REFRACTION MEDIA

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MEAT & LIVESTOCK AUSTRALIA

Animal Health

The science of healthy animals

Study guide

THE SCIENCE OF HEALTHY ANIMALS

Australia has long relied on its cattle and sheep industry for our food supply and to benefit our economy. Our farmers have a strong tradition of innovation to meet the challenges of farming on our vast land and variable climate. Keeping animals healthy is a complex process which involves science at many levels.

From understanding the diseases and parasites that affect cattle and sheep to managing animals in the most positive way and understanding how to best develop farm areas in regards to fencing and feedlots, there are a myriad of challenges to meet.

Science can help to inform best practice, and farmers are at the forefront of utilising and funding research into animal health. In this study guide, we delve into the issues associated with breeding, health and animal welfare in the cattle and sheep industries, and explain some of the science involved.

You'll learn about many of the ways in which Australia's cattle and sheep farmers are keeping animals healthy and funding the research that ensures they stay that way; how farmers and scientists are working together to breed healthy livestock well suited to the Australian landscape and how researchers in the areas of genetics, vaccine development, vet science and even computer science are actively involved in improving animal health.

You'll also learn how the focus in animal welfare is shifting from solving problems to giving animals 'a good life' and implementing and maintaining the five freedoms for animals.

MEAT & LIVESTOCK AUSTRALIA FOR A SUSTAINABLE FUTURE

Meat & Livestock Australia is an initiative by Australian cattle and sheep farmers, along with the broader industry, to deliver sustainable farming by 2020. It's a commitment to take positive action, both big and small, to continually improve the way farmers operate, and to improve sustainability throughout the red meat supply chain.

Sustainability isn't a new thing – the whole Australian cattle and sheep industry has been investing in environmental research and development for many years. It continues to invest more than $13 million every year in research and development to reduce the industry's environmental impact through improved farming practices.

As caretakers of the land, farmers are committed to leaving it in better shape than when they found it by improving efficiency and reducing resources used. Apart from harnessing the latest technology and science to reduce farming's footprint, Meat & Livestock Australia is also about sharing ideas, celebrating successes and providing a focal point for environmental, social and ethical farming action to ensure we all enjoy a sustainable food supply into the future.

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Published in conjunction with Meat & Livestock Australia: goodmeat.com.au/education

HOW TO USE THE GUIDE

The notes in this study guide offer both variety and flexibility of use for the differentiated classroom. You and your students can choose to use all or any of the five sections – although it is recommended to use them in sequence, along with all or a few of the activities within each section.

THE 'FIVE Es' MODEL

This guide employs the 'Five Es' instructional model designed by Biological Sciences Curriculum Study, an educational research group in Colorado. It has been found to be extremely effective in engaging students in learning science and technology. It follows a constructivist or inquiry-based approach to learning, in which students build new ideas on top of the information they have acquired through previous experience. Its components are:

Engage Students are asked to make connections between past and present learning experiences and become fully engaged in the topic to be learned.

Explore Students actively explore the concept or topic being taught. It is an informal process where the students should have fun manipulating ideas or equipment and discovering things about the topic.

Explain This is a more formal phase where the theory behind the concept is taught. Terms are defined and explanations given to models and theories.

Elaborate Students develop a deeper understanding of sections of the topic.

Evaluate Teacher and students evaluate what they have learned in each section.

The science of animal health

From protecting cattle and sheep against disease and parasites, to understanding how best to look after them on the land, science can inform best practice in animal health.

WHAT IS ANIMAL HEALTH?

Animal health encompasses animals' physical and physiological wellbeing. It's something in which cattle and sheep farmers, and other people like veterinarians who help to raise or manage cattle and sheep, are directly involved. It's also an area in which science helps inform and adapt the ways we treat and manage the animals on which we rely for food.

Top researchers in the areas of genetics, vaccine development, vet science and even computer science are actively involved in improving animal health and welfare in the cattle and sheep industry. This research and development goes hand in hand with practises to improve sustainability, so farms can have happier, healthier animals along with a healthy environment. For example, managing weeds on farms is essential to improve farm biodiversity, but also to ensure that cattle and sheep don't become sick from eating noxious weeds.

Every year, cattle and sheep farmers pay levies that directly fund initiatives in scientific research to help improve animal health and welfare. Along with government funds, this represents a $13 million dollar annual investment in improving the way cattle and sheep are treated for diseases, kept safe from predators and parasites, and provided low stress environments in which to live.

Cattle and sheep farmers are at the frontline of caring for their animals every day. They work around the clock to ensure their animals have food, water and shelter. Meat & Livestock Australia is an initiative by the Australian cattle and sheep industry to advance sustainable practices and ensure a sustainable food supply for generations to come. It allows farmers to share how they proactively develop better ways to manage and care for their cattle and sheep.

This guide will take you through the science of producing healthy cattle and sheep and the stories of the farmers who raise animals using best practice animal care. The four main areas of focus for this guide are outlined on the next four pages.

About Meat & Livestock Australia

Meat & Livestock Australia (MLA) is owned by Australian beef, sheep and goat producers and represents the Australia's red meat and livestock industry via marketing and research & development programs. Educating young Australians about the red meat industry is very important to Australian farmers, this is why MLA make it a priority to offer teachers and students a wide range of curriculum linked resources and interactive activities as an aid to bring the farm into the classroom. *goodmeat.com.au/education*

PREVENTING DISEASE

Disease prevention is a complex business for farmers. Animals like cattle and sheep have their own diseases and are also exposed to parasites that differ depending on which region of Australia they live in. Two key elements to maintaining the health of cattle and sheep are vaccinations against diseases and parasite control.

VACCINES

Vaccines can help prevent common livestock diseases, leading to improved animal health and ensuring animals are able to breed and grow. In Australia, vaccines can help prevent diseases like bovine respiratory disease, which is caused by a combination of stress and disease-causing agents (viruses and bacteria). Vaccination of lambs against ovine Johne's disease, a bacterial disease, can reduce the number of lamb deaths by 90%. Vaccines are used at different times in the production cycle, depending on the disease and the vaccine. Vaccines may also be used as part of industry biosecurity programs, to limit the spread of or help eradicate emergency animal diseases.

PARASITES

Parasites that affect cattle, sheep and goats include internal parasites, such as worms, flukes and protozoa (a type of single-celled organism), and external parasites, such as flies, ticks, lice and mites. Parasites of cattle and sheep can be zoonoses, meaning they can als infect humans, for example the hydatid tapeworm found in sheep and dogs.

There are a number of ways in which parasites can have a negative impact on the health and welfare of animals. Parasites can cause blood loss, diarrhoea or open sores on the skin. Infestation with parasites can reduce appetite, resulting in debilitated animals that are more susceptible to other diseases. They can also act as agents for disease transfer (much like the way in which mosquitoes transfer malaria parasites to humans). Flies can annoy animals, causing them to reduce grazing behaviour or, in severe fly waves, become very agitated (fly worry). In the case of flystrike, this can even lead to death. Parasites can reduce the growth, milk production and reproductive rates of cattle and sheep.

Parasite control initiatives include quarantine to prevent them from entering the country in the first place. Some varieties of parasites of cattle, sheep and goats are not found in Australia, for example screwworm fly and some types of mites. It is important to keep these parasites out of Australia and industry biosecurity helps ensure this.

Parasites can cross from one species to another. In research funded by cattle and sheep farmers, Charles Sturt University scientists are working to eradicate sheep measles, which is caused by a specific dog tapeworm. The worms' intermediate stage causes clear fluid-filled cysts in muscle, which can degenerate into calcified nodules. Together with National Red Card Fox Control Program, a community based feral animal control program operating in Western Australia, the researchers are investigating the role of foxes and wild dogs in spreading the tapeworm. As part of the project, an education package is being developed for farmers for the control of sheep measles on-farm.

1796 English physician Edward Jenner trials a cowpox vaccine to prevent smallpox.

1881 French scientist Louis Pasteur successfully vaccinates sheep and cattle against the human and animal disease anthrax.

1909 Danish scientist Wilhelm Johannsen coins the word "gene".

1930s CSIRO's Arthur Turner had developed a vaccine against contagious bovine pleuropneumonia in the 1930s. Australian herds are finally free of the devastating disease in 1973, following a national eradication program.

1952 American geneticists Alfred Hershey and Martha Chase show that only the DNA of a virus needs to enter a bacterium to infect it, supporting the idea that genes are made of DNA.

1965 The British government releases the Brambell Report, which later leads to the development of the five freedoms for animals under human control.

2009 The complete sequence of the bovine genome and a study of global cattle genetic diversity are published in the journal *Science*.

BREEDING, GENETICS AND ANIMAL HUSBANDRY

GENETICS

Recent rapid advances in genetics have resulted in a push for science to provide insights into how we can predict which animals will be the best for any particular system. This is a priority area for the industry's research and development program. Genetic technology is used to identify animals that have favourable traits that can improve animal welfare outcomes. For example, the more active a lamb is at birth, the more likely it is to survive. Studies have shown that lamb vigour, shown by behaviours – such as the time it takes a lamb to stand and suckle, or bleat – is a trait that can be passed on genetically.

Research funded by cattle and sheep farmers and carried out by CSIRO and the University of New England in New South Wales, is looking at ways to increase lamb survival rates by identifying these active lambs. This project is using SmartTag technology to measure ewe and lamb behaviour during and immediately after birth. The results will help improve field-based measures for assessing the vigour of newborn lambs.

Genetic research can decrease the need for surgical procedures, such as dehorning cattle. This is important, as horned cattle can injure other animals and people working with the animals. Some cattle are naturally born without horns (polled cattle). Northern Territory farmers are working with scientists in farmer-funded research to demonstrate a genetic test to selectively breed polled cattle.

BREEDING AND ANIMAL HUSBANDRY

Just like household pets are desexed to prevent unwanted breeding, castrating of males is an important husbandry technique to prevent unwanted breeding in cattle and sheep. As well as reducing unwanted breeding, which allows greater control over genetic gains through selective mating, castration also results in male animals that are less aggressive and less likely to fight – reducing bruising and injuries to other animals.

