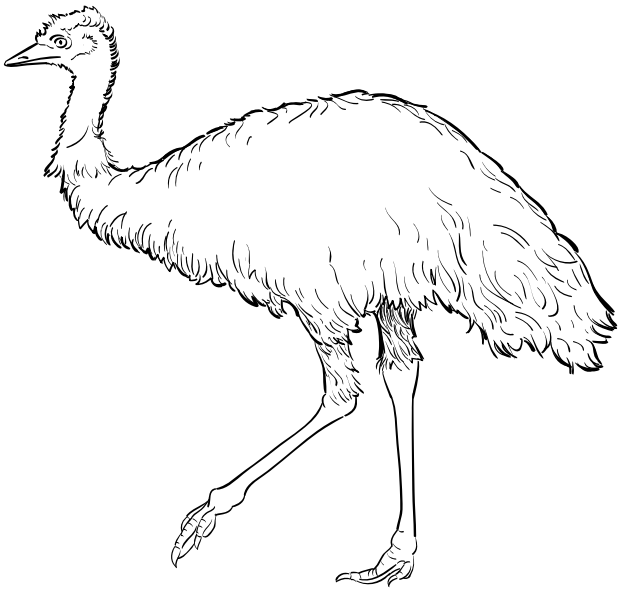
(Giraffa camelopardalis)

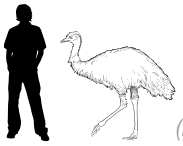
Animal features



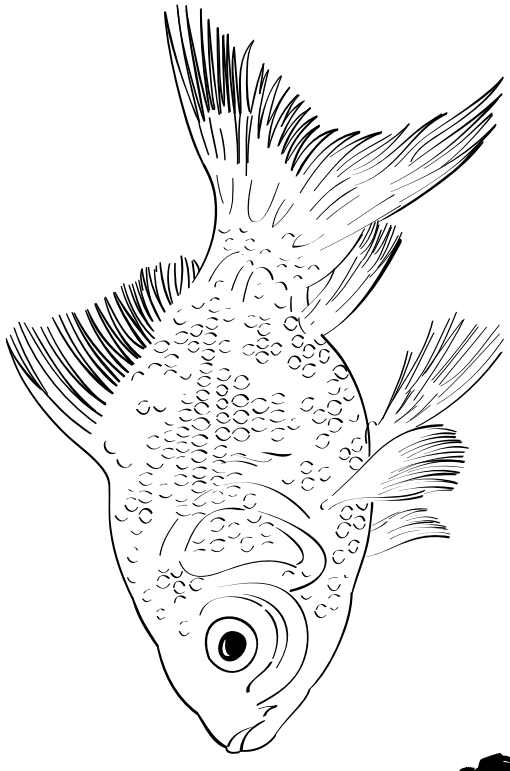


Eastern grey kangaroo
(Macropus giganteus)

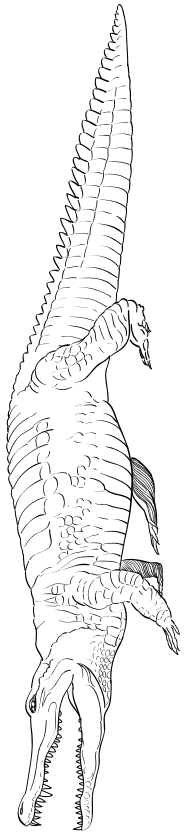




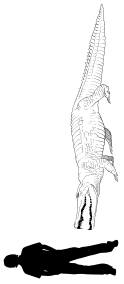
Emu
(Dromaius novaehollandiae)



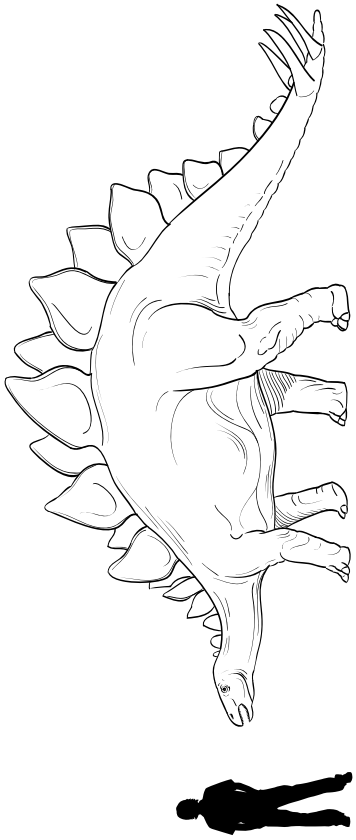
Goldfish
(Carassius auratus)



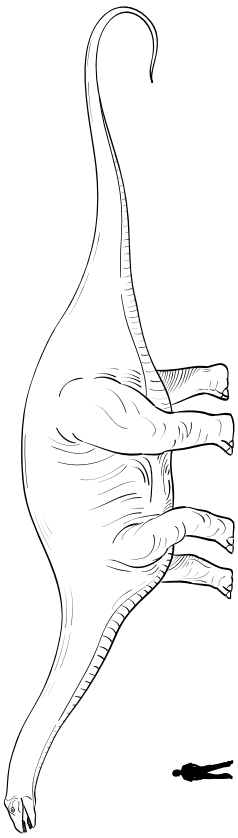
Crocodile
(Crocodylus porosus)



Prehistoric animals

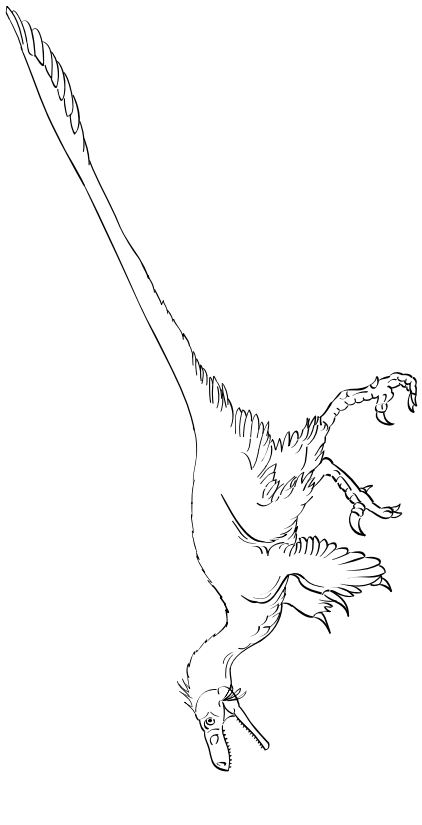


Stegosaurus
(Stegosaurus armatus)



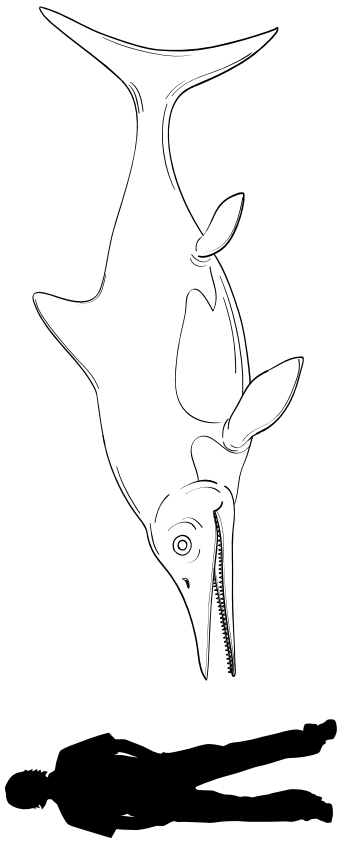
Brontosaurus
(Brontosaurus excelsus)

Plesiosaurus
(Plesiosaurus cryptocleidus)

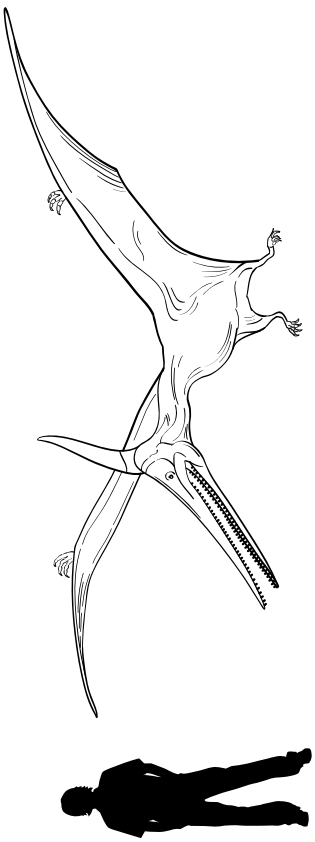


Velociraptor
(Velociraptor osmolskae)

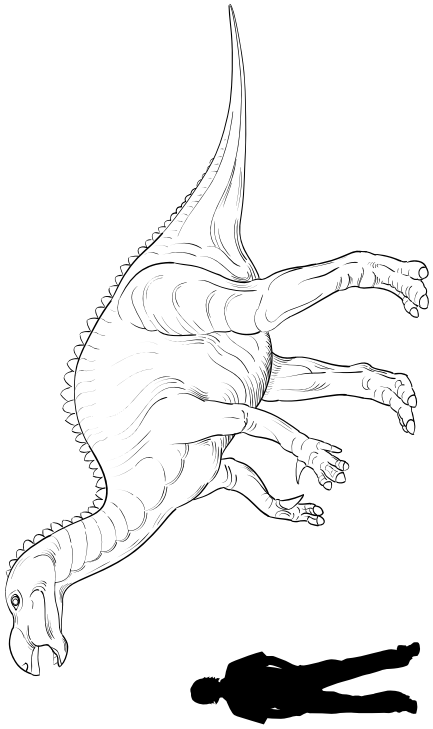
Prehistoric animals



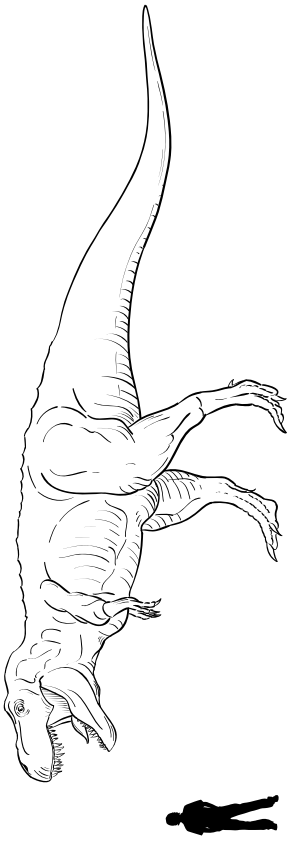
Ichthyosaurus
(Ichthyosaurus communis)



Pteranodon
(Pteranodon longiceps)



Muttaburrasaurus
(Muttaburrasaurus langdoni)



Tyrannosaurus rex
(Tyrannosaurus rex)

Session 2 Skeleton clues

Equipment

FOR THE CLASS

- class science journal
- word wall
- team roles chart
- team skills chart
- 1 enlarged copy of 'Animal features' (Resource sheet 1)
- 1 enlarged copy of 'Animal skeletons' (Resource sheet 3)
- 1 image of a fossil skeleton (see 'Preparation')
- *optional:* X-ray image

FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Manager and Speaker
- 1 copy of 'Animal features' (Resource sheet 1) per student (see 'Preparation')
- 1 copy of 'Animal skeletons' (Resource sheet 3) per student (see 'Preparation')

Preparation

- Decide whether to ask your students to match four or eight animals to their skeletons. To match four, photocopy only the first page of 'Animal features' (Resource sheet 1) and the first page of 'Animal skeletons' (Resource sheet 3) for each student.
- Prepare an enlarged copy of 'Animal skeletons' (Resource sheet 3).
- Source an image of a fossil skeleton of a prehistoric animal, preferably in a museum. For example, see http://phenomena.nationalgeographic.com/2014/01/21/dinosaur-13-and-the-ghost-of-tyrannosaurus-sue/
- *Optional:* Display the fossil skeleton image and 'Animal skeletons' (Resource sheet 3) in a digital format.

