Achievement standard AS92022 (5 credits) external assessment

This unit was designed to meet the requirements for the CB1.3 standard based on information and clarifications from various sources, including resources and webinars' notes from NZASE, BEANZ, Ministry of Education, gathered between November 2023 to September 2024. Links to existing online resources are suggested to provide a variety of options for student activities. The unit also includes some important concepts that will benefit students advancing to senior biology but are not assessed for the purpose of CB1.3. Therefore, please be aware that the proposed unit of plan includes some content that extends beyond the scope of CB1.3. Feel free to select the content that is relevant to your local curriculum and meets your students' needs.

Note that additional updates are likely to become available before the start of 2025 and teachers must consider these updates prior to delivering the proposed unit. The Scipad workbook pages listed here are those taken from the Scipad workbook, second edition.

Overview:

Students will be able to:

- Review the different characteristics of an organism
- Understand how scientists classify organisms
- Learn and/or review the levels of organisation in an ecosystem and the relationships within it
- Discuss how and why organisms adapt to their environment
- Understand the structure and function of DNA
- Explain how genetic variation arises in individuals or populations
- Discuss the importance of genetic variation for the survival of populations in response to environmental changes
- Understand how genetic variation can be used to trace inheritable characteristics
- Predict the inherited phenotype/genotype of offspring inherited from their parents
- Analyse DNA sequences to identify the genetic source of a trait and/or compare the relatedness of individuals within and across species
- Understand that genes or traits can be tracked for multiple purposes, such as tracing heredity within a family, across generations, between species and over extended periods, as well as potential health outcomes

Acknowledgements: the following mentioned resources were developed in collaboration with:

"Analysing DNA to identify who killed baby Tara iti" Dr Thierry Lints, Dr Polona Le Quesne Stabej, Dr Tamsin Robb and Prof Cris Print (University of Auckland), "From DNA sequence to phylogenetic tree, using the GULO gene for vitamin C synthesis" Dr Nicholas Matzke (University of Auckland), "Exploring evolution, unveiling the history of flightless birds through phylogenetic trees" Carla Finn (Victoria University of Wellington), "Analysing DNA to identify seabirds in fisheries bycatch" Imogen Foote (Victoria University of Wellington).

This resource was developed by Dr Wilda Laux, Department of Molecular Medicine and Pathology, University of Auckland.

Email: wilda.laux@auckland.ac.nz

Lesson	Lesson title	Learning outcomes	Strategies	Suggested Resources
1	**Introduction to living things**	Introduction to genetics Review the different characteristics of an organism	Motivational video: while the video runs, comment/pause on areas of Biology and keywords used in this unit throughout the video and focus on the main ideas/keywords related to genetics/genomics Review 'atom to organism' in the context of a chosen species that you will use for later lessons, e.g., Tara iti (atom, molecule, cell, tissue, organ, organ system, organism = Tara iti) Review MRSGREN, the 7 characteristics of living things **(reiterate that respiration is not breathing)**	https://www.youtube.com/watch?v=B_PQ8qYtUL0&t=75s (introduction to genetics) Ecology.pdf (slide 4)
2	**Suggestion: Looking at animal vs plant cells**	Differentiate between animal and plant cells	PRACTICAL session: microscopy with onion cell vs animal slides	Microscopes, onions, slides, coverslips, iodine, water, forceps, prepared animal tissue slides https://hi-static.z-dn.net/files/d5d/69a5d971d7970df3681c933cd0df845c.doc
3-4	**Dichotomous keys and taxonomy**	Understand how scientists classify organisms	Make simple dichotomous keys to classify some objects and organisms: Initially make a key using items in a pencil case then move on to your chosen organism used in lesson 1.	Dichotomous keys.pdf Other resources are available on the internet: e.g., https://www.madriverschools.org/cms/lib/OH01914812/Centricity/Domain/544/createyourowndichotomouskeyactivity.docx https://mrfaught.weebly.com/uploads/2/3/1/1/23113288/lab-building-a-dichotomous-key-take-home.pdf