It also means that males and female animals can be kept together for longer and the animals are easier to handle and less likely to get stressed. While these practices are being carried out using the best possible techniques today, scientists are also using farmer-funded research to develop alternatives.

A research project being undertaken by the CSIRO and SVW Technologies that is looking at the use of needle-free technology to develop a device that could inject a local anaesthetic. This is being developed to reduce pain associated with castration and potentially other surgical husbandry practices.

Another project funded by farmers and carried out by CSIRO and Meat & Livestock Australia, is investigating the training of animals to self-administer pain relief drugs by consuming food containing medicine. Reward from the relief of pain leads to associative learning by animals. If sheep and cattle can readily learn to self-medicate on feed containing non-addictive medication it could provide an opportunity for animals to provide themselves with extended pain relief by repeated self-dosing. This project will look at whether self-medication is feasible for on-farm delivery of analgesics for pain relief and whether self-medication can be used as an indicator of pain in sheep and cattle.

LOW-STRESS STOCK HANDLING

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There is plenty of science involved in understanding animal behaviour and how to best work with sheep and cattle to decrease stress. In handling animals there are several reasons why it's important to minimise stress – to both the cattle and sheep and to the operator handling the animals. The prime concern is health and welfare of the people and animals involved; however, handling can also affect animal performance and meat quality. Successful handling of cattle and sheep requires an understanding of their natural behaviour. For example, cattle and sheep are herd animals – meaning they like to follow each other. A separated animal will always try to return to the mob.

It is important to ensure that the people handing animals are trained in low-stress stock handling. Research funded by cattle and sheep farmers and undertaken by the Australian College of Training, recognises training for livestock export stockmen. Under this initiative, stockmen accompany exported animals on their journey from Australia to their destination market to ensure their health and well being. This project is working to have the stockman-training course formally recognised and approved under the Australian Qualification Training Framework.

Another initiative funded through farmer levies involves investigating alternative ways of handling sheep. For this project the University of Western Australia, Stress Free Stockmanship and ProHand will use alternative handling techniques that utilise the natural behaviour of sheep to achieve desired movements without activating the animals' stress responses. The project will also seek to demonstrate the value of stockperson training on animal welfare by targeting the behaviour and attitudes of stockpeople to ensure long-lasting changes in the way animals are handled.

The following summarises ways to minimise stress in animals:

- Keep animal handling to the minimum level necessary.
- Design handling facilities to minimise the risk of injury and to take advantage of natural cattle, sheep or goat behaviour.
- Maintain handling facilities in good working order and complete repairs well before major husbandry practices are carried out.
- Ensure handlers are competent.
- Avoid sudden jerking movements and loud noises.
- Behave in a calm and controlled manner.
- Apply optimal pressure rather than excessive pressure by taking advantage of the 'flight zone' (the sheep's personal space. If a person moves into the space, the sheep will move away, or if the person moves in too close, the sheep will move towards and past the person. Extensively managed animals that are not familiar with people have a larger flight zone than cattle and sheep that are handled more often).

MEAT & LIVESTOCK AUSTRALIA

- Avoid rushing livestock; give them time to assess a situation.
- Use dogs carefully (muzzle dogs that bite and tie them up when they are not working).
- Prevent overcrowding in confined spaces.
- Avoid handling cattle and sheep during extreme weather conditions.

FIVE FREEDOMS FOR ANIMALS

Part of ensuring animals' health and welfare comes from understanding their basic needs. In 1965, the British government released a report led by Professor Roger Brambell whose tenets were later adopted by many organisations, including the RSPCA. These became the five freedoms for animals under human control. The following links contain short videos introducing the Five Freedoms of Animal Welfare in relation to cattle in feedlots.

- Freedom from hunger and thirst: by ready access to fresh water and a diet to maintain full health and vigour.
www.youtube.com/watch?v=AE-evhfWqjo

- Freedom from discomfort: by providing an appropriate environment including shelter and a comfortable resting area.
www.youtube.com/watch?v=yBvxpdRoAOE&list=UUFyeUVkzA7w1180GtqStYA

- Freedom from pain, injury or disease: by prevention through rapid diagnosis and treatment.
https://youtu.be/IAIKBVKU-l0

- Freedom to express normal behaviour: by providing sufficient space, proper facilities and company of the animals' own kind.
www.youtube.com/watch?v=_hMOvxzK49s

- Freedom from fear and distress: by ensuring conditions and treatment that avoids mental suffering.
www.youtube.com/watch?v=iJVAS8kGr08&list=UUFyeUVkzA7w1180mGtqStYA

PROTECTION FROM INVASIVE ANIMALS AND PLANTS

More than 50 animal species have been introduced into Australia since the late 1800s and are now considered invasive animals. Rabbits, feral pigs, foxes, wild dogs and feral goats are of the greatest concern to cattle and sheep farmers. Controlling these animals has been a major scientific goal for Australian scientists and farmers for more than a century. Feral rabbits, for example, cause significant environmental damage and are estimated to cost Australian farmers more than $110 million annually. Feral rabbits reduce the carrying capacity of farms by competing with cattle and sheep for feed and reduce plant biodiversity by eating seedlings and killing shrubs.

Feral pigs, found mostly in eastern Australia and the Northern Territory, are estimated to cost Australian farmers more than $100 million annually. They contribute to lamb and goat losses, compete with stock for feed and are potential hosts of diseases. Research being carried out by Invasive Animals Australia on behalf of cattle and sheep farmers, looks at developing specific baits, which are more humane and can also be delivered via specially designed containers that allow only feral pigs to access the baits.

Other feral animals that contribute significantly to the cost of raising animals and affect animal welfare and health include foxes, feral goats and wild dogs.

Meat & Livestock Australia is supporting the Invasive Animals CRC to research wild dog management.

Controlling weeds is another vital part of managing grazing land and ensuring cattle and sheep can roam with access to nutritious and non-noxious foods, as well as ensuring natural biodiversity. Weeds such as rubber bush, introduced as an ornamental plant, have spread to northern Australian cattle grazing lands, where it covers an estimated 1.8 to 3.7 million hectares. Research funded by farmers through levies and undertaken by the QLD Department of Employment, Economic Development and Innovation looks at understanding and controlling the spread of this invasive shrub, which is toxic to cattle.

Useful websites

- This link takes you to a video about Meat & Livestock Australia *bit.ly/19bW6FG*
- Search the Good Meats website for an overview of why healthy livestock are important to the industry goodmeat.com.au
- The MLA website has information on a variety of topics related to animal welfare:
  Vaccination – *mla.com.au/Livestock-production/Animal-health-welfare-and-biosecurity/Husbandry/Vaccinating*

  Parasites – *mla.com.au/Livestock-production/Animal-health-welfare-and-biosecurity/Parasites*

  Animal handling: *mla.com.au/Livestock-production/Animal-health-welfare-and-biosecurity/Husbandry/Animal-handling*
- The industry's R&D strategy is in line with the International priorities of the Office International des Epizooties (OIE), the world animal health organisation, and the Australian Government's national strategic framework – the Australian Animal Welfare Strategy (AAWS) www.agriculture.gov.au/animal/welfare
- Videos from the Virtual Farm *virtualfarm.mla.com.au/*
- This page of the animal welfare site provides a list of scientists and their research into animal welfare – *animalwelfare.net.au/article/scientists*
- Further videos on animal health and welfare are available on Meat & Livestock Australia's YouTube channel *youtube.com/Target100AUS*

A low-stress environment

The Herbert family work hard to be at the cutting edge of their fast-developing industry, and their efforts produce a better workplace for staff and cattle alike.

Name:
Herbert family

Location: Eugowra, New South Wales

Find out more at
goodmeat.com.au/education

GROWTH IN THE grain fed beef industry, or feedlot industry, first spurred Tess Herbert and her husband Andrew into feedlotting. Grain prices were plummeting, so it was a logical way to use the grain growing facilities they already had in place at their property.

The Herbert family has been farming in Eugowra, NSW for more than 150 years, and Tess and Andrew aim to improve the condition of the farmland for future generations.

They started the Gundamain feedlot in 2001, a 6000-head feedlot, tailoring the entire design to reduce stress for the cattle. In 2010, they also purchased an existing 6500-head feedlot at Ladysmith, a village just east of Wagga Wagga in the Riverina region of New South Wales. Ladysmith, Tess says, was built in the early days of feedlotting, so it required "a bit more work to bring it up to scratch".

The feedlot industry is fast evolving as everything becomes more automated. At Gundamain, every animal is electronically identified, drafting gates operate remotely, and the feeding system is managed by computer software.

"The technology advances we're seeing, they make a safer working place and I think they make a better environment for the cattle," says Tess. The Herberts have a strong commitment to animal welfare, training all of their staff in low-stress stock handling. "We don't use noise, so it's very quiet," explains Tess.

Tess and her livestock manager are both trained animal welfare officers, and they are currently looking at some of the areas that they think their feedlots "could do a little bit better". At the moment they are investigating how heat affects cattle and what type of feed the cattle prefer.

In the feedlots, any sick animals are quickly identified by five pen riders, staff on horseback that move among the cattle, at the break of dawn every day. Sick animals are taken to a hospital pen for observation and treatment.

The Herberts also take great care to manage the environmental impact of the farm. The National Feedlot Accreditation Scheme (NFAS) has set guidelines for environmental performance as well as animal welfare. However, Tess explains that at Gundamain and Ladysmith they strive to go above and beyond the NFAS standards: "We use those as the minimum requirement," she says.

Nothing is wasted on their farm. Effluent is irrigated onto their crops, other waste water is recycled for dust suppression on roads, and manure is spread either onto their farmland as a fertiliser or sold to neighbouring farms or landscaping companies to be made into compost.

In 2013 Tess became Vice President at the Australian Lot Feeders Association (ALFA) and regularly attends workshops and conferences to share her expertise and hear the results of new research and development for her industry. "Feedlotting is an interesting industry to be in, there are really no secrets, and everyone's quite willing to share what they're doing."

