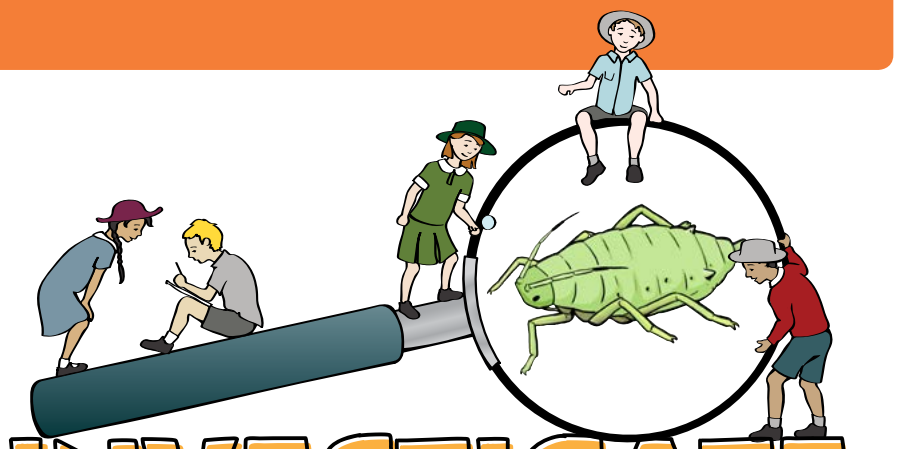
NSW GOVERNMENT
Department of Primary Industries

Stage 3 Science and Technology Competition

Teacher's Handbook and Learning Sequence



INVESTIGATE: aphids

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Disclaimer

The information in this document is based on knowledge and understanding at the time of writing (November 2016).

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Contents

About this resource

Background and aims

The *Investigate* science and technology competition is an initiative of the NSW Department of Primary Industries. The competition is open to all NSW Stage 3 students and teachers.

Intended audience

This Teacher's Handbook and Learning Sequence are intended for teachers of Years 5 and 6 students working towards Stage 3 outcomes in the Science and Technology K-6 syllabus. The activities in this unit assist students to achieve outcomes in the Living World, Built Environment and Information strands and in the skills areas of Working Scientifically and Working Technologically. Cross curricular links are made to Geography, English and Mathematics outcomes.

NSW Syllabus links

NSW Syllabus outcomes for the Investigate: aphids learning sequence are detailed in the following table.

Stage 3 NSW Science and Technology	
A student:	
ST3-2VA	demonstrates a willingness to engage responsibly with local, national and global issues relevant to their lives, and to shaping sustainable futures
ST3-4WS	investigates by posing questions, including testable questions, making predictions and gathering data to draw evidence-based conclusions and develop explanations
ST3-5WT	plans and implements a design process, selecting a range of tools, equipment, materials and techniques to produce solutions that address the design criteria and identified constraints
ST3-10LW	describes how structural features and other adaptations of living things help them to survive in their environment
ST3-11LW	describes some physical conditions of the environment and how these affect the growth and survival of living things
ST3-14BE	describes systems in built environments and how social and environmental factors influence their design
ST3-15I	describes how social influences impact on the design and use of information and communication systems

Stage 3 NSW Geography	
A student:	
GE3-1	describes the diverse features and characteristics of places and environments
GE3-2	explains interactions and connections between people, places and environments
GE3-3	compares and contrasts influences on the management of places and environments
GE3-4	acquires, processes and communicates geographical information using geographical tools for inquiry

Stage 3 NSW English	
A student:	
EN3-1A	communicates effectively for a variety of audiences and purposes using increasingly challenging topics, ideas, issues and language forms and features
EN3-2A	composes, edits and presents well-structured and coherent texts
EN3-3A	uses an integrated range of skills, strategies and knowledge to read, view and comprehend a wide range of texts in different media and technologies
EN3-5B	discusses how language is used to achieve a widening range of purposes for a widening range of audiences and contexts
EN3-8D	identifies and considers how different viewpoints of their world, including aspects of culture, are represented in texts

Stage 3 NSW Mathematics	
A student:	
MA3-1WM	describes and represents mathematical situations in a variety of ways using mathematical terminology and some conventions
MA3-2WM	selects and applies appropriate problem-solving strategies, including the use of digital technologies, in undertaking investigations
MA3-3WM	gives a valid reason for supporting one possible solution over another
MA3-9MG	selects and uses appropriate unit and device to measure lengths and distances, calculates perimeters, and converts between units of length
MA3-10MG	selects and uses appropriate unit to calculate areas, including areas of squares, rectangles and triangles
MA3-17MG	locates and describes position on maps using a grid-reference system
MA3-18SP	uses appropriate methods to collect data and constructs, interprets and evaluates data displays, including dot plots, line graphs and two-way tables

Stage 3 Literacy Continuum – Cluster 11 (End of Year 5)		
Reading	**Vocabulary Knowledge**	**Aspects of writing**
Uses text navigation skills such as skimming and scanning to efficiently locate specific information in literary, factual and electronic texts.	Demonstrates understanding of new words for new concepts.	Writes coherent, structured texts for a range of purposes and texts. Selects appropriate language for eg descriptive, persuasive, topic, technical, evaluative, emotive, and colloquial. Plans and designs more complex multimodal texts.

Safety and ethical considerations

Safety policies are of particular relevance to the activities in this unit. Students and their supervising teachers or parents should ensure that their science investigations are conducted in a responsible and safe manner. It is essential that student activities are conducted according to procedures developed through appropriate risk assessments at the school.

Teachers should ensure correct cleaning and hygiene practices are followed prior to and following handling of foods, insects and field work.

Stinging/biting insects could be encountered in the course of the investigation and this possibility should be allowed for.

What should I do if I get stung during field work?

Apply ice to relieve the swelling and pain. Gently wash the area with soap and water and leave any blisters intact. People who experience an allergic reaction after an insect sting should seek medical attention immediately.

Teaching and learning

A learning sequence and activities to guide teachers in the teaching of science, technology and biosecurity concepts are provided in this document. The learning sequence has been developed using the 5Es inquiry approach and comprises nine learning experiences.

There are nine learning experiences across the five phases of inquiry.

Activities provided in the learning sequence will guide you in designing an aphid surveillance program for your school garden and learning about their impacts on the environment, garden and agricultural production. In solving the problem 'How can we keep aphids away?' you will explore our wonderful natural world and the importance of beneficial insects in the control of pests. To synthesise your learning you will create a persuasive text, in the form of an advertisement, to promote your insectary design, IPM and beneficial insects.

Background information is provided throughout the learning experiences in break out boxes and hyperlinks to support teachers.

