

**QUEENSLAND
MUSEUM**

World
Science
Festival
Brisbane

LEARNING RESOURCE



Unlocking the Power of Biodiversity

YEARS 11 & 12 Biological Sciences

**QUEENSLAND
MUSEUM**



**Queensland
Government**

World Science Festival Brisbane

Each year World Science Festival Brisbane paints the town red and takes science out of the laboratory and into the streets, parks, museums, galleries and performing arts venues of Brisbane. The festival then travels throughout regional Queensland as World Science Festival Queensland.

Queensland Museum holds exclusive licence to host the festival in the Asia Pacific — the only global extension of this initiative. It has attracted over 1.5 million attendees since its launch in 2016.

World Science Festival Brisbane and Queensland reinforce Queensland Museum’s position as a leader in Science, Technology, Engineering and Mathematics (STEM) education and engagement. Through the festival, Queensland Museum engages audiences outside the traditional education sphere and promotes a whole-of-life “entanglement” with STEM. World Science Festival Brisbane and Queensland deliver on a mission to create authentic and compelling experiences and stories that inspire, enrich, and empower.

Front Page Image attribution: Jack Barnes Bicentennial Mangrove Boardwalk © Queensland Museum, Gary Cranitch

Copyright © 2026 Queensland Museum.

**QUEENSLAND
MUSEUM**



**Queensland
Government**



The images included in this teaching resource may be used for non-commercial, educational and private study purposes. They may not be reproduced for any other purpose, in any other form, without the permission of the Queensland Museum. This education resource was developed by Queensland Museum and has been peer reviewed.

Unlocking the Power of Biodiversity

Have you ever wondered why some species thrive in extreme environments while others struggle to survive? Or how scientists are using nature's designs to solve some of the world's biggest challenges? Biodiversity is the key to understanding these questions and more. It's the variation we see in life on Earth, from the tiniest microbes to the largest mammals, and it plays a vital role in shaping the world we live in.

This activity gives students the opportunity to explore the concept of biodiversity and its importance in solving global challenges. They will begin to uncover how the diversity of lifeforms in ecosystems inspires innovation, supports human health, and protects our planet.



Purling Brook Falls @ Queensland Museum, Gary Cranitch

ACTIVITY 1

Brainstorming Activity: Nature's Problem-Solvers

TEACHER NOTES

Purpose: Encourage students to connect biodiversity to real-world problem-solving and collaboration.

Instructions:

1. Divide students into small groups (3–4 students per group).
2. Provide each group with a *Brainstorming Worksheet* (see template below).
3. Ask groups to brainstorm examples of how humans have used nature to solve problems. Examples include:
 - Velcro inspired by burrs.
 - Passive cooling systems inspired by termite mounds.
 - Water filtration inspired by mangroves.
4. Groups write their examples on the worksheet and prepare to share with the class.
5. After 15 minutes, each group presents one example to the class.

Teacher Tip:

Provide hints if groups struggle (e.g., “Think about how animals adapt to their environment—how could humans use those adaptations?”).

ACTIVITY 2

Biodiversity in Action: Video/Article Reflections

TEACHER NOTES

Teachers may elect to use either video or articles for this activity. Directions for both options are provided below.

Video Reflection

Purpose: Provide real-world examples of biodiversity's importance and inspire curiosity.

Instructions:

1. Play a short 5-minute video that explains biodiversity and highlights its role in ecosystem services, agriculture, and sustainability.
2. After the video, ask students to reflect on what they learned. Use the following prompts:
 - What examples of biodiversity did you see in the video?
 - How does biodiversity connect to human health, agriculture, or technology?
 - Did anything in the video surprise you?

Recommended videos:

A. "Why is biodiversity so important? - Kim Preshoff"

Description: This animated video from TED-Ed explains the importance of biodiversity in maintaining healthy ecosystems and supporting life on Earth. It covers key concepts like ecosystem services, species interactions, and the consequences of biodiversity loss.

Duration: 4:19 minutes

Link: [Why is biodiversity so important? - TED-Ed](#)

Recommended for: General overview of the topic

B. "What is Biodiversity and Why Does it Matter to Us?" by the Natural History Museum

Description: This video from the Natural History Museum in London explores the concept of biodiversity and its importance to human life, including its role in providing food, medicine, and clean water.

Duration: 5:00 minutes

Link: [What is Biodiversity and Why Does it Matter to Us? - Natural History Museum](#)

Recommended for: Conservation focus of the topic

C. "How Wolves Change Rivers" by Sustainable Human

Description: This video tells the fascinating story of how the reintroduction of wolves to Yellowstone National Park transformed the ecosystem and even altered the physical geography of the park. It's a powerful example of how biodiversity impacts ecosystems.

Duration: 4:33 minutes

Link: [How Wolves Change Rivers - Sustainable Human](#)

Recommended for: Specific case study for the topic

Teacher Tip: Pause the video at key moments to emphasise important points.

Article Reflection

TEACHER NOTES

Purpose: Provide real-world examples of biodiversity's importance and inspire curiosity.

Instructions:

1. Select an article: Choose an article that aligns with the focus of your lesson (e.g., general overview, conservation, health, or innovation).
2. Provide a Reading Task: Distribute printed copies or share the link with students. Ask them to read the article individually or in pairs.
3. Distribute the below worksheet and ask students to complete using the information in the article.
4. Facilitate a Discussion: Use the following prompts:
 - What examples of biodiversity did you read about?
 - How does biodiversity connect to human health, agriculture, or technology?
 - What might happen if biodiversity were significantly reduced?

Optional Extension: Ask students to summarise the article in their own words or create a short infographic highlighting the key points.

Recommended Articles:

- A. **"International Day for Biodiversity" by Queensland Museum**
Description: This article highlights the significance of biodiversity through the lens of Queensland's Eungella rainforests, a unique biodiversity hotspot, emphasising the critical role of ecosystems in supporting human survival, the importance of conservation efforts, and the vulnerability of endemic species to climate change and environmental threats.
Link: [International Day for Biodiversity – Queensland Museum](#)
- B. **"Biodiversity and Health" by the World Health Organization (WHO)**
Description: This article focuses on the relationship between biodiversity and human health, explaining how biodiversity contributes to clean air, water, food security, and disease prevention.
Link: [Biodiversity and Health – WHO](#)
- C. **"Explainer: What is Biodiversity and Why Does it Matter?" by Morton, S., Shepphard, A., and Lonsdale, M. (The Conversation)**
Description: This article emphasises the critical importance of biodiversity for sustaining life on Earth, providing essential ecosystem services, supporting human well-being, and addressing the urgent need for effective conservation policies to combat biodiversity loss driven by climate change and human activities.
Link: [Explainer: what is biodiversity and why does it matter?](#)

Exploring the Value of Biodiversity

STUDENT WORKSHEET

Read the article provided by your teacher.

Answer the questions below using information from the article. Be sure to write in complete sentences and provide examples where possible. Be prepared to discuss your answers with the class.

Part 1: Understanding the Article

What is biodiversity? Define biodiversity in your own words based on the article.

Why is biodiversity important?

List three reasons biodiversity is important, as explained in the article.

Reason 1: _____

Reason 2: _____

What are some examples of how biodiversity supports ecosystems or human life?

Provide at least two examples from the article.

Example 1: _____

Example 2: _____

What are the main threats to biodiversity mentioned in the article?

Part 2: Reflecting on the Article

What was the most surprising or interesting fact you learned from the article? Why?

What might happen if biodiversity continues to decline?

Describe at least two potential consequences of biodiversity loss.

