Acknowledgements

Founder of From Paddock to Plate, Louise FitzRoy, has produced this national educational resource to be incorporated into the curriculum programs of schools across Australia.

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Year level: 10
Curriculum focus

This unit highlights several case studies in which food waste plays a prominent role in the activities and operations of schools and organisations showcased in our virtual excursion. Teachers and students will be inspired to turn food waste into compost within the school grounds and create worm farms to encourage prolific vegetable gardens. Students will explore how to grow food in even the most confined city spaces and learn to appreciate the time and effort it takes to produce food to reduce food wastage. The teaching materials provide students with an understanding of where food waste goes after it’s thrown in the bin and how damaging it can be to the environment. The video also profiles different initiatives to recycle food waste and associated packaging, and turn it into useful products to create a sustainable future and assist Australian farmers to feed their animals in times of flood or drought.

In this unit students will:
- see how schools are utilising food waste to grow more food;
- learn how to grow large amounts of food in small spaces;
- discover inventions to turn food waste into useful products that will benefit others;
- visualise what happens to food waste after it is thrown in the bin;
- develop their own initiatives to grow a sustainable future.

Source: Australian Curriculum, Assessment and Reporting Authority (ACARA), downloaded from the Australian Curriculum website in January 2017.

Sample of topics covered for discussion and further consideration

- Food security
- Sustainability
- Biodiversity
- Environment
- Waste management
- Water security
- Drought & natural disasters
- Traceability
- Nutrition
- Food waste & recycling
- Innovation & design
- Technology
- Food miles
- Ethics
- Animal welfare
- Animal health
- Soil & pasture management
- Community
- Pests & diseases
- Economics
Science Year 10

**Strand:** Science Understanding: Biological sciences

**PAGE 9 | ACSSU184**
The transmission of heritable characteristics from one generation to the next involves DNA and genes

**PAGE 15 | ACSSU185**
The theory of evolution by natural selection explains the diversity of living things and is supported by a range of scientific evidence

**Strand:** Science Understanding: Chemical sciences

**PAGE 17 | ACSSU187**
Different types of chemical reactions are used to produce a range of products and can occur at different rates

**Strand:** Science Understanding: Earth and space sciences

**PAGE 19 | ACSSU189 (Cross-curriculum priorities: Sustainability)**
Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere

**Strand:** Science Understanding: Physical sciences

**PAGE 21 | ACSSU190 (Cross-curriculum priorities: Sustainability)**
Energy conservation in a system can be explained by describing energy transfers and transformations

**PAGE 21 | ACSSU229**
The motion of objects can be described and predicted using the laws of physics

**Strand:** Science as a Human Endeavour: Nature and development of science

**PAGE 23 | ACSHE191**
Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community
Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries

**Strand:** Science as a Human Endeavour: Use and influence of science

People can use scientific knowledge to evaluate whether they should accept claims, explanations or predictions

**Strand:** Science Inquiry Skills: Questioning and predicting

The values and needs of contemporary society can influence the focus of scientific research

**Strand:** Science Inquiry Skills: Planning and conducting

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

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

**Strand:** Science Inquiry Skills: Processing and analysing data and information

Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies

Use knowledge of scientific concepts to draw conclusions that are consistent with evidence
Strand: Science Inquiry Skills: Evaluating

PAGE 28 | ACSIS205
Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data

PAGE 26 | ACSIS206
Critically analyse the validity of information in secondary sources and evaluate the approaches used to solve problems

Strand: Science Inquiry Skills: Communicating

PAGE 28 | ACSIS208
Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations

Source: Australian Curriculum, Assessment and Reporting Authority (ACARA), downloaded from the Australian Curriculum website in January 2017.
Fun fast facts about food waste

- Australians discard up to 20% of the food they purchase
- This equates to 1 out of every 5 bags of groceries they buy
- Up to 40% of the average household garbage bin is food
- For the average Australian household $1,036 of food is thrown away each year

- This money could be spent on:
  - Enough food to feed the average household for over a month
  - Paying off six months of your electricity bill

- Aussies throw out $8 billion of edible food every year
- Australia wastes 4 million tonnes of food each year
- This equates to 523kg per household, which is the same weight as just over 5 average size fridges!

- Out of the $8 billion what do we waste every year?
  - $2.67 billion of fresh food = 33%
  - $2.18 billion of leftovers = 27%
  - $1.17 billion of packaged and long-life products = 15%
  - $727 million of drinks = 9%
  - $727 million of frozen food = 9%
  - $566 million of takeaways = 7%

- Why is it wasted?
  - We cook too much food
  - Food is mistakenly thrown out before the use-by/best before date
  - We forget about leftovers in the fridge/freezer
  - We don’t know how to use leftovers
  - We buy too much because we don’t stick to a shopping list
  - We often shop when we’re hungry so we buy more food than we need
  - We don’t check the cupboard or fridge before going shopping
  - We are not planning our meals and menus as much as we could
  - Buying takeaways at the last minute instead of cooking the food we have in/family members changing plans
• Who are the biggest wasters of food?
  o Young consumers (18-24)
  o Households with incomes of more than $100,000 per year
  o Families with children

• When food rots in landfill, it gives off a greenhouse gas called Methane that is 25 times more potent than the carbon pollution that comes out of your car exhaust.

