BEANZ
BIOLOGY EDUCATORS OF AOTEAROA NZ
TE RŌPŪ WHAKAAKO KOIORA O AOTEAROA

TERM 2 NEWSLETTER 2025

Kia ora koutou,

As we move through 2025, I want to take a moment to thank you all for your continued dedication to Biology education across Aotearoa. The executive committee has been working steadily behind the scenes to respond to feedback from our membership.

A special thank you to Erica Jar for organising the NZQA Making Assessment Judgements workshops. These sessions were incredibly well received, with feedback from participants highlighting how valuable and affirming the experience was. It's clear that having the time and space to connect over assessing Biology internals has been a much-needed opportunity for teachers across the motu, and we are grateful to Erica and all involved.

Also a huge mihi to Sarah, our BEANZ facilitator, who continues to bring energy and connection to our community, especially for those new to teaching or new to New Zealand classrooms. Whether you're just starting out or have been teaching for decades, feel free to reach out to her.

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Looking ahead, we encourage you to stay connected. If you're curious about getting more involved, or just want to contribute in a small way, please reach out, we'd love to hear from you.

And finally, do remember to take some time out over the upcoming holidays. While you're relaxing, feel free to browse the resources section on the BEANZ website. There's a raft of new assessment materials now available. These include two NZQA Quality Assured Assessment Materials (QAAM) for Level 3 Homeostasis, focusing on glucoregulation and thermoregulation, as well as the BEANZ Level 3 Biology Exam, the Scholarship Exam, and the ChemBio 1.3 Genetics Exam.

Kia pai tō rā

BEANZ 2025 RAMP Review

(Sent to membership April 16)

Responses (26 Responses)

Authenticity and AI

Respondents: 19 of 26 (73%)

Themes:

1. *Group work and authenticity, validity of assessments if students use AI. Some Kaiako have particular concerns with student use of generative AI in assessment.*
2. *However, other teachers are happy to incorporate AI accessibility into internal assessment practices.*
3. *All Kaiako would like direction from MoE and PD on how to manage AI.*

2.1 AS91153 Carry out a practical investigation in a biology context, with supervision. 4 credits, Internal

Respondents: 8 of 26 (31%)

Themes:

1. *Overall positive feedback: a great/solid internal that Kaiako and ākonga like.*
2. *Two (25% of respondents) Kaiako commented on the discussion with relation to biological reference - for Merit*

2.2 AS91154 Analyse the biological validity of information presented to the public. 3 credits Internal

Respondents: 5 of 26 (19%)
(There were six respondents, but one response was 'don't do standard')

Themes:

1. *Overall positive feedback*
2. *Two (40% of respondents) Kaiako recommend either upping the credit amount or reducing the amount of work required.*

Editor's note: *The general lack of feedback may be indicative of the number of schools not undertaking this Achievement Standard, which may be an indicator of a larger problem with the standard.*

2.3 AS91155 Demonstrate understanding of adaptation of plants or animals to their way of life.
3 credits Internal

Respondents: 11 of 26 (42%)

Themes:

1. *Overall Kaiako think the volume of work required for all levels of achievement is disproportionate to the number of credits available. This standard should be 4 credits*.

2.4 AS91156 Demonstrate understanding of life processes at the cellular level.
4 credits External

Respondents: 20 of 26 (77%)

T**hemes:**

1. *Overall varied and contrasting feedback.*
2. *Some Kaiako thought it was a great standard.*
3. *One thought it had an extreme amount of content. In contrast, another thought more detailed biological knowledge (NADPH) should be included.*

Editor's note: *The variation in these comments might signal an inability within the sector to differentiate Biology curriculum levels or interpret AS91156, which could be addressed with the introduction of a detailed syllabus.*

2.5 AS91157 Demonstrate understanding of genetic variation and change.
4 credits External

Respondents: 9 of 26 (35%)

Themes:

1. *Overall, comments were focused on the 2024 exam and the inclusion of sex linkage. All respondents agreed that sex linkage is not included in the Standard according to the current explanatory notes.*

Editor's note: *Comments identify the need for a detailed syllabus.*

Respondents: 8 of 26 (31%)

Themes:

