Problematic Polymers

FUTURE MAKERS TEACHER RESOURCE

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM NETWORK | Queensland Government

Future Makers

Future Makers is an innovative partnership between Queensland Museum Network 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.

QUEENSLAND MUSEUM NETWORK

Queensland Government

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

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Contents

Workshop Overview

It can be difficult to imagine modern life without plastic. Despite its many uses, plastic has been criticised for its detrimental effects on our planet. Within this workshop, students collect and analyse the types of litter present in their local community. They explore the pros and cons associated with the use of plastic and investigate the impacts of plastics on living things and the environment. Finally, students examine ways to reduce our consumption of single use plastics and decrease the amount of waste polluting our environment by conducting an innovative experiment creating biodegradable and edible water 'bottles' made from brown algae.

Queensland Museum has been an authority on the investigation, documentation and conservation of Queensland's biodiversity for over 150 years. Through this research we have seen firsthand the growing problem of plastic pollution. We find plastics in sea birds, marine turtles, fish and even whales. While on expeditions studying life in the abyssal zone off eastern Australia, scientists from Queensland Museum have found plastics in previously unexplored areas, 4000 metres below the surface (in fact, plastics were collected in every sample).

Problematic Polymers aligns to the Australian Curriculum, and encourages students to think about how their everyday actions can impact the environment and the world around them. This workshop was also inspired by the Hatchery at the World Science Festival Brisbane, where you can see real turtles hatch and complete related activities about the impact of plastics on marine life.

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	**Plotting Against Waste** Collect and analyse the types of litter present in the local community.
EXPLORE	**All Bottled Up: Object Analysis** Observe and compare a glass/ceramic bottle and a plastic bottle to explore prior knowledge of materials, and examine the importance and proliferation of plastics.
EXPLORE	**Plastic Planet: Community of Inquiry** Participate in a community of inquiry to discuss the properties that make plastics useful and the impacts of plastics on the planet.
EXPLORE **EXPLAIN** **ELABORATE**	**A Pain in the Guts: Analysing Gut Contents** Investigate the impact of plastics on living things in a replicated gut content analysis activity.
EXPLAIN **ELABORATE**	**Queensland Museum: Where the Research Happens** Learn about life as a Queensland Museum curator, and explore what we can learn from fossils and faeces.
ELABORATE **EVALUATE**	**Finding Solutions: It's a Marathon** Investigate an innovative solution to our plastic problem by creating biodegradable and edible water 'bottles' made from brown algae.

ENGAGE

Plotting Against Waste

Teacher Resource

Waste generation accompanies all human activities. It is produced by households, institutions and businesses, and through demolition and construction activities. It can occur in solid, liquid and gaseous forms and, if not disposed of appropriately, can significantly impact the environment.

Waste that is out of place, that is waste that has been deliberately or accidentally left lying in an open or public space, is litter. Litter can be moved from place to place by wind, water, traffic and animals; it pollutes the environment, can harm living things and facilitates the spread of disease and pests. Despite the many problems associated with litter, we can all play a part in reducing and preventing its presence in our communities.

This activity is designed to set the context for future learning, create interest and stimulate curiosity. During the activity, students collect litter from their local community. They sort, count and analyse the litter that is collected, calculate the percentage frequency of collected litter types and represent this data using a pie chart. Students could also plot the location of litter on a map of their chosen collection site using a grid reference system, for example by drawing a grid reference over a map of the school grounds.

If desired, data that is collected by students can be entered into the Australian Marine Debris Database. This database enables individuals to collect data on the amounts and types of marine and terrestrial debris impacting environments around the country. A substantial number of specific categories are used to sort collected litter items. If entering data into the Australian Marine Debris Database, you may wish to share these categories (see following page) with students before they begin sorting collected litter items.

Many organisations such as schools and workplaces encourage staff to regularly collect litter, for example Queensland Museum staff pick up litter around the Cultural Centre Precinct every Thursday lunch (see *Queensland Museum: Where the Research Happens*). Students are encouraged to do the same in their local area.

Please note: Ensuring student safety during the litter collection is of utmost importance.
Explicitly discuss safety requirements with students prior to engaging in the activity, including:

- Litter that is and is not acceptable to pick up (i.e. glass, broken glass, jagged tin, medical or sanitary waste, animal waste).
- The wearing of personal protective equipment, including appropriate gloves, and/or use of pick up tongs throughout the litter collection.
- Washing hands with soap after completing the litter collection.

Australian Marine Debris Database Item Categories

Plastic packaging items

- Bleach and cleaner bottles
- Lids and tops, pump spray, flow restrictor and similar
- Mesh bags
- Packaging accessories
- Personal care and pharmaceutical packaging
- Plastic bags
- Plastic bottles, drums, jerry cans and buckets
- Plastic containers, non-food
- Plastic drink bottles
- Plastic packaging, food (wrap, packets, containers)
- Plastic sheeting (tarpaulin, woven bags, pallet wrap)
- Plastic wrap, non-food (bubble wrap etc.)
- Strapping band scraps
- Strapping band whole
- Synthetic cardboard (corflute) signs and packaging Plastic fishing items
- Aquaculture items
- Bait and tackle bags and packaging
- Bait containers and lids, bait savers
- Baskets, crates and trays
- Commercial fishing remnants (float, pot, crate bits)
- Commercial fishing traps, pots and intact parts
- Glow sticks
- Fishing line
- Fishing net
- Plastic buoys and floats
- Recreation fishing items (lures, floats, rods, reels)
- Rope and net scraps
- Rope

Plastic consumer items

- Childcare items
- Cigarette butts and filters
- Cigarette lighters
- Fibreglass fragments
- Pens, markers and other plastic stationary
- Plastic ceremonial and festive (wreaths, flowers)
- Plastic furniture, outdoor and camping
- Plastic gardening items, implements and fittings
- Plastic housewares, tablewares, house fittings
- Recreation and outdoor equipment
- Straws, confection sticks, cups, plates and cutlery
- Toothbrushes, brushes and combs, hair ties etc.
- Toys, party poppers, ribbons, clips and similar

Plastic industrial, commercial, shipping and miscellaneous

- Cable ties and plastic fasteners
- Carpet and lino household, boat deck and padding
- Marine safety, survival and boating equipment
- Municipal activities (tree guard, barrier fence etc.)
- Occupational health and safety items
- Plastic electrical cable, connectors and fittings
- Plastic oddments
- Plastic pipe PVC, irrigation and reticulation
- Plastic tubes and hoses
- Plastic vehicle parts
- Research items, oceanic
- Tags
- Tape adhesive, electrical, duct, hazard marker and rolls

Plastic remnants

- Plastic bits and pieces, hard and solid
- Plastic film remnants (bits of plastic bag, wrap etc.)
- Remnants burnt plastic

Foam items

- Drift net floats
- Foam buoys
- Foam cups, food packs and trays
- Foam insulation and packaging, whole and remnants
- Foam sponge and sheeting
- Weather balloon parts

Metal items

- Aerosol cans
- Aluminium cans
- Foil wrappers, packets, bladders and alfoil
- Metal fishing items (sinkers, lures, hooks, traps, pots)
- Metal bottle caps, lids and pull tabs
- Metal building and trade materials, fixings and fittings
- Metal buoys and floats
- Metal drums, cans and buckets over 4 litres
- Metal motor vehicle parts and batteries
- Metal outdoor equipment, implements and furniture
- Metal scrap and remnants
- Metal signs and sheeting
- Metal tools
- Metal unspecified
- Small machinery and electric motors
- Tins under 4 litres (food, drink tins etc.)
- Wire, metals stakes and pipes

Paper and cardboard items

- Miscellaneous paper, labels and tickets
- Newspaper, magazines and brochures
- Paper and cardboard packaging
- Tetra packs and drink cartons

Cloth items

- Binding, thread, string and cord, natural fibre
- Canvas, sailcloth and hessian materials
- Cloth, clothing, hats and towels
- Rope, natural

Rubber items

- Rubber balloons, balls and toys, elastic straps and bands
- Rubber buffers, tyres, seals and similar
- Rubber footwear and thongs
- Rubber remnants
- Rubber sheeting

Miscellaneous categories

- Unspecified non-plastic items
- Unspecified plastic items

Wood items

- Brooms, brushes and paint brushes
- Processed timber, pallets and other wood
- Wooden fishing items
- Wooden confection sticks, pencils, matches etc.
- Wooden furniture

Other materials

- Appliances, electronics and batteries
- Boat parts, wreckage and remnants
- Building and trade materials, fixings and fittings
- Food scraps
- Organic materials
- Shoes, leather and fabric
- Wax (surf wax candles, paraffin and similar)

Curriculum Links

Science

YEAR 5

Science as a Human Endeavour

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

Science Inquiry Skills

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

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

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

YEAR 6

Science as a Human Endeavour

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

Science Inquiry Skills

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)

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

YEAR 7

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 (ACSIS129)

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS130)

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

YEAR 8

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)

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

Mathematics

YEAR 5

Number and Algebra

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

Measurement and Geometry

Calculate perimeter and area of rectangles using familiar metric units (ACMMG109)

Estimate, measure and compare angles using degrees. Construct angles using a protractor (ACMMG112)

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)

YEAR 6

Number and Algebra

Select and apply efficient mental and written strategies and appropriate digital technologies to solve problems involving all four operations with whole numbers (ACMNA123)

Measurement and Geometry

Investigate, with and without digital technologies, angles on a straight line, angles at a point and vertically opposite angles. Use results to find unknown angles (ACMMG141)

Statistics and Probability

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

YEAR 7

Number and Algebra

Round decimals to a specified number of decimal places (ACMNA156)

Measurement and Geometry

Establish the formulas for areas of rectangles, triangles and parallelograms, and use these in problem-solving (ACMMG159)

Statistics and Probability

Construct and compare a range of data displays including stem-and-leaf plots and dot plots (ACMSP170)

Humanities and Social Sciences

YEAR 5

Knowledge and Understanding: Geography

The influence of people, including Aboriginal and Torres Strait Islander Peoples, on the environmental characteristics of Australian places (ACHASSK112)

The environmental and human influences on the location and characteristics of a place and the management of spaces within them (ACHASSK113)

Inquiry and Skills

Develop appropriate questions to guide an inquiry about people, events, developments, places, systems and challenges (ACHASSI094)

Locate and collect relevant information and data from primary sources and secondary sources (ACHASSI095)

Organise and represent data in a range of formats including tables, graphs and large- and small-scale maps, using discipline-appropriate conventions (ACHASSI096)

Interpret data and information displayed in a range of formats to identify, describe and compare distributions, patterns and trends, and to infer relationships (ACHASSI100)

Evaluate evidence to draw conclusions (ACHASSI101)

Present ideas, findings, viewpoints and conclusions in a range of texts and modes that incorporate source materials, digital and non-digital representations and discipline-specific terms and conventions (ACHASSI105)

General Capabilities

Numeracy

Estimating and calculating with whole numbers

Using fractions, decimals, percentages, ratios and rates

Using spatial reasoning

Interpreting statistical information

Using measurement

Critical and Creative Thinking

Inquiring – identifying, exploring and organising information and ideas

Reflecting on thinking and processes

Personal and Social Capability

Social management

Plotting Against Waste

Student Activity

Making Predictions

1. Before collecting litter, make predictions about the following:

   What types of litter do you think you will collect? Why?