• When you throw out food, you also waste the water, fuel and resources it took to get the food from the paddock to your plate.

• An estimated 20-40% of fruit and vegetables are rejected even before they reach the shops mostly because they do not match consumers' and supermarkets' high cosmetic standards.

• If you add up the foods Australia wastes each year, it’s enough to fill 450,000 garbage trucks. Placed end to end, the convoy would bridge the gap between Australia and New Zealand just over three times.

FoodWise, January 2017

Do Australians actually waste $8 billion worth of edible food each year?

Useful words and phrases

Sustainability
Recycle
Landfill
Greenhouse gas emissions
Methane
Carbon pollution
Compost
Worm farm
Food scraps
Cosmetic standards
Vertical foodwall
Urban sky farm
Fuel consumption
Self-sufficient
Carbon neutral coffee
Food bank
Food security
Freegan
Locavore
Food supply chain
Consumer
Edible
LET’S GET STARTED

Firstly, please read the FP2P Welcome Guide on the FP2P website - www.frompaddocktoplate.com.au/school-programs/

It is important to understand the level of knowledge your students have of food waste in Australia and around the world. This will determine the structure of your delivery for this unit.

- ASK the students to describe and list what they know about food waste.
- DISCUSS the useful words and phrases.
- BRAINSTORM and gather ideas and information from the class and use this as a platform to begin this unit.

It is now a great time to watch the From Paddock to Plate ‘Food Waste’ virtual excursion.

Ask the students to do the follow-on activities below in succession or as standalone lessons.

__________

ACSSU184
Food security | Environment | Genetics | Sustainability | Ethics | Biodiversity | Nutrition | Breeding | Technology | Pests and diseases | Food waste | Health | Retail

DESCRIBE the role of genes in plant breeding for new traits and the development of transgenic plants.

Modern plant breeding is applied genetics, but its scientific basis is broader, covering molecular biology, cytology, systematics, physiology, pathology, entomology, chemistry and statistics (biometrics). DISCUSS, EXPLORE and EXPLAIN these study forms within the context of vegetable varieties and plant breeding.

DEFINE phenotype and genotype. DISCUSS with students the phenotype of a carrot and the effects of genotype on carrots. EXPLAIN qualitative and quantitative traits. EXPLORE the meaning of dominant and recessive traits.
Text references:

• ‘There is a long history of genetic and environmental influences on carrot flavor. In the tenth century A.D., Arabian red-rooted carrots were considered tastier than white-rooted types, and warm weather was thought to develop a more “acrid” flavor than cool weather. In eighteenth-century Europe, purple and yellow carrots were considered best flavored, orange roots less desirable, and white roots nearly unpalatable (Banga 1957A,B). More recent reports have considered bitterness, sweetness, and harsh flavor in fresh, stored, and processed carrots (see reviews by Aubert et al. 1979; Simon et al. 1981). Like many vegetables, no single compound has been found to account for a distinctively “carrot-like” flavor. However, it has been possible to determine several of the compounds which contribute to carrot flavor and to attribute variation in carrot flavor to certain genetic, environmental, and postharvest factors or treatments.’ – Carrot Flavor: Effects of Genotype, Growing Conditions, Storage, and Processing by P.W. Simon, Evaluation of Quality of Fruits and Vegetables

• ‘From the 10th through 18th centuries, phenotypic selections of domesticated carrot root colour were, perhaps surprisingly to people today, yellow and purple. The latest genetic research shows conclusively that orange carrot was developed from yellow varieties. "The fact that orange carrots used in this research form a sister clade with all other cultivated carrots (yellow, red, and purple) supports the idea that orange carrot was selected from cultivated carrot. Furthermore, genetic evidence suggests that two recessive genes, y and y2 , play a major role in the accumulation of yellow and orange carotenoids in the root (Just et al., 2009). This observation, along with the study referenced below, provides support for Banga’s (1957b) hypothesis that orange root colour was selected out of yellow, domesticated carrots." – Source: Iorizzo, Simon and others - Genetic Structure and Domestication of Carrot( daucus carota subsp. sativus ) (apiaceae), American Journal of Botany 100(5): 930–938. 2013

• ‘The effects of genotype, root size, storage, and processing on the content of bioactive compounds in carrots were determined to investigate the possibilities for optimizing the health-promoting properties of this vegetable. The content of polyacetylenes (falcariinol, falcariindiol, falcariindiol-3-acetate), carotenoids (α- and β-carotene), and isocoumarin 6-methoxymellein (6-MM) varied significantly between 6 genotypes of the Nantes type. The content of falcariindiol, falcariindiol-3-acetate, and 6-MM was significantly higher in small (50- to 100-g root size) than in extra-large root sizes (>250-g root size). Refrigerated storage of the roots for 4 mo at 1 °C before processing resulted in a significantly higher content of polyacetylenes and no differences in the content of carotenoids and 6-MM compared with frozen storage of processed carrots. The content of falcariinol increased and that of falcariindiol and
falcarindiol-3-acetate decreased during steam blanching of the carrots before freezing. No changes were observed in the content of carotenoids and 6-MM.’ - Effects of Genotype, Root Size, Storage, and Processing on Bioactive Compounds in Organically Grown Carrots (Daucus carota L.) by U. Kidmose, S. L. Hansen, L. P. Christensen, M. Edelenbos, E. Larsen & R. Nørbæk, Journal of Food Science

