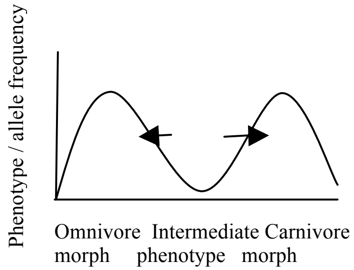
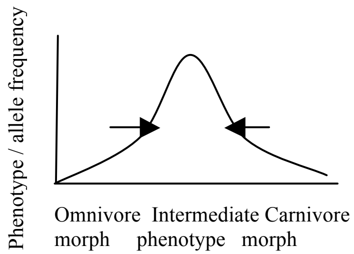
Assessment Schedule – 2016

Biology: Demonstrate understanding of evolutionary processes leading to speciation (91605)

Assessment Criteria

	Evidence	Achievement	Merit	Excellence
ONE	A well labelled diagram is acceptable evidence of understanding. Disruptive selection occurs in a population when two or more phenotypes have higher fitness than intermediate phenotypes. E.g. the omnivore form and carnivore form populations in high density, low food abundance ponds. Stabilising selection occurs in a population when intermediate phenotypes have the highest fitness, rather than those at one or both extremes. E.g. the intermediate phenotype population in low density, high food abundance ponds. Genetic diversity is the variation of heritable traits in a population. High population density will reduce survivorship and reproductive success due to intraspecific competition for food resources reducing food availability. Extreme phenotypes may have exclusive access to novel food resources, and therefore may have increased survivorship and reproductive success (as an adult), which is favoured by selection. Disruptive selection increases diversity by favoring extreme phenotypes, which may then be further selected for, based on diet-related morphological advantage. This may lead to niche expansion. In contrast, stabilising selection reduces diversity by favouring intermediate phenotypes and selecting against extreme phenotypes. Disruptive selection promotes further divergence between the carnivore morph and omnivore morph by favouring characteristics / traits that enhance each morph's ability to use its particular resource type. Selection improves their ability to survive by favouring morph-specific traits that render each morph more effective at occupying its particular niche. Selection should then favour those alleles	• Describes genetic diversity. Genetic diversity is the variation of heritable traits in a population. • Describes disruptive selection.  Selection of ominivore and carnivore phnenotypes / alleles • Describes example of disruptive selection from resource material, AND / OR describes example of stabilising selection from resource material. • Describes stabilising selection.  • Describes selection pressure that promotes disruptive selection as	• Explains strong intraspecific competition or strong competition for food resources is an important driver of disruptive selection, e.g. the omnivore and carnivore morphs have access to alternative food sources and escape competition with the intermediate phenotype, thereby promoting disruptive selection OR competition for food will disproportionally impact the intermediate phenotype, thereby promoting disruptive selection. • Explains weak intraspecific competition OR weak competition for food resources is an important driver for stabilising selection. • Explains that disruptive selection promotes diversity AND / OR stabilising selection reduces diversity.	• Compares and contrasts disruptive and stabilising selection: E.g.: Disruptive selection increases diversity by favouring extreme phenotypes, which may then be further selected for. In contrast, stabilising selection reduces diversity by favouring intermediate phenotypes and selecting against extreme phenotypes. • Discusses a plausible speciation mechanism incorporating information from the resource (3 steps linked). E.g.: Selection acting differentially on carnivore morph population and omnivore morph population / gene flow disruption / reproductive isolation / RIM's develop.

	or gene combinations that best support the expression of these alleles in the population. Such adaptations can contribute to the accumulation of genetic differences between populations which, in turn, promotes further divergence. Matings between such populations should produce offspring that are not as well adapted to the different niches, which means they are less fit. E.g. matings between adults derived from the carnivore form and omnivore form are likely to produce offspring that are intermediate in phenotype, and therefore are out-competed by both parent populations, due to being poorly adapted to either niche. Consequently, selection should favour assortative mating, and thereby complete the speciation process by promoting the evolution of reproductive isolation.	strong (intraspecific) competition, OR strong competition for food resources. • Describes selection pressure that promotes stabilising selection as weak (intraspecific) competition OR weak competition for food resources.		