Lesson steps

1 Review the previous session and discuss the features that students identified.

2 Revise the images of the modern and prehistoric animals. Ask students:

- How did the artist know how to draw the modern animal? (By looking at a photo of an animal or the animal itself.)
- What do you think the artist looked at to draw the prehistoric animals?

EXPLORE

3 Introduce the image of a fossilised skeleton (see 'Preparation'). Ask students:

- What can you see in this image?
- What is a skeleton?
- Where might you see a skeleton of a dinosaur?
- Where have you seen a skeleton?
- Can skeletons help us to know what something looked like? Why do you think that?

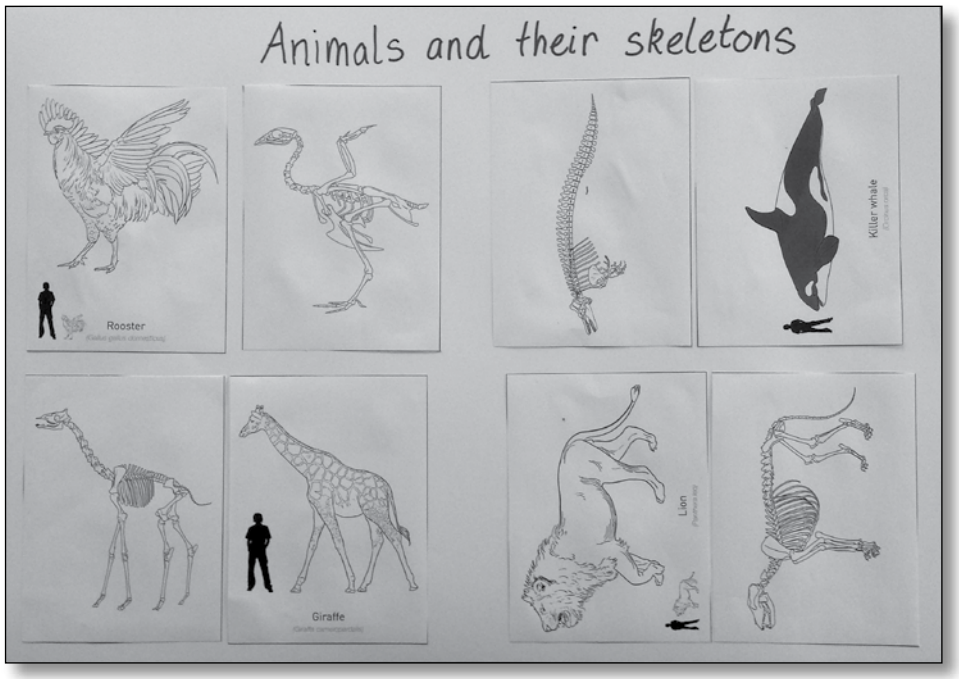
4 Discuss how fossils of dinosaur bones are what palaeontologists and artists use to imagine what dinosaurs looked like.

Optional: show students an X-ray image.

5 Introduce 'Animal skeletons' (Resource sheet 3). Explain that students will be working in their collaborative learning teams to look at the images of skeletons of animals and identify which modern animal they think it belongs to.

6 Model how to complete the activity using one of the images by cutting out the animal and its skeleton and pasting them together into the class science journal.

7 Re-form teams. Ask Managers to collect equipment. Allow time for teams to complete the activity.



Work sample of matching animals with their skeletons

8 For each animal, ask students if they can see any features that have been previously talked about. Ask questions such as:

- What features did you use to help you match the animal and its skeleton?
- What features of the animal can you easily see on a skeleton?
- What features of the animal are not shown by the skeleton?
- What things can you tell about an animal by looking at its skeleton? (For example, its size and how it moved because of the bones of legs, wings or fins.)

Record students' ideas in the class science journal.

9 Ask students to consider the pictures of prehistoric animals that they had in Session 1. Discuss how palaeontologists cannot be sure of all the features pictured, including the type and colour of skin.

10 Review students' questions to see if any have been answered. Update the word wall with words and images.

Curriculum links

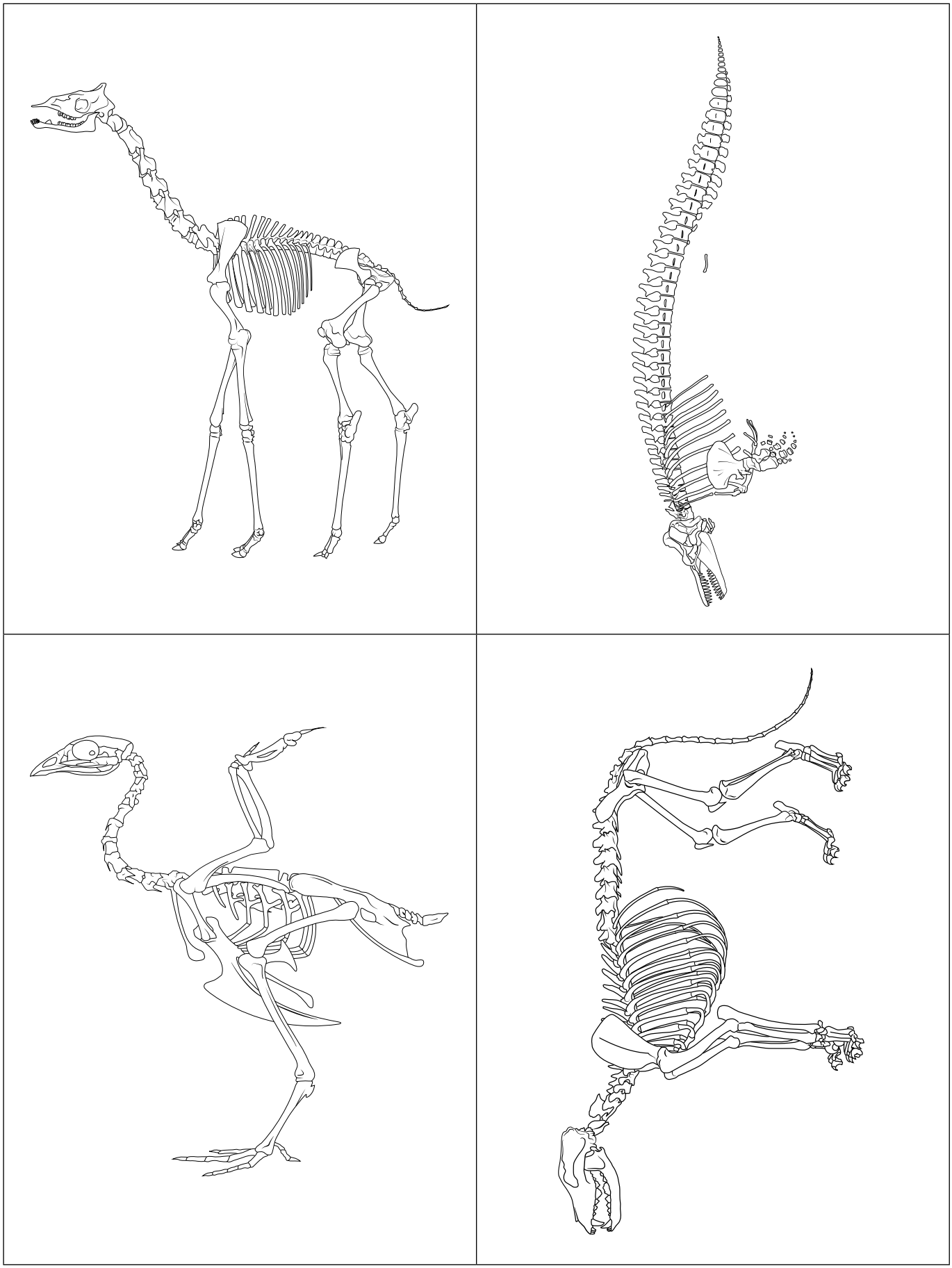
Science

- Visit a museum to see skeletons of dinosaurs and other animals.

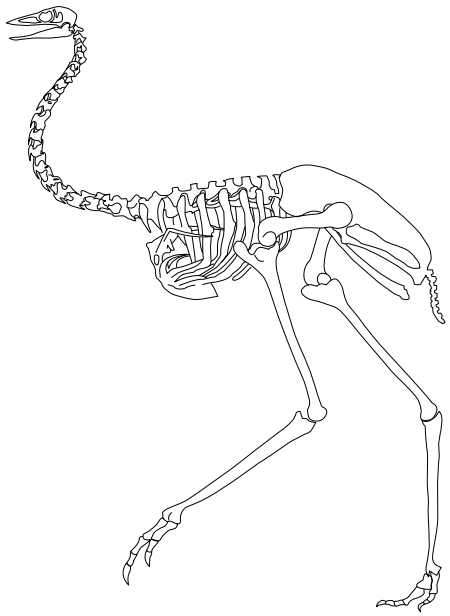
English

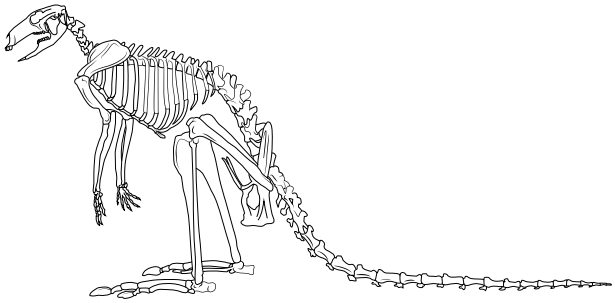
- Read stories about extinct animals.