1. *Overall positive feedback: a great/solid internal that Kaiako and ākonga like.*
2. *Two (25% of respondents) Kaiako commented on the discussion with relation to biological reference - for Merit*

2.6 AS91158 Investigate a pattern in an ecological community, with supervision.
4 credits Internal

Respondents: 4 of 26 (15%)

Themes:

1. *Overall positive feedback with no issues.*
2. *One Kaiako responded: There seems to be a large variation in the type of assessments for this standard, considerable overlap with the L2 geography standard. The assessment could use some refining so that it has a clear direction.*

2.7 AS91159 Demonstrate understanding of gene expression.
4 credits External

Respondents: 7 of 26 (27%)

Themes:

1. *Overall positive feedback regarding the Standard and NZQA's examination of the Standard.*
2. *Two Kaiako (29% of respondents, 8% total) commented on the volume of work required for all levels of achievement is disproportionate to the number of credits available.*

Editor's note: *These comments might signal an overall theme of an inability within the sector to interpret AS91159, which could be addressed with the introduction of a detailed syllabus.*

2.8 AS91160 Investigate biological material at the microscopic level.
3 credits Internal

Respondents: 15 of 26 (58%)

Themes:

1. *All Kaiako that responded thought it was a great practical Standard for ākonga.*
2. *All Kaiako agreed comments on the inability to gain Excellence and this was an issue. Many examples of how the Standard could be iterated to include Excellence was included.*

3.1 AS91601 Carry out a practical investigation in a biological context, with guidance.
4 credits Internal

Respondents: 8 of 26 (31%)

Themes:

1. *Overall, a great Standard.*
2. *Volume of work required for all levels of achievement is disproportionate to the number of credits available. Many thought it should be work 5 credits.*
3. *Exemplars requested by Kaiako.*

3.2 AS91602 Integrate biological knowledge to develop an informed response to a socio-scientific issue.
3 credits Internal

Respondents: 14 of 26 (54%)

Themes:

1. *Consistent theme of: volume of work required for all levels of achievement is disproportionate to the number of credits available. Many thought it should be worth 4 credits.*
2. *Exemplars requested*
3. *One Kaiako commented it was not really about biology - to ensure you have E you have to evaluate the success of your proposed action, which often has nothing to do with Biology. (**Editor's note:** This indicates the need for further NZQA Making Assessor Judgement workshops, as our ākonga need to be critical thinkers and problem solvers in a world where biological issues are often also societal issues.)*

3.3 AS91603 Demonstrate understanding of the responses of plants and animals to their external environment.
5 credits External

Respondents: 11 of 26 (42%)

Themes:

1. *Overall, a good Standard that uses lots of NZ examples.*
2. *The volume of work required for all levels of achievement is disproportionate to the number of credits available.*
3. *One Kaiako commented on more guidance on biological content and depth required in answers.*

***Editor's note:** A detailed syllabus would therefore be helpful.*

3.4 AS91604 Demonstrate understanding of how an animal maintains a stable internal environment. 3 credits Internal

Respondents: 6 of 26 (23%)

Themes:

1. *The volume of work required for all levels of achievement is disproportionate to the number of credits available.*
2. *One comment was that the recent NZQA Making Assessor Judgements workshops helped with understanding.*

3.5 AS91605 Demonstrate understanding of evolutionary processes leading to speciation. 4 credits External

Respondents: 4 of 26 (15%)

Themes:

1. *Overall, a good Standard*
2. *One Kaiako commented on more guidance on biological content and depth required in answers. (**Editor's note:** A detailed syllabus would therefore be helpful.)*

3.6 AS91606 Demonstrate understanding of trends in human evolution. 4 credits External

Respondents: 9 of 26 (35%)

Themes:

1. *Some Kaiako commented that this was their ākonga's favourite Standard.*
2. *Should be worth 5 credits.*
3. *One Kaiako commented, "Updates each year for teachers would be appreciated on what recent changes have occurred - a resource/summary mid-year of the last 12 months. It is a complete chance whether you come across a find or an alternative theory/interpretation that can then be assessed." (**Editor's note:** Possibly BEANZ could address this and summarise the changes annually.)*