			Make a key to identify shrimp, Tara iti, dog, cat, pukeko (students may use information from several websites of their choices to read about characteristics- functional, behavioural, physical,…) Describe taxonomy as an example of classification (kingdom, phylum, class, order, family, genus, species). Apply to Tara iti	Taxonomy.pdf
5	**From organism to ecosystem**	Understand the levels of organisation in an ecosystem	Watch a video on Tara iti (Fairy tern) OR read about Tara iti Teach about the levels of organisation in an ecosystem: species, population, niche, habitat, community, ecosystem Apply the above terms to Tara iti by making a poster/presentation or short video with pictures and naming the levels of organisation within Tara iti's ecosystem. (Special focus on niche)	https://www.nzbirdsonline.org.nz/species/fairy-tern (reading) https://www.youtube.com/watch?v=e-fZwprjBkw (4.45') Ecology.pdf
6-7	**Relationships within an ecosystem**	Discuss the relationships between organisms within an ecosystem to understand the threats to Tara iti	Different types of relationships can exist within an ecosystem (intra vs interspecific relationships) Focus on Interspecific relationships (competition, prey-predator, commensalism, parasitism, mutualism) Make a food chain/web mobile (optional)	https://www.youtube.com/watch?v=e-fZwprjBkw (4.52') https://www.nzgeo.com/stories/fallen-from-grace/ (read about the impacts of predators from 'Drew and I…) Relationships Ecosystem.pdf Make food chain/web (craft). https://www.startwithabook.org/sites/default/files/Food-Web.pdf
8	**Adaptations**	Explain the behavioural,	Make a digital presentation of how Tara iti has adapted to meet its niche. Cover	https://www.nzbirdsonline.org.nz/species/fairy-tern

		physical and physiological adaptations of your chosen organism, e.g., Tara iti and their significance for survival	structural, physiological and behavioural adaptations	CB1.3 Scipad Big ideas Level 1 Genetic variation p 52-3
9-11	**DNA the genetic material**	Review basic structure of DNA and how it carries the genetic information of an individual Understand the central dogma of Biology	Make a paper model of a DNA molecule Explain the terms DNA, gene, alleles, chromosome, trait Mention that different species have different numbers of chromosomes per cell. Draw a nucleotide and arrange several nucleotides to make a string of DNA Describe the base pairing rule Teach the central dogma: in theory, genetic information flows in one direction from DNA, RNA to protein (mention we now know it's not totally true with RT- reverse transcriptase) Make secret messages using life's code	CB1.3 Scipad Big ideas Level 1 Genetic variation p 7-10, 12 DNA and more.pdf slides 1-5 https://www.youtube.com/watch?v=9kOGOY7vthk (2.51') CB1.3 Scipad Big ideas Level 1 Genetic variation p 11 DNA and more.pdf slides 6-10 https://www.genomics-aotearoa.org.nz/sites/default/files/2024-03/Unlocking%20Lifes%20Code%20%28Student%20Version%29.pdf (Thierry Lints, Unlocking Life's code, p 8 -make secret messages using life's code)
12-13	**The nature of genetic variation**	Define variation	Cover the concept of variation including inherited vs acquired variations	CB1.3 Scipad Big ideas Level 1 Genetic variation p 15-17 or teacher's worksheet of human's variations (tongue rollers vs attached earlobes vs…)

