**Unit plan: Ethics of transgenic cows**

**Overview**

In this unit, students develop their knowledge of transgenics so they can formulate an argument and make ethical decisions about using transgenic cows to make medicines to treat human diseases.

**Purpose**

To use science knowledge when considering the ethical issues involved in genetic modification of animals. Students learn how cows can be modified with human genes to help treat human diseases. Ethical frameworks are used to help students explore their views and the views of others and to reach their own informed and justified decision about transgenic technologies.

**Background**

***Suggestions for a scenario***

Students learn about the transgenic cow research in New Zealand and consider the ethical issue: Should we allow cows to be modified with human genes to treat human diseases? Students are introduced to a scenario where scientists are planning to introduce a human gene into cows in order to produce a protein that will be used to treat people with a rare form of cancer. Research has already shown that this is possible. A ‘meeting’ is convened to determine whether or not these transgenic animals should be made. Students represent different stakeholders and need to argue their case.

***Ethics and transgenic animals***

Ethics is a crucial part of the nature of biotechnology. Transgenic animals can contain genes that would not normally arise through natural genetic variation. In New Zealand, transgenic technologies are highly regulated, with all genetically modified animals being kept in containment. However, using or adapting an animal raises issues about animal welfare, the environment, human health and wellbeing, and society. This issue may be viewed differently by different stakeholder groups according to their cultural, spiritual or religious beliefs and values.

***Using ethical frameworks***

[Ethical frameworks](https://www.sciencelearn.org.nz/resources/1497-using-ethical-frameworks-in-the-classroom) may be used to complete the summative assessment activity described in this unit. The tool’s consequentialism approach relates well to the focus of the learning activities. You may also wish to use the tool in a formative capacity in small groups, using a different ethical approach such as multiple perspectives or virtue ethics. If you decide to use the Ethics thinking tool, you need to register as a teacher and customise the tool to create your own ethical question and choice of approaches.

These video clips provide a brief introduction to teaching ethics and the different ethical approaches you can use to support students in developing ethical thinking:

[Introducing ethics in teaching](https://www.sciencelearn.org.nz/videos/1362-introducing-ethics-in-teaching)

[Reaching ethical consensus](https://www.sciencelearn.org.nz/videos/1364-reaching-ethical-consensus)

[Common ethical frameworks](https://www.sciencelearn.org.nz/videos/1359-common-ethical-frameworks)

**Curriculum focus**

***Technology (level 7) – Nature of technology***

Characteristics of technology: Understand the implications of on-going contestation and competing priorities for complex and innovative decision-making in technological development.

Characteristics of technological outcomes: Understand that technological outcomes are a resolution of form and function priorities and that malfunction affects how people view and accept outcomes.

***Technology (level 8) – Nature of technology***

Characteristics of technology: Understand the implications of technology as intervention by design and how interventions have consequences, known and unknown, intended and unintended.

Characteristics of technological outcomes: Understand how technological outcomes can be interpreted and justified as fit for purpose in their historical, cultural, social and geographical locations.

Transgenic animals are made for a particular purpose – in this case, transgenic cows are made to produce therapeutics that are difficult to manufacture by other methods.

***Science (level 7/8) – Nature of science – Participating and contributing***

Use relevant information to develop a coherent understanding of socio-scientific issues that concern them, to identify possible responses at both personal and societal levels.

***Science (level 8) – Living world***

Understand how humans manipulate the transfer of genetic information from one generation to the next and make informed judgements about the social, ethical and biological implications relating to this manipulation.

**NCEA Science** AS90728 – level 3 – 3.2 Research a current scientific controversy

**NCEA Biology** AS90718 – level 3 – 3.6 Describe applications of biotechnological techniques

**Health and safety**

Cyber safety considerations should be a part of your planning when you direct your students to use the internet. You may want to teach students some OOS avoidance strategies for computer use.