When asked whether she and her family are passionate about improving the practices of the feedlotting industry, Tess replies: "This is all we do! We work in the business as well as on the business." – *Cherese Sonkkila*

Useful references

Five Freedoms of Animal Welfare and Australian feedlots:
bit.ly/1f3ad6o
Managing heat stress in feedlots:
bit.ly/19ck4kf
Australian feedlots YouTube channel:
bit.ly/1eNCpMX

Genetics test for polled cattle

By developing a genetic test for polled (naturally hornless) cattle, researcher John Henshall is helping the industry to improve the lives of cattle and save money.

BUMPING THEIR WAY around yards and within the herd, the horns of Australia's cattle cost the livestock industry an estimated $20 million a year, not to mention the impacts on animal welfare. A solution, says John Henshall of CSIRO's Animal, Food and Health Sciences division, may lie in the genetic make-up of Australia's northern cattle breeds. John and his colleagues have developed a genetic test to determine which cattle are more likely to be born without horns, allowing farmers to breed for these cattle to reduce costs and improve animal health.

Horns are routinely removed from young cattle, but the process is time consuming, stressful for the animals and presents risk of infection. The alternative is to select hornless, or polled, cattle for breeding.

The problem is that even cattle which don't appear to have horns can have the genetic ingredients that mean the next generation again grow horns. By developing a genetic test to identify the polled gene, John and his colleagues have given more certainty to cattle farmers.

"The purpose of the work was to develop a test that was effective in northern Australian beef breeds and that would be suitable for use in Australia so that producers could breed for polled cattle more efficiently," says John.

To develop the test, John and his colleagues applied DNA fingerprinting technology to a sample of northern Australian cattle, looking for genetic differences between horned and polled individuals. The researchers were able to identify the site of the polled genes and develop an inexpensive test to identify them, which requires only a hair sample.

The test is 99.9% reliable and is the first designed for northern Australian cattle breeds such as Brahman.

> "We see it as a way of offering a tool to allow people to change the practices on the farm."

By reducing the need for dehorning, the test has the potential to improve the welfare of the over 6.5 million cattle in northern Australia.

"We see it as a way of offering a tool to allow people to change the practices on the farm," says John.

John, who grew up surrounded by a thriving cattle industry in Alice Springs, also conducts research into black tiger prawns and farmed Atlantic salmon. He says that modern agricultural science is expanding from traditional farm-based research to a world of genetics and computation.

For budding scientists with ambitions to improving animal health, a mathematical background provides the opportunity to embrace the challenges of these new research areas, says John. "It allows you to do things that you otherwise wouldn't be able to do."

– *Mischa Vickas*

Name: John Henshall

Location: CSIRO

Web: *beefcrc.com/documents/publications/fact-sheets/FS01-TheAustralianPollGeneMarkerTest.pdf*

Breeding better animals

Part A – Changing characteristics of cattle and sheep

Farmers who raise cattle and sheep do so as a business – they need to make a profit to generate an income, so they can make a living on the land. Changing the characteristics of stock animals through breeding practices is often about making the animals healthier, or better able to live together, or making them more productive and therefore more profitable.

From the list below, choose three characteristics for cattle, and another three characteristics for sheep, that you think might be useful in terms of breeding better animals.

Add your choices to the table provided.

In the second column of the table, add a sentence justifying why you chose each of the characteristics you did.

CHARACTERISTICS

- Producing more wool.
- Growing smaller (or no) horns.
- Producing better quality wool.
- Being resistant to parasitic worms.
- Growing faster.
- Having wool that naturally molts/falls off each year.
- Growing leaner (having less fat content).
- Eating less without growing less.
- Not having a tail.
- Being smarter.
- Having a calm/docile nature.
- Being able to run faster.
- Having a shorter gestation period (producing lambs or calves in less time).
- Being disease-resistant.
- Producing meat with a high iron content.
- Producing tastier meat.
- Being repellant to flies.
- Being heat tolerant.

Animal	Characteristic	Justification for selecting this characteristic
Cattle	1.	
	2.	
	3.	
Sheep	1.	
	2.	
	3.	

Part B

Draw a picture, or write a short description, of what one of the animals you described above would look or how it would behave differently as a result of possessing these characteristics.

Teacher's information

The aim of the Explore section is for the students to investigate some of the ideas around breeding, health and animal welfare. It is intended that the students make their own discoveries as they work around the stations in the room. The equipment table below lists the equipment and preparation required.

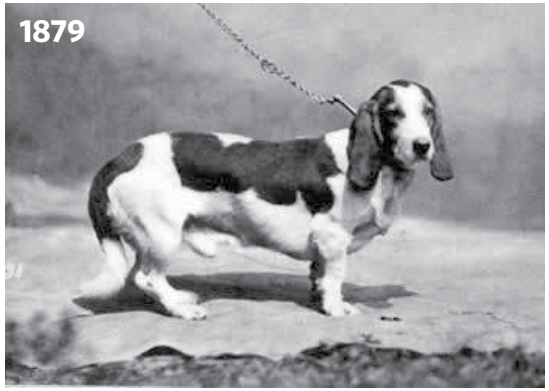
Station	Materials
Breeding for success	Images of animals showing breeding changes over time (provided).
Virtual farm 'Kalyeeda'	Computer to access the website *virtualfarm.mla.com.au/*
Virtual farm 'Iona'	Computer to access the website *virtualfarm.mla.com.au/*
Virtual farm 'Malabar'	Computer to access the website *virtualfarm.mla.com.au/*
Pet care	Access to classmates that have pets if students don't have any themselves. Students may be able to bring a few pets in to give a welfare talk on. If so, the relevant risk assessment forms will need to be completed.
Parasites	Parasites eg in photos; preserved in a jar; on microscope slides for viewing
Dog breeding activity	Computer to access the website *www.pbs.org/wgbh/nova/education/activities/3103_dogs.html*

Station One

[Task] Breeding for success

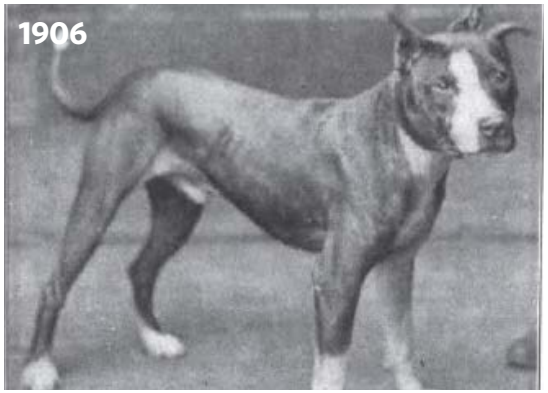
Consider the following images:

BASSET HOUND



123RF

PIT BULL TERRIER



123RF

BRITISH BULLDOG

123RF

Breed	Differences/changes
Basset hound	
Pit bull	
Bull dog	

Suggest why breeders would want to breed these changes into the animal.

How might farmers use breeding to improve their sheep or cattle?

Suggest one plus, one minus, and a question related to selectively breeding organisms.

Station Two

[Task] Kalyeeda station

1. Go to *virtualfarm.mla.com.au*
2. Click on 'Kalyeeda Station, The Kimberley' then 'Let's Go.'
3. Hover the mouse over the cattle and select 'Science'.
   Play the video 'Breeding Techniques'.
4. James says that they select 'good' cattle for mating. Suggest one characteristic that might be desirable to keep in the breed and considered 'good'.

Station Three

[Task] Iona station

1. Go to *virtualfarm.mla.com.au*
2. Click on 'Iona, Yeoval' then 'Let's Go.'
3. Hover the mouse over the cattle and select 'Science'. Play the video 'Animal Health'.
4. Complete the following table to summarise how the animals on Iona station are treated for intestinal worms
5.

Type of parasite	Where is the parasite found?	How are sheep treated?	How are cows treated?

Why is there a withholding time after giving parasite medicine to animals?

If you have pets, do you give parasite medicine to them? If so, how do you give it and why do you give it?

Now click on 'Back to Farm' and select 'Technology' when you hold the mouse over the sheep and cattle. Play the video 'Managing Livestock'. What kind of information is stored on the electronic tag the cows are wearing?

How will storing this information on the electronic tag help the farmer look after the cattle?

Station Four

[Task] Malabar farm

1. Go to *virtualfarm.mla.com.au*
2. Click on 'Malabar Farm, Gippsland' then 'Let's Go.'
3. Hover over the sheep, then click on 'Science'. Play the video 'Sustainable Breeding Techniques'.
4. Describe how Paul matches the growth and sale of the lambs to the environmental conditions.

Play the video 'Responding to Consumers'. List the ways that Jenny practices animal welfare in order to produce the Enviromeat brand.

Play the video 'Protecting animals'. Paul describes two new approaches to drenching sheep to protect them against parasites such as worms. Outline these two techniques for someone who has not heard about them before.

Station Five

[Task] Pet care

1. Choose three different types of pets (such as fish, dogs, cats, horses, mice). You can use your own pets and/or the pets of people in the class by asking them to share their experiences.
2. Write the type of pet in the column headings in the table below.
3. Fill in the rest of the table provided. Give details of specific ways you look after each pet, ie what they eat, how you keep them clean. Make sure you include specific things you would do to care for your pets.
4. Finally, next to each example given for each pet, state how often you do this.
5. At the bottom of the table, summarise the information you have recorded by identifying the main areas of care that are common to all the animals on a daily, weekly and monthly basis.

PET 1:		**PET 2:**		**PET 3:**	
Ways to look after Pet 1	How often?	Ways to look after Pet 2	How often?	Ways to look after Pet 3	How often?
Summary – General areas of animal welfare common to all animals					
Daily care activities (activities done every day)		Weekly care activities (activities done every week)		Monthly care activities (activities done every month)	

Station Six

[Task] Parasites

1. Examine the samples of parasites provided by your teacher.

2. Select one parasite and make a biological drawing of it here. Don't forget to use a pencil and include a scale

3. Annotate your diagram to describe how the parasite lives off its host. For example, does it have hooks or spikes to attach itself to its host, how does it reproduce, why might it be a particular shape or size?