Consequence 1: _____

Consequence 2: _____

How does biodiversity connect to human health, agriculture, or technology?
Provide one example from the article and explain its importance.

Part 3: Extending Your Thinking

What actions can individuals, communities, or governments take to protect biodiversity?
Suggest at least two actions and explain how they could help.

ACTIVITY 3

The Big Question: What is the Value in Biodiversity?

TEACHER NOTES

Purpose: Activate prior knowledge and encourage students to think critically about biodiversity.

Instructions:

1. Write the central question on the board: *What is the value in biodiversity?*
2. Ask students to brainstorm their ideas individually for 2 minutes.
 - Encourage them to think about biodiversity in terms of ecosystems, human health, agriculture, and technology.
3. Facilitate a class discussion. Use prompts such as:
 - Why is biodiversity important for ecosystems?
 - Can you think of examples where biodiversity has helped humans solve problems?
 - What might happen if biodiversity disappeared?
4. Record student responses on the board or a digital tool. Highlight recurring themes (e.g., ecosystem balance, human health, agriculture).

Teacher Tip: If students struggle to come up with examples, provide hints such as pollination by bees, coral reefs protecting coastlines, or medicines derived from plants.

ACTIVITY 4

Exploring Biodiversity Through Biomimicry, Biotechnology and Biosecurity

TEACHER RESOURCE

Introduction: The Power of Biodiversity

Biodiversity is the variety of life on Earth, encompassing the diversity of genes, species, and ecosystems. It is the foundation of life, providing essential ecosystem services such as clean air, water, food, and climate regulation. But biodiversity is more than just a measure of life's richness—it is also a source of inspiration, innovation, and protection. By studying and leveraging biodiversity, humans have developed groundbreaking solutions to some of the world's most pressing challenges in health, agriculture, technology, and environmental sustainability.

In this lesson, we will explore how biodiversity is examined through three interconnected fields: **Biomimicry**, **Biotechnology**, and **Biosecurity**. Each of these fields demonstrates how biodiversity not only sustains ecosystems but also drives human innovation and protects the delicate balance of life on Earth.

Biodiversity as a Source of Innovation

Nature has been solving problems for billions of years. Through evolution, organisms have developed ingenious adaptations to survive and thrive in diverse environments. These adaptations serve as a vast library of solutions that humans can study and emulate. Biodiversity inspires innovation in three key ways:

1. **Biomimicry:** Learning from nature's designs, processes, and systems to create sustainable human technologies.
 2. **Biotechnology:** Using the genetic and biochemical diversity of life to develop products and technologies that improve human health, agriculture, and the environment.
 3. **Biosecurity:** Leveraging biodiversity to protect ecosystems and human health from biological threats while ensuring the stability of natural systems.
-

Biomimicry: Nature's Blueprint for Innovation

What is Biomimicry?

Biomimicry is the practice of studying and emulating nature's designs, processes, and systems to solve human challenges. It is based on the idea that nature has already developed efficient and sustainable solutions through millions of years of evolution.

Biomimicry in Nature: How It Furthers Biodiversity

Biomimicry is not just about humans copying nature; it also highlights the importance of biodiversity as a source of inspiration for sustainable solutions. The intricate relationships and processes within ecosystems demonstrate how nature has evolved to solve challenges efficiently, often in ways that maintain and enhance biodiversity. For example:

- **Pollination Networks:** Bees, butterflies, and other pollinators have co-evolved with flowering plants, creating intricate systems of mutual benefit. These natural processes ensure the survival of both pollinators and plants, maintaining biodiversity in ecosystems.

- **Seed Dispersal:** Plants have evolved various mechanisms to disperse their seeds, such as burrs that cling to animal fur or fruits that attract animals to eat and spread seeds. These mechanisms ensure genetic diversity and the spread of plant species.

Biomimicry in Human Design: Learning from Nature

Humans have used biomimicry to create innovative designs and technologies that solve complex problems. Examples include:

1. **Velcro:**
 - Inspired by burrs that stick to animal fur, Swiss engineer George de Mestral invented Velcro, a hook-and-loop fastening system used in clothing, shoes, and even space suits.
2. **Passive Cooling Systems:**
 - Termite mounds in Africa maintain a constant internal temperature through natural ventilation. Engineers have mimicked this design to create energy-efficient buildings, such as the Eastgate Centre in Zimbabwe, which uses 90% less energy for cooling compared to traditional buildings.
3. **Antibacterial Surfaces:**
 - Shark skin has microscopic ridges that prevent bacteria from attaching. Scientists have replicated this design to create antibacterial surfaces for hospitals and medical devices, reducing the spread of infections.

Why Biomimicry Matters

Biomimicry promotes sustainable solutions by using nature's time-tested strategies. It can reduce the need for harmful chemicals and energy-intensive processes, highlighting the importance of preserving biodiversity as a source of future innovation.

Biotechnology: Harnessing Nature's Diversity

What is Biotechnology?

Biotechnology is the use of biological systems, organisms, or their components to develop products and technologies that improve human life. It combines biology with technology to address challenges in medicine, agriculture, and environmental sustainability.

How Biotechnology Uses Biodiversity to Find Solutions

Biotechnology relies on the genetic and biochemical diversity of life to create innovative solutions. Examples include:

1. **CRISPR Gene Editing:**
 - CRISPR, a revolutionary gene-editing tool, was developed by studying the immune systems of bacteria. It allows scientists to edit DNA with precision, enabling treatments for genetic diseases like sickle cell anaemia and certain cancers.
2. **Medicines from Nature:**
 - Many life-saving medicines are derived from natural compounds found in plants, fungi, and microorganisms. For example:
 - The rosy periwinkle, a plant native to Madagascar, has been used to develop treatments for leukaemia and Hodgkin's lymphoma.
 - Penicillin, the first antibiotic, was discovered from a mould called *Penicillium*.

3. **Agricultural Biotechnology:**

- Genetically modified crops, such as drought-resistant wheat or pest-resistant cotton, are developed using genes from other organisms. These crops improve food security and reduce the need for chemical pesticides.

Why Biotechnology Matters

Biotechnology harnesses the wealth of diversity in nature to solve global challenges. It enables the development of new medicines, sustainable materials, and agricultural innovations, all of which rely on the preservation of biodiversity as a resource.

Biosecurity: Protecting Biodiversity and Ecosystems

What is Biosecurity?

Biosecurity involves protecting ecosystems, agriculture, and human health from biological threats such as invasive species, pests, and diseases. It focuses on preventing, managing, and responding to these threats to safeguard biodiversity and human well-being.

How Biosecurity Uses Biodiversity to Find Solutions

1. **Monitoring Biodiversity for Early Warning Systems:**

- By studying biodiversity, scientists can identify early signs of biological threats, such as invasive species or emerging diseases. For example, monitoring bird populations can help detect outbreaks of avian influenza.

2. **Natural Pest Control:**

- Biodiversity provides natural predators and competitors that help control pest populations. For example, ladybirds are used to control aphid populations in agriculture.

How Biosecurity Protects Biodiversity and Ecosystems

1. **Preventing Invasive Species:**

- Invasive species, such as cane toads in Australia, can outcompete native species and disrupt ecosystems. Biosecurity measures, such as quarantine protocols and public awareness campaigns, help prevent their spread.

2. **Maintaining Ecosystem Balance:**

- Biosecurity ensures that ecosystems remain stable by preventing disruptions caused by invasive species or diseases. For example, efforts to control crown-of-thorns starfish outbreaks on the Great Barrier Reef help protect coral biodiversity.

Challenges in Biosecurity

1. **Complexity of Ecosystems:**

- The interconnected nature of ecosystems makes it difficult to predict how biosecurity threats will spread or impact biodiversity.