Which type of material do you think will be most frequently collected? Why?

Which type of material do you think will be least frequently collected? Why?

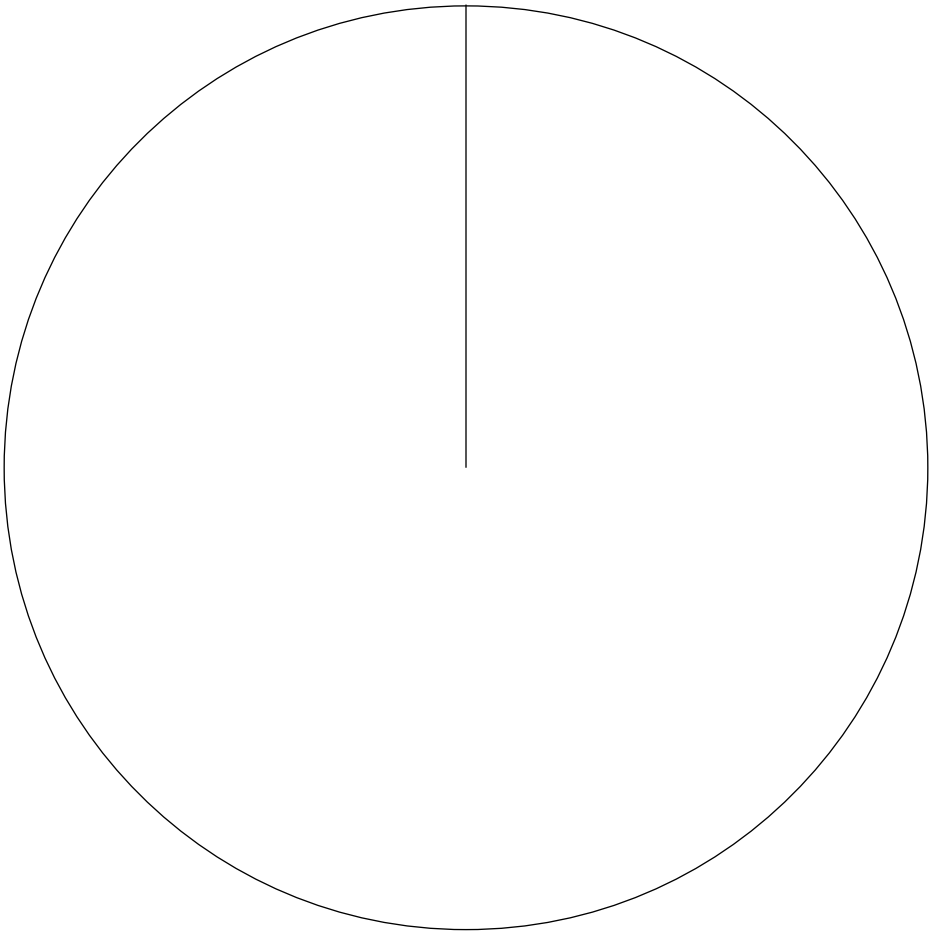
Analysis of Litter

Location	
Date	
Time	
Duration (hrs)	
Area Covered (m^2)	
Total Number of Litter Pieces Collected	

Litter Type	Tally	Total	Percentage of Total	Pie Chart Angle
Paper				
Plastic				
Metal				
Textiles				
Organic				
Composite with plastic				
Other composite				
Other				

Representing Results

1. Present the data you have collected in a pie chart.



Pie Chart Tips

- Write a title.
- Organise the segments by size, from largest to smallest working in a clockwise direction.
- Label each segment with the data type and percentage value.

Discussing Results

1. Identify the most frequently collected type of litter. Why do you think this was the most common type of litter collected at your chosen site?

2. Identify the least frequently collected type of litter. Why do you think this was the least common type of litter collected at your chosen site?

3. Did your results match your prediction? Why?

4. Compare your pie chart to another group's pie chart. Describe any similarities or differences you notice between the two pie charts.

5. Discuss possible reasons for any similarities or differences you observed.

6. Would you expect to find similar results if litter was collected in the following locations? Make sure to justify your response.
   - In a paddock
   - On the beach
   - Around a sporting field

7. Brainstorm some solutions! What could be done to reduce the amount of litter in your local community?

EXPLORE

All Bottled Up: Object Analysis

Teacher Resource

We use plastics every day, from working on a computer or driving in a car to eating our lunch. While natural polymers have been used for hundreds of years, the first synthetic plastic was Bakelite, developed in 1907. Before the invention of plastics, the only materials that could be moulded and shaped were potteries and glass and some natural substances like tree gums and rubber. Rubber wasn't very useful for storage because it eventually lost its ability to bounce back into shape and became sticky when heated.

This activity is designed to explore and build on students' prior knowledge of materials, and examine the importance and proliferation of plastics. Object-based learning is 'a mode of education which involves the active integration of authentic or replica material objects into the learning environment'[1] and is used to prompt investigation and promote student inquiry.

In this activity, students observe and compare a glass/ceramic bottle and a plastic bottle. They will identify features and explore advantages and disadvantages of the materials to identify why plastics have become such an integral part of human society. Students may want use a magnifying glass to scan for finer details.

You may wish to ask students to work through the object analysis table or use object analysis prompt cards. This activity can lead into the *Plastic Planet: Community of Inquiry*.

Students may wish to use objects from Queensland Museum's collection to complete this object analysis. These can be viewed at Queensland Museum Learning Resources (search 'bottle' and select 'image' and 'collection item' in more search options). See recommendations below:

- WM Shambrook Ginger Beer Bottle
- Glass Lamonts Drink Bottle
- Glass Kirks Drink Bottle

Additionally, Queensland Museum has many loan kits that highlight how life in Queensland has changed over the last 150 years. Many of these kits showcase what life was like before plastics. The Sustainable Living kit allows students to investigate common domestic items from the early 1900s and compare materials, waste and energy usage to the present. You may wish to learn more about how life has changed in the last 150 years by visiting any of the Queensland Museum campuses, or searching through other Queensland Museum loan kits.

[1] Jamieson, A. (2016). Object-based learning: A new mode in Arts West.
Retrieved from https://arts.unimelb.edu.au/articulation/editions/2016-editions/december-2016/object-based-learning-a-new-mode-in-arts-west

Curriculum Links

Science

YEAR 5

Science as a Human Endeavour

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 6

Science Understanding

Changes to materials can be reversible or irreversible (ACSSU095)

Science as a Human Endeavour

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

Science Understanding

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

YEAR 7

Science as a Human Endeavour

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE120)

Science Inquiry Skills

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

YEAR 8

Science as a Human Endeavour

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE135)

Science Inquiry Skills

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

YEAR 9

Science as a Human Endeavour

Values and needs of contemporary society can influence the focus of scientific research (ACSHE228)

Science Inquiry Skills

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

Design and Technologies

YEAR 5 AND 6

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)

YEAR 7 AND 8

Design and Technologies Knowledge and Understanding

Investigate the ways in which products, services and environments evolve locally, regionally and globally and how competing factors including social, ethical and sustainability considerations are prioritised in the development of technologies and designed solutions for preferred futures (ACTDEK029)

YEAR 9 AND 10

Design and Technologies Knowledge and Understanding

Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved (ACTDEK040)

Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions (ACTDEK041)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewing

Critical and Creative Thinking

Inquiring – identifying, exploring and organising information and ideas

Reflecting on thinking and processes

Personal and Social Capability

Social awareness

Ethical Understanding

Understanding ethical concepts and issues

Reasoning in decision making and actions

Intercultural Understanding

Interacting and empathising with others

Cross-Curriculum Priorities

Sustainability

Sustainable patterns of living rely on the interdependence of healthy social, economic and ecological systems. (OI.3)

World views are formed by experiences at personal, local, national and global levels, and are linked to individual and community actions for sustainability. (OI.5)

Actions for a more sustainable future reflect values of care, respect and responsibility, and require us to explore and understand environments. (OI.7)

Designing action for sustainability requires an evaluation of past practices, the assessment of scientific and technological developments, and balanced judgements based on projected future economic, social and environmental impacts. (OI.8)

