Assessment Schedule – 2014

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

Evidence Statement

Q1	Evidence	Achievement	Merit	Excellence
	A reproductive isolating mechanism is a barrier that prevents two organisms from differing species from mating and producing **fertile** offspring / prevents **successful** interbreeding / prevents gene flow These species have gone through divergence or adaptive radiation. Dingos would have become reproductively isolated when Australia mainland broke away from Gondwana, and would have remained isolated for millions of years, an example of allopatric speciation. The coyote in Northern America would have become reproductively isolated from other dog species, partly by allopatric speciation due to separation of landmasses and mountain building. This geographic barrier would have stopped gene flow and, as the coyote was subjected to different selection pressures (hot, dry environment) genetic differences (perhaps provided by mutations) would have been selected for, eventually leading to speciation. However, it has also survived other closely related wolf species living within the same range, so other factors such as behaviour, climate changes, and territory may have been factors. The coyote range does not appear to extend north into the colder northern parts of North America and Europe. This may have been both allopatric and sympatric speciation. The jackal species found in the Serengeti region of Africa appear to be reproductively isolated due to behavioural differences. Territoriality, courtship differences and recognition are factors that have operated to keep the three species reproductively isolated. They are sympatric species, but it is not clear from the information if they originally became separated due to sympatric speciation. As all these species have been known to reproduce with the domestic dog and produce viable offspring, they do	• Describes a Reproductive Isolating Mechanism (RIM). • Describes relevant RIMs for the species given. Eg: geographical isolation, behavioural or territorial isolation. • Describes relevant selection pressures. Eg: competition for resources, environmental conditions, predators. • Describes / defines speciation. Eg: creation of a new species from a common ancestor / that is reproductively isolated. **OR** Describes whether true speciation has occurred or not Eg. Gives a reason why not / why this is true speciation.	• Explains how RIM could have happened in these cases. Eg: Coyote and dingo probably went through **allopatric speciation**: Geographical isolation. → differences in behaviour / external features / gene pool / different species. • **Jackal** species went through allopatric speciation. They now occupy the same area (sympatric species). Behavioural or territorial differences prevent interbreeding. **OR** Another reasonable explanation. Eg: **Sympatric speciation**: Behavioural/niche isolation → named difference / different gene pool / species. Eg: Random mutation caused different appearance leading to reproductive isolation from the group. ▲ Explains link between selection pressures and speciation: Selection pressures include environmental conditions, climate, and availability of food. Individuals most suited to survive are **selected for**.	•Links ideas by explaining reproductive isolation in terms of **speciation** AND **selection pressures**: - Coyote and dingo probably went through **allopatric speciation**: Geographical isolation. → no gene flow / interbreeding → **different selection pressures** → differences in behaviour / external features / gene pool / different species. - Jackals: **Sympatric speciation**: Behavioural/niche isolation. → no gene flow / interbreeding → **different selection pressures** → named differences / different gene pool / different species. **OR** **Random mutation:** different appearance; no gene flow / reproductive isolation; different selection pressures; speciation / gene pool difference. - Explains link between selection pressures and speciation: Selection pressures include environmental conditions, climate, and availability of food. Individuals most suited to survive are **selected for and therefore have increased reproductive**

	not fit with the definition of a species commonly used in biology. However, each species is adapted to and naturally survives within its own preferred ecological niche and shows physical differences and presumably mating preferences (known to mate with the domestic dog, but not commonly). This example shows the complexity of the concept of speciation and calls into question whether or not these are all different species or different populations of the same species.					• Gives reasons why these are not true species: Although all these species appear (and probably behave) differently, they have all been known to reproduce with domestic dogs and produce **fertile offspring**, which suggests they are not true species / which does not fit with the biology definition of a true species.		**success / survival.** • Discusses why true speciation has not occurred: All these species can reproduce with domestic dogs and produce **fertile offspring**, which suggests they are not true species / which does not fit with the biology definition of a true species. **AND** Hybrid dog may have less survivability / hybrid breakdown. **OR** Insufficient time has elapsed / differences have accumulated for true speciation / complete reproductive isolation. **OR** As they can reproduce and produce fertile offspring they could be considered to be sub-species.	
	Not Achieved			**Achievement**		**Merit**		**Excellence**	
	NØ = no response or no relevant evidence	N1 = 1 partial point, eg one definition	N2 = 1 point from Achievement	A3 = 2 points	A4 = 3 points	M5 = 1 point	M6 = 2 points	E7 = 1 point	E8 = 2 points

