GENETICS ON THE GO: AN ACTIVITY-BASED MODEL FOR LEARNING ABOUT GENETICS

Photo by Warren Umoh on Unsplash

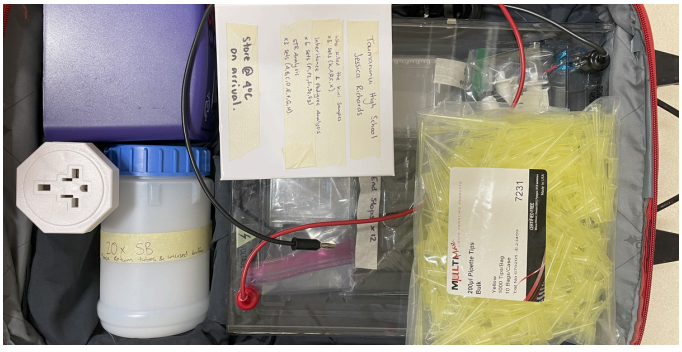
Genetics on the Go, headed by Dr. Emma Wade, is an initiative that offers free resources making genetics relevant and accessible to teachers and students around New Zealand. ***NZASE Science Communicator Heather Goodey*** *looks at what is on offer from the University of Otago's Genetics Department and how genetics can be contextualised into a range of learning experiences.*

"Genetics is in every living thing," explains Dr. Emma Wade, a research fellow at the University of Otago, who co-leads the Genetics on the Go project. "If you have an interest in the natural world, you will want to understand something about genetics. I really think biotechnology - technology that uses genetically modified organisms and single-cell eukaryotes - is going to be a massive thing in the 21st century. Cleaning up waste, curing diseases, making proteins for food, all of this is likely to be achieved by genetic modification of small organisms. It's going to be a massive industry in biotechnology."

Emma hopes the Genetics on the Go project will help teachers and students explore science careers beyond medicine and engineering. She also emphasises the need for math and computing abilities in life sciences. "Most studies in life sciences are becoming huge data sets that you need to 'wrangle' with a math mind," she observes.

GENETICS ON THE GO PROJECT

For several years, the Genetics on the Go project at the University of Otago has been supporting science education, providing schools with curriculum-relevant content and hands-on kits. These resources aim to align with current genetic research and enrich learning experiences while catering to the diverse needs of educators and students alike. They are free to schools and can be booked online. The Genetics Department also offers opportunities for schools to interact with a geneticist through the outreach programme. Geneticists can meet with the class, answer questions, and tell them more about their work.



ACTIVITY KITS

Genetics on the Go offers kits designed to be fully comprehensive which complement the New Zealand curriculum. From forensic

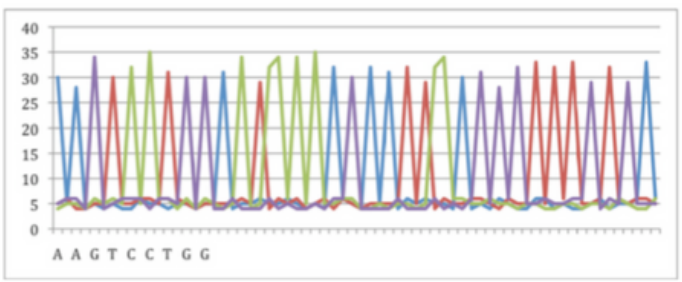
investigations to exploring rare diseases, these kits cover a spectrum of genetic concepts, providing students with real-world applications and ethical dilemmas to ponder. All kits have free online resources that allow classroom learning with an option to order the electrophoresis practical to further extend the learning. Schools can order these kits online which are posted in a suitcase to the school free of charge, for use over a limited time.

Kit #1: Who Killed the Kiwi?

This forensic investigation kit engages students from year 7 to year 11 in a captivating "whodunit" scenario, as they unravel the mysteries surrounding the demise of a kiwi. There is sample DNA from the kiwi and three 'suspects', and an authentic report from a Department of Conservation veterinarian on the kiwi's injuries as well as footprints and hair samples to analyse.