Not Achieved			**Achievement**		**Merit**		**Excellence**	
NØ = no response or no relevant evidence.	N1 = 1 point, from Achievement.	N2 = 2 points from Achievement.	A3 = 3 points from achievement	A4 = 4 points from achievement.	M5 = 1 point from Merit.	M6 = 2 points from Merit.	E7 = 1 point from Excellence.	E8 = 2 points from Excellence.

	Evidence	Achievement	Merit	Excellence
TWO	A mutation is a permanent alteration in the nucleotide base sequence of DNA. Variation of alleles / phenotypes exists in populations. Individuals with better adapted phenotypes will have increased fitness compared to less suited individuals, so are more likely to reproduce and pass on their favourable alleles. Favourable alleles will increase in frequency within the population over time. Increased spine length increases the probability of escape from puncturing / biting predators such as larger fish after capture (these failures are largely due to the erect dorsal and pelvic spines during predation. This triangle of erect spines pierces the mouthparts of predators and increases its chances of escape) whereas grappling / grasping invertebrate predators may use the spines to restrain captured juvenile stickleback as longer spines are easier / more accessible to grasp. Higher plate numbers can obstruct swallowing by larger fish which leads to greater manipulation time and more escape opportunities. Low plate number is adaptive in freshwater habitats where shelter is available because acceleration increases with low plate number due to lower mass and increased speed, meaning increased likelihood of the stickleback reaching shelter during evasive responses during predator pursuit, which increases the probability of survival. A mutation causes a new allele to form, and increases the allelic diversity. Mutations provide the totally new alleles upon which the mechanisms of natural selection can act. If the mutation increases fitness (survival / reproduction), the individuals with this adaptive phenotype are more likely to reproduce and pass on the favourable allele. The favourable allele will increase in frequency within the population over time.	• Describes mutation. A mutation is a (permanent) alteration in the nucleotide base sequence of DNA. • Describes natural selection. • Describes a selective biotic factor on plate number, e.g. higher plate numbers can obstruct swallowing by larger fish / lower plate numbers increase acceleration, so that predator avoidance more likely. • Describes a selective biotic factor on spine length, e.g. increased spine length increases the probability of escape from biting predators such as larger fish / spines do not provide defence against invertebrate predators. • Describes a selective abiotic factor, e.g. more shelter in freshwater means weaker selection for post-capture adaptations / less shelter in marine habitat means stronger selection for post-capture adaptation.	• Explains natural selection. • Explains a selective biotic factor on plate number, e.g. higher plate numbers can obstruct swallowing by larger fish, which leads to greater handling time and more escape opportunities. • Explains a selective biotic factor on spine length, e.g. increased spine length increases the probability of escape from biting predators such as larger fish due to increased diameter. • Explains a selective abiotic factor, e.g. more shelter in freshwater means weaker selection for post-capture adaptations. Low plate number increases avoidance success due to increased acceleration. • Explains the concept of a mutation being adaptive in one habitat and selected for yet a disadvantage in another habitat and selected against.	• Links roles of mutation AND natural selection. E.g. A mutation causes a new allele to form and increases the allelic diversity. Mutations provide the "raw material" upon which the mechanisms of natural selection can act. If the mutation increases fitness, the individuals with this adaptive phenotype are more likely to reproduce and pass on the favourable allele. The favourable allele will increase in frequency within the population over time. • Discusses how a biotic AND abiotic factor act as selective pressures in marine AND freshwater habitats. E.g.: Mutation in the *Eda* gene caused variation in plate number and a mutation in the *Pix1* gene caused variation in spine length. The selection pressures that the marine population were subject to of low amounts of shelter and predatory fish, meant higher plate number and long spine length were adaptive, whereas the selection pressures the freshwater population were subject to of high amounts of shelter, and grasping insects meant low plate number and short spine length were adaptive.