3.7 AS91607 Demonstrate understanding of human manipulations of genetic transfer and its biological implications. 3 credits Internal

Respondents: 7 of 26 (27%)

Themes:

1. *The volume of work required for all levels of achievement is disproportionate to the number of credits available.*
2. *One comment was that the recent NZQA Making Assessor Judgements workshops helped with understanding.*
3. ***Editor's note:** Personally, explaining the steps to a biotech process that is undertaken in a machine (for Merit), when the important skill is how to interpret the information, seems a waste of time.*

CB1.1 AS92020 Demonstrate understanding of the relationship between a microorganism and the environment.
5 credits Internal

Respondents: 5 of 36 (14%)

Themes:

1. *Moderation concerns*
2. *Exemplars requested*
3. *Overall tone from responses indicates Kaiako support this Standard and want to teach their ākonga well but need more guidance on A, M, E judgements.*

CB1.3 AS92022 Demonstrate understanding of genetic variation in relation to an identified characteristic.
5 credits External

Respondents:

Themes:

1. *Content required by the Standard is beyond L6.*
2. *The volume of work required for all levels of achievement is disproportionate to the number of credits available.*
3. *'Desperately' need exemplars and support*
4. *Overall tone of the responses indicates Kaiako do not feel supported to teach/deliver this Standard adequately for their ākonga.*

Genetactics

A genetics resource from Penny Daddy. Download it here.

Any questions contact Penny: daddypenny@ngatawa.school.nz

New BEANZ Resources on the Website.

**** Level 3 Practice Exam***

**** Scholarship Exam***

Two QAAM tasks for Biology 3.4 AS 91604 (v3): Demonstrate understanding of how an animal maintains a stable internal environment.

* **Thermoregulation**

Bio 3.4 - Thermoregulation - BEANZ

*** Glucoregulation**

Bio 3.4 - Glucoregulation - BEANZ

* **Unit of Work: Wahine Hauora - A Socio-scientific Issue for AS91062**

Wahine Hauora - A Socio-scientific Issue for AS91062 - BEANZ

Women's health is often considered synonymous with reproductive health. However, common diseases such as coronary artery disease present differently in women and men, and respond differently to commonly used drugs, which are typically developed to treat symptoms in men. Despite creating a Women's Health Strategy, the Ministry of Health in New Zealand continues to mainly fund reproductive health issues, yet some of the leading causes of death in women are dementia and heart attacks from coronary artery disease. This unit of work addresses why this is and how society can respond to instigate change.

***AS91155 Adaptations - Sexual Reproduction in Mammals**

AS91155 Adaptations - Sexual Reproduction in Mammals - BEANZ

AS91155 allows NCEA Level 2 students to present information that demonstrates understanding of adaptations of plants or animals to their way of life. Students can EITHER analyse adaptations for two life processes across two taxonomic groups OR analyse adaptations for one life process across three taxonomic groups.
This unit makes use of the latter option: adaptations for sexual reproduction in monotremes, marsupials, and placental mammals.
PLEASE NOTE: THE ASSESSMENT TASK PROVIDED HAS NOT BEEN THROUGH THE NZQA QAAM PROCESS AND ALTHOUGH BEANZ IS CONFIDENT THAT IT IS FIT FOR PURPOSE, BEANZ DOES NOT TAKE RESPONSIBILITY FOR ANY MODERATION FEEDBACK.

*** Journal Articles for Students - Pseudoscience and Sensationalist Headlines**

Journal Articles for Students 2025 - Pseudoscience and Sensationalist Headlines - BEANZ

This set of articles help students to identify how science is used to support weak claims and create news. Written for extensions Year 10 students to Year 13, each article is fully referenced and comes with a glossary.
Topics:

- *De-extinction of dire wolves* ***This article is the feature article for this newsletter. See page 13.***
- *Deer vs moa - ecological substitute or environmental disaster?*
- *We all have ancient DNA in us*
- *Will beech masts become more frequent with climate change?*
- *DNA ancestry tests - hype or inheritance?*
- *Paleo diets - is it really what early humans ate?*

Connecting Students to Freshwater Science through Place-Based Learning

In Aotearoa New Zealand, freshwater connects people to place. This connection is especially significant for tangata whenua on the southern slopes of Mt Ruapehu—Ngāti Rangi. The streams that flow from Ruapehu to the sea carry mauri, the life-supporting essence of all living things. As tangata tiaki, Ngāti Rangi hold the responsibility to sustain the integrity and flow of mauri, which includes the riverbeds, the catchments, the habitats, fish, and biodiversity.