Unit overview

ENGAGE	**Learning experience 1: What are aphids?**
	Students outline their prior knowledge of aphids and develop their understanding of aphids through research and shared learning. Examine students prior knowledge of insects and aphids and develop KWL chart Research aphids Share learning
	Learning experience 2: How can we find out if there are aphids in our school?
EXPLORE	**Students use design, planning and analytic skills in the collaborative development of an aphid surveillance program.** Brainstorm how you can find out if there are aphids in your school Introduce the term and concept of monitoring and surveillance Design an aphid surveillance program
	Learning experience 3: Are aphids in our gardens a problem?
	Students undertake a surveillance program and explore the impact aphids have on plant health through collaborative observation and research. Undertake aphid surveillance and identify aphid populations in your school Observe and research the impacts of aphids Discuss and record impacts of aphids on plants
	Learning experience 4: How do aphids affect our food and fibre?
	Students outline agricultural production in their area and investigate the recent impacts of Russian wheat aphid on agricultural production. Revise agriculture as the production of food and fibre resources Identify agricultural production in your area and outline Australian wheat production Introduce Russian wheat aphid and discuss the impacts of aphids on agriculture
EXPLAIN	**Learning experience 5: What is biosecurity for the garden and farm?**
	Students are introduced to the term biosecurity and develop an understanding of biosecurity measures to reduce the spread of aphids. Introduce/revise biosecurity Brainstorm biosecurity measures which could be used in gardens or on farms Brainstorm how we can control aphids in gardens or on farms

EXPLAIN	**Learning experience 6: How can we control aphids?**
	Collaboratively explore options for the control of aphids and pest species through Integrated Pest Management and learn about beneficial insects. Introduce the concept of Integrated Pest Management (IPM) and beneficial insects Watch and discuss 'A bug's life' Research beneficial insects
ELABORATE	**Learning experience 7: How can we attract beneficial bugs?**
	Students design an insectary, complete with plants and permanent habitat, for a selected location. Identify beneficial insects you want in your garden Research and explore insectaries Design an insectary
	Learning experience 8: Constructing your insectary
	Students work together to implement their design and construct an insectary, or a model of one, for beneficial insects. Revise your insectary design Outline construction method and roles and responsibilities Collate your resources and construct you insectary, or a model of it, based on your design
EVALUATE	**Learning experience 9: Advertising your insectary, IPM and beneficial insects**
	Collaboratively design and prepare an advertisement to promote your insectary, IPM and beneficial insects to gardening and farming communities. View advertisements and list the features of effective advertising campaigns Plan an advertisement to promote your insectary, IPM and beneficial insects Create and submit your advertisement

Learning sequence

Introducing Investigate: aphids

Explain to students that your class will be involved in a competition and as part of the competition you will investigate a common biosecurity pest and develop a solution to dealing with the pest.

Instruct students to complete the student entry surveys on our website in order to earn extra points for your competition entry. Teacher and student entry surveys should be completed prior to beginning the learning sequence.

Explain that throughout this unit you will be completing a range of activities to answer the question: how can we keep aphids away?

Learning experience 1: What are aphids?

Students outline their prior knowledge of aphids and develop their understanding of aphids through research and shared learning.

Accessing prior knowledge

Brainstorm and revise with students the types of insects that you see around your school grounds and home. Talk about where you see these insects, what they are doing when you see them, what they eat and where they live.

Ask students if they have ever heard of or seen aphids and share individuals understanding of and experiences with aphids.

Your KWL chart

Introduce students to the KWL chart you will be using to record your ongoing learning and knowledge throughout this unit.

How to use your KWL chart

When students come up with questions they should write them down and place them on the *'what we want to know'* section.

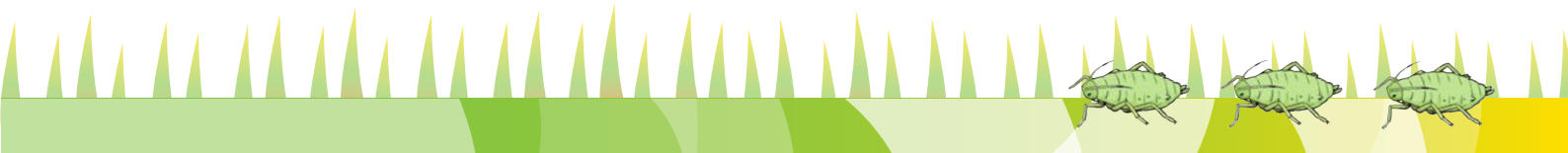
Questions on the chart should be addressed and answered, through learning and research, throughout the learning sequence. Once questions have been answered and the content is understood by students, this information may be placed on the 'what we learned' section of the chart.

You may choose to use an interactive KWL chart (readwritethink KWL creator) or the KWL chart provided.

Print your KWL chart on A3 paper and display in the classroom for students to post questions or learning on throughout the investigation. Alternatively print a chart for each student to keep their own.

If you are using a printed KWL chart, sticky-notes or paper with blue tac are good options to write and display students input on as they can be moved on the chart.

Add your learning to your KWL chart at the end of each lesson.



Discuss the key areas of the KWL chart and explain that everything on the chart is 'fluid' – meaning it can be moved as more is learned, removed if students find that their prior knowledge was a misconception, and new information and questions can be added at any time.

Add students' knowledge of aphids to the KWL chart and allow students to add any questions they have. Guide students to construct the following questions for your chart:

- What do aphids look like?
- What do aphids eat?
- Where do you find aphids?
- When are aphids most active?
- What is an aphids lifecycle?
- How do aphids breed?
- How do aphids move around/spread?
- Are there different species of aphids?
- Are there different types of aphids? (winged and wingless aphids)
- How do aphids impact the environment? (plants and other insects)

Researching aphids

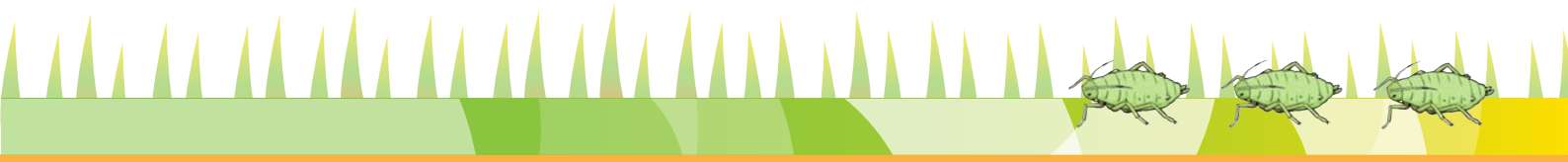
Use the questions posed by students and those above to focus small group research. Assign each group to one or two questions to research and then share their learning with the class.

Careers in Schools

Make connections between small group research and workplace collaboration. Explain that in workplaces each person or small group will take on different responsibilities or research and then share their learning with the others in the team. This means that more can be done in less time and everyone works together.

