Years 5 – 6

Worms

Teacher booklet

GOVERNMENT OF WESTERN AUSTRALIA

WASTE AUTHORITY
WA...TOO GOOD TO WASTE

WasteSorted Schools

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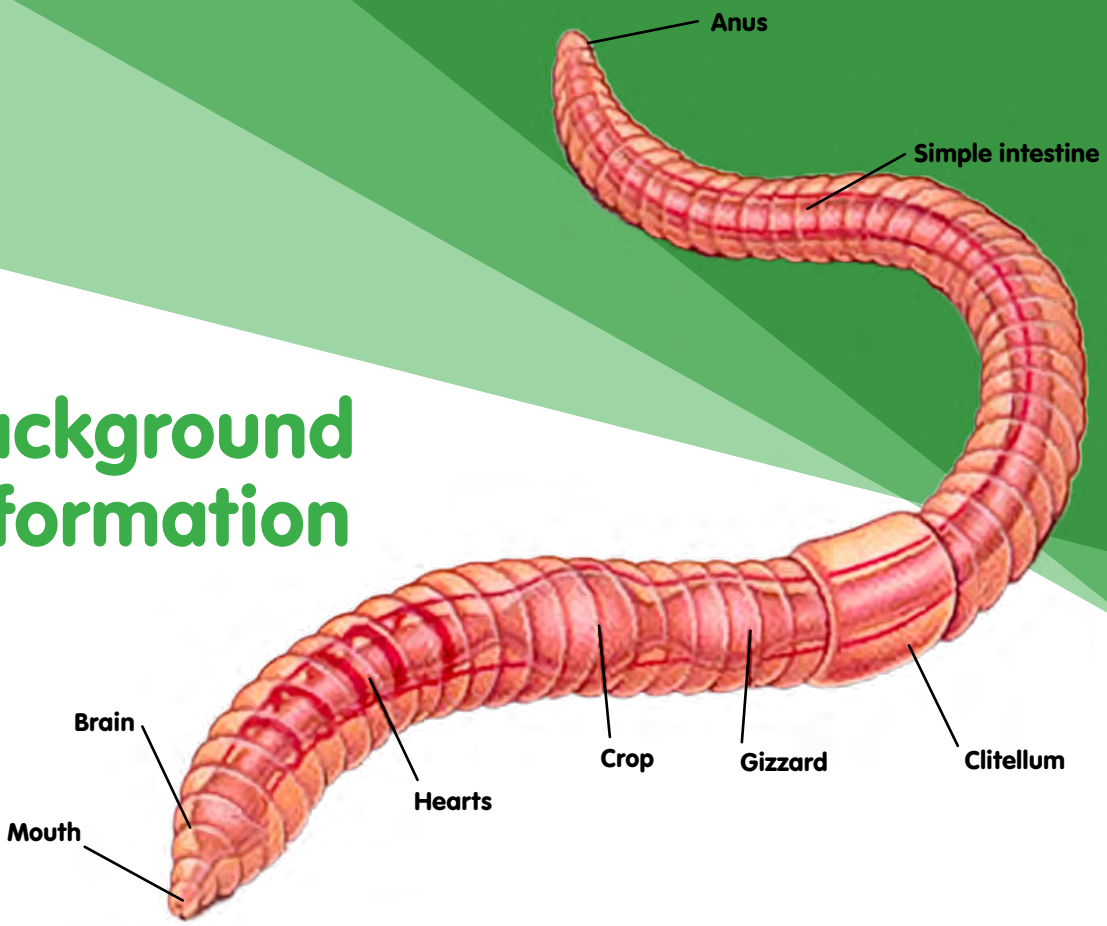
Background information



How do worms help us?

Worms are often considered to be little 'soil farmers' and by simply living, eating and reproducing they provide a wonderful service to plants and to us. Worms eat a wide variety of items including old plant material and food scraps. Their castings are expelled into the soil and provide nutrients for plants. As the worms move through the soil, their tunnels enable air and water to filter into the ground and loosen up the soil for plant roots, allowing easier absorption of oxygen and water by the plants.

The earthworms that we use in worm farms are a different species to those we find in our garden. The best worms for worm farming are European worms such as the Red Wriggler (Lumbricus rubellus) and the Tiger Worm (Eisenia fetida). Another good composting worm is the Indian Blue (Perionyx excavatus) that comes from Asia. These species are accustomed to soils high in nutrients. They are used in worm farming because they eat and breed much faster than other earthworms and can quickly transform our waste scraps into worm castings.

Description and characteristics of worms

Earthworms are invertebrates, which means they have no backbone. They belong to the phylum Annelida, which also includes leeches and marine worms. Annelids are different from most other invertebrates because they have long cylindrical bodies made up of many similar segments, and lack appendages, antennae and an obvious head.

The earthworm is blind, but sensitive to light. Its instinct is to move away from light due to its two 'photoreceptors' which are sensitive nerve endings located near the clitellum at the anterior (Murphy 2005).

It has three to five hearts depending on the species and breathes through its skin which is a mucous membrane.

We can identify its 'head' (anterior) as it is the end closest to the clitellum, a band around the worm near the centre and commonly referred to as the saddle. It feeds by using its mouth or prostomium.

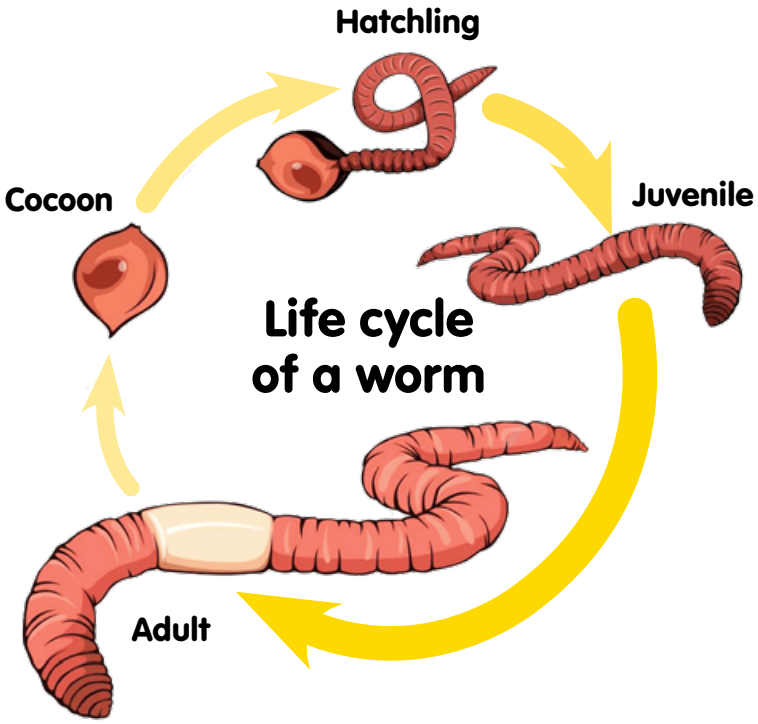
It moves through the soil by contracting and expanding its muscles and using its setae (bristles) to grip the soil.

Life cycle of a worm

Earthworms are hermaphrodites, which means they have both male and female sexual organs.

The method of reproduction varies between the different species. For Tiger Worms (common composting worms) two worms are needed for reproduction. During mating, the two worms align their clitellum, cover themselves in sticky mucous and exchange sperm. The worms separate and each worm's clitellum produces a thick mucous ring. As the worms wiggle backwards out of this ring, the eggs are picked up and then fertilised by the stored sperm.

Ultimately, the mucous ring forms a cocoon around the fertilised eggs which is deposited in the soil. Each cocoon contains four to ten infant worms, which hatch after about two weeks under the right conditions.



Worm key words

Adaptations: Any behavioural or physical characteristics of an animal that help it to survive in its environment.

Annelida: A large phylum of segmented worms including earthworms and leeches. They are also less-formally known as annelids, the name coming from the Latin 'annelus', meaning 'little ring'.

Cocoon: Formed from a mucous ring and containing the fertilised egg to be deposited in the soil. The cocoon on average will produce four baby worms and these can hatch after about two weeks in the right conditions.

Clitellum: A clitellum is part of the reproductive system of an annelid (a worm with small rings or segments). The clitellum is a thick, saddle-like ring found in the epidermis (skin) of the worm.

Hermaphrodites: Organisms having both male and female reproductive organs.

Invertebrates: Animals without a backbone.

Leachate: See worm leachate.

Photoreceptors: Nerve endings that are extremely sensitive to light.

Saddle: See clitellum.

Segmented: The body is divided into successive segments, as in earthworms or lobsters.

Seta (plural-setae): Stiff hair made of solid keratin that worms have on each segment of their bodies and use for grip and as sensors.

