Fantastic Features
(and where to find them)

FUTURE MAKERS TEACHER RESOURCE

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM | Queensland Government

Future Makers

Future Makers is an innovative partnership between Queensland Museum and Shell's QGC business aiming to increase awareness and understanding of the value of science, technology, engineering and maths (STEM) education and skills in Queensland.

This partnership aims to engage and inspire people with the wonder of science, and increase the participation and performance of students in STEM-related subjects and careers — creating a highly capable workforce for the future.

Cover image: The 'sea lion' woodcut illustration from Guillaume Rondelet's book, Libri de piscibus marinis (aka 'Summary of Marine Fishes'). This book, published in 1554, is the oldest book in Queensland Museum's collection. Queensland Museum.

Contents

Workshop Overview

Within this workshop, students explore the adaptations that assist the growth and survival of a range of organisms. Students make inferences about an unknown organism using only its structural features and a cell sample, investigate the adaptations that help Australian animals survive in their habitats and conduct scientific investigations to explore how the growth and survival of organisms are affected by the physical conditions of their environment.

Many of the animals and habitats highlighted within this workshop can be explored at the Queensland Museum, in the *Wild State* exhibition and the Discovery Centre. Queensland Museum has a legislated responsibility, as defined by the Queensland Museum Act 1970, to collect, research and promote Queensland's natural, cultural and technological heritage. Collections ranging in origin from just days ago to minerals over three billion years old provide temporal and spatial evidence of changes occurring in our natural and cultural environments.

This workshop has been structured using the 5E's instructional model. The following topics and concepts are explored in each aspect of the workshop:

ENGAGE	**Creature Features** Observe and make inferences about an unknown organism using its physical features and a cell sample.
EXPLORE EXPLAIN	**Staying Alive: Australian Animal Adaptations** Investigate how adaptations support the survival of Australian animals in different habitats, including arid outback, open forest, rainforest, coastal intertidal and marine habitats.
EXPLORE EXPLAIN	**Queensland Museum: Researching Living Things** Learn about the work of Dr Sue-Ann Watson, Senior Curator of Marine Invertebrates at the Museum of Tropical Queensland.
EXPLORE EXPLAIN ELABORATE	**Camouflage Capers** Investigate camouflage and model the effect of colour on the survival of organisms in different habitats.
ELABORATE EVALUATE	**Cameras in Disguise** Design a camouflaged camera that can be used to record footage of a native Australian animal.
ELABORATE EVALUATE	**Survival in Extreme Environments** Explore the adaptations that allow animals to survive in extreme environments. Plan and conduct a scientific investigation to answer the question/s: • Which animal will stay the coolest in a hot environment? • Which animal will stay the warmest in a cold environment?
EXPLORE EXPLAIN ELABORATE	**Breaking Down Digestion: Gut Content Analysis** Explore and analyse the replicated gut contents of five animals. Determine which animals are likely to have ingested the observed materials. Investigate and model the digestive system of one of these animals.
EXPLAIN ELABORATE EVALUATE	**Specialised Stinging Cells** Explore the specialised cells that give jellyfish a powerful sting.

ENGAGE

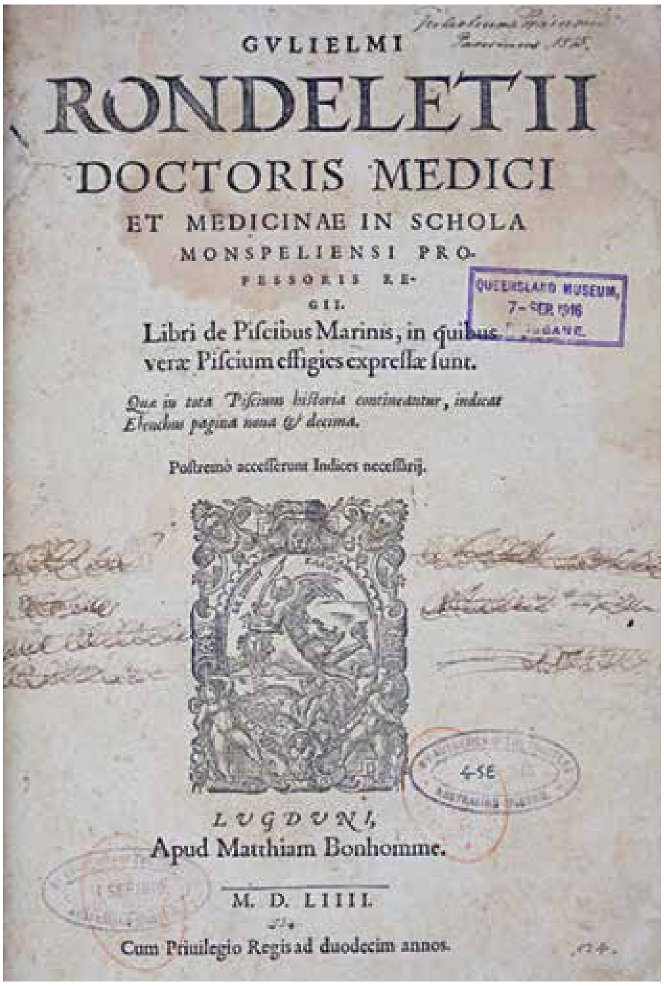
Creature Features

Teacher Resource

This activity is designed to explore and build on students' prior knowledge of adaptations.

In this activity, students observe an image of an unknown organism. Students identify what the organism might be and annotate a diagram to communicate ideas about the organism. Following this, Year 5 students examine the features of the organism to make and record inferences about its habitat, movement, diet and predators. Meanwhile, Year 8 students analyse a cell sample taken from the organism and use the cell sample to draw conclusions about the organism.

The images used in this activity are taken from the oldest book in Queensland Museum's collection, *Libri de piscibus marinis* (aka 'Summary of Marine Fishes') by Guillaume Rondelet. The book, published in France in 1554, is one of the earliest known undertakings in modern ichthyology to scientifically describe fish using the physical specimen – common practice now, but ground-breaking at the time.


GVLIELMI
RONDELETII
DOCTORIS MEDICI
ET MEDICINAE IN SCHOLA
MONSPELIENSI PRO-
FESSORIS RE-
GII.
Libri de Piſcibus Marinis, in quibus
veræ Piſcium effigies expreſſæ ſunt.
Quæ in tota Piſcium hiſtoria continentur, indicat Elenchus pagina nona & decima.
Poſtremò acceſſerunt Indices neceſſarij.
QUEENSLAND MUSEUM, 7-SEP 1916
LVGDVNI,
Apud Matthiam Bonhomme.
M. D. LIIII.
Cum Priuilegio Regis ad duodecim annos.

Title page of Guillaume Rondelet's, Libri de piscibus marinis, published in Lyon, France in 1554. Queensland Museum.

Rondelet chose to include two bizarre 'flights of fancy' in his book, the Sea Lion and Sea Bishop (both used in this activity), suggesting that he might have had a wicked sense of humour! You can learn more about Rondelet's book online at Queensland Museum's Google Arts and Culture page and the Queensland Museum blog.

To conclude the activity, Year 5 students could write an information report about the organism, while Year 8 students could construct a timeline of Rondelet's life. In the timeline, students identify Rondelet's scientific achievements and the ways in which these influenced the development of scientific knowledge, understanding and practice.

Curriculum Links (Version 8.4)

Science

YEAR 5

Science Understanding

Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)

Science Inquiry Skills

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)

YEAR 8

Science Understanding

Cells are the basic units of living things; they have specialised structures and functions (ACSSU149)

Science as a Human Endeavour

Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available (ACSHE134)

Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures (ACSHE226)

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity (ACSHE136)

Science Inquiry Skills

Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge (ACSIS139)

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS145)

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS148)

English

YEAR 5

Language

Understand how texts vary in purpose, structure and topic as well as the degree of formality (ACELA1504)

Literacy

Plan, draft and publish imaginative, informative and persuasive print and multimodal texts, choosing text structures, language features, images and sound appropriate to purpose and audience (ACELY1704)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewing

Composing texts through speaking, writing and creating

Text knowledge

Information and Communication Technology

Investigating with ICT

Managing and operating ICT

Critical and Creative Thinking

Generating ideas, possibilities and actions

Creature Features

Student Activity

Year 5 Investigation

Take a moment to observe the mysterious living thing below.

Living Thing Analysis

What type of living thing might this be? Could it be a plant, an animal or something else? Explain your response.

Annotate the image of the living thing. Label its physical features. Consider skin covering, limb type, mouthparts and other notable features.

Evidence and Adaptations

Living things have features and behaviours that help them survive in their environment. We call these adaptations.

Look at the features of your living thing to answer the following questions:

Living Thing		Prediction	Evidence
Habitat	What type of environment might it live in?		
Movement	How might it move?		
Diet	What might it eat? How might it catch its food?		
Predators	How might it stop and/or avoid predators?		

List two questions you have about the living thing.

1.

2.

Information Report

Write an information report about the living thing. Remember to include an introduction, description and conclusion. In your description, you could write about the living thing's classification, appearance, habitat, behaviour, food, life cycle and any other interesting facts.

Creature Features

Student Activity

Year 8 Investigation

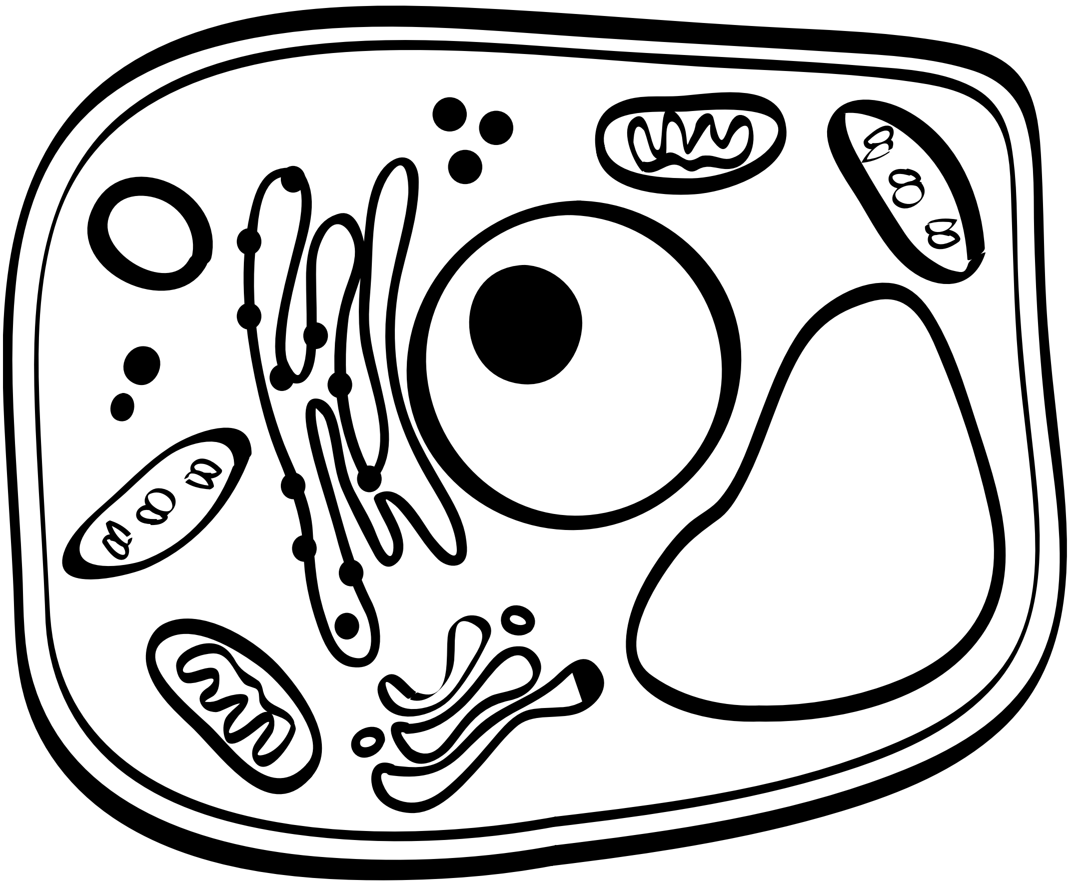
Take a moment to observe the mysterious organism below.

Make an inference. What type of organism is this? Is it a plant, an animal or something else entirely? Justify your response below.

Annotate the image of the organism. Label its physical features. Consider skin covering, limb type, mouthparts and other notable features.

Further Information

Scientists were able to take a cell sample from the organism. Examine the cell sample. Label the organelles within the cell and describe their structure and function in the table on the next page.



Organelle	Structure	Function

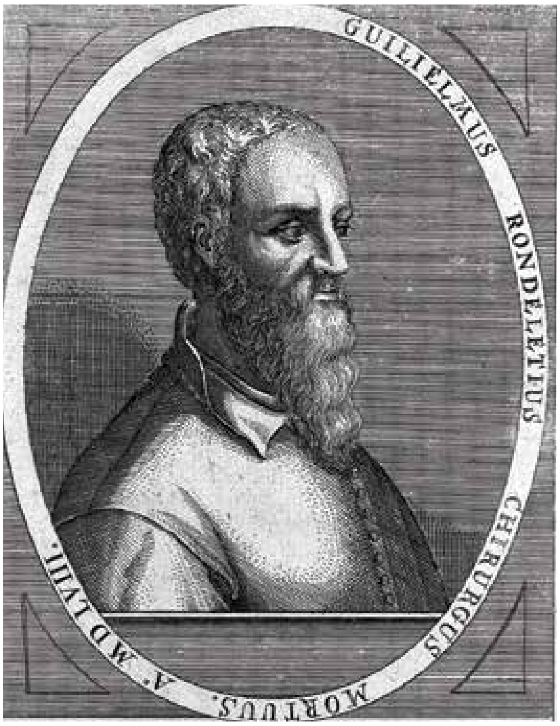
Explain what the cell sample reveals about the organism and how this evidence supports or refutes your original inference.

Use this evidence to hypothesise how the organism is likely to survive and reproduce.

Timeline: Guillaume Rondelet

The image you analysed is from the oldest book in Queensland Museum's collection, *Libri de piscibus marinis* (aka 'Summary of Marine Fishes') by Guillaume Rondelet, published in 1554. Although a scientific text, Rondelet chose to include two bizarre creatures of his own creation: the Sea Lion and Sea Bishop. You can view excerpts of this book in an online exhibition curated by Queensland Museum.

Rondelet was a French naturalist and physician, and his practices significantly impacted the scientific community at the time. Research Rondelet and construct a timeline of his life. In the timeline, list Rondelet's scientific achievements and comment on how these influenced the development of scientific knowledge, understanding and practice. Attach additional pages, if needed.



Image, right: Portrait of Guillaume Rondelet, 1566.

Year	Event

EXPLORE - EXPLAIN

Staying Alive: Australian Animal Adaptations

Teacher Resource

In this activity, students investigate how adaptations support survival in specific habitats. They consider the living and non-living (biotic and abiotic) conditions of five Queensland habitats and suggest general adaptations that would assist survival in these locations. Students then work in small groups to explore two animals from one habitat. They identify, analyse and compare the adaptations that help these animals survive in the habitat, linking form and function, before sharing their learnings with the class group.

The habitats and animals featured within this activity can be explored further in *Wild State* at the Queensland Museum. Queensland is the most biodiverse state of Australia; it is home to 70% of Australia's mammal species, 80% of bird species and 50% of reptile, frog and plant species. Such a diversity of animals exists because Queensland has a broad range of environmental conditions that produce unique habitats in which these animals can live. *Wild State* highlights Queensland's amazing array of habitats, including arid outback, open forest, rainforest, coastal and intertidal and marine, and unpacks why the state has such a huge diversity of animals. Further information about the exhibition can be found in the *Wild State* Teacher Resource.

Wild State exhibition at Queensland Museum. QM, Peter Waddington.

To extend or further support learning about adaptations, you and your students could view the Museum Experts Videos series. In this series, past and present Queensland Museum scientists discuss the structural, physiological and behavioural adaptations of some of our amazing wildlife, including: Bee Flies, Carpet Pythons, marine mammals, swimming crabs, Tortoise Beetles and Velvetfish.

Detailed step-by-step instructions for this activity can be seen below. It is recommended that you use these instructions to guide your students through the activity.

1. Inform students that Queensland is Australia's most biodiverse state. In other words, Queensland contains the greatest variety of living things in the country. Queensland has:
   - 70% of Australia's mammal species
   - 80% of Australia's bird species
   - 50% of Australia's reptile, frog and plant species

   These species live in five unique habitats across Queensland: arid outback, open forest, rainforest, coastal and intertidal and marine. Remind students that a habitat is the natural home or environment of an animal, plant or other organism. Explore students' prior knowledge and experiences of these habitats through a class discussion.

2. Divide students into groups of three or four. Ask student groups to choose a habitat from the following list:
   - Arid outback
   - Open forest
   - Rainforest
   - Coastal intertidal
   - Marine

   Distribute the related habitat image to student groups (see *Teacher Resource: Habitat Images*). Students work in groups to identify the living and non-living factors of the habitat, the challenges animals might experience living in the habitat and the features or adaptations that would help an animal survive in the habitat (see *Student Activity: Exploring Habitats*). Student groups then share their responses with the class.