Explain that your class is like a workplace team and you are all going to work together, by researching different questions and sharing your learning, in order to learn as much as you can about aphids as quickly as you can.

You may choose to use the Research Template provided to support students to record their research, summarise the information found and think about the quality and authenticity of resources being used for research.



Resources for research and learning

Life cycle of aphids – this YouTube video, developed by Koppert Biological Systems, provides an overview of aphids, their features and life cycle.

Critter catalog: aphids – this webpage has been developed as part of the United States BioKIDS website with information based on that of the National Science Foundation. Targeted for students, it provides a thorough overview of aphids, however US examples may sway students research and this should be discussed prior.

Aphids, mealybugs and scales – Department of Agriculture and Food WA provide information on aphids, their features, food sources, impacts and control on this webpage.

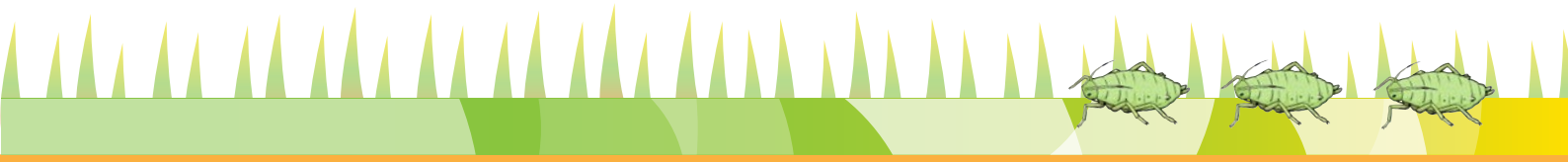
Aphids – AUSVEG, Australia's National peak industry body for vegetable and potato growers have a webpage dedicated to aphids which provides useful information.

Aphid Pests – GreenMethods.com provide an overview of aphids and why they are a pest.

Share and record learning with the class. You may choose to collate your classes learning in a document, class book, powerpoint or digital presentation as you continue through the unit.

Watch 'Aphids: weird poop, weirder babies', a fast paced and humorous YouTube clip about aphids, to review your research and learning. Discuss the clip and share any new learning.

Update your class KWL chart at the end of each lesson.



Learning experience 2: Are there aphids in our school?

Students use design, planning and analytic skills in the collaborative development of an aphid surveillance program.

Revise students learning about aphids and your KWL chart.

Explain to students that you need to investigate whether there are aphids in your school. Discuss and brainstorm how you find out if there are aphids in your school. Guide students towards designing and undertaking a monitoring and surveillance program.

Monitoring and surveillance

Discuss monitoring and surveillance and explain that surveillance is used by professionals to monitor the location, movement and spread of diseases or pests. Surveillance is undertaken at regular intervals during the growth and development of plants and during periods of pest and disease spread.

> Monitoring and surveillance involves looking for and recording the presence, absence and population levels of pests. Regular monitoring is a fundamental part of management practice and gives the best chance of spotting a new or established pest soon after it arrives.
> (Farm Biosecurity Program – www.farmbiosecurity.com.au).

Design an aphid surveillance program

Work through the following steps to design your aphid monitoring and surveillance program.

You may choose to use the Surveillance: Design Template to guide your students through this process.

Choose a title

Choose a fun and exciting title to explain what you are looking for.

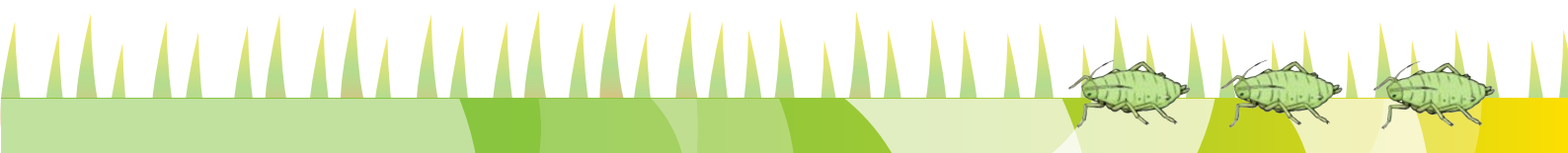
Determine the purpose

Record why you are undertaking surveillance.

Pest details

Revise and record details about the pest which will help you when designing and undertaking your surveillance. Pest details to record include:

- pest name, including scientific/latin name and common name/s.
- life cycle, specifically features of each stage of the life cycle.



- characteristics and/or identifiable features, this may include other insects or species which are commonly attributed to the pest e.g. aphids and ants are often found together as they live symbiotically.
- habitat or hosts where the pest is more likely to be found.
- an image, or series of images, of the pest.

Determine the surveillance location

Provide a description of the whole surveillance location and features. In this instance it is most likely to be your school grounds so provide the address of your school or identify it on a map. Explain the locality of your school in relation to nearby towns/locations and within NSW. Describe the built and natural features of your school, including:

- buildings
- walkways
- play equipment
- garden beds
- large trees or shrubs .

Give an overview of the climate in your area.

Next level learning

Broaden students learning and understanding by incorporating mapping skills and knoweldge.

View your school and location on Google Maps and/or SIX Maps and talk about the different views of the maps e.g. street view, google earth.

Create your own map of your school grounds incorporating mapping tools such as scales and keys. Locate the major features of your school on your map and record the surveillance sites using a key.

When you undertake your surveillance you may also incorporate a key to show the results of your surveillance.

Schedule surveillance

Surveillance is undertaken numerous times throughout a plant or crops growing period and the calendar year. Consistent and regular surveillance gives you the best chance of finding and responding to a pest or disease early. This will help minimise any detrimental impacts on plant health and/or productivity.

Outline aphids most active periods in relation to your climate on an annual calendar. Think about the plants or crops which aphids are most likely to impact and align their primary growth and productivity periods on your calendar.

Schedule your surveillance based on those periods which align on your calendar. For the sake of this program you should choose to undertake your initial surveillance in the near future.

Select surveillance sites

Use your knowledge of aphids to identify the garden beds and/or individual plants which are most likely to host aphids. Explain why you have chosen these surveillance sites.

It is recommended that you choose a number of different surveillance sites in different areas of the surveillance location to ensure your surveillance is as thorough as possible.

You may choose to increase the number or size of surveillance sites as you find aphids or signs and symptoms of them. For example, if you find aphids on one tomato bush in your school vegetable garden you may choose to extend your surveillance area from the

individual plant to the whole garden bed so you can determine the spread and extent of aphid populations in your school.