Worm science

Curriculum links

Learning area: Science

Science understanding

Year 5

- Living things have structural and behavioural adaptations that enable their survival in their environment (WA5SSUB1)

Year 6

- The growth and survival of living things are affected by the changing conditions in their environment and the influence of human activities (WA6SSUB1)

Science inquiry skills

Years 5 – 6

- Pose testable questions that include variables to be measured and changed, and apply science knowledge to make predictions (WA5SSIQ1)
- Plan and conduct fair, safe and repeatable investigations (WA5SSIPL1)
- Use equipment to observe, measure and record data (WA5SSIPL2)
- Organise and represent data using tables, graphs and models to identify the relationships between measured and changed variables (WA5SSIPR1)
- Compare findings with those of others, and to predictions; evaluate the fairness of an investigation and suggest improvements; and pose questions for further investigation (WA5SSIE1)
- Communicate ideas in a variety of ways, including scientific reports with appropriate language features (WA5SSICM1)
- Use science knowledge to develop considered responses to problems, at a local and global level, through investigation and research (WA5SSICL1)

Learning area: Maths

Measurement and geometry

Year 5

- Choose and use appropriate metric units and part units to estimate and measure lengths (WA5MMGTW3)

Year 6

- Convert between units of length by connecting metric units to the decimal system and extend to units of mass and capacity (WA6MMGTW3)

Timing

These activities should take about five 60-minute lessons to complete, although some lessons could be combined if needed. During these lessons, students will be handling and examining worms. Before giving students live worms, it is important to remind them that worms are living creatures and should be handled gently.

Learning objectives

Students will:

- ✓ explore the different stages of the worm life cycle
- ✓ learn the anatomy of a worm
- ✓ draw a labelled diagram of a worm
- ✓ describe how a worm looks, feels and moves
- ✓ use metric units to measure the length and weight of a worm
- ✓ design an experiment to investigate how a worm responds to an external environmental stimulus
- ✓ conduct their experiment and record their results.

Resources required

- Worm science PowerPoint presentation
- Screen to share with class
- Internet access for YouTube video
- Worms
- Worm castings
- Large plastic sheet
- Light coloured container lids – one per student/pair/group
- Magnifying glass – one per student/pair/group
- Ruler – one per student/pair/group
- Digital devices or non-fiction texts for researching worms
- *Worm adaptation websites* QR codes
- Tray - one per pair/group
- Exercise book or piece of paper - one per pair/group
- Light source
- Stopwatch
- Science journal or worksheets

Lesson 1
Life cycle of a worm

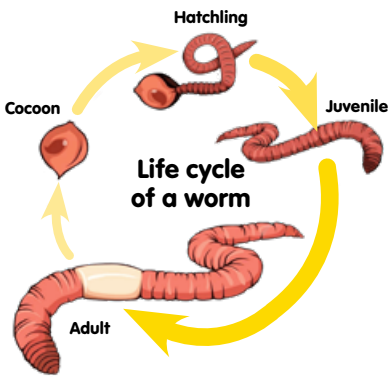
To prepare

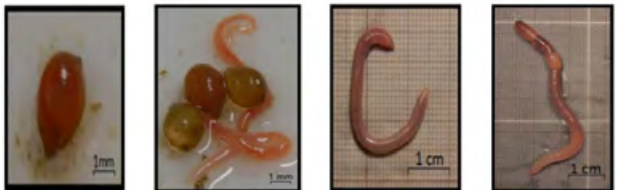
- Spread some worms and castings out on a plastic sheet. If possible, locate a cocoon, hatchling and juvenile worm to show the students.
- Students will also need their own sample of castings to examine to find a cocoon, hatchling, juvenile and adult worm.

Activities

1. Have students complete a *Mind map* to find out what they already know about worms.
2. Look at the pictures on the PowerPoint of a worm cocoon and have students predict what they think it could be.

3. Share the picture of the worm life cycle and discuss the different stages.
4. Share the *Measuring the stages of the life cycle* slide from the PowerPoint.
5. Using the scale attached to the photos, have students estimate the length of each stage of the life cycle.
6. Students can share and discuss their measurements with a partner.





7. Show the students the real cocoon, hatchling, juvenile and adult worms.
8. Give each pair/group a small sample of castings and worms and allow them time to search for a cocoon, hatchling, juvenile and adult worm of their own.
9. Students draw a labelled diagram of the life cycle of a worm in their science journals.
10. Using an appropriate unit of measurement, students measure the length of each of the stages of the life cycle.
11. Compare these measurements with those from the photos.

Lesson 2
Looking at worms

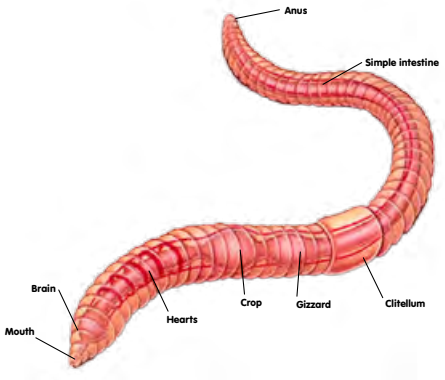
To prepare

> Students will need their own worms to examine with a magnifying glass. It is best to place the worms on a light-coloured plastic surface, such as a container lid, and add a small drop of water to stop them from drying out.

Activities

1. Begin the lesson by watching the video Earthworm Facts | 10 Animal Facts about Earthworms - YouTube (9:52 minutes).

2. Discuss some of the features of earthworms mentioned in the video.
3. Using the PowerPoint slide, label the parts of a worm.
4. In their science journals, have students create two headings – 'Diagram of a worm' and 'Observations' (or use the *Worm observations* worksheet).
5. Give each student/pair some worms to examine and a magnifying glass.



6. Instruct students to draw a labelled diagram of their worm, using the words discussed earlier in the lesson (display labelled PowerPoint slide if needed).
6. After completing their drawing, students should record their observations about the worms, using the questions on the PowerPoint to guide them.

Lesson 3
Researching worms

To prepare

> In this lesson, students research the features and adaptations of a worm. To prepare for this, it is advised to have digital devices with access to the internet or a selection of non-fiction texts relating to worms readily available. There is a selection of QR codes provided on the *Worm adaptations website* worksheet that will take students directly to websites containing information about worms.

Activities

1. Begin the lesson by sharing the features and adaptations page of the PowerPoint presentation.
2. Discuss the questions with the students, reminding them of their observations about worms from the last lesson.
3. Provide each student/pair with a copy of the *Worm adaptations* worksheet.
4. Using a digital device or non-fiction texts, students research to find the answers to the questions regarding the features and adaptations of worms.
5. As a class, share the answers to the research questions and discuss what you have learned about worms.

Lesson 4
Planning an experiment

Activities

1. Begin the lesson by explaining that the students will be designing their own experiment to investigate how worms respond to certain external stimulus such as light, moisture, food or temperature..
2. Discuss the steps involved in planning and conducting a scientific experiment.
3. Provide students with a list of stimuli they can test and materials they can use for their experiment.
4. Allow students time to plan their experiment in pairs or groups.
5. In their science journals (or using the *Science investigation* worksheet), students design their experiment, remembering to include their investigation question, prediction, materials needed, method, observations and results.

Outlined below is an example of how to conduct an experiment to see how worms respond to light. You may wish to share this with the students to help them in their experiment design.

How worms respond to light investigation instructions

1. Take the class outside or ensure that there is plenty of light in the space you are using for this investigation.
2. Cover half of a tray with a thin layer of worm castings.

3. Place an exercise book (or piece of paper) over half of the tray to cover the castings.
4. Students gently place about 10 worms on the side of the tray that is uncovered and give the worms some time to settle down. Use only 10 worms, because if there is more than that number, they will tend to bunch together rather than move around.
5. Have students make predictions about how the worms will respond to the light and record their ideas in their science journals.
6. Observe the worms for 15 to 20 minutes. During the investigation, carefully watch the worms to make sure they aren't drying out. If this is the case, return them immediately to the worm farm.
7. Students observe whether the worms head directly for the shelter of the castings.
8. Students count and tally how many worms there are on each side of the tray every three to five minutes and record in a table. You might like to discuss with the class how the table could look to record the data.
9. Students graph the results of their investigation (number of worms versus time).
10. Students describe the pattern represented in the graph.
11. Students create a report of their findings, including the graph, diagrams or photos.

Lesson 5
Conducting an experiment

To prepare

> In this lesson, students will carry out the experiment they designed in the last lesson. Before allowing students to proceed, check their experiment design to ensure it is safe for themselves and the worms.