4. What kinds of parasites can live on humans? Choose one human parasite and suggest how it could either be avoided or gotten rid of.

5. How do you think parasites might be a problem for farmers who breed sheep and cattle?

Station Seven

[Task] Dog breeding

1. Go to *www.pbs.org/wgbh/nova/education/activities/3103_dogs.html* to learn through an evolution card game how selective pressures can affect an organism's evolution.

2. Do you think a farmer would breed his or her farm dogs or sheep and cattle using the same approach? Give examples to support your answer.

3. What traits do you think a farmer might want to breed into cattle and sheep?

BRINGING IT ALL TOGETHER

What was your favourite station and why?

Identify what you learnt about looking after animals from carrying out this series of activities.

List any questions you have about animal breeding, health and welfare on farms.

Improving animal health

Student literacy activities

In this section, we delve into the issues associated with breeding, health and animal welfare in the cattle and sheep industries, and explain some of the science involved. Students read a series of articles and complete a number of linked discussion topics and literacy activities. These include:

- Brainstorm
- Glossary
- Comprehension and summary questions
- Questioning toolkit

ARTICLES

1. **The science behind healthy livestock**
   Farmers and scientists are working together to breed healthy livestock well suited to the Australian landscape.

2. **Welfare researchers seek to give animals 'good lives'**
   The focus in animal welfare is shifting from solving problems to giving animals 'a good life'.

3. **A better way of life**
   Farmer Kylie Schooley explains that working a farm successfully requires sound animal practices, caring for the land, and a healthy dose of of science.

Brainstorming

[Task] Create a mind map on 'Cattle and sheep breeding in Australia' to show what you already know about this topic. Some terms you might like to consider including are: Farmers, livestock, meat, wool, milk, genes, traits, selective breeding, productivity, profit, animal health, animal welfare, science, research, animal husbandry, parasites, environment.

The science behind healthy livestock

Farmers and scientists work together to breed healthy livestock and maintain them in the harsh conditions of the Australian landscape.

FROM GENETICS TO chemistry; successful animal husbandry draws from a broad scientific knowledge base. "Nothing gets done without science. All the advancements in animal production worldwide are driven by science, so it's hugely important," says Dr Michael Laurence, a veterinarian and lecturer in Production Animal Health and Management at Murdoch University in Perth, Western Australia.

First and foremost, animal husbandry is about keeping animals healthy, and there are a variety of medicines that are available to veterinarians to help achieve that goal. But it's more complicated than just prescribing a suite of injections to every animal. A dairy farm will use a different set of vaccinations to a beef farm, each tailored to provide preventative protection against known diseases. Different production systems are affected by different pathogens, hence the need for different vaccines.

There are a myriad of diseases that cattle and sheep can catch and a plethora of parasites that farmers need to watch out for. Ticks, lice and buffalo flies live permanently on animals in some areas while internal parasites such as liver flukes and gastrointestinal worms that cause black scours are also common. Managing these parasites is essential to maintaining the animals' health.

However, in the same way that humans shouldn't take antibiotics for non-bacterial diseases such as colds and 'flu, it's important not to over-prescribe medicines to cattle and sheep. As bacteria breed and evolve, or meet and exchange genetic information, they can develop resistance to the drugs that worked effectively against previous generations. Just like doctors do, vets need to make sure they don't overprescribe antibiotics. Exposure to antibiotics increases the possibility that antibiotic resistant bacteria will evolve.

To prevent this, organisations such as the CSIRO are working on new treatments based on cytokines. These are proteins that are naturally produced by the body's immune system following infection by bacteria or viruses. Research has shown that cytokines not only reduce the effects of disease like inflammation but can also improve the effectiveness of vaccines.

The prevention of infectious diseases in Australia's livestock is an incredibly complex issue, and one that is taken very seriously by the cattle and sheep industry, governments and scientists. Such diseases don't just make the animals sick, they can also cause much hardship for the farmers who graze those animals as well as others whose livelihoods depend on the industry. Quite apart from the suffering of the animals, were we to get foot-and-mouth disease in this country, animal production would be severely compromised for the foreseeable future, says Laurence. "Our export market would disappear completely and our domestic market would be shattered. It would cost us billions of dollars." Preventing disease incursion is like fighting an ongoing war where tactical deployment of vaccines, high hygiene standards, and strategic fencing can make all the difference at the frontline. These concepts are encompassed by the term biosecurity.

"Nothing gets done without science. All the advancements in animal production worldwide are driven by science, so it's hugely important."

Healthy herds

Genetic research plays a huge part in how farmers select animals in order to boost productivity and maintain a herd. The genetics of any animal determines the way they look, how muscular they are and therefore how much meat they can produce. Recent rapid advances in genetics have resulted in a push for science to provide insights into how we can predict which cows will be the best for any particular production system.

"Any farmer who wants to maximise their production will, without a doubt, use very powerful genetics tools," says Laurence. One of the tools of genetic selection in cattle in use in Australia is called Breedplan. The sheep equivalent is Lambplan. Breedplan is a data collection system that records different traits in cows over generations. Take our earlier example of muscle: farmers who are running beef cattle farms want to select cows for breeding that will produce offspring with lots of muscle. By measuring the muscle in a breed of cows over successive generations, a measure of the heritability of that trait can be estimated. Heritability is simply how easily a trait is passed onto the next generation. The overall likelihood of a particular trait is summed up in a number called the 'estimated breeding value'.

This estimated breeding value can be used to predict how likely a particular animal is to produce a particular trait in its offspring. An example of this is the Angus Society: the breeders of the famous Angus beef that is commonly used in beef production. They have highly specific breeding data for over a dozen traits in their cows, which they can use to select

the most suitable cows for efficient production. The Angus cattle are also naturally polled (dehorned), which makes it easier to avoid injury in herds.

One of the Meat & Livestock Australia initiatives, Initiative #53, funded by cattle and sheep farmers and being researched by Northern Territory Department of Primary Industry & Fisheries, is showing how a genetic test can help selectively breed cattle without horns. This is important, as horned cattle can injure other animals as well as people working with them. Gene Pol sought to identify a genomic marker of polledness (the natural lack of horns) that could be used for the selective breeding of polled cattle, eliminating the need to manually de-horn the animals. Once validated in a larger population of cattle, scientists anticipate that a genetic test using the marker will be released into the industry for use on farms.

The research is also demonstrating a breeding technique known as 'best practice fixed-time artificial insemination', which enables high quality genetics to be introduced into breeding herds that roam over vast expanses of Australia's outback.

Keep stock stress free

Keeping stock healthy means keeping them in a low stress environment. Just like humans, animals that are stressed are far more likely to have an immune system that isn't functioning at 100%. This increases their risk to infectious diseases such as the potentially fatal Ovine Johne's disease, an infectious wasting disease of sheep caused by bacteria.

One of the most essential aspects of low-stress handling is the behaviour of the stockperson. Poor handling can increase an animal's fear of people and increase its stress. This is why stock are often handled by people on horseback. Cattle for example show less fear at being managed by horses than they do people. Australian researchers and people in the industry are developing techniques to train handlers in low-stress stock handling both in farms and during live animal export to minimise the stress on animals.

Recently a team at the Animal Welfare Science Centre developed ProHand®, a computer-based training program that uses cognitive-behavioural psychology techniques to target and improve the attitudes of stock people towards their animals to encourage better animal handling. ProHand®, along with a couple of other entities, is involved in farmer-funded Meat & Livestock Australia Initiative #47, which aims to improve sheep handling. Low-stress handling initiatives can include:

Preventing disease incursion is like fighting an ongoing war where tactical deployment of vaccines, high hygiene standards, and strategic fencing can make all the difference at the frontline.

- Farm design to minimise the risk of injury and allow livestock to move naturally.
- Ensuring dogs don't bite by muzzling if necessary.
- Handler behaviour, such as keeping calm and speaking to the animals while interacting with them.
- Avoiding jerking movement and loud noises.
- Avoiding overcrowding livestock, or rushing them into new situations.

The science behind low-stress handling is just one of the tools we can use to help us to understand, respect and make comfortable the animals we rely on for food. – *Phill English*

GENETICS BASICS

Genetics is the science of genes, heredity and variation in living organisms. Offspring inherit characteristics based on the genes (segments of DNA or RNA – ribonucleic acid) that are passed on to them by their parents. DNA (dioxyribonucleic acid) is a molecule that contains the basic instructions used in the development and function of all living organisms. We inherit half of this code from each of our parents, and changes (mutations) also occur as DNA replicates itself. It's these changes and rearrangements that allow animals to evolve in response to their environment, or when we breed certain favourable characteristics into organisms. Humans have been selectively breeding plants and animals in this way for thousands of years.

Activity 1 – Glossary

[Task] Define some of the scientific terms used in the article, using a scientific dictionary.

Term	Definition
Animal husbandry	
Vaccinations	
Parasites	
Liver flukes	
Gastrointestinal worms	
Black scours	
Over-prescribe	
Non-bacterial diseases	
Antibiotic-resistant bacteria	
Disease incursion	

Term	Definition
Productivity	
Production system	
Traits	
Successive generations	
Selectively breeding	
Heritability	
Polled	
Infectious diseases	
Low-stress handling	
Ovine Johne's disease	

Activity 2 – Summarising

[Task] Answer the following questions relating to the article.

1. Dr Laurence is quoted in the article as saying 'Nothing gets done without science.'
a) What do you think he means by this remark?

b) Give an example, from the article, of something useful 'getting done' with science.

2. Give three reasons why CSIRO is working on developing vaccines based on cytokines.

3. Why do scientists take the prevention of infectious diseases in livestock so seriously?

4. Explain, in your own words, why farmers are interested in the genetics of their stock animals.

5. Fill in the table to show different low-stress handling initiatives, and how these help reduce the stress of stock animals.