2. **High Biodiversity Can Mask Threats:**

- In biodiverse ecosystems, it can be challenging to detect new invasive species or emerging diseases.

Why Biosecurity Matters

Biosecurity protects biodiversity, human health, and agriculture from biological threats. It ensures the stability of ecosystems and prevents economic losses caused by invasive species and diseases.

Conclusion: The Interconnected Fields

Biomimicry, Biotechnology, and Biosecurity are deeply interconnected and rely on biodiversity as their foundation.

- **Biomimicry** uses nature's designs to inspire sustainable human innovation.
- **Biotechnology** harnesses the genetic and biochemical diversity of life to create solutions for health, agriculture, and the environment.
- **Biosecurity** protects biodiversity and ecosystems from threats, ensuring the stability of natural systems.

By exploring these three topics, we can better understand the importance of biodiversity and its role in shaping a sustainable future. This lesson sets the stage for students to dive deeper into each pillar, analyse real-world data, and propose innovative solutions inspired by nature.

TEACHER NOTES

Discussion Prompts:

- Why is biodiversity essential for innovation and problem-solving?
- Can you think of other examples of biomimicry, biotechnology, or biosecurity in action?
- What might happen if biodiversity continues to decline?

Suggested Resources:

- [Biomimicry Institute](#)
- [Biosecurity in Australia - Department of Agriculture](#)

ACTIVITY 5

Group Research Challenges: Introducing the Three Fields

TEACHER NOTES

Overview

This lesson is designed to engage students in exploring how biodiversity can inspire solutions to real-world challenges through biomimicry, biotechnology, and biosecurity. Students will work collaboratively to analyse a scenario, investigate natural solutions, and design innovative responses.

Lesson Structure

This lesson is divided into three challenges, each focusing on a different application of biodiversity:

1. Challenge 1: Solving Water Challenges in a Drought-Prone Region
2. Challenge 2: Using Nature to Develop a Natural Pesticide
3. Challenge 3: Protecting a Wetland from an Invasive Species

Teachers can choose to:

- Assign one challenge to all groups for a focused class discussion.
- Rotate through the challenges over multiple lessons, dedicating one lesson to each challenge.
- Assign different challenges to different groups to encourage a variety of solutions and perspectives.

Lesson Objectives

By the end of the lesson(s), students will:

- Understand how nature can inspire solutions to real-world challenges.
- Collaboratively analyse problems and decide on a focus for their solutions.
- Investigate natural solutions and design innovative responses.
- Present and evaluate their designs, considering feedback from their peers.

Lesson Steps

STEP 1: Presenting the Challenges

Purpose: Introduce the challenge(s) and guide students in analysing the problem.

Instructions:

1. Introduce the Lesson:
 - Explain that students will be working in groups to solve challenges using biodiversity as inspiration.
 - Highlight the three challenges and explain the options for structuring the lesson (one challenge for all groups, rotating challenges, or assigning different challenges to different groups).
2. Form Groups:
 - Divide students into small groups (3–4 students recommended per group).
3. Present the Scenario:
 - Read or display the scenario for the selected challenge(s).
4. Set Expectations:
 - Explain that each group will:
 - Analyse the scenario and decide on the primary focus of their solution.
 - Investigate how biodiversity provides solutions to similar challenges.
 - Design an innovative solution inspired by nature.
 - Present their design to the class and receive feedback.
5. Guiding Questions for Analysis:
 - What is the main problem or challenge in the scenario?
 - What factors contribute to this problem?
 - What is the primary focus of your solution? Why?
 - How does nature solve similar problems?
 - What materials could you use to replicate this natural process?

STEP 2: Investigating Nature for Inspiration

Purpose: Students will explore how nature provides solutions to the challenges presented in their assigned scenario.

Instructions:

1. Research Natural Solutions:
 - Provide students with examples of how biodiversity has inspired solutions to similar challenges (examples are included in each challenge section).
 - Encourage students to research additional examples using online resources or printed materials.
2. Guiding Questions for Research:

- How does nature solve similar challenges?
 - What organisms or ecosystems could serve as sources of inspiration for your solution?
 - How could these natural solutions be applied to address the challenge?
-

STEP 3: Designing a Solution

Purpose: Students will use their research to design a solution to their assigned challenge. The SparkLab Design Process (Challenge, Think, Make, Test, Improve) will guide their thinking and actions as they develop and refine their ideas. Teachers and students can refer to the SparkLab Design Process video on the Queensland Museum website (SparkLab Design Process – Queensland Museum) for an explanation of this iterative process and how it can be applied to classroom design challenges.

Instructions:

1. Design the Solution:
 - Each group will create a design for their solution, including:
 - The natural inspiration behind their solution.
 - How their solution works and how it addresses the problem.
 - How they would test their solution to ensure it is effective.
 2. Sketch and Label:
 - Students should sketch their design and label the key features.
 3. Encourage Creativity:
 - Students can combine multiple natural inspirations in their design.
-

STEP 4: Presenting and Evaluating Solutions

Purpose: Students will present their designs to the class and evaluate the effectiveness of their solutions.

Instructions:

1. Group Presentations:
 - Each group will present their design to the class, explaining:
 - The problem they focused on.
 - The natural inspiration behind their solution.
 - How their solution works and how it addresses the problem.
 - How they would test their solution.
2. Class Feedback:
 - After each presentation, the class will provide feedback by answering the following questions:
 - What do you like about this solution?
 - What challenges might the group face in implementing their solution?
 - How could the solution be improved?

Challenge 1: Solving Water Challenges in a Drought-Prone Region

TEACHER NOTES

Scenario: Life in a Drought-Prone Community

Imagine you are part of a team of environmental engineers working to help a small rural community in western Queensland. This region experiences long periods of drought, with very little rainfall for months at a time. When rain does come, it is often in the form of short, intense storms, causing most of the water to run off the dry, compacted soil instead of being absorbed. The community relies on groundwater and seasonal rainfall for drinking water, agriculture, and daily needs, but these resources are becoming increasingly scarce due to climate change and overuse.

The community faces two major challenges:

1. **Water Collection:** The community struggles to collect and store enough water during the rainy season to last through the dry months.
2. **Water Filtration:** The available water sources, such as groundwater and rainwater runoff, are often contaminated with dirt, bacteria, and other pollutants, making the water unsafe to drink.

Your team has been tasked with designing a sustainable solution to address the community's water challenges. However, before you can begin, you must first decide:

- Is the primary issue water collection (e.g., capturing and storing water during rainfall)?
- Or is the primary issue water filtration (e.g., making the available water safe to drink)?

Once your team has identified the primary issue, you will design a solution inspired by nature.

STEP 1: Understanding the Problem

Purpose: Students will analyse the provided scenario, identify the key challenges, and decide whether the primary issue is water collection or water filtration.

Instructions:

1. **Read the Scenario:**
 - Provide students with the detailed scenario above.
2. **Guiding Questions for Analysis:**
 - What are the main water-related challenges faced by the community?
 - Is the primary issue water collection, water filtration, or both? Why?
 - What factors contribute to the water challenges in this region (e.g., climate, soil conditions, pollution)?
3. **Decision-Making:**
 - Each group must decide whether to focus on water collection or water filtration.
 - Groups should justify their decision based on the information provided in the scenario.

STEP 2: Investigating Nature for Inspiration

Purpose: Students will explore how nature solves similar water-related challenges and identify potential sources of inspiration for their design.