3. Distribute the following animal images to student groups (see *Teacher Resource: Animal Images*). Student groups should receive the animal that lives in their chosen habitat:
   - Arid outback: Greater Bilby (*Macrotis lagotis*)
   - Open forest: Eastern Grey Kangaroo (*Macropus giganteus*)
   - Rainforest: Southern Cassowary (*Casuarius casuarius*)
   - Coastal intertidal: Saltwater Crocodile (*Crocodylus porosus*)
   - Marine: Green Sea Turtle (*Chelonia mydas*)

   We recommend printing the animals to A3 to assist in viewing and labelling. Inform students that these animals live in the students' chosen habitats. Ask students to observe the animal, and to identify any features they think would assist its survival in the habitat. Students could record these features in their workbooks; they should also justify their responses.

4. Distribute relevant adaptation lists to student groups (see *Teacher Resource: Animal Adaptations*). Provide time for students to read and discuss the adaptations. You could also ask students to respond to the following questions: Which adaptations do you already know about and which are new to you? Are there any adaptations that surprised you? Why did they surprise you? Ask students to cut out the adaptations.

5. Inform students that animals can have three different types of adaptations. Organisms can have structural adaptations. These are the physical features of an animal's body that help it to survive in its environment. Ask students to find an example of a structural adaptation in their list of adaptations. Students share their examples with the class.

   Organisms can also have behavioural adaptations. These are something an organism does in response to a change in its environment. Provide students with examples of behavioural adaptations, if required. Ask students to find an example of a behavioural adaptation in their list of adaptations. Students share their examples with the class.

   Finally, organisms can have physiological adaptations. These are the internal features of an organism that help it to survive in its environment. We cannot see these adaptations when looking at the organism, because they occur inside the organism. Provide students with examples of physiological adaptations, if required. Ask students to find an example of a physiological adaptation in their list of adaptations. Students share their examples with the class.

6. Ask students to sort the adaptations of their animal into these three types. Ask students to let you know when they have finished, so that you can check their work. Students then colour code the adaptations using three different colours, and then glue the adaptations on the animal sheet, making sure to place the adaptation near the appropriate feature. Students draw in label lines using a pencil and a ruler.

7. Inform student groups that they will now research the adaptations that help a second, different animal survive in the same habitat (see *Student Activity: Comparing Adaptations*). Provide students with time to complete the research task. Students may find more search results by broadening their search terms, i.e. by searching 'shearwater adaptations' in addition to 'wedge-tailed shearwater adaptations'.

   To conclude the research task, students use a Venn diagram to compare and contrast the adaptations of the two animals. They then suggest why these animals might have different adaptations, even though they live in the same habitat. This discussion could occur in small groups and then as a class group to ensure misconceptions are not developed. You may like to discuss how different animals have different predators and different prey or how they may live in different parts of the same habitat (i.e. in the water or on land). Animals will therefore develop different features that respond to these requirements, in order to help them survive. You could also discuss how adaptations to specific habitats develop over a very, very long period of time. Over the course of time, animals may develop different solutions to the same problem – similar to students who are provided with the same brief to a design challenge, and yet many develop different designed solutions.

8. Student groups could share their findings from the activity with the class group or in a jigsaw group. They could also display their findings in the classroom for others to view.

Curriculum Links (Version 8.4)

Science

YEAR 5

Science Understanding

Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)

Science Inquiry Skills

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewing

Composing texts through speaking, writing and creating

Information and Communication Technology

Investigating with ICT

Critical and Creative Thinking

Inquiring – identifying, exploring and organising information and ideas

Personal and Social Capability

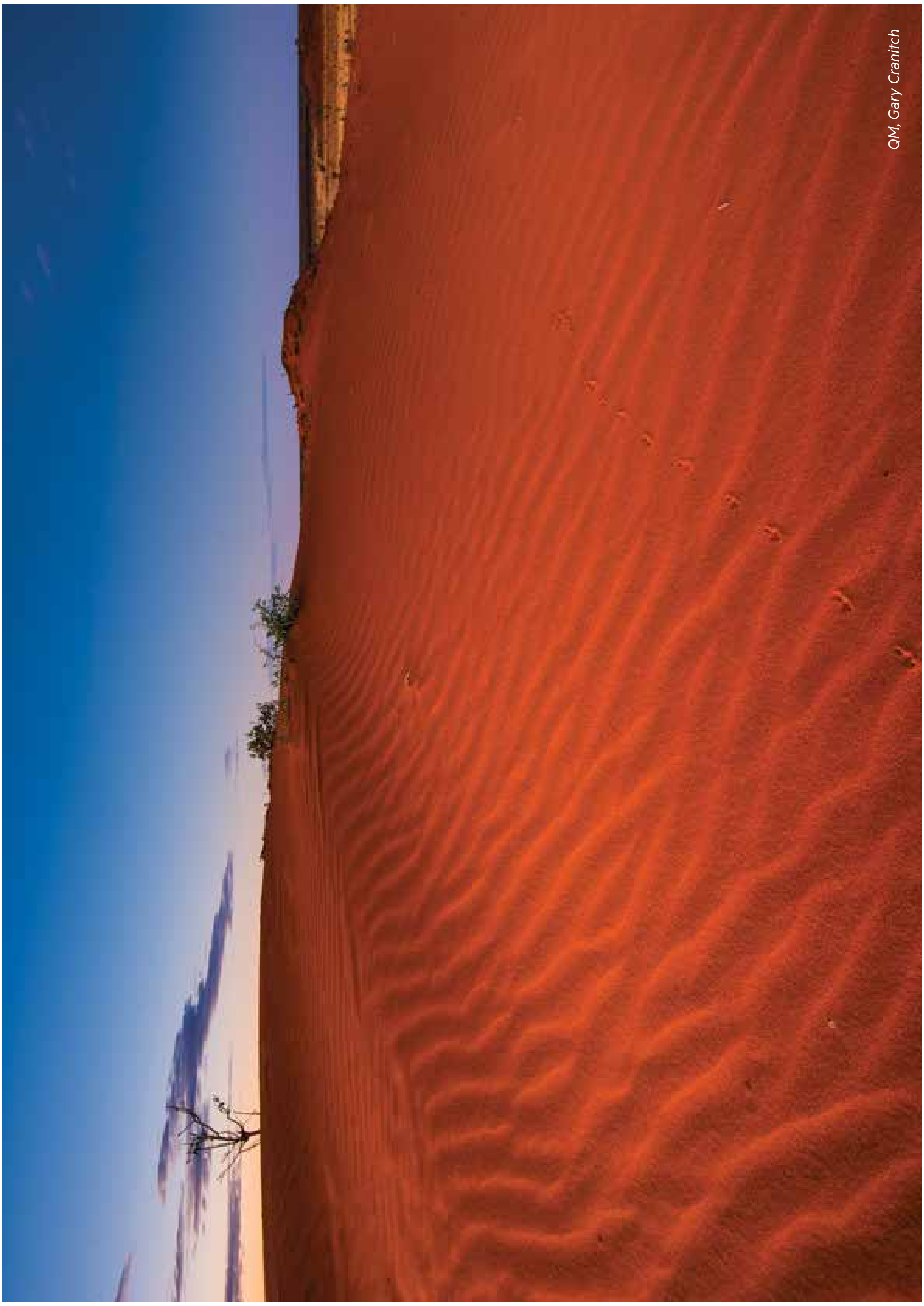
Social Management

Staying Alive: Australian Animal Adaptations

Teacher Resource

Habitat Images

Arid Outback



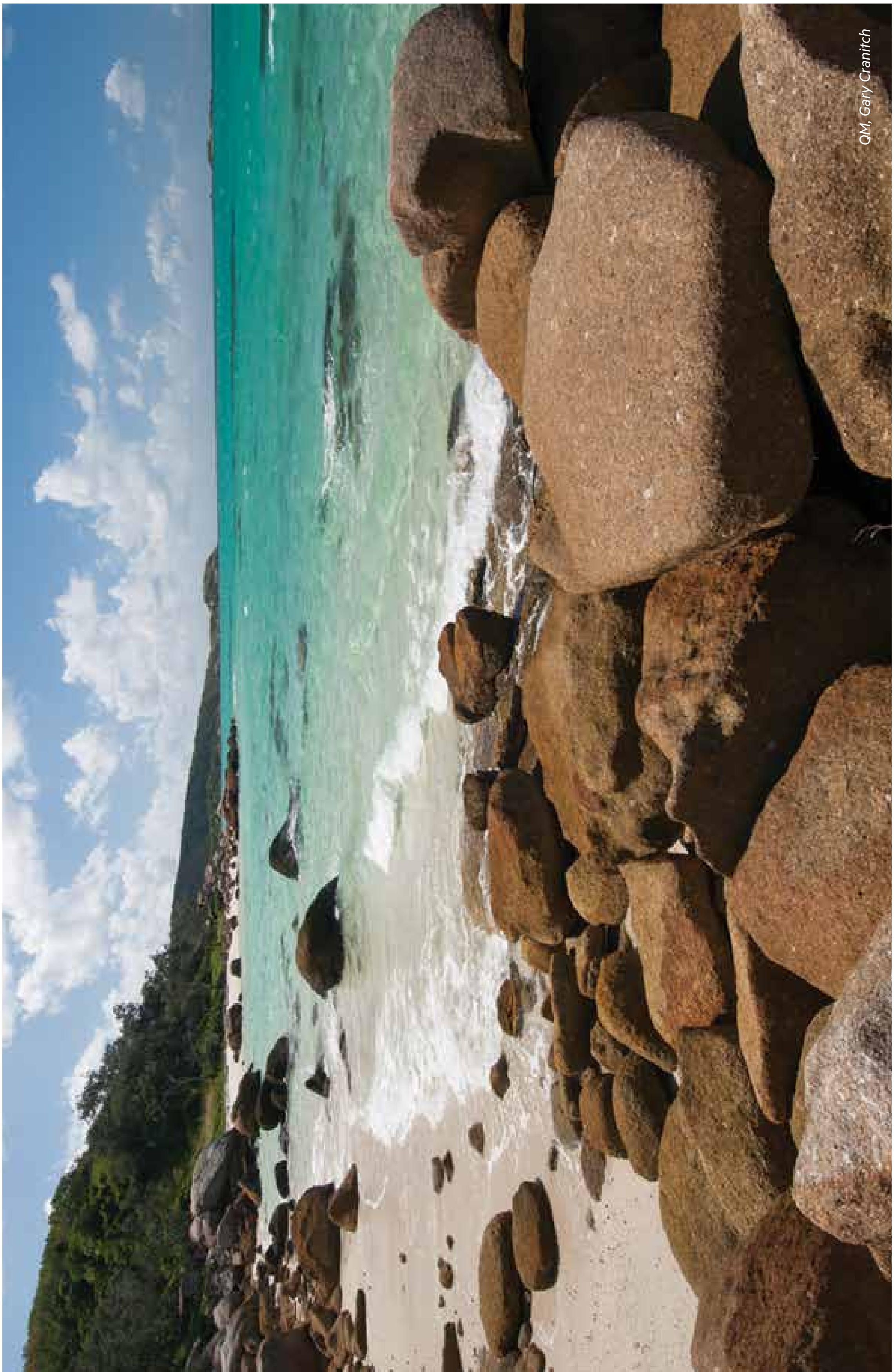
QM, Gary Cranitch

Open Forest

Rainforest


QM, Gary Cranitch

Coastal Intertidal



QM, Gary Cranitch

Marine

QM, Gary Cranitch

Staying Alive: Australian Animal Adaptations

Teacher Resource

Animal Images

Greater Bilby *(Macrotis lagotis)*

Eastern Grey Kangaroo *(Macropus giganteus)*

Southern Cassowary (*Casuarius casuarius*)

Saltwater Crocodile *(Crocodylus porosus)*

Green Sea Turtle (Chelonia mydas)

Staying Alive: Australian Animal Adaptations

Teacher Resource

Animal Adaptations

Greater Bilby *(Macrotis lagotis)*

Sleeps in a deep burrow during the day to avoid the heat.	Produces concentrated urine to reduce water loss.	Large, thin ears to release heat.
Powerful forelimbs and claws for digging burrows and finding food.	Keen sense of smell to detect predators and prey.	Female pouch opens backwards so that it doesn't fill with dirt when digging.
Long, sticky tongue to lick up seeds and small insects from the ground.	Does not need to drink water, as they obtain enough moisture from their food.	Keen sense of hearing to detect predators and prey.

Eastern Grey Kangaroo *(Macropus giganteus)*

Large, powerful tendons in the hind legs act like springs to move the animal at fast speeds with minimum effort.	Long, muscular tail used for balance when hopping and to provide stability while fighting upright.	Light grey fur to blend into its habitat.
Feeds from dusk until dawn when food is most abundant.	The nutrients in a female kangaroo's milk change depending on the nutritional requirements of the joey.	Spends time under shady trees during the day to avoid heat.
Adult males 'spar' to establish dominance.	Licks forearms to cool down.	Stomach is divided into two parts. The first part ferments the food to release nutrients. The second part breaks down the food to complete digestion.

Southern Cassowary *(Casuarius casuarius)*

Black feathers to blend into the dark rainforest habitat.	The helmet, or casque, on top of its head may help to keep the cassowary cool.	The inside toe has a large, dagger shaped claw used to fight other cassowaries.
A specialised digestive system lets the bird eat toxic fruits and seeds.	Stretches tall, ruffles its feathers and makes a loud hissing sound to scare off intruders.	Tough skin to protect from fights with other cassowaries.
Males have bright blue skin and a red, fleshy wattle (seen under the neck) to attract females.	Long, sharp claws to scratch leaf litter for food.	Males teach their chicks which foods to eat and which to avoid.

Saltwater Crocodile *(Crocodylus porosus)*

Brown skin to blend into its habitat.	Nostrils, eyes and ears are along the top of the head so the animal can smell, breathe, hear and see while the rest of its body is underwater.	When underwater, small flaps of skin cover the ears to make them watertight.
Powerful jaws to hold onto and crush prey.	Hatchlings ‘chirp’ to gain the attention of their mother.	Reduces heart rate to stay underwater for long periods of time.
A special transparent eyelid closes over the crocodile’s eye for protection when underwater.	Strong, muscular tail to help make sudden lunges from the water to catch prey.	Excellent hearing to locate prey in poor light or low visibility conditions.

Green Sea Turtle *(Chelonia mydas)*

Two long, muscular front flippers to propel through the water.	Finely serrated jaws to help eat vegetation.	Reduces heart rate to stay underwater for long periods of time.
Has salt glands to get rid of excess salt in the body. These empty from the eyes.	Counter-shaded (the top shell is dark while the bottom shell is light) to blend into its habitat.	The shell provides protection from predators.
Uses the Earth's magnetic field to navigate the oceans.	Females lay many eggs (as many as 575 in a breeding season) to help ensure the survival of some offspring.	Two short rear flippers act like rudders to help steer through the water.

Staying Alive: Australian Animal Adaptations

Student Activity

Exploring Habitats

Select a habitat to investigate. Use the image provided by your teacher to think about the:

- Living (biotic) and non-living (abiotic) factors of the habitat
- Challenges animals might experience living in the habitat
- Features or adaptations that would help animals survive in the habitat

Record your thoughts and ideas in the mind map below.

Living Factors:	**Non-Living Factors:**
Habitat:	
Challenges:	**Adaptations:**

Staying Alive: Australian Animal Adaptations

Student Activity

Comparing Adaptations

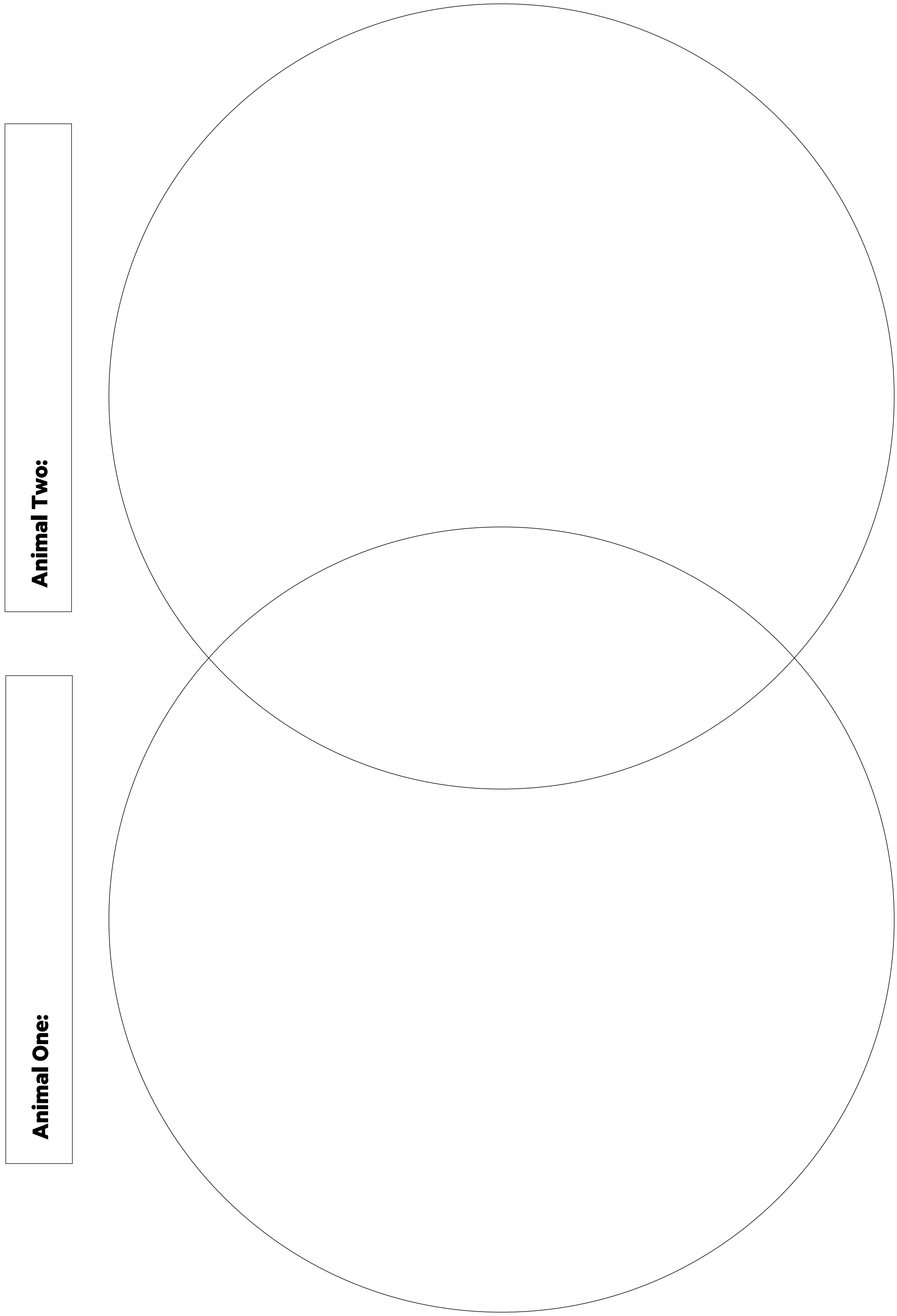
You will now research the adaptations of a second animal that lives in the same habitat. Select your animal from the list below, and then identify the structural, behavioural and physiological adaptations that help the animal survive in its habitat.