Ruapehu College students with Ngati Rangi

Meredith Wilson, a teacher at Ruapehu College, is passionate about providing education and learning opportunities in freshwater science for secondary students in the Ruapehu region. One of the Science Department's key goals is to connect students with their local environment and involve them in real-life science. We are fortunate to have access to high-quality freshwater awa (rivers) that offer authentic, place-based learning experiences right on our doorstep. By focusing on freshwater systems, we help students see that science is all around them.

Meredith working alongside students at the Mangawhero River

Meredith participated in the Royal Society Te Apārangi Science Teaching Leadership Programme in 2018. Her placement was with the local iwi, Ngāti Rangi Trust, where she worked alongside a freshwater scientist monitoring the impacts of the Tongariro Power Scheme. During her placement, Meredith began developing ideas for teaching and learning that she could implement in both the junior science curriculum and senior biology. She also began building her understanding of Ngāti Rangi tikanga and the unique values, properties, and whakapapa of the different awa, including the kaitiaki that reside near them.

Horizons working with akonga from Ruapehu College

Since then, Meredith has collaborated with Horizons Regional Council, Ngāti Rangi Trust, the Department of Conservation, and Project

Tongariro. She has also received sponsorship from Genesis Energy and funding from the Horizons Regional Freshwater Grant to provide opportunities for students at all year levels to participate in freshwater investigations. These have included measuring and collecting data from the major awa that flow from Mt Ruapehu. As part of this learning, ākonga have engaged in tiakitanga by restoring a local reserve and participating in citizen science, learning about the native plants and trees that support local ecosystems.

A key focus in building freshwater science into the curriculum has been ensuring there is enough equipment to allow more students to actively engage in fieldwork and data collection. By increasing access to scientific tools and resources, the aim is to foster curiosity, build practical scientific skills, and spark long-term interest in environmental science. Over the past few years, we've built up a collection of specialised equipment used to measure freshwater quality and ecosystem health. Through support from Horizons Regional Council, we secured funding to purchase a water quality probe, waders, clarity tubes, gravelometers, and equipment for sampling E. coli and nutrient levels. We are now working toward gathering data on fish species and kōura, and are seeking sponsorship to begin collecting eDNA samples to build a long-term monitoring database.

During our field trips to the awa, we have incorporated both Ngāti Rangi perspectives and scientific methods. We are appreciative of Ngāti Rangi's ongoing support, especially in sharing their cultural monitoring practices and demonstrating how they use science to inform their understanding of awa health and flow. We also continue to collaborate with other agencies and members of the local community to engage students in tiakitanga and build connections between freshwater science and biodiversity.

For more information or questions you can contact Meredith Wilson: mwilson@ruapehu.school.nz

Ruapehu College Students measuring clarity of Mangawhero Awa.

DOC with Ruapehu Students for streamside restoration.

Science Teachers Leadership Program

Applications are closed for 2026. You could start thinking about applying in 2026 for 2027
Go to...

About the Science Teaching Leadership Programme

Budding Biologists Take on Tāmaki

Over the Easter school holidays, 25 budding biologists from across the motu convened in Tāmaki Makaurau for this year's New Zealand International Biology Olympiad training and selection camp. Tauira got the chance to work in the lab with some of the best in the field at the University of Auckland School of Biological Sciences, hear about some of the cutting edge research taking place, and undertake fieldwork.

This group of students hailed from all over the country, as far south as Dunedin and as north as Whangarei, representing a diverse group of state, state-integrated, and independent schools, but what they had in common was a love of biology and a keen interest to learn more!