All Bottled Up: Object Analysis

Student Activity

Object Analysis Prompt Cards

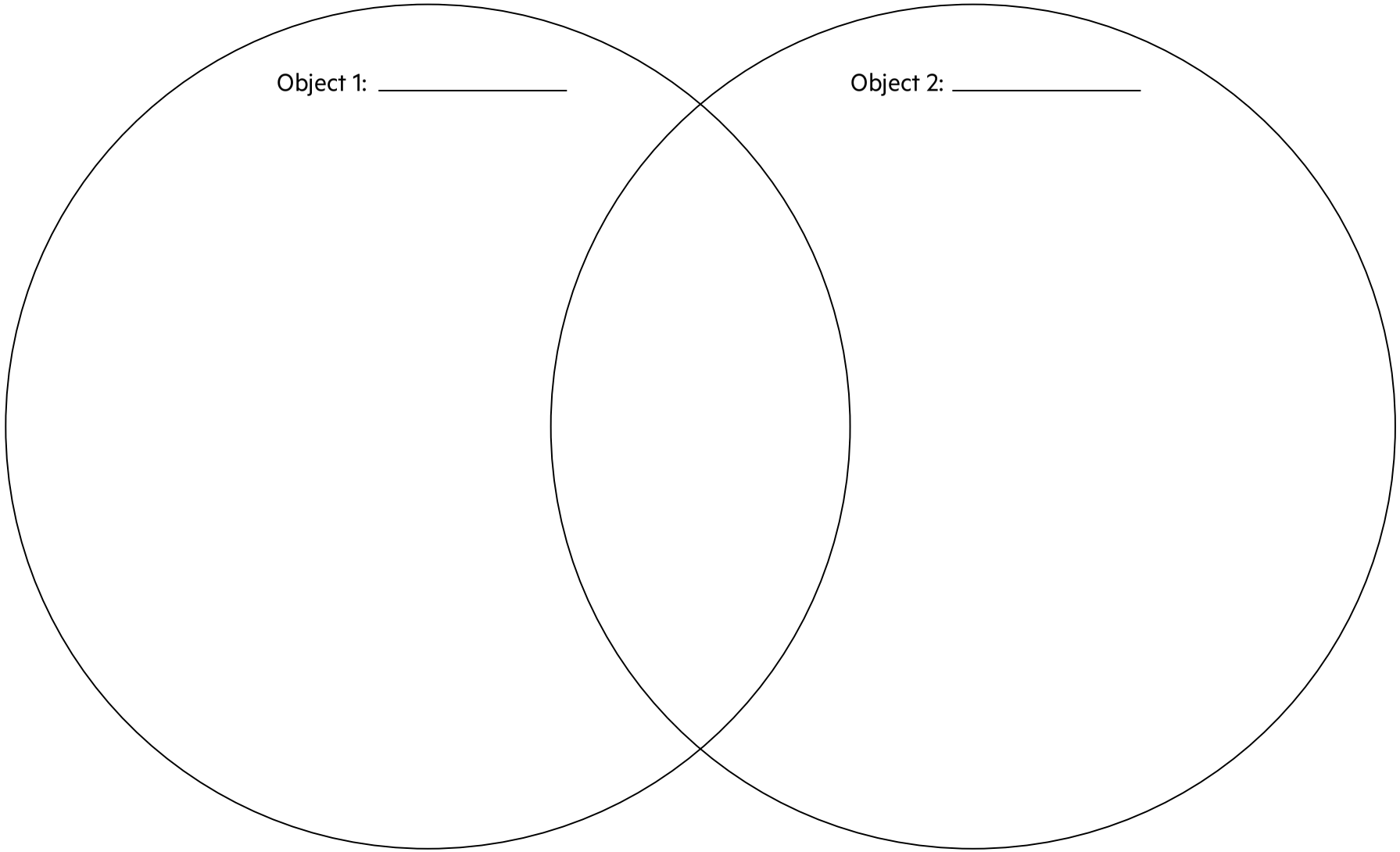
Description What does it look like?	**Size** What size is it?	**Date** When was it made?
Material What is it made from?	**Purpose** Why did people use it?	**User** Who used it?
Construction Who made it and how?	**Condition** What condition is the object in?	**Significance** Why was it collected?

Object Analysis Table

Question	Description
Description – What does it look like?	
Size – What size is it?	
Date – When was it made?	
Material – What is it made from?	
Purpose – Why did people use it?	
User – Who used it?	
Construction – Who made it and how?	
Condition – What condition is the object in?	
Significance – Why was it collected?	

Object Comparison

Compare the similarities and differences of the two objects. What are the advantages and disadvantages of their use?



EXPLORE

Plastic Planet: Community of Inquiry

Teacher Resource

In this activity, students participate in a community of inquiry to discuss the properties that make plastics useful and the impacts of plastics on the planet. This process provides students with an opportunity to reach a deep, shared understanding of the concepts and issues underpinning the inquiry topic. The activity could lead on from the object analysis *All Bottled Up* and/or the litter sorting activity *Plotting Against Waste*.

The community of inquiry is a process of discussion where participants pose open-ended questions, listen to the viewpoints of others, and share their own ideas. Disputed or contestable issues and concepts are considered collaboratively within a supportive and respectful learning environment. It is important that all participants reflect on their thinking.

The following ways of working are used during the community of inquiry process. These should be put up on a wall for all students to refer to throughout the process:

- Listen attentively to others
- Build upon and connect ideas
- Have respect for others, yourself and place
- Disagree reasonably and respectfully
- Many responses and opinions may be considered to be correct

Detailed step-by-step instructions for this activity can be seen below.

1. In small groups, students discuss the overarching question: ***Why do we use so much plastic?*** Remind students to give reasons for their answers. (Students may wish to start this activity with the object analysis *All Bottled Up* and/or the litter sorting activity *Plotting Against Waste.*)

2. Ask students to share their responses to these questions and you can record their answers on the whiteboard or butchers paper.

3. Pose the next question: ***Should we use plastic?*** Students should again discuss in small groups.

4. Ask students to share their responses to these questions and you can record their answers on the whiteboard or butchers paper. Record any questions posed by students on a separate page. These can be addressed in the future.

5. Keep a record of the responses to display around the room. These can be added or referred to throughout the unit.

Curriculum Links

Science

YEAR 5

Science as a Human Endeavour

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 6

Science as a Human Endeavour

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

Science Inquiry Skills

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

YEAR 7

Science as a Human Endeavour

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE120)

Science Inquiry Skills

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

YEAR 8

Science as a Human Endeavour

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE135)

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YEAR 9

Science as a Human Endeavour

Values and needs of contemporary society can influence the focus of scientific research (ACSHE228)

Science Inquiry Skills

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

Design and Technologies

YEAR 5 AND 6

Design and Technologies Knowledge and Understanding

Examine how people in design and technologies occupations address competing considerations, including sustainability in the design of products, services, and environments for current and future use (ACTDEK019)

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

YEAR 7 AND 8

Design and Technologies Knowledge and Understanding

Investigate the ways in which products, services and environments evolve locally, regionally and globally and how competing factors including social, ethical and sustainability considerations are prioritised in the development of technologies and designed solutions for preferred futures (ACTDEK029)

YEAR 9 AND 10

Design and Technologies Knowledge and Understanding

Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved (ACTDEK040)

Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions (ACTDEK041)

Humanities and Social Sciences

YEAR 5

Knowledge and Understanding: Geography

The influence of people, including Aboriginal and Torres Strait Islander Peoples, on the environmental characteristics of Australian places (ACHASSK112)

The environmental and human influences on the location and characteristics of a place and the management of spaces within them (ACHASSK113)

Knowledge and Understanding: Business and Economics

The difference between needs and wants and why choices need to be made about how limited resources are used (ACHASSK119)

Types of resources (natural, human, capital) and the ways societies use them to satisfy the needs and wants of present and future generations (ACHASSK120)

Influences on consumer choices and methods that can be used to help make informed personal consumer and financial choices (ACHASSK121)

YEAR 6

Knowledge and Understanding: Business and Economics

The effect that consumer and financial decisions can have on the individual, the broader community and the environment (ACHASSK150)

Geography

YEAR 9

Geographical Knowledge and Understanding

The effects of the production and consumption of goods on places and environments throughout the world and including a country from North-East Asia (ACHGK068)

YEAR 10

Geographical Knowledge and Understanding

Human-induced environmental changes that challenge sustainability (ACHGK070)

Environmental world views of people and their implications for environmental management (ACHGK071)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewing

Critical and Creative Thinking

Inquiring – identifying, exploring and organising information and ideas

Reflecting on thinking and processes

Personal and Social Capability

Self-management

Social awareness

Ethical Understanding

Understanding ethical concepts and issues

Reasoning in decision making and actions

Exploring values, rights and responsibilities

Intercultural Understanding

Interacting and empathising with others

Cross-Curriculum Priorities

Sustainability

Sustainable patterns of living rely on the interdependence of healthy social, economic and ecological systems. (OI.3)

World views are formed by experiences at personal, local, national and global levels, and are linked to individual and community actions for sustainability. (OI.5)

Actions for a more sustainable future reflect values of care, respect and responsibility, and require us to explore and understand environments. (OI.7)

Designing action for sustainability requires an evaluation of past practices, the assessment of scientific and technological developments, and balanced judgements based on projected future economic, social and environmental impacts. (OI.8)

EXPLORE - EXPLAIN - ELABORATE

A Pain in the Guts: Analysing Gut Contents

Teacher Resource

In 2018, the Department of the Environment and Energy released findings from the 2017-18 Australian Plastics Recycling Survey. Key findings from this survey indicated:

- A total of 3.4 million tonnes of plastics were consumed in Australia.
- A total of 320,000 tonnes of plastics were recycled.

Of the 3,080,000 tonnes of plastics that were not recycled, most were sent to landfill or ended up in the environment. Many plastics are not biodegradable; instead they break up into smaller and smaller pieces over time. As a result, most plastics never fully disappear and can exist in landfill and the environment for hundreds of years.

This plastic waste can cause a number of different problems for living things and can significantly affect their growth and survival. The ingestion of plastics, for example, can result in death through the perforation or impaction of the digestive system, false satiety and exposure to chemicals leaching from plastic[2]. To investigate the impact of plastic on the digestive system, you may wish to model the digestive system with your class (for example, the Making Poo experiment). Students can then add a hard piece of plastic and assess how it impacts the digestive system model.