**Resources**

[Transgenic cows – introduction](https://www.sciencelearn.org.nz/resources/834-transgenic-cows-introduction); activity: [Ethics of modifying cows with human genes](https://www.sciencelearn.org.nz/resources/862-ethics-of-modifying-cows-with-human-genes); activity: [Ethical frameworks and transgenics](https://www.sciencelearn.org.nz/resources/861-ethical-frameworks-and-transgenics); activity: [Role-play ethics and transgenics](https://www.sciencelearn.org.nz/resources/863-role-play-ethics-and-transgenics)

**Useful links**

**Environmental protection agency (EPA)**

The Environmental Protection Agency (EPA), formerly the Environmental Risk Management Authority (ERMA), is responsible for regulating genetically modified organisms in New Zealand.

<https://www.epa.govt.nz/industry-areas/new-organisms/>

**Ethics and animal use in science**

A comprehensive resource about using animals in research from ANZCCART(NZ) and the Animal Welfare Science and Bioethics Centre at Massey University in New Zealand.

<http://anzccart.rsnz.org>

**Royal Commission on Genetic Modification**

A report summarising the social, environmental and cultural issues raised by genetic modification in New Zealand.

[www.mfe.govt.nz/publications/organisms/royal-commission-gm/](http://www.mfe.govt.nz/publications/organisms/royal-commission-gm/)

**National Animal Ethics Advisory Committee (NAEAC)**

View the New Zealand definition of a genetically-modified organism (GMO).

<http://www.mfe.govt.nz/publications/hazards/gm-nz-approach-jun04/genetic-modification-new-zealand>

| **Suggested learning intentions** | **Suggested learning experiences** | **Possible teaching/assessment activities** |
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| **Introduction – understanding the science** |
| Understand what genetic modification is and what a transgenic organism is. Explore transgenic cows as an example of a genetically modified organism in New Zealand. Understand that genetic modification is highly regulated in New ZealandUnderstand that any transgenic animals in New Zealand are kept in containment.  | Review existing knowledge on genes and inheritance. As a class, discuss genetic modification and transgenics and compile these on a class chart: * What does genetic modification mean?
* What is a transgenic organism?
* How are transgenic organisms made?
* Are there transgenic plants and animals in New Zealand?

Genetic modification is the deletion, change or moving of genes within an organism, the transfer of genes from one organism to another, the modification of existing genes or the construction of new genes and their incorporation into any organism. Transgenic animals are genetically modified organisms (GMOs). Transgenic cows are an example of a GMO in New Zealand. Scientists at AgResearch have successfully produced healthy transgenic cows that make modified milk or human therapeutic proteins in their milk. Students explore the following resources to understand that the transgene is expressed in specific tissues and only produced in the cows’ milk: * Intro article: [Transgenic cows](https://www.sciencelearn.org.nz/resources/834-transgenic-cows-introduction)
* Video clip: [Transgenic cows with modified milk](https://www.sciencelearn.org.nz/videos/425-transgenic-cows-with-modified-milk)
* Video clip: [Transgenic cows making therapeutic proteins](https://www.sciencelearn.org.nz/resources/856-transgenic-cows-making-therapeutic-proteins).

Any transgenic or GMOs in New Zealand, such as bacteria, plants or animals, are kept in containment and subject to strict regulations. Have students explore the following resources to learn about the regulations in New Zealand and their application in the transgenic cow research:* Article: [Regulating transgenic cow research](https://www.sciencelearn.org.nz/resources/859-regulating-transgenic-cow-research)
* Video clip: [Regulations, consultation and monitoring](https://www.sciencelearn.org.nz/videos/453-regulations-consultations-and-monitoringhttp%3A/www.biotechlearn.org.nz/focus_stories/transgenic_cows/video_clips/regulations_consultations_and_monitoring)
* Video clip: [The containment facility](https://www.sciencelearn.org.nz/videos/454-the-containment-facility)

