Assessment Schedule – 2024

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

Assessment Criteria

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate ***understanding*** involves: • using biological ideas and/or scientific evidence to describe evolutionary processes leading to speciation.	*Demonstrate* ***in-depth understanding*** involves: • using biological ideas and/or scientific evidence to explain how or why evolutionary processes lead to speciation.	*Demonstrate* ***comprehensive understanding*** involves: • linking biological ideas and/or scientific evidence about evolutionary processes leading to speciation; linking of ideas may involve justifying, relating, evaluating, comparing and contrasting, or analysing the evolutionary processes that lead to speciation.

Cut Scores

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

Evidence

Question One

Evidence	Achievement	Achievement with Merit	Achievement with Excellence
Founder populations are when a small subset of a population breaks away from the main population and colonises a new area. It is often found that the founder and subset gene pools differ a lot, with different allele frequencies. Through gene flow (the movement of alleles between populations), the alleles, including any new mutated alleles populations, do not diverge. With limited gene flow, populations can diverge. The formation of the Southern Alps, approximately 5 million years ago (mya), brought habitat changes, including geographical barriers, due to tectonic movement at the boundary of the Indo-Australian and Pacific plates. Orogeny (mountain building) and glaciation are geographic forces that can fragment habitats. The fragmentation of habitat, due to a geographical barrier, stops gene flow between populations, and this may lead to allopatric speciation when followed by accumulation of random-mutations coding for different phenotypes. Should this continue, there may be reproductive isolation (speciation). Allopatric speciation can lead to divergent evolution as species continue to diverge from a common ancestor. Translocation of kōura between different habitats by Māori would have maintained gene flow between populations, slowing down or stopping genetic divergence between populations. This is why kōura have not become multiple, separate species despite the high genetic diversity between populations. It is an important factor because, for speciation to occur, any new mutations occurring in one population should not be introduced into the other population. It is the accumulation of mutations that means, eventually, the chromosomes cannot pair in cell division.	Describes: • founder population: a small subset of a population breaks away from the main population (colonises a new area) or implied • gene flow: the movement of alleles between populations • allopatric speciation: occurs when populations of the same species become geographically isolated • divergent evolution: species sharing a common ancestry become more distinct due to differential selection pressures • habitat change due to formation of the Southern Alps • why the Southern Alps would be a barrier: crayfish have a low dispersal capacity (they can't move far) • that local populations are vulnerable if their environment rapidly changes, e.g. agriculture / water pollution • movement by Māori would have maintained gene flow and prevented speciation between populations.	Explains: • that the founder population will not have the full range of alleles as the main population, which may lead to differences between them increasing over time • that processes like tectonic events (e.g. mountain building) would have geographically separated population, hence the two species / three groups (this occurred before the arrival of humans) • that high genetic diversity between populations suggests that, once they become separated, populations tend to remain separated, i.e. a strong pressure towards speciation • how allopatric speciation works, i.e. that barriers and different environmental pressures are selective agents for different phenotypes • traditional Māori practices may have maintained gene flow between populations, keeping the integrity of the gene pool, reducing inbreeding, and lessening the likelihood of speciation.	Discusses: • the divergent evolution and allopatric speciation of the koura, and the accumulation of random-mutations coding for different phenotypes, using examples from the stimulus material; and demonstrating understanding of the concepts of gene flow and the founder group, and the influence this has on species. • the predicament / future of the kōura now that Māori no longer translocate; the mtDNA data better demonstrates how many species there are, rather than being based simply on morphological differences.

Not Achieved		Achievement		Achievement with Merit		Achievement with Excellence	
N1	**N2**	**A3**	**A4**	**M5**	**M6**	**E7**	**E8**
Describes ONE evidence point at Achievement.	Describes TWO evidence points only at Achievement.	Describes THREE evidence points at Achievement.	Describes FOUR evidence points at Achievement.	Explains TWO evidence points at Merit.	Explains THREE evidence points at Merit.	Discusses ONE evidence points at Excellence.	Discusses BOTH evidence points at Excellence.

N0 = No response; no relevant evidence.

