

Unit overview

Multi-cellular organisms contain systems of organs carrying out specialised functions, which enable them to survive and reproduce. Carnivores, such as dogs, and herbivores, such as sheep, have distinctly different digestive systems, which allow them to successfully break down their food and extract the nutrients they require for their wellbeing and survival.

The following lessons can be taught as stand-alone lessons or incorporated into a full unit of work on the digestive system.

By allowing students to investigate the structure and function of the ruminant digestive system, these lessons aim to help students be more consciously aware of the basic needs of the animals that rely on humans for survival, such as livestock, and the way humans support these needs while using science to consider the impacts of livestock production on the environment.

By exploring a range of resources, carrying out hands-on activities and exploring current scientific research, students will gain an understanding of and appreciation for the challenges livestock producers face in managing animals for food and fibre. Students will also learn how researchers and farmers work together to ensure livestock are managed in a sustainable way, which considers the needs of both the animals and the environment.

Students use what they have learned to develop a presentation on the impact of science on ruminant livestock production to manage methane emissions.

Cross-curriculum priority:

Sustainability

Early lessons about the interdependence of animals, plants and people.

Links with the Australian Curriculum

This unit links to all three strands of the Australian Curriculum: Science — Science understanding, Science as a human endeavour and Science inquiry skills.

The table below outlines the sub-strands covered in this unit of work.

Strand	Sub-strand	Code	Content descriptions
Science understanding	Biological sciences	ACSSU150	Multi-cellular organisms contain systems of organs carrying out specialised functions that enable them to survive and reproduce.
Science as a human endeavour	Use and influence of science	ACSHE136	People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity.
Science inquiry skills	Questioning and predicting	ACSI139	Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge.
	Processing and analysing data and information	ACSI145	Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence.
	Communicating	ACSI148	Communicate ideas, findings and evidence-based solutions to problems using scientific language, and representations, using digital technologies as appropriate

Achievement standard

The sequence of the lessons in this unit of work provides opportunities to gather information about students' understanding related to the sections in bold in the achievement statement below:

By the end of Year 8, students will be able to **analyse the relationship between structure and function at cell, organ and body system levels**. Students **examine the different science knowledge used in occupations**. They explain how evidence has led to an improved understanding of a scientific idea and **describe situations in which scientists collaborated to generate solutions to contemporary problems**. They **reflect on implications of these solutions for different groups in society**.

Students **identify and construct questions and problems that they can investigate scientifically**. They consider safety and ethics when planning investigations, including designing field or experimental methods. They identify variables to be changed, measured and controlled. Students construct representations of their data to reveal and analyse patterns and trends, and use these when justifying their conclusions. They explain how modifications to methods could improve the quality of their data and **apply their own scientific knowledge and investigation findings to evaluate claims made by others**. They **use appropriate language and representations to communicate science ideas, methods and findings in a range of text types**.

Source: [Australian Curriculum, Assessment and Reporting Authority \(ACARA\)](#)

Unit snapshot

Lesson	At a glance
Lesson 1: Modelling digestion	- Identify the organs and overall function of a the ruminant digestive system. - Describe the structure of each organ in the system and relate its function to the overall function of the system - Briefly compare the digestive systems of herbivores and carnivores.
Lesson 2. Methane management	- Recognise the role of knowledge of the environment and ecosystems in a number of occupations. - Describe how technologies have been applied to modern farming techniques to improve yields and sustainability. - Use information and knowledge from their own investigations and secondary sources to predict the expected results from an investigation. - Use digital technologies to construct a range of text types to present science ideas. - Select and use appropriate language and representations to communicate.

Safety in the classroom

Learning to use materials and equipment safely is central to working scientifically. It is important, to review each lesson before teaching to identify and manage safety issues specific to a group of students.

The following guidelines will help minimise risks:

- Be aware of the school's policy on safety in the classroom and for excursions.
- Carry out activities beforehand to identify potential risks.
- Caution students about potential dangers before they start any activity.
- Clean up spills immediately as slippery floors are dangerous.
- Instruct students never to taste, smell or eat anything unless they are given permission.
- Discuss and display a list of safe practices for science activities.

Pre-lesson preparation, materials and equipment

The resources listed below provide ample background information to carry out this lesson and answer a range of questions posed by students.

Useful resources:

LEARN ABOUT WOOL secondary factsheets

- [Sheep the wool producers](#)
- [Wool production in Australia](#)
- [The woolgrower](#)

NOTE: These factsheets and a range of other resources are available online as downloadable PDFs in the Resource library at learnaboutwool.com (search for Year 8 Science) or as hard copies in the LEARN ABOUT WOOL Kit.