Scientists from Queensland Museum are constantly analysing evidence from animals to learn more about them. The gut content of animals allows scientists to analyse feeding relationships; it can also show us the impact that human waste, particularly plastics, can have on these animals. This can be seen from the plastics found in the Flesh-footed Shearwater and Green Turtles, shown in the gut content photo plates. Floating litter is hazardous to many marine animals. The stomach of a rare Bryde's Whale (*Balaenoptera edeni*) that washed ashore in 2000 contained a mass of plastic sheets, bait bags, zip-lock bags, fertiliser bags, frayed rope, shopping bags and several metres worth of plastic strips. Some of this material may have been accidentally ingested, mistaken for food[3].

In this activity, students investigate the impact of plastics on living things as they explore and analyse replicated gut contents of five animals.

The See-Scan-Analyse strategy has been used to structure this activity. Detailed step-by-step instructions can be seen below. It is recommended that you use these instructions to guide your students through the activity.

[2] Schuyler, Q., Hardesty, D.B., Wilcox, C., & Townsend, K. (2012). To eat or not to eat? Debris selectivity by marine turtles. *PLoS ONE 7*(10), 1-9. doi: 10.1371/annotation/0215f07d-0265-485c-966f-aee192a18313

[3] Czechura, G. (2013). The Great Barrier Reef: A Queensland Museum Discovery Guide. South Brisbane, Queensland: Queensland Museum

1. Present the following information to students:

   - In 2018, the Department of the Environment and Energy released findings from the 2017-18 Australian Plastics Recycling Survey.
   - Key findings from this survey indicated:
     – A total of 3.4 million tonnes of plastics were consumed in Australia.
     – A total of 320,000 tonnes of plastics were recycled.

2. Ask students to calculate approximately how many tonnes weren't recycled.

3. Discuss the following questions with the class group. You may wish to use the Think-Pair-Share strategy during this time.

   - Where did these plastics go?
   - Why is this problematic?

4. Introduce the ingestion of plastics by animals as a problem associated with plastic waste, if not already discussed by students. State that some living things are more vulnerable to ingesting plastics than others, and the ingestion of plastics can significantly affect the growth and survival of these organisms.

5. Introduce the activity. Students will:

   - Use gut content analysis to explore plastics ingested by varied animals.
   - Use information gathered during the gut content analysis to identify which animals are likely to have ingested observed materials.

6. Divide students into groups of two or three and distribute the gut content photo plates. Students use the See-Scan-Analyse strategy to engage with the photo plates. Distribute the animal cards to students after they have completed the Scan questions. Ask students to identify which animal is likely to have ingested the material shown in each photo plate. Students then complete the Analyse questions. Answers can be revealed after students have finished this activity. It is important to note with students that the animal cards used in this activity also show the gastrointestinal tract, and each of the animals have digestive accessory organs, including the liver, pancreas and gall bladder.

   - See: View the gut content photo plates.
     List the ingested material seen for 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?

7. After the completion of the activity, facilitate a whole-class discussion. You may like to pose the following questions during the discussion:

    - Which animals did you match to which gut content plates?
      What informed your decisions?
    - How might the ingested items affect the growth and survival of each animal?
    - How and why do the digestive systems differ between animals?
    - Compare each animal's diet and their digestive systems. Use this comparison to explain differences between the digestive system of each animal, 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?
    - How might plastic waste affect food webs and food chains?
    - What does the gut content of each animal tell us about the influence of people on natural environments?
    - Could plastic waste create health problems for other animals living within these habitats? Which ones? What about humans?
    - Should we care about this issue? Why or why not?
    - How could we use this information to inform community action?
    - What further questions do we have about this issue? How might we find the answers to these questions?

The *Wild State* exhibition at Queensland Museum in South Brisbane highlights the extreme beauty, yet fragile state of each environment. It explores how we, the human race, need to protect and preserve our precious natural world for future generations. The *Death by plastic* display in this exhibition shows the plastics that have been found in five different species of seabird.

Curriculum Links

Science

YEAR 5

Science as a Human Endeavour

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

Science Inquiry Skills

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

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

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

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

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

Science Inquiry Skills

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)

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

YEAR 7

Science Understanding

Interactions between organisms, including the effects of human activities can be represented by food chains and food webs (ACSSU112)

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 (ACSIS129)

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS130)

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

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)

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)

Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems (ACSSU176)

Science Inquiry Skills

Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS170)

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

Humanities and Social Sciences

YEAR 5

Knowledge and Understanding: Geography

The influence of people, including Aboriginal and Torres Strait Islander Peoples, on the environmental characteristics of Australian places (ACHASSK112)

The environmental and human influences on the location and characteristics of a place and the management of spaces within them (ACHASSK113)

Inquiry and Skills

Locate and collect relevant information and data from primary sources and secondary sources (ACHASSI095)

Evaluate evidence to draw conclusions (ACHASSI101)

Work in groups to generate responses to issues and challenges (ACHASSI102)

Use criteria to make decisions and judgements and consider advantages and disadvantages of preferring one decision over others (ACHASSI103)

Reflect on learning to propose personal and/or collective action in response to an issue or challenge, and predict the probable effects (ACHASSI104)

Present ideas, findings, viewpoints and conclusions in a range of texts and modes that incorporate source materials, digital and non-digital representations and discipline-specific terms and conventions (ACHASSI105)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewing

Composing texts through speaking, writing and creating

Numeracy

Estimating and calculating with whole numbers

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 awareness

Social management

Intercultural Understanding

Interacting and empathising with others

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)

A Pain in the Guts: Analysing Gut Contents

Student Activity

	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

	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			

Gut Content Analysis: Student Photo Plates

Photo Plate 1

Gut Content Analysis: Student Photo Plates

Photo Plate 2

Gut Content Analysis: Student Photo Plates

Photo Plate 3

Gut Content Analysis: Student Photo Plates

Photo Plate 4

Gut Content Analysis: Student Photo Plates

Photo Plate 5

Gut Content Analysis: Teacher Photo Plates

Photo Plate 1 – Flesh-footed Shearwater

Gut Content Analysis: Teacher Photo Plates

Photo Plate 2 – Green 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

Flesh-footed Shearwater

Ardenna carneipes

Habitat

Coastal, Marine

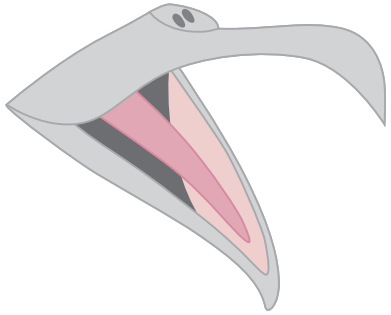
Interesting facts

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.

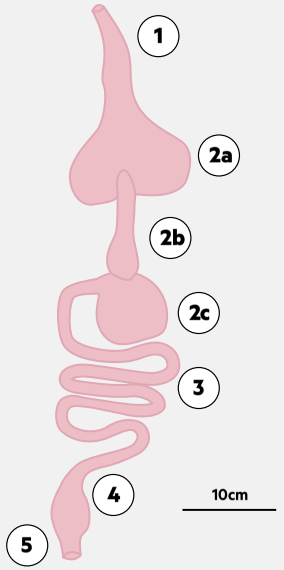
The Flesh-footed Shearwater is a trans-equatorial migrator, flying from the southern to the northern hemisphere after the breeding season.

Mouth



Gastrointestinal tract

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



Distribution

Green Turtle

Chelonioidea mydas

Habitat

Marine

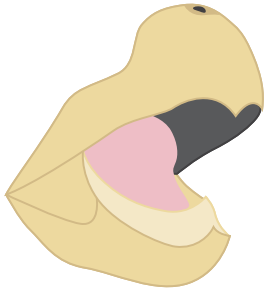
Interesting facts

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.

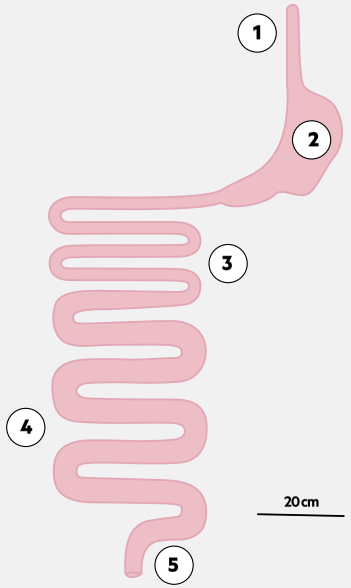
The oesophagus and mouth of sea turtles is lined with papillae, sharp prongs that point toward the stomach. Papillae help them hold onto and digest food.

Mouth



Gastrointestinal tract

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



Dingo

Canis lupus dingo

Distribution

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.

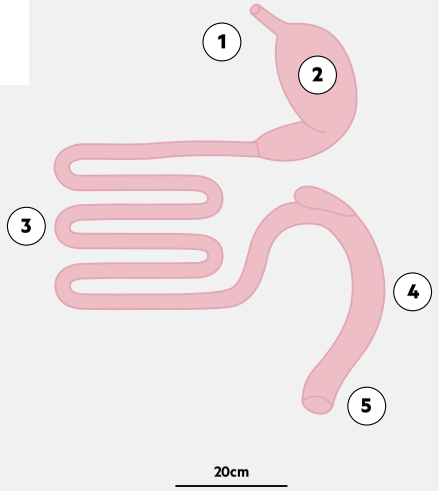
The colour of a Dingo's coat is largely determined by its environment.