Question Two

Evidence	Achievement	Achievement with Merit	Achievement with Excellence
Sympatric means living in the one geographical area but in a different ecological niche. Sympatric species are closely related species that exist in the same geographical location at the same time. Species are individuals that can breed, producing fertile offspring. The graph shows punctuated equilibrium rather than gradualism, as there are sudden speciation events followed by periods of little change (seems to be in the last 2–3 mya). While mutations are always occurring (because they are random), there needs to be a change in environment for the diverse / new traits to be selected for. For gradualism, slow change due to similar selection pressures would be evident, and we would see many intermediate forms. Adaptive radiation is a pattern of evolution, a type of divergent evolution, except that we see arising many species in a short period of time (geologically), usually due to open niche. In Australia, wallabies have existed for at least seven million years, which is sufficient time for the population to spread into the different available niches in Australia. In New Zealand, the wallaby was introduced only in the 19th century. This is not sufficient time for adaptive radiation to occur. In New Zealand, the wallabies are found only in a restricted geographical location, with a small range of niches. This is another factor which acts against adaptive radiation. The two wallaby species in New Zealand have many mechanisms against interbreeding, including habitat use, mechanical, behavioural, chemical, and times they are mating. These are prezygotic isolating mechanisms. It may also be that there are postzygotic isolating mechanisms such as hybrid breakdown.	Describes: • species: individuals that can breed and produce fertile offspring • sympatric: living in the one geographical area / different ecological niche or similar • gradualism: slow evolutionary change due to similar selection pressures • punctuated equilibrium: rapid evolutionary change takes place in short bursts followed by periods of no change • states punctuated equilibrium as most likely • adaptive radiation: multiple species evolving from a single ancestor species (in a relatively short period of time) • TWO named RIMS.	Explains: • how the graph shows punctuated equilibrium as long periods of stasis that are followed by rapid speciation events as niches become available, and uses data from the graph (2–4 mya) • that adaptive radiation / speciation takes time to occur, and refers to the length of time wallabies have existed in Australia and / or New Zealand • that Australia has a wide range of niches for the wallaby to expand into, comparing this to the limited range of niches on Kawau Island / in Aotearoa New Zealand • how a RIM acts to prevent successful hybridisation between the two wallaby species on Kawau Island / in Aotearoa New Zealand • how a second RIM acts to prevent successful hybridisation between the two wallaby species on Kawau Island / in Aotearoa New Zealand.	Provides detailed discussion of: • species terminology and adaptive radiation of wallabies in Australia as compared to Aotearoa New Zealand; and the RIMs that may be preventing hybridisation; demonstrating comprehensive understanding of rates of evolution by comparing punctuated equilibrium with gradualism, using data from the graph (2–4 mya) and linking to the wallabies • the potential influence of hybrids that may result as the populations accumulate mutations.

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Describes ONE evidence point at Achievement.	Describes TWO evidence points only at Achievement.	Describes THREE evidence points at Achievement.	Describes FOUR evidence points at Achievement.	Explains TWO evidence points at Merit.	Explains THREE evidence points at Merit.	Discusses ONE evidence point at Excellence.	Discusses BOTH evidence points at Excellence.

N0 = No response; no relevant evidence.

Question Three

Evidence	Achievement	Achievement with Merit	Achievement with Excellence
Convergent evolution is when two non-related species, over time and through the process of natural selection, look morphologically similar. Selection pressures are environmental factors that influence the likely success of an individual. These pressures can be abiotic (e.g. wind, temperature) or biotic (e.g. mate selection, predation). Individuals with characteristics that make them more likely to successfully survive and reproduce will be selected for, and they will pass on their alleles for these traits to their offspring. Genetic evidence shows that species that are only distantly related have produced similar features because they are subject to similar selection pressures. For example, if in a gene the sequence of nucleotides is the same or a little different (i.e. few single nucleotide polymorphisms (SNPs)), this would show divergence. When the gene is different or the sequence is quite different, but it did lead to a phenotype similarity, then this shows convergence. Analogous structures are features of different species that are similar in function but not necessarily in structure, and which do not derive from a common ancestral feature, e.g. the bird wing and the insect wing. Originally, there would have been variation in phenotype for the bird and bee species. Those that reached reproductive age and mated passed on the alleles coding for their phenotypic variation. If both species occupy a niche where flying will result in more success, then phenotypes leading to this behaviour will be selected for. Energy-efficient flying will also be selected for. These lead to similarities due to the process of natural selection. Birds and insects have very different gene mutations with which to produce a wing and, as a result, use different biological materials to produce structures that are different but that both have the same function. In the process of natural selection, the environment selection pressures influence which individuals reach reproductive age and have reproductive success. Phenotypes (which are due to the genotype) may result in an individual more often finding more food, avoiding predators, finding a mate, etc., so they contribute their alleles coding for these successful traits more often to the next generation. Therefore, while the features are different in origin, each has been selected for.	Describes: • selection pressure: environmental factors that influence the likely success of an individual • selection pressure for this context, e.g. food source or similar, linked to flight • convergent evolution: two unrelated species develop similar traits because they live in similar environments • natural selection: individuals most favourable phenotypes / adaptations / traits to the environment will survive and reproduce, and will pass these favourable alleles on to their offspring • distantly related species: will have more differences in their DNA / genetic makeup. ONE of: • analogous features: features of different species that are similar in function but not in structure. • bird and bee wings as analogous structures.	Explains: • how selection pressures, giving an example of influence- convergent evolution • the natural selection process, linking to context • that DNA / genetic differences can be used to show convergent evolution, with similar structures being formed by the action of different genes • that analogous structures are features of different species that are similar in function but not necessarily in structure, and which do not derive from a common ancestral feature, e.g. the bird wing and the insect wing.	Discusses: • evolution, due to natural selection, as leading to convergent evolution in the case given • how genetics is used to show structures are analogous; links this to mutation and selection pressures of the phenotype coded for in the context given.

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