Initiative	How it helps reduce livestock stress

Activity 3 – Questioning Toolkit

[Task] Write your ideas and opinions relating to each of the different types of questions.

Inspired by Jamie McKenzie's Questioning Toolkit. Further reading on questioning toolkits: McKenzie, Jamie (2000) Beyond Technology, FNO Press, Bellingham, Washington, USA. www.fno.org/nov97/toolkit.html

Type of question	Your ideas and opinions
Essential questions These are the most important and central questions. **Questions** What is selective breeding? What is it used for? Why is knowing the genetics of stock animals important to farmers? Why is the health of stock animals important to farmers? What is animal welfare?	
Subsidiary questions These questions help us to manage our information by finding the most relevant details. **Questions** How does selective breeding work? What is the link between genetics and productivity? What are the main risks to the health and wellbeing of stock animals? How can we control those risks?	

Type of question	Your ideas and opinions
Hypothetical questions Questions designed to explore the possibilities, the 'what ifs?' **Questions** What if all scientific research into livestock genetics stopped? What would/wouldn't happen?	
Provocative questions Questions to challenge convention. **Questions** Do you think it might be a problem in the future if we rely on genetic testing to improve animal health and welfare? If so, what might some of the advantages and disadvantages of this be?	

Welfare researchers seek to give animals 'good lives'

By Anna Vidot

THE FOCUS IN animal welfare is shifting from solving problems to giving animals 'a good life'.

Experts have told an RSPCA seminar in Canberra their understanding of what makes animals happy, and how that can be measured, is improving all the time.

And they say that an animal's happiness, like good nutrition, will eventually be considered an essential part of good livestock management.

David Mellor is a director of the Animal Welfare Science and Bioethics Centre at New Zealand's Massey University. He's worked in welfare field for decades on both sides of the Tasman and the UK.

He says many of the livestock welfare issues that were huge problems decades ago have already been solved, as scientists and farmers developed a better understanding of what animals need to keep them healthy and safe, and that's bringing about an evolution in what 'good welfare' actually means.

Increasingly, it's an animal's happiness that's the issue: how to give livestock positive life experiences, like chances to explore, forage and interact.

Professor Mellor acknowledges that many farmers will hear that and be worried about the prospect of these emerging concepts of welfare being forced onto their production systems.

But he says farmers shouldn't panic; that this is a process of evolution, not revolution, and one in which farmers will be closely involved, just as they were in solving problems with poor animal nutrition, and suffering through disease, that were significant issues for livestock industries in previous decades.

Professor Mellor says giving animals happier lives needn't necessarily be a costly exercise, and could involve things like improving the foraging experience for livestock, by varying the type of feed and the way animals are fed. Similarly, giving social animals the opportunity to interact with each other, and young animals the opportunity to play, where appropriate, could also come to form part of good welfare management over time.

While it's the scientific community's understanding of the happiness of animals that's driving this shift in thinking, it's clear that consumers are also increasingly concerned that farm animals should live actively happy lives.

James Yeates, the chief veterinary officer for the RSPCA in Britain, believes happy animals shouldn't make livestock production unaffordable, and says there's evidence to show that happy animals can have production benefits for farmers.

"Of course, especially in difficult times, farmers are concerned about the bottom line, they've got to make sure that the farm is sustainable," he said.

"But very few farmers that I've ever met are concerned only about the bottom line; there's the financial bottom line, but it's also about having a viable, flourishing farm, with a successful herd and part of the rural fabric, and the happiness of animals can very much form part of that."

Just as a perfect life is usually not possible for humans, Dr Yeates says it's probably impossible to reduce animal suffering to zero, but it's about achieving an acceptable balance.

"Veterinary treatment is an obvious example: you're going to cause some pain, but you're hoping it provides benefits.

"It's absolutely not about reducing suffering to zero. It's about striking that balance, as one idea, and then a separate idea is about minimising suffering.

"So, for example, if you do transport animals, making sure that one does it with the minimum of suffering."

Dr Yeates acknowledges that selling that balance to a consumer can be difficult, but he says an emphasis on providing a happy life for animals would give livestock industries an opportunity to say, 'look, what we're doing here is a win-win'.

"The animals have an enjoyable, happy life, the farmers are an important part of the rural community, and the consumers get to eat meat that they enjoy.

"I think there is something there [to communicate to consumers], we have to simplify it and make sure it's a key message, but I think it's a much more positive message than saying 'we've minimised the harms as much as we can'."

Source: *abc.net.au/site-archive/rural/news/content/201302/s3699458.htm*

Explain (article two)

RESEARCH LEADS THE WAY
Research funded by the levies paid by cattle and sheep farmers is continually improving the productivity of the sheep and cattle industries through better breeding and the application of new gene technologies. Two examples of such research are outlined here.

BREEDING FOR WORM RESISTANCE IN MERINO SHEEP
CSIRO scientists have worked out a way of using selective breeding to control internal parasites in Merino sheep. In the past, farmers have often had to rely on anti-worm chemicals called anthelmintics to control internal parasites. However, anthelmintic resistance (resistance of the worms to the chemicals) is a growing problem. Back in the 1970s, scientists worked out that worm resistance was moderately heritable in Merinos, and began selectively breeding sheep for this trait. In the 1990s, a large-scale technology transfer project called Nemesis was launched. Today, many ram breeders test for worm resistance, and this trait is becoming an integral part of Merino breeding objectives in worm-prone regions.


MEAT & LIVESTOCK AUSTRALIA

INCREASING LAMB SURVIVAL RATES
This project, a collaboration between CSIRO and the University of New England, is using 'SmartTag' technology to measure ewe and lamb behaviour during and immediately after birth. The results will help improve field-based measures for assessing the vigour of new-born lambs. The more active a lamb is at birth, the more likely it is to survive. Studies have shown that lamb vigour – shown by behaviours such as the time it takes a lamb to stand and suckle, or bleat – is a trait that is able to be passed on genetically. If this stage of the project is successful, it is hoped that the technology can be developed further to apply it to larger-scale genetic improvement schemes, thereby lifting lamb survival rates.

For more information about industry initiatives, go to *goodmeat.com.au/education*

Activity 1 – Glossary

[Task] Define some of the scientific terms used in the article, using a scientific dictionary.

Term	Definition
Nutrition	
Evolution	
Disease	
Sustainable	
Levies	
Gene technologies	
Internal parasites	
Selective breeding	
Trait	
Vigour	

Activity 2 – Summarising

[Task] Answer the following questions relating to the article.
The article talks about finding ways to give sheep and cattle a good life.

1. What are three ways livestock can be given positive life experiences?

_____

_____

_____

2. Why do you think it is important to consider animal welfare on farms?

_____

_____

_____

3. Give an example of a research project mentioned in this article by filling in the following table:

Research	Purpose
Identify the problem to be solved.	
Who is conducting the research?	
How is the problem being solved?	
Outline any further difficulties that arise.	
How will this research help the animal?	

Activity 3 – Questioning Toolkit

[Task] Write your ideas and opinions relating to each of the different types of questions.

Inspired by Jamie McKenzie's Questioning Toolkit. Further reading on questioning toolkits: McKenzie, Jamie (2000) Beyond Technology, FNO Press, Bellingham, Washington, USA. *fno.org/nov97/toolkit.html*

Type of question	Your ideas and opinions
Essential questions These are the most important and central questions. **Questions** What are the features of good livestock management? Why it is important for consumers to know the meat they eat comes from sheep and cattle that have been looked after in the best possible way and have had a happy life?	
Subsidiary questions These questions help us to manage our information by finding the most relevant details. **Questions** What are the benefits of different organisations working together to better solve animal welfare problems?	

Type of question	Your ideas and opinions
Hypothetical questions Questions designed to explore the possibilities, the 'what ifs?' **Questions** If indigenous cultures were to help educate us about animal welfare, what do you think they would try to teach us?	
Provocative questions Questions to challenge convention. **Questions** How does a farmer know when livestock are having a good life? Is it possible to give livestock a good life 100% of the time?	

A better way of life

Understanding the needs of your farm means combining good animal welfare practices with caring for the land, as well as a healthy dose of science knowhow.

Name: Kylie Schooley
Location: Hawkwood, Queensland
Find out more at: *goodmeat.com.au/education*

KYLIE SCHOOLEY'S CATTLE munch across 6000 hectares of grassy scrub, drink from a spring-fed creek and nestle amongst hills of ironbark forest. Her property near the town of Mundubbera in southeastern Queensland provides the ideal environment for the animals. "Honestly, if your land is in really good condition, then your cattle will always be in good condition," says Kylie, who lives on the property with husband, Simon, and two children.

For Kylie, the health of her 2000 head of cattle goes hand in hand with the health of the land on which they live, which also includes another property to the north of Mundubbera. Over 10 years of managing the property, they have been lowering stock numbers to improve the quality of the grass and soils, ensuring the cattle always receive good nutrition. "If they're not healthy, they're not productive," says Kylie.

"Not everyone is a born animal handler," she says. But Kylie is an exception, having worked with animals all her life, studied cattle behaviour and handling and worked as a veterinarian for 10 years. Now a dedicated grazier, she still finds time to lend a hand, using her veterinary expertise to help out on the neighbouring properties.

Kylie ensures the welfare of her animals by practising low-stress stock handling. This is an approach that aims to better recognise the needs and instincts of the animals when they are being handled. "When they are doing what they should be doing, which is driving to the yard or going up the race, you are away from them," she says. "It is about kindness, but it is also about training your cattle to do what you want them to do in an efficient manner."

Amilia Schooley and one of the family's cows

Kylie has also taken part in a number of scientific research projects. In the first, run by the Queensland Department of Primary Industries over two years, fresh cow manure was collected from paddocks and analysed to determine what cattle were eating and whether they were receiving good nutrition. A second project, called Cashcow, involved the electronic tagging of cattle to measure herd fertility over four years, and a third Queensland-wide project involved rotating cattle between paddocks to maximise grass and soil health.