			Practical: Investigate continuous and discontinuous variations in the classroom (tally, histogram)- opportunity to use cultural context, e.g., Pasifika students may want to use their family members to tally physical characteristics	https://sciencesauceonline.com/wp-content/uploads/18.-Variation.pdf (continuous variations p 4-5, discontinuous variations p6-7)
14-16	**The source of genetic variation at the individual level**	Define sexual reproduction, asexual reproduction, fertilisation, mutation, meiosis, mitosis	Recap Sexual vs Asexual reproduction and how variation occurs through sexual reproduction (meiosis, fertilisation) Understand the creation of new alleles by mutations. Unpack the different types of mutations (using message codes) and their effects How do mutations affect phenotype? – explain that change in DNA (mutation) may affect protein level (review codon table and remind students that not all mutations change the protein expression. A single amino acid may be coded for by more than one codon, we say the code is degenerate)	CB1.3 Scipad Big ideas Level 1 Genetic variation p 20-21, 13, 14, 18-19, 25 CB1.3 Scipad Big ideas Level 1 Genetic variation p 22-24 https://www.genomics-aotearoa.org.nz/sites/default/files/2024-03/Unlocking%20Lifes%20Code%20%28Student%20Version%29.pdf (Thierry Lints, Unlocking Life's code, p 7) Other good resources to practise mutations: https://www.nclark.net/Codon_analogy_key.pdf https://www.studocu.com/row/document/city-university/actuarial-science/kami-export-dna-mutations-worksheet/13871806
17-18	**Genbank database**	Understand that normal or variant genes and genomes are stored in databases accessible to all	Learn to navigate Genbank functions.	DNA and more.pdf slides 11-19 CB1.3 Scipad Big ideas Level 1 Genetic variation p 82 https://www.youtube.com/watch?v=QLcmEqBayr0 https://www.ncbi.nlm.nih.gov/genbank/ https://genome.ucsc.edu/ https://www.ncbi.nlm.nih.gov/datasets/genome/GCF_000001405.40/ (human genome)
19-21	**How genetic variation arises and its**	Discuss how we can predict	Become familiar with the meaning of genotype, phenotype, gene pool, allele,	CB1.3 Scipad Big ideas Level 1 Genetic variation p31-9

	effects on biological systems	the inheritance of changes	allele frequency, genome, dominant vs recessive alleles, pure breeding. Can use cultural context here, e.g., extend from lessons 12-13 by using the characteristics and match them to the terminology. Punnett squares = prediction of inheritance (do not show actual offspring). Cultural link: may use a fictional scenario with students' input, e.g., predicting the pheno/genotype of a future sibling. Students may take one characteristic of Tara iti, assume monogenic inheritance and design a fictional Punnett square to show inheritance of one characteristic of Tara iti	
22-23	**The importance of genetic variation for the survival of populations in response to environmental changes**	Understand how natural selection helps in the inheritance of variation for the survival of a species	Peppered moth simulation game – natural selection Types of selection (stabilising, directional, disruptive) Link adaptations of Tara iti with survival of the species discussing how the most favourable alleles have been selected through time to allow Tara iti to survive (students could produce a narrative- use for PaCT /literacy assessment).	https://drive.google.com/file/d/1VjeZqM2dB15Qb4FAKrju31BFeDKz7FR4/view CB1.3 Scipad Big ideas Level 1 Genetic variation p 50-1, 54-5
24-26	**Other sources of variation affecting populations**	Understand how migration (gene flow) and population dynamics (genetic drift, non-random	Review the concepts of allele frequency and gene pool. Migration (gene flow) increases variation in the resident population as the migrants will bring new alleles that did not exist before in the resident population. This may be advantageous to the resident population in	Migration and popdynamics.pdf CB1.3 Scipad Big ideas Level 1 Genetic variation p 49, 56-9, 62

		mating) create variation in populations	times of changing environments if the new alleles are favourable and enhance ability to adapt and survive to changing environments. Population dynamics: change in size of a population. In smaller populations, the effects of genetic drift have stronger effect, causing loss of genetic diversity. Then due to smaller number of individuals, non-random mating (Organisms can be quite choosy about who they mate with) further decreases variation. When a new population is established by a small number of individuals (a founding event), the genetic variation of the new population is limited to the alleles present in the founders. This can lead to reduced genetic diversity compared to the source population.	NB: Tara iti as an example for bottleneck was used in the 91157 paper (2023) question 3 https://www.nzqa.govt.nz/nqfdocs/ncea-resource/schedules/2023/91157-ass-2023.pdf
27-29	**Genetic variation can be used to trace inheritable characteristics** **Evaluate findings when genetic variation has been identified and tracked for the purpose of identifying**	How can we track genetic changes during short vs long periods of time?	Discuss the similarities and differences of Punnett squares and pedigree charts before teaching pedigree charts Pedigree charts	Punnett squares: https://www.genomics-aotearoa.org.nz/sites/default/files/2024-03/Unlocking%20Lifes%20Code%20%28Student%20Version%29.pdf (Thierry Lints- Unlocking Life's code p45) Pedigrees: CB1.3 Scipad Big ideas Level 1 Genetic variation p 40-43, p 45-47