Arid Outback:	Thorny Devil (*Moloch horridus*)
Open Forest:	Sugar Gilder (*Petaurus breviceps*)
Rainforest:	Lumholtz's Tree Kangaroo (*Dendrolagus lumholtzi*)
Coastal Intertidal:	Wedge-tailed Shearwater (*Ardenna pacifica*)
Marine:	Gulf Wobbegong Shark (*Orectolobus halei*)

Animal Image:

Structural Adaptations	**Behavioural Adaptations**	**Physiological Adaptations**

Compare the adaptations of the two animals you have investigated.



Suggest why these animals might have different adaptations, even though they live in the same habitat.

EXPLAIN - ELABORATE

Queensland Museum: Researching Living Things

Teacher Resource

Queensland Museum has a responsibility to collect, research and promote Queensland's natural, cultural and technological heritage. Our collections provide evidence of changes occurring in our natural and cultural environments.

Dr Sue-Ann Watson is the Senior Curator of Marine Invertebrates at the Museum of Tropical Queensland, Townsville. In this activity, students learn about life working in a museum, the organisms Sue-Ann researches and some of the fascinating adaptations that help these organisms survive and thrive in their environments.

Curriculum Links (Version 8.4)

Science

YEAR 5

Science Understanding

Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)

Science as a Human Endeavour

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE081)

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)

Science Inquiry Skills

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)

YEAR 8

Science as a Human Endeavour

Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available (ACSHE134)

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity (ACSHE136)

Science Inquiry Skills

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS148)

Queensland Museum: Researching Living Things

Student Activity

Scientists at Queensland Museum have been studying Queensland's unique biodiversity for over 150 years. Dr Sue-Ann Watson is the Senior Curator of Marine Invertebrates at the Museum of Tropical Queensland (MTQ), Townsville. Learn more about life working in a museum, the organisms Sue-Ann researches and some of the fascinating adaptations that help these organisms survive and thrive in their environments.

A Chat with Dr Sue-Ann Watson, Senior Curator of Marine Invertebrates, MTQ

Dr Sue-Ann Watson, observing a sea star from MTQ's collection.

- **How did you become interested in your field of study?**

  I loved being in, on or near the ocean as a kid. Growing up near London in England, we didn't live close to the ocean, so going there was a real treat on summer holidays. I also loved animals, art and natural sciences, as well as learning new things. I liked going for walks in the countryside, to the zoo or aquariums and poking in rock pools and rivers. I made ponds in the back garden with fish and frogs and kept fish, rabbits and guinea pigs as pets. I would've had a lot more animals if I'd been allowed.

- **What do you enjoy most about your work?**

  Going to interesting places is definitely the highlight of my work. As scientists, we tend to travel internationally for work. I'm lucky to have travelled to all seven continents, including Antarctica. In the summer, Antarctica is light 24 hours a day, so it's possible to go skiing late in the evening and then get up to go SCUBA diving in the morning. It's actually hard to remember to go to bed sometimes, because it doesn't get dark.

  I also enjoy doing fieldwork (where I get to conduct research outdoors). Marine biologists usually love getting in the water. I snorkel or SCUBA dive to make observations or collect animals for experiments in the aquarium or to study in the laboratory. It's great to be able to get out on the ocean, in a boat and under the water.

Sue-Ann working in one of her offices – the ocean!

I also come across interesting things while working in the museum. For example, we have hundreds of specimens awaiting description in our wet collection room – each will eventually become a new species. Most of these are marine invertebrates – animals without backbones. There are potentially tens of thousands of new species of marine invertebrates to be discovered, especially in highly diverse tropical areas and less explored areas such as the deep sea.

- **Describe some of the living things you are currently researching.**

  Marine invertebrates are incredibly diverse. I work on molluscs (e.g. snails, clams, squid), echinoderms (e.g. sea urchins, sea cucumbers, sea stars), crustaceans (e.g. hermit crabs) and brachiopods (also known as lampshells). I have also worked on projects about sharks, fish, corals and seawater chemistry.

  One of the groups I work on are giant clams. There are 12 species of giant clam. The true giant clam is the largest shelled animal in the world, reaching 1.3 m in length and 250 kg in mass. This species may live to be 100 years old. In some areas of the Indo-Pacific region, giant clams are harvested for their meat and shells. This has led to giant clams becoming threatened, and some species are vulnerable to extinction.

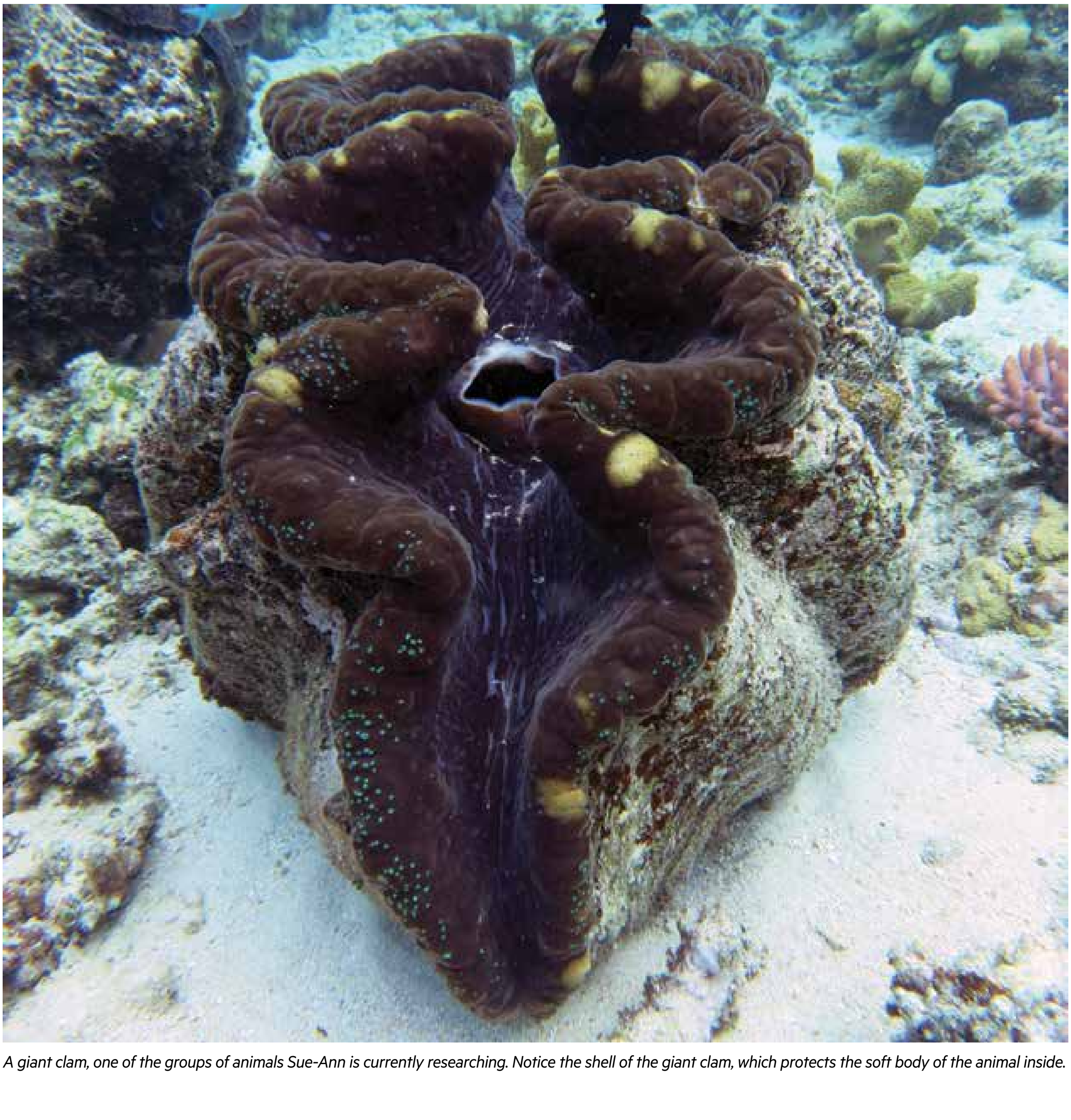
  I also work on pygmy squid. These are the world's smallest squid and are only about 1 cm long. These charismatic little critters can be found in the waters around Townsville.

- **Why did you decide to research these living things?**

  I thought about researching larger marine animals like birds or whales, but there isn't much hands-on work with these animals. In contrast, marine invertebrates are usually easy to collect, observe in the field and use for aquarium experiments. This allows me to ask scientific research questions and find answers by directly observing and studying the animals.

- **What scientific processes are involved in the research of these living things?**

  Most scientific research is question-driven. For example, as a scientist, I wondered why animals have particular adaptations and how they might fare with climate change. I then set about to answer those questions. I conducted fieldwork (which included underwater observations and collections, as well as experiments in a research aquarium) and analysis in a laboratory. I collected lots of data on special waterproof paper and video-recorded the experiments. Then I spent many days in the office doing computer work – recording data from the videos and then analysing the data using computer programs. After this, I spent several weeks writing up this information in a scientific paper called a journal article.



A giant clam, one of the groups of animals Sue-Ann is currently researching. Notice the shell of the giant clam, which protects the soft body of the animal inside.

I love my job because I get to discover new things about marine animals. Being the first person to discover something is really exciting. Although big discoveries don't happen all the time, I do get to contribute to new knowledge everyday by analysing data and writing scientific journal articles.

- **What adaptations do these living things have to help them survive in their environments?**

  Marine invertebrates have many interesting ways to cope with life in the oceans.

  One of my main study groups are molluscs. Gastropod (snail) and bivalve (clam) molluscs have shells, and these shells are a structural adaptation that protects the soft body of the animal inside.

  The humpbacked conch (or jumping snail) is another interesting animal we have on the Great Barrier Reef. These animals have a behavioural and structural adaptation that allows them to 'jump' away from cone snails to avoid these dangerous predators. You can see the snail and their jumping adaptation in action in this story about our research: https://www.youtube.com/watch?v=VAE3rN-1i-o.

  However, I've found that ocean acidification alters the behaviour of the jumping snail, making them less likely to avoid their predators; this is not good for the survival of the jumping snail.

A humpbacked conch (or jumping snail), jumping away from its predator – the cone snail.

- **What do you hope to achieve from this research?**

  By discovering patterns in marine animals across the globe and how they will cope with changing ocean conditions, we can start to predict how groups of marine animals will respond to climate change. We can then use this information to inform other people about what is happening and influence decisions around climate change solutions.

- **What would you recommend for students who would like to work in a similar field?**

  I didn't plan to be exactly where I am now, but I chose to do things that I enjoyed and that didn't feel like work to me. I think this is very important. Also make sure you gain experience, paid or voluntary, in jobs that interest you.

Imagine you are a scientist working at Queensland Museum. What animal would you most like to study and why?

EXPLORE - EXPLAIN - ELABORATE

Camouflage Capers

Teacher Resource

In this activity, students investigate camouflage and model the effect of colour on the survival of organisms. Year 5 students explore the effects of camouflage on predation, while Year 6 students explore the impact of changing environments on camouflaged organisms.

To introduce, extend or further support learning about camouflage, you and your students could visit *Wild State* at the Queensland Museum. Here, students could work in small groups to tally the colours of animals found in the various habitats of Queensland. Students could represent the data in tables and graphs, identify patterns in the data and then develop explanations for these patterns. If you would like to visit the Queensland Museum with your class, please visit the Schools & Groups page to plan, book and prepare for your visit. Bookings are essential for all schools and groups.

Detailed step-by-step instructions for this activity can be seen below. It is recommended that you use these instructions to guide your students through the activity.

1. Print and display the five camouflage images, either at different corners of the classroom or along a wall (see *Teacher Resource: Camouflage Images*). Divide students into five groups. Ask the student groups to stand three to four metres away from one image (or at a greater distance, if space permits). Ask students to observe the image and to describe what they can see in the image with their groups. Then, ask students to take one large step towards their images. Repeat the previous questioning of students. Ask students to continue to take one large step towards their images until they can spot something interesting or unusual about the image (i.e. the camouflaged animal).

2. Ask student groups to share what they saw in their image and when they noticed the animal in the image (i.e. how many centimetres/metres from the image). Inform students that animals use colour in various ways; some animals use colour to blend into their environment. Ask students if they know the scientific word used to describe this ability (camouflage). Ask students to identify this type of adaptation (structural) and to discuss how camouflage can assist survival. Inform students that they will explore how camouflage can assist survival in a scientific investigation.

3. Complete the scientific investigation with students. Year 5 students focus on the importance of camouflage for predators (see *Student Activity: Year 5 Scientific Investigation*). Year 6 students focus on how changing environments may affect the success of camouflage as a physical adaptation (see *Student Activity: Year 6 Scientific Investigation*).

4. Review students' findings and evaluate the investigation.

Curriculum Links (Version 8.4)

Science

YEAR 5

Science Understanding

Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)

Science Inquiry Skills

With guidance, pose clarifying questions and make predictions about scientific investigations (ACSIS231)

Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS086)

Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS087)

Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS090)

Compare data with predictions and use as evidence in developing explanations (ACSIS218)

Reflect on and suggest improvements to scientific investigations (ACSIS091)

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)

YEAR 6

Science Understanding

The growth and survival of living things are affected by physical conditions of their environment (ACSSU094)

Science as a Human Endeavour

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE098)

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE100)

Science Inquiry Skills

With guidance, pose clarifying questions and make predictions about scientific investigations (ACSIS232)

Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS103)

Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS104)

Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS107)

Compare data with predictions and use as evidence in developing explanations (ACSIS221)

Reflect on and suggest improvements to scientific investigations (ACSIS108)

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS110)

Mathematics

YEAR 5

Number and Algebra

Identify and describe factors and multiples of whole numbers and use them to solve problems (ACMNA098)

Use estimation and rounding to check the reasonableness of answers to calculations (ACMNA099)

Solve problems involving division by a one digit number, including those that result in a remainder (ACMNA101)

Use efficient mental and written strategies and apply appropriate digital technologies to solve problems (ACMNA291)

Recognise that the place value system can be extended beyond hundredths (ACMNA104)

Compare, order and represent decimals (ACMNA105)

Measurement and Geometry

Connect decimal representations to the metric system (ACMMG135)

Convert between common metric units of length, mass and capacity (ACMMG136)