Q2	Evidence	Achievement	Merit	Excellence
	The evolutionary relationship between the monarch butterfly and the milkweed plant is an example of co-evolution, where the species have exerted selection pressures on each other over time. The monarch butterfly is adapted to survive the toxicity of the milkweed, which normally poisons most other animal species. The milkweed is adapting to the damage caused by the monarch caterpillar feeding on its leaves by undergoing rapid regrowth of damaged tissue. A co-evolution relationship develops where over time two species develop specific adaptations to enable their existence in the presence of the other organism. This might be, for example, predator-prey, parasitic, mutualistic or herbivory relationships, so that both are able to survive the impact of one upon the other. In the case of the monarch butterfly and the milkweed plant, the monarch caterpillar has developed immunity to the milkweed's poisonous alkaloids. This gives the monarch a virtual monopoly over milkweed both as a food supply for its larvae and a safe place for laying its eggs, as the poisonous nature of the plant keeps other animals from eating it. Potential predators of the monarch butterfly when they, in turn, become poisonous to many animals, will be reduced. The milkweed, in response to the caterpillar herbivory, have developed the ability to rapidly regenerate and replace damaged tissues. There would be pressure for this to happen where monarch caterpillar populations are high and the resulting damage to milkweed plants due to caterpillar feeding is also high. The high levels of herbivory could threaten the co-evolutionary relationship if plants became too heavily grazed and the monarchs lost their food and egg-laying preference and the protection it offers.	• Describes co-evolution - Changes in one species leads to reciprocal changes in the other – they evolve and change together / exert selection pressures on each other. • Describes how this type of relationship develops. • Describes selection pressures working for or against: (max. 2 points). - Monarchs can **tolerate** toxic, sticky alkaloids given out by milkweeds. - Monarchs have developed the ability to chew around the base of milkweed leaves to **reduce** intake of toxins. - Milkweeds have developed the ability to rapidly self-repair **damage by monarchs**. - Monarch caterpillars are now **toxic** so avoid **predation.**	• Explains how co-evolutionary relationships develop. - Two species may have an existing relationship and changes in one cause reciprocal changes in the other. As one changes over time due to selection pressures, the other changes too. • Explains selection pressures. – Milkweeds can be badly damaged by monarchs. Rapid repair is a selective advantage. Plants that can rapidly self-repair will **survive** the monarch grazing / go on to **reproduce**. – Monarchs feeding on milkweed provides selective advantage as monarch is toxic to most other animals and therefore protected and better survival chances / reproductive success.	• Links ideas to give a comprehensive explanation of how co-evolutionary relationship develops. - A co-evolutionary relationship depends on the ability of each species involved to adapt to changes that occur in the other. In this case, the monarch's survival depends on its feeding on milkweed, and **gaining an advantage** from protection due to high levels of toxicity keeping potential **predators** away; leading to reproductive success / increased survival. • Evaluation of selection pressures. - Milkweeds are responding to increased pressure due to monarch caterpillar grazing by increasing their ability to **repair** damaged plant material **instead of** increasing their defence (becoming more toxic) OR by reducing levels of toxins which **results in** increased survival / reproductive success. - Monarchs feeding on milkweed provides selective advantage as monarch is toxic to most other animals and therefore protected and better survival chances / reproductive success. **Less toxic milkweed** plants will probably lead to **reduced toxicity in monarchs,** opening them up to **increased predation**. **OR** Discusses advantages to the milkweed.