Instructions:

1. **Research Natural Solutions:**

- Students will investigate how organisms in nature collect or filter water.
- Provide the following examples to guide their research:

Examples of Water Collection in Nature:

- **Namib Desert Beetle:**
 - Lives in one of the driest places on Earth.
 - Collects water from fog by using its bumpy shell, which condenses water droplets that roll into its mouth.
- **Cacti:**
 - Use their spines to collect and channel water droplets toward their roots.
 - They have thick, fleshy stems that expand to hold water during rainfall and slowly release during dry periods.
 - Their waxy surfaces reduce water loss.
- **Pitcher Plants:**
 - Use their shape to collect rainwater, which is stored in their tubular leaves.

Examples of Water Filtration in Nature:

- **Mangroves:**
 - Filter salt from seawater through their roots, allowing them to survive in saline environments.
- **Oysters and Mussels:**
 - Filter water by removing particles and pollutants as they feed.
- **Wetlands:**
 - Act as natural water filters, trapping sediments and pollutants while allowing clean water to flow through.

2. **Guiding Questions for Research:**

- How does this organism or ecosystem collect or filter water?
- What adaptations make it effective in its environment?
- How could these adaptations be applied to solve the community's water challenge?

STEP 3: Designing a Solution

Purpose: Students will use their research to design a sustainable solution to the community's water challenge, inspired by nature. They may wish to refer back to the SparkLab Design Process (Challenge, Think, Make, Test, Improve) to guide their actions ([SparkLab Design Process – Queensland Museum](#)).

Instructions:

1. **Design the Solution:**
 - Each group will create a design for a water collection or filtration system based on their chosen natural inspiration.
 - Students should sketch their design and label the key features.
2. **Guiding Questions for Design:**
 - What is the specific problem being solved?
 - How will the design address the community's water challenge?
 - What natural organism or process inspired your design?
 - What materials would you use to build your design?
 - How would you test your design to ensure it works?
3. **Encourage Creativity:**
 - Students can combine multiple natural inspirations in their design. For example, a water collection system could use the Namib Desert beetle's fog-harvesting technique combined with the water storage capabilities of a cactus.
4. **Create a Prototype**
 - Create a detailed sketch of the water collection or filtration system.
 - Label the sketch with key features. These features may include, but not be limited to:
 - The delivery method (e.g., spray, trap, additive).
 - The physical properties (e.g., texture, shape, or form).
 - The chemical properties (e.g., active compounds or natural ingredients).
 - If time and resources allow, students can create a physical model of their design using craft materials (e.g. paper, cardboard, straws, tape).
5. **Evaluate and Refine the Design**
 - Each group should review their prototype to refine their design
 - Some guiding questions for this process include:
 - What does the design look like?
 - What are the key features of the design?
 - How will each feature solve the water challenge?
 - Using these observations, students should seek to refine the design.

STEP 4: Presenting and Evaluating Solutions

Purpose: Students will present their designs to the class and evaluate the effectiveness of their solutions.

Instructions:

1. **Group Presentations:**

- Each group will present their design to the class, explaining:
 - The problem they focused on (water collection or filtration).
 - The natural inspiration behind their design.
 - How their design works and how it addresses the problem.
 - How they would test their design.

2. **Class Feedback:**

- After each presentation, the class will provide feedback by answering the following questions:
 - What do you like about this design?
 - What challenges might the group face in implementing their design?
 - How could the design be improved?

Teacher Tip: Use open-ended questions to guide students who are struggling, such as:

What do you think is the biggest challenge for the community?

How does nature solve similar problems?

What materials could you use to replicate this natural process?

Challenge 1: Solving Water Challenges in a Drought-Prone Region

STUDENT WORKSHEETS

Scenario: Life in a Drought-Prone Community

Imagine you are part of a team of environmental engineers working to help a small rural community in western Queensland. This region experiences long periods of drought, with very little rainfall for months at a time. When rain does come, it is often in the form of short, intense storms, causing most of the water to run off the dry, compacted soil instead of being absorbed. The community relies on groundwater and seasonal rainfall for drinking water, agriculture, and daily needs, but these resources are becoming increasingly scarce due to climate change and overuse.

The community faces two major challenges:

3. **Water Collection:** The community struggles to collect and store enough water during the rainy season to last through the dry months.
4. **Water Filtration:** The available water sources, such as groundwater and rainwater runoff, are often contaminated with dirt, bacteria, and other pollutants, making the water unsafe to drink.

Your team has been tasked with designing a sustainable solution to address the community's water challenges. However, before you can begin, you must first decide:

- Is the primary issue water collection (e.g., capturing and storing water during rainfall)?
- Or is the primary issue water filtration (e.g., making the available water safe to drink)?

Once your team has identified the primary issue, you will design a solution inspired by nature.

Understanding the Problem

Is the primary issue water collection, water filtration, or both? Why?

What factors contribute to the water challenges in this region (e.g., climate, soil conditions, pollution)?

Which water issue will you focus on solving? Why?

Investigating Nature for Inspiration

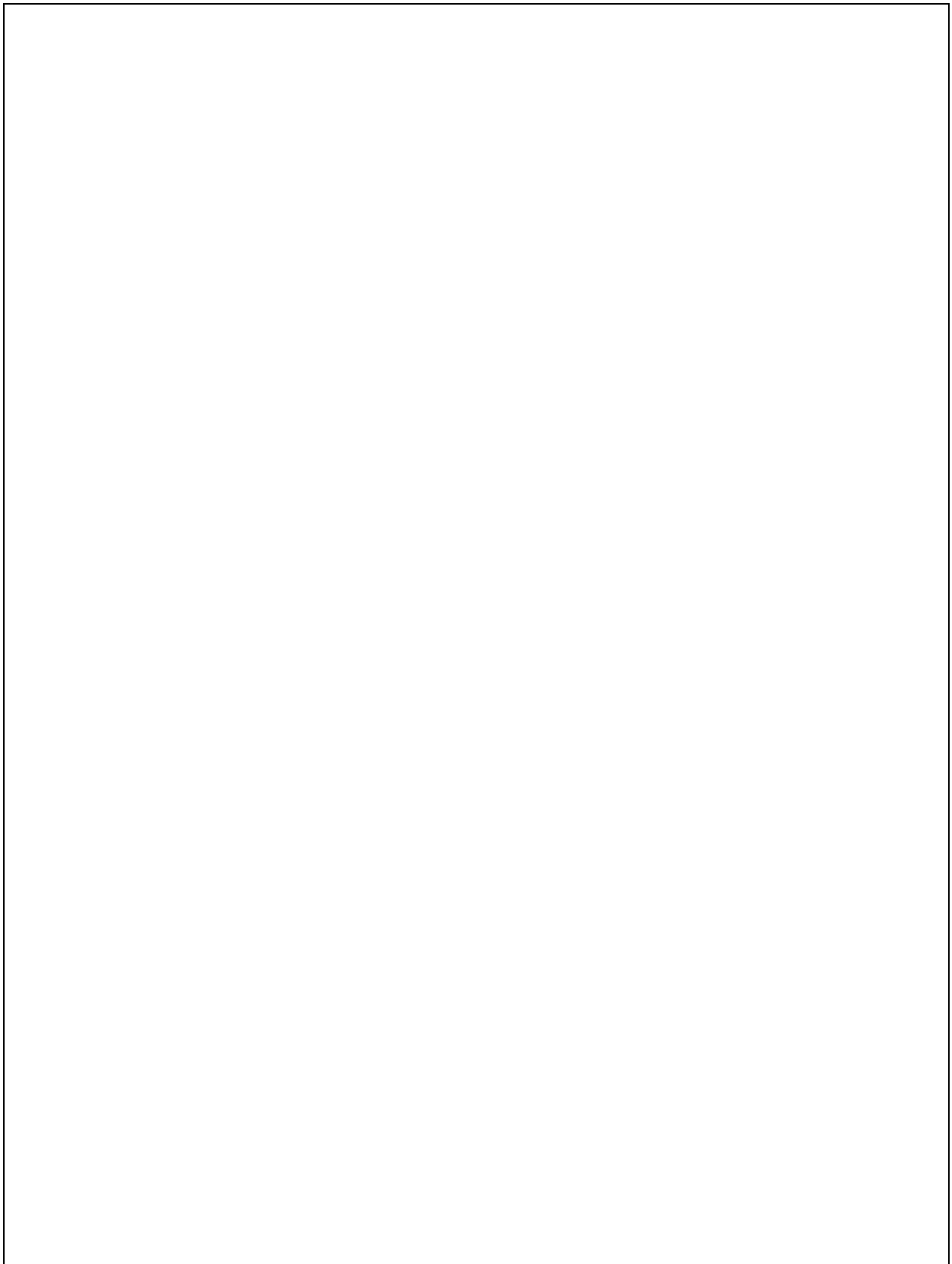
Explore how nature solves similar water-related challenges and identify potential sources of inspiration for your design.