One of the greatest challenges for cattle properties is maintaining profitability, but this does not have to mean compromising on animal welfare, says Kylie. "Not looking after animal welfare does not make you money," she says. But the livestock industry faces high costs, partly as a result of drought and government regulation. Kylie feels government and communities need to understand the balance and logistics of these massive systems before making political decisions. "If people are profitable then their animal welfare is much more likely to be high."

All of this makes for a challenging way of life. But by sustaining the health and welfare of her animals and the quality of the land, it also makes a fulfilling one. – *Mischa Vickas*

Activity 1 – Glossary

[Task] Define some of the scientific terms used in the article, using a scientific dictionary.

Term	Definition
Animal practices	
Grassy scrub	
Stock numbers	
Animal handler	
Veterinarian	
Grazier	
Electronic tagging	
Herd fertility	

Activity 2 – Summarising

[Task] Answer the following questions about the case study.

1. Farmer Kylie talks about the condition of the land, the health of the animals, productivity, and profitability. Explain how these things are all related.

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2. What has Kylie done to improve the nutrition of her cattle?

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3. According to the article, what is the aim of low-stress stock handling?

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4. What two things does Kylie say practising low stress stock handling is about?

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Activity 3 – Questioning Toolkit

[Task] Write your ideas and opinions relating to each of the different types of questions.

Inspired by Jamie McKenzie's Questioning Toolkit. Further reading on questioning toolkits: McKenzie, Jamie (2000) Beyond Technology, FNO Press, Bellingham, Washington, USA. www.fno.org/nov97/toolkit.html

Type of question	Your ideas and opinions
Essential questions These are the most important and central questions. **Questions** What are 'good animal practices'? Are they important? Can you run a profitable farm at the same time as treat your animals well?	
Subsidiary questions These questions help us to manage our information by finding the most relevant details. **Questions** What sorts of things are being done by farmers to look after stock? Is it in the best interests of farmers to look after the welfare of their animals in this way?	

Type of question	Your ideas and opinions
Hypothetical questions Questions designed to explore the possibilities, the 'what ifs?' **Questions** What if farmers didn't do anything to manage the health and wellbeing of their stock animals – what would be the consequences (for the animals, for the farmer, and for consumers?)	
Provocative questions Questions to challenge convention. **Questions** If you were a farmer, how much do you think you would care about the health and welfare of your stock? Why?	

Activity 4 – Bringing it all together

[Task] Answer the following questions relating to the article.

1. Create any kind of graphic (e.g. mind map) to show the main topics covered by the three articles, and how the articles relate to one another.

2. List five issues you have learnt about from reading the articles.

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3. List five questions you have after reading the articles.

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About the Refraction Science Matrix

What is the Refraction Science Matrix?
A learning matrix such as the Refraction Science Matrix is a flexible classroom tool designed to meet the needs of a variety of different learning styles across different levels of capabilities. Students learn in many different ways; some are suited to hands-on activities, others are strong visual learners, some enjoy intellectually challenging, independent, hands-off activities, while others need more guidance. The matrix provides a smorgasbord of science learning activities from which teachers and/or students can choose.

Can I use the matrix for one or two lessons, or for a whole unit of study?
Either! The matrix is designed to be time flexible as well as educationally flexible. A time frame for each activity is suggested on the matrix. Choose to complete one activity, or as many as you like.

Is there room for student negotiation?
Yes! Students can be given a copy of the matrix and choose their own activities, or design their own activities in consultation with their classroom teacher.

Can I use the matrix for a class assessment?
Yes! You can set up a point system – perhaps one lesson equals one point. Students can be given a number of points to complete. If they choose less demanding activities, they will have to complete more of them.

What do the column headings mean?

1. Read and revise
Designed to enhance student comprehension of information.
2. Read and relate
Gives the student the opportunity to apply or transfer their learning into a unique format.
3. Read and review
Requires the more challenging tasks of analysing and/or assessing information to create and express new ideas and opinions.

What do the row headings mean?

Row heading	Description of activity
Scientific procedure	Hands-on activities that follow scientific method. Includes experiments and surveys. Great for kinaesthetic and logical learners, as well as budding scientists.
Science philosophy	Thinking about science and its role in society. Includes discussion of ethical issues, debates and hypothetical situations. An important part of science in the 21st century.
Being creative with science	For all those imaginative students with a creative flair. Great for visual and musical learners and those who like to be innovative with the written word.
Science time travel	Here we consider scientific and technological development as a linear process by looking back in time or travelling creatively into the future.
'Me' the scientist	Personalising the science experience in order to engage students more deeply.
Communicating with graphics	Using images to communicate complex science ideas.
ICT	Exploring the topic using computers and the Internet.

	1. Read and revise	2. Read and relate	3. Read and review
Scientific procedure	Farmers selectively breed animals so that favourable genes in the DNA can be passed onto the next generation. What is DNA and what does it look like? Carry out an investigation to isolate DNA from the cells of wheat germ. See Linked Activity 1.	Carry out Linked Activity 2 to breed barley in order to understand how farmers breed cattle and sheep.	Which of the following pairs of traits are possibly dominant or recessive? Conduct a survey of the general public to gather data in order to find evidence for recessive traits for the following characteristics, and any others you wish to add to the list. Tongue rolling/no tongue rolling, ear lobes attached/ear lobes not attached, widow's peak/straight hair line, second toe longer than big toe, mid-digit hair/no mid-digit hair.
Science philosophy	Write down at least three questions you could ask Kylie Schooley about her philosophy behind promoting animal welfare.	Why do you think it is important to take care of animals? Are people behaving unethically if they do not do their best to look after the animals that are in their care? Give reasons and examples to support your opinion.	Assess the Five Freedoms of animal welfare from the video link provided here. How is it helpful? Is there anything else you would add? Do you think it could be easily implemented and monitored? Do you think these should be adopted by other countries? Does it apply to all animals? Write an article on animal welfare based around the Five Freedoms. *youtube.com/watch?v=iJVAS8kGr08*
Being creative with science	Design a poster or pamphlet for farmers, educating them about all the different diseases mentioned in the first article that cattle and sheep can develop, if their health is not taken care of.	Do some research and produce a short magazine article (including pictures) that tells readers about the main breeds of cattle and the specific traits they have been bred for.	Create a cartoon that explains selective breeding and how it is done using a specific example, such as Robert Bakewell and Leicester sheep.
Science time travel	From what you have read in the articles, identify one other animal welfare improvement you would like to see on farms in the future.	Choose a disease mentioned in the articles and create a timeline of the discovery of its cause, various medicines that have been developed, any major outbreaks, and different trends in managing the disease.	Where do you imagine the breeding of animals such as cattle and sheep might go in the future? What might it become possible to do and produce, using genetics and animal breeding techniques? Write a diary entry in the year 2050 describing what it has now become possible to do through breeding and genetics.
'Me' the scientist	Imagine you are an animal scientist and someone is bringing their pets into the classroom. Using the information in the article and any previous experience of handling animals, suggest how the students in the classroom should behave towards the animals so that the animals do not become stressed.	Imagine you are a rural vet and look after several cattle and sheep farms within a 200km radius. Write a journal of a week in your life that describes a variety of activities that make up your job. Or As a geneticist, carry out a breeding activity to find out how variety can occur in offspring of the same parents. See Linked Activity 3.	Imagine you are a biotechnologist and are on the research team to genetically engineer Omega sheep to produce healthy omega-3 fatty acids. Create a classroom activity to help students understand how Omega sheep are created, why they are created, any challenges to creating Omega sheep, and how those challenges are overcome. Use diagrams to help explain the biotechnology.
Communicating with graphics	Use the information in the articles to create a meme or logo to communicate the benefits of animal welfare in a fun way.	Watch the video *youtube.com/watch?v=LaO3HeaaSzE* and present the ways Jane Sale describes how cattle are handled in a low-stress way as a flow chart. You can have several options to the flow chart, ie, there may be several benefits branching off due to low-stress handling.	Research how quarantine methods help protect Australia from diseases such as foot and mouth that have affected other countries. Design a sign for an Australian airport that travelers may encounter that could help contribute to protecting Australia during an outbreak of foot and mouth disease occurring in another country. Make sure the sign is informative and relevant to target travelers that may be carrying the disease. How will the sign help screen travelers, and which quarantine directions will it include for those that may be affected?
ICT	How much do you rely on the sheep and cattle industries? Keep a blog for a few days and record all the things you consume (use/eat) that relate to these industries. Make sure you include dairy (cattle), meat (beef and lamb), wool, leather etc.	Use the parasite atlas to identify the parasites that affect cattle in the area closest to where you live. Use a PowerPoint or Prezi to highlight the problems local farmers have and how to solve them.	Create a webpage to promote ways in which farmers and scientists interact. Provide examples and case studies to communicate your findings. Include suggestions about ways in which scientists and farmers could work together in order to continue to improve animal husbandry.

Activity 1

DNA EXTRACTION

BACKGROUND INFORMATION

DNA is found in the nucleus of cells and contains the genes that make every living organism unique. Whether that organism is a human, sheep, worm or wheat plant, the cells that make up these organisms contain DNA.

In this investigation you will use wheat germ to extract DNA from the wheat cells. The 'germ' part is the embryo and it provides the source of DNA.

AIM

To extract DNA from the germ cells of wheat.

MATERIALS

- Teaspoon of fresh wheat-germ.
- 20ml of tap water heated to 50°C–60°C.
- Kettle.
- Thermometer.
- 1ml eye dropper/syringe filled with liquid detergent.
- 20ml syringe or a measuring cylinder.
- 14ml of ethanol.
- 50ml test tube in test tube rack.
- Wooden stick or glass rod.
- Clock or stopwatch with minutes hand.
- Pipette/strip of paper towel.

METHOD

1. Place the teaspoon of wheat germ in the 50 ml test tube.

2. Heat the 20 ml of water to 50°C-60°C and pour into the test tube with the wheat germ. Stir constantly for three minutes using a wooden stick or glass rod.