General Capabilities

Literacy

Comprehend texts through listening, reading and viewing

Composing texts through speaking, writing and creating

Numeracy

Estimating and calculating with whole numbers

Using fractions, decimals, percentages, ratios and rates

Interpreting statistical information

Critical and Creative Thinking

Inquiring – identifying, exploring and organising information and ideas

Analysing, synthesising and evaluating reasoning and procedures

Personal and Social Capability

Social management

Camouflage Capers

Teacher Resource

Camouflage Images

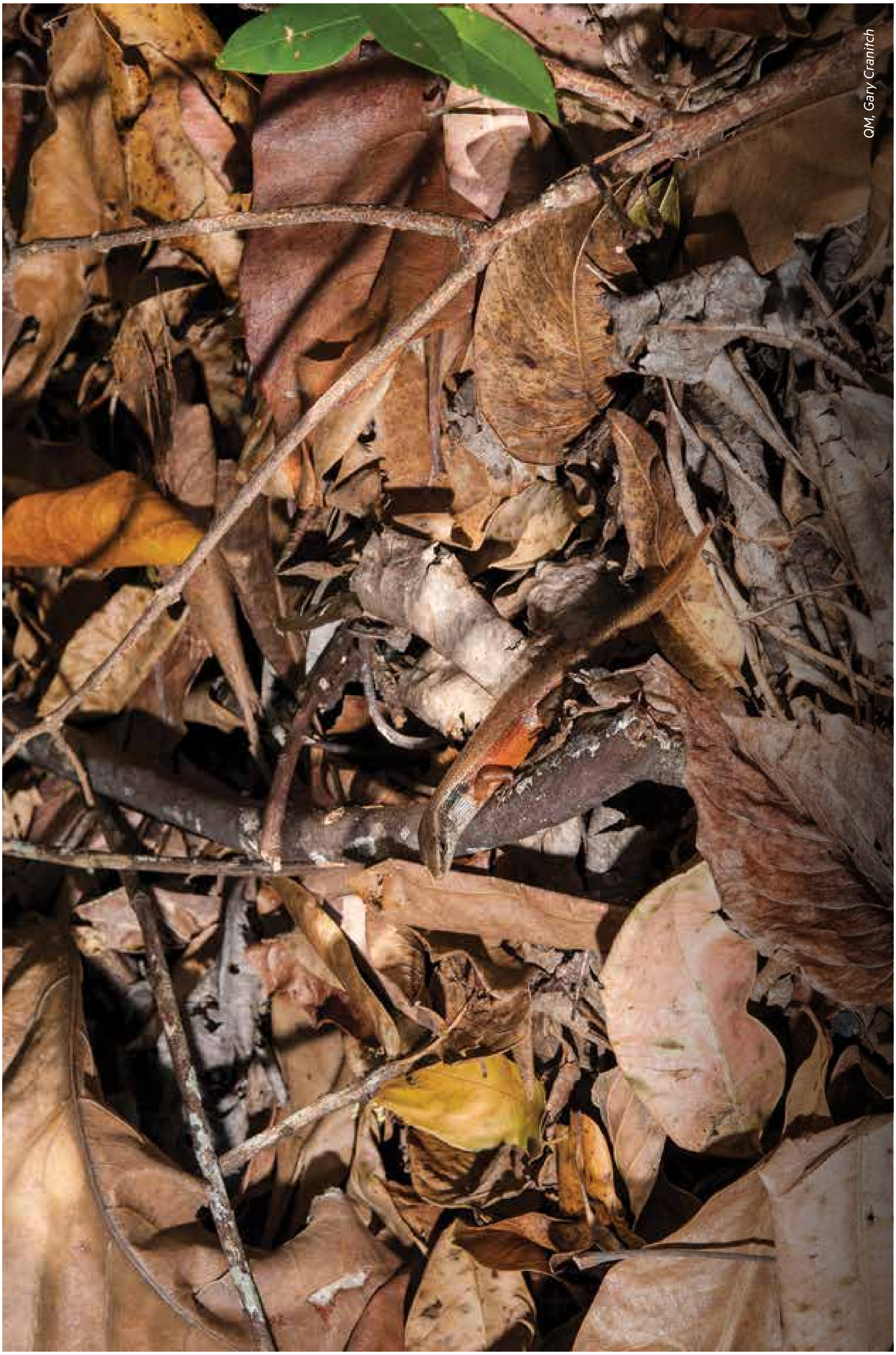
Use the following images to introduce the concept of camouflage to students. The animals shown in the images include:

- Spotted Wobbegong, *Orectolobus maculatus*
- Capricorn Silvereye, *Zosterops lateralis chlorocephalus*
- Closed-litter Rainbow Skink, *Carlia longipes*
- Purple-ringed Aeolid, *Flabellina exoptata*

QM, Gary Cranitch


QM, Gary Cranitch


QM, Gary Cranitch



QM, Gary Cranitch

QM, Gary Cranitch

Camouflage Capers

Student Activity

Year 5 Scientific Investigation

Colour in nature serves many purposes, including camouflage, attracting a mate, warning predators, mimicry, physical protection and temperature regulation. Camouflage is a structural adaptation that helps an animal to blend in with its surroundings and survive in its environment. Animals use camouflage to avoid predators and to remain unseen by prey.

Image, top: The colour patterns of the Spotted Wobbegong, Orectolobus maculatus, provides camouflage against the rocky reefs and sand of its habitat. Queensland Museum, Gary Cranitch. Image, bottom: The greenish-yellow and grey plumage of the Capricorn Silvereye, Zosterops lateralis chlorocephalus, provides camouflage against the coastal trees, shrubs and rocks of its habitat.

Dingo, *Canis lupus dingo*

The Dingo is Australia's only native canine (canines include domestic dogs, wolves, foxes and other dog-like mammals). Dingoes are descended from south Asian wolves. Evidence suggests Dingoes arrived in Australia around 3,500 years ago.[1]

Dingoes are found in every habitat and state of Australia, except Tasmania. They live in deserts, dry grasslands, woodlands, rainforests and even in the Australian alps.

Dingoes are carnivores. They hunt many kinds of animals, but generally eat small native mammals, introduced feral animals and some domestic animals.

Dingoes range in colour from white, to sandy-yellow, to ginger, to black and tan. The colour of a Dingo is mostly determined by where it lives.

A Dingo with white fur (left) and a Dingo with ginger fur (right).

In this activity, you will investigate the effect of coat colour on the survival of Dingoes in different habitats. You will conduct a scientific investigation to determine which colours will best camouflage a Dingo at the beach, in the desert and in a rainforest so that they can catch prey undetected. You will use coloured matchsticks to represent the Dingoes. If a Dingo is spotted by its prey, the prey may be able to avoid being caught; this could lead to a Dingo going hungry.

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[1] Australian National University. (2018). Research reveals when dingoes first arrived in Australia. https://www.anu.edu.au/news/all-news/research-reveals-when-dingoes-first-arrived-in-australia

Aim

To investigate the effect of Dingo coat colour on their camouflage in different environments.

Materials

- 10 yellow matchsticks
- 10 orange matchsticks
- 10 black and brown matchsticks
- Surfaces and/or materials to represent three different environments (beach, desert, rainforest)
- Ruler or tape measure
- 4 x 1 metre lengths of string
- Stopwatch

Method

1. Paint, colour or use food colouring to dye the matchsticks so that they are the required colours. Let the matchsticks dry.
2. Select at least three different surfaces to represent each of the environments: beach, desert and rainforest. These surfaces could be located inside or outside the classroom. You could also add additional materials to the surface to help represent each environment. Record your chosen surfaces and materials in the table on the next page.
3. Make a prediction. Which coloured matchstick (or Dingo) would have the best chance of surviving in each of the environments? Record and justify your prediction in table on the next page.
4. Read steps 6 to 11. Identify the variables you are going to change (independent variable), measure or observe (dependent variable) and keep the same (control variables). Record these variables in the table on the next page.
5. Identify any potential risks you may encounter before, during and after the investigation. Explain how you will work safely on the following pages.
6. Prepare the first environment. Measure out 1 m^2 on your chosen surface. Use the string to mark out this area. Add any extra materials to the surface to help represent the environment.
7. Ask one person (the 'spotter') to look away while the matchsticks are randomly scattered over the marked area.
8. Start the stopwatch. Ask the spotter to collect as many matchsticks as they can in six seconds using only one hand. Stop the spotter and the stopwatch after six seconds have elapsed.
9. Count the number of coloured matchsticks collected by the spotter. Record the data.
10. Collect all matchsticks and repeat steps 7 to 9.
11. Repeat steps 6 to 10 for the remaining two habitats.

Predicting and Planning

Record the surfaces and materials used to represent each of the environments.

Predict which coloured matchstick (or Dingo) would have the best chance of surviving in each of the environments. Remember to justify your predictions.

Desert	
Surface and Materials:	Prediction:
Beach	
Surface and Materials:	Prediction:
Rainforest	
Surface and Materials:	Prediction:

Identify the variables you are going to change, measure or observe and keep the same

Change? **(Independant variable)**	**Measure/Observe?** **(Dependent variable)**	**Keep the same?** **(Control variables)**

Explain how you will work safely during this investigation.

Recording Results

Record results in the tables below.

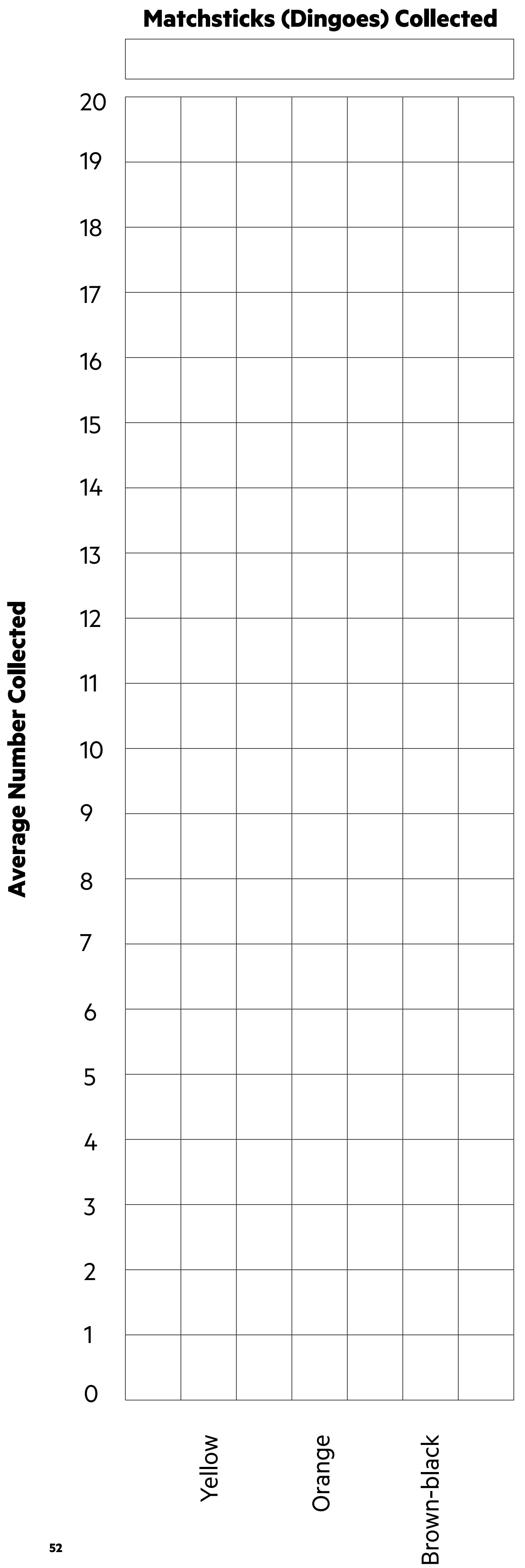
Environment:				
Matchstick colour:	**Number of collected matchsticks**			
	Trial 1	**Trial 2**	**Trial 3**	**Average**
Yellow				
Orange				
Brown-black				

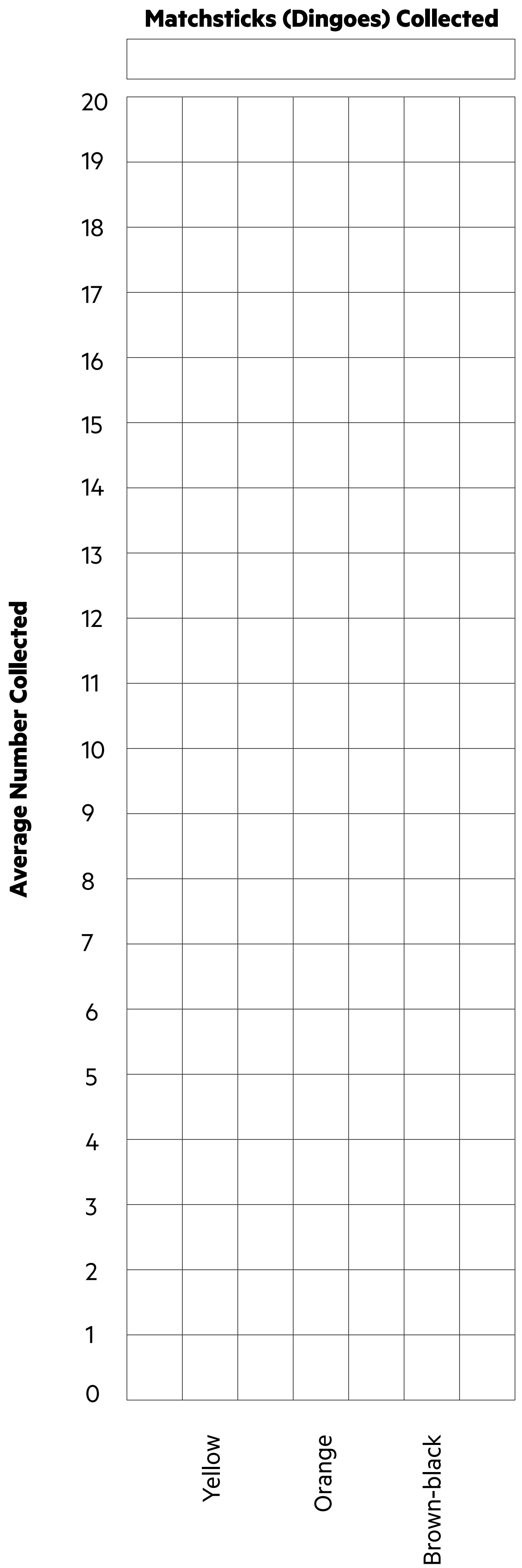
Environment:				
Matchstick colour:	**Number of collected matchsticks**			
	Trial 1	**Trial 2**	**Trial 3**	**Average**
Yellow				
Orange				
Brown-black				

Environment:				
Matchstick colour:	**Number of collected matchsticks**			
	Trial 1	**Trial 2**	**Trial 3**	**Average**
Yellow				
Orange				
Brown-black				

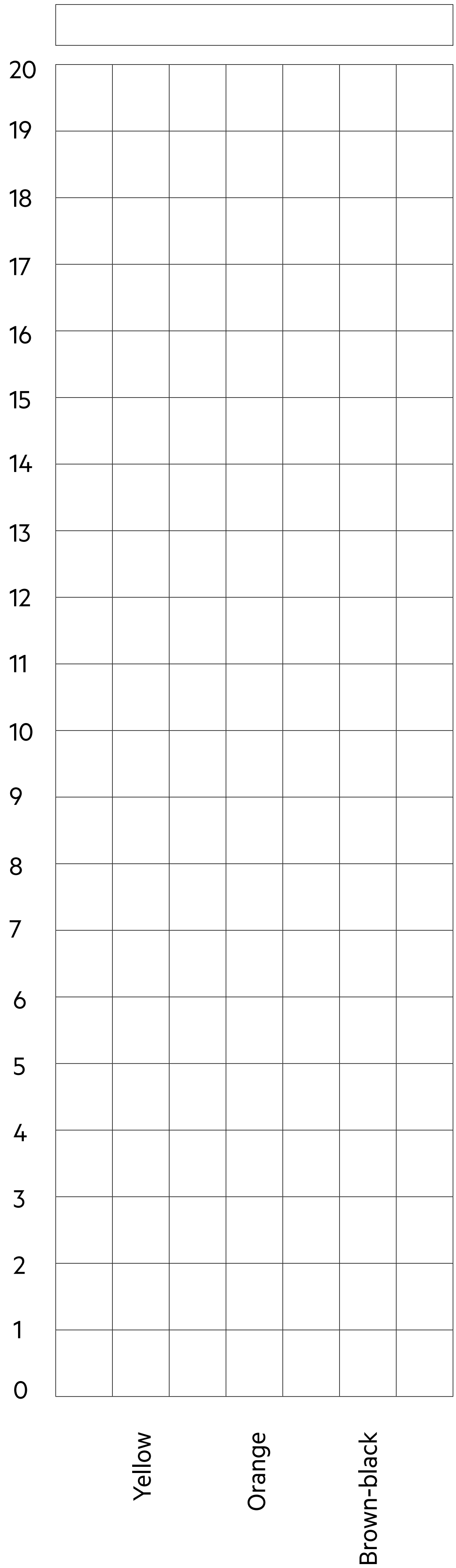
Representing Results

Construct bar graphs to show the number of matchsticks (Dingoes) collected in each environment.





Matchsticks (Dingoes) Collected



Analysing Results

Summarise your results for each environment.

Explain your results for each environment. Use your results to determine which Dingo coat colour – sandy-yellow, ginger (orange) or black and tan – would be best suited to each environment.

Were your original predictions supported by the data collected? Why or why not?

Imagine that the three different coloured matchsticks (Dingoes) were part of one large matchstick (Dingo) population in a rainforest environment. Predict what might happen to this population over a long period of time. Remember to give reasons for your prediction.

Use your results to make a generalisation about the effect of colour on the survival of predators.

Evaluating

Describe any challenges you experienced during the investigation.

Explain how you could improve the investigation.

Conclusion

Summarise the experiment and the results. Was the prediction supported or refuted?

Camouflage Capers

Student Activity

Year 6 Scientific Investigation

Colour in nature serves many purposes, including camouflage, attracting a mate, warning predators, mimicry, physical protection and temperature regulation. Camouflage is a structural adaptation that helps an animal to blend in with its surroundings and survive in its environment. Animals use camouflage to avoid predators and to remain unseen by prey.