Example of Water Collection in Nature	Collect or Filter Water?	How it Works	How could these adaptations be applied to your design?
Namib Desert Beetle	Collect Water	Condenses fog on its bumpy shell and the water droplets roll into its mouth.	A large reservoir with bumps could condense any fog into stored water.

Designing a Solution

Use your research to design a sustainable solution to the community's water challenge, inspired by nature.

Sketch your design and add detailed labels

A large, empty rectangular box with a thin black border, intended for students to sketch their design and add detailed labels. The box occupies most of the page's vertical space.

Explain your design

How will the design address the community's water challenge?

What natural organism or process inspired your design?

What materials would you use to build your design?

Challenge 2: Using Nature to Develop a Pesticide

TEACHER NOTES

Scenario: Protecting Crops with Natural Solutions

Imagine you are part of a team of agricultural scientists working to help a farming community in Queensland. This community relies on growing crops such as wheat, sugarcane, and vegetables to support their livelihoods. However, they are facing a major problem: pests are damaging their crops, reducing yields, and threatening their income. Farmers in the area have traditionally used chemical pesticides to control pests, but these chemicals are expensive, harmful to the environment, and can kill beneficial insects like bees and ladybirds.

Your team has been tasked with designing a natural pesticide that is effective against crop-damaging pests but safe for the environment and non-target species. To do this, you will use biotechnology to investigate how biodiversity can provide natural solutions to pest control.

STEP 1: Understanding the Problem

Purpose: Students will analyse the scenario, identify the key challenges, and decide on the focus of their investigation.

Instructions:

1. **Read the Scenario:**
 - Provide students with the detailed scenario above.
2. **Guiding Questions for Analysis:**
 - What are the main challenges faced by the farming community?
 - Why are chemical pesticides problematic for the environment and biodiversity?
 - What are the benefits of using another solution instead of a chemical pesticide?
3. **Decision-Making:**
 - Each group must decide on the focus of their natural pesticide. For example:
 - Should the pesticide target a specific pest species?
 - Should the pesticide be designed to avoid harming beneficial insects like bees?

STEP 2: Investigating Biodiversity for Inspiration

Purpose: Students will explore how biodiversity provides natural pest control solutions and identify potential sources of inspiration for their pesticide design.

Instructions:

1. **Research Natural Solutions:**
 - Provide students with examples of how pest control is found in nature (see examples below).
 - Encourage students to research additional examples using online resources or printed materials.

Examples of Pest Control in Nature:

- **Neem Tree:**
 - The neem tree produces a natural compound called azadirachtin, which acts as an insect repellent and disrupts the growth and reproduction of pests. Neem oil is widely used as a natural pesticide.
 - **Marigold Plants:**
 - Marigolds produce chemicals that repel nematodes (microscopic worms) and other pests. Farmers often plant marigolds alongside crops to protect them.
 - **Bacillus thuringiensis (Bt):**
 - A naturally occurring soil bacterium that produces proteins toxic to certain insect pests. Bt is widely used in organic farming and has been incorporated into genetically modified crops.
 - **Ladybirds:**
 - Ladybirds are natural predators of aphids and other crop-damaging insects. Farmers can attract ladybirds to their fields by planting specific flowers.
2. **Guiding Questions for Research:**
- How does this organism or plant control pests?
 - What makes it effective in its environment?
 - How could this natural solution be applied to create a safe and effective pesticide?
-

STEP 3: Designing a Solution

1. Design the Solution

- Each group will create a design for their natural pesticide, including:
 - The organism or plant that inspired their solution.
 - How the pesticide works (e.g., repelling pests, killing pests, or disrupting their life cycle).
 - How the pesticide avoids harming beneficial species, humans, or the environment.

2. Guiding Questions for Design

- What is the specific pest problem being solved?
- How will the design address the pest problem?
- What natural organism or process inspired your pesticide?
- How does your pesticide work to control pests?
- How will your pesticide avoid harming beneficial species, humans, or the environment?
- How would you test your pesticide to ensure it is effective?

3. Encourage Creativity

- Students can combine multiple natural inspirations in their design. For example:
 - A pesticide could combine the repellent properties of neem oil with the pest-attracting properties of pheromones to create a targeted trap.
 - A probiotic feed additive could be inspired by beneficial bacteria found in soil ecosystems.

4. Create a Prototype

- Sketch the Design:
 - Create a detailed sketch of the pesticide system or product.
 - Label the sketch with key features. These features may include, but are not limited to:
 - The delivery method (e.g., spray, trap, additive).
 - The physical properties (e.g., texture, shape, or form).
 - The chemical properties (e.g., active compounds or natural ingredients).
 - If time and resources allow, students can create a physical model of their pesticide design using craft materials (e.g., paper, cardboard, straws, tape).

5. Evaluate and Refine the Design

- Review the Prototype:
 - Each group should review their prototype to refine their design.
 - Guiding Questions for Evaluation:
 - What does the design look like?
 - What are the key features of the design?
 - How will each feature solve the pest problem?
 - How effective is the design likely to be?
 - Are there any potential risks to beneficial species, humans, or the environment?
- Using the observations, students should refine their design to improve its effectiveness.

STEP 4: Presenting and Evaluating Solutions

Purpose: Students will present their designs to the class and evaluate the effectiveness of their solutions.

Instructions:

1. **Group Presentations:**

- Each group will present their pesticide design to the class, explaining:
 - The problem they focused on.
 - The natural inspiration behind their solution.
 - How their pesticide works and how it addresses the problem.
 - How they would test their pesticide.