The first four days of the programme were spent at the university, with a wide range of practical activities organised by Julie McIntosh, Chair of Teaching and Learning in the School of Biological Sciences, and Associate Professor Chris Squire. The UoA team was vital in ensuring that students had the opportunity to learn practical skills that they would need for not only the IBO competition, but also for future university studies. Alongside this, they were privy to a number of seminars from leading researchers including bioenergetics, protein structure and function, genomics, and more. Time was also spent at the Grafton Medicine campus, providing students an opportunity to hear a seminar around ankyloglossia (tongue-tie) and explore the learning potential of the Whakaaro Pai - the anatomy museum.

Camp isn't all hard work though! Students also had a number of opportunities to connect with these scientists in a more relaxed environment. After a long day in the lab, NZIBO campers and a number of current graduate students were treated to a pizza dinner so they could kōrero about their wide range of biological pathways. Later in the week, the whole group got a hint of what travel with the national team would be like in the Philippines at Boracay Garden Restaurant - university staff and researchers, as well as NZIBO campers and staff, all sat down for a shared traditional 'boodle fight' to show gratitude for giving up their holiday time to help promote biology learning.

Over the weekend, the fieldwork began. Tauira travelled to Tāwharanui Regional Park to work with graduate students studying bird behaviours in this predator-free environment. The next day was spent at the Leigh Marine Lab, working on marine biology. The highlight of the day was meant to be a snorkelling outing in Goat Island Marine Reserve, but alas, the Auckland weather had other ideas.

The rest of the programme was run by the incredible NZIBO executive committee members, with support from teachers at Auckland Diocesan School for Girls. The final practical preparations for the upcoming exams saw students dissecting plants, bivalves, and arthropods and building their microscopy skills.

After eight days of practical learning, campers were ready for the team selection practical exam - a three hour endeavour designed to highlight the skills they'd be building during camp. This, along with an additional three hour long theory exam, their mahi during the tutorial programme, and the ability of the students to represent Aotearoa on the world stage at a challenging international competition, formed the basis for the selection of the 2025 New Zealand IBO team.

L to R: Sophie Main , Jamie Cartwright Jessica Wu. Oren Dabbach

In late July, Jamie Cartwright (Glendowie College), Jess Wu (St. Cuthbert's College), Oren Dabbach (Pinehurst School), and Sophie Main (Glendowie College) will represent New Zealand at the 36th Annual International Biology Olympiad in Quezon City, Philippines. Accompanying them are Dr Angela Sharples, NZIBO Chairperson and principal at Matamata College and Liam Hewson, NZIBO co-Head Tutor and former NZIBO participant himself!

While competing internationally is thrilling, the NZIBO is about more than just bringing home medals. The organisation, driven entirely by passionate volunteers, aims to grow a passion for biological sciences, highlight New Zealand research, and encourage innovation and excellence in the next generation of scientists.
Camp is a highlight of the year, showcasing the thousands of hours put into the programme from committee members, academics, and secondary science educators from around the country.

Also, while the team is preparing for overseas travel, the rest of the committee is gearing up for the next NZIBO cycle! Registration for the 2025/2026 programme opens on June 15th! Interested students should register at https://nzibo.org/registration.

Please note that NZIBO registration closes **Wednesday 6th August,** with the exam taking place on **Wednesday 13th August.**

After registering, the two hour entrance exam will be held online on Wednesday, 20th August at a time that suits the coordinating teacher and students. (If there are scheduling conflicts with this date, please get in touch as we always have a plan B.)

NZIBO is grateful to BEANZ and all of the amazing teachers that support students to participate in our programme each year and furthers our mission to foster interest, participation, and excellence in biology.

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Dire wolf de-extinction - Fact or a stretch of the truth?

By Assoc. Prof. Nic Rawlence and Erica Jar.

Figure 1: Dire wolf skull. Image Source: https://tarpits.org/stories/our-evolving-understanding-dire-wolves

Dire wolves (*Aenocyon dirus*) used to roam across the Americas, from the forests and plains of North America to the savanna of South America. They weren't fans of the cold, and fossils remains have not been found above 42°N, which is where you will find Detroit and Chicago. Neither were they gigantic as depicted in Game of Thrones. Instead, they were about the size of the largest gray wolves (*Canis lupus*), averaging around 40 kilograms and 80 kilograms at the heaviest. No frozen or desiccated skins have been found to confirm the dire wolf coat colour. White seems sensible given that it was the end of the Ice Age, but they probably weren't all white. Big, white, and living in the cold, were features decided by the imaginings of a television production team.