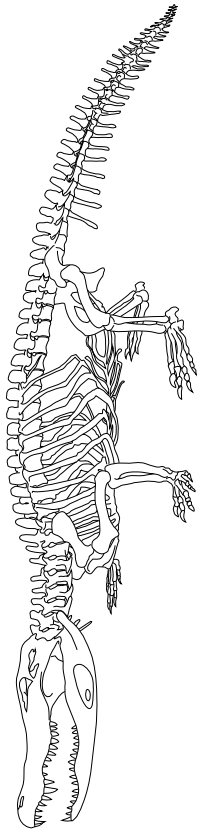
Animal skeletons

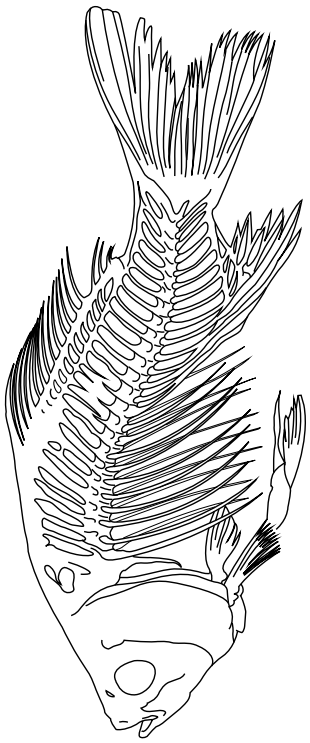


Animal skeletons









Lesson 3 Open wide!

EXPLORE

AT A GLANCE

To provide students with hands-on, shared experiences of how animals have different types of teeth to eat different types of food.

Session 1 Testing teeth

Students:

- observe and discuss own teeth types
- eat food and observe which teeth are used to bite and chew.

Session 2 Juxtaposing jaws

Students:

- explore images of the skeletons of animals' jaws with teeth
- select food type that matches the animal's teeth.

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. It involves monitoring students' developing understanding of how:

- animals have a variety of external features, for example, teeth
- animals have features that help them to meet their needs in their environment.

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

Key lesson outcomes

Science

Students will be able to:

- identify which teeth are used for eating different types of food
- compare teeth of different animals
- make claims about what prehistoric animals ate based on their teeth.

Literacy

Students will be able to:

- follow instructions to complete an investigation of their teeth
- complete a table
- engage in discussions and contribute ideas about what different animals ate based on their teeth.

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

Teacher background information

Structures for eating

Teeth have evolved into a variety of shapes and sizes, and are used by vertebrate animals (animals with a backbone) to eat a variety of types of food. In mammals, the three different types of teeth can be used to infer diet.

- *Incisors:* sharp, serrated teeth located at the front of the jaw, used for slicing and chopping.
- *Canines:* located at the corners of the mouth, with a pointed edge to hold, rip and tear food.
- *Molars:* located at the back of the mouth, they have a large surface area for grinding food.

The diversity of shapes and sizes of teeth can be used to classify different species. For example, most Australian marsupial fossils are classified by their teeth. Tooth replacement also depends on the species: humans replace their teeth once while sharks continuously replace teeth (estimated to lose one a week).

Some vertebrates do not have teeth. Beaks can tear away plant material, be used as a spear or pouch to hold food, as well as for crushing and grinding food. In birds, the size and shape of beaks varies greatly due to the range of foods consumed by different species. Internal features also grind food, for example, gizzards are a muscular structure containing small stones (gastroliths). By contracting around food and the gastroliths repeatedly, the gizzard grinds and pulverises food before it reaches the stomach.

Prehistoric diets

The enamel on teeth is one of the hardest parts of an animal. As such, teeth represent the most numerous animal fossil. By comparing size and shape of teeth with modern animals, palaeontologists can hypothesise what types of diets prehistoric animals had.

- Carnivorous (meat-eating) animals generally have canine teeth for ripping and tearing flesh, and molars for grinding. The *Tyrannosaurus rex* had teeth that were conical in shape and serrated on the edges, like those of the Great White shark. They terminated at a sharp point that could pierce tough hide and penetrate flesh. Plesiosaurs had sharp serrated teeth in a pattern that effectively formed a trap for fish.

- Plant-eating (herbivorous) animals generally have incisors for biting off leaves from stems and molars for grinding up fibrous vegetable matter. They can also have peg-like teeth for stripping branches and plate-like teeth for cutting vegetation. Dinosaurs such as *Brontosaurus* ate leaves and stems, and some scientists think their tall neck helped to reach the tops of tall plants, although others think their neck was not that flexible. Hadrosaurs (duck-billed dinosaurs) also ate plant matter, though whether they were grazers (like cows) or browsers (like goats) remains the subject of scientific debate.
- Animals that eat both plants and meat (omnivores such as humans) usually have all three types of teeth (incisors, canines and molars).

Palaeontologists also consider other evidence when thinking about the diets of prehistoric animals, including fossilised dinosaur dung, stomach contents and gastroliths (stomach stones that can be used by some animals, for example, chickens, to grind food in their gizzard as they do not have grinding teeth).

EXPLORE

Students' conceptions

Young students might think that all animals eat the same types of foods as humans. The diet of herbivorous dinosaurs usually consisted of available plants including ferns, moss, horsetails and club mosses. The diet of carnivorous species would likely have included fish, reptiles, insects, shellfish and other sea creatures, as well as other dinosaurs.

Session 1 Testing teeth

Equipment

FOR THE CLASS

- class science journal
- word wall
- team roles chart
- team skills chart
- 1 enlarged copy of 'Which teeth?' (Resource sheet 4)
- *optional:* large model of human teeth

FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Manager and Speaker
- 1 small mirror (see 'Preparation')
- 1 quarter of an apple per team member
- 1 copy of 'Which teeth?' (Resource sheet 4) per team member

Preparation

- Prepare two apple quarters for each team.
  Safety note: incorrect food handling procedures can result in illness. Ensure that all food items are prepared in a hygienic and safe manner. Check for students with allergies or special dietary requirements. Ensure children have clean hands before taking their apple quarters.

SAFETY

- Source small mirrors for each team. If they are difficult to find consider alternatives, such as cameras on phones.
- *Optional:* Display 'Which teeth?' (Resource sheet 4) in a digital format.

Lesson steps

1 Review the previous lesson focusing students' attention on how features of prehistoric animals can help palaeontologists think about where they lived and how they moved.

2 Ask students how palaeontologists might work out what dinosaurs ate. Remind students that palaeontologists look at modern animals to help them understand how dinosaurs lived.

3 Introduce the enlarged copy of 'Which teeth? (Resource sheet 4). Ask students to identify the three main shapes of teeth. For example, four flat teeth across the front, two pointy teeth and five bumpy teeth at the back. Ask students to feel the matching teeth in their own mouth.

Optional: Show students a model of human teeth to help identify the three main types of teeth.

SAFETY

Safety note: Ensure students have washed their hands before doing this activity

4 Read the three questions on 'Which teeth?' (Resource sheet 4). Show students the apple quarters. Explain that one team member will bite into and chew the apple quarter while looking into the mirror held by the other team member to observe which of the three types of teeth they use to eat the apple quarter. Explain that students will then answer the questions by colouring the teeth.

5 Ask students to predict which teeth they think will be the best for biting and which will be the best for chewing. Record students' predictions in the class science journal.

SAFETY

Safety note: Remind students that tasting is not normally used in science for safety reasons. An exception is made here as they are studying how to eat things and the food has been prepared in a safe way.

6 Form teams and allocate roles. Ask managers to collect equipment. Remind students that they need to wash their hands before testing the foods.

Note: At this year level many students will have missing front teeth. pair those students with others who do not have missing front teeth.

7 After students have made and recorded their observations, ask teams to share their findings and compare them with the predictions in the class science journal.

Ask questions such as:

- Which teeth were best for biting the apple?
- Which teeth were best for chewing the apple?
- Which teeth do you think might be best for tearing meat off a bone? Why do you think that?

Record students' answers in the class science journal.

8 Discuss what kinds of teeth different modern animals such as pets might have based on their diets. Encourage students to look at a pet's teeth when at home.

SAFETY

Remind students not to put their fingers near or in the mouths of an animal. Encourage them to look from a distance, for example, when an animal is yawning, or look at photos.

9 Review students' questions to see if any have been answered. Update the word wall with words and images.

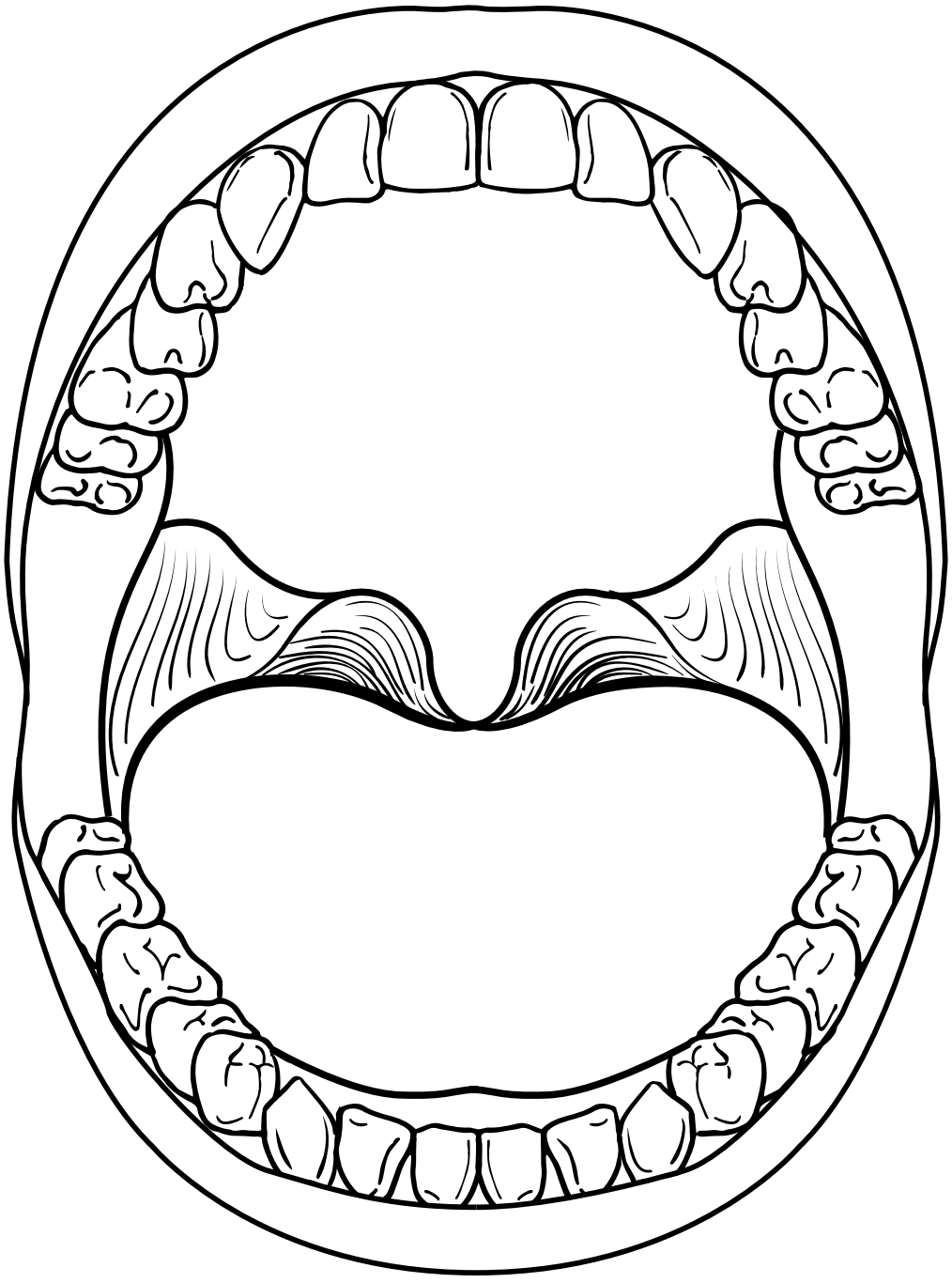
EXPLORE

Which teeth?