Image, top: The colour patterns of the Spotted Wobbegong, Orectolobus maculatus, provides camouflage against the rocky reefs and sand of its habitat. Queensland Museum, Gary Cranitch. Image, bottom: The greenish-yellow and grey plumage of the Capricorn Silvereye, Zosterops lateralis chlorocephalus, provides camouflage against the coastal trees, shrubs and rocks of its habitat.

In this activity, you will investigate the impact of changing environments on camouflaged organisms.

The Effect of Changing Environments

You are an ecologist, studying the relationship between animals and their environment. You have been asked to model the effects of gradual land clearing on two species of ground-dwelling insects. One species is brown in colour, while the other species is green. The land is being cleared for a new housing estate. If approved, the land clearing process will happen over three years.

Aim

To investigate the impact of reduced leaf cover on the survival of two species of ground-dwelling insects.

Hypothesis

How will reduced leaf cover affect the survival of each species? Write a prediction, giving reasons for your response.

Materials

- 10 brown matchsticks
- 10 green matchsticks
- Green poster board or paper, enough to cover a 60 cm x 60 cm surface
- Masking tape
- 2 litres of leaf litter, which could include grass clippings, bark and mulch, soil etc.
- Gloves
- Measuring cup
- Stopwatch
- Dustpan and brush

Method

1. Paint, colour or use food colouring to dye the matchsticks so that they are the required colours. Let the matchsticks dry.
2. Read steps 4 to 19. Identify the variables you are going to change (independent variable), measure or observe (dependent variable) and keep the same (control variables). Record these variables in the table on the following pages.
3. Identify any potential risks you may encounter before, during and after the investigation. Explain how you will work safely on the following pages.

4. Prepare the environment. Measure out a 60 cm x 60 cm square on an outdoor surface (i.e. concrete or outdoor pavers). Use masking tape to mark out the square. Place the green poster card or paper within the marked area. You may also like to tape the card or paper to the ground so it does not move around. Ensure everyone puts on a pair of gloves. Place the leaf litter within the marked area.
5. Ask one person (the 'spotter') to look away while the matchsticks are randomly scattered throughout the marked area. The matchsticks can be placed on top of and within the leaf litter.
6. Start the stopwatch. Ask the spotter to collect as many matchsticks as they can in six seconds using only their gloved hand. Stop the spotter and the stopwatch after six seconds have elapsed.
7. Count the number of coloured matchsticks collected by the spotter. Record this data on the next page.
8. The land clearing has started. Six months have passed since the first trial. Remove one cup of leaf litter. Ensure any matchsticks collected by the cup are removed. Place these matchsticks aside with the matchsticks collected by the spotter – these will be added back to the pile of leaf litter.
9. Ask the spotter to look away. Spread out the remaining leaf litter and matchsticks within the marked area. Randomly scatter any matchsticks removed by the spotter or the cup throughout the marked area. Repeat steps 6 and 7.
10. 1 year has passed since the first trial. Remove one cup of leaf litter. Ensure any matchsticks collected by the cup are removed. Place these matchsticks aside with the matchsticks collected by the spotter – these will be added back to the pile of leaf litter.
11. Repeat step 9.
12. 1.5 years have elapsed since the first trial. Remove one cup of leaf litter. Ensure any matchsticks collected by the cup are removed. Place these matchsticks aside with the matchsticks collected by the spotter – these will be added back to the pile of leaf litter.
13. Repeat step 9.
14. 2 years have elapsed since the first trial. Remove one cup of leaf litter. Ensure any matchsticks collected by the cup are removed. Place these matchsticks aside with the matchsticks collected by the spotter – these will be added back to the pile of leaf litter.
15. Repeat step 9.
16. 2.5 years have elapsed since the first trial. Remove one cup of leaf litter. Ensure any matchsticks collected by the cup are removed. Place these matchsticks aside with the matchsticks collected by the spotter – these will be added back to the pile of leaf litter.
17. Repeat step 9.
18. 3 years have elapsed since the first trial. Remove one cup of leaf litter. Ensure any matchsticks collected by the cup are removed. Place these matchsticks aside with the matchsticks collected by the spotter – these will be added back to the pile of leaf litter.
19. Repeat step 9.

Variables

Record the variables in the table below.

Independant Variable	Dependant Variable	Control Variables

Risk Assessment

Explain how you will work safely during this investigation.

Recording Results

Complete the data table.

Matchstick colour:	Number of collected matchsticks						
	Trial 1 (Start)	Trial 2 (6 months)	Trial 3 (1 year)	Trial 4 (1.5 years)	Trial 5 (2 years)	Trial 6 (2.5 years)	Trial 7 (3 years)
Brown							
Green							

Calculate the percentage of matchsticks (insects) collected in each trial.

Matchstick colour:	Number of collected matchsticks						
	Trial 1 (Start)	Trial 2 (6 months)	Trial 3 (1 year)	Trial 4 (1.5 years)	Trial 5 (2 years)	Trial 6 (2.5 years)	Trial 7 (3 years)
Brown							
Green							

Represent this data in a line graph. You may use Excel to create the graph.

Analysing Results

Summarise your results.

Explain your results. How did the changing environment affect each insect species?

Were your original predictions supported by the data collected? Why or why not?

Predict how this environmental change would affect the growth and survival of these two insect species. You may also like to consider how this change would impact organisms that are eaten by these insect species as well as organisms that eat these insect species.

Write a letter of recommendation to the developer. In your letter, you should state whether the development should proceed based on the evidence gathered during the investigation.

Evaluating

Describe any challenges you experienced during the investigation.

Explain how you could improve the investigation.

Conclusion

Summarise the experiment and the results. Was the hypothesis supported or refuted?

Camouflage Capers

Student Activity

The Colours of a Wild State

Visit the *Wild State* exhibition at Queensland Museum.

Select a habitat to explore. Make a prediction: What colours will the animals who live in this habitat mostly be? Remember to include a reason for your answer.

Tally the different colours of the animals found in the habitat.

Colour	Tally	Total

Represent the data in a graph.

Were your original predictions supported by the data collected? Why or why not?

Identify any patterns in the data, and then develop an explanation for these patterns.

ELABORATE - EXPLAIN

Cameras in Disguise: Design Challenge

Teacher Resource

In this activity, students design a camouflaged camera that can be used to record footage of a native Australian animal. Students must consider both the behaviour of the animal and the conditions of the environment in which the animal lives to make their designed solution.

Students gain inspiration from wildlife documentaries to complete the design challenge. People who work in this setting often disguise cameras to record footage of animals that may be scared away by the presence of humans and/or large camera rigs. Cameras disguised as rocks, eggs, snowballs and logs have been used to record footage of animals, as have cameras that are designed to look like the animals that are being filmed!

A camera disguised in a nesting box.

Curriculum Links (Version 8.4)

Design and Technologies

YEAR 5

Design and Technologies Knowledge and Understanding

Investigate characteristics and properties of a range of materials, systems, components, tools and equipment and evaluate the impact of their use (ACTDEK023)

Design and Technologies Processes and Production Skills

Critique needs or opportunities for designing, and investigate materials, components, tools, equipment and processes to achieve intended designed solutions (ACTDEP024)

Generate, develop and communicate design ideas and processes for audiences using appropriate technical terms and graphical representation techniques (ACTDEP025)

Select appropriate materials, components, tools, equipment and techniques and apply safe procedures to make designed solutions (ACTDEP026)

Mathematics

YEAR 5

Statistics and Probability

Pose questions and collect categorical or numerical data by observation or survey (ACMSP118)

Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies (ACMSP119)

General Capabilities

Literacy

Comprehend texts through listening, reading and viewing

Composing texts through speaking, writing and creating

Numeracy

Interpreting statistical information

Information and Communication Technology

Investigating with ICT

Creating with ICT

Critical and Creative Thinking

Inquiring – identifying, exploring and organising information and ideas

Generating ideas, possibilities and actions

Reflecting on thinking and processes

Analysing, synthesising and evaluating reasoning and procedures

Personal and Social Capability

Social management

Cameras in Disguise: Design Challenge

Student Activity

Task:

You are a wildlife documentary maker, preparing to film a new documentary about native Australian animals. Some of the animals you need to film are very shy. They tend to hide if they sense humans in their environment, and they will not come out of their hiding places until the humans have left.

In order to make your film, you need to design a camouflaged camera that can be used to record footage of some of these animals. Your camouflaged camera should remain undetected by the animals. You will also need to consider both the behaviour of the animal and the conditions of the environment in which the animal lives to make your designed solution.

You must:

- **Investigate** how other documentary makers capture footage of animals. You will also need to research the behaviour of your chosen animal and the environmental conditions of the habitat.
- **Design** a camouflaged camera that can be used to record footage of the animal. Consider how the characteristics of the animal and the environmental conditions of the habitat will influence your design.
- **Create** a model of the camouflaged camera.
- **Test** the model. You could position the camouflaged camera in your school, and then record how many people stop to look at or inspect the device.
- **Refine** the camouflaged camera to improve on the original design.
- **Collaborate** in teams of two or three.
- **Evaluate** your design. You may also be required to evaluate social interactions and your ability to work effectively in a team.

Investigate

Wildlife documentary makers use a variety of techniques to capture footage of animals. Investigate some of the camouflaged cameras documentary makers use in their productions:

- Polar Bear: Spy on the Ice
- Dolphins: Spy in the Pod
- Trek: Spy on the Wildebeest

Compare the features and components of these cameras.

You have short-listed the following animals to film. Select one animal to film first. You will design a camouflaged camera specifically for this animal.

- ☐ Greater Bilby, *Macrotis lagotis*
- ☐ Fawn Hopping Mouse, *Notomys cervinus*
- ☐ Thorny Devil, *Moloch horridus*
- ☐ Pale-headed Rosella, *Platycercus adscitus*
- ☐ Platypus, *Ornithorhynchus anatinus*
- ☐ Southern Cassowary, *Casuarius casuarius*
- ☐ Lumholtz's Tree Kangaroo, *Dendrolagus lumholtzi*
- ☐ Albert's Lyrebird, *Menura alberti*
- ☐ Dugong, *Dugong dugon*

Research the behaviour of your chosen animal. Record any important information below.

Research the environmental conditions of the habitat in which the animal lives. Record any important information below.

Design

Draw a labelled diagram of the camouflaged camera design. Include reasons for your design and selection of materials.

Create and Test

Create and then test the camouflaged camera. Place your camera in the school grounds during lunchtime. Record how many people see or interact with the camera. You may also like to record this data in a graph.

Location	
Duration	

Time	**Number of times camera seen/ interacted with**

Record further observations in the PMI Chart below.

Plus	**Minus**	**Interesting**

Refine

Recommend future changes that could improve the effectiveness of the camouflaged camera.

Evaluate

Reflect on your actions with your team or class after you have completed the design challenge. You might like to think about the following questions to assist in your reflection.

- What scientific knowledge helped you make decisions about your designed solution?
- What aspects of your designed solution are you very satisfied with and why?
- What were the main challenges you experienced during the design process? How did you overcome these challenges?
- What have you learnt about science and the design process from this activity?
- How could you apply this knowledge and understanding to your learning in other contexts?
- What more would we like to know about camouflage?

ELABORATE - EVALUATE

Survival in Extreme Environments

Teacher Resource

In this activity, students explore the adaptations that allow animals to survive in extreme environments. Students plan and conduct a hands-on investigation to answer the question/s below. Student groups may investigate one or both inquiry questions.

- Which animal will stay the coolest in a hot environment?
- Which animal will stay the warmest in a cold environment?

Detailed step-by-step instructions for this activity can be seen below. It is recommended that you use these instructions to guide students through the activity.

1. Facilitate a class discussion by posing the following questions:
   - Where is the coldest place you have ever been?
   - Where is the hottest place you have ever been?
   - How did you stay warm and keep cool in these places?

2. View a map of the world, and focus in on Australia and Asia. Ask students to predict where the hottest and coldest places might be for each continent. Students should justify their predictions.

3. Working as a class, or in small groups, visit the World Meteorological Organisation's Global Weather and Climate Extreme Map. Identify the location and temperatures of the hottest and coldest places in Asia and Australia. Compare students' predictions with this information.

   Year 6

   Students calculate the difference in temperature for the:

   - Hottest places in Australia and Asia.
   - Coldest places in Australia and Asia.

4. Students generate explanations for these extreme temperatures. Students may like to view images of these locations to assist this process. Ask students: ***How might the conditions of these places affect the animals that live there? How might an animal adapt to stay warm and keep cool in these places?***

   Inform students that they will explore these questions in a scientific investigation. Students work in small groups to design and complete an investigation to explore which animals will stay the coolest in a hot environment and/or which animals will stay the warmest in a cold environment. Students could respond to one or both of the inquiry questions. If only responding to one question, student groups can share the results of their investigation with groups that completed the other investigation (i.e. student groups investigating cold environments can share their results with groups investigating hot environments and vice versa). The responses shared by students during the above class discussion could provide inspiration for students' scientific investigations.

5. After the investigation, you may like to discuss the following questions with students:
   - Polar Bears live in cold, tundra habitats, and they are white. Explain how this adaptation helps the Polar Bear survive in its environment.
   - The fur of a Polar Bear is white, yet its skin is black. Explain how this adaptation helps the Polar Bear survive in its environment.
   - The Arctic Fox and Arctic Hare live in polar regions. These animals change their coat colours at different times of the year. In summer, their coat is a tawny brown. In winter, their coat is white. Explain how this adaptation helps these animals survive in their environment.
   - Some animals moult or shed their coat. Identify when an animal would do this, and explain how this adaptation helps these animals survive.
   - Other animals, like the Humpback Whale, do not have a coat, yet they can survive in freezing cold conditions. Explain how these animals survive in such conditions.

Curriculum Links (Version 8.4)

Science

YEAR 5

Science Understanding

Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)

Light from a source forms shadows and can be absorbed, reflected and refracted (ACSSU080)

Science as a Human Endeavour

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE081)

Science Inquiry Skills

With guidance, pose clarifying questions and make predictions about scientific investigations (ACSIS231)

Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS086)

Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS087)

Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS090)

Compare data with predictions and use as evidence in developing explanations (ACSIS218)

Reflect on and suggest improvements to scientific investigations (ACSIS091)

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)

YEAR 6

Science Understanding

The growth and survival of living things are affected by physical conditions of their environment (ACSSU094)

Science as a Human Endeavour

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions (ACSHE098)

Science Inquiry Skills

With guidance, pose clarifying questions and make predictions about scientific investigations (ACSIS232)

Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS103)

Decide variables to be changed and measured in fair tests, and observe measure and record data with accuracy using digital technologies as appropriate (ACSIS104)

Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS107)

Compare data with predictions and use as evidence in developing explanations (ACSIS221)

Reflect on and suggest improvements to scientific investigations (ACSIS108)

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS110)

Mathematics

YEAR 5

Statistics and Probability

Pose questions and collect categorical or numerical data by observation or survey (ACMSP118)

Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies (ACMSP119)

Describe and interpret different data sets in context (ACMSP120)

YEAR 6

Number and Algebra

Investigate everyday situations that use integers. Locate and represent these numbers on a number line (ACMNA124)

Add and subtract decimals, with and without digital technologies, and use estimation and rounding to check the reasonableness of answers (ACMNA128)

Statistics and Probability

Interpret and compare a range of data displays, including side-by-side column graphs for two categorical variables (ACMSP147)

Humanities and Social Sciences

YEAR 6

Knowledge and Understanding: Geography

The geographical diversity of the Asia region and the location of its major countries in relation to Australia (ACHASSK138)

Inquiry and Skills

Locate and collect relevant information and data from primary sources and secondary sources (ACHASSI123)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewing

Composing texts through speaking, writing and creating

Numeracy

Estimating and calculating with whole numbers element

Using fractions, decimals, percentages, ratios and rates element

Interpreting statistical information element

Using measurement element

Information and Communication Technology

Investigating with ICT element

Creating with ICT element

Critical and Creative Thinking

Inquiring – identifying, exploring and organising information and ideas

Reflecting on thinking and processes

Analysing, synthesising and evaluating reasoning and procedures

Personal and Social Capability

Social management

Survival in Extreme Environments

Student Activity

Scientific Investigation: Extreme Heat

You will now design an experiment to investigate how different physical features help animals survive in extreme environments.

Aim

To investigate which animal will stay the coolest in a very hot environment.

Hypothesis

Select a physical feature to investigate. How will this feature affect an animal's ability to stay cool in a very hot environment? Write a prediction, giving reasons for your response.

Variables

Identify the variables you are going to change, measure or observe and keep the same.

Change? (Independent variable)	Measure/Observe? (Dependent variable)	Keep the same? (Control variables)

Materials

List all of the equipment you will use in the experiment. Remember to include numbers and amounts.

Method

List all of the steps you will take to conduct the experiment.

Risk Assessment

What safety considerations must be made before, during and after the experiment? Identify at least five risks and how to minimise them.

Risk	How to manage the risk

Recording Results

Record your results in a table. You could use Excel to create the table.

Represent this data in a line graph. You could use Excel to create the graph.

Analysing Results

Summarise your results.

Explain your results. Use your results to determine which animal would stay the coolest in a very hot environment.

Were your original predictions supported by the data collected? Why or why not?

Evaluate the ability of this feature to help an animal survive in its environment.

Explain the other ways the animal might keep cool in a hot environment. You may like to conduct research to inform your response.