It did have bigger teeth with stronger canine tooth bite force and greater shearing ability than gray wolves though, all the better to eat large herbivores such as mammoths and giant sloths roaming the Americas at the time. Dire wolves became extinct about 13,000 years ago, probably because climate change and/or over hunting by humans caused extinction of its prey.

Roll forward to 2025 and Colossal Biosciences announced that they had de-extincted the dire wolf. Scientists at the biotech company analysed a dire wolf genome reconstructed from ancient DNA fragments extracted from two dire wolf fossils, one a 13,000 year old tooth and the other a 72 000 year old ear bone. The team identified key genetic differences between the species and one of its extant relatives - the gray wolf.

Using genetic engineering, the company introduced 20 changes to 14 genes in the gray wolf genome that were seen in the dire wolf genome, and produced three pups - Romulus and Remus (born in 2024), and Khaleesi (born in 2025). No ancient dire wolf DNA is actually in the pup's genomes. The pups have a white coat and are going to be larger with more powerful shoulders and a wider head than gray wolves. Their teeth and jaws are larger, they have more-muscular legs, and howling and whining vocalizations thought to be characteristic of dire wolves (although how Colossal Biosciences could know this is hard to tell, since noone recorded dire wolf vocalisations).

Having been hand reared, the three pups will live their entire life on a protected reserve. They're not capable of living in the wild, and quite correctly, Colossal Biosciences want to study them for their whole lives to understand how the edited genome may have been modified is unpredictable ways.

The de-extinction claim was swiftly met by a highly critical global commentary on what Colossal Biosciences have done. For example Professor Phil Seddon, Department of Zoology, University of Otago, comments:

"*Wolves and dire wolves, despite the wolf part of their names, are not closely related, having parted ways from a common ancestor some 6 million years ago,.. .. What Colossal has done is to introduce a small number of changes to the genetic material of a gray wolf to produce gray wolf pups with dire wolf features.*"

In short, the dire wolf has not been brought back from extinction. All Colossal Biosciences has done is create a genetically engirneered designer gray wolf.

Figure 2: Photograph of a dire wolf reconstruction on exhibit at the La Brea Tar Pits Museum. Image source: https://tarpits.org/stories/our-evolving-understanding-dire-wolves

To de-extinct an organism, the organism would have to be cloned by transferring an intact nucleus containing a functioning whole genome from a fossilised cell into an enucleated donor egg cell using somatic cell nuclear transfer. But ancient DNA can not be extracted intact from fossilised cells. The fossilisation processes degrades and fragments the DNA molecule and modifies it so that it wouldn't be able to be used to make proteins or undergo DNA replication.

Comparing DNA that can be used for whole organism cloning with ancient DNA is like comparing cookie dough with an old broken cookie at the bottom of the cookie tin. The cookie dough can make cookies whereas the old broken cookie can neither be turned back into cookie dough or put back together like a brand new jigsaw puzzle; there will always be some small crumbs missing.

Gray wolf genomes have around 19,000 genes and are approximately 2 billion 500 million (2 500 000 000) individual bases long. Colossal Biosciences say that the gray wolf and dire wolf are >99% identical - that still leaves millions of differences and all Colossal Biosciences have done is 20 edits in 14 genes, cherry-picking the most obvious phenotypes for dire wolves. To de-extinct the dire wolf, every single difference would have to be introduced - a tall order for any genetic engineer.

Figure 3: A pack of dire wolves (*Aenocyan dirus*) are feeding on their bison kill while a pair of gray wolves (*Canis lupus*) approach in the hopes of scavenging.
Image Credit: Mauricio Antón; https://doi.org/10.1038/S41586-020-03082-x

To have a population of these so-called dire-wolves large enough to avoid inbreeding, there would need to be about 500 individuals, each genetically different. With only three pups, there are only two options to achieve this - a programme of selective breeding where Khaleesi is bred with her brothers and then the offspring are back-crossed with gray wolves to increase genetic diversity in non-dire wolf genes; or making lots and lots more genetically engineered pups with dire wolf phenotypes.