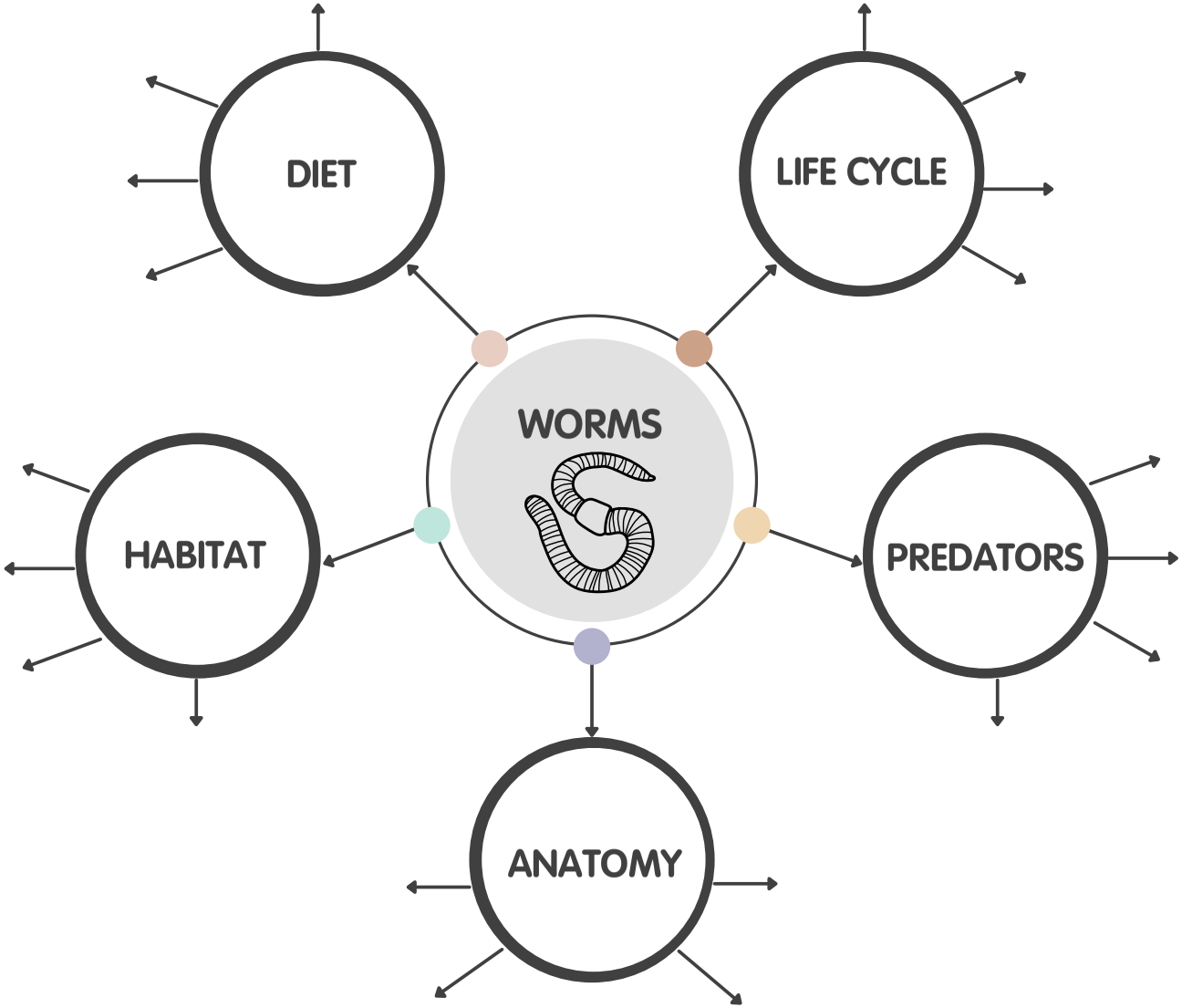
Activities

1. Provide students with castings, no more than 10 worms, and the equipment they have selected to use for their experiment.
2. Allow them time to set up their experiment, ensuring the safety of the worms during this process.
3. Observe the worms for 15 to 20 minutes and record what happens.
4. Instruct students to count and tally the movement of worms towards or away from the stimulus every 3 to 5 minutes.
5. After the experiment has finished, students graph their results.
6. As a class, discuss students' findings using the discussion questions on the PowerPoint as a guide.

7. If time allows, have students complete the *3-2-1 reflection* worksheet.

Mind map

Name: _____



Name: _____

Worm observations

Diagram

mouth hearts clitellum crop anus gizzard brain intestine

Observations:

Name: _____

Worm adaptation websites

ABC Education

Australian Museum

Fact Animal

Science Learn

Te Ara Encyclopedia of New Zealand

Kiddle

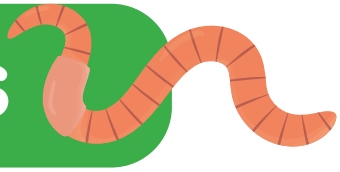
The Worm - YouTube

Earthworms - YouTube

Facts About Earthworms - YouTube

Name: _____

Worm adaptations



Use your research skills to answer the following questions about worms.

1 How do worms' physical features allow them to move easily in their habitat?

_____

_____

_____

2 How do worms' adaptations cause them to respond to sunlight?

_____

_____

_____

3 How have worms adapted to be able to breathe when underground?

_____

_____

_____

4 How do worms use rain to their advantage?

_____

_____

_____

5 How can a worm's adaptations help them survive predators?

_____

_____

_____

6 How does a worm's life cycle help their survival?

_____

_____

_____

Name: _____

Science investigation

Investigation question:

_____

_____

Materials

- worms
- worm castings
- tray
- exercise book/piece of paper
- timing device
- magnifying glasses
- recording sheet
- water/food/light/heat source

Safety considerations

Worms are living creatures and must betreated with care and consideration. Carefully watch the worms during the experiment to make sure they are not in distress. If this is the case, return them immediately to the worm farm.

Method:

Science investigation

Name: _____

Prediction:

Observations:

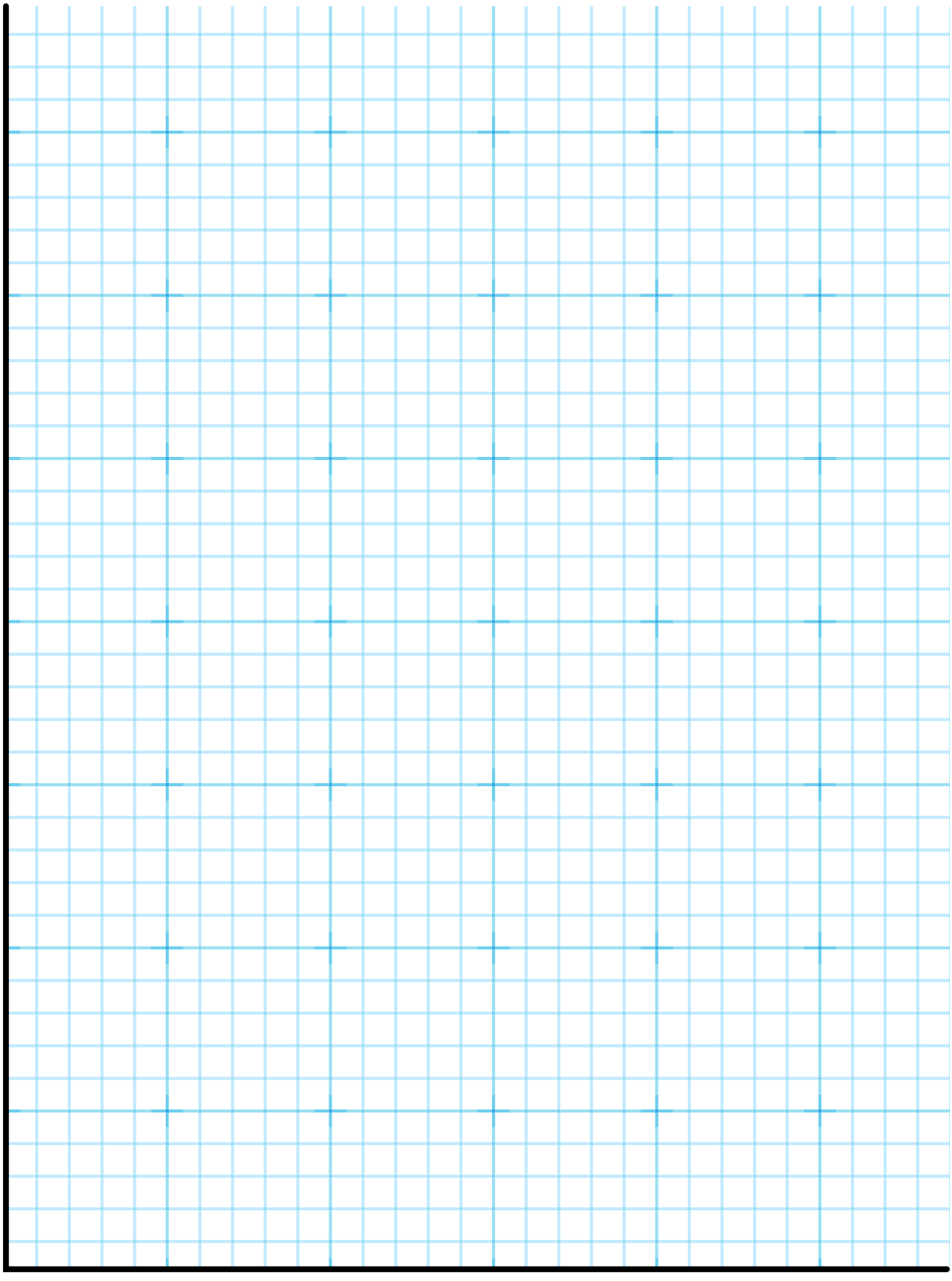
Time	No. of worms moving towards _____	No. of worms moving away from _____
Start		
__minutes		
__minutes		
__minutes		
__minutes		

Results:

Conclusion:

Name: _____

Title:



Name: _____

3-2-1 reflection

3 things I learned

1. _____

2. _____

3. _____

2 things I found interesting

1. _____

2. _____

1 question I still have

1. _____

_____

Worm food

Years 5 – 6

Background information

Worm farms

Worm farms contain composting worms that eat food scraps and turn them into a natural liquid (worm leachate) and compost (castings) that can be used in the garden. Composting worms thrive in a moist, high-nutrient environment. We can create this environment in a worm farm.