• “The aim of the study was to generate PR10-reduced hypoallergenic carrots by silencing either one of these genes in transgenic carrots by means of RNA interference (RNAi). The efficiency of gene silencing by stably expressed hairpin RNA (hnRNA) was documented by means of quantitative RT-PCR (qPCR) and immunoblotting. Quantification of the residual protein revealed that PR10 accumulation was strongly decreased compared with untransformed controls,” wrote S. Peters and colleagues, University of Giessen. The researchers concluded: “This constitutes a reasonable approach to allergen avoidance.” - Allergies: New Insights for the Healthcare Professional: 2012 Edition, 2012 Edition

DRAW diagrams and CONSTRUCT models to represent the relationship between DNA, genes and chromosomes.

DISCUSS the reasons for using selective breeding and cross breeding techniques on different plant foods. RECOGNISE that optimum genetics can be passed on using these techniques to limit food waste.

Text references:
• ‘By modifying crops to last longer in storage farmers can sell more of them and they can be kept longer, which, overall, results in more food for all–something we’re going to need even more in the near future.
  ➢ The Simplot potato was bred to use RNAi (small strips of RNA from the same, or a wild type potato that can halt or reduce gene expression) to regulate acrylamide levels, reducing browning and improve the quality of the spud’s starch. All of these traits would reduce the rejection of potatoes at market (either by a shop owner or a consumer), reducing the amount of food that, well, thrown away.
  ➢ The Arctic Apple, just approved this year, also uses RNAi to reduce browning (though it’s not from acrylamide like in potatoes). This also helps keep a lot more apples from the first-world waste bin, as more consumers would accept an apple without brown spots.
  ➢ Researchers at the University of Southampton, England, identified the genes that make lettuce leaves smaller, and closer together. These traits, it turned out, allow lettuce to stay fresher longer, both on the shop shelf and in a consumer
refrigerator. While the researchers identified the genes, they used them to guide more traditional breeding methods.

- Other so-called “second generation” traits (unlike pest and pesticide resistance, or yield enhancements of the first) have also similarly focused on direct consumer benefits, including longer storage life, and resistance to post-harvest diseases and degradation.’ - Eliminating food waste requires behavioral changes, but GMOs can help too by Andrew Porterfield, Genetic Literacy Project, 14 September 2016

- ‘Scientists have created genetically modified tomatoes which stay fresh for a month longer than usual. The fruits remained firm for 45 days, three times as long as normal tomatoes which start to wilt after just 15 days, researchers said. The team believe that the breakthrough could also lead to an extended shelf life for other fruits, including bananas, and see the cost of their production tumble. They lengthened the life of the tomatoes by “turning off” genes linked to the production of two enzymes which cause the fruit to start to ripen. Similar chemicals are involved in the maturation of other fruits, meaning the technique has the potential to extend the lifespan of mango, papaya and bananas as well as tomato. The alterations did not cause any other changes to the plants, the researchers said.’ - Scientists create GM tomatoes ‘which stay fresh for a month longer than usual’ by Kate Devlin, Medical Correspondent, The Telegraph, 2 February 2010

Teacher resource:

Also CONSIDER selective breeding and cross breeding techniques to reduce pest and disease resistance, enhance flavour and appearance and reduce water reliability.

Text references:
- ‘Prof Solah said there was nothing sinister about our supersized fruit. "The breeding program for fruit and vegetables is very advanced and they’ve been looking at varieties for a long time. I think they’ve been very successful and there’s nothing bad about it," she said. "It’s just selective breeding which means they take varieties that grow large then cross them to get the other characteristics, like colour and flavour, and then rename them. People can be assured there are no genetically modified fruit and vegetables in Australia."’ - Selective breeding is supersizing Australian fruit by Kristin Shorten, News Limited, 21 August 2013

- ‘This year broccoli plants that have been bred selectively for five generations were inoculated four times with the fungus that causes blackrot, but they showed virtually no symptoms of the disease. Most of them developed into excellent plants. A new molecular marker
associated with resistance to blackrot disease was discovered this year. This discovery may make selection of resistant plants more convenient in the future. Plans are under way to apply what has been learned from broccoli to cauliflower and cabbage.’ – Cornell University