Explain how the animal may adapt if it were forced move to a cooler habitat.

Evaluating

Describe any challenges you experienced during the investigation.

Explain how you could improve the investigation.

Conclusion

Summarise the experiment and the results. Was the hypothesis supported or refuted?

Survival in Extreme Environments

Student Activity

Scientific Investigation: Extreme Cold

You will now design an experiment to investigate how different physical features help animals survive in extreme environments.

Aim

To investigate which animal will stay the warmest in a very cold environment.

Hypothesis

Select a physical feature to investigate. How will this feature affect an animal's ability to stay warm in a very cold environment? Write a prediction, giving reasons for your response.

Variables

Identify the variables you are going to change, measure or observe and keep the same.

Change? (Independent variable)	Measure/Observe? (Dependent variable)	Keep the same? (Control variables)

Materials

List all of the equipment you will use in the experiment. Remember to include numbers and amounts.

Method

List all of the steps you will take to conduct the experiment.

Risk Assessment

What safety considerations must be made before, during and after the investigation? Identify at least five risks and how to minimise them.

Risk	How to manage the risk

Recording Results

Record your results in a table. You could use Excel to create the table.

Represent this data in a line graph. You could use Excel to create the graph.

Analysing Results

Summarise your results

Explain your results. Use your results to determine which animal would stay the warmest in a very cold environment.

Were your original predictions supported by the data collected? Why or why not?

Evaluate the ability of this feature to help an animal survive in its environment.

Explain the other ways the animal might keep warm in a very cold environment. You may like to conduct research to inform your response.

Explain how the animal may adapt if it were forced move to a warmer habitat.

Evaluating

Describe any challenges you experienced during the investigation.

Explain how you could improve the investigation.

Conclusion

Summarise the experiment and the results. Was the hypothesis supported or refuted?

EXPLORE - EXPLAIN - ELABORATE

Breaking Down Digestion: Gut Content Analysis

Teacher Resource

In this activity, students explore and analyse the replicated gut contents of five Australian animals. They use the information gathered during the analysis to determine which animals are likely to have ingested the observed materials. They then investigate and model the digestive system of one of these animals. This activity is based on *A Pain in the Guts: Analysing Gut Contents,* which is featured within the *Problematic Polymers Teacher Resource.*

Scientists from Queensland Museum are constantly analysing evidence from animals to learn more about them. Gut content analysis helps scientists understand the nutritional requirements and feeding relationships of individual animals, as well as the transfer of material and energy between and within ecosystems. Gut content analysis can also reveal the impact of human activity on the health and survival of animals, as explored in this activity.

The plastics shown in Photo Plate 1 (Flesh-footed Shearwater) and Photo Plate 2 (Green Sea Turtle) are samples of real ingested plastics taken from a Flesh-footed Shearwater and Green Turtle. These plastics samples, among others, were on display at The Hatchery during the World Science Festival Brisbane 2021 to raise awareness about the impacts of plastic waste.

Detailed step-by-step instructions can be seen below. It is recommended that you use these instructions to guide your students through the activity.

1. Introduce the activity to students. Students will:
   - Use gut content analysis to explore materials ingested by varied animals.
   - Use information gathered during the gut content analysis to determine which animals are likely to have ingested the materials.
   - Investigate and model the digestive system of one of these animals.

2. Divide students into groups of two or three and distribute *Student Activity: Student Photo Plates*. Students use the See-Scan-Analyse strategy to analyse the photo plates (listed on the following page and in *Student Activity: See-Scan-Analyse Questions*).

   Students firstly respond to the *See* and *Scan* questions. After students have responded to the Scan questions, distribute the *Animal Cards* to students (see *Student Activity: Animal Cards*). Ask students to identify which animal is likely to have ingested the material shown in each photo plate. Students then complete the *Analyse* questions. Reveal answers after students have finished the activity (see *Teacher Resource: Teacher Photo Plates*).

   It is important to inform students that each of the animals featured in this activity have digestive accessory organs, including the liver, pancreas and gall bladder, that are not shown on the *Animal Cards*.

- See: Look at the gut content photo plates.
  List the ingested material you can see in each photo plate.
- Scan: Use a magnifying glass to look closer at the gut contents.
  What do you notice about the ingested items?
  What do the images make you wonder?
- Analyse: What type of animal ingested these items?
  How do you know?
  Why might this animal have ingested these items?
  How might these ingested items affect the animal?

3. Following the gut content analysis, you may wish to facilitate a whole-class discussion with students. The following questions can lead to valuable discussion:
   - Which animals did you match to each gut content plate? What informed your decisions?
   - Predict how the ingested items may affect the growth and survival of each animal.
   - Describe how the digestive systems differ between animals.
   - Compare the diet and digestive system of each animal. Use this comparison to explain any differences between the digestive systems, and justify the purpose of these differences.
   - How might plastic in the digestive system impact the organism's access to the requirements for life (for example: oxygen, nutrients, water and removal of waste) and the function of other body systems?
   - How might ingested plastics affect feeding relationships in varied habitats?

4. Ask student groups to select one animal to investigate further. Students research the organs within the animal's digestive system (see *Student Activity: Exploring the Digestive System*). At this stage, students could compare and contrast the digestive system of their chosen animal to the digestive system of a human.

5. Students use this information to create a hands-on model of their chosen animal's digestive system (see *Student Activity: Modelling the Digestive System*). The model should clearly demonstrate how food moves through the animal's digestive system. Students should consider the animal's diet and how they could replicate this in their models. They then analyse their model.

Curriculum Links (Version 8.4)

Science

YEAR 8

Science Understanding

Multi-cellular organisms contain systems of organs carrying out specialised functions that enable them to survive and reproduce (ACSSU150)

Science Inquiry Skills

Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies as appropriate (ACSIS144)

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS145)

Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements (ACSIS146)

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS148)

YEAR 9

Science Understanding

Multi-cellular organisms rely on coordinated and interdependent internal systems to respond to changes to their environment (ACSSU175)

Science Inquiry Skills

Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (ACSIS165)

Select and use appropriate equipment, including digital technologies, to collect and record data systematically and accurately (ACSIS166)

Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data (ACSIS171)

Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS174)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewing

Composing texts through speaking, writing and creating

Critical and Creative Thinking

Inquiring – identifying, exploring and organising information and ideas

Generating ideas, possibilities and actions

Reflecting on thinking and processes

Analysing, synthesising and evaluating reasoning and procedures

Cross-Curriculum Priorities

Sustainability

All life forms, including human life, are connected through ecosystems on which they depend for their wellbeing and survival. (O1.2)

Breaking Down Digestion: Gut Content Analysis

Teacher Resource

Teacher Photo Plates

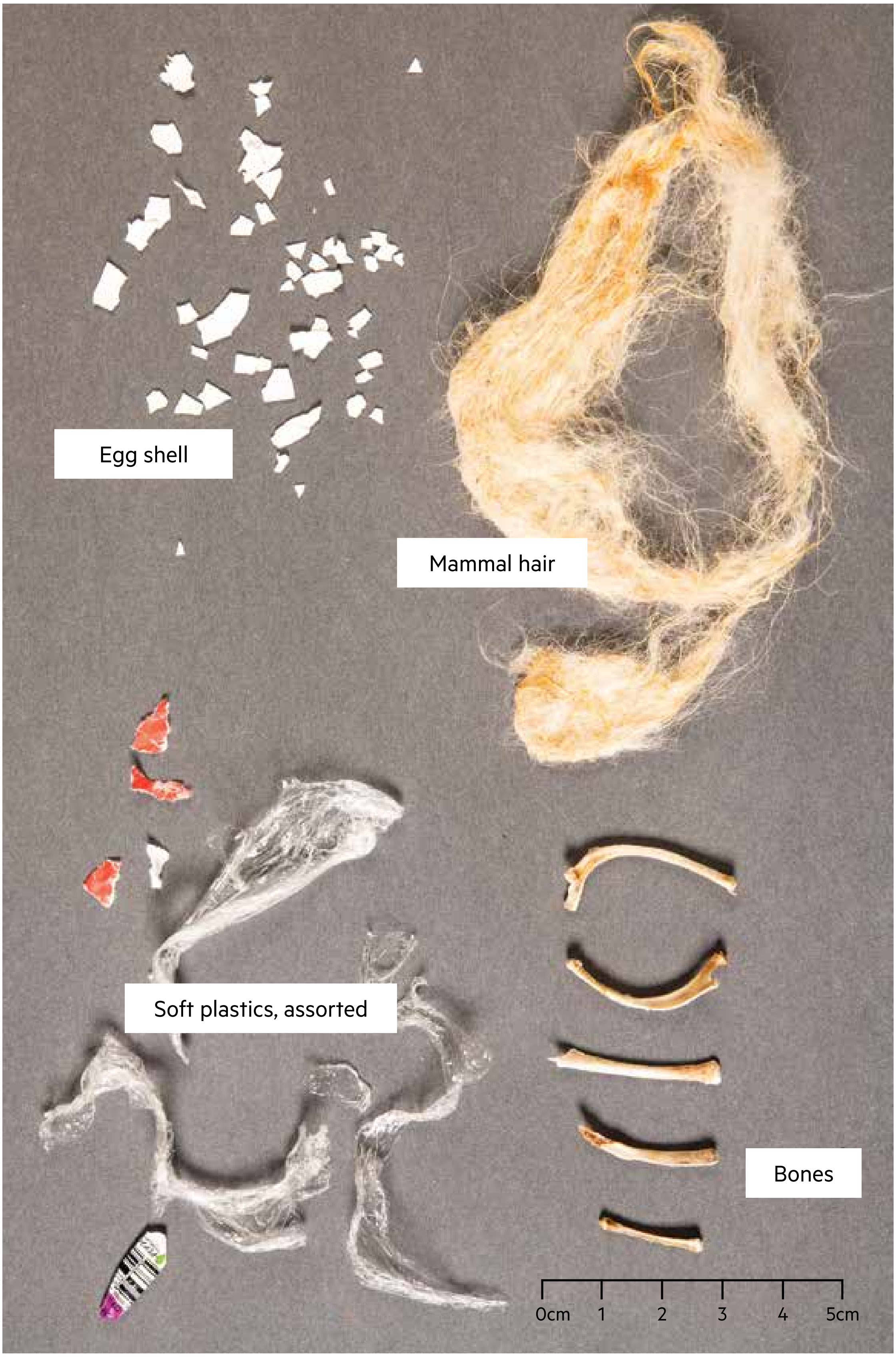
Photo Plate 1 – Flesh-footed Shearwater

Gut Content Analysis: Teacher Photo Plates

Photo Plate 2 – Green Sea Turtle

Gut Content Analysis: Teacher Photo Plates

Photo Plate 3 – Dingo



Gut Content Analysis: Teacher Photo Plates

Photo Plate 4 – Southern Cassowary

Gut Content Analysis: Teacher Photo Plates

Photo Plate 5 – Eastern Grey Kangaroo

A Pain in the Guts: Analysing Gut Contents

Student Activity

See-Scan-Analyse Questions

	SEE	SCAN
	List the ingested material seen in each photo plate.	What do you notice about the ingested items? What do you wonder about each image?
Photo Plate 1		
Photo Plate 2		
Photo Plate 3		
Photo Plate 4		
Photo Plate 5		

A Pain in the Guts: Analysing Gut Contents

Student Activity

See-Scan-Analyse Questions

	ANALYSE		
	What type of animal ingested these items? How do you know?	**Why might this animal have ingested these items?**	**How might these ingested items affect the animal?**
Photo Plate 1			
Photo Plate 2			
Photo Plate 3			
Photo Plate 4			
Photo Plate 5			

Breaking Down Digestion: Gut Content Analysis

Student Activity

Student Photo Plates

Photo Plate 1

Photo Plate 2

Photo Plate 3

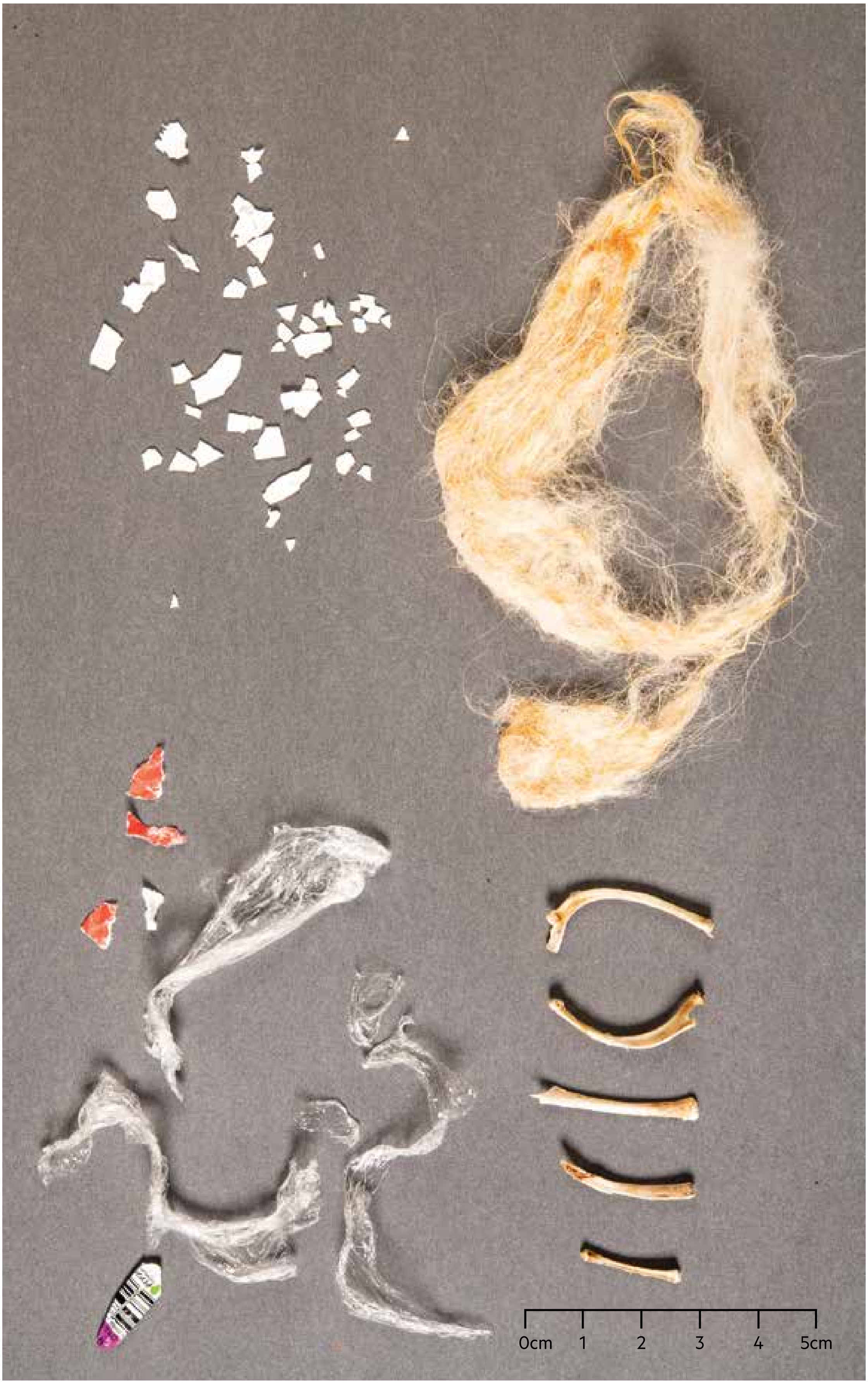


Photo Plate 4

Photo Plate 5

Breaking Down Digestion: Gut Content Analysis

Student Activity

Animal Cards

Flesh-footed Shearwater

Ardenna carneipes

Habitat

Coastal, Marine

Interesting facts

The Flesh-footed Shearwater can dive to a depth of 4 metres to catch prey.

Adult shearwaters regularly regurgitate indigestible parts of their food. Chicks do not tend to regurgitate until they are almost fully developed and ready to leave the nest.

The Flesh-footed Shearwater is a trans-equatorial migrator, flying from the southern to the northern hemisphere after the breeding season.

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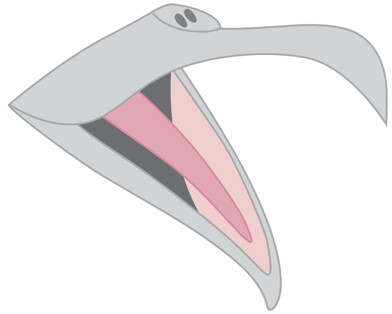
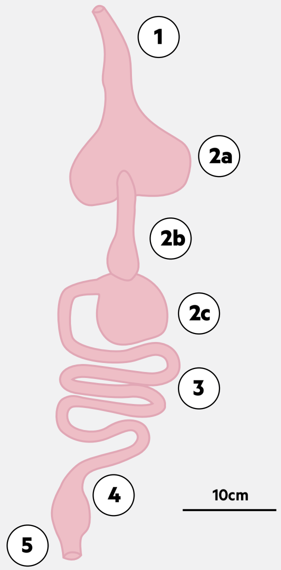
Mouth



Gastrointestinal tract

1. Lower oesophagus
2. Stomach
   - a. Crop
   - b. Proventriculus
   - c. Gizzard
3. Small intestine
4. Large intestine
5. Cloaca



Green Turtle

Chelonioidea mydas

Habitat

Marine

Interesting facts

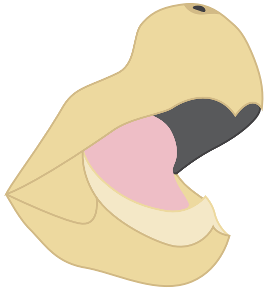
The Green Turtle's name comes from the green colour of its fat, rather than the colour of its shell (carapace).