Worm farms:

- decrease the amount of organic waste sent to landfill
- close the recycling loop by changing food waste back into organic fertiliser for growing food
- reduce greenhouse gases. In a well-maintained worm farm, the decomposition process is aerobic (with oxygen), rather than anaerobic (without oxygen).

The earthworms used in worm farms are a different species to those we find in our garden. The best worms for worm farming are European worms such as the Red Wriggler (Lumbricus rubellus) and the Tiger Worm (Eisenia fetida). These species are accustomed to soils high in nutrients. They eat and breed much faster than other earthworms and can quickly transform food scraps into worm castings. They do this in a small amount of space, while other earthworms are better equipped for burrowing and searching for food in our drier, nutrient-poor soils.

Living conditions in a worm farm

Worm farms should be situated in a cool, shady spot. Worms need cool, moist conditions and a temperature of 25 to 26 degrees Celsius. They need a layer of bedding to live in, which can include castings, shredded paper, newspaper, cardboard, brown leaves, and straw. As food scraps decompose, they will make the worm bedding more and more acidic, therefore it is a good idea to occasionally add some garden lime to maintain the pH as worms prefer a neutral environment.

School worm farms

A worm farm is made from a container that has a drainage hole for water and a lid that keeps out vermin but allows air in.

You can buy worm farm containers, make your own, or have one custom made. Some schools use old bathtubs but most use old fridges that have been safely degassed. Look at the 'How to make a fridge worm farm' fact sheet to find out more. For most schools, at least one large worm farm (such as a fridge or bathtub) is needed.

For more information on setting up a worm farm at school, see the fact sheets or watch the instructional videos.

Food to put in your worm farm

Materials you can put in your worm farm include:

- shredded, moist cardboard, newspaper and paper scraps (avoid shiny magazines)
- coffee grounds and tea bags (with staples removed)
- fruit and vegetable scraps
- leaves
- straw (but not hay with seeds in it)
- coconut fibre
- egg shells (pulverised) or other sources of grit (good to add when the worm farm gets a bit smelly or acidic).

The smaller the pieces of food, the easier it is for the worms to get through. Some schools blend food scraps or chop them up with a metal spade in a bucket or wheelbarrow.

Food to keep out of your worm farm

Anything organic will eventually be broken down in a worm farm. However, in a small worm farm it is a good idea to omit certain foods such as:

- citrus fruits, pineapple, onions and garlic – can make the worm farm too acidic (pH less than 7) and the worms may even try to move out because of the acidic conditions
- meat and fish – can become smelly as they decompose and attract mice, rats and wasps
- dairy – can become smelly and cause anaerobic conditions
- bread – tends to clump up and worm farms can't cope with the amount of bread that schools produce
- oils – smother worms (as they breathe through their skin)
- weeds – as weed seeds are not destroyed in a worm farm.

A good rule of thumb is: If in doubt, leave it out!

A composting system such as heap, bin or tumbler can also help to manage your organic waste and is perfect for composting citrus, onion and garlic scraps that should be left out of your worm farm.

Worm farm key words

Aerobic decomposition: Organic matter being broken down in the presence of oxygen.

Anaerobic decomposition: Organic matter being broken down without the presence of oxygen.

Carbon dioxide (CO_2): An odourless, colourless gas produced during respiration. It is a greenhouse gas.

Castings/vermicast: See worm castings.

Decomposition: The process of organic matter being broken down physically and chemically by bacterial or fungal action; the rotting process; decomposition can be aerobic (with oxygen) or anaerobic (without oxygen).

Inorganic: Not organic. That is, matter that has not come from a living thing (e.g. plastic, glass, metal, synthetic fertilisers).

Leachate: See worm leachate.

Microbes: Micro-organisms such as bacteria and actinomycetes. In the case of worm leachate and castings, these are the beneficial micro-organisms that accelerate decomposition (Murphy 2009).

Organic: Matter that has come from a once-living organism and is capable of decay or is the product of decay (e.g. plants, leaves, food scraps, paper, straw etc.).

Worm castings/vermicast: Organic material that has been digested by worms and passed through their digestive system (i.e. faeces). Both worm leachate and castings contain a wide variety of nutrients and beneficial microbes necessary for plant growth. Castings also assist in improving the water retention of soil.

Worm farm: A bought or constructed home for worms put in place to convert organic matter into worm castings and 'worm wiz'.

Worm leachate ('worm wiz'): A highly nutritious organic liquid plant food produced by the worms and collected from a worm farm.

Vermiculture: The raising and production of earthworms and their byproducts.

Worm food

Curriculum links

Learning area: Science

Science understanding	**Year 5** • Living things have structural and behavioural adaptations that enable their survival in their environment (WA5SSUB1) **Year 6** • The growth and survival of living things are affected by the changing conditions in their environment and the influence of human activities (WA6SSUB1) • Materials can undergo reversible changes and irreversible changes (WA6SSUC1)
Science inquiry skills	**Years 5 – 6** • Pose testable questions that include variables to be measured and changed, and apply science knowledge to make predictions (WA5SSIQ1) • Plan and conduct fair, safe and repeatable investigations (WA5SSIPL1) • Use equipment to observe, measure and record data (WA5SSIPL2) • Organise and represent data using tables, graphs and models to identify the relationships between measured and changed variables (WA5SSIPR1) • Compare findings with those of others, and to predictions; evaluate the fairness of an investigation and suggest improvements; and pose questions for further investigation (WA5SSIE1) • Communicate ideas in a variety of ways, including scientific reports with appropriate language features (WA5SSICM1) • Use science knowledge to develop considered responses to problems, at a local and global level, through investigation and research (WA5SSICL1)

Timing

This activity will require one 60-minute lesson for planning and one 60-minute lesson to set up the experiment. The students will need a short time to observe their worm farms and record their observations on an ongoing basis over several weeks. It will also require one 60-minute lesson at the end of the experiment for students to compile their data and discuss their results.

This activity can be completed as a paired/group activity.

Learning objectives

Students will:

- ✓ build a mini worm farm
- ✓ investigate factors that affect the rate at which worms consume food
- ✓ observe and record changes
- ✓ discuss their findings.

Resources required

- Worm food PowerPoint presentation and screen to share with class
- Two-litre clear plastic drink bottle (with the top cut off, see *infographic* on page 31) – up to four per pair/group
- Moist worm castings
- Water
- Compost worms
- Newspaper
- Vegetable and fruit scraps
- Fork/knife/grater/mortar and pestle/blender (optional)
- Labels
- Science journals, worksheet or digital device to record observations

Lesson 1

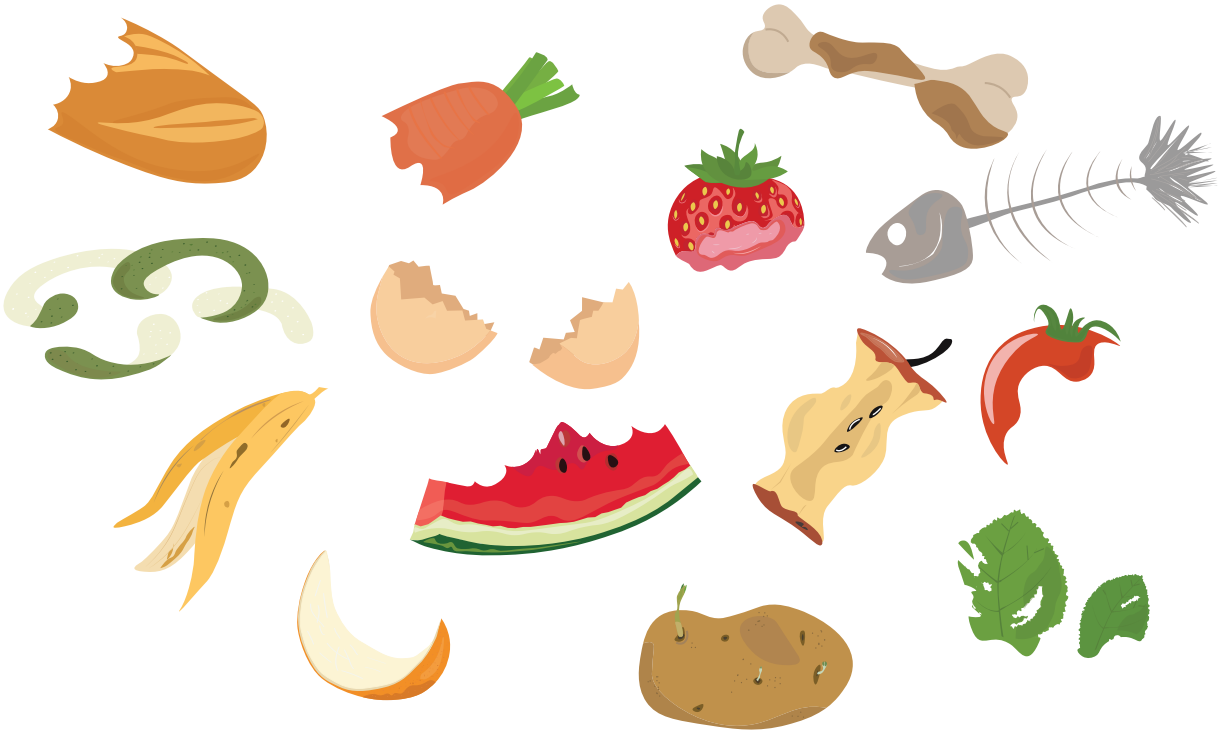
Planning an experiment - mini worm farm

To prepare

> Have the plastic bottles and food preparation tools ready so students can see what materials they will have access to when planning their experiment.