• ‘Next time you bite into a slice of watermelon or a cob of corn, consider this: These familiar fruits and veggies didn’t always look and taste this way. Genetically modified foods, or GMOs, inspire strong reactions nowadays, but humans have been tweaking the genetics of our favourite produce for millennia. From bananas to eggplant, here are some of the foods that looked totally different before humans first started growing them for food: Throughout their history, eggplants have come in a wide array of shapes and colours, such as white, azure, purple, and yellow. Some of the earliest eggplants were cultivated in China. Primitive versions used to have spines on the place where the plant’s stem connects to the flowers. The earliest known carrots were grown in the 10th century in Persia and Asia Minor. These were thought to originally be purple or white with a thin, forked root, but they lost their purple pigment and became a yellow colour. Farmers domesticated these thin white roots, which had a strong flavour and annual biennial flower, into these large, tasty orange roots that are a winter annual crop. Perhaps the most iconic example of selective breeding is North American sweetcorn, which was bred from the barely edible teosinte plant. Natural corn, shown here, was first domesticated in 7,000 B.C., and was dry like a raw potato.’ – *Here’s what your food would look like if it wasn’t genetically modified over millennia* by Tanya Lewis, *Business Insider Australia*, 26 August 2015

**Teacher resources:**
- [http://nysipm.cornell.edu/reports/ann_rpt/AR97/breed.asp](http://nysipm.cornell.edu/reports/ann_rpt/AR97/breed.asp)

**CONSIDER** what role genetically modified foods have in the world.

**EXPLAIN** your reasoning, highlighting both sides of the debate.

**Text references:**
- ‘Plant genetic engineering methods were developed over 30 years ago, and since then, genetically modified (GM) crops have become commercially available and widely adopted. In 2009, GM crops were being grown on 10 percent of the Earth’s arable land. In these plants,
one or more genes coding for desirable traits have been inserted. The genes may come from the same or another plant species, or from totally unrelated organisms. The traits targeted through genetic engineering are often the same as those pursued by conventional breeding. However, because genetic engineering allows for direct gene transfer across species boundaries, some traits that were previously difficult or impossible to breed can now be developed with relative ease. So-called first-generation GM crops have improved traits. Herbicide-resistant soybeans and corn (maize), for example, can be “weeded” with herbicides that are more effective, less toxic, and cheaper than the alternatives. Cotton and corn have been modified to incorporate Bacillus thuringiensis (Bt) genes, producing proteins that are toxic only to larval pests. Crops can also be modified to ward off plant viruses or fungi. Even though the seed is more expensive, these GM crops lower the costs of production by reducing inputs of machinery are needed to harvest the significantly higher yields. One study in India suggests that Bt cotton produces 82 percent higher incomes for small-farm households compared with conventional cotton—a remarkable gain in overall economic welfare. Second-generation GM crops involve enhanced quality traits, such as higher nutrient content. “Golden Rice,” one of the very first GM crops, is biofortified to address vitamin A deficiency, a common condition in developing countries that leads to blindness and entails higher rates of child mortality and infectious diseases. Other biofortification projects include corn, sorghum, cassava, and banana plants, with enhanced minerals and vitamins. Widespread production and consumption of biofortified staple crops could improve health outcomes and provide economic benefits in a very cost-effective way, especially in rural areas of developing countries. A recent simulation shows that Golden Rice could reduce health problems associated with vitamin A deficiency by up to 60 percent in rice-eating populations. Despite all those real and potential advantages, GM crops have aroused significant opposition, particularly in Europe. The major concerns relate to potential environmental and health risks, such as allergenicity of transgenes or loss of biodiversity. But there are also fears about adverse social implications—for instance, that GM technology could undermine traditional knowledge systems in developing countries—and the monopolization of seed markets and exploitation of small farmers. Unexpected risks have not materialized so far, and those risks that do exist seem to be manageable. There is even evidence that GM technology can contribute to the preservation of agrobiodiversity, because the new traits can be inserted into local heirloom varieties. Nevertheless, concerns have led to complex and costly biosafety, food safety, and labeling regulations. Governments have responsibility for ensuring that foods are safe for consumption and
that new agricultural inputs do not damage the environment or harm agricultural production.’ – Professor of International Food Economics and Rural Development at Georg-August-University of Goettingen in Germany, Matin Qaim, Resources for the Future (RFF), 2 April 2010

• ‘Currently, the only genetically modified food crops produced in Australia are canola and cotton, but a variety of other GM foods can be imported and used as an ingredient in packaged foods. Foods where GM ingredients are highly refined do not need to be labelled as containing GM products. Field trials of pineapple, papayas, wheat, barley and sugarcane are underway in Australia. These products have been modified for insect resistance, herbicide tolerance, color, oil production, sugar composition, flowering and fruit development. Gene technology research is also underway in Australia on bananas, rice and corn.’ - Find out which genetically modified foods are available in Australia and which GM crops can be grown here by Chiara Pazzano, SBS, 15 November 2012

Teacher resources:


FOOD FOR THOUGHT
UNDERSTAND how gene technology works and give some examples of its current application in food production.

DEVELOP an awareness and understanding of the positive and negative impact of genetically modified foods.

ASK critical questions about the interests served by those promoting GM food products and/or food production practices.

DEBATE the importance of labelling GM foods.