Name: _____ **Date:** _____

Eat the apple and answer the questions.

1. Which teeth were best for biting the apple? Colour them orange.
2. Which teeth were best for chewing the apple? Colour them green.
3. Which teeth are pointy like a lion's and would be best for tearing meat off a bone? Colour them red.



Session 2 Juxtaposing jaws

Equipment

FOR THE CLASS

- class science journal
- word wall
- team roles chart
- team skills chart
- 1 enlarged copy of 'Modern teeth' (Resource sheet 5)
- 1 enlarged copy of 'Mystery teeth' (Resource sheet 6)

FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Manager and Speaker
- 1 copy of 'Mystery teeth' (Resource sheet 6) for each team member

Preparation

- Prepare enlarged copies of 'Modern teeth' (Resource sheet 5) and 'Mystery teeth' (Resource sheet 6).
- *Optional:* Display 'Modern teeth' (Resource sheet 5) and 'Mystery teeth' (Resource sheet 6) in a digital format.

Lesson steps

1. Review the previous session by asking students to recall which types of teeth are best for biting, chewing and tearing meat.
2. Ask students what they learned about looking at teeth of pets.
3. As a class, discuss what types of teeth a sheep and a crocodile might have. Record students' thoughts in the class science journal.
4. Introduce the enlarged copy of 'Modern teeth' (Resource sheet 5) and discuss the types of teeth each animal has. Record class answers on the enlarged resource sheet and display in the classroom.
5. Explain that students will be working in collaborative learning teams to discuss the teeth of prehistoric animals and think about what type of food they probably mostly ate.
6. Introduce the enlarged copy of 'Mystery teeth' (Resource sheet 6) and 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.

7 Form teams and allocate roles. Ask Managers to collect equipment. Allow time for students to complete the activity.

8 Ask Speakers to present their team's responses. Ask students questions such as:

- Why might palaeontologists claim (think) that a particular prehistoric animal ate plants? (It has biting and chewing teeth to cut and chew plants.)
- Why might palaeontologists claim (think) that a particular prehistoric animal ate meat? (It has tearing teeth to tear meat apart.)

9 Discuss other features that might help animals to catch, tear-up and grind food, including beaks and claws.

10 Review students' questions to see if any have been answered. Update the word wall with words and images.

EXPLORE

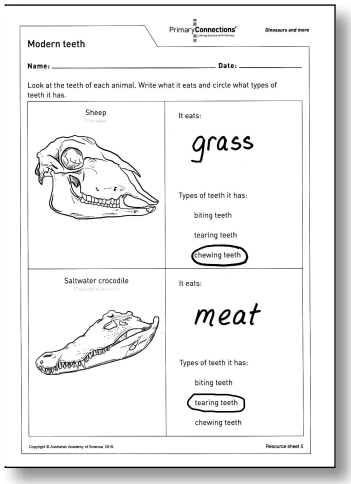
Curriculum links

Science

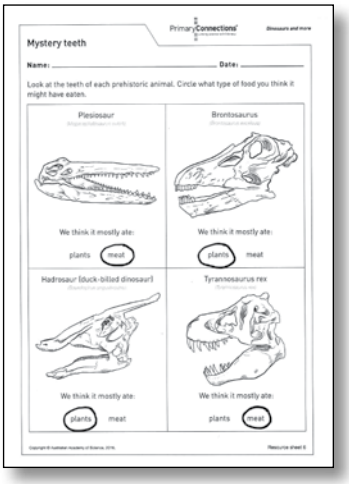
- Investigate how predators, such as lions and eagles, catch and hold prey using their claws.

Indigenous perspectives

- Examine images of tools made by Aboriginal and Torres Strait Islander people using teeth.
- PrimaryConnections 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 PrimaryConnections website (www.primaryconnections.org.au).



Work sample of 'Modern teeth' (Resource sheet 5)



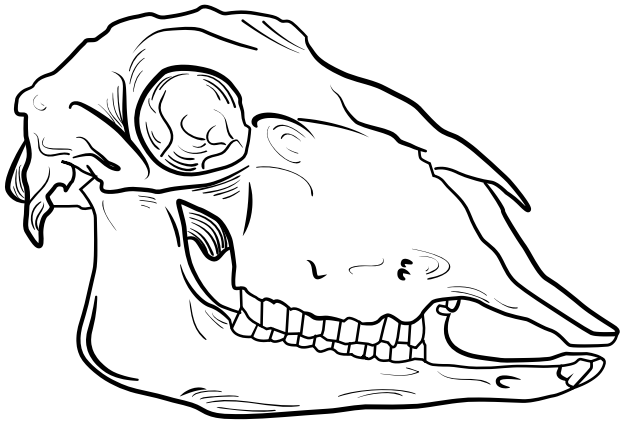
Work sample of 'Mystery teeth' (Resource sheet 6)

Modern teeth

Name: _____ **Date:** _____

Look at the teeth of each animal. Write what it eats and circle what types of teeth it has.

Sheep
(Ovis aries)



It eats:

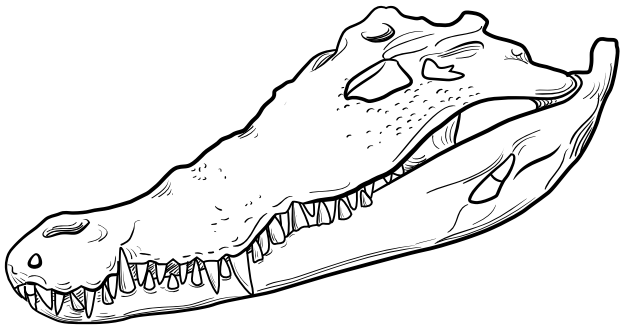
Types of teeth it has:

biting teeth

tearing teeth

chewing teeth

Saltwater crocodile
(Crocodylus porosus)



It eats:

Types of teeth it has:

biting teeth

tearing teeth

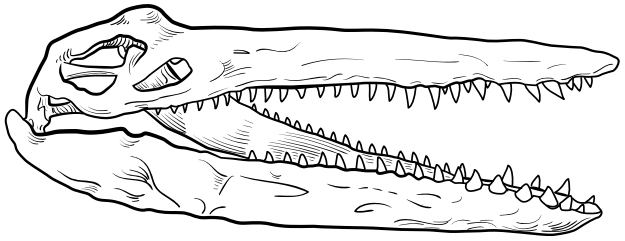
chewing teeth

Mystery teeth

Name: _____ **Date:** _____

Look at the teeth of each prehistoric animal. Circle what type of food you think it might have eaten.

Plesiosaur
(Megacephalosaurus eulerti)



We think it mostly ate:

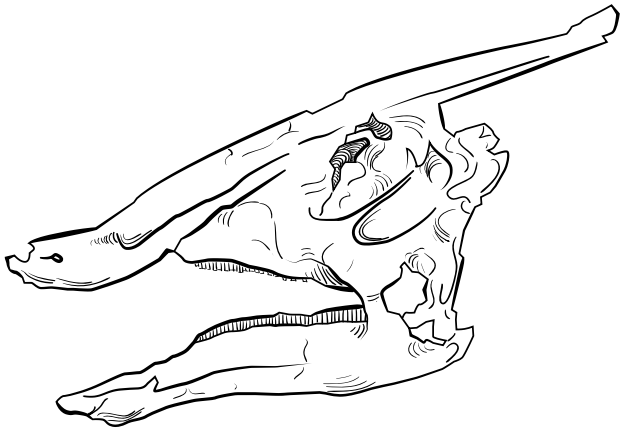
plants meat

Brontosaurus
(Brontosaurus excelsus)

We think it mostly ate:

plants meat

Hadrosaur (duck-billed dinosaur)
(Saurolophus angustirostris)



We think it mostly ate:

plants meat

Tyrannosaurus rex
(Tyrannosaurus rex)

We think it mostly ate:

plants meat

Lesson 4 Finding food

AT A GLANCE

To provide students with hands-on, shared experiences of the features of ferns and environments in which this prehistoric food source could be found.

Students:

- work in teams to explore the basic features of a fern
- draw a labelled diagram of a fern
- view environments in which ferns lived.

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. It involves monitoring students' developing understanding of:

- the external features of a fern
- different environments where ferns grow.

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

Key lesson outcomes

Science

Students will be able to:

- locate and label the external features of a living and fossilised fern (stem, roots, leaves)
- identify the basic needs of a fern
- explain that ferns were one source of food for some prehistoric animals.

Literacy

Students will be able to:

- create a labelled diagram
- engage in and contribute to discussions about the features and needs of ferns.

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

Teacher background information

Prehistoric climates

Dinosaurs and their relatives roamed the planet for approximately 180 million years (the Mesozoic era). During the Mesozoic era, Australia was closer to the South Pole and experienced a cool, wet climate with long, dark winters. The Tarkine rainforest in Tasmania is an example of what such environments might have looked like. Africa, North America, South America and India were closer to the equator and, thus, were warm and wet tropical areas.

During the Mesozoic era, concentrations of carbon dioxide in the atmosphere were much higher than today. This meant that, globally, the Earth's atmosphere was warmer, although local climates varied from tropical to polar. Swampy environments, that decomposed very slowly, gradually captured carbon-rich organic materials. These materials turned into some of the 'fossil fuels' that we burn today, releasing energy as well as carbon dioxide back into the atmosphere.

Prehistoric land environments

Today when we think of tall plants in the environment we often think of flowering plants, such as gum trees, or gymnosperms (plants that produce seeds but not flowers), such as pines. However, during most of the Mesozoic era, ferns, horsetails and club mosses were the tallest, dominating the landscape.

All three have roots, stems and leaves, but do not produce seeds. Instead they reproduce by spores, which are small capsules that require water to survive. We therefore know that areas that have many fossils of these plants most likely grew under moist climates.

There were also gymnosperms and numerous insects, many of which look like modern insects, but during the Mesozoic era were much larger. For example, fossil dragonflies have been found with wingspans of up to 65 cm. One reason insects were larger is because there was more oxygen available in the atmosphere. Insects do not have lungs; they rely on diffusion through tubes directly to the tissues, and this was less size-limiting in the Mesozoic era.

The oceans also teemed with life. In addition to large marine reptiles, such as ichthyosaurs and plesiosaurs, the oceans were home to a variety of algae, marine invertebrates (animals without backbones) like ammonites, shrimp and horseshoe crabs, armoured fish, turtles and crocodiles. There were no mammals, such as whales, dolphins and seals, at the time.

Students' conceptions

Students might not believe that plants are alive because they do not move like animals. Some plants can open and close their leaves. Sunflowers, for example, orient their flowers to follow the Sun. However, for many plants their growth is their 'movement'. For example, roots explore the soil by growing into it in search of water and dissolved minerals for growth.