One of the goals of de-extinction is to release the animals back into the wild (rewilding) so that they can re-establish lost ecological interactions. To be able to do that, the animal needs to be able to behave like they would have in the ecosystem they originally existed in. But the ecosystem of the extinct dire wolf can also be said to be extinct. What will they eat? The herbivores dire wolves ate are all extinct. Would it even be sensible to release dire-wolves into the modern American environment?

Wolves are territorial, and the size of their home range depends on the size of their pack, number of pups in the pack, and food availability. Anything from 33km^2 to 6,000km^2. How will rewilded dire wolves learn to mark and hold a territory? They have no dire-wolf parents or wolf-pack to teach them. Any innate behaviours, will be those of a gray wolf. For example, Romulus and Remus already practise stalking prey, and they are wary of humans; an innate behaviour of gray wolves.

A good use for the genetic modification technology developed by Colossal Biosciences is to use it to increase genetic diversity of endangered endemic species. For example, engineering genes in those species most affected by climate change or disease to become more resilient. According to the Center for Biological Diversity, around 30% of Earth's species will be lost by 2050 due to global warming.

The same genetic manipulation technology can be used in to increase genetic variation in species that have undergone human induced genetic bottlenecks, for example the endangered red wolf, of which only around 20 still exist in the wild, or closer to home the endemic and critically endangered pekapeka | long-tailed bat. Genetic bottlenecks are a lack of genetic variation between members of a population which can lead to infertility and a higher than normal rate of inherited birth defects. Using variations in DNA from preserved museum samples of species to guide decisions about genetically engineering increased genetic diversity would be a big step in conservation efforts.

Professor Tammy Steeves of University of Canterbury thinks that even this process would be difficult. She says that using genetic engineering in conservation to recover small, inbred populations would first require identification of the multiple genes associated with reproduction and survival of offspring. If all of the genes could be found, they would need to be edited in a large number of individuals. Then the population containing genetically engineered individuals would need to grow rapidly to avoid losing the gene edits in the generations that follow. That is fine for fast breeding animals like red wolves, but most endangered New Zealand species are slow to mature, fussy breeders, who have low numbers of offspring per breeding season.

Besides which, when you consider endangered species in New Zealand, birds are the organisms that come to mind most readily. The technology is a long way away from being useful for bird conservation. Creating the hard shells for embryonic birds to develop in is a hopeful and distant development.

Which brings up a final point. When did Colossal Biosciences discuss with the First Nation tribes of America their plans? They are quoted as saying that the Mandan, Hidatsa, and Arikara Nation tribes of North Dakota have expressed a desire to have dire wolves live on their lands but was that before or after the pups were born?

In Aotearoa New Zealand, Associate Professor Nic Rawlence has engaged with tangata whenua and states that iwi, hapu, rūnaga and trust partners are all dead set against de-extinction as it is against tikanga.

"*We need to be having these conversations and there needs to be community engagement. We need to have discussions around indigenous intellectual property, bio-prospecting, biopiracy, and what happens if animals are brought back from the dead and they are trademarked by these de-extinction companies?*" says Rawlence.

Given the complexity of the ethics, ecological impact, and cultural implications, companies undertaking this kind of work need to proceed with caution and decide whether what they are doing is worth the unpredictability of the outcomes.

Understand, Know, Do:

Understand:

1. State whether you agree or disagree with the statement "dire wolves have been de-extincted" and using the evidence from the article, provide an explanation for your answer.

Know:

2. Explain why low genetic diversity is an issue for conservation management of species.
3. Explain how genetic engineering can be used to increase genetic diversity in endangered species.

Do:

4. Use information provided in the article, and your own research, to discuss factors that can influence the success of rewilding of organisms into ecosystems that humans have modified.

Glossary

Ancient DNA - Refers to the genetic material recovered from ancient biological samples.

Bases - The basic units of the genetic code. There are four bases - Adenine, Thymine, Cytosine, Guanine. Their order determines the code for a protein.

Back-crossing - A breeding technique where an individual is crossed with one of its parents, or an individual genetically similar to its parent, to create offspring that are more genetically similar to that parent.