ACSSU185
Natural selection | Evolution | Biodiversity | Sustainability | Climate | Breeding | Drought | Water security | Environment

READ and RESEARCH the theory of evolution by natural selection.
BRAINSTORM words and ideas, in groups or as a class, to explain and describe this theory.

DEBATE why or why not you agree with this theory.

OUTLINE the processes involved in natural selection.

For example:
- Variation
- Isolation
- Selection

Text reference:
Darwin wrote, "...Natural selection acts only by taking advantage of slight successive variations; she can never take a great and sudden leap, but must advance by short and sure, though slow steps." - On the Origin of Species by Means of Natural Selection, Charles Darwin

Teacher resources:

RESEARCH ASSIGNMENT
IDENTIFY a country, other than Australia, that has a thriving agriculture industry. RESEARCH the characteristics of the foods produced. COMPARE your findings with Australian grown produce.

For example:
- China
- India
- United States
- Turkey
- Iran

CASE STUDY
RESEARCH, ANALYSE AND PRESENT the genetic variants of vegetables in India that have allowed them to adapt to their geographic location.

For example:
- Kantola
- Elephant yam
- Malabar spinach
- Brinjal
BRAINSTORM ideal genetic characteristics for vegetables.

For example:
- Less susceptible to pests and diseases
- Utilise water efficiently
- Flavoursome

Talk about the word ‘sustainability’.

As a class CONSIDER the differences between ‘environmental sustainability’, ‘economic sustainability’, ‘social sustainability’ and ‘political sustainability’.

ACSSU187
Chemistry | Sustainability | Fuel | Waste management | Environment

INVESTIGATE how chemistry can be used to benefit the agriculture industry, such as understanding the chemical composition of leafy greens and their associated nutritional properties.

EXPLAIN how this understanding can educate and encourage a healthier diet.

Text references:
- ‘Originality of research is to contribute to understanding the chemical composition of common leafy vegetables, by identifying new constituents and the content for some of them. Scientific novelty of the study is to establish ratio Na: K. Green Leafy Vegetables occupy an important place among the food crops as these provide adequate amounts of vitamins and minerals for humans. They are rich source of carotene, ascorbic acid, riboflavin, folic acid and minerals like calcium, iron and phosphorous. In nature, there are many underutilized greens of promising nutritive value, which can nourish the ever increasing human population.’ – *Chemical composition of common leafy greens* by Angela CAUNII, Rodica CUCIUREANU, Andrea Miklósné ZAKAR, Elena TONEA & Camelia GIUCHICI, Vasile Goldis University Press
- ‘Eating dark leafy greens is vital to a balanced diet. Greens provide some of best sources of essential nutrients on the planet and they should be much more prevalent in our daily food intake. The key is learning how to make them palatable! Most leafy greens are high in alkaline-forming minerals. They are loaded with chlorophyll, which is essentially “green blood” as their chemical composition is identical to hemoglobin in our red blood cells, the difference being a mineral
molecule at the core of the nucleus; iron in hemoglobin and magnesium in chlorophyll. A short list of benefits from consuming more leafy greens:

- Leafy greens are an excellent source of essential vitamins, minerals and anti-oxidants
- Eating more kale promotes healthy digestion and elimination by sustaining healthy gut bacteria
- Chlorophyll is a natural body and breath deodorant
- Greens are not calorie-dense but they can fill you up through their fibre content
- According to medical research, many leafy greens and vegetables contain anti-cancer compounds that reduce oxidation, inflammation and the formation of free radicals.

5 Creatively Delicious Ways to Eat More Leafy Greens by Lindajoy Rose, Ph.D., founder of the Natural Wellness Academy and Raw Fusion Living, 17 June 2015

Teacher resources:
- www.huffingtonpost.com/lindajoy-rose-phd/5-creatively-delicious-wa_b_7465588.html

EXPERIMENT
DEMONSTRATE and OBSERVE the iron content in vegetables.

Materials needed:
- 8 different vegetables
- tea
- hot water
- food processor
- sieve
- 8 x containers

1. CUT up one cup of each vegetable.
2. BLEND each vegetable separately until pureed.
3. STRAIN each solution to remove the pulp and collect the liquid.
4. ADD tea to the juice solutions to create a chemical reaction, which will cause iron to precipitate at the bottom of each container.
5. WEIGH the collected iron from each container on a gram scale and record the weights.

Results:
Broccoli averaged 3.01 grams per cup, asparagus averaged 1.24 grams per cup and spinach averaged 1.13 grams per cup. Broccoli averaged 0.046
grams per calorie, asparagus averaged 0.025 grams per calorie and spinach averaged 0.023 grams per calorie.

ACSSU189
Climate | Global warming | Biodiversity | Environment |
Pollination | Greenhouse gases | Sustainability | Ecosystems

DISCUSS the meanings of:
- biosphere
- lithosphere
- hydrosphere
- atmosphere

MODEL a cycle such as the water, carbon, nitrogen or phosphorus cycle within the biosphere.

EXPLAIN the causes and effects of the greenhouse effect and the impact of climate change on sea levels and biodiversity.