Activities

1. Explain to the class that they will be designing an experiment to investigate how food should be prepared to optimise its consumption in a worm farm.
2. Brainstorm different ways to prepare food for example, pureeing, chopping, grating, or leaving food items whole.
3. Discuss what foods can and cannot be placed in a worm farm.
4. Decide on a list of food items and ways to prepare these foods.
5. Show students the mini worm farms they will be using to conduct this experiment so that they can design their experiments accordingly.
6. Give students time to plan their experiment in pairs or groups. Allow them to choose up to four different food preparation methods per pair/group, depending on the number of plastic bottles and worms you have available.
7. In their science journals (or using the *Science investigation* worksheet), students design their experiment, remembering to include their investigation question, prediction, materials needed, safety procedures, method, observations and results.



Lesson 2
Conducting an experiment

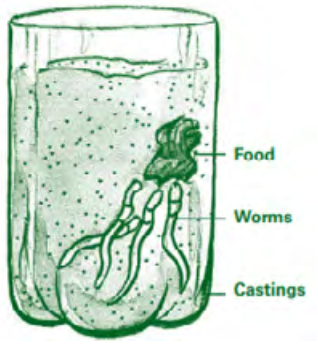
To prepare

> In this lesson, students will set up the experiment they designed in the last lesson. Before allowing students to proceed, check their experiment design to ensure it is safe for themselves and the worms.

Activities

1. Model how to set up a mini worm farm using the steps outlined in the *infographic* on page 31.

2. Allow students time to make their own mini worm farms in pairs/groups. They will need one worm farm for each food preparation method they will be investigating.
3. Monitor students for safety reasons as they prepare their food.
4. Dig a small hole along the side of each mini worm farm and place a differently prepared type of food into each one. Make sure that you can see the food through the side of the bottle and that the food is completely covered with castings.
5. Clearly label each container.



Observations

Check the mini worm farms every few days and add a little water if required. Observations should continue until all the food scraps have been converted into castings.

- Record observations in their science journals or using the *Science investigation* worksheet provided. Observations may include things like size of the food, number of worms visible near it, movement of the food, etc.
- Measure the size of their different food samples in the worm farm on the first day and then again on a regular basis until the end of the experiment.
- Take photos to create a digital record of the changes they observe.

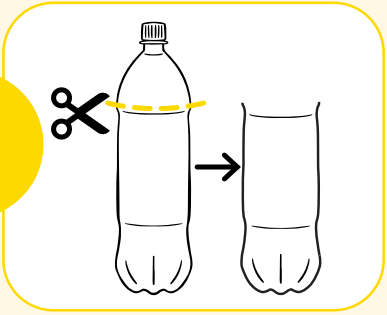
Lesson 3
Findings and discussion

Activities

1. At the end of the experiment allow students time to share their observations and findings with each other.
2. Compare the data and see if there are any similarities or differences. Discuss why different groups may have different results.
3. Discuss students' findings using the discussion questions on the PowerPoint as a guide.

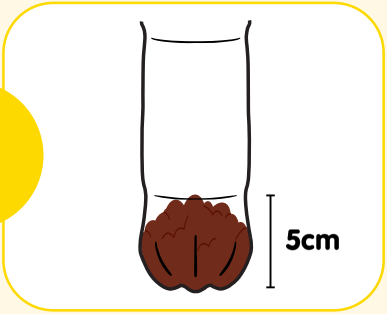
How to make a mini worm farm

1



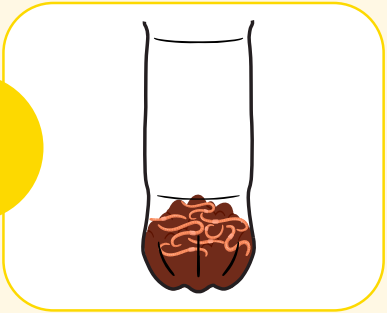
Cut the top off a two litre clear plastic drink bottle.

2



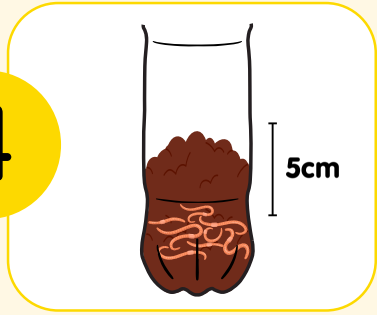
Place roughly 5cm of worm castings at the bottom of the bottle.

3



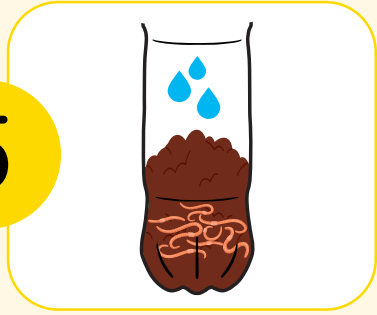
Add a small handful of worms.

4



Add another 5cm of the castings.

5



Add a small amount of water to moisten the farm.

6

Wrap the outside with a piece of newspaper and place a damp newspaper ‘plug’ on top.

Name: _____

Science investigation

Investigation question:

_____

_____

Materials

- worms
- worm castings
- clear plastic bottle
- water
- newspaper
- food scraps
- chopping equipment
- labels

Safety conditions

Worms are living creatures and must be treated with care and consideration.

Make sure to take suitable care when using cutting implements.

Variables

What I will change	What I will keep the same	What I will measure

Method:

Science investigation

Name: _____

Prediction:

Observations:

Food and method prepared	Day 1	Day ___	Day ___	Day ___	Day ___

Results:

Conclusion:

Important worms

Years 5 – 6

Background information

Beneficial products of a worm farm

Worm castings and leachate are highly nutritious organic foods for plants that can be added to your school garden. They contain a wide variety of nutrients and beneficial microbes necessary for plant growth while improving the water retention of soil.

Environmental impact of a worm farm

When organic waste decomposes in landfill, it is usually through anaerobic decomposition which produces methane gas. Methane is a harmful greenhouse gas with a global warming potential of 25 times that of carbon dioxide and is therefore a significant contributor to the warming of the Earth's climate. Currently, the waste sector produces about 13.6 million tonnes of greenhouse gas emissions (or 'carbon pollution') each year, equivalent to almost 3 per cent of Australia's emissions (Australian Government 2023). Aerobic composting (in a worm farm or another compost system) which is done at home, school or on an industrial scale is therefore a more desirable way to process organic waste as it reduces greenhouse gas emissions.

Worm farms contribute to environmental sustainability in several ways, some of which are:

- decreasing the amount of organic waste that is normally put in your school's/home's rubbish bins and sent to landfill
- 'closing the recycling loop' because our organic waste is changed into organic fertiliser for our plants which then produce food for us to eat
- reducing greenhouse gases, because in a well-maintained worm farm the decomposition process is aerobic (with oxygen) rather than anaerobic (without oxygen)
- improving and building soil by using castings and leachate by enriching it with micro-organisms, improving water-holding capacity, enhancing germination, improving plant growth and crop yield, and improving root growth and structure.

Worm farm key words

Aerobic decomposition: Organic matter being broken down in the presence of oxygen.

Anaerobic decomposition: Organic matter being broken down without the presence of oxygen.

Carbon dioxide (CO_2): An odourless, colourless gas produced during respiration. It is a greenhouse gas.

Castings/vermicast: See worm castings.

Decomposition: The process of organic matter being broken down physically and chemically by bacterial or fungal action; the rotting process; decomposition can be aerobic (with oxygen) or anaerobic (without oxygen).

Inorganic: Not organic. That is, matter that has not come from a living thing (e.g. plastic, glass, metal, synthetic fertilisers).

Leachate: See worm leachate.

Microbes: Micro-organisms such as bacteria and actinomycetes. In the case of worm leachate and castings, these are the beneficial micro-organisms that accelerate decomposition (Murphy 2009).

Organic: Matter that has come from a once-living organism and is capable of decay or is the product of decay (e.g. plants, leaves, food scraps, paper, straw etc.).

Worm castings/vermicast: Organic material that has been digested by worms and passed through their digestive system (i.e. faeces). Both worm leachate and castings contain a wide variety of nutrients and beneficial microbes necessary for plant growth. Castings also assist in improving the water retention of soil.

Worm farm: A bought or constructed home for worms put in place to convert organic matter into worm castings and 'worm wiz'.

Worm leachate ('worm wiz'): A highly nutritious organic liquid plant food produced by the worms and collected from a worm farm.

Vermiculture: The raising and production of earthworms and their byproducts.