2. **Class Feedback:**

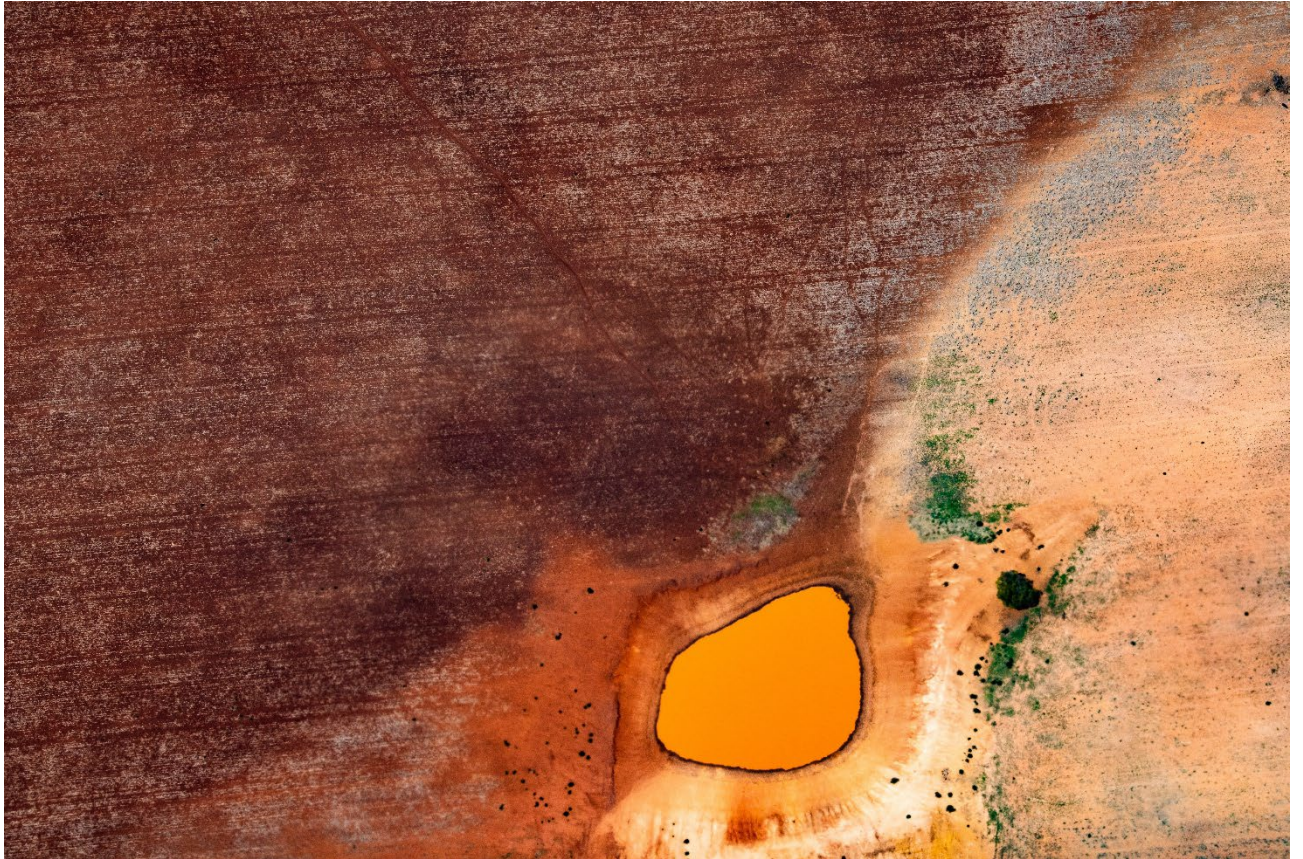
- After each presentation, the class will provide feedback by answering the following questions:
 - What do you like about this solution?
 - What challenges might the group face in implementing their solution?
 - How could the solution be improved?

Teacher Tip: Use open-ended questions to guide students who are struggling, such as:

What do you think is the biggest challenge for farmers in this scenario?

How does nature solve similar problems?

What materials or resources could you use to replicate this natural process?



Darr Creek @ Queensland Museum, Gary Cranitch

Challenge 2: Using Nature to Develop a Pesticide

STUDENT WORKSHEETS

Scenario: Protecting Crops with Natural Solutions

Imagine you are part of a team of agricultural scientists working to help a farming community in Queensland. This community relies on growing crops such as wheat, sugarcane, and vegetables to support their livelihoods. However, they are facing a major problem: pests are damaging their crops, reducing yields, and threatening their income. Farmers in the area have traditionally used chemical pesticides to control pests, but these chemicals are expensive, harmful to the environment, and can kill beneficial insects like bees and ladybirds.

Your team has been tasked with designing a natural pesticide that is effective against crop-damaging pests but safe for the environment and non-target species. To do this, you will use biotechnology to investigate how biodiversity can provide natural solutions to pest control.

Understanding the Problem

What are the main challenges faced by the farming community?

Why are chemical pesticides problematic for the environment and biodiversity?

What is the focus of your natural pesticide? Targeting a specific pest species or designed to avoid harming beneficial insects like bees?

Investigating Nature for Inspiration

Explore how nature solves similar challenges to identify potential sources of inspiration for your design.

Examples of Pest Control in Nature:

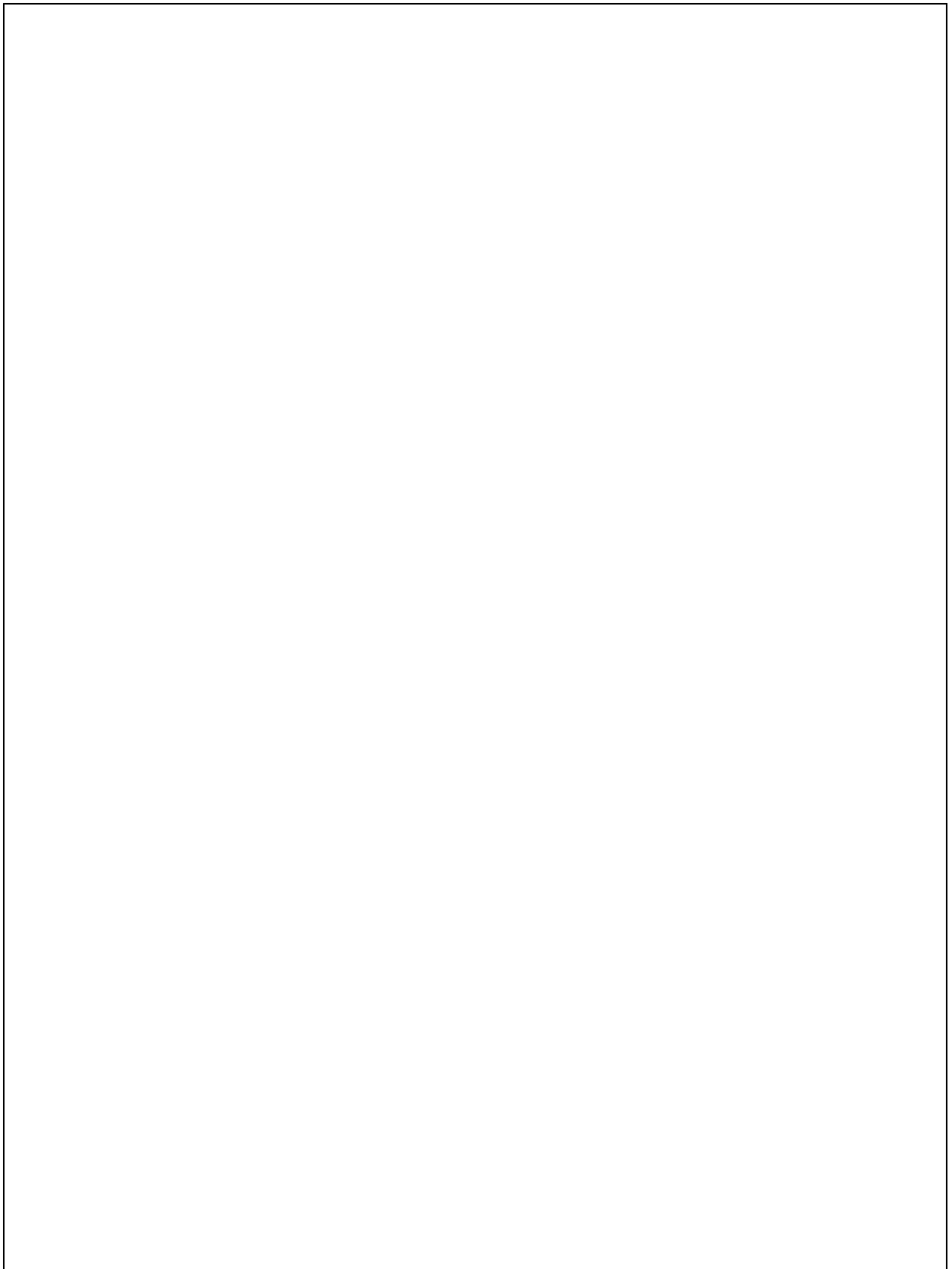
- **Neem Tree:**
 - The neem tree produces a natural compound called azadirachtin, which acts as an insect repellent and disrupts the growth and reproduction of pests. Neem oil is widely used as a natural pesticide.
- **Marigold Plants:**
 - Marigolds produce chemicals that repel nematodes (microscopic worms) and other pests. Farmers often plant marigolds alongside crops to protect them.
- **Bacillus thuringiensis (Bt):**
 - A naturally occurring soil bacterium that produces proteins toxic to certain insect pests. Bt is widely used in organic farming and has been incorporated into genetically modified crops.
- **Ladybirds:**
 - Ladybirds are natural predators of aphids and other crop-damaging insects. Farmers can attract ladybirds to their fields by planting specific flowers.