Students might believe that plants live only on dry land as opposed to in waterlogged or swampy areas. Most ferns, however, live in very moist environments, while some plants are aquatic, for example, water lilies.

Students might believe that all dinosaurs and plants lived in a warm climate. There is fossil evidence to suggest that dinosaurs lived in cool temperate and subantarctic climates. Scientists have suggested that feathers, found on many dinosaurs, provided warmth in cool climates.

Equipment

FOR THE CLASS

- class science journal
- word wall
- team roles chart
- team skills chart
- 1 enlarged copy of 'Two ferns' (Resource sheet 7)
- images or videos of prehistoric environments (see 'Preparation')
- *optional:* images of fossils of ferns and/or a living fern in a pot

FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Manager and Speaker
- piece of living fern with the soil removed from around its roots (see 'Preparation')
- magnifying glass
- 1 copy of 'Two ferns' (Resource sheet 7) for each team member

Preparation

- Prepare an enlarged copy of 'Two ferns' (Resource sheet 7).
- Obtain a clump of fern, such as 'maidenhair' or 'bracken'. Prepare a specimen for each team by separating individual plants and washing away the soil from around the roots using running water. Pat dry with paper towel.

  Note: Any fern type can be used. If ferns are unavailable in your area then introduce a different plant, for example, a dandelion, and discuss with students why you were unable to find a fern in their local environment.

  Safety note: If collecting ferns from outside, wear gloves and ensure no insects or spiders remain on the plants when brought into the classroom.
- Find images or videos for students to explore artists' representations of prehistoric environments that contained ferns. For example, see: 'Early dinosaur evolution' http://www.sciencekids.co.nz/videos/dinosaurs.html

Lesson steps

1. Review the previous lesson, focusing students' attention on what dinosaurs ate. Ask questions such as 'How do palaeontologists know that some dinosaurs ate plants?'
2. Introduce images or videos of prehistoric environments (see 'Preparation'). Discuss how these represent a claim of what the environment might have looked like, using evidence such as fossils of plants.
3. Introduce the enlarged copy of 'Two ferns' (Resource sheet 7). Explain that this is a photo of a fossil fern that grew when dinosaurs were alive, so palaeontologists think that plant-eating dinosaurs would have eaten ferns.

4 Show students a clump of fern (see 'Preparation'). Explain to students that this is also a fern. Tell students that they will work in collaborative learning teams to use a magnifying glass to look closely at the two ferns and see what is similar about them.

Optional: Introduce images of fossils of ferns and/or a living fern in a pot.

5 Ask students to draw a labelled diagram to show the main features of the two ferns. Show students the words that they will use to label their fern, such as leaves, stem and roots. Discuss the purpose and features of a labelled diagram.

Literacy focus

Why do we use a labelled diagram?

We use a **labelled** diagram to show the shape, size and features of an object.

What does a labelled diagram include?

A **labelled diagram** might include a title, a drawing, a scale to show the object's size and labels showing the main features. A line or arrow connects the label to the feature.

6 Form teams and allocate roles. Ask Managers to collect team equipment. Allow time for teams to complete the activity.

Drawing a labelled diagram of a fern

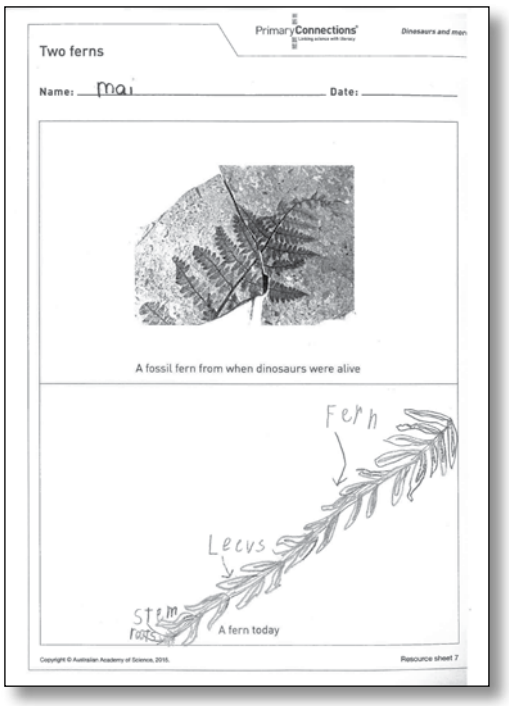
7 As a class, discuss the activity, asking questions such as:

- What features can you identify?
- Do both of the ferns have the same features? How are they alike? How are they different?
- Have you seen ferns growing? What was it like where they were?
- Have you been to a rainforest? What do you think it would be like in a rainforest?

Record students' responses in the class science journal.

8 Explain that rainforests are very wet places and that is the type of place in which ferns like to live. Explain that scientists think that the fossil ferns probably grew in very wet places in prehistoric times too.

9 Review students' questions to see if any have been answered. Update the word wall with words and images.



Work sample of 'Two ferns' (Resource sheet 7)

Curriculum links

Science

- Build a soft-drink bottle terrarium using ferns to investigate conditions required for fern growth.
- Read 'The little dinosaur' by Catriona Hoy about how a dinosaur fossil is formed.

The Arts

- Make fern stencil prints.
- Make leaf rubbings from a variety of ferns.

Indigenous perspectives

- Explore the use of Bunya pine, bracken fern and tree fern as bush tucker.
- 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

Two ferns

Name: _____ **Date:** _____

A fossil fern from when dinosaurs were alive

A fern today

Lesson 5 Making models

AT A GLANCE

To support students to represent and explain their understanding of the external features of prehistoric animals and where they lived.

To introduce current scientific views about features of dinosaurs.

Students:

- make a model of a dinosaur
- view a video on what scientists think dinosaurs looked like.

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 have a variety of external features.

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

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

Key lesson outcomes

Science

Students will be able to:

- explain some external features of a dinosaur
- explain recent scientific knowledge about the features of dinosaurs
- describe how the dinosaur moved and where it lived (land, air or sea).

Literacy

Students will be able to:

- make a model of a dinosaur
- verbally present the features of their dinosaur model
- contribute to discussions.

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

Teacher background information

Scientists have identified feathers with certain species of dinosaurs for decades. However, recent discoveries have led to the claim that feathers and modified scales might have been more ubiquitous on dinosaurs than previously thought. There is also evidence that suggests feathers were brightly coloured. Structures called melanosomes, which are responsible for producing colour in modern animals, have been identified in fossilised dinosaur feathers. They are very similar in structure to those found in the iridescent feathers of modern birds. It is also possible that dinosaur feathers might have produced ultraviolet patterns (not visible to the human eye), which suggests that dinosaurs might have been able to see in the ultraviolet spectrum (as many modern birds can).

Studies in modern birds suggest that colour, including ultraviolet patterns, plays a vital role in courtship and territorial behaviour as well as in kin recognition and feeding behaviour. It is reasonable to presume that colour might have played a similar role in dinosaur behaviour, although we cannot be sure since there is no direct evidence.

Downy feathers might have provided insulation to help dinosaurs keep warm and live in icy environments near the poles. Dinosaurs living in very cold environments might also have been able to keep their blood warm, as modern mammals do, and might have huddled together in groups in the extreme cold, as penguins do. Dinosaurs living near the poles had bigger eye-sockets, and therefore are likely to have had bigger eyes that would have helped them locate prey during the long, dark polar winters. It is also likely that they hibernated when food was not easily available.

Students' conceptions

Young students might believe that common representations of dinosaurs with grey and green reptilian-like skin represent a scientific fact rather than a claim based on evidence. New evidence suggests that many dinosaurs had feathers of various sizes, shapes and colours.

Many students might believe that dinosaurs and their relatives were either 'cold-blooded' or 'warm-blooded'. It is now thought that these animals could regulate and change their blood temperature to make it warm or cool, depending on their needs, for example, by basking in the sun as snakes and lizards do.

Students might think that all reptiles from the prehistoric past were dinosaurs. Dinosaurs were a group of animals related to reptiles. They lived on land and had legs under their body, as opposed to legs at the sides of their body like most reptiles.

Equipment

FOR THE CLASS

- class science journal
- word wall
- video on what dinosaurs looked like (see 'Preparation')
- paint
- feathers, assorted colours

FOR EACH STUDENT

- science journal
- modelling clay or salt dough

Preparation

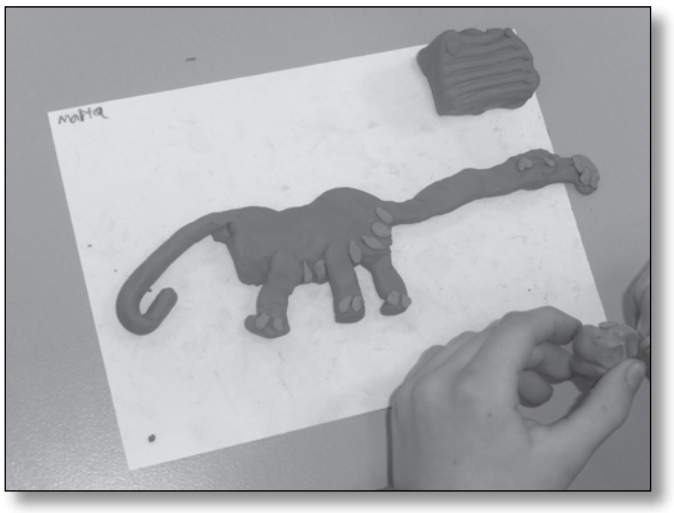
- Read 'How to facilitate evidence-based discussions' (Appendix 4).
- Source a video on new evidence about what dinosaurs looked like, for example:
  – http://thekidshouldseethis.com/post/49454144062
- Prepare a page in the class science journal with the title 'Dinosaur features'.

Lesson steps

1. Review the previous lessons using the class science journal. Ask students to think about different features that dinosaurs had to help them move and eat.
2. Explain that students will create a model of a dinosaur of their choice. As a class, brainstorm different dinosaurs students might want to choose to model. Ask students to carefully consider which features most need to be included in the model to help people know how the dinosaur moved and what it ate.
3. Allow time for students to complete the activity.

   Ask students to present their dinosaur to the class, including important features, how it moved, what it ate and where it probably lived. Ask students to question each other using the 'Science question starters' in Appendix 4.
4. Introduce the video about what dinosaurs looked like (see 'Preparation').
5. After viewing the video ask questions such as:
   - How do scientists know what dinosaurs looked like?
   - How do scientists know that dinosaurs had feathers?
   - What else did you learn?

   Record students' responses in the class science journal.
6. Ask students to update their dinosaur models to reflect what they have learned. For example, painting their dinosaur in bright colours and/or adding feathers.



Student adding feathers to model

7 Review 'Our questions' in the class science journal to see if any can be answered.

8 Update the word wall with words and images.

Curriculum links

English

- Dinosaurs might have had feathers but they did not fly. Read stories about birds that do not fly.

Lesson 6 Dinosaur defence

AT A GLANCE

To support students to design and make a shield inspired by the features that helped dinosaurs to defend themselves.

Session 1 Defensive designs

Students:

- plan and develop a drawing of a shield.

Session 2 Construction time

Students:

- follow their drawing to construct a shield.

