Assessment Schedule – 2022

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

Evidence Statement

Question One

Evidence	Achievement	Merit	Excellence
Coevolution where over time, two unrelated species develop specific adaptations to enable their existence in the presence of the other organism. Convergent evolution is where distantly related species exhibit similar traits due to similar selection pressures. Mutations are random / permanent changes in the base sequence (in this case it has brought about a new amino acid order in the protein). Toxin production is an effective predator avoidance strategy and has evolved multiple times (same or different mutations?). The octopus and pufferfish and the newt do not share a niche, or habitat and yet have the same phenotype. This is because the random mutation has been selected for in each region. Co-evolution is like an arms race: with toxin production killing some snakes, those snakes with a random mutation leading to resistance will survive, passing on this allele. Those newts who make more toxin will then be selected for, etc. Thus, toxin production in a prey species will result in a pressure towards toxin resistance in the predator, which then results in a pressure on the prey to increase toxin production (through random mutations). With reference to survival: a point is reached where the energy devoted to toxin production / resistance becomes a drain on fitness. (energy not devoted to reproduction etc.) / the successful members of the prey species will have very high levels of toxin through expressing more or multiple gene copies. They will be the only ones able to survive and pass on their alleles in an area with the snakes.	• Defines coevolution. • Defines convergent evolution. • Defines mutation. • Identifies mutation as random, leading to new phenotype. • Identifies predation avoidance as selection pressure for production of TTX. • Identifies TTX poison as selection pressure for resistance in snakes. • Identifies that different mutations cause TTX production in the 3 species. • Identifies which members have more 'fitness' / reproductive success. • Identifies trend in graph.	• Coevolution explained in contextual terms of the evolution of one species affecting the evolution of another in other words they are each other's selection pressure. • Explains using the context given how convergent evolution under similar selection pressures give similar phenotypic results in unrelated species. • Explains that a random mutation would lead to a selective advantage for the octopus / pufferfish / newt (selection pressure named) / Explains idea of independent mutations having the same phenotypic effect (TTX). • Explains selection pressure for snakes and newts (idea of "arms race" / predator:prey relationship idea). • Explains how the data shows the pattern with a reason (for example, links TTX resistance to increased survival and reproductive success in snakes and vice versa) • Explains directional selection as linked to example.	• Discusses the concept of convergent and co-evolution and how it comes about and the future implication to survival of the newt as demonstrated from the data on TTX. • Discusses the concept of convergent of the three species and co-evolution of newt and snake – and how it occurs and the future implication to newts, as demonstrated from the data on TTX, **the costs and benefits** of the evolutionary strategy. Links TTX resistance to increased survival and reproductive success in snakes.

Not Achieved			Achievement		Merit		Excellence	
NØ = no response or no relevant evidence.	1a	2a	3a	4a	2m	3m	1st bullet point.	2nd bullet point.

Question Two

Evidence	Achievement	Merit	Excellence
Endemic species are those found in one location and nowhere else. A species is a group of organisms which can interbreed to produce fertile offspring. Niche refers to the habitat and the role the species have. Species have a range within their niche where survival is possible. Close to the optimum a species may still be able to survive, but not as well as if it were in its optimum niche. Natural selection is a process that acts on variation in phenotypes. The phenotypes, due the genotypes are the alleles carried for the trait. Each allele has originally come about by mutation. The environment selects for or against phenotypes and the environment encompasses both the abiotic and biotic features. Some individuals have more success in reproduction, passing on their alleles more. Over a lot of time / generations we can see groups diverge until they are reproductively isolated. Adaptive radiation is the pattern we see when many species develop in a short geological period of time / available niche or similar. As New Zealand has many niches, there will be a lot of speciation / endemism, as there are strong selection pressures stopping gene flow. In this case, it is the temperature of the water at different tides. If this stops gene flow, populations will occupy different habitats, and over time, they will accumulate more genetic differences. This is divergent evolution, but because there are so many, it is called adaptive radiation. New Zealand has many niches due to the variety of habitats in its waters – shallow reefs, estuaries, river mouths, though to our deeper seas.	• Defines endemic species. • Species definition. • Defines adaptive radiation / divergent evolution. • Identifies that species have 'preferred' temperature zones. • Describes the process of natural selection / selection pressures / directional selection • Describes mutation brings different phenotypes.	• Explains idea of endemic as found nowhere else linked to different habitats / niche linked to the resource. • Explains adaptive radiation as quick / rapid divergent evolution due to habitats with difference selection pressures that select for a specific phenotype. • Explains how natural selection acting on fish can result in many spp. • Explains how changes in temperature change metabolic processes, e.g. linked to enzyme function / oxygen levels in water • Explains a relevant RIM.	• Discusses how natural selection can give rise to endemic / new species and adaptive radiation in the triple fin fish in New Zealand. • Discusses how natural selection can give rise to endemic species and adaptive radiation of the triple fin fish, using the data shown, linked to temperature and how New Zealand may have 20 species. E.g. links to why New Zealand may have so many niches.