Go to learnaboutwool.com to order a free copy of the kit.

Farm 300 website and videos

- www.farm300.mla

Beyond the Bale

[March 2015 \(page 48\)](#)

ABC Science Online

[Dr Karl: Methane myth gives cattle a bum steer](#)

Meat and Livestock Australia (MLA)

[Reducing emissions from livestock program](#)

Lesson objective:

- In this lesson students investigate the structure and function of the ruminant digestive system.

Students will have the opportunity to:

- identify the organs and overall function of a the ruminant digestive system
- describe the structure of each organ in the system and relate its function to the overall function of the system
- briefly compare the digestive systems of herbivores and carnivores.

Lesson focus

The focus of this lesson is to encourage students to adapt their knowledge of what they have learned so far about the systems of organs multi-cellular organisms contain, which carrying out specialised functions, which enable them to survive and reproduce.

Setting the context

This lesson assumes students have some knowledge of the human (omnivore) digestive system.

An omnivore is an animal that eats both plants and other animals (e.g. humans, pigs and chickens).

A carnivore is an animal that only eats meat (e.g. dogs, cats).

A herbivore is an animal that only eats plants (e.g. sheep and cattle).

Monogastric animals have a stomach that has a single compartment. Humans have a monogastric stomach, as do pigs, chickens, rabbits and horses.

Ruminants are animals (such as sheep, cattle, goats and deer) that have more than one stomach and that swallows food and then brings it back up again to continue chewing it. Sheep have four stomachs (rumen, reticulum, omasum, abomasum).

Introduction

Explain to students that in this lesson they will be investigating the ruminant digestive system.

Start the lesson by establishing students' current level of understanding of the digestive systems of a range of animals. Ask questions such as:

- What is an omnivore/carnivore/herbivore?
- To which of the above groups do the following

animals fit — human, horse, dog, sheep, cat, pig?

- What do the terms 'monogastric' and 'ruminant' mean?
- To which of the above groups do the following animals fit — human, horse, dog, sheep, cat, pig?
- How many stomachs do humans/horses/dogs/sheep/cats/pigs have?

Body of lesson

1. Provide each student with a copy of (or online access to) the following LEARN ABOUT WOOL factsheets:
 - [Sheep — types of sheep](#)
 - [Sheep the wool producers](#)
 - [Wool production in Australia](#)
 - [The woolgrower](#)
2. Divide students into small groups (3–4 students). Distribute packs of coloured modelling clay, toothpicks and sticky notes to each group. Using the information provided on the factsheets and other sources (such as the internet), students are to work together to build a scale model of a ruminant digestive system, complete with correctly-labeled parts (using the toothpicks and sticky notes).
3. Provide students with the following list and ask them to ensure each item of the list is included in their model.
 - mouth
 - oesophagus
 - rumen
 - reticulum
 - omasum
 - abomasum
 - intestine
 - anus
4. Explain to students that at the end of the lesson each student needs to be prepared to explain the function of at least one part of their ruminant digestive system model.

Conclusion

When students have finished, select a group to share their model with the class and explain the structure and function of the ruminant digestive system.

Ask the students questions such as:

In Australia, sheep are domestic animals managed for food and fibre production — what are main sources of feed for sheep?

- Why do you think sheep only have front teeth on their bottom jaw?
- Why do sheep chew their 'cud'?
- What role do microbes play in the ruminant digestive process?
- What is methane and where is it produced in the ruminant digestive process?
- What do sheep producers need to consider when managing their pastures to look after both the animals and the environment?
- What does the term 'stocking rate' mean?
- Why are stocking rates important on sheep farms?

Encourage students to consider both the animal's needs and the environment when answering this question.

Note: The LEARN ABOUT WOOL factsheets listed as resources for this lesson and the background information provided will provide all the information you need to help students answer these questions.

Links to the Australian curriculum:

- Multi-cellular organisms contain systems of organs carrying out specialised functions that enable them to survive and reproduce ([ACSSU150](#))
- People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity ([ACSHE136](#))
- Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate ([ACSYS148](#))

Extension activity

Allocate students to small groups and ask them to develop an infographic to explain the key differences between ruminant and monogastric (e.g. human) digestive systems.

Encourage students to include a balance of graphics, text and tables and charts into their infographics.

You might like to get your students to present and explain their infographics to another class — get the class to vote on the most engaging, informative and easy-to-understand infographic.

Note: Infographics are a visual representation of data. When students create infographics, they are using information, visual, and technology literacies.