	genetic relationships			
30-31	**Use the information of DNA sequences to identify the genetic source of a trait and compare the relatedness of individuals within and across species**	Understand that gene tracking can help to solve a crime	Explanation of gene sequencing methods (DNA markers) Use the Blast function to solve a crime scene Opportunity to extend this lesson to introduce and cover validity of information in preparation to Level 2-3 standards (Goal: develop an action plan to save Tara iti. Students work on a personal action plan and complete research for valid information.)	CB1.3 Scipad Big ideas Level 1 Genetic variation p 65-8 WS_TaraitiBlast.pdf Seabird.BLAST.pdf and SeabirdBLAST_answers.pdf
32-33	**Use the information of DNA sequences to identify the genetic source of a trait and compare the relatedness of individuals within and across species**	Identify the relatedness of species though the tracking of variation for a particular gene	Compare sequences to make a phylogenetic tree, e.g., “Exploring evolution, unveiling the history of flightless birds through phylogenetic trees”, “From DNA sequence to phylogenetic tree, using the GULO gene for vitamin C synthesis”	Scipad CB 1.3 p 72-5, 78-9, WS_cladogram.pdf RatitePhylo_student.pdf AND RatitePhylo_teacher.pdf AND ratite_sequences.fasta.txt GULO_Phylo_student_instructions_final.pdf and GULO_Phylo_teacher_instructions_final.pdf GULOMatrix.doc GULO_exon12_unaligned_PRINT_TO_A3.pdf GULO_exon12_aligned_TREE_PRINT_TO_A4.pdf GULO_exon12_alignedPRINT_TO_A4.pdf
34-35	**The use of genomics for several purposes**	Understand that tracking of genes/traits and knowledge of genomes	How can eDNA monitoring be used to provide information on the identity of organisms living in a specific area?	https://www.genomicsinmedicine.auckland.ac.nz/genomics-for-schools/ (Whose DNA is in our awa?) CB1.3 Scipad Big ideas Level 1 Genetic variation p 76-7 https://www.rnz.co.nz/programmes/what-if-genomics-in-aotearoa/story/2018952815/what-if-we-sequenced-every-

		can be used for multiple purposes		waterway-in-new-zealand (What if..we sequenced every waterway in New Zealand?)
			Using DNA to trace origins of human race/whakapapa	CB1.3 Scipad Big ideas Level 1 Genetic variation p 80-1
			The forensic use of DNA profiling	CB1.3 Scipad Big ideas Level 1 Genetic variation p 69
			DNA profiling and paternity	CB1.3 Scipad Big ideas Level 1 Genetic variation p 70-1
			Conservaton genomics: Saving the kākāpō from extinction	https://www.genomics-aotearoa.org.nz/news-and-events/saving-species-extinction and see video in https://www.rnz.co.nz/programmes/what-if-genomics-in-aotearoa/story/2018952806/what-if-genomics-could-help-save-an-endangered-species
			Genetic modified organisms: Genomics could safeguard our food supply (target specific genes to manipulate apples...to resist drought, to control flowering..)	https://www.rnz.co.nz/programmes/what-if-genomics-in-aotearoa/story/2018957870/what-if-genomics-could-safeguard-our-food-supply
			Genetic testing to beat cancer	https://www.rnz.co.nz/programmes/what-if-genomics-in-aotearoa/story/2018952807/what-if-we-can-use-genetic-testing-to-beat-cancer
			Genomics and Covid (tracking the Covid strains across the NZ population)	https://www.rnz.co.nz/programmes/what-if-genomics-in-aotearoa/story/2018952813/what-if-we-sequenced-every-infectious-disease-in-nz
			Gene therapy	https://www.childrenshospital.org/programs/gene-therapy-program https://www.gov.uk/government/news/mhra-authorises-world-first-gene-therapy-that-aims-to-cure-sickle-cell-disease-and-transfusion-dependent-thalassemia