Canine tooth - Pointed teeth located on either side of the incisors (front teeth) in both the upper and lower jaws. They are strong teeth, particularly used for biting and play a role in guiding the rest of the teeth into proper alignment when biting.

De-extinction - Bringing members of a species back from extinction.

Ecosystem - A biological community of interacting organisms and their physical environment.

Endemic - Organisms that are only found in one specific location in the world.

Enucleated - A cell that has had the nucleus removed.

Extant - Still in existence, living.

Extinct - A species, family, or other group of animals or plants with no living members; no longer in existence.

Fossil - Any preserved remains, impression, or trace of any once-living thing from a past geological age.

Genes- A sequence of DNA that codes for a protein.

Genetic bottleneck - A sudden and drastic reduction in a population's size, leading to a decrease in its genetic diversity.

Genetic diversity - The total of all variants of genes and genetic characteristics within a species or population.

Genetic engineering - The process of directly altering an organism's DNA to change its characteristics. It involves modifying or inserting genes to achieve desired traits.

Genetic variation - The total of all variants of genes and genetic characteristics within a species or population.

Genome - All of the DNA in a single cell of an organism.

Home range - A undefended geographical area an organism or group of organisms will travel to gain resources.

Inbreeding - The mating of individuals that are closely related by ancestry.

Infertility - The inability to reproduce.

Innate - Present in an individual at birth. Has a genetic component.

Nucleus - Part of the cell that contains the DNA.

Organism - An individual animal, plant, or single-celled life form.

Phenotype - The proteins coded for by genes that result in traits.

Selective breeding - A process where humans choose which plants or animals will reproduce to pass on desirable traits, leading to the development of specific characteristics over time.

Shearing ability - The ability of teeth to cut and slice food.

Somatic cell nuclear transfer - The transfer of the nucleus of a somatic cell into an enucleated egg.

Territory - A small area within the home range that an organism or group of organisms will defend.

Tikanga - Customs and traditional values of Māori.

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Regional Representatives 2025
North Island

Northland	**Rep needed**	
Auckland	Chandar Dewan Heidi Brown Barbara McGowan Phil Henwood Marwan Juma	chandard@tangaroa.school.nz BRW@northcote.school.nz b.mcgowan@ags.school.nz phil.henwood@greenbayhigh.school.nz MJuma@westlakegirls.school.nz
Waikato	Kiryn Curnow Michelle Isbister	kiryncurnow@thameshigh.school.nz michellei@haurakiplains.school.nz
Bay of Plenty	Vicki Wallace	vickia@mmc.school.nz
Central North Island	Meredith Wilson	mwilson@ruapehu.school.nz
Gisborne	**Rep needed**	
Hawkes Bay	Coral Dean-Webb	coral.deanwebb@teaute.school.nz
Taranaki	Sarah Sheely	sarah.sheely@inglewoodhs.school.nz
Manawatu-Wanganui	Penny Daddy Heather Meikle	daddypenny@ngatawa.school.nz hmeikle@inspire.net.nz
Porirua / Hutt Valley	**Rep needed**	
Wellington Central	Jan Szydlowski	jan.szydlowski@onslow.school.nz
Kapiti Coast / Horowhenua	Jeanette Summers	jeanette.summers@kc.school.nz
Wairarapa	Emma Stoddard	stoddarte@chanelcollege.school.nz

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Regional Representatives 2025
South Island

Nelson/ Marlborough	Gerd Banke	gerd.banke@nayland.school.nz
West Coast	Ange Fox	fox@swas.ac.nz
Canterbury North and Christchurch	Helen Katandawa Libby Caygill	katandawah@ellesmere.school.nz cae@cashmere.school.nz
Canterbury West & South	Jessica Smith	smithj@opihicollege.school.nz
Eastern Otago & Urban Dunedin	Yvonne Caulfield Jean Allibone	ymc@lphs.school.nz jallibone@kavanagh.school.nz
Central Otago	Rose Kidd	rkidd@wakatipu.school.nz
Southland	Urte Bierlin	Urte.bierlin@southlandgirls.school.nz

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For more information contact ***biologynz@gmail.com***