Observations and data

Identify what you are looking for at the surveillance sites. Think about the following questions:

- What signs and symptoms of aphids could you look for which might help you identify that aphids may be there or have previously been there?
- Where are aphids most likely to be found and which locations on the plant are you going to look for aphids?
- How many locations on each plant or in each surveillance site are you going to look for aphids?
- What will you do if you find aphids? Will you extend your surveillance in that area?
- What observations and data are you going to record? For example you may choose to estimate the population of aphids in each surveillance site or simply identify the presence or absence of aphids.
- How are you going to record your observation data? Do you need to develop a template or system so everyone is recording their observations and data in the same way or format?

Method

Discuss how you are going to undertake your surveillance.

You may choose to undertake your surveillance as a whole class and allocate specific surveillance sites and/or jobs to small groups. Alternatively you may choose to work in small groups and have each group undertake surveillance at every site and then compare and collate your findings at the end.

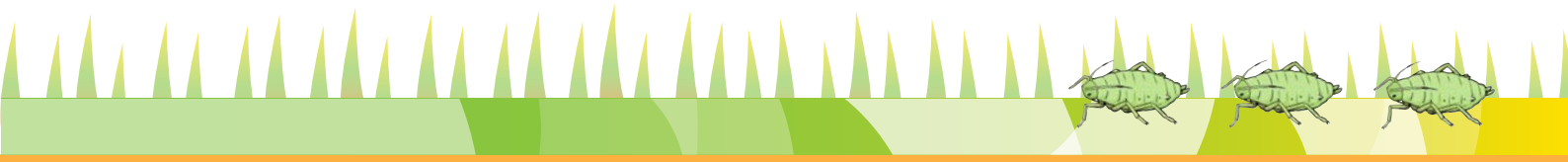
Work with your students to develop an effective method for your class and situation.

Equipment

Identify what equipment and resources you need in order to undertake your surveillance. This may include:

- template or blank paper to record observations and data.
- clip boards to lean on.
- magnifying glasses (if your school has access to some).

This is also a good time to review any safety considerations and/or equipment you may require. For example if a student in your class is allergic or anaphylactic to bees or other insects/outdoor features you may like to review the safety and emergency procedures and ensure that you take the correct equipment, such as an epi-pen with you.



Learning experience 3: What's the problem with aphids?

Students undertake a surveillance program and explore the impact aphids have on plant health through collaborative observation and research.

Monitoring and surveillance

Revise your monitoring and surveillance program, collect equipment and undertake your surveillance.

Once you have completed your surveillance collate your findings and share your experiences. Encourage students to analyse their findings and identify any relationships, patterns or trends in the locations or populations of aphids.

Observing and identifying aphid impacts

In small groups select some of the plants that you found to have aphids and observe the plant over a few days or a week. Brainstorm the different types of things you may look for and observe over the period, this may include:

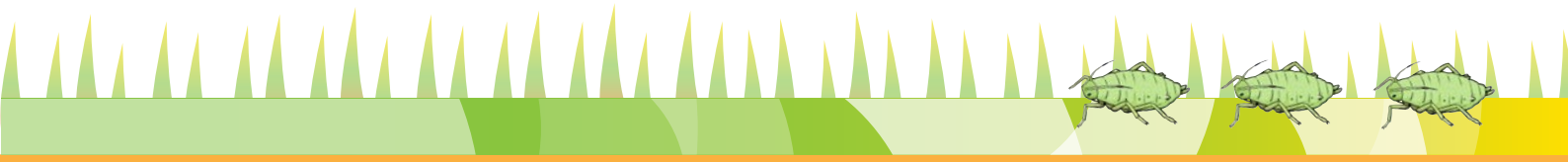
- Other insects you see at each site and the relationships between insect species
- Changes to plant – this may include changes to the colour or distinctive features on any part of the plant
- Spread or movement of aphids
- Populations and number of aphids at each site

You can also identify aphid symptoms on plants such as:

- Decreased growth rate of plant
- Mottled, yellowing or browning leaves
- Curled leaves
- Low production or yields
- Wilting
- Plant death

Record your observations each day and discuss the impacts of aphids on plants and their local environment.

If you did not find aphids on any plants in your school you may choose to buy a bunch of cut flowers from a local store, or bring some from home, and check them for the presence of aphids and observe aphid impacts.



Research aphid impacts

Revise your prior learning and observations to determine the impact aphids have on plants. Research the impacts aphids have on plants. Aphids impact on the health and productivity of plants. The damage done by aphids can be due to a number of causes, these may include:

- Loss of sap
- Clogging of leaf surfaces with honeydew
- Growth of moulds and fungi on the honeydew aphids secrete
- Leaf curling to protect the aphid population
- Transmission of viruses to the plant.

Through your observations and research, discuss and mindmap how aphids affect plants. Discuss how this could affect vegetable produce from the garden, then introduce students to the idea that aphids also affect agricultural production and crops.

Learning experience 4: From garden to farm, Russian wheat aphid

Students outline agricultural production in their area and investigate the recent impacts of Russian wheat aphid on agricultural production.

Accessing prior knowledge

Introduce/revise farms as places which produce food and fibre, much like a home or school garden, but on a larger scale. Farms grow a range of plants and animals dependent on the size of the farm, weather and soil conditions as well as the availability of water and farm infrastructure.

Discuss the types of agricultural production that occur in your area. If you are in an urban area talk about market gardeners/agriculture in the peri-urban area and the ways that people farm small areas.

If students are unsure of the agricultural production which occurs in their area you may use the following guiding questions:

- What have you seen on farms nearby?
- What is growing in the paddocks?
- What changes do you notice at different times of the year?
- Why does the cost and availability of fruit and vegetable varieties change at different times of year? (Seasonal variations impact on supply and demand and ultimately price)
- Why do you think some products are grown in specific areas and not in others? Talk about how topography, climate, weather and soil all impact on the variety and types of produce which can be grown in each area.

Agriculture in our area

NSW Local Land Services website provides information on NSW Regions. Select your region and in the 'Our region' tab have a look at your regional profile to find out more about the agricultural production which occurs in your area.

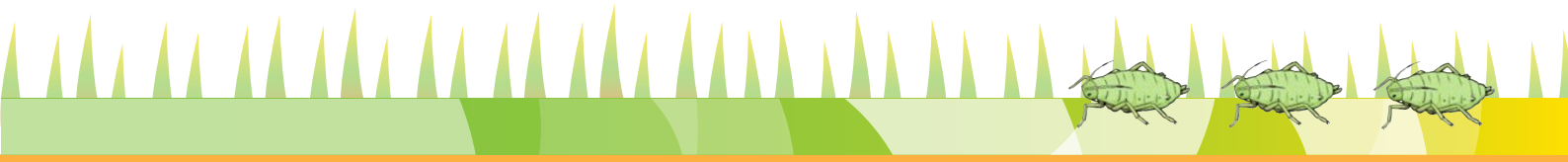
Aphids – from garden to farm

Revise the impacts aphids have on gardens and make connections between aphids impact on plant health and productivity and the way this would affect large scale producers such as farmers.