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

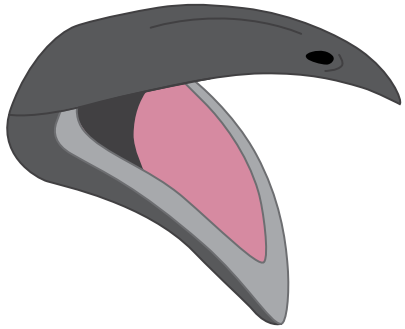
Interesting facts

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

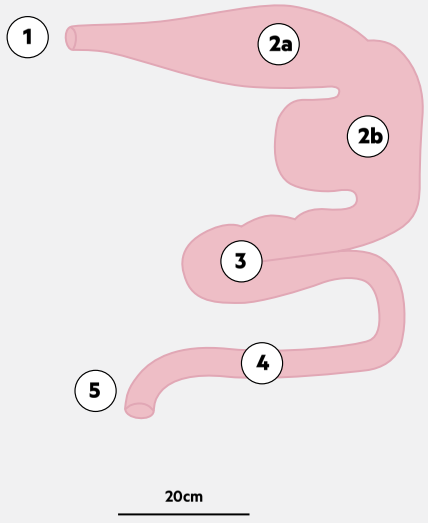
Cassowaries are keystone species due to their important role in seed dispersal. They have a short digestive system preventing the complete digestion of plant material. Due to this and their large size, they are the sole animal responsible for the distribution of over 100 species of plants.

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.

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

Distribution

Habitat

Open forest

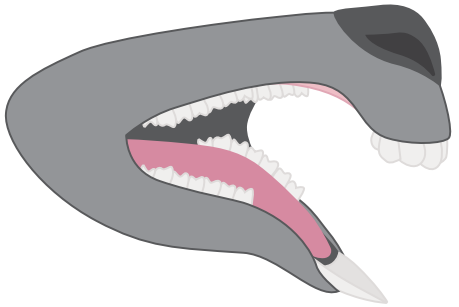
Interesting facts

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

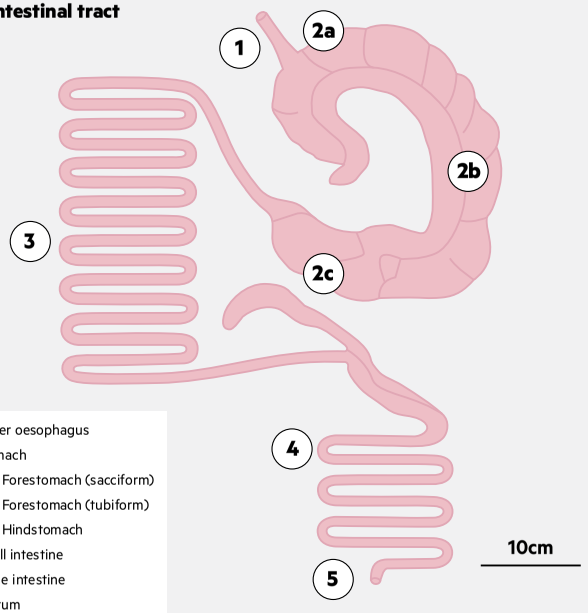
When full, a kangaroo's stomach can be up to 15% of its body mass.

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

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Human

Homo sapiens

Habitat

All

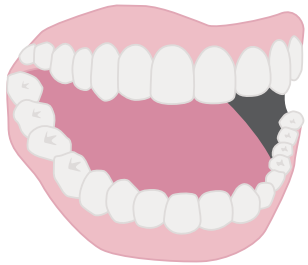
Interesting facts

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

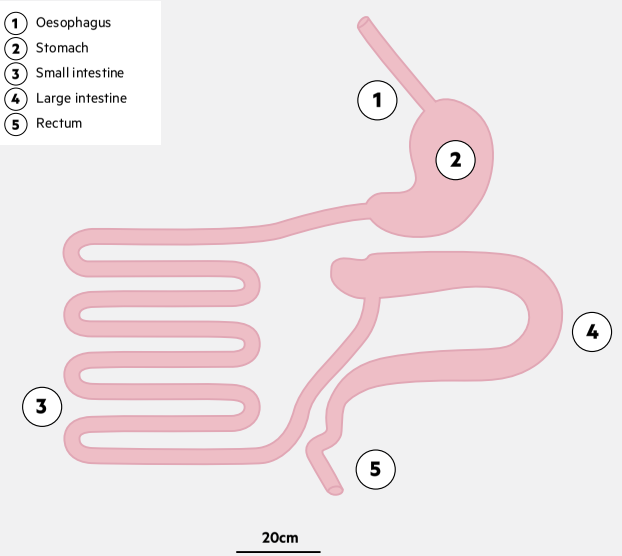
Scientific studies suggest the rate of human evolution increased with the advent of agriculture and cities.

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

Mouth



Gastrointestinal tract



EXPLAIN - ELABORATE

Queensland Museum: Where the Research Happens

Teacher Resource

Scientists at Queensland Museum have been studying Queensland's unique biodiversity for over 150 years. In these activities, learn about current research and be a scientist, analysing evidence from millions of years ago, and then your local environment, to make predictions.

Patrick Couper, Senior Curator of Reptiles and Amphibians

In this activity students learn about life as a curator at Queensland Museum, and the projects that Patrick Couper has worked on. Students will also learn why Patrick is so interested in plastics, and some ways he reduces his impact on the environment. Students are then encouraged to think about how they can reduce plastic consumption and litter and encourage others to do the same.

Fossil Food

In *A Pain in the Guts*, students become scientists analysing the gut content of Queensland animals. In this activity students will analyse the diet of extinct Queensland animals and use their prior knowledge to predict the structure of the digestive systems of dinosaurs and marine reptiles. They will also construct a food chain of an extinct marine reptile.

Students can learn more about these dinosaurs and extinct marine reptiles in the *Lost Creatures* exhibition at Queensland Museum in Brisbane.

The Queensland Museum Discovery Guide In Search of Ancient Queensland also showcases the outstanding fossil collections and research of the Queensland Museum, including pictures of coprolites, illustrations of corkscrew intestines and the gut content of an ankylosaur.

Fascinating Faeces

Scientists are forensic investigators, always collecting evidence to better understand the world. Students explore what palaeontologists can learn from coprolites (fossilised faeces). Students are then encouraged to explore their local environment to find evidence of living things and investigate what they can learn from this evidence.

Both the Queensland Museum Network Field Guide to Queensland Fauna App and Queensland Museum's Ask an Expert service can help provide more information if students have questions about what they have found. They can also drop into the Discovery Centre on Level 4 of Queensland Museum in Brisbane where knowledgeable staff can answer questions about Queensland's animals, rocks, fossils, people and history.

Curriculum Links

Science

YEAR 5

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

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

YEAR 6

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)

YEAR 7

Science Understanding

Interactions between organisms, including the effects of human activities can be represented by food chains and food webs (ACSSU112)

Science as a Human Endeavour

Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available (ACSHE119)

Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures (ACSHE223)

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE120)

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity (ACSHE121)

Science Inquiry Skills

Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge (ACSIS124)

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)

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

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE135)

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)

YEAR 9

Science Understanding

Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems (ACSSU176)

Science as a Human Endeavour

Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available (ACSHE119)

Values and needs of contemporary society can influence the focus of scientific research (ACSHE228)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewings

Critical and Creative Thinking

Inquiring – identifying, exploring and organising information and ideas

Generating ideas, possibilities and actions

Reflecting on thinking and processes

Ethical Understanding

Understanding ethical concepts and issues

Reasoning in decision making and actions

Queensland Museum: Where the Research Happens

Student Activity

Queensland Museum has been an authority on the investigation, documentation and conservation of Queensland's biodiversity for over 150 years. Through this research we have seen firsthand the growing problem of plastic pollution. Plastics are now commonly found in the digestive tracts of seabirds, marine turtles, fish and even whales. We have even found plastic waste in areas previously unexplored by humans, collecting samples from the abyssal zone off the eastern Australian coast, on the sea-floor, 4000 meters down.

A Chat with Patrick Couper, Senior Curator of Reptiles and Amphibians

Patrick Couper is the Senior Curator of Reptiles and Amphibians at Queensland Museum. Learn more about life working in a museum and how you can reduce your plastic consumption below.

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

  I was always interested in natural history and as a child I had collections of shells, feathers and rocks. A pivotal experience was visiting the Dominion Museum in Wellington, New Zealand, for a behind the scenes tour and seeing shelves of whale bones, drawers of study skins and a taxidermist at work. I set my sights on a museum career, studied zoology at university and learnt how to do taxidermy. These skills equipped me for a job at the Queensland Museum and led to my current position as Senior Curator of Reptiles and Amphibians.

Patrick Couper examining turtle skulls in the Queensland Museum's reptile collection (left) and monitoring nesting Flatback Turtles, Crab Island, north Queensland (right).

- **What is your favourite part of your work?**

  I enjoy all my work. Participating in a field survey assessing the status of a Tuatara population on a remote island off the east coast of New Zealand and studying marine turtles feeding in Moreton Bay stand out as career highlights. More recently, I've enjoyed my involvement in the World Science Festival's Turtle Hatchery and engaging with museum visitors.

- **Describe some of the projects that you are currently working on.**

  I am currently collaborating with other scientists working on the descriptions of two new burrowing skinks and investigating field sites to assess the status of some leaf-tailed gecko populations. A large part of my work over the last four years has involved the Hatchery at the World Science Festival Brisbane. This is a public engagement exercise that focuses on turtle research and the conservation and management of Loggerhead Turtles nesting along the southeast Queensland coast. The event highlights plastic waste in the oceans as a major problem for wildlife, particularly marine turtles during the open ocean stage of their life histories. As surface feeders they ingest small, hard pieces of plastic which result in gut blockages and death.

- **Why did you decide to undertake these projects?**

  The description of new species has always been a focus of my research. Although I'm particularly interested in geckos and burrowing skinks, my approach is largely opportunistic – if I suspect something is new I'll investigate it further. The Hatchery provides people with the opportunity to witness Loggerhead Turtle hatchlings emerging from their eggs. In natural circumstances it occurs 60 cm below the beach surface. It's a special event and is well received by museum visitors. It provides an opportunity to tell the story of Loggerhead Turtles nesting at Mon Repos, on the Bundaberg coast, the conservation successes and how Queensland scientists have unravelled many of their life history mysteries.