Example in Nature (Organism or plant name)	How it Works	What makes it effective in its environment?	How could these adaptations be applied to your design?
Neem Tree	Produces azadirachtin (natural compound) which repels insects and disrupts the growth and reproduction of pests.	Prevents insects destroying the trees by repelling them and disrupting their lifecycle.	The oil from the tree could be sprayed on crops to repels insects.

Designing a Solution

Use your research to design a sustainable solution to the community's water challenge, inspired by nature.

Sketch your design and add detailed labels

A large, empty rectangular box with a thin black border, intended for students to sketch their design and add detailed labels. The box occupies most of the page below the instructions.

Explain your design

How will the design address the pest problem?

What natural organism or process inspired your pesticide?

How does your pesticide work to control pests? How will your pesticide avoid harming beneficial species, humans, or the environment?

Challenge 3: Protecting a Wetland from an Invasive Species

TEACHER NOTES

Scenario: Managing an Invasive Species in a Wetland Ecosystem

Imagine you are part of a team of biosecurity officers working to protect a vital wetland ecosystem in Queensland. This wetland is home to a rich diversity of plants, fish, birds, and other wildlife. It provides critical ecosystem services, such as filtering water, preventing floods, and supporting local fisheries. However, a new invasive species has recently been discovered in the wetland: the red swamp crayfish (*Procambarus clarkii*), a highly aggressive freshwater crustacean native to the southern United States.

The red swamp crayfish reproduces rapidly and competes with native species for food and habitat. It also burrows into riverbanks, causing erosion and damaging the wetland's natural infrastructure. If left unchecked, this invasive species could disrupt the wetland's delicate balance, leading to the decline of native species and the loss of ecosystem services.

Your team has been tasked with developing a plan to manage the red swamp crayfish and protect the wetland ecosystem. However, before you can begin, you must first decide:

- Should your focus be on removing the red swamp crayfish from the wetland?
- Or should your focus be on preventing the spread of the red swamp crayfish to other areas?

Once your team has identified the primary focus, you will use biosecurity principles and knowledge of biodiversity to design a solution.

STEP 1: Understanding the Problem

Purpose: Students will analyse the scenario, identify the key challenges, and decide whether the primary focus should be on removing the invasive species or preventing its spread.

Instructions:

1. **Read the Scenario:**
 - Provide students with the detailed scenario above.
2. **Guiding Questions for Analysis:**
 - What are the main challenges posed by the red swamp crayfish in the wetland?
 - Is the primary focus removing the invasive species or preventing its spread? Why?
 - What factors make the red swamp crayfish a threat to the wetland ecosystem?
3. **Decision-Making:**
 - Each group must decide whether to focus on removing the red swamp crayfish or preventing its spread.
 - Groups should justify their decision based on the information provided in the scenario.

STEP 2: Investigating Biodiversity for Inspiration

Purpose: Students will explore what strategies are evident in other ecosystems and biosecurity strategies which can be used to manage invasive species and protect the wetland.

Instructions:

1. Research Natural and Biosecurity Solutions:

- Provide students with examples of how biosecurity strategies have been used to manage invasive species (see examples below).
- Encourage students to research additional examples using online resources or printed materials.

Examples of Managing Invasive Species:

- **Control of Cane Toads:**
 - Cane toads, an invasive species in Australia, have been controlled in some areas by using traps that target their specific behaviours and managing the habitat to limit the availability of artificial water sources (such as ponds or dams) which reduce breeding opportunities.
- **Sterile Insect Technique (SIT):**
 - This method involves releasing sterilised male insects into the wild to reduce the population of invasive species over time. It has been used to control fruit flies in agriculture.
- **Barriers and Containment:**
 - Physical barriers, such as nets or fences, can prevent invasive species from spreading to new areas. For example, electric barriers have been used to stop invasive Asian carp from entering the Great Lakes in North America.

Examples of Using Biodiversity to Protect Ecosystems:

- **Native Predators:**
 - Encouraging the growth of native predator populations can help control invasive species. For example, certain fish species prey on invasive crayfish.
- **Habitat Restoration:**
 - Restoring native vegetation can help strengthen ecosystems and make them more resilient to invasive species.

2. Guiding Questions for Research:

- How have other invasive species been managed or controlled?
- Are there any natural predators or competitors that could help control the red swamp crayfish?
- How could physical barriers or other biosecurity measures prevent the spread of the crayfish?

STEP 3: Designing the Solution

1. Design the Biosecurity Plan

- Each group will create a biosecurity plan based on their chosen focus:
 - Removing the red swamp crayfish from the wetland.
 - OR: Preventing the spread of the red swamp crayfish to other areas.

- Groups should outline the key steps in their plan and explain how it will protect the wetland ecosystem.

2. Guiding Questions for Design

- What is the specific problem being solved (removal or prevention)?
- How will the design address the challenges posed by the red swamp crayfish?
- What natural or biosecurity strategies inspired your plan?
- What are the key steps in your biosecurity plan?
- How would you test your plan to ensure it is effective?

3. Encourage Creativity

- Students can combine multiple strategies in their biosecurity plan. For example:
 - A plan to remove crayfish could include traps inspired by natural predators and habitat restoration to support native species.
 - A plan to prevent the spread of crayfish could include physical barriers, public awareness campaigns, and monitoring programs.

4. Create a Prototype

- Sketch a detailed diagram or flowchart to illustrate the biosecurity plan.
- Label the diagram with key features. These features may include, but are not limited to:
 - Physical barriers (e.g., nets, fences).
 - Traps or removal methods (e.g., traps inspired by natural predators).
 - Monitoring and surveillance strategies (e.g., mapping crayfish populations).
 - Community engagement or education strategies (e.g., signs, workshops).
- If time and resources allow, students can create a physical model of their biosecurity plan using craft materials (e.g., paper, cardboard, string, markers).

5. Evaluate and Refine the Design

- Review the Prototype:
 - Each group should review their prototype to refine their biosecurity plan.
 - Guiding Questions for Evaluation:
 - What does the biosecurity plan look like?
 - What are the key features of the plan?
 - How will each feature help solve the problem (removal or prevention)?
 - How effective is the plan likely to be?
 - Are there any potential challenges or risks in implementing the plan?
- Refine the Design:
 - Using the observations, students should refine their biosecurity plan to improve its effectiveness and sustainability.