View the Grains Research Development Corporation's (GRDC) Crop Aphids Back Pocket Guide and look at the different types of aphids which effect crops. Discuss which types of crops they affect and how they affect those crops.

Introduce students to the Russian wheat aphid. Ask students to outline what their name tells them about the Russian wheat aphid. Where is it from? What plants do you think it likes?

Discuss with students what wheat is, how it is grown and which daily products are made from wheat.



Wheat

Wheat is the major winter crop grown in Australia with sowing starting in autumn and harvesting, depending on seasonal conditions, occurring in spring and summer. The main producing states are Western Australia, New South Wales, South Australia, Victoria and Queensland. Wheat is predominantly grown in what is known as the 'wheat belt', as demonstrated by the area shaded yellow in Figure 1.

The majority of Australian grown wheat is exported with a smaller portion used for our domestic market. Wheat is a valuable livestock feed however it is mainly used for human consumption to make a range of foods. Wheat is typically milled into flour which is then used to make a wide range of foods including bread, crumpets, muffins, noodles, pasta, biscuits, cakes, pastries, cereals, snack foods, crackers, sauces and confectionary such as liquorice.

Figure 1. Australian wheat belt

Resources for research and learning:

NSW DPI Where does our food come from? Wheat – This short video introduces you to wheat production, and the farmers behind it, in Warren NSW.

I love Barooga at harvest time - A short video on a farm in Barooga on the Murray River in Victoria. It is a race against time to get the wheat harvested and into the silo before it rains. Great footage of the wheat crop, big harvesters, trucks and their operators.

YouTube video Growing Wheat Traditionally – A short video which provides you with an overview of wheat production in Australia.

The Workboot Series: The Story of Wheat – Check your School or local library for this book which takes you into Australian wheat farms where you can discover how wheat is produced, processed and made into a wide range of nutritious foods available to you every day.

Sustainable Farming: Wheat – produced by the Northern Agricultural Catchments Council (WA) this resource provides an overview of wheat farming.

Australian wheat, Australian agricultural and rural life – this document from the State Library of NSW provides an overview of the historical development and importance of wheat production in NSW and Australia.

Watch GCTV20: Russian wheat aphid – recommendations for ongoing management YouTube video and discuss your learning.

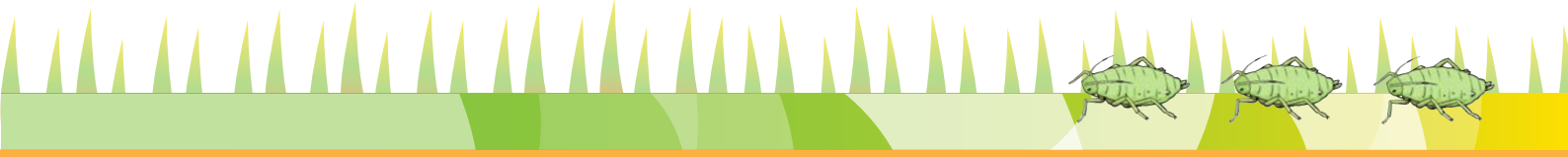
View the Russian wheat aphid distribution map from the Biosecurity Portal and discuss the spread of the Russian wheat aphid to date. Identify that their spread is predominantly within the Australian wheat belt – the primary wheat growing areas.

Discuss the impact of Russian wheat aphid on agricultural crops and productivity. Explain that they are a pest which have made their way into Australia and we need to control their populations so they have as little impact on our agricultural crops as possible.

Next level learning

View the scientific illustrations of aphids (listed under 'True bugs') on the NSW DPI website. Discuss the history of the artist EH Zeck and the role of illustrations such as these in the historical development and understanding of our natural world and agriculture.

Try your hand at creating your own scientific illustrations of the Russian wheat aphid.



Learning experience 5: Biosecurity for the garden and farm

Students are introduced to the term biosecurity and develop an understanding of biosecurity measures to reduce the spread of aphids.

Biosecurity

Introduce or revise biosecurity and discuss why biosecurity is important. Explain that biosecurity helps to keep NSW and Australian ecosystems, agriculture and communities safe by keeping out and controlling animal and plant diseases and pests such as weeds and pest animals and insects, such as aphids.

Watch Pawder Patrol: Declare or dispose from the New Zealand Ministry for Primary Industries.

Explain to students that there are a variety of biosecurity measures and management practices that help keep us and our environments safe. Ask students if they know how we try to prevent the spread of diseases and pest animals and plants. Your list could include:

- Vaccinations for us, our pets and livestock
- Not being allowed to take specific items to specified areas or across state borders, eg. You cannot take oranges into citrus growing areas
- Having our bags checked at the airport
- Quarantining animals and livestock in yards or separate areas if they have been moved from a different property to control the spread of weeds and diseases
- Washing your hands after you have been playing with animals or in soil
- Controlling weeds to make sure they don't spread

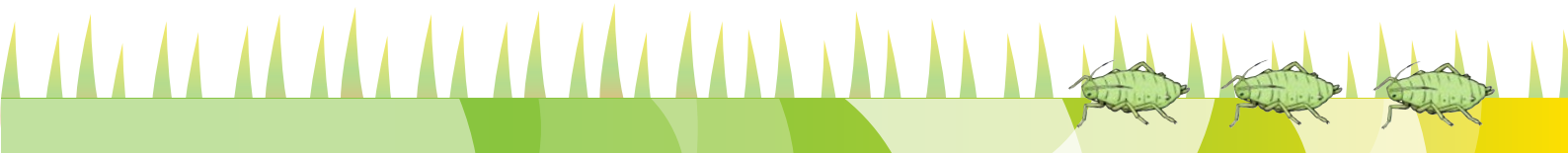
What is biosecurity?

Biosecurity is defined as the protection of the economy, environment and community from the negative impacts of pests, diseases, weeds and contaminants.

How does biosecurity work?

Biosecurity includes measures to:

- prevent new pests, diseases and weeds from entering our country and becoming established
- manage established pests, diseases and weeds to eradicate them where feasible or lessen their impact
- ensure an appropriate preparedness and response capacity that is internationally recognised and meets our trading obligations and international treaties
- maintain or improve the status of Australia's biosecurity systems.



Why is biosecurity important?

- Australian flora and fauna are unique; by protecting them we protect our natural biodiversity, distinctive ecosystems and heritage.
- Australia's domestic and international markets demand products that are free of pests, diseases and contaminants.
- Biosecurity helps to keep food and other products from our primary industries safe from diseases such as Salmonella and pathogenic E. coli. Biosecurity also protects people from diseases that can be passed from animals to humans (called zoonoses), such as Hendra virus and Avian Influenza.