Not Achieved			Achievement		Merit		Excellence	
NØ = no evidence or no relevant evidence.	1a	2a	3a	4a	2m	3m	1st bullet point.	Both bullet points.

Question Three

Evidence	Achievement	Merit	Excellence
Polyploidy is the presence of more than two chromosome sets in a somatic cell / body cell (this can occur with individuals of the same species (autopolyploidy) or different species (allopolyploidy)). Reproductive isolation is when a barrier prevents two organisms from differing species from mating and producing fertile offspring / prevents successful interbreeding / prevents gene flow. Sympatric speciation is the formation of a new species from parent species in the same location / different niche. Polyploidy is due to the non-disjunction of chromosomes at meiosis, leading to diploid gametes due to spindle fibres pulling the incorrect number of chromosome to the pole during meiosis. The fusion of diploid gametes is a form of instant speciation. The offspring have different chromosome numbers than their parents, so are unable to breed with their parent species due to not having homologous pairs. This is reproductive isolation. Even if chromosome numbers are the same, if gametes from different species have fused (allopolyploidy), then the chromosomes may not be sufficiently compatible to allow successful reproduction. Polyploidy is a relatively common occurrence in plant species and many common species e.g. kūmara are polyploids. Travellers would take large food sources for the long journey to add to the food caught on route. Polyploids are often larger than their parent species. This would have made them more valuable as food crops to early Māori. As a result, these larger kūmara would have been retained and used to plant the next year's crop. This may then lead to further polyploidy events, further increasing the size of the kūmara. Other RIMS from mutation that could isolate the crops are: chemical isolation, e.g. sperm and egg cannot fuse, mechanical where the pollen cannot land on the stigma, and temporal when they have different flowering seasons.	• Defines polyploidy (may be taken from a labelled diagram). • Defines reproductive isolation • Provides a RIM described. • Provides a second RIM (described). • Describes sympatric speciation. • Identical chromosome number / compatible chromosomes needed for successful reproduction.	• Explains polyploidy linked to non-disjunction of chromosomes during meiosis / diploid gametes OR a good annotated diagram on polyploidy. • Explains reproductive isolation for polyploid by referring to allo / auto polyploidy therefore chromosomes may not be compatible for successful reproduction. • Explains sympatric speciation by linking in the example(s) given. This must refer to how polyploidy could have occurred. • Explains a relevant RIM that could lead to sympatric speciation. • Explains a second relevant RIM that could lead to sympatric speciation. • Explains that polyploids may have greater value as food crop than "wild" ancestors / hybdrid vigor.	• Discusses polyploidy as a means of sympatric speciation linked to reproductive isolation, both in terms of chromosome number and chromosome compatibility alongside and TWO clear RIMS that can lead to the speciation of the named plant(s). • Discusses polyploidy as a means of sympatric speciation linked to reproductive isolation, both in terms of chromosome number, meiosis (or somatic doubling) and spindle fibres and chromosome compatibility alongside another TWO clear RIM that can lead to the speciation of the named plant(s).

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Not Achieved			Achievement		Merit		Excellence	
NØ = no response or no relevant evidence.	1a	2a	3a	4a	2m	3m	1st bullet point.	Both bullet points.

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 7	8 – 13	14 – 18	19 – 24