STEP 4: Presenting and Evaluating Solutions

Purpose: Students will present their biosecurity plans to the class and evaluate the effectiveness of their solutions.

Instructions:

1. **Group Presentations:**

- Each group will present their biosecurity plan to the class, explaining:
 - The problem they focused on (removal or prevention).
 - The natural or biosecurity strategies that inspired their plan.
 - How their plan works and how it addresses the problem.
 - How they would test their plan.

2. **Class Feedback:**

- After each presentation, the class will provide feedback by answering the following questions:
 - What do you like about this plan?
 - What challenges might the group face in implementing their plan?
 - How could the plan be improved?

Teacher Tip: Use open-ended questions to guide students who are struggling, such as:

What do you think is the biggest threat posed by the red swamp crayfish?

How have other invasive species been managed in the past?

What materials or resources could you use to test your biosecurity plan?

Challenge 3: Protecting a Wetland from an Invasive Species

STUDENT WORKSHEETS

Scenario: Managing an Invasive Species in a Wetland Ecosystem

Imagine you are part of a team of biosecurity officers working to protect a vital wetland ecosystem in Queensland. This wetland is home to a rich diversity of plants, fish, birds, and other wildlife. It provides critical ecosystem services, such as filtering water, preventing floods, and supporting local fisheries. However, a new invasive species has recently been discovered in the wetland: the red swamp crayfish (*Procambarus clarkii*), a highly aggressive freshwater crustacean native to the southern United States.

The red swamp crayfish reproduces rapidly and competes with native species for food and habitat. It also burrows into riverbanks, causing erosion and damaging the wetland's natural infrastructure. If left unchecked, this invasive species could disrupt the wetland's delicate balance, leading to the decline of native species and the loss of ecosystem services.

Your team has been tasked with developing a plan to manage the red swamp crayfish and protect the wetland ecosystem. However, before you can begin, you must first decide:

- Should your focus be on removing the red swamp crayfish from the wetland?
- Or should your focus be on preventing the spread of the red swamp crayfish to other areas?

Once your team has identified the primary focus, you will use biosecurity principles and knowledge of biodiversity to design a solution.

Understanding the Problem

What are the main challenges posed by the red swamp crayfish in the wetland?

What factors make the red swamp crayfish a threat to the wetland ecosystem?

Is the primary focus removing the invasive species or preventing its spread? Why?

Investigating Nature for Inspiration

Explore what strategies are evident in other ecosystems and biosecurity strategies which can be used to manage invasive species and protect the wetland. Below are some ideas of cases to investigate.

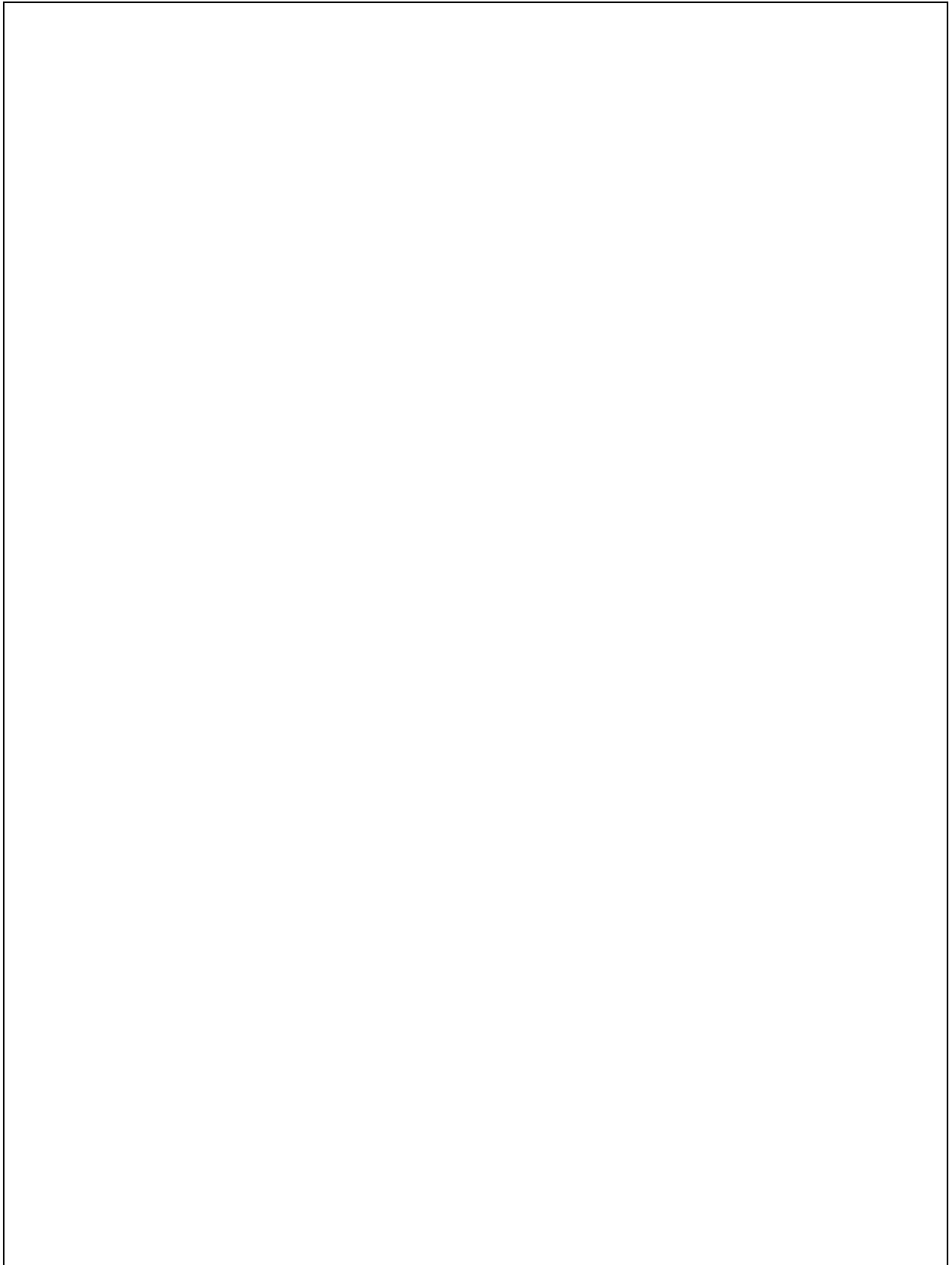
- **Control of Cane Toads:**
 - Cane toads, an invasive species in Australia, have been controlled in some areas by using traps that target their specific behaviours and managing the habitat to limit the availability of artificial water sources (such as ponds or dams) which reduce breeding opportunities.
- **Queensland fruit fly (*Bactrocera tryoni* 'Qfly') in New South Wales, Victoria and South Australia**
 - Large numbers of sterilised male insects were released into the wild to reduce the population of invasive Queensland fruit fly over time. The method is known as Sterile Insect Technique (SIT). This method relies on disrupting the lifecycle of the fly by preventing fertile offspring.

Method of Species Management	How it Works	Examples
Native Predators	Encouraging native predator populations to increase pressure on population	
Barriers and Containment		Electric barriers to stop Asian Carp from entering Great Lakes in North America

Designing a Solution

Use your research to create a biosecurity plan.

Sketch a detailed diagram or flowchart to illustrate the biosecurity plan. Label key features.



Explain your design

How will the design address the pest problem?

What natural organism or process inspired your pesticide?

How does your pesticide work to control pests? How will your pesticide avoid harming beneficial species, humans, or the environment?

**QUEENSLAND
MUSEUM**



Brisbane