- **How did you become interested in working with plastics?**

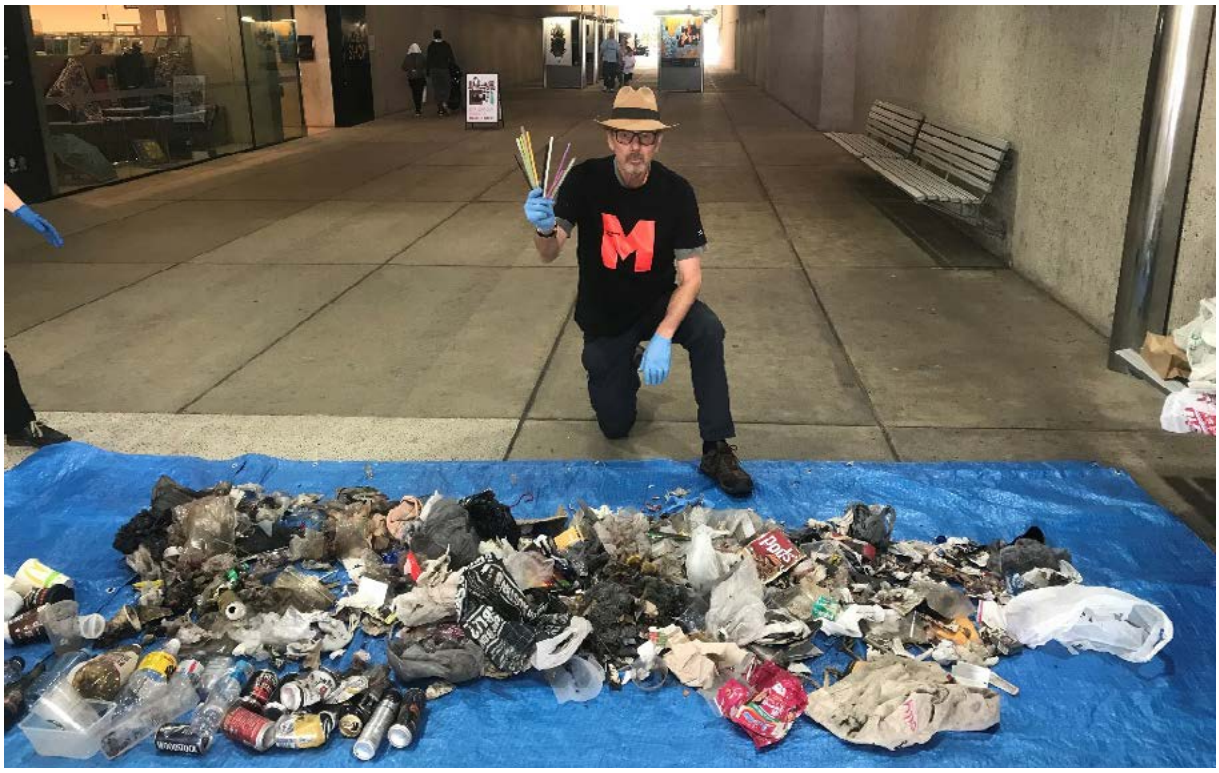
  Programs like Blue Planet 2 (BBC) and War on Waste (ABC) have brought the plastics issue to the forefront. It seems that everybody is now aware of the issues surrounding plastic waste and its terrible impacts on the environment and wildlife. Working in the World Science Festival Brisbane Hatchery gave us an opportunity to focus on plastic waste and to introduce a school program around this. I wanted to reduce my use of plastics and influence others to do the same, particularly students who, in turn, can influence their parents.

- **How have you seen plastics affect living things?**

  Like everyone else, I've seen televised images of marine turtles entangled in abandoned fishing nets (ghost nets) and seabirds and turtles dying from eating plastic waste. I've watched necropsies of post-hatchling turtles that have washed up dead along the Queensland coast and seen many with small, hard pieces of plastic in their guts. For the Hatchery, I've collected samples of plastic taken from the digestive tracts of turtles and seabirds and I've displayed these to show museum visitors the consequences of plastic waste entering the environment.

- **What do you do to reduce your impact on the environment?**

  I organise a walk from the museum every Thursday to remove rubbish, particularly plastic waste, from city streets. I recycle at home and work and deposit my soft plastics in the designated bins at shopping centres. I use a bamboo toothbrush, a keep-cup for my coffee and carry a reusable water bottle. I reduce the amount of plastic wrapping around products I buy and try to influence others to do the same.



Rubbish collected around Queensland Museum, Brisbane on a lunchtime litter walk.

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

  Study subjects you're interested in to a graduate or postgraduate level and be proactive in taking advantage of any opportunities that will increase your skill set. Many organisations take volunteers, and scientists and postgraduate students at universities are often looking for people to assist with field studies. I learnt taxidermy and skeletal preparation by volunteering in a small museum in the Zoology Department at the University of New England (Armidale) and this helped me to get a job at the museum. There are opportunities to volunteer in the Turtle Research Program at Bundaberg each summer and I would encourage any student interested in turtles or wildlife management to get involved. Make your face known to the people who work in these fields.

After seeing the effect of plastics on animals, particularly turtles, Patrick, Senior Curator of Reptiles and Amphibians at the Queensland Museum, is working to reduce his impact on the environment.

1. How could you reduce plastic consumption and litter in your area?

If you want to learn more about life as a curator, or see some baby Loggerhead Turtles, watch as Patrick Couper visits Mon Repos Turtle Rookery. Mon Repos is the most significant Loggerhead Turtle nesting population in the South Pacific region (located 15 minutes outside Bundaberg).

Fossil Food

Patrick is not the only person at Queensland Museum who studies the gut content of turtles. In fact, palaeontologists also study the gut content of turtles, the main difference being that their turtles are from the Cretaceous Period between 145 – 66 million years ago! The gut contents from turtles from the Cretaceous Period in Queensland show that they ate the bottom-dwelling bivalve, Inoceramus.

While fossilised records of gut contents are rare, the information they provide makes it possible to reconstruct the food webs that existed in ancient environments. For example, analysis of gut contents from a land dwelling, armoured ankylosaur confirms that it was a herbivore, eating ferns and other plants.

This specimen of ankylosaur, Kunbarrasaurus found near Richmond is the most complete dinosaur specimen from Australia. This specimen has rows of simple teeth to grind its food. Analysis of its fossilised gut content (right) revealed that it ate soft vegetation, including flowering plants, ferns and fruit. QMF18101, QM, Peter Waddington

Plesiosaur stomach stones. These marine reptiles often ingested stones to aid buoyancy and digestion. QMF18785. QM, Peter Waddington.

The gut contents of plesiosaurs reveal that these marine reptiles fed on the squid-like belemnites that also existed at this time. More interesting still, plesiosaur vertebrae have been found in the gut contents of pliosaurs, another type of marine reptile. This suggests that pliosaurs either hunted plesiosaurs, or scavenged on their remains.

You can find more information on fossils and the work of palaeontologists in the Queensland Museum Discovery Guide In Search of Ancient Queensland and in the *Lost Creatures* exhibition at Queensland Museum in Brisbane.

2. The animals mentioned above have been extinct for millions of years, but we can still learn about them from fossils.

   Using the information provided above, and the *Pain in the Guts* activity, predict the structure of the gastrointestinal tract of the extinct animals below. Draw a labelled diagram and justify your answer.

Predicted structure of the gastrointestinal tract of extinct Queensland animals

a) Turtle from the Cretaceous	b) Armoured ankylosaur	c) A pliosaur

3. Draw a pliosaur food chain.

Fascinating Faeces

Forensic-style analysis of animal remains, hair, scats, and other traces can provide valuable evidence of where animals have lived, what they were doing, and who was eating who. Queensland Museum's carefully preserved collections of animal specimens, as well as dried scats or poo, are a vital resource for nature detectives.

Fossilised faeces, known as coprolites, can also provide information about the diet of extinct animals. Coprolites associated with fish, amphibians and reptiles are known from the Triassic Period of Queensland and there are also a number of turtle coprolites from Cretaceous-age marine rocks.

In some cases, the shape of the coprolite can reveal which animal made the droppings. For example, sharks, rays and lungfish have a spiral valve, a corkscrew-like structure in the lower intestine, and some spirally twisted coprolites probably originated from these fishes. The size of the coprolite, alone, gives information about the size of the animal. Sections through coprolites may also provide information on the diet of the animal.

Corkscrew-like lower intestine. QM, Geoff Thompson

4. Look for evidence of animals in your local area. Record any evidence of animals and living things in the table below, and explain what you can learn from this evidence.

Evidence of living things	What we can learn from this evidence

You may wish to use the Queensland Museum Network Field Guide to Queensland Fauna App to identify animals that may live in your local area.

Have a question about something you found? You can ask the helpful and knowledgeable staff at Queensland Museum questions about Queensland's animals, rocks, fossils, people, history and more! Just complete the question form on Queensland Museum's Ask an Expert, or drop into the Discovery Centre on Level 4 of Queensland Museum in Brisbane. Here you can also see (and touch!) more examples of coprolites (fossilised faeces).

ELABORATE - EVALUATE

Finding Solutions: It's a Marathon

Teacher Resource

Scientists, engineers, entrepreneurs, communities and individuals are all investigating ways to reduce the consumption of single use plastics and decrease the amount of waste polluting our environment.

In this activity, students explore an innovative solution to this problem by creating biodegradable and edible water 'bottles' made from brown algae. These edible water bottles, called Ooho, were one of the sustainability solutions implemented during the 2019 London Marathon to reduce the use of over 200,000 plastic water bottles.

You may wish to work through each of the following activities, or choose the parts that are most relevant to your class.

Part 1: Preparing Materials

Instructions for creating sodium alginate and calcium lactate solutions used in the *Edible Water 'Bottle' Experiment*. You may wish to pre-prepare solutions for students, or have the students prepare the solutions in groups.