Biosecurity is a shared responsibility

Government, industry and the people of NSW working together to protect the economy, environment and community from the negative impacts of animal and plant pests, diseases and weeds for the benefit of all people in NSW.

Biosecurity for the garden and farm

Talk about how biosecurity practices aim to help reduce the spread of pests whether it's between countries/continents, states, farms or gardens and garden beds.

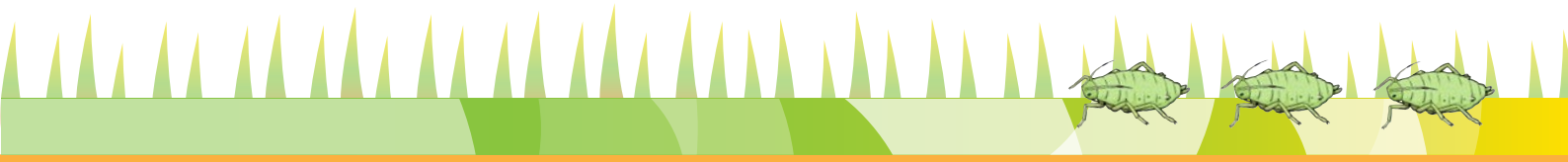
Draw on your observations and learning and talk about the way that Russian wheat aphid and aphids spread – they are slow movers but they can breed quickly. Aphids can be transported considerable distances on vehicles, clothing and plant material. Winged aphids can be transported on the wind.

Brainstorm biosecurity measures which could be put in place to help reduce/stop the spread of aphids between: garden beds and/or crops or between separate gardens or farms. Your biosecurity measures may include:

- Cleaning tools and implements after each use
- Removing dirt which may contain aphids or other pests from shoes and vehicles
- Disinfecting clothing and shoes
- Monitoring your plants and crops – early detection helps control the population and spread
- Reporting anything unusual
- Checking plants and seeds that you bring into your farm or garden for any signs of pests and/or diseases

Watch '[Biosecurity and people movement on farms]' and add any new biosecurity measures to your list.

Talk about and list the different biosecurity measures which you think you should or could implement in your school or a local farm to help keep your gardens and produce safe from pests and diseases.



Learning experience 6: How can we control aphids?

Collaboratively explore options for the control of aphids and pest species through Integrated Pest Management and learn about beneficial insects.

Aphid control options

Revise the biosecurity measures for your garden or local farm which you developed in the previous learning experience. Explain that you have identified ways to reduce the spread of aphids to protect gardens and farms but now you have to work out how to control aphids if they are already in a garden or agricultural crop.

Brainstorm ways that aphids are controlled in gardens and crops and list the positive and negative points of these. Make evident that different management techniques are required for different circumstances.

Integrated Pest Management

Introduce Integrated Pest Management (IPM) as an environmentally sensitive way of managing pests. It uses a combination of practices and control methods to prevent problems from occurring rather than dealing with them after they have happened.

What is IPM?

Integrated pest management (IPM) is a philosophy of pest control founded on the principles of ecology.

IPM practices include forward planning, regular monitoring and timely decision-making. IPM control methods include:

- biological control, using predators, parasites or microbial pathogens to suppress pests
- cultural and physical control, using methods such as barriers and traps; adjusting planting location or timing; or crop rotation and cultivation techniques which expose pests to predation or destroy their food, shelter and breeding habitats
- chemical control, selecting the least toxic pesticides and using them only when needed as opposed to regular preventative spraying
- plant choice, choosing plant varieties that are resistant to diseases in an area, and matching species to the site
- genetic control, releasing sterilised male insects to decrease the incidence of successful mating of pest species
- pheromone control, using pheromones to monitor insect populations in a crop or orchard.

IPM can be applied in agricultural and non-agricultural settings, such as the home, garden, workplace and natural spaces. (Source: NSW EPA)

Watch Chemicals or insects to control pests from ABC Splash. Discuss the variety of methods used by the farmers to control pests and the importance of the beneficial insects in the video.

Beneficial insects

Look at GRDC Beneficial Insects: The Back Pocket Guide and select the beneficial insects which may help control aphids. List these beneficial insects.

In small groups research a variety of beneficial insects which may help to control aphids in a garden, crop or farm. Research the following for each beneficial insect:

- How they control aphids
- Their preferred habitat
- Food sources
- Plants or other insects which may attract the beneficial insect
- Interesting facts or features

You may choose to use the Research Template provided to support students to record their research, summarise the information found and think about the resources being used for research.

Share learning with the class and collaboratively create an overview of beneficial insects. Update your KWL chart to include your new learning and any new questions raised by students.

Learning experience 7: How can we attract beneficial bugs to our garden?

Students design an insectary, complete with plants and permanent habitat, for a selected location.

Exploring insectaries

Brainstorm with students the ways in which you could attract beneficial insects to your garden or a local farm. Explain that there are two main elements to attracting beneficials to a place: plants, as a food and energy source, and permanent habitat. Discuss that beneficial insects in the garden or farm are not just those which control one or more types of pests but also insects which help pollinate flowers.

Explain that you will be creating an insectary to help attract and house beneficial insects in a specific area.

Watch Enticing the Insects produced by Gardening Australia and/or view Growing flowers to attract beneficial insects, Insect Hotels – Encourage beneficial insects into your garden and Insect Hotels to learn more about insectaries and attracting beneficial insects.

Designing an insectary

Work through the following steps to collaboratively create your insectary.

Target beneficials

Discuss which insects you want to encourage to your garden or farming space. Different insects require different accommodations and host plants in which to thrive. Revise your learning about beneficial insects and their habitats and hosts to help you decide on these features for your insectary.

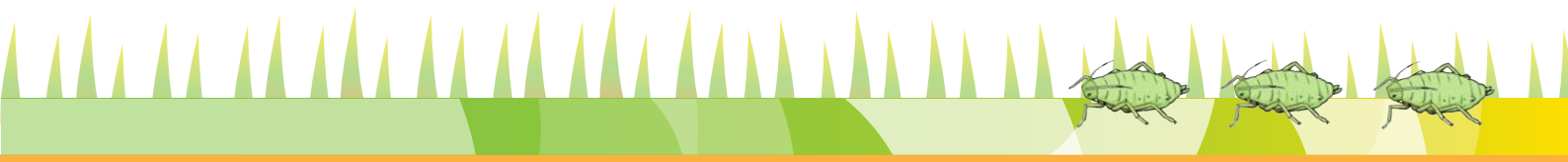
Climate

Think about the climate in your area before you decide what kind of insect hotel to make and plants to incorporate in your insectary. Each bug habitat performs a different function depending on the location's climate. In cold climates, they offer a refuge for hibernation, while in warmer climates they function as dry nesting places during the wet season and shelter from the heat. You will need to ensure that your insectary plant choices are suitable for your climate.