Important worms

Curriculum links

Learning area: Science

Science understanding

Year 5

- Living things have structural and behavioural adaptations that enable their survival in their environment (WA5SSUB1)

Year 6

- The growth and survival of living things are affected by the changing conditions in their environment and the influence of human activities (WA6SSUB1)

Science inquiry skills

Years 5 – 6

- Pose testable questions that include variables to be measured and changed, and apply science knowledge to make predictions (WA5SSIQ1)
- Plan and conduct fair, safe and repeatable investigations (WA5SSIPL1)
- Use equipment to observe, measure and record data (WA5SSIPL2)
- Organise and represent data using tables, graphs and models to identify the relationships between measured and changed variables (WA5SSIPR1)
- Compare findings with those of others, and to predictions; evaluate the fairness of an investigation and suggest improvements; and pose questions for further investigation (WA5SSIE1)
- Communicate ideas in a variety of ways, including scientific reports with appropriate language features (WA5SSICM1)
- Use science knowledge to develop considered responses to problems, at a local and global level, through investigation and research (WA5SSICL1)

Learning area: Maths

Statistics and probability

Year 5

- Describe and interpret line graphs that show how real-life continuous data changes over time (WA5MPSS1)
- In a real-world context, pose and refine questions, and collect categorical or discrete numerical data. Organise and make choices to represent data. Interpret and communicate findings in terms of the context, and reflect on variation and accuracy (WA5MPSS2)

Year 6

- Describe and interpret a range of displays for real-life numerical data, including side-by-side column graphs, using mode, range and shape (WA6MPSS1)
- In a real-world context involving continuous and discrete numerical data, use the following process
  - I. analyse the situation to pose a question
  - II. choose the most appropriate way to collect data to ensure accuracy and consistency, and make choices to represent data, including line graphs and side-by-side column graphs
  - III. interpret and communicate findings in terms of the context and describe reasons for variation (WA6MPSS3)

Timing

This activity will require one 60-minute lesson for planning and one 60-minute lesson to set up the experiment. The students will need a short time to observe their grassy heads and record their observations on an ongoing basis over several weeks. It will also require one 60-minute lesson at the end of the experiment for students to compile their data and discuss their results.

This activity can be completed as a paired/group activity.

Learning objectives

Students will:

- ✓ discuss the importance of worms
- ✓ explore the relationship between worms and plant growth
- ✓ design and conduct a grassy heads experiment to test the benefits of worm castings and leachate on plant growth
- ✓ record their observations
- ✓ discuss their findings.

Resources required

- Important worms PowerPoint presentation and screen to share with class
- Old stockings/knee highs –up to four sections per pair/group

  *Note: Long stockings can be cut into multiple sections and tied in a knot at one end to get more use out of each one.
- Grass seeds or other fast-growing varieties such as wheat grass
- Measuring spoons and cups
- Glass jars – up to four per pair/group
- Water
- Worm castings
- Plain soil from the garden (do not use potting mix as this contains additives which may skew the results)
- Newspaper
- Measuring tools, e.g. ruler, measuring tape
- Labels
- Science journals, worksheet or digital device to record observations

Lesson 1
Planning an experiment - grassy heads

To prepare

> You will need equipment to demonstrate how to make a grassy head. Depending on the quantity of materials available, you may want to allow each pair/group to choose up to four variables to test in their experiment.

Activities

1. Watch the video
Why are earthworms important? - YouTube (1:36 minutes).

2. Discuss some of the benefits we gain from having worms present in our soil.
3. Explain to the students that they will be designing an experiment that will allow them to investigate the impact of worm castings and leachate on plant growth using grassy heads.
4. Demonstrate how to make a grassy head using the steps outlined in the *infographic*.

5. Explain to the students the materials they will have available to them and the different variables they can work with during this experiment, i.e. plain soil, plain water, a 50/50 mixture of soil and worm castings, worm leachate.
6. Allow students time to plan their experiment in pairs/groups.
7. In their science journals (or using the *Science investigation* worksheet), students design their experiment, remembering to include their investigation question, variables, prediction, method, observations and results.

Lesson 2
Conducting an experiment

To prepare

> In this lesson, students will be setting up their grassy heads experiment. Ensure they have the equipment needed and check their experiment design is valid before they begin.

Activities

1. Following the instructions in the *infographic* and their experiment write up, students will make their own grassy heads in pairs/groups.
2. Remind students that the amount of grass seed and the total volume of soil/castings added to each head must be kept consistent to ensure a fair experiment.
3. Label each jar clearly to identify what variables are being used.
4. Place jars in a sunny location and check regularly to ensure they do not dry out.
5. After the grassy heads have been set up, discuss with the class what data can be collected to answer the investigation question.

Observations

Check the grassy heads regularly and record observations.

- Students record their observations for each of their grassy heads on the *Science investigation* worksheet provided or create a similar table in their science journals.
- Record observations on a regular basis over several weeks.
- Students can also take photos to create a digital record of the changes they observe.

Lesson 3
Findings and discussion

To prepare

> How often you see the students will impact on when you can complete this final lesson. Allow sufficient time to ensure students have been able to collect adequate data to draw a reasonable conclusion.

Activities

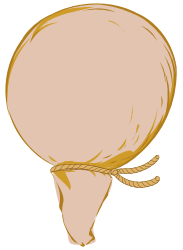
1. At the end of the experiment, students transfer the data collected onto a graph.
2. Students then complete their scientific reports and share their observations and results with each other.
3. As a class, compare the data and see if there are any similarities or differences. Discuss why different groups may have different results.

How to make a grassy head

1. **Add** one tablespoon of grass seeds to the end of a stocking.

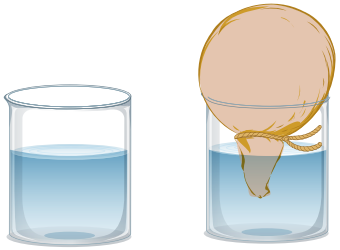
2. **Place** a handful of soil into the stocking, on top of the grass seeds.

3. **Tie** a knot in the end of the stocking, leaving a tail piece hanging down.

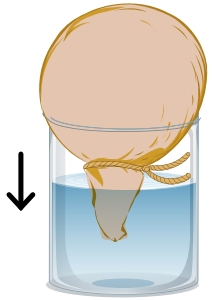


4. **Water** the grassy head so that it is wet through.

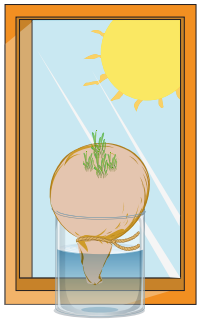
5. **Place** the grassy head on top of a jar filled with water.



6. **Make** sure the tail is submerged in the water.



7. **Place** the jar in a sunny location.



8. **Water** regularly to make sure the head doesn't dry out.

Name: _____

Science investigation

Investigation question:

_____

_____

Materials

- old stockings
- grass seeds
- measuring spoons and cups
- glass jars
- water
- worm castings
- plain soil from the garden
- measuring tools
- labels

Method

Variables

What we will change:	What we will keep the same:	What we will measure:

Prediction:

Science investigation

Name: _____

Observations:

Soil and water	Day ___	Day ___	Day ___	Day ___	Day ___
Seeds germinated					
Height					
Colour					

Soil and leachate	Day ___	Day ___	Day ___	Day ___	Day ___
Seeds germinated					
Height					
Colour					

50/50 mix soil and castings and water	Day ___	Day ___	Day ___	Day ___	Day ___
Seeds germinated					
Height					
Colour					

50/50 mix soil and castings and leachate	Day ___	Day ___	Day ___	Day ___	Day ___
Seeds germinated					
Height					
Colour					

Science investigation

Name: _____

Results:

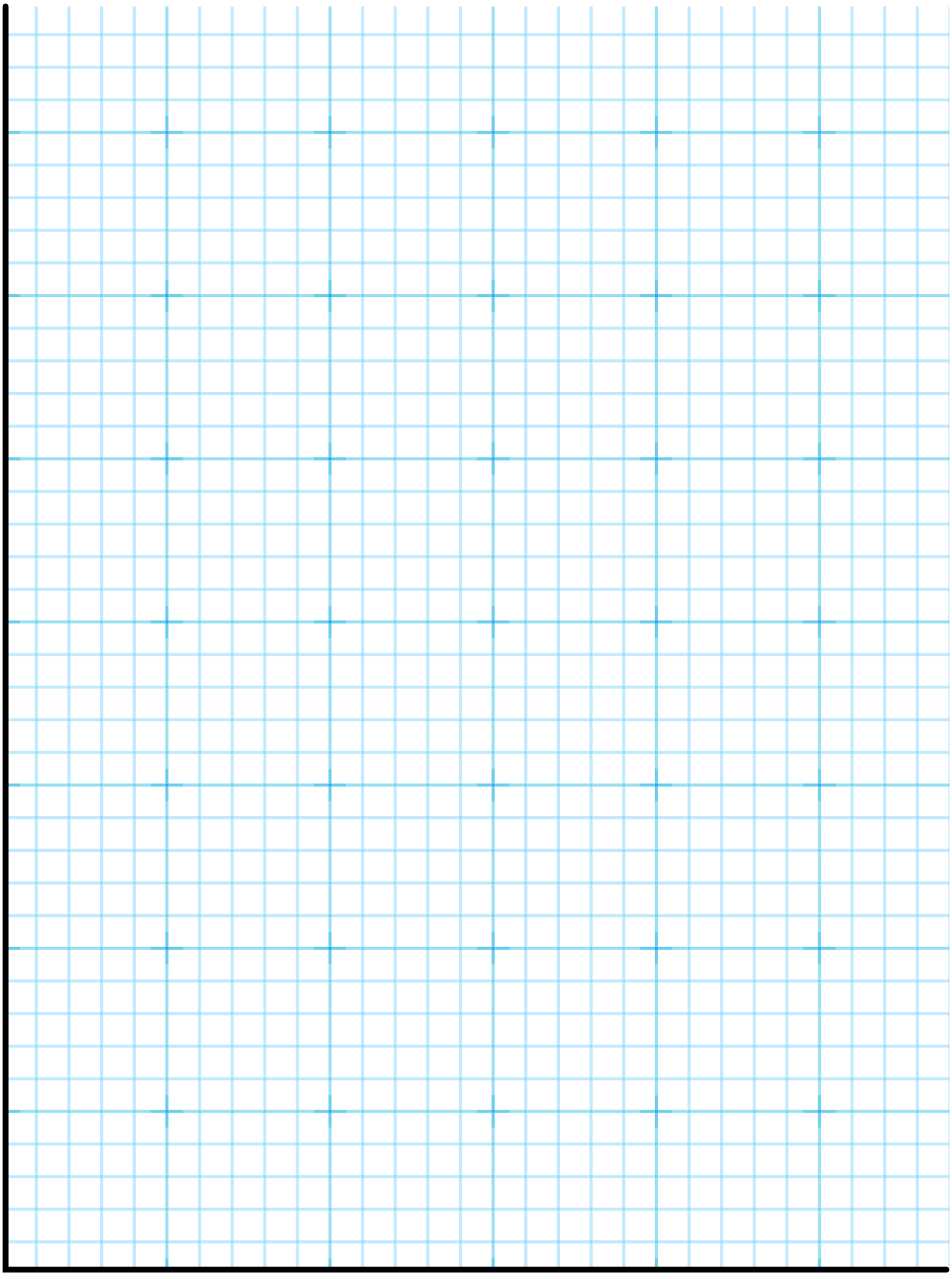
Similarities with other groups:

Differences with other groups:

Conclusion:

Name: _____

Title:



Designing a worm farm

Years 5 – 6

Background information

Types of worm farms

A worm farm is made from a container that has a drainage hole for water and a lid that keeps out vermin but allows air in. It is normally filled with layers of castings, shredded paper or other types of bedding and composting worms. You can buy worm farm containers, make your own, or have one custom made.

Modern worm farms are generally constructed of lightweight plastic with a series of stackable plastic trays. They can process up to 15 kg of fruit and vegetable scraps per month and are useful for small areas only, such as one class or an early childhood area.

School worm farms

As schools produce a large amount of organic waste, a larger container is required. Reusing a degassed fridge as a worm farm may work better for whole school use. This system provides a larger surface area which, when operating at full capacity, is capable of processing about 66 kg of fruit and vegetable scraps per month. Four hundred students produce about 3–3.5 kg of fruit and vegetable scraps per day, or 66–70 kg per month, making a degassed fridge ideal for a school of this size.

Look at the 'How to make a fridge worm farm' fact sheet to find out more. For most schools, at least one large worm farm (such as a fridge or bathtub) is needed.

You can also see how to make a worm farm from a polystyrene box in the following videos:

How to make a worm farm - YouTube (Ecofaeries)
How to be a good parent to your worms - Sustainable Gardening Australia Footprint Flicks - YouTube (Sustainable Gardening Australia)

How many worms?

You will need enough worms to manage your organic waste. It is a good idea to conduct a waste audit to find out how much organic waste your school produces to work out the size and/or number of worm farms that you'll need. As a general guide, one kilogram of worms will eat one kilogram of fruit, vegetable and paper scraps in two to three days. As the quantity of worms needed also depends on the amount of fruit and vegetable waste your school produces, you may need more than one worm farm.

A school of about 300 students might need one to three fridge worm farms (with about a two square metre base). To start a fridge worm farm, we recommend having three kilograms of worms.

For more information on setting up a worm farm at school, see the fact sheets or watch the instructional videos.

Worm farm key words

Aerobic decomposition: Organic matter being broken down in the presence of oxygen.

Anaerobic decomposition: Organic matter being broken down without the presence of oxygen.

Carbon dioxide (CO_2): An odourless, colourless gas produced during respiration. It is a greenhouse gas.

Castings/vermicast: See worm castings.

Decomposition: The process of organic matter being broken down physically and chemically by bacterial or fungal action; the rotting process; decomposition can be aerobic (with oxygen) or anaerobic (without oxygen).

Inorganic: Not organic. That is, matter that has not come from a living thing (e.g. plastic, glass, metal, synthetic fertilisers).

Leachate: See worm leachate.

Microbes: Micro-organisms such as bacteria and actinomycetes. In the case of worm leachate and castings, these are the beneficial micro-organisms that accelerate decomposition (Murphy 2009).

Organic: Matter that has come from a once-living organism and is capable of decay or is the product of decay (e.g. plants, leaves, food scraps, paper, straw etc.).

Worm castings/vermicast: Organic material that has been digested by worms and passed through their digestive system (i.e. faeces). Both worm leachate and castings contain a wide variety of nutrients and beneficial microbes necessary for plant growth. Castings also assist in improving the water retention of soil.

Worm farm: A bought or constructed home for worms put in place to convert organic matter into worm castings and 'worm wiz'.

Worm leachate ('worm wiz'): A highly nutritious organic liquid plant food produced by the worms and collected from a worm farm.

Vermiculture: The raising and production of earthworms and their byproducts.

Designing a worm farm

Curriculum links

Learning area: Science

Science understanding

Year 5

- Living things have structural and behavioural adaptations that enable their survival in their environment (WA5SSUB1)

Year 6

- The growth and survival of living things are affected by the changing conditions in their environment and the influence of human activities (WA6SSUB1)

Learning area: Design and technologies

Context: Materials and technologies specialisations

Year 5

- Properties for a range of materials, related components and use of given technologies to achieve a purpose (WA5TDECMT1)

Year 6

- Properties of selected materials, technologies, and production systems affect suitability and functionality in a product (WA6TDECMT1)

Technologies and society

Year 5

- Technologies are used in the design of products, and implementation of services and environments (WA5TDETS2)

Year 6

- Competing technologies are used for the design of products, services and environments for community needs (WA6TDETS2)

Design thinking skills

Year 5

- Use agreed protocols and management roles to communicate decisions, plan and manage time, to develop designed solutions (WA5TDEDTPM1)
- Break down a design brief to define the purpose and requirements for a given task (WA5TDEDTID1)
- Investigate and select resources based on properties and functions for the given task (WA5TDEDTID2)
- Design solutions considering competing factors, with annotated diagrams, storyboards and/or a sequence of steps, using technical terms and an iterative process (WA5TDEDTD1)
- Use technologies, components and/or equipment to implement agreed protocols to produce a designed solution (WA5TDEDTPI1)
- Use given criteria to evaluate design features, consideration of competing factors, processes and the designed solution (WA5TDEDTE1)

Year 6

- Use agreed protocols to set goals, manage competing factors, resources and time, to plan, develop and communicate decisions, when developing designed solutions (WA6TDEDTPM1)
- Break down a design brief to define the purpose, requirements and constraints for a given task (WA6TDEDTID1)
- Investigate and select resources considering constraints, properties and functions appropriate for the given task (WA6TDEDTID2)

	• Design alternative solutions achieved through an iterative process, including critical thinking, graphical representations, use of a range of technologies, techniques, technical terms and/or a sequence of steps (WA6TDEDTD1) • Use a range of technologies, components and/or equipment to implement agreed protocols to produce a designed solution (WA6TDEDTPI1) • Develop negotiated criteria to evaluate design features, graphics, selected technologies, processes and functionality with consideration of constraints for the designed solution (WA6TDEDTE1)
Learning area: English	
Literacy	**Year 5** • Use appropriate interaction skills, including paraphrasing and critical literacy questioning to clarify meaning, make connections to own experience, and present and justify an opinion or idea (WA5ELYI1) • Plan, create, rehearse and deliver spoken and multimodal presentations that include relevant, elaborated ideas, sequencing ideas and using complex sentences, specialist and technical vocabulary, pitch, tone, pace, volume, and visual and digital features (WA5ELYC2) **Year 6** • Use interaction skills and awareness of formality when paraphrasing, questioning, clarifying and interrogating ideas, developing and supporting arguments, and sharing and evaluating information, experiences and opinions (WA6ELYI1) • Plan, create, rehearse and deliver spoken and multimodal presentations that include information, arguments and details that develop a theme or idea, organising ideas using precise topic specific and technical vocabulary, pitch, tone, pace, volume, and visual and digital features (WA6ELYC2)

Learning objectives

Students will:

✓ research

- the optimal living conditions required by worms in a worm farm
- the quantity of organic waste produced at school
- the quantity of organic waste that worms can process
- the design features of a worm farm
- collection and storage of leachate

✓ use the findings from their research to design a school worm farm

✓ create a presentation about their design.

Timing

The number of lessons required to complete this activity will be at the teacher's discretion. Students will need time to research and design their worm farm. They will also need time to create a presentation about their design.