Some questions to ask students to help them reflect on specific infographics:

- Why is this infographic useful to me?
- What is the purpose of the visuals (charts, maps, drawings, etc) in this document?
- Is the text important for me to understand this infographic? Why?
- How can I evaluate this infographic? What does it do well? Where could it be improved?
- What information am I learning thanks to this infographic?
- Is this infographic helping me learn? How? Why?

Allow your students to spend some time investigating different forms of infographics. [The Daily Infographic](#) is a site dedicated to curating the most interesting infographics available on the web.

There is a variety of freely-available tools to create infographics online, such as [Canva](#). Most online infographic tools provide templates students can use for their own purposes. Students can adapt available infographic templates and add their own content, images, designs, etc.

The following article from EducationHQ Australia provides more information on using infographics in the classroom: <http://au.educationhq.com/news/33589/using-infographics-in-class/> (Accessed 23 July 2017)

Lesson objective:

- In this lesson students investigate the science behind managing methane production in ruminant livestock production.

Students will have the opportunity to:

- recognise the role of knowledge of the environment and ecosystems in a number of occupations
- describe how technologies have been applied to modern farming techniques to improve yields and sustainability
- use information and knowledge from their own investigations and secondary sources to predict the expected results from an investigation
- use digital technologies to construct a range of text types to present science ideas
- select and use appropriate language and representations to communicate science ideas within a specified text type and for a specified audience.

Lesson focus

The focus of this lesson is to encourage students to adapt their knowledge of what they have learned so far about ruminant digestion to address the issue of methane production in livestock industries.

Setting the context

The digestion of ruminant animals produces a waste by-product — methane.

As well as being the most potent greenhouse gas, it is a waste of energy. If the energy used to produce methane can be redirected, animal growth can be improved.

The Australian Government has instituted the [Carbon Farming Initiative \(CFI\)](#) to support farmers who reduce emissions. This initiative aims to deliver financial incentives to farmers who use CFI approved technologies that reduce emissions.

One area of current research is investigating the impacts of different diets on methane emissions from livestock. Initial research results suggest some pastures and forage shrubs result in lower methane emissions than others (e.g. legumes, such as clover and lucerne, produce less methane during ruminant digestions than grasses, such as perennial ryegrass and phalaris)

Introduction

Explain to students that in this lesson they will be investigating the science and technology Australian livestock producers are using to reduce methane emissions in sheep and cattle systems in Australia.

To begin the lesson ask students a range of questions, reviewing the previous lesson, to establish their current understanding of the link between ruminant digestion and methane production.

Body of lesson

1. Ask students to read the ABC Science article [Methane myth gives cattle a bum steer](#) (see Appendix 1) or listen to the [audio file](#) online.
2. Ask students to share their ideas about how livestock producers might manage the level of methane emissions from their livestock. Record students' ideas on the board or in a class science journal. Explain to students that scientists are working with livestock producers to investigate ways to manage methane emissions from livestock. Allow students to read the article: *FARM300 Increasing productivity to lower emissions intensity* from [page 48 Beyond the Bale magazine March 2015](#) (see Appendix 2).
3. Review students' ideas in light of the management options outlined in the table at the end of this article.

Explain to students they are going to investigate some case studies of Australian livestock producers who are adapting their management practices to maintain or improve productivity while reducing the overall methane emissions from their livestock enterprises. Separate students into small project groups. Visit the [MLA Farm300 website](#) and ask each group to select a farmer case study to investigate. Some of the case studies are listed below:

- SA cattle producer Sandy Nott — Investigating grape marc as a supplementary feed source
- NSW sheep producer Tom McGuinness focused on matching stocking rate with feed availability and the changing climate.
- Victorian mixed farmer Simon Ross measured the efficiency, emissions and profitability of the farm's sheep feedlot.
- SA cattle and sheep producer Janet Furler — alternative pasture species and feed to fill feed gaps, increase efficiencies and reduce methane emissions.

4. Ask students to review these case studies and using a digital format (such as PowerPoint® or Slideshare®) develop a presentation that outlines:
 - the relevant production system (e.g. location and livestock type — sheep or cattle)
 - feedbase — pasture, novel feed, grain
 - the innovation or management change employed (e.g. change in grazing management, change in feedbase)
 - the results.
5. Encourage students to include information on the ‘science behind the story’ in their presentations.
6. Ask students to be prepared to explain why and how the “innovation” is reducing emissions or increasing productivity in each case.

Conclusion

Ask students to share their presentations with the class.

Ask the students questions such as:

- What are the challenges for livestock producers in Australia in terms of balancing production and sustainability?
- How do livestock producers use science to produce food and fibre sustainably?