3. Add the 1ml of liquid detergent and stir gently for five minutes. Try not to make bubbles. If bubbles are made, remove them with a pipette or a strip of paper towel.

4. Measure 14ml of ethanol with the syringe or measuring cylinder. Tilt the test tube and slowly pour the ethanol down the inside of the test tube so that it sits on top of the wheat-germ/water/detergent mix. Do not mix this solution.

5. Slowly place the test tube up right and rest it in the test tube rack. The DNA will immediately begin to precipitate in the ethanol just above the interface of the two solutions. Monitor for 10 minutes and watch as the DNA gradually clumps and floats to the top of the ethanol. In the results table below, describe the appearance of the DNA as it is in the test tube.

6. Put the wooden stick or glass rod into the test tube and try to remove some DNA. Touch the DNA. What does it feel like? Does it have a smell? Record your observations of the DNA in the results table below.

WHAT EFFECT DO THE DIFFERENT TREATMENTS HAVE?

Water temperature

The three-minute soak in 50°C–60°C water softens the phospholipids (fats) that surround the cell and the nucleus, it also denatures the DNase which is an enzyme that cuts the DNA. DNA itself is denatured at about 80°C.

Detergent

Sodium laurel sulphate in the detergent removes the fats and proteins in the membranes of the cell wall and nuclear wall. Once they are broken down the DNA is released from the cell.

Ethanol

The ethanol precipitates the DNA out of the water/wheat-germ solution so it can be purified from the other cell components and visualised with the naked eye.

RISK ASSESSMENT

Complete the following risk analysis table before you conduct this experiment.

Hazard	Precaution	Consequence
Sharp broken glass	Check glassware for breaks and discard if cracked.	
		Will cause scalding and burns
Ethanol – toxic if drunk		

RESULTS

Observations of DNA

Describe the appearance of the DNA in your test tube.	Describe the appearance of the DNA when removed from the test tube.

DISCUSSION

1. What is a precipitate? Give another example of a precipitate other than DNA.

_____

_____

_____

_____

2. List three pieces of equipment you used during this investigation and the measurement you took with them. Comment on how accurate you think you were when measuring with each piece of equipment.

Equipment	Measurement taken	How accurate were you?
1.		
2.		
3.		

3. Were your results reliable? That is, were your results the same as everyone else's?

4. What is the role of DNA?

5. If a friend was about to conduct this investigation in their science lesson, what advice would you give them so they could carry it out easier?

6. What did you enjoy the most about conducting this experiment?.

Activity 2

BREEDING ALBINO BARLEY

BACKGROUND INFORMATION

When farmers breed sheep and cattle they don't always get the desired characteristics in their offspring. Often they have to breed over several generations for the desired traits in the animal to be shown consistently in the offspring. This is due to the combination of genes each parent can give to their offspring. Each parent gives one of two genes to their offspring so the offspring itself has two genes.

In this investigation you can model the way genes are passed to offspring by studying genes in barley plants.

Ablino barley (barley with no green pigment) has two recessive genes (alleles). A recessive allele is represented with 'a'. An albino plant receives an 'a' allele from both parents and has the genotype 'aa'.

The allele for normal pigment is represented with an 'A'. A plant with normal pigment could have received an 'A' from both parents so will have the genotype 'AA'.

A plant that has the genotype 'Aa' has received an 'a' from one parent and an 'A' from the other parent. This offspring also has the normal green pigment because the 'A' is dominant over the recessive 'a'. The table at right summarises the genotypes and phenotypes of the plants.

Summary of genotype (genes) and phenotype (appearance) in barley.

Allele donated by parent 1	**Allele donated by parent 2**	**Offspring genotype**	**Phenotype (appearance)**
A	A	AA	Green pigment
A	a	Aa	Green pigment
a	a	aa	Albino (no pigment)

Both the parents of the seeds used in this experiment are green with the genotype Aa. What are the possible genotypes of the offspring? What are the possible phenotypes of the offspring?

You can use a Punnett square to work the possible genotypes out:

		Parent 1	
		A	**a**
Parent 2	**A**	AA	Aa
	a	Aa	aa

Possible phenotypes: _____

AIM

To study genes and appearance in barley.

MATERIALS

- 1 petri dish.
- 20 Genetic Barley Seeds (avaliable from Southern Biological – catalogue code S2.1).
- Cotton wool.

METHOD

1. Place a layer of cotton wool on the bottom of the petri dish.
2. Water the cotton wool in the petri dish until the cotton wool is quite wet but the dish is not flooded.
3. Place 20 seeds on the cotton wool in the petri dish.
4. Place the petri dish on the bench in the sunlight.
5. Water the seeds every day to keep the cotton wool moist.
6. Once the seeds are fully grown record how many are albino in the data table below.
7. Add in any other results from the class.

HYPOTHESIS

Using the information in the Punnett square, write a hypothesis that estimates how many of the 20 barley seeds will be albino.

RESULTS

	Number of albino plants	Number of green plants
Predicted number		
Actual result		
Total result of the class		
Percentage of total number of plants		

DISCUSSION

1. What is the ratio of albino plants to green plants?

2. What is the genotype of the albino plants?

3. What is the genotype of the green plants?

4. Which allele is dominant?

5. If you were given a green barley plant how could you determine its genotype?

6. Suggest why the albino plants fail to thrive.

7. Using the knowledge gained by this investigation, explain to a farmer why he or she might breed a male and female sheep with one trait or phenotype, but produce offspring with a different trait/phenotype.

8. Explain to the farmer how they could eventually breed the offspring with the trait they desire.

CONCLUSION

Write a conclusion to summarise your results and respond to your aim.

Activity 3

HUMAN CHROMOSOMES

BACKGROUND INFORMATION

Humans have 23 different chromosomes that come in pairs, making 46 chromosomes in total. When egg and sperm cells are made, the 46 chromosomes they contain halve in number. This means that each egg and sperm contains only 23 chromosomes; one copy of each chromosome. Depending on the genes on the chromosomes that the egg and sperm contain, the offspring can look very different. At fertilisation the 23 chromosomes from mum and 23 chromosomes from dad come together to make 46 again. In this activity you will simulate making sperm and egg cells from five chromosome pairs, then bring them together to make a new baby.

WHAT YOU WILL NEED

- Scissors.
- Blank A4 sheet of paper.
- Coloured pencils.
- Paternal (father's) chromosomes (page 46).
- Maternal (mother's) chromosomes (page 46).
- Genotype/Phenotype Key (see right).

Genotype (alleles)	Phenotype
AA or Aa	3 eyes
aa	4 eyes
BB	Square body shape
Bb	Round body shape
bb	Triangular body shape
DD or Dd	Yellow spots on a flat head
dd	Pink stripes on a pointy head
EE	Red body
Ee	Green body
ee	Blue body
FF	4 legs, no arms
Ff	1 arm, 2 legs
ff	No arms or legs

WHAT TO DO

1. Cut out each pair of the five father's chromosomes and place them on the desk in front of you in pairs. That is, line them up with chromosome 1 next to the other chromosome 1, chromosome 2 next to the other chromosome 2.

2. Cut out each pair of the five mother's chromosomes and place them on the desk in front of you in pairs, but separate from the father's chromosomes.

3. Randomly select one Chromosome 1 from the father's group and place it on the A4 sheet of paper.

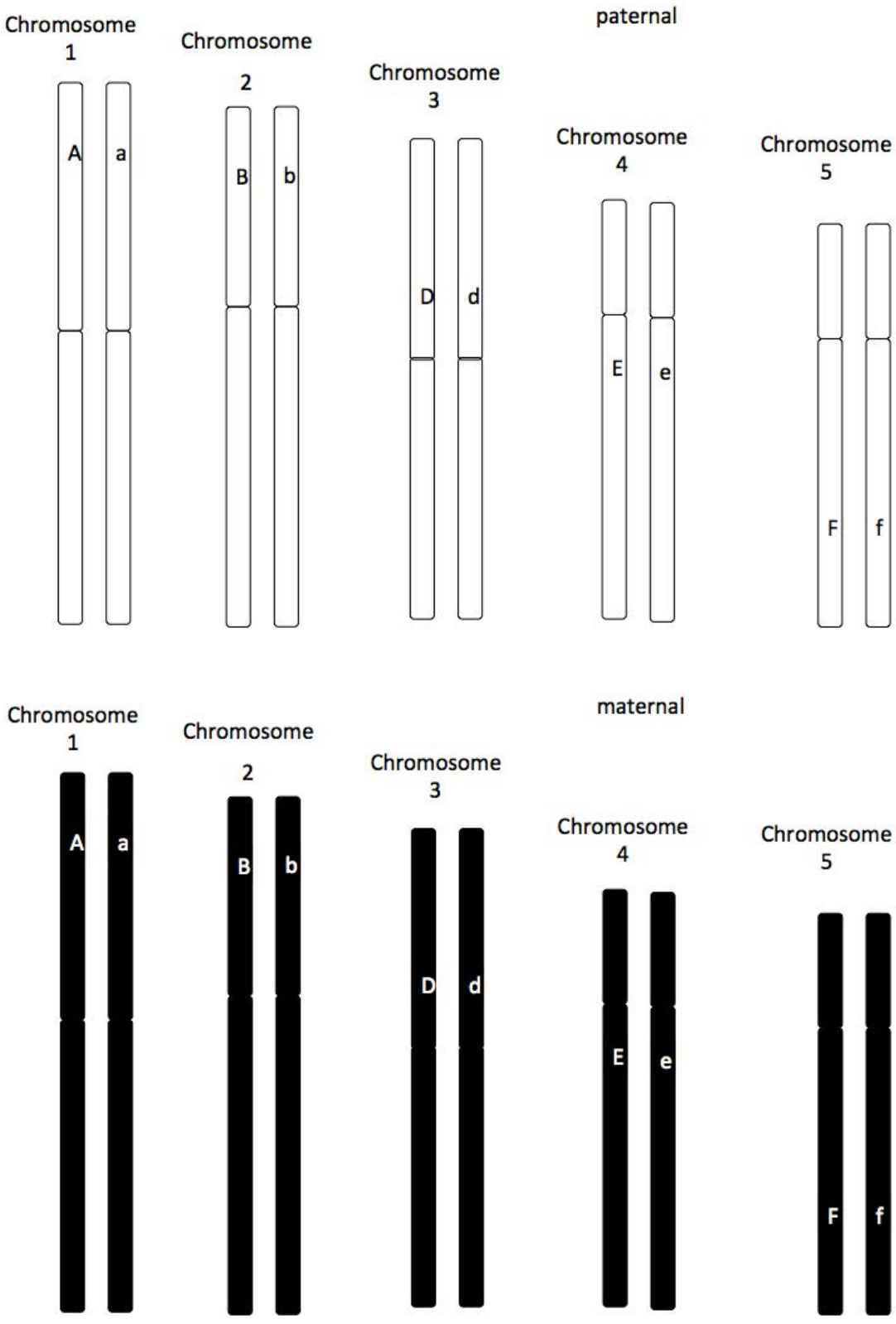
4. Randomly select one Chromosome 2 from the father's group and place it on the A4 sheet of paper.