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 v).

Key lesson outcomes

Science

Students will be able to:

- generate and develop ideas to make a shield
- make and appraise a shield using a dinosaur defence.

Literacy

Students will be able to:

- create an annotated drawing of their ideas
- present and describe the features of their shield.

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

ELABORATE

Teacher background information

Some animals prey on other animals for food. Animals of the same species can compete against each other by fighting. Animals have evolved a wide variety of features to attack and to defend themselves against others. Some adaptations are clearly for defence, for example, red kangaroos have extra thick skin over their bellies and their neck. Others are less clear, for example, horns and spines can be used for both attack and defence. However, scientists make claims on their use both by where the horns and spines are located but also observations of modern-day animal behaviour.

Fossil evidence suggests that dinosaurs and their relatives had a variety of adaptations for defence and protection, and that many of these were similar to present-day animals. Horns, spikes and plated armour are readily identified and are discussed in the lesson below. Some fossils also show wounds, for example, holes made by spikes.

How to pronounce the dinosaurs on Resource sheet 8:

- Kentrosaurus *(KEN-truh-SORE-us)*
- Struthiosaurus *(STROOTH-ee-o-SORE-us)*
- Kosmoceratops *(KOZ-moe-SAIR-uh-tops)*
- Triceratops *(try-SAIR-uh-tops)*

Students' conceptions

Students might think that animals choose to grow spikes or spines because of the environment they are in. The ability to develop defence or attack features depends on having the right genes, and are generally not under the direct control of the animal itself.

ELABORATE

Session 1 Defensive designs

Equipment

FOR THE CLASS

- class science journal
- word wall
- team roles chart
- team skills chart
- 1 enlarged copy of 'Fearless features' (Resource sheet 8)
- 1 enlarged copy of 'Dino shield' (Resource sheet 9)
- materials to make shield (see 'Preparation')
- dino shield base (see 'Preparation')
- *optional:* video clip of a battle between dinosaurs (see 'Preparation')
- *optional:* collection of multimedia resources depicting different dinosaurs (see 'Preparation')

FOR EACH STUDENT

- each team member's science journal
- role wristbands or badges for Manager and Speaker
- 1 copy of 'Fearless features' (Resource sheet 8)
- 1 copy of 'Dino shield' (Resource sheet 9)

Preparation

- Prepare an enlarged copy of 'Fearless features' (Resource sheet 8) and 'Dino shield' (Resource sheet 9).
- *Optional:* Source a video clip from a scene depicting a battle between two dinosaurs. For example 'Stegosuarus v Allosaurus' www.sciencekids.co.nz/videos/dinosaurs.html
- *Optional:* Identify multimedia resources, including books, photos and videos, to help students explore the defensive features of a greater variety of dinosaurs.
- Collect a variety of materials for students to create their shields, such as large paper plates, egg cartons, straws, margarine containers, tissue boxes, cardboard tubes, yoghurt containers, aluminium foil, string, wire, popsticks and cardboard boxes.
- Prepare a shield base using an A4 sheet of thick cardboard. See 'Dino shield' (Resource sheet 9).
- *Optional:* Display 'Fearless features' (Resource sheet 8) and 'Dino shield' (Resource sheet 9) in a digital format.

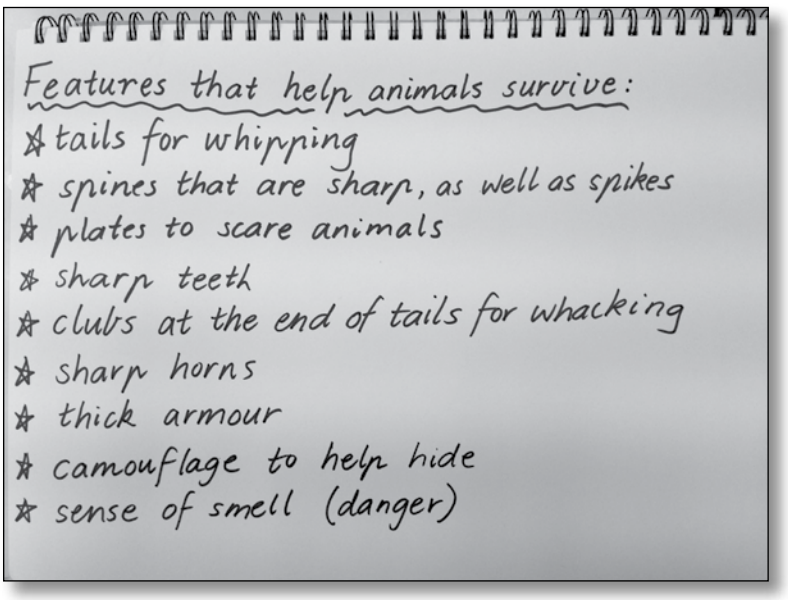
Lesson steps

1 Review the previous lessons using the class science journal and word wall.

2 Ask students what features they have looked at so far that might help animals to survive, such as claws for catching food and fur/feathers to keep warm. Record these in the class science journal. Discuss how people are able to make things to help them survive, whereas wild animals rely on what they naturally have.

3 *Optional:* Show students the video (see 'Preparation') of a battle between two dinosaurs. Ask what features of dinosaurs they saw in the video that could help them to survive.

Record students' responses in the class science journal.

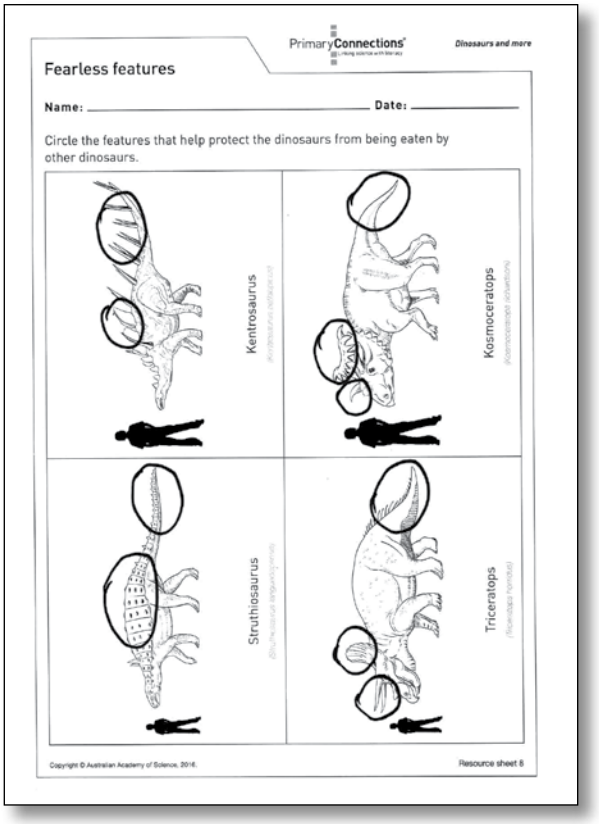


Work sample of ideas about features

ELABORATE

4 Introduce the enlarged copy of 'Fearless features' (Resource sheet 8). Ask students to identify external features that dinosaurs might have used to protect themselves. Complete the activity as a class.

Optional: Ask students to consult the multimedia resources to identify more defensive features to report to the class.



Work sample of 'Fearless features' (Resource sheet 8)

ELABORATE

5 Introduce an enlarged copy of 'Dino shield' (Resource sheet 9).

6 Explain to students that they will be working in their collaborative learning teams to plan and then make a shield to protect against an attack from an imaginary dinosaur. Show teams the A4 size cardboard sheet that they will use as the basis for their shield.

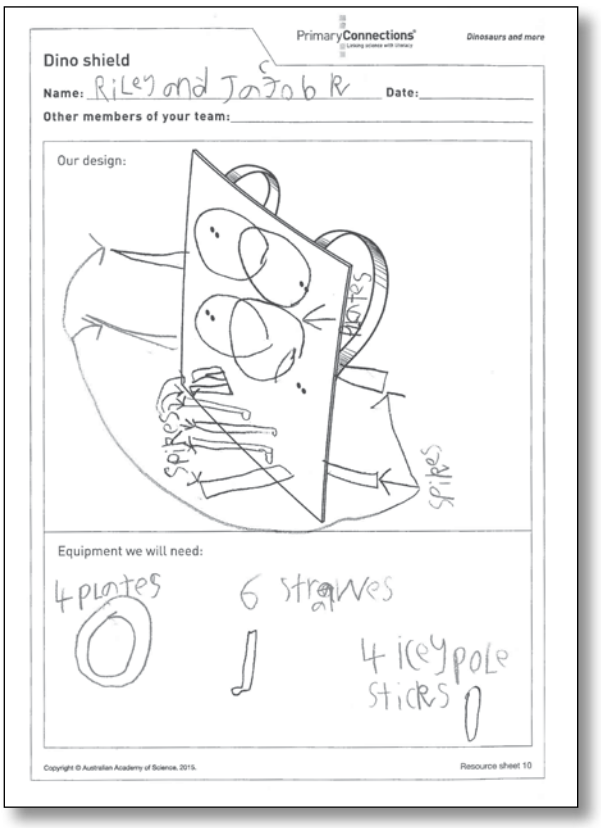
Optional: Ask students to work in teams to discuss their ideas, but each student creates their own shield.

7 Ask teams to create an annotated drawing to show their design. Remind them they can inspire themselves from features on 'Fearless features' (Resource sheet 8).

8 Ask teams to list or draw the equipment that they will use to make their shield. Show students the materials collected for this activity (see 'Preparation').

9 Form teams and allocate roles. Allow time for teams to complete the activity.

10 Explain to students that they will make their shield in the next session.



PrimaryConnections

Dinosaurs and more

Dino shield

Name: Riley and Jacob R **Date:**

Other members of your team:

Our design:

Equipment we will need:

Resource sheet 10

Work sample of 'Dino shield' (Resource sheet 9)

ELABORATE

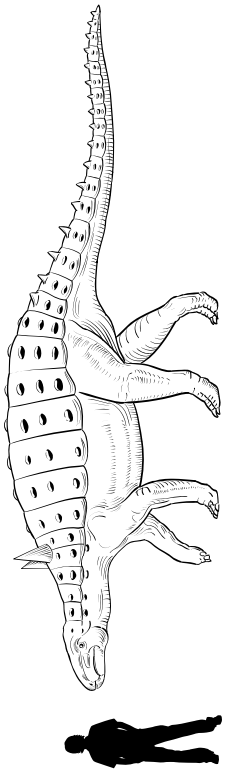
Fearless features

Name: _____ **Date:** _____

Circle the features that help protect the dinosaurs from being eaten by other dinosaurs.