Adult Green Turtles feed mainly on seagrasses and algae, and occasionally jellyfish. Juvenile Green Turtles are carnivorous.

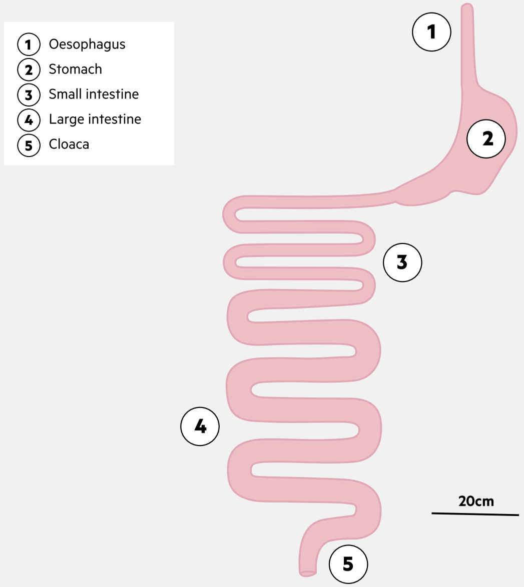
The oesophagus and mouth of sea turtles is lined with papillae, sharp prongs that point toward the stomach. Papillae help them hold onto and digest food.

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM | Queensland Government

Mouth



Gastrointestinal tract



Dingo

Canis lupus dingo

Habitat

Arid outback, Open forest, Rainforest, Coastal

Interesting facts

The Dingo is thought to have been introduced to Australia by Asian seafarers over 4000 years ago.

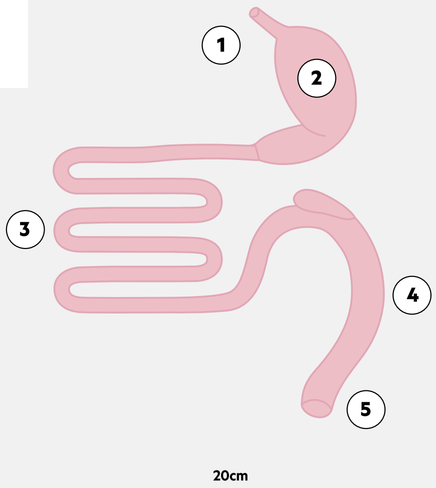
The colour of a Dingo's coat is largely determined by its environment.

Dingo saliva does not contain enzymes; it only lubricates food to aid in swallowing.

Mouth

Gastrointestinal tract

1. Lower oesophagus
2. Stomach
3. Small intestine
4. Large intestine
5. Rectum



Southern Cassowary

Casuarius casuarius

Habitat

Rainforest

Interesting facts

The cassowary's digestive system is adapted to process many species of fallen fruits and fungi which are poisonous to humans.

Cassowaries are keystone species due to their important role in seed dispersal. They have a short digestive system preventing the complete digestion of plant material. Due to this and their large size, they are the sole animal responsible for the distribution of over 100 species of plants.

The casque, or helmet, found on top of the cassowary's head is made of a foam-like material that is covered with a thick layer of keratin.

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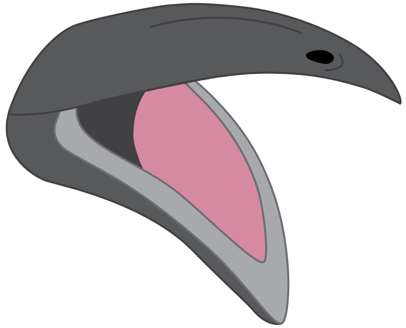
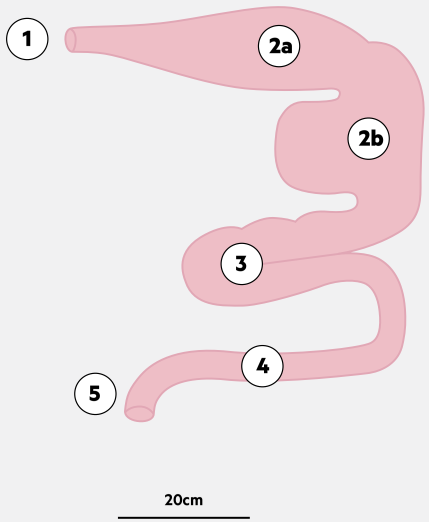
Mouth



Gastrointestinal tract



1. Lower oesophagus
2. Stomach
   - a. Proventriculus
   - b. Gizzard
3. Small intestine
4. Large intestine
5. Cloaca

Eastern Grey Kangaroo

Macropus giganteus

Habitat

Open forest

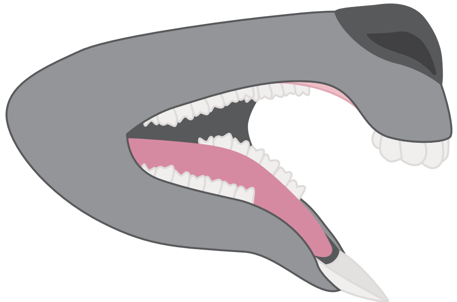
Interesting facts

The word kangaroo derives from 'Gangurru', the name given to Eastern Grey Kangaroos by the Guuga Yimithirr people of Far North Queensland.

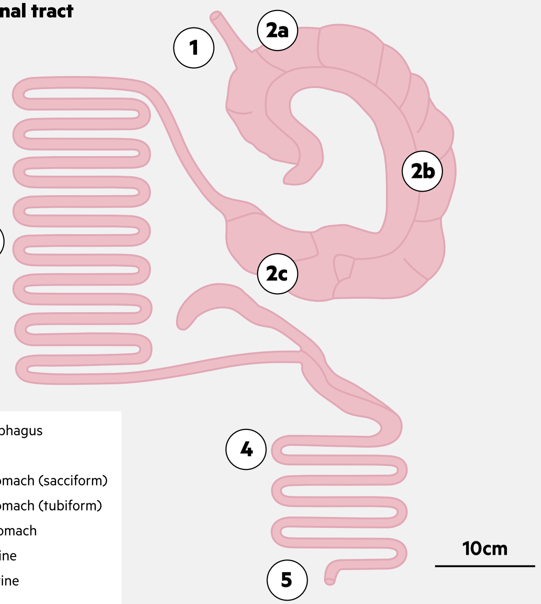
When full, a kangaroo's stomach can be up to 15% of its body mass.

Kangaroos can pause embryonic development during unfavourable conditions (embryonic diapause).

Mouth



Gastrointestinal tract



1. Lower oesophagus
2. Stomach
   - a. Forestomach (sacciform)
   - b. Forestomach (tubiform)
   - c. Hindstomach
3. Small intestine
4. Large intestine
5. Rectum

Human

Homo sapiens

Habitat

All

Interesting facts

Homo sapiens evolved in Africa around 200,000 years ago.

Scientific studies suggest the rate of human evolution increased with the advent of agriculture and cities.

A healthy person produces an average of 500 mL to 1.5 L of saliva a day!

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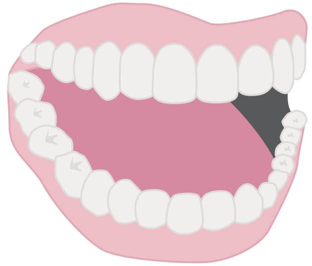
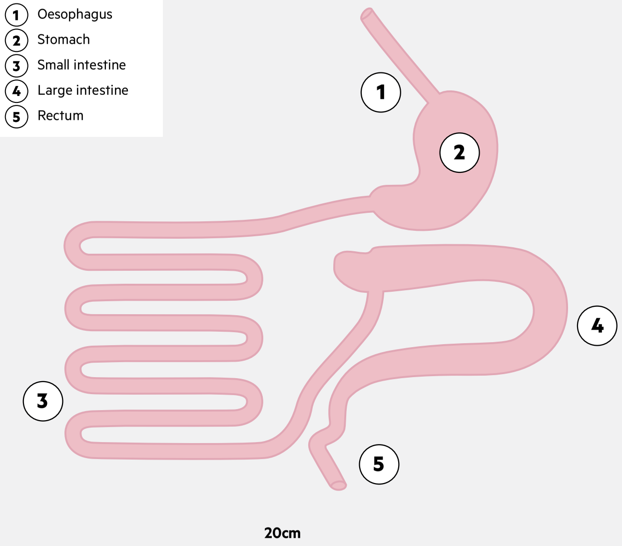
Mouth



Gastrointestinal tract

1. Oesophagus
2. Stomach
3. Small intestine
4. Large intestine
5. Rectum



Breaking Down Digestion: Gut Content Analysis

Student Activity

Exploring the Digestive System

Animal:

Organ	Structure	Function	How does the structure help achieve the function?

Breaking Down Digestion: Gut Content Analysis

Student Activity

Modelling the Digestive System

Create a hands-on model of your chosen animal's digestive system. The model should clearly demonstrate how food moves through the animal's digestive system. Ensure you consider the animal's diet and how you could replicate this in your model.

Draw a labelled diagram of your model.

Explain how you replicated the digestive system of your chosen animal.

Discuss the strengths and limitations of your model.

Suggest any improvements you could make to your model.

EXPLAIN - ELABORATE - EVALUATE

Specialised Stinging Cells

Teacher Resource

In this activity, students explore the specialised cells that give jellyfish (and other cnidarians) a powerful sting.

Cells are studied by researchers from many different institutions, including the Queensland Museum. Museum scientists may examine cells as a part of the process of discovering new species. For example, in this activity students read about marine biologists who studied stinging cells in a new species of box jellyfish. Other Queensland Museum researchers (like parasitologists) study organisms that are unicellular, so their work requires a detailed knowledge of cells. Finally, some Queensland Museum scientists (like geneticists) extract DNA from the cells of organisms of interest, and then collect and analyse these DNA sequences. However they are used, cells play an important role in current biological research.

Curriculum Links (Version 8.4)

Science

YEAR 8

Science Understanding

Cells are the basic units of living things and have specialised structures and functions (ACSSU149)

Science as a Human Endeavour

Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available (ACSHE134)

Science Inquiry Skills

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS148)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewing

Numeracy

Estimating and calculating with whole numbers

Specialised Stinging Cells

Student Activity

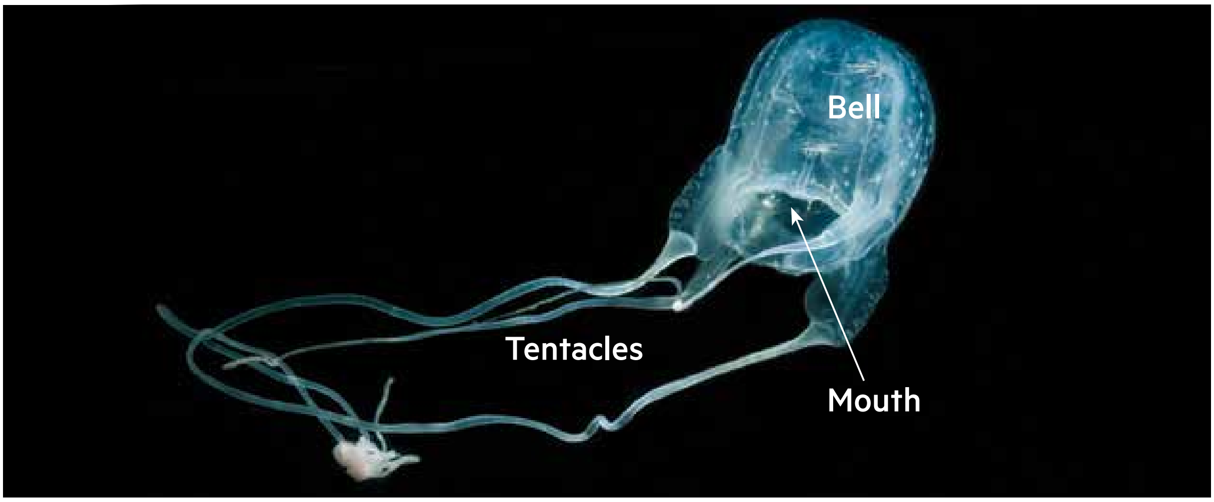
Have you ever been stung by a jellyfish? Ouch! Jellyfish (and other organisms like coral and sea anemones) have special stinging cells called cnidocytes (pronounced “NYE-dough-sites”).

It is these cells that define the phylum Cnidaria (pronounced “nye-DARE-ee-uh”), meaning that every organism in this phylum has these cells.

Phylum Cnidaria includes jellyfish (top), corals (left), anemones (middle) and soft corals (right). All cnidarians have stinging cells called cnidocytes. All images: Queensland Museum, Gary Cranitch..

In this activity we will learn more about the specialised cells that give jellyfish (and other cnidarians) a powerful sting.

Firstly, take a look at the jellyfish in the image below.



Morbakka fenneri, a type of Irukandji jellyfish from the Gold Coast, Queensland. Image: Queensland Museum, Gary Cranitch.

Although they are very simple animals, jellyfish are multicellular and have different "body parts."

In the picture you can see the bell, tentacles and mouth of a Morbakka jellyfish.

The bell contains the stomach and mouth of the jellyfish, while the tentacles are covered in stinging cells that help the jellyfish capture a meal.

It is important to note that stinging cells can be found on all parts of a jellyfish, not just the tentacles!

Stinging cells help jellyfish catch prey because they contain organelles called nematocysts.

When something brushes against a jellyfish, the nematocysts shoot out, pierce whatever they encounter, and release venom, causing what we experience as a sting.

Other organisms experience it as something worse... then they become dinner!

You can compare the nematocyst to a harpoon, a weapon that was historically used in fishing and whaling.

Attached to rope, a harpoon was thrown at animals like whales, where its barb would stick into skin and allow the animal to be captured.

Similarly, nematocysts have a coiled tube that shoots out and attaches to prey. This tube may be covered in spines that help it stick to whatever it touches.

Jellyfish don't want to waste nematocysts, as they cannot "reload" or reuse them; new nematocysts have to be produced to replace the ones that have discharged.

The nematocyst before and after it fires.

Not all nematocysts are the same – it is estimated there are at least 30 different kinds.

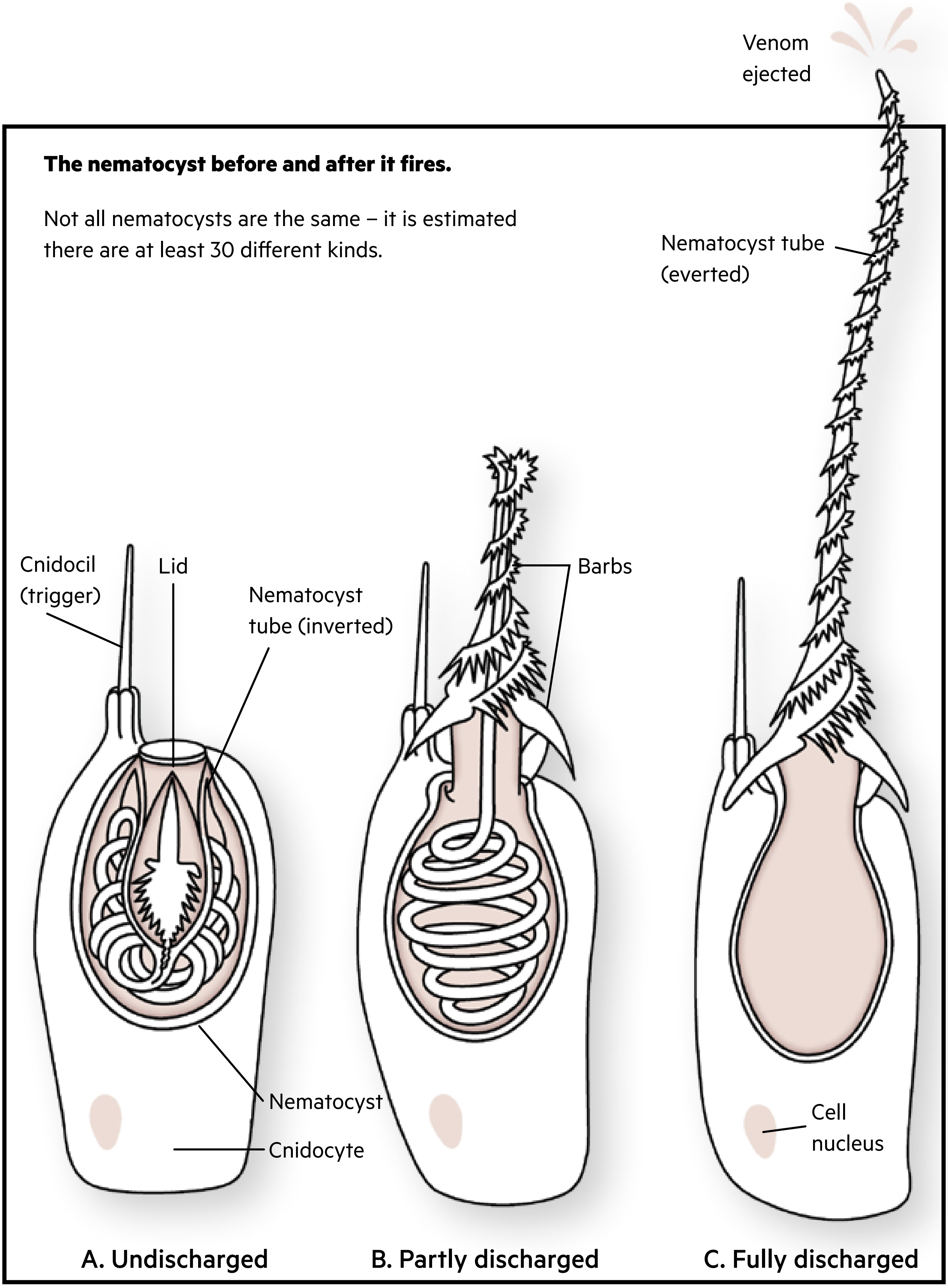


Image: ©University of Hawaii. Reprinted with permission from the Curriculum Research & Development Group. Reprinted from the original on the Exploring Our Fluid Earth website at http://manoa.hawaii.edu/exploringourfluidearth/

How Big?