5. Repeat step 4 for chromosome 3 , 4 and 5 by selecting one of them and placing them on the A4 sheet of paper.

6. Discard the father's chromosomes that you did not select. You should be discarding one of each pair of chromosome 1 to 5.

7. Repeat step 3 to 6 for the mother's chromosomes; that is select one of each number and place it on the A4 sheet of paper.

8. Pair all the white chromosomes with their black chromosome pairs. For example, pair mum's black chromosome 1 with dad's white chromosome 1. Do the same for chromosomes 2 to 5. Congratulations, you have made a new monster baby!


paternal
Chromosome 1
A
a
Chromosome 2
B
b
Chromosome 3
D
d
Chromosome 4
E
e
Chromosome 5
F
f
maternal
Chromosome 1
A
a
Chromosome 2
B
b
Chromosome 3
D
d
Chromosome 4
E
e
Chromosome 5
F
f

9. Fill in the following table to record your baby's genotype.

Chromosome number	Letter (or gene) on dad's white chromosome	Letter (or gene) on mum's black chromosome	Baby's letter pair (genes)	Baby's phenotype (matched to their gene combination using the key provided)
1				
2				
3				
4				
5				

Draw your monster baby here:

DISCUSSION QUESTIONS

1. When you paired a mum's white chromosome with a dad's black chromosome, which process in biology were you simulating?

2. Have a look around the classroom at the other babies. Were there any identical to yours? How did so much variety arise from the same parents?

3. What relationship would the different babies from the same parents have?

4. What characteristic did the letter (gene) B represent?

5. What were the two varieties (alleles) for gene B?

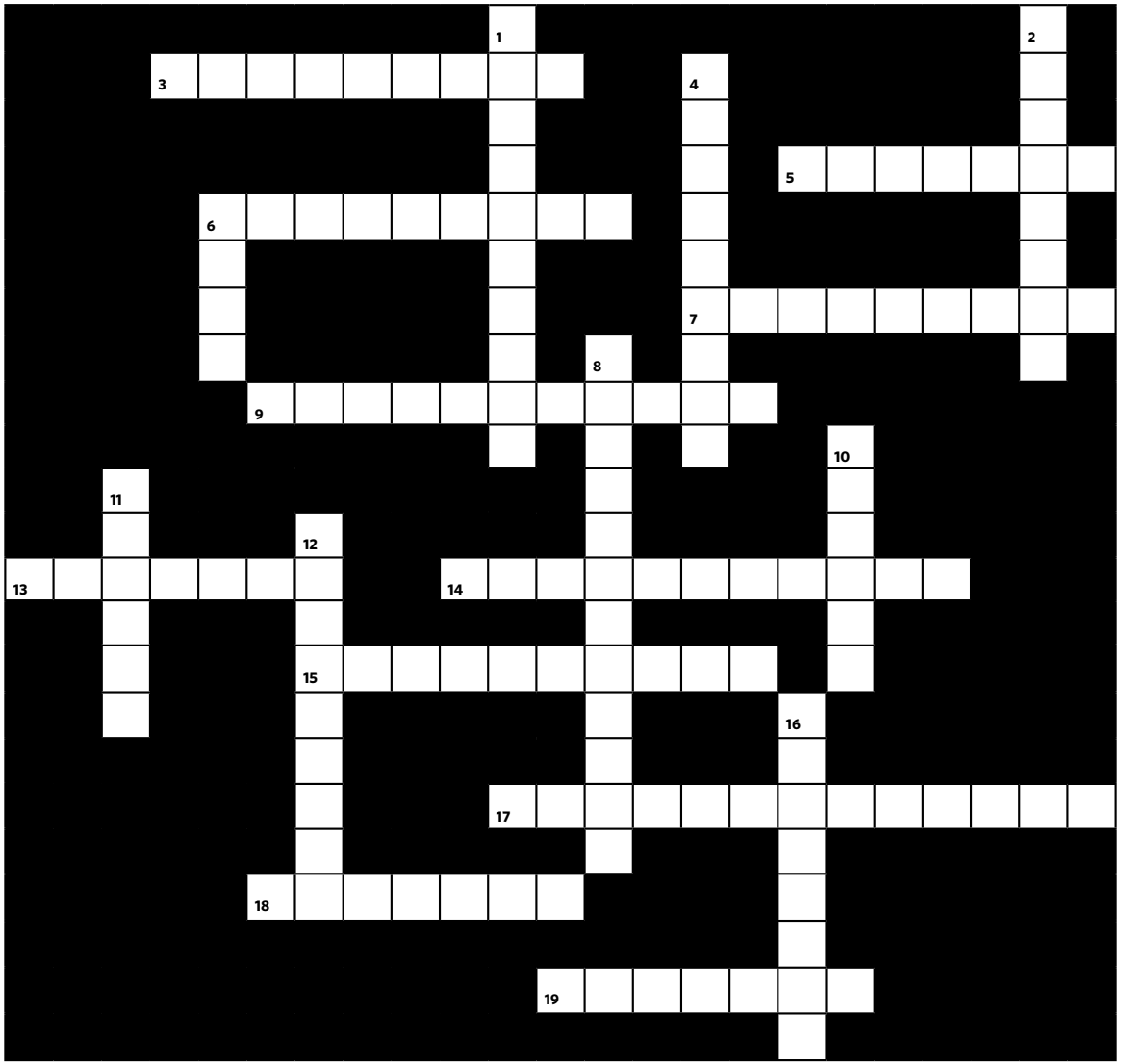
6. What were the different appearances (phenotypes) for the two varieties listed in question 5?

7. Which variety (allele) for number of eyes dominates over the other, A or a? What evidence do you base your response on?

8. How did this activity help you learn about inheritance?

Crossword

Animal breeding, health and welfare



Activities to allow students to show what they know about breeding, health and welfare in the cattle and sheep industries, and evaluate their learning.

Across

3. The care and breeding of animals
5. A farmer who grazes cattle or sheep for market
6. Type of animal breeding where people select the traits they want the offspring to possess
7. Domestic animals, such as cattle or horses, raised on farms
9. The quality or state of being muscular
13. The physical and psychological well-being of animals
14. The use of vaccines to prevent specific diseases
15. Category of disease caused by and/or capable of being transmitted by a pathogen
17. A person qualified to treat diseased or injured animals
18. The activity of controlling the mating of animals and the production of offspring
19. A person in physical charge of an animal

Down

1. Yielding financial gain; able to make a profit
2. The study of heredity and inherited characteristics or traits
4. The condition or degree of being fertile, ie, able to produce offspring
6. A group of animals kept for breeding, or a place where breeding animals are kept
8. The efficiency of a person, animal, etc., in converting inputs into useful outputs
10. Genetically determined characteristics
11. Lacking horns, either naturally or because of removal
12. Capable of being passed from one generation to the next
16. Person that eats or uses something, eg meat

(answers on page 50)

DIY quiz

1. Ask each student to call out a word or term that relates to the topic (e.g. animal welfare). Record these on the board.

2. Each student is to pick three terms from the board and write a definition for each.

3. Each student is to pick another three terms from the board, and write a paragraph about the cattle/sheep industry that uses each of these words.

4. Students create their own concept map, or some other type of diagram, to show what they have learnt about animal breeding, health and welfare. They are to use as many words/terms from the board as possible, and show the connections between these.

Class debate

1. Choose one of the following questions to use as the topic for a class debate:

   a) Farmers need to look after the welfare of their stock animals, not just their health

   b) There is a lot of science involved in raising livestock.

2. Divide the class into two groups. Group 1 will debate the affirmative and Group 2 will debate the opposing view.

3. Appoint an adjudicator, or an adjudicating team to decide which debating team presented the most compelling argument.

Group presentations

1. Place students into small groups, within which they will work to prepare and give a short presentation to the class. (Members should have a few minutes each to talk).

2. Allocate a topic to each group, or have them choose their own, based on the activities they have been doing in this unit. For example, selective breeding; genetic testing; animal welfare; managing parasites in livestock; case studies of Australian farms or farmers.

3. Give each group a mark for their overall presentation, and each group member an individual mark for their part of the talk.

Crossword answers

Across:

3. Husbandry
5. Grazier
6. Selective
7. Livestock
9. Muscularity
13. Welfare
14. Vaccination
15. Infectious
17. Veterinarian
18. Breeding
19. Handler

Down:

1. Profitable
2. Genetics
4. Fertility
6. Stud
8. Productivity
10. Traits
11. Polled
12. Heritable
16. Consumer

Personal review of unit

Personal summary	**Where to now?**
Make a dot point summary of all the things you learnt during this unit of work. Highlight the things you found the most interesting.	Write five questions that have come up for you during this unit, which you would like to know the answers to.
Something ethical	**Something political**
Think of two ethical issues that came up during this unit, and propose some ideas about how these issues might be addressed.	If you were a leader in agriculture in Australia, what changes would you make to the way the livestock industry is run?