“The students and teachers at Monbulk Primary School didn’t like the fact that the food scraps were just going into our bins and then into the big skip to fill up landfill. It was so wasteful when we could be using it to put in our compost for the gardens or giving it to the chickens and the worm farm.” (1:08 – 1:20)

“So one of the most exciting parts of this space is the way that we recycle, not the food because we don’t waste the food, but definitely the scraps from the food. And we use worms to do this. So when we grab that waste and give it to the worms, they feed on it and they turn it into castings and then something that’s 10 times as fertile, it’s a conduit from all that good stuff in the soil to get to the plants and then it goes towards growing the next batch of food. We had a big worm farm at the back here and unfortunately the worm farm got cut off and then we learnt something about the way that worms migrate. Basically under the cover of darkness, when it’s wet and cool, worms will migrate to find food, that’s all they want. Then they’ve migrated into our veggie patches and unfortunately or fortunately they’re now eating our crates, because they are so prolific, but they way that we make sure they’re working properly is by having properly functioning worm farms.” (3:51 – 4:45)
“We have 1.3 billion tonnes of food waste going to landfill every year. That’s enough food to feed half of the world’s population. However, all of that food waste is going to landfill today. If we use that food waste to instead transform the fertility of the soil and grow more food, then we wouldn’t have hunger in this world. We wouldn’t be having these big issues like climate change that is heavily impacted by food waste. So food waste is possibly one of those actions that we take every day. Every time we sit down and we enjoy our food, in the preparation of that food and at the end of that meal, we have a great opportunity to contribute to all of these causes in a much more positive way.” (5:15 – 5:51)

“Fresh produce in a typical Australian food basket may travel a combined 21,000km – or more than half way around the earth - from its origins to our plate. We could save all that fuel by growing food locally and turning our cities into catchments and food bowls.” (7:16 – 7:33)

“My biggest competitor is landfill. It’s a very efficient competitor. It puts a single bin at your feet and you don’t have to think. You can just throw everything in there and that’s why landfill takes millions of tonnes of waste every year. Until we make it as easy as landfill, that problem will remain until you are very old. We need to change it. It’s not sustainable to put food in landfill.” (10:48 – 11:18)

CONSIDER the long-term effects of loss of biodiversity on the Australian agriculture industry.

Text reference:
As explained in the UN’s third Global Biodiversity Outlook, the rate of biodiversity loss has not slowed because the five principle pressures on biodiversity are persistent, even intensifying:

1. Habitat loss and degradation
2. Climate change
3. Excessive nutrient load and other forms of pollution
4. Over-exploitation and unsustainable use
5. Invasive alien species

- Global Biodiversity Outlook

Teacher resources:
- https://www.cbd.int/gbo3/
- http://www.ecology.info/biodiversity-ecosystems.htm
EXPLAIN and DISCUSS the meaning of the Law of Conversation of Energy with the class.

** The Law of Conservation of Energy states that energy cannot be created or destroyed, just transformed from one form to another. These forms can include kinetic and potential energy as well as light, heat and sound. Energy can also be transferred between objects. The conservation of energy has nothing to do with saving energy: it’s all about where energy comes from and where it goes.

USE diagrams to describe how energy is transferred and transformed within systems.

You might like to consider:
- Driving a car
- Boiling a kettle
- Pushing a car uphill

BRAINSTORM examples of energy transfer and transformation in the From Paddock to Plate virtual excursions.

EXPLAIN and DISCUSS the law of physics. Who was Sir Isaac Newton?

EXPERIMENTS
ASK the students to form a hypothesis before the activities and then DISCUSS findings at the conclusion of them.
DEMONSTRATE and OBSERVE every day motions produced by forces.

For example:
- measurements of distance and time
- speed
- force
- mass
- acceleration

USE Newton’s Second Law to predict how a force affects the movement of an object.

Newton’s Second Law of Motion states that ‘when an object is acted on by an outside force, the strength of the force equals the mass of the object times the resulting acceleration’. In other words, the formula to use in calculating force is \( \text{force} = \text{mass} \times \text{acceleration} \). Opposing forces such as friction can be added or subtracted from the total to find the amount of force that was really used in a situation.

ACTIVITY ONE
Drop a potato and a scrunched-up piece of paper at the same time into a dish of sand or flour. They fall at an equal rate—their acceleration is constant due to the force of gravity acting on them. However, the potato has a much greater force of impact when it hits the ground, because of its greater mass. You can see how different the force of impact for each object is, based on the crater made in the sand by each one.

APPLY Newton’s Third Law to describe the effect of interactions between two objects.

Newton’s Third Law of Motion states that ‘for every action, there is an equal and opposite reaction’.

ACTIVITY TWO
Materials needed:
- plastic cup
- 2 plastic bendable straws
- string
- craft knife
- water and sink
- modelling clay

1. POKE two small holes in the plastic cup near the top rim on opposite sides from one another.
2. THREAD string through the holes and TIE a knot so that the cup can be suspended from the string.
3. MAKE two slightly larger holes near the bottom of the (make sure the holes are just large enough for the straws to fit through)
4. CUT each straw about 4 centimetres below its bendable portion.
5. SLIDE the straws into the holes. MAKE sure that they both point in a clockwise direction.
6. USE your modelling clay to SEAL the space between the cup and the straw so that no water leaks out when you fill the cup.
7. HOLD the finished Hero engine away from your body. POUR water into the cup and observe.