Location

Select an area in your school garden or local farm which you think could benefit from and lend itself to the development of an insectary. You will need to think about the following aspects when selecting your location:

- What the area is currently used for and how this may change in the future
- Existing buildings and infrastructure such as walkways and any problems or opportunities these pose
- Existing gardens and plants and the opportunity to plant more insect attracting plants
- The aspect of the location and how this will affect the sunlight and weather reaching the insectary and plants.



Plants

Research and select plants for your insectary which attract insects and are suited to your climate and location while being practical and safe. Insects are attracted to 'clumps' or groups of plants rather than individual plants so think about how and what you can plant which lends itself to planting in groups.

You will also want plants which attract a variety of beneficial insects throughout the year so use a calendar to align the flowering time of plants selected to ensure the insects targeted can survive across the seasons.

Get your local community involved by asking a nursery or gardening professional from your local area to work with and advise students on plant selections and insectary features.

Materials

A huge variety of materials may be used to create your insect hotel. Natural, reclaimed and repurposed materials including: old pallets, drilled logs, hollow bamboo poles, cardboard tubes, egg cartons, small stones, pieces of concrete and tile, pine cones, pieces of bark, twigs, dead and rotting wood, hay, plant stems, and discarded planters are perfect for constructing a habitat for your garden's pollination and pest control workforce. Steer clear of any painted, stained or treated materials and try to minimise plastic or artificial materials.

Revise the preferred habitat of beneficial insects to help you decide on the types of materials and structures wanted for your insect hotel. Collect materials from around your school grounds and ask your school community to donate useful but unwanted materials. A large variety of materials will provide habitat for a range of beneficial insects and enhance biodiversity in your area.

Measure and record the materials available to you, in the form of a 'stocktake' so you can consider this in the design of your insect hotel. You will also need to measure your garden beds and consider the size and distribution of plants to ensure you accommodate for the growth and development of your insectary garden.

Challenge yourselves by only using recycled and natural materials to build a five star bed and breakfast for your beneficial bugs!

Design and structure

The design and structure of your insect hotel is where you can let your creativity shine through. A quick image search for insect hotels will provide inspiration to multipurpose your insect hotel as an aesthetically pleasing outdoor artwork.

Consider your insectaries location and the materials available to you when designing your insect hotel. For instance you may choose to create a large free standing hotel or a smaller hotel which could hang from a tree, wall or stand. You will need to consider the potential weight and size of your insect hotel throughout the design process.

Encourage students to think about and record the measurements, including area and perimeter, of your insect hotel, insect garden and materials to ensure you will be able to construct your insectary efficiently. Plans developed to a scale will be easier to follow during the construction phase of your project.

Resources

List any resources or tools you will need to build your insect hotel and plant your insectary plants. Ensure that you think about any safety or personal protective equipment (PPE) that may be required. If you require any power or specialist equipment, such as a drill or saws, ensure the appropriate person/s are aware and will be available to aide you in undertaking these tasks.

Learning experience 8: Constructing your insectary.

Students work together to implement their design and construct an insectary, or a model of one, for beneficial insects.

Construction method

Based on your insectary design, including your plants and insect hotel, develop a step-by-step method to undertaking the construction of your insectary or model insectary. Encourage students to think about how all students can be involved in all aspects of the construction.

A Round-Robin style series of 'workstations' would lend itself very well to the construction and development of your insectary. You may choose to use this method, or another of your choice, to complete your insectary construction.

Round Robin

Set up a number of workstations, with a supervisor at each. Split students into the equivalent number of groups. Assign a series of activities at each station and allocate a period of time for students to work at each station. Following the assigned time period students will rotate to the next workstation.

Try and develop your workstations so that at each workstation students are involved in a different aspect of construction and skills development.

Roles and responsibilities

Whether constructing one insectary as a class or a number of insectaries in small groups it is important that students understand their roles and responsibilities to complete the tasks safely and efficiently. You may elect to assign students individual roles and responsibilities in order to reflect an authentic project team and a variety of careers.

Materials and resources

Collate your materials and resources and check these off the list to ensure you have everything required. Ensure you account for any safety or personal protective equipment (PPE) that may be required.

Plant, build, construct and have fun!

Working from your design plans and construction method, undertake all the tasks required to develop your insectary. This can be a really rewarding and authentic learning experience for students so remember to have fun and get everyone involved.

Family and community participation - "Many hands make light work"

The design and construction of your insectary is the perfect time to enhance family and community engagement in student learning. Ask family and community members to get involved and draw on individuals knowledge and skills to support student learning.

(Links to NSW DoE 'Family and Community Engagement' guide and strategies).

"Strong partnerships between a school, its teachers, parents and community make a positive contribution to student learning." (NSW DoE)

Ask family and community members with expertise and/or experience to talk about careers related to the activities you are undertaking. Ongoing and frequent exposure to careers information will broaden students understanding and demonstrate the authenticity and value of their learning and activities.

Learning experience 9:
How can we persuade others to do the same?

Collaboratively design and prepare an advertisement to promote your insectary, IPM and beneficial insects to gardening and farming communities.

Revise your KWL chart and discuss your learning throughout the unit. Outline the reasons it is important that you promote your insectary design, IPM and beneficial insects.

Discuss ways you could promote this and lead students to the idea of creating an advertisement.

View a range of text, digital and multimodal advertisements and discuss the features of these advertisements with particular emphasis on:

- Language features such as: rhetorical questions, powerful verbs, emotive words, facts and statistics, exaggerations, strong adjectives and repetition.
- Visual and audio elements which help convey and intensify the message of the text.

Identify your target audience, in this case gardening and farming community members, and brainstorm ideas for your advertisement and the information you can include in your advertisement. Lead students to list and emphasise the following points:

- The negative impacts of pests such as aphids on agricultural production
- The design features of your insectary and how these features provide habitat and food sources for beneficial insects
- A variety of simple and effective ways in which others can implement Integrated Pest Management (IPM) practices and encourage beneficial insects in their own gardens or farms.

Collaboratively design and create an advertisement that promotes your insectary, IPM and beneficial insects in the management of gardening and farming systems.

Check the judging criteria provided to help you create an amazing advertisement for your competition entry!

Following completion of your program complete the student and teacher exit surveys and submit your entry.