Part 2: Edible Water 'Bottle' Experiment

Students will create their water 'bottles' using the process of reverse spherification. This process is commonly used in molecular gastronomy to create spheres of juice, preserves or jam. If students are having trouble creating their water 'bottles' you may ask them to add the calcium lactate solution to the sodium alginate and leave the mixture without touching it for 5 minutes, when they can submerge the ice cube for 30 seconds, and then leave it untouched until it has melted completely. Playing with the water 'bottles' while they are forming can cause them to burst, releasing calcium lactate solution into the sodium alginate. When this happens, alginate slime may be formed rather than the 'bottle'.

This experiment can be conducted using different amounts of calcium lactate and sodium alginate, depending on the materials available. Additionally, you may wish to complete the experiment using kitchen equipment rather than science equipment (e.g. cups rather than a 500 ml beaker) if you want to allow students to eat their water 'bottles'. Water 'bottles' should only be consumed if they are made under food-safe conditions, following the safely guidelines of your school.

Part 3: Elements, Compounds and Mixtures (Year 8 Science)

Students analyse the changes that occur throughout the experiment, identifying physical and chemical changes and how these changes impact the properties and arrangement of particles. They will also examine the number of atoms and elements found in one monomer of calcium alginate.

Part 4: Ions and Chemical Reactions (Year 9 Science)

In Part 4, students investigate how ions impact chemical reactions, exploring the impact of calcium chloride and sodium chloride on alginate. Students will conduct an experiment, and then analyse the results with a focus on the charge of calcium and sodium ions.

Part 5: Design Evaluation (Design and Technologies)

In Part 2 of this activity, students created an edible and biodegradable water 'bottle' using sodium alginate from brown algae. In Part 5, students will evaluate the water 'bottles' to determine if they are a viable alternative to plastic water bottles.

Part 6: Future Solutions (Design and Technologies)

In Part 6, students will design an innovative solution to reduce the problem of single-use plastics. You may wish to develop the criteria for success as a class or model how criteria for success may be developed in *Part 5: Design Evaluation*. Students may pitch their ideas to the class and share feedback. You may also wish to submit student design solutions to one of the many environmental/sustainability design challenges that are scheduled throughout the year.

Curriculum Links

Science

YEAR 6

Science Understanding

Changes to materials can be reversible or irreversible (ACSSU095)

Science as a Human Endeavour

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

Science Inquiry Skills

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)

YEAR 8

Science Understanding

Differences between elements, compounds and mixtures can be described at a particle level (ACSSU152)

Properties of the different states of matter can be explained in terms of the motion and arrangement of particles (ACSSU151)

Chemical change involves substances reacting to form new substances (ACSSU225)

Science as a Human Endeavour

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE135)

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)

Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (ACSIS140)

Measure and control variables, select equipment appropriate to the task and collect data with accuracy (ACSIS141)

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

All matter is made of atoms that are composed of protons, neutrons and electrons; natural radioactivity arises from the decay of nuclei in atoms (ACSSU177)

Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed (ACSSU178)

Science as a Human Endeavour

Values and needs of contemporary society can influence the focus of scientific research (ACSHE228)

People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities (ACSHE160)

Science Inquiry Skills

Formulate questions or hypotheses that can be investigated scientifically (ACSIS164)

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)

Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS170)

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

YEAR 10

Science Understanding

The atomic structure and properties of elements are used to organise them in the Periodic Table (ACSSU186)

Different types of chemical reactions are used to produce a range of products and can occur at different rates (ACSSU187)

Science as a Human Endeavour

People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities (ACSHE194)

Values and needs of contemporary society can influence the focus of scientific research (ACSHE230)

Science Inquiry Skills

Formulate questions or hypotheses that can be investigated scientifically (ACSIS198)

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 (ACSIS199)

Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS204)

Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS208)

Design and Technologies

YEAR 5 AND 6

Design and Technologies Knowledge and Understanding

Examine how people in design and technologies occupations address competing considerations, including sustainability in the design of products, services, and environments for current and future use (ACTDEK019)

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)

Negotiate criteria for success that include sustainability to evaluate design ideas, processes and solutions (ACTDEP027)

Develop project plans that include consideration of resources when making designed solutions individually and collaboratively (ACTDEP028)

YEAR 7 AND 8

Design and Technologies Knowledge and Understanding

Investigate the ways in which products, services and environments evolve locally, regionally and globally and how competing factors including social, ethical and sustainability considerations are prioritised in the development of technologies and designed solutions for preferred futures (ACTDEK029)

Design and Technologies Processes and Production Skills

Critique needs or opportunities for designing and investigate, analyse and select from a range of materials, components, tools, equipment and processes to develop design ideas (ACTDEP035)

Select and justify choices of materials, components, tools, equipment and techniques to effectively and safely make designed solutions (ACTDEP037)

Independently develop criteria for success to evaluate design ideas, processes and solutions and their sustainability (ACTDEP038)

Use project management processes when working individually and collaboratively to coordinate production of designed solutions (ACTDEP039)

YEAR 9 AND 10

Design and Technologies Knowledge and Understanding

Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved (ACTDEK040)

Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions (ACTDEK041)

Investigate and make judgments on how the characteristics and properties of materials, systems, components, tools and equipment can be combined to create designed solutions (ACTDEK046)

Design and Technologies Processes and Production Skills

Critique needs or opportunities to develop design briefs and investigate and select an increasingly sophisticated range of materials, systems, components, tools and equipment to develop design ideas (ACTDEP048)

Evaluate design ideas, processes and solutions against comprehensive criteria for success recognising the need for sustainability (ACTDEP051)

Work flexibly to effectively and safely test, select, justify and use appropriate technologies and processes to make designed solutions (ACTDEP050)

Develop project plans using digital technologies to plan and manage projects individually and collaboratively taking into consideration time, cost, risk and production processes (ACTDEP052)

Humanities and Social Sciences

YEAR 6

Knowledge and Understanding: Business and Economics

The effect that consumer and financial decisions can have on the individual, the broader community and the environment (ACHASSK150)

How the concept of opportunity cost involves choices about the alternative use of resources and the need to consider trade-offs (ACHASSK149)

Inquiry Skills

Develop appropriate questions to guide an inquiry about people, events, developments, places, systems and challenges (ACHASSI122)

Examine different viewpoints on actions, events, issues and phenomena in the past and present (ACHASSI127)

Evaluate evidence to draw conclusions (ACHASSI129)

Work in groups to generate responses to issues and challenges (ACHASSI130)

Use criteria to make decisions and judgements and consider advantages and disadvantages of preferring one decision over others (ACHASSI131)

Reflect on learning to propose personal and/or collective action in response to an issue or challenge, and predict the probable effects (ACHASSI132)

Present ideas, findings, viewpoints and conclusions in a range of texts and modes that incorporate source materials, digital and non-digital representations and discipline-specific terms and conventions (ACHASSI133)

Geography

YEAR 9

Geographical Knowledge and Understanding

The effects of the production and consumption of goods on places and environments throughout the world and including a country from North-East Asia (ACHGK068)

YEAR 10

Geographical Knowledge and Understanding

Human-induced environmental changes that challenge sustainability (ACHGK070)

Environmental world views of people and their implications for environmental management (ACHGK071)

General Capabilities

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

Self-management

Social awareness

Social management

Ethical Understanding

Understanding ethical concepts and issues

Reasoning in decision making and actions

Exploring values, rights and responsibilities

Cross-Curriculum Priorities

Sustainability

Sustainable patterns of living rely on the interdependence of healthy social, economic and ecological systems. (OI.3)

World views are formed by experiences at personal, local, national and global levels, and are linked to individual and community actions for sustainability. (OI.5)

Actions for a more sustainable future reflect values of care, respect and responsibility, and require us to explore and understand environments. (OI.7)

Designing action for sustainability requires an evaluation of past practices, the assessment of scientific and technological developments, and balanced judgements based on projected future economic, social and environmental impacts. (OI.8)

Sustainable futures result from actions designed to preserve and/or restore the quality and uniqueness of environments. (OI.9)

Finding Solutions: It's a Marathon

Student Activity

Problematic Polymers

Scientists from Queensland Museum have found plastics in turtles, seabirds, whales, and even on the unexplored ocean floor 4000 m below the water surface. Some of the plastics that we have found can be seen in the *Death by plastics* display in *Wild State*. They have also been displayed through the Hatchery during the World Science Festival Brisbane.

By 2050 it is predicted there will be more plastic than fish in the world's oceans[4], and this is harming our wildlife. Humans purchase over one million plastic bottles per minute. Most of these are not recycled and may end up in landfill or in our oceans where they slowly break down into smaller pieces of plastic and can last hundreds of years.

Plastic pollution is a huge problem that people all over the world are working to solve. Scientists at Queensland Museum are trying to raise awareness of this issue in order to encourage people to reduce their consumption of plastic and to dispose of waste thoughtfully. Other solutions being implemented in Australia are based on policy changes, for example removing free plastic bags from the supermarkets, or public awareness campaigns such as encouraging people to refuse plastic straws, while other groups are working on engineered solutions to our plastic problem.

London Marathon

The London Marathon is one of the largest races worldwide. In 2018, 919,000 plastic bottles were used by participants in the marathon. To reduce the amount of plastic waste created by the London Marathon, many sustainability initiatives were implemented in 2019 to reduce the environmental impact of the marathon. One of these initiatives was a trial of Ooho, edible and biodegradable seaweed capsules filled with sports drink, which were used to replace plastic cups or bottles at one drink station. In total, the number of plastic bottles used in the London Marathon decreased by over 200,000 due to the sustainability initiatives that were enacted between the 2018 and 2019 marathon.

Runners in the London Marathon, and piles of plastic bottles left on the roadside after the marathon.

[4] Neufeld, L., Stassen, F., Sheppard, R., & Gilman, T. (2016). The new plastics economy: rethinking the future of plastics. *In World Economic Forum*.