Created by an engineer named Hero of Alexandria about 2000 years ago, this invention was able to show one way in which an action can lead to an equal and opposite reaction: an example of Newton's third law.

Results:
Gravity draws the water downward and out through each straw. This causes the engine to spin in a clockwise direction.

Why?
The water being forced by gravity to leave the cup in a clockwise direction pushes back on the cup in a counter-clockwise direction, causing the cup to turn. This is the same principle that enables rockets to work—gas that’s forced out of the nozzle pushes back on the rocket, propelling it forward!

DECIDE how much data is needed to produce reliable measurements.

Teacher resource:

ACSHE191
Climate | Sustainability | Productivity | Drought | Irrigation | International markets | Water security | Weather | Seasonality | Food security | Pest and weed control

CONSIDER the role of science in identifying and explaining the causes of climate change.

What impact will climate change have on food production in Australia?

THINK about changing seasons, water availability and pollination of food crops. JUSTIFY your reasons.
WATCH our From Paddock to Plate virtual excursions for ideas.

CASE STUDY
EXPLORE what impact drought conditions have on farmers.

Text references:

- 'As world leaders meet in Paris to set a target to reduce carbon emissions, scientists and farmers fear even the ambitious aim of limiting global warming to two degrees would have huge impacts on Australian farm production, leading to more expensive food prices. Lesley Hughes, a professor of biology at Macquarie University and a councillor on the independent Climate Council, has examined the impact of global warming on Australian farming and says two degrees of warming creates real risks. "(It's) very dangerous for agricultural production, 2.7 degrees is even more dangerous, though, on the bright side it's still considerably safer than the four to six degrees that is what we are heading for currently on our emissions trajectory," Professor Hughes said. She said more extreme weather conditions linked to global warming, including longer droughts and more intense cyclones, were already affecting food production, and increasing the price consumers pay. "There will come a time when in many regions, many of the climatic extremes will be simply too great to adapt to," Professor Hughes said.’ - Warning even two degrees of global warming ‘very risky’ for farm production, will increase food prices, by Sarina Locke and Catherine McAloon, ABC Rural, 1 December 2015
- ‘The California drought will cost more in 2015 than it did in 2014, and while projected losses won’t be as bad as earlier forecasts, the use of groundwater as a temporary fix may cause its own, longer-term problems. The unyielding drought will likely have harsh effects on the state’s agriculture this year, with total losses climbing as high as nearly $3 billion or worse if conditions continue into 2016, according to a new report from a team of California researchers. California farmers will lose about 33 percent of their normal water supply in 2015, and though they will offset much of that by aggressively pumping groundwater, the agricultural sector will still lose revenue that comes to about 4 percent of its $45 billion total, according to a study from researchers at the University of California, Davis, and a Davis-based consultancy called ERA Economics. About half a million acres of farmland will have to be "fallowed" or left unused, which is a 33 percent increase over 2014. That will result in $856 million in gross crop revenue losses, according to the report. Livestock and dairy farms will could see $350 million in revenue disappear as well. Direct revenue losses, therefore, will total about $1.2 billion, and additional costs—from the expense of pumping
groundwater to other spillover effects—will bring the total to about $2.7 billion. Almost 19,000 jobs will be lost—affecting full-time, part-time and seasonal workers. Owners and workers could lose more than $700 million in income.’ - Billions in losses for drought-stricken farmers this year by Robert Ferris, CNBC, 3 June 2015

Teacher resources:
- [www.cnbc.com/2015/06/03/billions-in-losses-for-drought-stricken-farmers-this-year.html](http://www.cnbc.com/2015/06/03/billions-in-losses-for-drought-stricken-farmers-this-year.html)

FOOD FOR THOUGHT
- ‘More days above 35 degrees will increase sun damage to apples
- Shade netting will increase costs of production
- Lower and more variable production
- Lower dietary value in wheat crops
- Up to 70% of Australia’s winegrowing regions with a Mediterranean climate will be less suited to grape production in 2050
- Shorter winter growing season for cabbage of up to a month by 2030
- Higher temperatures will result in longer period of pest activity
- Warmer temperatures affect flavour, texture and physical structure of vegetables
- Production will be less viable in warmer areas, production will move south’ – University of Melbourne, Melbourne Sustainable Society Institute

ACSHE192
Technology | Innovation | Design | Climate | Space

DISCOVER what developments in technology and technological advances have been applied in the food industry worldwide to enhance scientific understanding and that are linked to scientific discoveries.

Name three scientific projects.