INVESTIGATE: aphids

Judging criteria

Performance level	Performance level	Performance level	Performance level	Marks
Aphids, IPM and beneficial insects				
3	2	1	0	**/ 9**
Identifies 5 or more symptoms of aphids and outlines the impact aphids can have on food and fibre production	Identifies 3-4 symptoms of aphids and outlines the impact aphids can have on food and fibre production	Identifies 1-2 symptoms of aphids or outlines the impact aphids can have on food and fibre production	No identification of the symptoms of aphids or the impact aphids can have on food and fibre production	/ 3
Describes and justifies 7 or more features of your insectary which provide habitat and plants for beneficial insects	Describes and justifies 4-6 features of your insectary which provide habitat and plants for beneficial insects	Describes and justifies 1-3 features of your insectary which provide habitat and plants for beneficial insects	Does not describe or justify any features of your insectary	/ 3
Provides 5 or more ideas to implement IPM and increase beneficial insect populations in gardens or farms	Provides 3-4 ideas to implement IPM and increase beneficial insect populations in gardens or farms	Provides 1-2 ideas to implement IPM and increase beneficial insect populations in gardens or farms	Does not provide ideas to implement IPM and increase beneficial insect populations in gardens or farms	/ 3
Survey completion				
6	4	2	0	**/ 6**
100% of the class or group completed both the entry and exit surveys and teacher surveys completed	50% or more of the class or group completed both the entry and exit surveys and teacher surveys completed	25% or more of the class or group completed both the entry and exit surveys and teacher surveys completed	Less than 25% of entry or exit surveys were completed by the class or group and/ or the two teacher surveys were not completed	/ 6
Advertisement				**/ 15**
Creativity: The overall originality of the advertisement; use of original ideas, illustrations and style.				/ 5
Suitability: Suited to capturing the attention of your local gardening and/or farming community; appropriate advertising format and content, use of persuasive language and clarity of the message.				/ 5
Quality: Students have made the best use of the chosen advertising method and the overall quality of the advertisement including format, design, presentation and content.				/ 5
Total marks and comments _____ _____ _____ _____ _____				**/ 30**

Assessment

INVESTIGATE: aphids

Assessment guide

The Investigate: aphids learning sequence provides a variety of opportunities for teachers to assess students knowledge and skills development, as shown below. Level of achievement may be completed as per your local assessment or reporting system.

Student name:_____ _____ Class / Year: _____

Phase	Assessment activity	Syllabus outcome/s	Date of assessment	Level of achievement	Notes
Learning experience 1	Student participates in and contributes to discussions on known and un-known topics, poses questions for investigation and undertakes research, using a variety of media and research materials, to develop evidence-based and informed explanations.	EN3-1A EN3-2A EN3-3A ST3-10LW ST3-11LW			
Learning experience 2	Student participates in the planning and design of a science investigation and selects equipment and techniques to produce solutions that address the investigation criteria. While planning their investigation student poses questions, makes predictions and gathers data. Student uses and displays mapping and geographical skills to view maps and map a selected location.	EN3-1A ST3-2VA ST3-5WT ST3-4WS ST3-10LW ST3-11LW GE3-1 MA3-1WM MA3-2WM MA3-1WM MA3-9MG MA3-10MG MA3-17MG			
Learning experience 3	Student undertakes an investigative surveillance program during which they make and record observations, gather data, share and compare findings and develop evidence-based explanations.	EN3-2A EN3-3A ST3-2VA ST3-4WS ST3-5WT ST3-10LW ST3-11LW GE3-1 MA3-2WM MA3-18SP			
Learning experience 4	Student learns about and discusses agricultural management practices and develops an understanding of the interactions between living things, non-living things, people and places which influence the management of agricultural lands.	EN3-3A ST3-2VA ST3-10LW ST3-11LW ST3-14BE			

Phase	Assessment activity	Syllabus outcome/s	Date of assessment	Level of achievement	Notes
Learning experience 5	Student develops their understanding of the interactions between people, places and environments by learning about the management of environments and ecosystems through biosecurity measures.	ST3-2VA ST3-5WT ST3-11LW GE3-2 GE3-3 GE3-1 GE3-2 GE3-3 GE3-4			
Learning experience 6	Student develops their understanding of the interactions between various living and non-living things and the impacts of these interactions on the growth, health and survival of living things.	ST3-4WS ST3-10LW ST3-11LW GE3-1 GE3-2 GE3-3 GE3-4			
Learning experience 7	Student uses scientific, technological, engineering and mathematical skills in the design and planning of an insectary to encourage and support beneficial insect populations in specific places.	ST3-2VA ST3-4WS ST3-5WT ST3-10LW ST3-11LW ST3-14BE GE3-1 GE3-2 GE3-3 GE3-4 MA3-1WM MA3-2WM MA3-3WM MA3-9MG MA3-10MG			
Learning experience 8	Student participates in the planning of a complex project and works both collaboratively and individually to complete various tasks in the development and construction of an insectary.	ST3-2VA ST3-5WT ST3-10LW ST3-11LW GE3-1 GE3-2 GE3-3 GE3-4			
Learning experience 9	Student participates in the composition and editing of an advertisement using increasingly complex modes of communication and design. Student composes, edits and presents a text which effectively persuades others to encourage beneficial insects. Student uses a range of language and design features to promote and persuade others of the value of their insectary design and its importance to the management of pest species.	EN3-1A EN3-2A EN3-3A EN3-5B EN3-8D ST3-5WT ST3-10LW ST3-11LW ST3-14BE ST2-15I			

KWL Chart

INVESTIGATE: aphids

K What we know	W What we want to know	L What we learned

Research template

INVESTIGATE: aphids

Name: _____

Date: _____

Research topic / question

_____

_____

_____

Research notes

_____

_____

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Research summary

The most important / useful information found is:

Resources

These resources were used for research:

These are good resources for research because:

Surveillance: Design template

INVESTIGATE: aphids

Name: _____

Date: _____

Title

_____

Purpose

We are doing this surveillance in order to:_____

_____

_____

_____

Pest details

Pest name_____

Life cycle_____

_____

_____

_____

Characteristics / identifying features_____

_____

_____

_____

_____

_____

Habitat / hosts_____

_____

_____

_____

_____

_____

Location

Location name, features and description _____

Surveillance schedule

When and how often will you undertake surveillance?_____

Surveillance sites

Where are you undertaking surveillance? Why did you choose these places/plants?_____

Observations and Data

What signs and symptoms are you looking for? _____

_____

_____

_____

_____

Where on the plant are you going to look?_____

_____

_____

_____

_____

_____

How many places on each plant are you going to look? _____

_____

_____

_____

_____

_____

What observations and data are you going to record?_____

_____

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_____

_____

_____

How are you going to record these observations and data? _____

_____

_____

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_____

Method

How are you going to allocate sites/jobs between people/groups? _____

Equipment

What equipment and/or resources do you need? _____