Polymers and Monomers

A polymer is a large molecule (macromolecule), made up of many small molecule repeating units (known as monomers). While plastics are environmentally problematic polymers derived from fossil fuels, many polymers occur naturally in the environment and in biological systems (e.g. cotton, starch, silk, wool, natural rubber). Your body is made of some of these polymers, including proteins made of amino acids and your DNA (deoxyribonucleic acid is composed of repeating nucleotides).

Sustainable Seaweed, Amazing Algae

Brown algae (also known as kelp or brown seaweed) is often exposed to rough seas, so it needs to be tough and flexible. The flexibility of brown algae is caused by the presence of the natural polymer sodium alginate in its cell walls.

Brown algae grows in the marine environment, providing habitat and food for other marine organisms. It is tough and flexible to survive rough seas and strong currents.

Brown algae is processed to extract the sodium alginate, which is used commonly to thicken and stabilise food mixtures, such as ice cream, pudding, canned fruit, the pimento strips in green olives and even canned dog food! It is also used in indigestion tablets and for moulding and casting, including in the creation of dental impressions. Sodium alginate is also used in molecular gastronomy, a food science discipline that uses science to create unusual textures and an exciting food experience.

Sodium alginate from brown algae can be used in spherification, where liquids are solidified or gelled into spheres, for example to create spheres of juices or flavoured 'caviar'.

Finding Solutions: It's a Marathon

Part 1: Preparing Materials

Preparing your materials

To complete the edible water bottle experiment you will need to prepare a solution of sodium alginate, and prepare and freeze a solution of calcium lactate.

Materials

1 heaped tbs calcium lactate

1 heaped tbs of alginate

2 L distilled water

1 x blender

1 x 1 L measuring jug

1 x large ice cube tray

6 x ½ cup measurements (approximately, you could use any small container)

Preparing calcium lactate solution

1. Add 1 heaped tablespoon of calcium lactate to 1 litre of water.
2. Use a blender to mix until the calcium lactate has completely dissolved. You may wish to add some food colouring.
3. Pour calcium lactate solution into an ice cube tray and place in a freezer until completely frozen. Pour the remaining calcium lactate solution into ½ cup containers.
4. Place in freezer and leave until frozen through.

Preparing sodium alginate solution

1. Add 1 heaped tablespoon of alginate and 1 L of distilled water into a clean blender. Blend until the alginate has completely dissolved.
2. Pour the alginate solution into a large bowl and leave for 1 hour to eliminate bubbles.

Finding Solutions: It's a Marathon

Part 2: Edible Water 'Bottle' Experiment

Aim

Use chemistry to create a biodegradable and edible water 'bottle'!

Creating Your Water 'Bottle'

Materials

300 mL of sodium alginate solution

Calcium lactate ice cubes

1 x 500 mL beaker

Soup spoon

Slotted spoon

Water

Timer

Method

1. Pour 300 mL of sodium alginate solution into a 500 mL glass beaker.
2. Warm the sodium alginate solution in a microwave for 45 seconds.
3. Gently drop a calcium lactate ice cube into the sodium alginate. Start the timer. After one minute, use your finger to gently submerge the calcium ice cube for 3 seconds. Repeat after every minute, making observations.
4. Once the calcium ice cube has completely melted, use your hand or a slotted spoon to gently remove the water 'bottle' from the alginate solution and place in a bowl of water to rinse. The water 'bottle' is now ready to eat!
5. Repeat steps 1 to 3 with ½ cup frozen calcium lactate solution for an even larger water 'bottle'!

Results

Record your observations.

Draw a diagram or attach a labelled picture of the product.

How did the properties of the materials change throughout the experiment?

Part 3: Elements, Compounds and Mixtures

Draw the arrangement of particles:

a) Before the calcium solution has been placed in the freezer.	b) Immediately after the calcium solution has been removed from the freezer.

Why is a frozen solid calcium solution used for this experiment, rather than a liquid calcium solution? Include information on the properties of matter.

Why is the alginate solution heated before adding the frozen calcium solution? Include information on the properties of matter.

Does a physical or chemical change occur when the calcium lactate ice cube is placed into the sodium alginate? Why?

One of the products in this experiment is calcium alginate. The formula for calcium alginate is $C_{12}H_{14}CaO_{12}$. Explain if this is an element, compound or a mixture.

Record the name and number of each element in $C_{12}H_{14}CaO_{12}$ in the table below.

Element Name	Chemical Symbol	Number of atoms

How many elements are in calcium alginate?

How many atoms are in a monomer of calcium alginate?

Part 4: Ions and Chemical Reactions

In Part 4 of this activity you will investigate how the charge of an ion may impact the chemical reaction.

1. Complete the table below
   a) Use the periodic table to find sodium and calcium.
   b) Draw the structure of the atoms below, showing the protons, neutrons and electrons.
   c) Explain how each atom forms an ion.
   d) Draw the structure and charge of the ion, include protons, neutrons and electrons.

Atom	Sodium	Calcium
Draw the atom		
How does this atom form an ion?		
Draw the ion, including the charge		

2. Sodium can form the ionic compound sodium chloride, while calcium can form calcium chloride. What is an ionic compound, and how are these ionic compounds formed?

Ions and Chemical Reactions

In this experiment you will compare the effect of sodium chloride and calcium chloride on alginate, and identify how ions can impact chemical reactions.

Materials

Sodium alginate solution

2 g sodium chloride (NaCl)

2 g calcium chloride ($CaCl_2$)

200 mL distilled water

2 x 200 mL beaker

2 x plastic pipette

Method

1. Prepare a sodium alginate solution using the instructions in Part 1.
3. Add 2 grams of sodium chloride to 100 mL of distilled water and stir until dissolved. Label the beaker Na^+.
4. Add 2 grams of calcium chloride to 100 mL of distilled water and stir until dissolved. Label the beaker Ca^{2+}.
5. Use a clean pipette to pour a thin stream of alginate into the sodium chloride solution.
   NOTE: Hold the pipette above the sodium and calcium salt solutions; do not dip the end of pipette into the salt solutions.
6. Leave for 3 minutes, record observations and use a slotted spoon to try and remove the alginate from the salt solution.
7. Repeat steps 4 and 5 with the calcium chloride solution.

Variables

Record the variables in the table below.

Independent variable	Dependent variable	Control variables

Hypothesis

Write a hypothesis for the experiment.

Results

Record your observations.

Sodium chloride (NaCl)	Calcium chloride ($CaCl_2$)

Explain what the results found.

Discussion

Explain why these results occurred.

Your answer should include the words in the word bank below.

ion	bonds	chemical reaction	periodic table	electrons	charge

Complete the table below to analyse the chemical reaction.

Unbalanced Equation
____ $C_6H_7NaO_6$ + ____ $CaCl_2$ $\longrightarrow$ ____ $C_{12}H_{14}CaO_{12}$ + ____ NaCl
Write the balanced equation below.
Write the word equation below.
Identify reactants and products.

Part 5: Design Evaluation

What are some advantages of this edible water 'bottle'?

Do you think that this is a viable alternative to plastic water bottles? Consider criteria that alternatives would require for successful use.

Can you think of other uses for the water 'bottle'?

How could you improve this design?

Once you have brainstormed design improvements you may wish to make these changes and repeat the experiment, or move to *Part 6: Future Solutions*.

Part 6: Future Solutions

We know that single use plastics pose a major threat to our environment. How can you fix this problem?

In this activity you will design an innovative solution to the world's plastic problem.

You will either develop a solution to:

a) Reduce the consumption of single use plastics;

b) Reduce the amount of plastics in our oceans and/or environment;

c) Improve our recycling solutions; or

d) Improve the edible and biodegradable water 'bottle' you made in Part 2 of this activity.

How could you reduce the impact of plastics on our planet?

You will:

- **Investigate** how plastics impact our environment and look at current solutions to improve this problem. Develop criteria that solutions would need to meet to successfully improve our plastic problem (success criteria).
- **Design** an innovative solution to the plastic problem, and develop a project plan to manage the development and implementation of your solution. You should consider success criteria in your design.
- **Create** your design solution.
- **Test** your design solution and evaluate it against the success criteria.
- **Refine** your design solution to better solve the problem and meet the success criteria.
- **Evaluate** the design solution continuously against the success criteria, and make changes to improve the design.
- **Collaborate** with your team members, pitch your design and respond to feedback from other teams.

Appendix 1: Additional Activities

Identifying Nurdles

Nurdles are small plastic pellets about the size of a lentil, used as raw materials to produce nearly all of our plastic products. Countless billion are used each year, but many of these end up washing up on our shores.

An excellent activity involves collecting samples of sand from the beach and having students go through the sand to identify the nurdles. They are hard to find as they discolour over time, however this is a great example to show students that plastic waste washes up everywhere and you often cannot see it.

More information:

- ABC Science – Most plastic on our beaches could have come from anywhere. But not the Durban nurdle.
- Nurdle Hunt – Nurdle Free Oceans

Beat the Microbead

Microbeads are a type of microplastic used in cosmetics for scrubbing or exfoliating. These flow straight from the bathroom drain into the sewer system and then the ocean. Students can use this resource to identify common products that contain microbeads.

Beat the Microbead – beatthemicrobead.org

Timeline for Decomposition

Students predict how long common materials take to break down. This can then lead into an interesting class discussion and/or a research task.

Timeline for Decomposition – peacecorps.gov/educators/resources/timeline-decomposition

Conserving Plastics

Although plastic is a big problem in our environment, scientists and conservators are working to prevent the decomposition and loss of significant plastic artefacts in museums and art galleries.

For more information on the conservation of plastics, see the National Geographic article The Race to Save Historic Plastic Artifacts.

In this activity, students can use Queensland Museum Learning Resources to search some of the plastic objects in the Museum collection (choose 'see more search options', the select 'collection item'. Type the search term 'plastic'). Students should choose one plastic object and discuss why the object was collected, and why it is important to conserve.


QGC | FUTUREMAKERS | QUEENSLAND MUSEUM NETWORK | Queensland Government