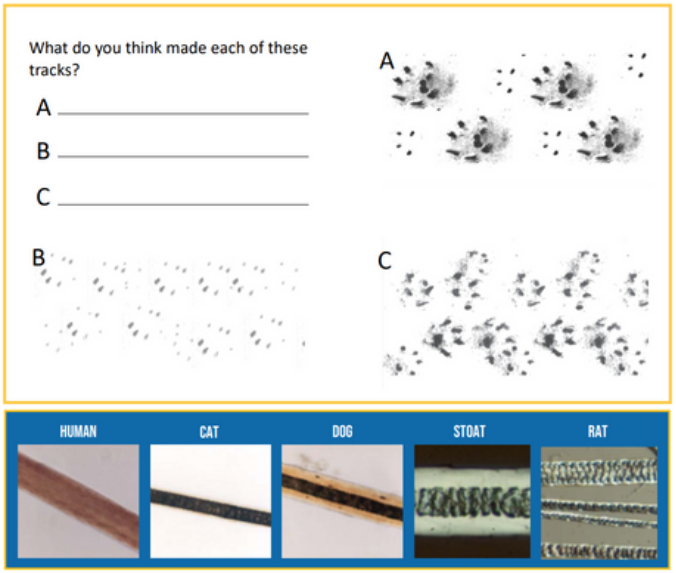
This activity helps students *interpret data, use evidence, and make observations and inferences*. Students look at DNA sequences as a *pattern-seeking* exercise and learn that DNA is made from a combination of 4 nucleotides (Adenosine, Cytosine, Guanine, Thymine).

The nucleotides are colour-coded, making the concept easily accessible across the year levels. They learn that it is the order of the nucleotides that makes a DNA sample from one suspect unique from the other.



DNA sequence task for Who killed the Kiwi. Students use the colour code to sequence the DNA from the attacker and compare it to suspect DNA.

Footprints and hair samples (magnified and differences highlighted) are all included to help students solve the mystery and reach an appropriate conclusion using evidence.



Images from the Genetics on the Go 'Who Killed the Kiwi' kit resources, showing footprint and hair samples as forensic evidence

The activity kit can also be used to extend the learning and *engagement in science ideas*. For instance, the Who Killed the Kiwi kit not only engages students in a fun mystery-solving activity to learn more about DNA and how they are used in forensic analysis, but it can also help lead to discussions on the subject of ecology and the ethical issues in predator control and pet ownership.

The project also provides additional resources which can be ordered for free along with the kits to extend the learning. For instance, with the DNA extraction kits, students can also extract DNA from fruits to visually observe DNA from a living organism. This can be run in conjunction with this unit or separately. There is also an option for using electrophoresis to confirm the killer. The practical kit comes with everything needed to run an electrophoresis assay with clear instructions on

how to set it up. Students can then compare the results of the accused's DNA, confirming or disproving their inference, and offering an opportunity to *critique the evidence*.

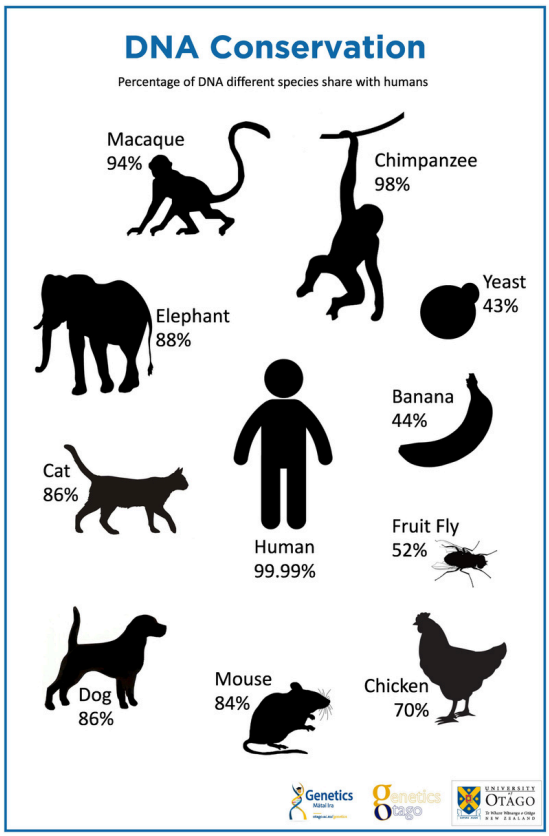
Everything needed for the lesson is available for free on Genetics on the Go.