Note: Additional information about current research projects investigating ways to reduce methane emissions in livestock production can be found on the [MLA National Livestock Methane Program](#) webpage.

Links to the Australian curriculum:

- People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity ([ACSH136](#))
- Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge ([ACSI139](#))
- Summarise data, from students’ own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence ([ACSI145](#))
- Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate ([ACSI148](#))

Methane myth gives cattle a bum steer

The atmospheric scientists tell us that we humans have affected our planet's atmosphere in two major ways.

We have punched a hole in the ozone layer; and we have, quite separately, set off global warming by dumping so-called greenhouse gases into the atmosphere.

Most of us know that the most villainous of these gases is carbon dioxide. Many of us probably know that methane from cattle and sheep is another significant greenhouse gas.

But practically all of us wrongly believe that this methane gas comes from the back end of the animals. And very few of us know that methane is 22-or-so times nastier than carbon dioxide.

Once again, let me start by saying 'everything is made from atoms'.

Carbon dioxide is made from one atom of carbon and two atoms of oxygen. Methane is a bigger molecule. It's made from one atom of carbon and four atoms of hydrogen.

Livestock, of which cattle are a significant proportion, produce about 20 per cent of the world's methane output. The rest comes from rice paddies, coal mining, landfill sites and so on.

There are about 1.3–1.5 billion cattle on Earth today. India has about 30 per cent, Brazil about 20 per cent, the USA about 10 per cent and Australia just three per cent.

The methane that comes from cows is not made directly by the cows. No, it's made by tiny bacteria-like critters that live in the gut of the cattle.

These critters have a happy symbiotic relationship with the cattle. The cattle give the critters a safe home and the critters turn grass into food for the cattle.

More specifically, these critters eat cellulose. Cellulose is a big molecule that makes grasses stiff and tough enough to stand upright. We humans would starve to death if we tried to eat grass.

But cattle can eat grass and grow big and healthy because the critters in their gut can digest the cellulose.

Animals that can do this are called ruminants. Cattle are ruminant animals, as are sheep, goats, deer, giraffes and moose.

They're not called ruminants because there is lots of room in it. No, the word rumen comes from the Latin for gullet, or throat.

Ruminants will partially digest the food in the rumen, and then vomit it back up into the mouth to chew it some

more. A more polite word for vomit is regurgitate.

(By the way, another meaning for the word ruminant is a person who ruminates: they think deeply on matters, they contemplate and they meditate. They 'chew over' ideas and concepts, in the same way that cattle 'chew over' their food. The word ruminant comes from the Latin word *ruminat*, meaning chewed over, and it's closely related to the word *rumen*.)

So cattle can eat grass because they have not one but four digestive chambers at the top end of their gut. The first of these chambers is called the rumen. The average rumen can hold around 160 litres, which is two to four times the volume of your car's petrol tank. Tiny creatures (bacteria, fungi, protists and viruses, and bacteria-like critters called archaea) live in the rumen, and help digest the cellulose.

Some of these archaea can actually eat the cellulose, as well as the by-products of the other microbes living in the rumen.

The next chamber, the reticulum, is the smallest. This is where metal objects (barbed wire fragments, etc.) usually end up.

The third compartment is the omasum, which absorbs nutrients and water.

The fourth chamber, the abomasum, is similar to our human stomach, which is why it's called the 'true stomach'.

Getting back to the first chamber, the rumen is loaded with tiny critters, including archaea. These archaea are messy eaters and 'waste' about six to 10 per cent of what they eat. The waste comes out as methane.

If this potential source of energy were not wasted, it could be used to bulk up the cow.

But on the other hand, the strange combination of cow-and-archaea does have a marvellous, very special and very rare skill, so surely we can forgive their slight inefficiency?

Their special skill is to turn non-protein into protein, or grass into cattle. I have always been amazed that a cow can get so huge and meaty, while eating such a low-energy food as grass. It is all because of the archaea in their gut.

We humans do not have critters in our gut that can do that for us, so we have to eat protein.

But there is the unfortunate side-effect of the archaea-making methane, which the cattle then release. And I'll talk more about that, next time.

Source: <http://www.abc.net.au/science/articles/2010/09/28/3023670.htm> Accessed 10 August 2016

48 ON FARM

FARM300

INCREASING PRODUCTIVITY TO LOWER EMISSIONS INTENSITY



Farm300 producers at a field day near Springfield in Western Australia in October last year.

More than 300 beef and sheep producers across Australia are participating in the Farm300 project which aims to reduce greenhouse gas (GHG) emissions of cattle and sheep businesses by up to 30 per cent while boosting both profitability and productivity by 10 per cent.