Kentrosaurus *(Kentrosaurus aethiopicus)*

Kosmoceratops *(Kosmoceratops richardsoni)*



Struthiosaurus *(Struthiosaurus languedocensis)*

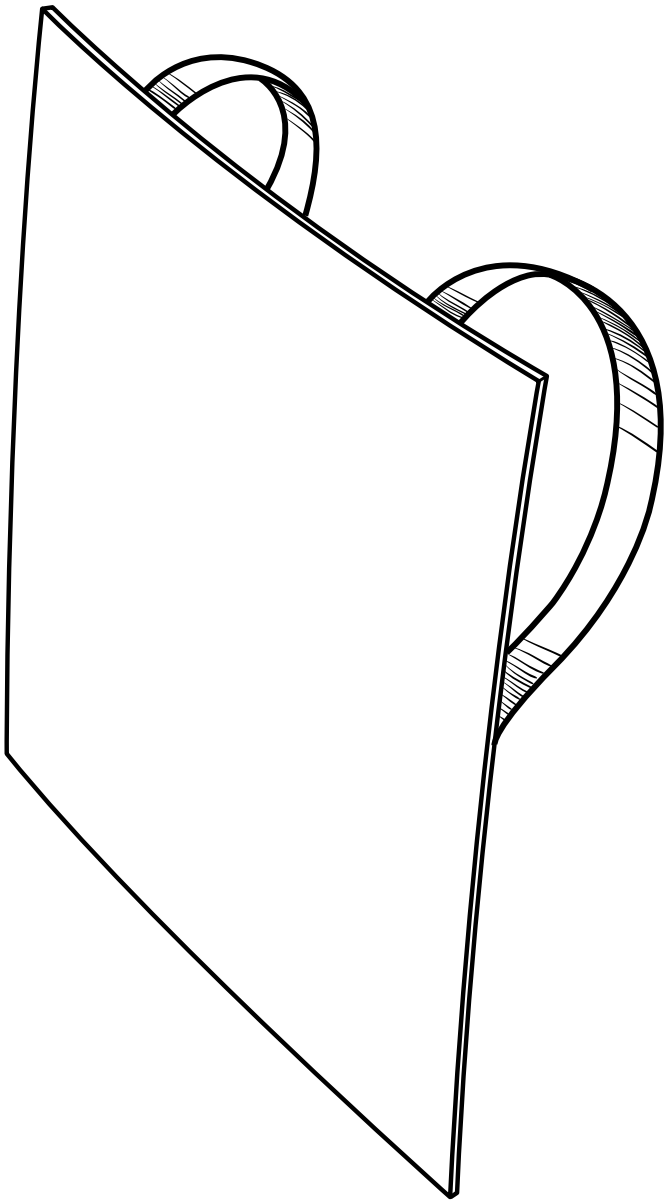
Triceratops *(Triceratops horridus)*

Dino shield

Name: _____ **Date:** _____

Other members of your team: _____

Our design:



Equipment we will need:

Session 2 Construction time

Equipment

FOR THE CLASS

- class science journal
- word wall
- team roles chart
- team skills chart
- materials to make shield (see 'Preparation')
- *optional:* digital camera

FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Manager and Speaker
- each team's annotated drawing from 'Dino shield' (Resource sheet 9)
- A4 thick cardboard sheet

Preparation

- Make available on the equipment table the materials that have been collected for students to create their designs, such as large paper plates, egg cartons, straws, margarine containers, tissue boxes, cardboard tubes, yoghurt containers, aluminium foil, string, wire, popsticks and cardboard boxes.

Lesson steps

1. Remind students of their annotated drawings from the previous session. Explain that teams will now make their designs.
2. Re-form teams and allocate roles. Ask Managers to collect team equipment.
3. Allow time for teams to make their design.

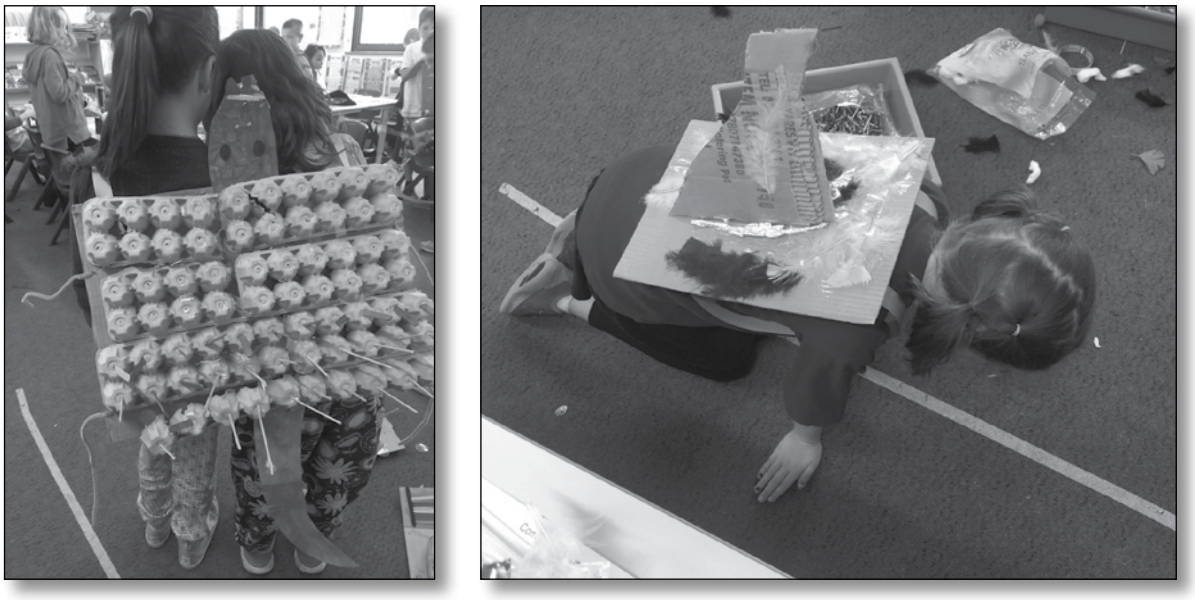
Making a 'Dino shield'

ELABORATE

4 Ask teams to present their shield and explain which dinosaur feature they used in their design. Ask teams questions such as:

- What dinosaur feature(s) did you use?
- How does your shield work?
- What materials did you use and why?
- Are there any improvements that would make your design work better?

Optional: Take photos of the teams' designs.



Work samples of completed shields

5 Review students' questions to see if any have been answered. Update the word wall with words and images.

Curriculum links

Science

- Explore features from wild animals that are used for protection or defence, including camouflage. See: https://animals.net/nine-awesome-defenses-animals-use-to-avoid-predators/

Lesson 7 Like a palaeontologist

AT A GLANCE

To provide opportunities for students to represent what they know about how living things have a variety of external features and live in different places where their needs are met, and to reflect on their learning during the unit.

Students:

- draw an annotated diagram of a prehistoric animal to show its features and habitat
- reflect on their learning.

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 a variety of external features
- living things live in different places where their needs are met.

Key lesson outcomes

Science

Students will be able to:

- describe some external features of a prehistoric animal and relate these to their use
- describe where prehistoric animals might live (air, land, water)
- describe a prehistoric plant and where it might live.

Literacy

Students will be able to:

- create an annotated drawing
- speak clearly to show their understanding and reflect on their experiences.

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

Equipment

FOR THE CLASS

- class science journal
- word wall

FOR EACH STUDENT

- science journal
- A4 sheet of paper

Preparation

- Prepare a page in the class science journal as follows:
  1. Draw a dinosaur.
  2. Add words and sentences about its features.
  3. Draw where it lives.
  4. Show what it eats.

Lesson steps

1 Review what the students have learned throughout the unit using the class science journal, students' models and the word wall. Discuss with students what they have learned about features of dinosaurs, what they ate and how they moved.

2 Discuss with students how palaeontologists are still finding out new things about dinosaurs all the time.

3 Explain that students are now going to create an annotated drawing of a dinosaur or another prehistoric animal using what they have learned during this unit. Discuss how it is a claim since we cannot be sure exactly what the dinosaur looked like. Review the purpose and features of an annotated drawing.

Note: For students that are not able to write, discuss their pictures with them to assess their science understanding.

Optional: Ask students to draw three prehistoric animals: one that lived on land, one that lived in the sea and one that lived in the air. Discuss how their different features enabled them to live in the different environments.

4 Introduce the prepared page in the class science journal. Read through and discuss how to complete the activity. Explain that students can choose to illustrate a dinosaur or another prehistoric animal.

5 Allow time for students to complete the activity. Encourage students to use their science journals, their drawings and diagrams and their investigation record to provide accurate information.

6 *Optional:* Collate the completed dinosaur drawings to make a class book, photocopying sheets of any students that want to keep their work. Read the book as a class and add it to the class reading area.

7 Review the 'Our questions about dinosaurs' to see if all questions have been answered.

8 Ask students to reflect on the unit. Ask questions such as:

- What was the most interesting thing that you learned about prehistoric animals?
- What are some things that palaeontologists say about prehistoric animals that you did not know before?
- What animal feature would you like to have? Why?
- Which activity helped you learn something new?
- Which activity did you like best?
- What are you still wondering about?

Appendix 1
How to organise collaborative learning teams (F–Year 2)

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 xiii.

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 experience working 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 F–Year 2, teams consist of two students: Manager and Speaker. (For Year 3–Year 6, teams consist of three students: Director, 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 coloured clothes 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
- Stay with your team
- Take turns.

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

TEAM SKILLS

1 Move into your teams quickly and quietly

2 Stay with your team

3 Take turns

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.

Maintaining a science journal aligns to descriptions in the Australian Curriculum: Science and English. See pages xi and xiii.

Using a science journal

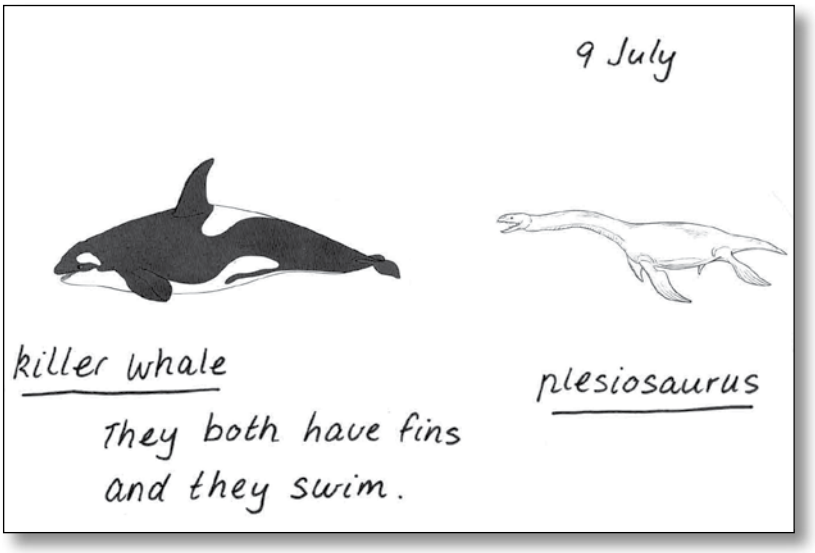
1. At the start of the year, or before starting a science unit, provide each student with a notebook or exercise book for their science journal or use an electronic format. Tailor the type of journal to fit the needs of your classroom. Explain to students that they will use their journals to keep a record 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.



Dinosaurs and more **science journal entry**

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.

Creating a class word wall, including words from different dialects and languages, aligns to descriptions in the Australian Curriculum: English. See page xiii.