Relevant links:

Who Killed the Kiwi Resource

Poster - guide to animal tracks

Note: Kits for DNA extraction can only be provided to Dunedin schools. But the resources required are easily available from the super-market and hardware stores.



The powerful idea is that all DNA of all living things is made up of the same stuff, just in a different sequence.

Kit #2: The Claire kit

This rare diseases kit offers senior students a glimpse into genetic diagnostics. The kit has been created with the help of Sally Aldrich, who lost her daughter Claire to a rare genetic disease. Sally's own experience of learning about genetics through her baby's condition inspired the creation of the Claire kits. With the help of this activity kit, students navigate through the complexities of genetic variation, which helps them assess the vital role of genetics in understanding and addressing rare diseases. Support materials, including a 'how to' video, are provided to the teacher and class about the significance of diagnostics while a video created by the family sets the scene for the students about this poignant, real-life context investigation.

Students complete a computer-based task emulating the actual diagnosing process. The task is based on an Excel spreadsheet which has a representation of every single variant in the coding gene for this family. The students experience how a diagnostic scientist works, sifting through genetic variants that we all have, while learning to appreciate that we all have a substantial amount of genetic variation that is benign.

Students are further presented with other clinical scenarios and have the opportunity to find a diagnosis based on different types of changes to DNA. They become aware that there are different kinds of variation DNA that we can find using these data sets, but also that not every type of variation can be found, nor is the definitive cause of the disease always found. It is really important to acknowledge the limitations of this type of analysis. The kit also opens discussions around the ethics of whole genome sequencing, whether being aware of all of our own genetic variation is a good thing, and the cultural sensitivities surrounding one's DNA in New Zealand.

Everything that comes in the kit allows up to 6 groups to complete the electrophoresis once they have identified the candidate DNA of interest in the informatic task. Instructions for teachers and lab technicians are included. Students can make up the gels for the electrophoresis if time permits.

The students then confirm the candidate gene through electrophoresis. The particles of DNA are negatively charged and put in an

electric field where they are attracted to the positive side. The gel acts like a sieve so smaller particles move further. In the kits, a mixture of special dyes is used in place of DNA to get the expected results. With this kit, the family hopes to inspire students to consider genetics as a career and recognise how important it can be, even though it may not always provide an answer.

GENETICS ON THE GO IN THE CLASSROOM

At Otago Girls High School the activity kits from Genetics on the Go are a highlight of their genetics topic. The teacher sets the stage for a "murder" scene and students work in small groups of 3-4 to solve the mystery. Dr. Zoe Williams, a science teacher at the school says they can run a basic version at the end of the unit in a single 50-minute lesson but some teachers at their school use 2 lessons to go into more depth. She recommends that the gels be made up by the technician or teacher for Y10 and that if they haven't run a gel before (electrophoresis) they try it before the class does it. She says, "I highly recommend this activity. It's a lot easier than you think. This is when the students see how genetics is relevant to real life and a real career." She added that her students enjoyed the activity-based learning echoing "This was our favourite lesson all year" and "Can we do this again next week?"

The instructions for setting up the kits and electrophoresis are included with the kits. Genetics on the Go is keen to provide professional learning to all teachers. "If we can find a school that is willing to host a practical session for other local schools, we are keen to get someone out there to run it. Especially the rural areas in which teachers might be more isolated," says Emma.

To view all the resources available from Genetics on the Go and to make bookings, check https://blogs.otago.ac.nz/go/genetics-on-the-go/.

For more information, you can email Dr Emma Wade (emma.wade@otago.ac.nz) or Dr Rebecca Oliver (Rebecca.oliver@otago.ac.nz)

USEFUL TEACHER RESOURCES

DNA and genetics

- DNA sequencing explained
- Basic genetic resources and videos

Who Killed the Kiwi extension

- Predator free 2050 context
- Tracking Tunnels

DNA Extraction

Video and information on extracting DNA from fruit: use kiwifruit, banana or strawberries (fresh or frozen) and use non-iodized salt