The project is funded by the Australian Government, managed by Meat and Livestock Australia (MLA) and delivered in partnership with the Australian Farm Institute (AFI), Australian Wool Innovation (AWI) and Dairy Australia, and concludes in May 2015.

The Farm300 project aims to boost the productivity of livestock enterprises by improving producers' ability to manage greenhouse gas emissions.

Currently the main opportunities for livestock producers to manage their GHG emissions are to reduce the intensity of livestock emissions (the GHG emissions per kg of red meat or wool produced). As a result, on-farm practice changes which improve productivity, including by reducing wastage, can significantly reduce the estimated level of emissions intensity. As an example, increasing lambing percentage by reducing mortality may reduce emissions intensity by 30 per cent.

While the carbon policy environment has changed rapidly in recent years, and the specifics for farmer engagement in the Government's Emissions Reduction Fund are still being resolved, the Farm300 project seeks to assist farmers take a proactive approach to minimising their emissions intensity, while improving productivity and profitability.

128 specialist farm advisors have been trained to build their practical knowledge and skills in managing on-farm GHG emissions as well as options on how to

participate in the Government's Emissions Reductions Fund. These advisors use the knowledge to support producers to adopt new management techniques that will increase productivity and profitability, whilst reducing emissions. Of these advisors, 23 were selected to work around the country with one or more producer groups and run workshops, discussion forums and one on one coaching sessions.

The 337 producers participating in the program will become skilled in the best management practices and principles that can reduce on-farm emissions and boost farm productivity. They will also learn about relevant opportunities under the Australian Government's Emissions Reduction Fund (as they become available) to mitigate greenhouse gases and earn carbon credits.

Each coach uses a GHG calculator with their group to help benchmark the baseline emissions of their farm businesses, and then to test the impact of different on-farm strategies that look to improve those baseline emissions. These calculators are freely available online – see the links right – and while they are relatively easy to use, you may require assistance, which can be arranged through the Farm300 National Coordinator.

Using the calculators, a number of management changes have been identified which increase productivity and simultaneously reduce emissions intensity – see table below.

By evaluating the application of management practice changes, Farm300 aims to support and underpin producers' business objectives, encouraging them to make small and robust adjustments to their enterprise now, rather than wait and be forced to make large, more radical and often more costly decisions under stress.

While Farm300 is a two year program, due to finish in May 2015, it aims to leave a lasting legacy by equipping producers and advisors with the skills to manage emissions on farm, understand and respond to challenges from climate variability and potentially benefit from trading carbon credits while minimising their environmental footprint.

RESOURCES

- Tracking of producers participating in Farm300: www.mla.com.au/Farm300
- Why Sustainability Matters – a short video which outlines why industry should act now to reduce emissions: <http://youtu.be/8SiR3nVIEV4>
- A video tutorial which outlines three key steps to managing climate variability in livestock enterprises: www.mla.com.au/News-and-resources/Industry-news/Steps-to-managing-climate-variability
- The 'Sustainable Grazing' producer manual explains how grazing management techniques can be used to achieve productivity and emissions benefits: www.mla.com.au/Livestock-production/Environmental-management/Sustainable-grazing-a-producer-resource

GREENHOUSE GAS CALCULATORS

- FarmGAS calculator (an online calculator: users must register with AFI): www.farminstitute.org.au/calculators/farm-gas-calculator
- SheepGAF and BeefGAF (Excel files downloaded from the University of Melbourne website): www.greenhouse.unimelb.edu.au/Tools.htm

MORE INFORMATION
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WAYS PRODUCERS ARE INCREASING PRODUCTIVITY AND REDUCING EMISSIONS

ON-FARM MANAGEMENT CHANGE	PRODUCTIVITY/PROFITABILITY INCREASE	EMISSIONS REDUCTION
Rotationally grazing to increase native grasses	May enable additional lambs to be weaned and sent to market earlier	Stock are turned off faster
Establishing higher quality pastures	May make livestock production systems more efficient	Potentially reduced methane emissions
Improving soil health	May improve pasture utilisation, and retention of moisture and nutrients	May improve soil carbon sequestration
Genetic selection for faster lamb growth rates	May enable growth targets to be achieved sooner	Stock could be turned off faster
Change of stock enterprise, from breeding to finishing or vice versa	Might result in increased income or better cash flow	Animals could be turned off earlier and have reduced maintenance requirements.
Improve weaning rates through scanning etc	Increase production per ewe joined, and reduces wastage	Potentially increased weaner turnoff per ewe joined
Revegetation of less productive land	Potentially increases grazing capacity	Possible productivity and carbon sequestration increase