Nematocysts (the organelles within stinging cells) vary in size from about 4–90 microns (also known as micrometres) in length, but on average are 20–30 microns long. Cnidocytes (stinging cells) also vary in size, but as the nematocyst takes up much of the cell (see figure above), cnidocytes are only slightly bigger than the nematocyst inside them.

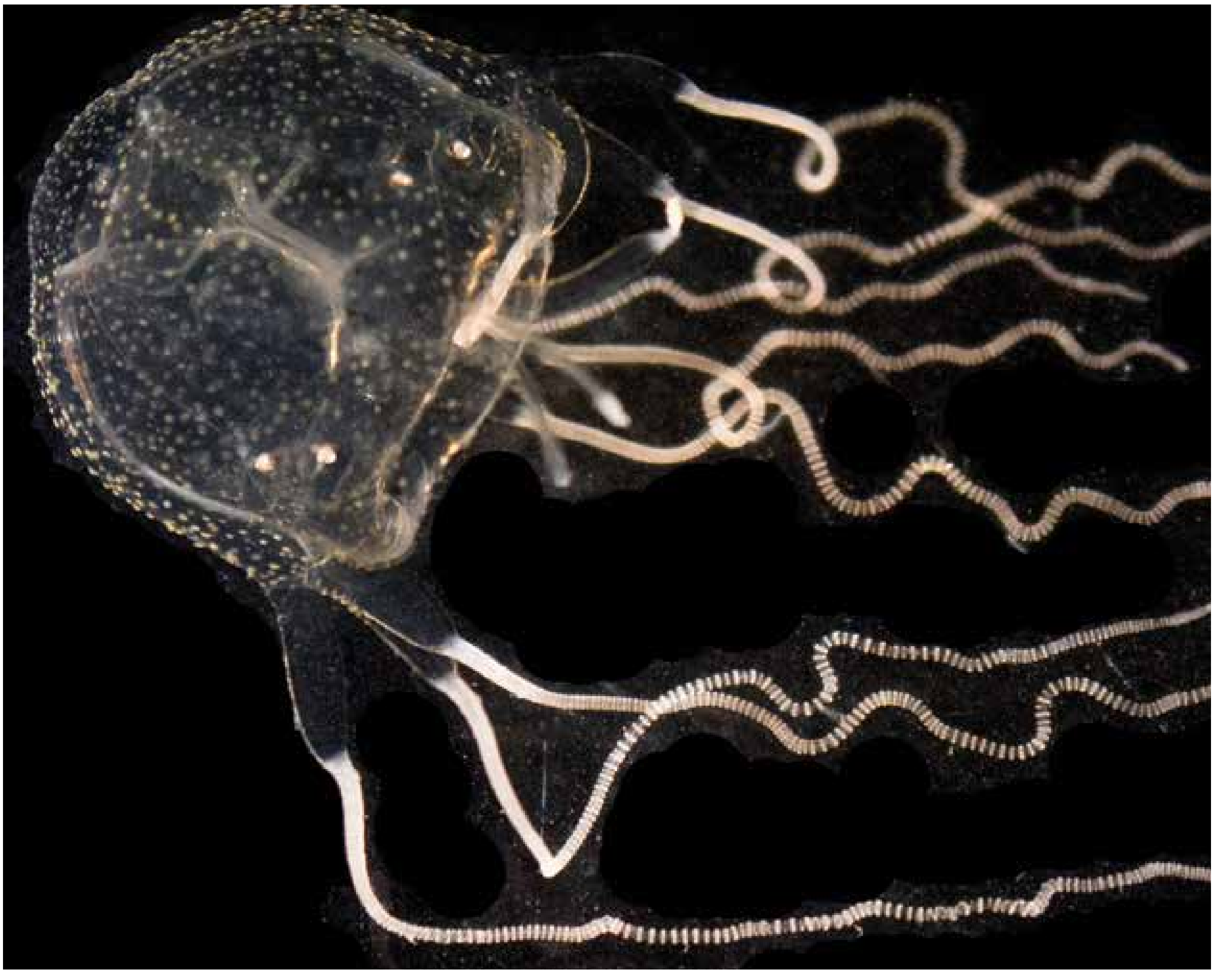
From this we can see that nematocysts are much bigger than mitochondria (~1–2 microns in length), and are more similar to the size of a mammalian cell nucleus (~10 microns in diameter).

Nematocysts have been described as the cnidarian's secret weapon. One scientific study[1] found that they only take about 3 milliseconds to fire, travelling at an average speed of 2 m/s and accelerating more than 40,000 g (astronauts experience 3 g during shuttle launch). This is one of the fastest reaction times in the animal world!

Given their variety, nematocysts can be useful in jellyfish identification. In 2015, scientists at the Queensland Museum and CSIRO discovered a new species of pygmy box jellyfish from southeast Queensland (unlike its more venomous tropical cousin, it is not considered dangerous). In their scientific paper[2] describing this new species, the authors identified three different types of nematocysts they found in the jellyfish specimens.

What's the Deal with Vinegar?

Some scientists and health authorities recommend pouring vinegar onto box jellyfish stings. This is because vinegar prevents any additional nematocysts from firing. Unfortunately, vinegar cannot stop the pain caused by the nematocysts that have already been discharged into the skin. **If stung, seek medical attention immediately or call 000.**



Caribbean box jellyfish (Tripedalia cystophora), first recorded in Australia by scientists from Queensland Museum and CSIRO. Photo: Queensland Museum, Merrick Ekins. More details in: Ekins, M. and Gershwin, L. (2014) 'First record of the Caribbean box jellyfish Tripedalia cystophora in Australian waters', Marine Biodiversity Records, 7.

1 Paper: Holstein, T, and Tardent, P. (1984). The ultrahigh-speed analysis of exocytosis: nematocyst discharge. Science 223: 830-834.
2 Paper: Gershwin, L. and Ekins, M. (2015). A new pygmy species of box jellyfish (Cubozoa: Chirodropida) from sub-tropical Australia. Marine Biodiversity Records 8. doi: 10.1017/S175526721500086X.

Have a look at the jellyfish nematocyst images on the next page. These images show what you would see if you were looking down a microscope at slides of jellyfish nematocysts from three objective lenses: the 10x, 20x and 40x. The eyepiece of the microscope also has a magnification of 10x. Can you figure out the total magnification of each image?

Pick one image, and make a scientific illustration of what you see. Be sure to label if the nematocysts are “fired” or “not fired.” Measure the length of one nematocyst (fired or not fired). Approximately how long is it in microns? Can you convert that to metres?

Jellyfish Nematocyst Images

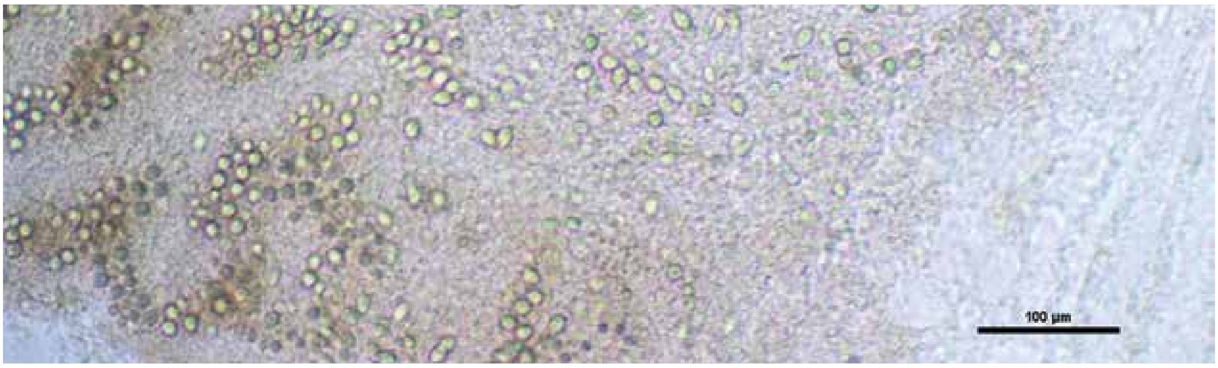


Image 1. Nematocysts from Pelagia noctiluca (Mauve Stinger) tentacles. 10x objective. Scale bar: 100 microns.

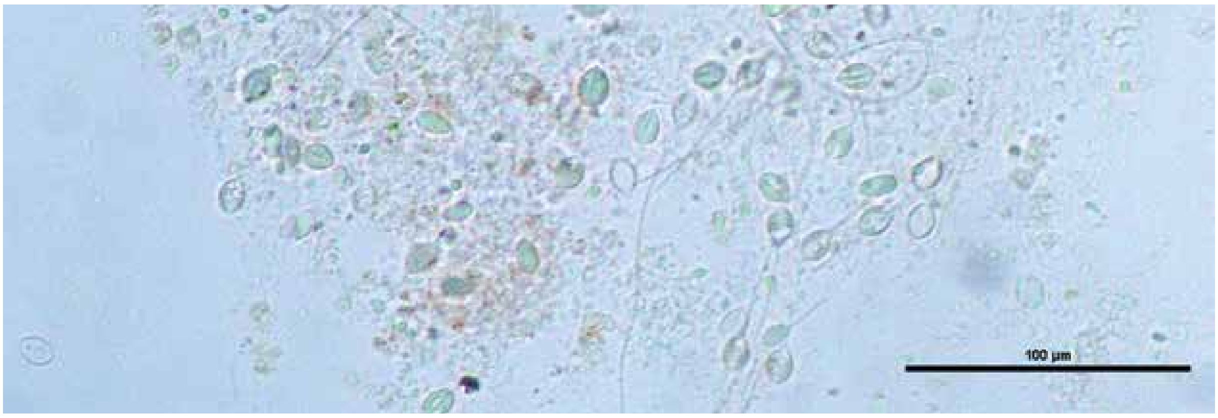


Image 2. Nematocysts from Pelagia noctiluca (Mauve Stinger) tentacles. 20x objective. Scale bar: 100 microns.

Image 3. Nematocysts from Pelagia noctiluca (Mauve Stinger) tentacles. 20x objective. Scale bar: 100 microns.

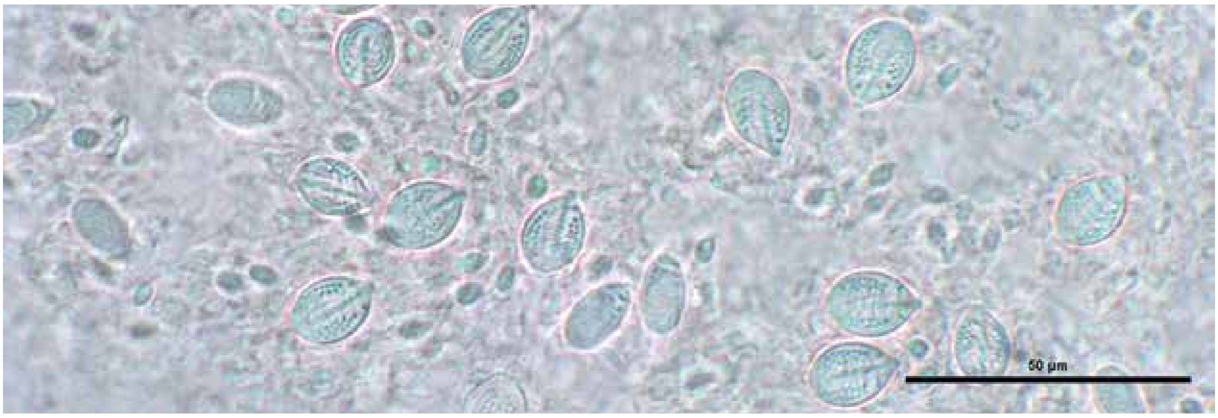


Image 4. Nematocysts from Pelagia noctiluca (Mauve Stinger) tentacles. 40x objective. Scale bar: 50 microns.

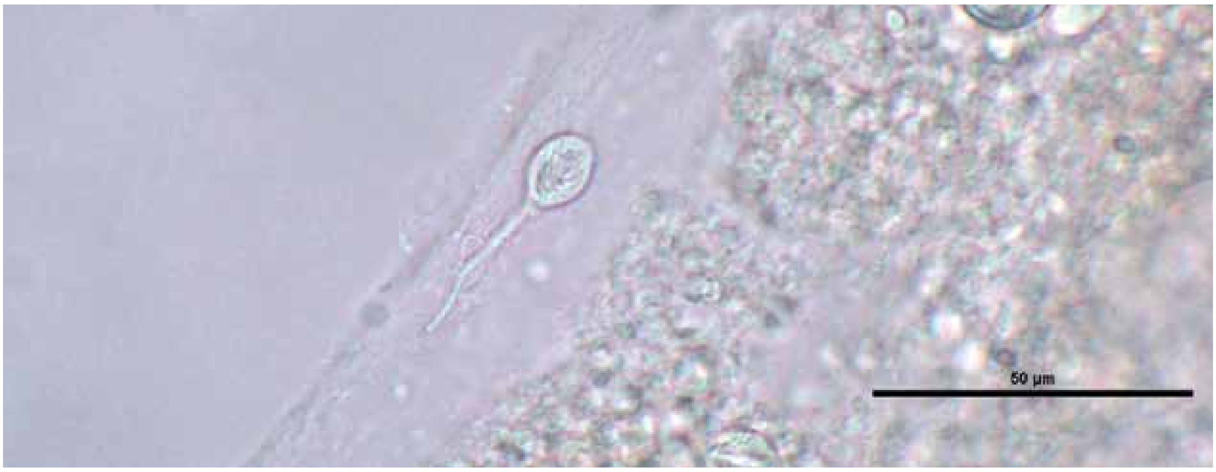


Image 5. Nematocysts from Pelagia noctiluca (Mauve Stinger) tentacles. 40x objective. Scale bar: 50 microns.

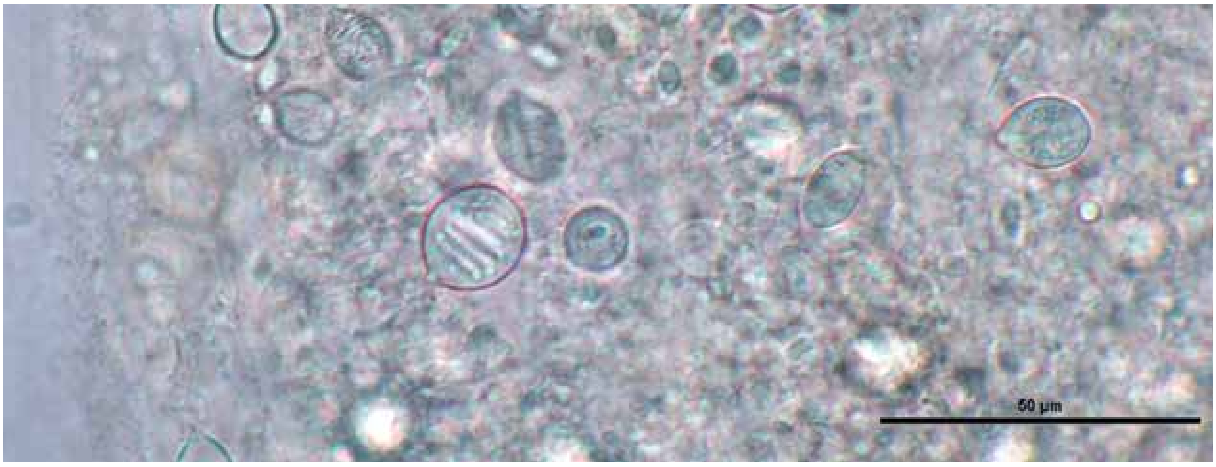


Image 6. Nematocysts from Pelagia noctiluca (Mauve Stinger) tentacles. 40x objective. Scale bar: 50 microns.

Image 7. Nematocysts from Pelagia noctiluca (Mauve Stinger) tentacles. 40x objective. Scale bar: 50 microns.

There are at least 30 different types of nematocysts, with varying shapes and arrangements of spines. Why do you think there are so many different kinds of nematocysts?

Hint: Think about how different kinds of cnidarians might use nematocysts in different ways.

Does viewing nematocysts up close change how you think about jellyfish or jellyfish stings? Why or why not?