Assessment Schedule – 2023

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 – 6	7 – 12	13 – 18	19 – 24

Evidence

Question One

Evidence	Achievement	Achievement with Merit	Achievement with Excellence
The kākāpō have small population numbers and, although they are actively protected, there is a risk of the species dying out due to their limited genetic diversity. Genetic diversity is increased by mutation. Mutation is a random, permanent change in the base sequence of an organism. There are two gene pools for the kākāpō – island and mainland. Gene pool refers to all the alleles contained within a population. Genetic drift is the random change in allele frequency in populations. It occurs alongside natural selection; however, in small populations, its effects are pronounced. We tend to get small populations as a result of the founder effect and the bottleneck effect. Species with smaller populations tend to have a smaller gene pool, so any genetic changes will have a greater effect. Genetic drift may cause significant changes in the gene pool. Alleles may become fixed or lost. The slow accumulation of mutations would tend to have a negative effect on the fitness of the kākāpō population because they lose genetic diversity but, if the drift is slow enough, harmful mutations may be removed from the gene pool by natural selection. This may explain why small populations can survive for many generations despite extremely limited genetic diversity. The kākāpō have some harmful mutations and this means the future population may be restricted; however, if the two populations are mixed, it will mean there is less chance of deleterious allele combinations.	**Defines:** • mutation: random, permanent change in the base sequence of DNA • gene pool: all the alleles contained within a population. **Describes:** • a founder population: new population established by a very small number of individuals from a larger population • genetic drift: random change in allele frequency in populations • natural selection: individuals with the most favourable phenotypes / adaptations / alleles to the environment will survive and reproduce, passing these favourable alleles to their offspring • a selection pressure: disease, predation, habitat loss • a plausible future implication, e.g. extinction / further decline in population.	**Explains:** • genetic drift's more noticeable influence through founder effect, due to small numbers (both ideas linked) • the process of natural selection for kākāpō means harmful mutations are selected out in smaller, island populations, resulting in fewer mutations than the mainland population; or vice versa for useful mutations. • the process of genetic drift for kākāpō can cause significant changes, i.e. alleles can be fixed or lost in the gene pool (linked to the kākāpō) • an implication of genetic drift for the future population is loss of genetic diversity / smaller gene pool • an implication of natural selection for the future population is speciation / environmental change, resulting in different selection pressures and potentially causing extinction, e.g. a disease linked to the kākāpō population.	**Discusses,** demonstrating comprehensive understanding of: • the processes leading to evolution (genetic drift, mutation, natural selection) that influence the two gene pools of the kākāpō (all **three** processes linked together.) • implications for the future of the kākāpō population due to **both** genetic drift and natural selection (low biological fitness / smaller population thus increased likelihood of inbreeding, etc.)

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

N0 = No response; no relevant evidence.