This activity can be completed as a paired/group activity.

Resources required

- Designing a worm farm PowerPoint presentation and screen to share with class
- Non-fiction texts about worms
- Digital devices with internet access
- Large paper for mapping and design
- Writing/drawing implements

Step 1: Research

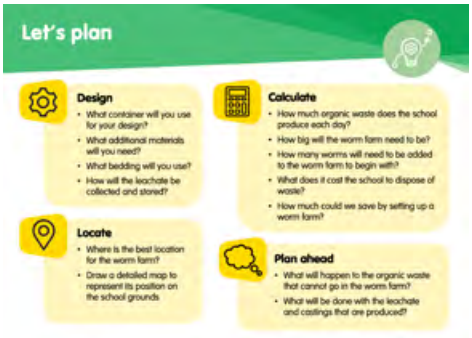
Explain to students that over the next few weeks they will be researching and designing a new worm farm for the school to use. When designing their worm farm there are a number of factors they need to consider including:

- what worms need to survive
- the amount of organic waste produced by the school
- the design features a worm farm needs to have
- how the school could benefit from having a worm farm.

Using the prompts on the PowerPoint slide as a guide, allow students time to research the information they will need to plan for and design their worm farms.

Step 2: Design

Once students have had sufficient time to complete their research, they can begin to design their worm farm.



Their designs should include details on:

- the size of the container they will use to hold the worms
- the materials it will be made from
- where in the school grounds it should be placed
- a plan for leachate collection and storage.

Step 3: Presentation

Using their research and planning, students will create a presentation about their worm farm designs.

Their presentations should include:

- a labelled diagram of their worm farm design
- a map of where it will be placed on the school grounds
- their calculations regarding organic waste produced by the school
- the number of worms needed to process it, and a plan for leachate collection and storage.

In their presentations, they should explain and justify their design choices based on the research they have conducted.

Worm farm enterprise

Years 5 – 6

Background information

Benefits of worm castings and leachate

Worm castings and leachate are highly nutritious organic foods for plants that can be added to your school garden. They contain a wide variety of nutrients and beneficial microbes necessary for plant growth while improving the water retention of soil.

Harvesting the worm leachate

Many schools collect and bottle the liquid (leachate) that filters out of the worm farm and sell it as a plant fertiliser for fundraising. Plastic milk bottles can be collected and reused as containers to store and sell the leachate. Please note that the leachate contains living beneficial bacteria so, to avoid killing them, do not store the leachate for a prolonged time (up to two days is okay). Also, avoid exposing the leachate to sunlight as ultra violet (UV) rays kill the bacteria. If there is no smell, it should be fine to use on your garden. Note that it is not good to put a lot of water through your worm farm. Regular light watering is ideal. It is better to harvest castings and produce 'worm wiz' by mixing the castings with water than to run a lot of water through your worm farm.

Harvesting a small amount of castings

Depending on the type of worm farm, there are a couple of ways to harvest the castings, from either the top or from the bottom of the worm farm.

When collecting castings from a bath or fridge worm farm, follow these instructions:

- Open the lid or remove the cover of the worm farm.
- Place the food at one end and replace the lid or cover.
- Continue to feed the worms in the same place for about two to three weeks.
- Harvest the castings from the section they have evacuated (the majority of the worms will have slowly moved toward the food source).

Another technique is to remove the cover of the worm farm to allow light in. The worms will move away from the light, burrowing down to allow you to gently remove the top layer of the castings in the area. Some schools empty sections of the worm farm onto a table and allow the worms to burrow down so that castings from the top can be harvested and remaining worms returned to the worm farm.

If there is a sliding panel installed, (usually with custom-built farms) the castings can be harvested from the base of the worm farm. The advantage of this kind of system is that the worms will not be disturbed when removing the castings (Murphy 2005).

Harvesting all castings

Some sources recommend separating worms from their castings at least twice a year to keep them healthy because at high concentrations, the castings create an unhealthy environment for worms. One method for doing this ('bait and switch') is particularly suitable for fridge worm farms:

1. Move the worm bin contents to one side of the bin so it fills about three-quarters of the bin's volume.
2. Add fresh bedding and food to the empty section.
3. Let the new section stand for two to four weeks without adding fresh food to the old section.
4. Water and cover only the new side of the bin.

The light and lack of moisture will cause the old side to dry out and speed up worm migration. As it dries out, the worms will leave it for the new side. After the worms have moved, harvest the old section. Plan to not feed your worms for at least two weeks before starting this harvest method. That way, you can harvest much sooner.

Worm farm key words

Castings/vermicast: See worm castings.

Leachate: See worm leachate.

Microbes: Micro-organisms such as bacteria and actinomycetes. In the case of worm leachate and castings, these are the beneficial micro-organisms that accelerate decomposition (Murphy 2009).

Worm castings/vermicast: Organic material that has been digested by worms and passed through their digestive system (i.e. faeces). Both worm leachate and castings contain a wide variety of nutrients and beneficial microbes necessary for plant growth. Castings also assist in improving the water retention of soil.

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Vermiculture: The raising and production of earthworms and their byproducts.

Worm farm enterprise

Curriculum links

Learning area: Design and technologies

Context: Materials and technologies specialisations

Year 5

- Properties for a range of materials, related components and use of given technologies to achieve a purpose (WA5TDECMT1)

Year 6

- Properties of selected materials, technologies, and production systems affect suitability and functionality in a product (WA6TDECMT1)

Learning area: HASS

Knowledge and understanding: Economics and business

Year 5

- The difference between needs and wants, and how they may differ between individuals (WA5HAKUE1)
- Resources can be natural, human, or capital, and how these are used sustainably to make goods and services to satisfy the needs and wants of present and future generations (WA5HAKUE2)
- Due to scarcity, choices need to be made about the use of limited resources and how the alternative use of resources result in the need to consider trade-offs (WA5HAKUE3)

Year 6

- The impact consumer purchasing decisions can have on a family, the broader community and the environment (WA6HAKUE1)
- Businesses provide goods and services in different ways to earn revenue (WA6HAKUE2)
- Influences on consumer choices and strategies that can be used to help make informed personal consumer and financial choices (WA6HAKUE3)

Humanities and Social Science skills

Years 5 – 6

- Develop and refine a range of questions required to plan an inquiry (WA5HASKQ2)
- Locate and collect information and/or data from a range of appropriate primary sources and secondary sources (WA5HASKQ3)
- Record selected information and/or data using a variety of methods (WA5HASKQ4)
- Develop and use criteria to determine the relevancy of information (WA5HASKA1)
- Analyse information and/or data collected (WA5HASKA2)
- Draw and justify conclusions, and give explanations, based on the information and/or data displayed in texts, tables, graphs and maps (WA5HASKE1)
- Use decision making processes including the use of criteria to assess the possible effects (WA5HASKE2)
- Present findings, conclusions and/or arguments, appropriate to audience and purpose, in a range of communication forms and using subject-specific terminology and concepts (WA5HASKC1)

Learning area: Maths	
Number and algebra	**Year 5** • Identify features of budgets and create a simple budget, comparing prices where possible (WA5MNAF1)
Learning area: English	
Literacy	**Year 5** • Plan, create, edit and publish written and multimodal texts whose purposes may be imaginative, informative and persuasive, developing ideas using visual features, text structure appropriate to the topic and purpose, text connectives, expanded noun groups, specialist and technical vocabulary, and punctuation, including dialogue punctuation (WA5ELYC1) **Year 6** • Plan, create, edit and publish written and multimodal texts whose purposes may be imaginative, informative and persuasive, using paragraphs, a variety of complex sentences, expanded verb groups, tense, topic specific and vivid vocabulary, punctuation, spelling and visual features (WA6ELYC1)

Learning objectives

Students will:

✓ develop a business plan to sell worm leachate and/or castings. They will:

- research and design suitable packaging options
- develop an advertising campaign
- calculate the costs involved.

Timing

The number of lessons required to complete this activity will be at the teacher's discretion. Students will need time to research the benefits of worm farm products, create a design for their product and devise an advertising campaign.

This activity can be completed as a paired/group activity.

Resources required

- Worm farm enterprise PowerPoint presentation and screen to share with class
- Student devices for online research
- Paper
- Writing/drawing instruments

Step 1: Research

Explain to students that over the next few weeks they will be creating a business plan to sell a worm farm product to the school community. They will need to consider the various factors that influence purchasing decisions and ensure that their proposed business plan will meet the needs of their intended consumers.

Using the prompts on the Powerpoint slide as a guide, allow students time to research the information they will need to begin to create their business plan.

They need to research packaging options, effective advertising strategies and potential costs versus possible income.

Step 2: Planning

Once students have had sufficient time to complete their research, they can begin to create their business plan.

They should think about a business name, design ideas for branding and packaging, costs involved in running their business, price of their product, and division of responsibilities within the business.

Step 3: Creating a business plan

Using their research and planning, students will create a final business plan for their worm farm product.

Their business plan should include:

- their identified target market
- how they intend to advertise/sell their product
- how much they intend to charge for their product
- projected earnings
- what will be done with any revenue raised
- key roles each team member will play in the business.

Students should be able to explain and justify their choices based on the research they have conducted.

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