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	Evidence	Achievement	Merit	Excellence
THREE	Evolution pattern is adaptive radiation, which is the diversification of related species from a single ancestor, to exploit unoccupied niches. When climate changes occurred, the ancestral species radiated out to occupy the new niches formed. The ancestor of *Cyanoramphus* dispersed from New Caledonia to Aotearoa (possibly via Norfolk Island) in the last ~550 000 years, and then colonised offshore and subantarctic islands. *Cyanoramphus* colonised the Chatham Islands 440 000 years b. p. giving rise to Forbes' kakariki. A later independent colonisation by the New Zealand red-crowned kakariki 60 000 b. p. gave rise to the Chatham Island red-crowned kakariki. *Cyanoramphus* colonised the Antipodes Islands 280 000 years b. p. The sympatric Reischek's kakariki arose from a much later second colonisation of the Antipodes Island about 30 000 years b. p. The Norfolk Island *Cyanoramphus* lineage, *C. cooki*, arose from established *Cyanoramphus* populations on the Aotearoa mainland 195 000 years b. p. by 'back colonisation'. Adaptive radiation was stimulated by fluctuating glacial and interglacial episodes during the Pleistocene, which may have isolated populations into multiple allopatric areas (refugia), subject to different selection pressures. E.g. Northern areas would have experienced less severe glacial episodes, while the South would be too cold for trees and had tussock instead, which reflects the current habitat type of *C.unicolor* on the subantarctic Antipodes Islands. Therefore, proto-*C.unicolor* may have dispersed to the Antipodes Islands towards the end of a warmer interglacial period. The yellow, red and orange-fronted kakariki speciated allopatrically due to glacial action, causing isolated pockets of suitable habitat on mainland Aotearoa but now occur sympatrically which may be the result of re-establishment of large tracts of forest during the last 10 000 years.	• Describes adaptive radiation / divergent evolution. • Punctuated equilibrium. • Describes stimulus for adaptive radiation. • Describes allopatric speciation using example from resource material. • Describes New Caledonia as origin. • Describes timing of initial colonisation. • Describes sympatric species using example from resource material.	• Explains adaptive radiation or allopatric speciation with reference to glaciation. • Explains Aotearoa mainland colonised first, offshore islands subsequently. • Explains different selection pressures in different areas. • Explains Southern areas resembles current habitat of Antipodes Islands. • Explains timing of colonisation events from phylogenetic tree. • Explains sympatric species using example from resource material. • Explains punctuated equilibrium with evidence from phylogenetic tree to glacial periods.	Discusses how biological **AND / OR** geographical events contributed to adaptive radiation / allopatric speciation by integrating evidence from the resource information. E.g. • Adaptive radiation was stimulated by glacial and interglacial periods, which may have isolated populations into different areas subject to different selection pressures. E.g. Northern areas would have experienced less severe glacial episodes, while the south would be too cold for trees, and had tussock instead. • The periodic linking of the main islands of Aotearoa to each other and to near-shore islands, and the persistent separation of offshore islands further away from the mainland led to allopatric speciation due to different selection pressures in each location. • The yellow, red and orange-fronted kakariki speciated allopatrically due to glacial action causing isolated pockets of suitable habitat with different selection pressures but now occur as sympatric species.

	Further evidence for radiation in allopatric refugia are that all non-subantarctic *Cyanoramphus* species inhabit forest. Glaciation in the South meant *Nothofagus* forest was not established until about 10 000 b. p. meaning the yellow-crowned, red-crowned and orange-fronted kakariki are recent radiations. The periodic linking of the main islands of Aotearoa to each other and to near-shore islands, and the persistent separation of offshore islands further away from the mainland led to allopatric speciation due to different selection pressures in each location.			

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Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 6	7 – 13	14 – 18	19 – 24