Question Two

Evidence	Achievement	Achievement with Merit	Achievement with Excellence
Adaptive radiation is where multiple species evolve from a single ancestor species in a relatively short period of time. The niche is the role of the organism within the environment. Different species may evolve different features through mutation that allow success in different environments, e.g. temperate New Zealand through to tropical Papua New Guinea. With adaptive radiation, populations of the same species end up in different areas. For plants, it could be that pollen was taken or blown between areas. Each plant would grow and, if they had the phenotype enabling success, they would contribute their alleles more often to the next gene pool. Consequently, allele frequencies are likely to change. Each population has new random mutations and without gene flow / migration, the populations would diverge. After an accumulation of mutations, speciation could occur and there may be a lot of new species in a short period of time due to the different environments /niche. There may be different browsing species, e.g. birds in New Zealand but marsupial mammals in Australia. Consequently, different traits would be selected. There would also be different pH soils, different amounts of light, etc. On different islands, there are different environmental selection pressures and so, different phenotypes are selected.	**Defines:** • niche: role of the organism within the environment • species: organisms that can successfully interbreed and produce fertile offspring • adaptive radiation: multiple species evolve from a single ancestor species (in a relatively short period of time). **Describes:** • *Coprosma* can result from multiple environments through mutation • a habitat selection pressure for the plants, e.g. high altitude in Tasmania therefore more intense sunlight • how the plants may well have ended up in different areas, e.g. distribution by birds • forms linked to environment, e.g. plants in dryer soils might need a more extensive root system.	**Explains:** • adaptive radiation, e.g. many species arising in a short amount of time due to open / vacant niche, as seen in *Coprosma* that originated in New Zealand and has radiated to the Pacific, etc. • how multiple species of *Coprosma* can come about from multiple environments as they can have features very specific to the environment • natural selection for *Coprosma*, e.g. with selection pressures of soil or bedrock / climate / temperature • how the plants may well have ended up in different areas, linked to specific islands, e.g. people, birds, ocean current • forms linked to environment and / or processes, e.g. windy areas would be dryer therefore the plant would need a more extensive root system.	**Discusses,** demonstrating comprehensive understanding of: • the evolution of species through adaptive radiation, in New Zealand and islands in the Pacific, including knowledge of links to phenotypes in different habitats / niche (all linked) • how natural selection results in speciation of *Coprosma* (in a short period of time), i.e. after an accumulation of mutations, speciation could occur, possibly resulting in a lot of new species in a short period of time, due to the different environments / niche.

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

N0 = No response; no relevant evidence.

Question Three

Evidence	Achievement	Achievement with Merit	Achievement with Excellence
Allopatric speciation is the formation of new species from ancestral species when original gene flow was stopped by a geographical barrier. Sympatric speciation is where two populations are in the same area and gene flow is stopped by a non-geographical barrier. Volcanism, orogeny (mountain building), glaciation, sea level changes, and other geographical influences may separate populations, which then change due to different local conditions and subsequent selection of favourable mutations /phenotypes. There may also be microclimates, further encouraging speciation, e.g. laying eggs versus live birth. Egg-laying would allow Peripatus to escape challenging conditions, or egg-laying is viable only in extreme (cold) environments. Other adaptations needed to survive in cold environments may mean egg-laying is the preferred reproductive strategy. The species doesn't range widely, so this would also tend to reduce gene flow between populations, leading to speciation, both allopatric and sympatric. DNA analyses may show up differences not visible in the phenotype, so would lead to new species being described. There could be different genes / base sequences or DNA sections that would result in different behaviours or structures to stop fertile offspring being possible. There are a number of reproductive isolating mechanisms (RIMs) that would stop hybrid formation, pre- or post-zygotic, e.g. behavioural differences, chemical differences that would mean no fertilisation, or temporal isolation due to differences in timing for mating.	**Defines:** • allopatric speciation: new species from ancestral species when original gene flow was stopped by a geographical barrier • sympatric speciation: two populations are in the same area and gene flow is stopped by a non-geographical barrier. **Describes:** • a geological process linked to speciation, e.g. mountain building, etc. • how DNA knowledge leads to identification of new species, such as different DNA are not shown through in phenotype • **two** RIMs, e.g. structural and gamete incompatibility • how hybrids don't go on to form new species, e.g. different chromosomes, numbers.	**Explains:** • how geological processes link to speciation / niche formation (makes links to the velvet worm, e.g. egg-laying) • **one** RIM explained and linked to the velvet worm • **a second** RIM explained and linked to the velvet worm • how DNA knowledge leads to identification of new species (linked to the velvet worm) • how hybrids don't go on to form new species, e.g. hydrid breakdown / fertility issues (linked to the velvet worm).	**Discusses**, demonstrating comprehensive understanding of: • the evolution of velvet worms in New Zealand due to various speciation events, which are more common due to the geological history of New Zealand • how there may be more species, as yet unidentified due to our lack of genetic knowledge, and what this DNA might show (may include discussion of phylogenetic trees or similar).

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

N0 = No response; no relevant evidence.