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.

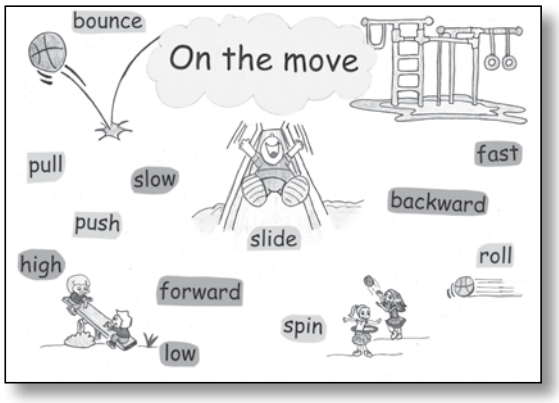
Word walls do not need to be confined to a wall. Use a portable wall, display screen, shower curtain or window curtain. Consider a cardboard shape that fits with the unit, for example, an apple for a needs unit.

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 unit about the external features of dinosaurs and modern day animals, might be arranged under the headings ‘Dinosaur features’ and ‘Modern day animal features’.

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

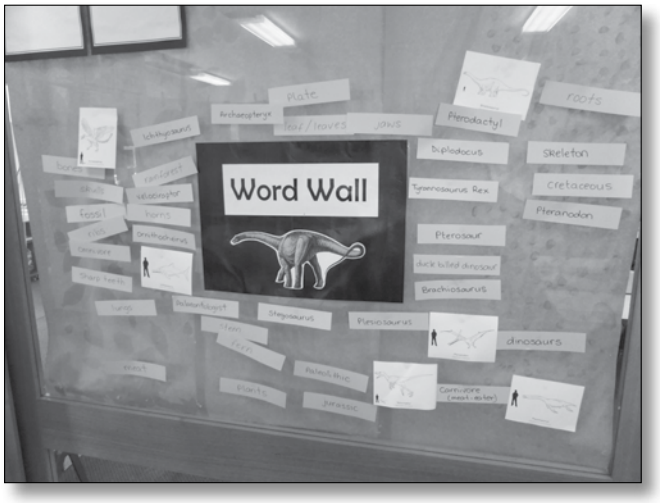
Weather in my world **word wall**



On the move **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.



Dinosaurs and more **word wall**

Appendix 4
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.

Question, 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, 'What type of food did the dinosaurs mostly eat?'

C The **claim**. For example, 'The dinosaurs with tearing teeth mostly ate meat'.

E The **evidence**. For example, 'Animals that eat meat, such as crocodiles and dogs, have tearing teeth. Dinosaurs with tearing teeth might have eaten meat too'.

R The **reasoning**. Saying how the evidence supports the claim. Not required at Year 1.

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 below) 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 video, *Elaborate*).

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?

DISCUSSION SKILLS

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

Appendix 5
Dinosaurs and more equipment list

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	3	3	4	5	6	6	7
		SESSION		1	2	1	2			1	2	
Equipment and materials												
A4 paper	1 per student											●
A4 thick cardboard sheet	1 per team										●	
Dino shield base	per class									●		
feathers, assorted colours	per class								●			
fern, living in a pot *optional*	per class							●				
image of a fossil skeleton	per class				●							
magnifying glass	1 per team							●				
materials to make shield	per class									●	●	
mirror, small	1 per team					●						
modelling clay or salt dough	per student								●			
model of human teeth, large *optional*	per class											
paint	per class					●			●			
piece of living fern with the soil removed from around its roots	per team							●				
quarter of an apple	1 per student					●						
x-ray image *optional*	per class				●							
Resource sheets												
‘Animal features’ (RS1)	1 per student				●							
‘Animal features’ (RS1), enlarged	1 per class			●	●							
‘Prehistoric animals’ (RS2), enlarged image	1 per student			●								
‘Prehistoric animals’ (RS2), enlarged	1 per class			●								
‘Animal skeletons’ (RS3)	1 per student				●							
‘Animal skeletons’ (RS3), enlarged	1 per class				●							
‘Which teeth?’ (RS4)	1 per student					●						
‘Which teeth?’ (RS4), enlarged	1 per class					●						
‘Modern teeth’ (RS5), enlarged	1 per class						●					

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	3	3	4	5	6	6	7
		SESSION		1	2	1	2			1	2	
'Mystery teeth' (RS6)	1 per student						●					
'Mystery teeth' (RS6), enlarged	1 per class						●					
'Two ferns' (RS7)	1 per student							●				
'Two ferns' (RS7), enlarged	1 per class							●				
'Fearless features' (RS8)	1 per student									●		
'Fearless features' (RS8), enlarged	1 per class									●		
'Dino shield' (RS9)	1 per student									●	●	
'Dino shield' (RS9), enlarged	1 per class									●		
Teaching tools												
class science journal	1 per class		●	●	●	●	●	●	●	●	●	●
role wristbands or badges for Manager and Speaker	1 per team			●	●	●	●	●		●	●	
student science journal	1 per student		●	●	●	●	●	●	●	●	●	●
team roles chart	1 per class			●	●	●	●	●		●	●	
team skills chart	1 per class			●	●	●	●	●		●	●	
word wall	1 per class		●	●	●	●	●	●	●	●	●	●
Multimedia												
collection of multimedia resources depicting different dinosaurs, *optional*										●		
digital camera *optional*											●	
images or videos of prehistoric environments								●				
scientific recording of dinosaurs roaring			●									
video on what dinosaurs looked like									●			
video clip 'battle between dinosaurs' *optional*										●		

Appendix 6
Dinosaurs and more 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** Hear it roar!	• discuss their existing ideas about the external features of animals • discuss their existing ideas about dinosaurs and where they lived.	• engage in conversations and discussions • create an annotated drawing • share and compare ideas with a partner.	• listen to a scientifically recreated recording of a dinosaur roar • draw and annotate what they think a dinosaur might have looked like and where it lived.	**Diagnostic assessment** • Science journal entries • Class discussions • Annotated drawing
EXPLORE	**Lesson 2** Legs, fins and wings ***Session 1*** Creature features ***Session 2*** Skeleton clues	• identify external features of animals • recognise the features of a dinosaur • identify where prehistoric animals lived according to their features • match an animal to its skeleton by identifying features.	• use a T-chart to sort animals • sort and match images • engage in conversations and discussions.	***Session 1*** Creature features • discuss features of modern animals • work in teams to identify the features of a prehistoric animal. ***Session 2*** Skeleton clues • match skeletons of modern animals with their images.	**Formative assessment** • Science journal entries • Class discussions • T-chart

*For information on how the lessons align with the relevant descriptions of the Australian Curriculum, see page xi for Science, page xiii for English and page xiv for Mathematics, and Technology and Design.

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students:	
EXPLORE	**Lesson 3** Open wide! ***Session 1*** Testing teeth ***Session 2*** Juxtaposing jaws	• identify which teeth are used for eating different types of food • compare teeth of different animals • make claims about what prehistoric animals ate based on their teeth.	• follow instructions to complete an investigation of their teeth • complete a table • engage in discussions and contribute ideas about what different animals ate based on their teeth.	***Session 1*** Testing teeth • observe and discuss own teeth types • eat food and observe which teeth are used to bite and chew. ***Session 2*** Juxtaposing jaws • explore images of the skeletons of animals' jaws with teeth • select food type that matches the animal's teeth.	**Formative assessment** • Science journal entries • Class discussions • 'Which teeth?' (Resource sheet 4) • 'Modern teeth' (Resource sheet 5) • 'Mystery teeth' (Resource sheet 6)
EXPLORE	**Lesson 4** Finding food	• locate and label the external features of a living and fossilised fern (stem, roots, leaves) • identify the basic needs of a fern • explain that ferns were one source of food for some prehistoric animals.	• create a labelled diagram • engage in and contribute to discussions about the features and needs of ferns.	• work in teams to explore the basic features of a fern • draw a labelled diagram of a fern • view environments in which ferns lived.	**Formative assessment** • Science journal entries • Class discussions • 'Two ferns' (Resource sheet 7)

*For information on how the lessons align with the relevant descriptions of the Australian Curriculum, see page xi for Science, page xiii for English and page xiv for Mathematics, and Technology and Design.

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students:	
EXPLAIN	**Lesson 5** Making models	• explain some external features of a dinosaur • explain recent scientific knowledge about the features of dinosaurs • describe how the dinosaur moved and where it lived (land, air or sea).	• make a model of a dinosaur • verbally present the features of their dinosaur model • contribute to discussions.	• make a model of a dinosaur • view a video and read a factual text on what scientists think dinosaurs looked like.	**Formative assessment** • Science journal entries • Class discussions
ELABORATE	**Lesson 6** Dinosaur defence ***Session 1*** Defensive designs ***Session 2*** Construction time	• generate and develop ideas to make a shield • make and appraise a shield using a dinosaur defence.	• create an annotated drawing of their ideas • present and describe the features of their shield.	***Session 1*** Defensive designs • plan and develop a drawing of a shield. ***Session 2*** Construction time • follow their drawing to construct a shield.	**Summative assessment** of Science Inquiry Skills • Science journal entries • Class discussions • Annotated drawing • Dino shield • 'Dino shield' (Resource sheet 9)

*For information on how the lessons align with the relevant descriptions of the Australian Curriculum, see page xi for Science, page xiii for English and page xiv for Mathematics, and Technology and Design.

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students:	
EVALUATE	**Lesson 7** Like a palaeontologist	• describe some external features of a prehistoric animal and relate these to their use • describe where prehistoric animals might live (air, land, water) • describe a prehistoric plant and where it might live.	• create an annotated drawing • speak clearly to show their understanding and reflect on their experiences.	• draw an annotated diagram of a prehistoric animal to show its features and habitat • reflect on their learning.	**Summative assessment** of Science Understanding • Science journal entries • Class discussions • Annotated drawing

*For information on how the lessons align with the relevant descriptions of the Australian Curriculum, see page xi for Science, page xiii for English and page xiv for Mathematics, and Technology and Design.

PrimaryConnections®
Linking science with literacy

PrimaryConnections Units

Year	Biological sciences	Chemical sciences	Earth and space sciences	Physical sciences
F	*Staying alive*	*That's my hat!*	*Weather in my world*	*On the move*
	Growing well	*What's it made of?*		
1	*Schoolyard safari*	*Spot the difference*	*Changes all around*	*Look! Listen!*
	Dinosaurs and more	*Bend it! Stretch it!*	*Up, down and all around*	
2	*Watch it grow!*	*All mixed up*	*Water works*	*Machine makers*
				Push-pull
3	*Feathers, fur or leaves?*	*Melting moments*	*Night and day*	*Heating up*
4	*Plants in action*	*Material world*	*Beneath our feet*	*Magnetic moves*
	Friends or foes?			
	Among the gum trees	*Package it better*		*Smooth moves*
5	*Desert survivors*	*What's the matter?*	*Earth's place in space*	*Light shows*
6	*Marvellous micro-organisms*	*Change detectives*	*Creators and destroyers*	*Circuits and switches*
	Rising salt		*Earthquake explorers*	*Essential energy*