 Look at original ideas and add or change new information on class chart.  | Class discussion and recording of students’ ideas on class chart.Read articles and watch video clips. Discuss why transgenic organisms are subject to strict regulations and why these regulations are stricter in New Zealand than other countries. Read articles and watch video clips. Add/change ideas on the class chart. |
| **Characteristics of technology** |
| Explore the application or uses of transgenic animals. Understand that the use or application of a transgenic animal may influence how acceptable we find the technology. | Transgenic animals have a wide variety of potential applications in biomedicine, agriculture, animal health and environmental sustainability. Use the resources in this story to explore the possible impacts of this technology (known and unknown, intended and unintended, long-term and short-term). In small groups, students discuss why people may find some uses more or less acceptable than others and present their thoughts to the class as a short skit or play. | Students research uses of genetically modified (GM) animals. Student presentations.  |
| **Introduce ethics** |
| Understand that ethics is the study of why certain decisions are morally right or morally wrong and the reasoned views behind making these judgements. Understand that each framework has its strengths and weaknesses. Introduce ethics and transgenic cows in New Zealand. | Ethics is the study of what is the right or wrong thing to do. Have students complete the student activity: [Ethical frameworks and transgenics](https://www.sciencelearn.org.nz/resources/861-ethical-frameworks-and-transgenics). Discuss whether one framework is better than another when considering the ethical issue. Write up the question: Should we modify cows with human genes to help treat human diseases? Set up a continuum line (using chalk or string/ribbon). At one end, place a sign ‘Strongly agree’ and the other ‘Strongly disagree’. Have students consider their personal stance on the ethical question and form a class continuum to indicate this. You could ask some students to volunteer the reasons for their position. If students are unsure or don’t know, they should stand in the middle. Make it clear there’s no right or wrong answer.  | Student activity: [Ethical frameworks and transgenics](https://www.sciencelearn.org.nz/resources/861-ethical-frameworks-and-transgenics)Students share their reasons for their place on the line and explain how they made their decision. |
| **Ethical perspectives – benefits and harms** |
| Use a consequentialist ethical framework that focuses on the benefits and harms of modifying cows with human genes. | Introduce a consequentialist ethical framework by showing the second section of the video clip [Common ethical frameworks](https://www.sciencelearn.org.nz/videos/1359-common-ethical-frameworks) – stop the video at the end of that section.Read articles:* [Transgenic cows making therapeutic proteins](https://www.sciencelearn.org.nz/resources/856-transgenic-cows-making-therapeutic-proteins)
* [Future uses of transgenic cows](https://www.sciencelearn.org.nz/resources/880-future-uses-of-transgenic-cows)

Watch videos: * [Advantages of transgenic technologies](https://www.sciencelearn.org.nz/videos/470-advantages-of-transgenic-technology)
* [Advantages of making proteins in transgenic cows](https://www.sciencelearn.org.nz/videos/696-advantages-of-making-proteins-in-transgenic-cows)

Have students complete the activity: [Ethics of modifying cows with human genes](https://www.sciencelearn.org.nz/resources/862-ethics-of-modifying-cows-with-human-genes).Have students complete the activity: [Role-play ethics and transgenics](https://www.sciencelearn.org.nz/resources/863-role-play-ethics-and-transgenics) where students use role-play to discuss the issue and reach an informed decision on whether cows should be modified with human genes.  | Activity: [Ethics of modifying cows with human genes](https://www.sciencelearn.org.nz/resources/862-ethics-of-modifying-cows-with-human-genes)Activity: [Role-play ethics and transgenics](https://www.sciencelearn.org.nz/resources/863-role-play-ethics-and-transgenics) |
| **Ethical deliberation and justification** |
| Make a decision with justification.  | Ask students to position themselves on the value continuum line again in response to the statement: Should we modify cows with human genes to help treat human diseases. Has anyone’s position changed? Why? Why not?Have student write a report that outlines their own position on whether New Zealand should have a transgenic cow research programme. Any statements in the report should be justified with explanations – what have they based their position on? They may also explore how their opinion may differ from the opinion of others.  | Students share their reasons for their place on the line and explain how they made their decision. Argument writing (assessment). |