For example:
- Space-grown vegetables

Text reference:
- ‘NASA astronauts are preparing to take their first bites of fresh food grown in space — red romaine lettuce. International Space Station (ISS) crew members will sample the "Outrageous" lettuce grown as part of NASA’s plant experiment Veg-01 in the Veggie plant growth system. Giving new meaning to "clean eating", astronauts must first...’
clean the leafy greens with citric acid-based, food-safe sanitizing wipes before tucking in. But only half the space harvest will be eaten, with the remainder to be packaged and frozen before being returned to Earth for scientific analysis. Veg-01 forms a critical part of NASA’s Journey to Mars, enabling crew to grow and eat their own food on long-duration exploration missions. Green-thumbed astronauts may also use Veggie for recreational gardening during deep space missions, according to NASA. The lettuce was grown using rooting “pillows”, containing seeds — which are activated, watered and cared for by astronauts.’ - Lettuce eat: Space-grown vegetables on the menu for NASA astronauts, ABC News, 11 August 2015

Teacher resource:

CONSIDER how computer modelling has improved knowledge and predictability of phenomena such as climate change and atmospheric pollution.

ACSHE194 • ACSIS206
Media | Ethics | Economics | Opinion

DESCRIBE how science is used in the media to explain a natural event or justify people’s actions.

RESEARCH the methods used by scientists in studies reported in the media.

DESCRIBE how scientific arguments, as well as ethical, economic and social arguments, are used to make decisions regarding personal and community issues.

ACSHE194
Careers | Education | Training | Technology | Sustainability | Jobs | Skills | Food security | Innovation | Design | Employment | Safety

THINK about how advances in science and emerging sciences and technologies can significantly affect people’s lives, including generating new career opportunities.
CONSIDER how the computing requirements in many areas of modern science depend on people working in the area of information technology.

For example:
- Finding long range weather forecasts and temperature predictions

RECOGNISE that scientific developments in areas such as environmentally sustainable and energy saving packaging requires people working in a range of fields of science, engineering and technology.

You may like to consider:
- Engineers
- Information Technology experts
- Scientists
- Natural resources specialists

What job in the Australian agriculture industry would you like to have? EXPLAIN.

WATCH our *From Paddock to Plate* ‘Careers in Grains’ introductory video and LISTEN to the different jobs and tasks required of each person.

ACSHE230 • ACSIS198
Technology | Environment | Pollution | Sustainability |
Community | Renewable energy | Global warming | Recycle

RESEARCH ASSIGNMENT
CHOOSE a technology associated with the reduction of carbon pollution, such as carbon capture.

FORMULATE questions and IDENTIFY problems of this technology that can be investigated scientifically within the scope of the classroom and with available resources.

FIND out how it works, what are the pros and cons and ASSESS whether you would use this technology. EVALUATE information from secondary sources as part of the research process.

CONSTRUCT evidence based arguments and engaging in debate about scientific ideas. PRESENT your findings to the class using formal experimental reports, oral presentations, slide shows and/or poster presentations.
**Excursion | Food miles | Food origin**

VISIT a local farm or community kitchen garden to EXPLORE and INVESTIGATE what effects productivity, including environmental changes, and to what extent.

USE this fieldwork to collect reliable data, assess risk and address ethical issues associated with these methods. SELECT and USE appropriate equipment and IDENTIFY where human error can influence the reliability of data. ANALYSE patterns and trends in data, including describing relationships between variables and identifying inconsistencies. EXPLORE relationships between variables using spreadsheets, databases, tables, charts, graphs and statistics.

USE primary or secondary scientific evidence to support or refute a conclusion.

CONSTRUCT a scientific argument showing how this evidence supports the claim.

EVALUATE the strength of a conclusion that can be inferred from a particular data set. DISTINGUISH between random and systematic errors and how these can affect investigation results. IDENTIFY alternative explanations that are also consistent with the evidence.

*Use the Paddock to Plate app and From Paddock to Plate book to discover the journeys of specific foods from farmer to store. The app allows you to map the food miles for a range of food products and showcases farmer profiles to assist further with this research task.*

**Local community**

PRESENT an argument about how farming and agriculture is represented and portrayed in society through the media, by your friends, your parents and other role models. You must PRESENT a point of view and justify your position in order to persuade other about this issue. Include texts that integrate visual, print and audio features.

CONSIDER all attitudes, opinions, values and beliefs.

What conclusion can you draw?
DID YOU KNOW?
‘By buying locally grown food you’ll be strengthening your community by investing your food dollar close to home. Only 18 cents of every dollar, when buying at a large supermarket, go to the grower. 82 cents go to various unnecessary middlemen. Cut them out of the picture and buy your food directly from your local farmer.’ – Local Harvest, www.localharvest.org.au/why-is-local-important/

Reflect

What have the students learnt from this unit?

- What is something new that you have learnt about reducing food waste in Australia?
- Describe what you know about sustainable farming practices.
- How might you help others know more about how Australian farmers grow food?
- What have you learnt about food security and food packaging?
- What questions do you have about growing food, utilising food waste and reducing rubbish at your school?
- What piece of work are you most satisfied with?

Websites (viewed January 2017) - As content of the websites suggested for research purposes in this unit is updated or moved, hyperlinks may not always function.