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Q3	Evidence	Achievement	Merit	Excellence
	Allopatric speciation describes the formation of a new species as a result of physical separation of populations of the same species, which over time, become reproductively isolated and diverge into different species, adapted to a particular niche or environment. In this example the proto-kākā diverged into kea, adapted to alpine conditions, and kākā, adapted to lowland forests, approximately 3 mya. This divergence coincided with the formation of the Southern Alps and available alpine niches. The kākā survived in the warmer northern forest niches. and migrated to off-shore islands, becoming isolated. Sympatric species are species, which previously diverged from a common ancestor, and now exist in the same area but remain reproductively isolated. The kākā returned to the South Island when it became warmer after the last glaciation and now exists alongside the kea, occupying different niches and remaining reproductively isolated. When sea levels rose about 0.4 mya, the North and South Island became separated by Cook Strait (rising sea levels) so the South Island and North Island kākā populations became isolated. They are now considered to be subspecies as they do not reproduce with each other, probably due to differences in size, behaviour, and markings. Their isolation (0.4 mya) is not long enough for complete speciation to occur. The Norfolk Island and Chatham Island species remained reproductively isolated, however, and have now become extinct. The loss of female nesting birds over several generations will severely impact on the size of the kākā gene pool and reduce allele frequencies. This will lead to a decline in overall numbers and a loss of genetic diversity (genetic drift). The populations will become vulnerable to environmental changes and risk the possibility of extinction. Speciation between the two subspecies of kākā may not continue if hybridisation happens due to conservation measures, although this may not even be possible.	Describes allopatric speciation as the formation of a new species / speciation as a result of geographical or physical isolation / separation of populations of same species. Describes sympatric species as occupying the same geographical range / area. Describes sympatric species as being reproductively isolated. Describes South Island kākā and kea as sympatric species. Describes North Island and South Island kākā as becoming reproductively isolated due to allopatric speciation or geographical separation. Identifies a recent impact on kākā speciation, such as loss of genetic diversity / loss of genetic variation / genetic drift / endangered due to female losses / at risk of extinction. Describes the **geographical barriers** - between North Island and South Island kākā as the **Cook Strait.** OR - between kea and kākā as the **Southern Alps.**	• Explains allopatric speciation using the example of the kea / kākā divergence from proto-kākā (3 mya). **OR** The separation of North Island and South Island kākā subspecies (0.4 mya) Eg: Kea and kākā diverged from the proto-kaka species by; **separation** by geographic features (Southern Alps); **different selection pressures** in the different areas and evolved differently. **OR** Rising levels of Cook Strait **separated** kākā populations (geographic isolation); **different selection pressures** led to **changes** (genetic, phenotypic). • Explains South Island kākā and kea as sympatric species because they are reproductively isolated as a consequence of selection pressures. • Explains the impact of a recent event on kākā species. Eg: The loss of female breeding kākā will **reduce diversity** .This will leave the current species **vulnerable** to environmental change / at risk of extinction.	• Discusses allopatric speciation, using the kea and kākā divergence from proto- kākā. Eg: Kea and kākā diverged from the proto-kaka species by * **separation** by geographic features (Southern Alps); * **different selection pressures** in the different areas led to changes (genetic, phenotypic); * changes accumulated until **reproductive isolation** / different species. • Kākā migrated back to the South Island (as well as inhabiting the North Island), but were at this stage reproductively isolated from their kea relatives, existing as **sympatric species** in different habitats within the same geographical area – the South Island. • Discusses the events leading to the formation of North and South Island kāā subspecies **OR** The 4 different groups of kākā. Eg: Geographic isolation (water) separated kākā populations; different selection pressures led to changes. This has resulted in the North & South Island kākā populations / sub-species (NOT species). **OR** Kākā diverged into four separate areas; **separation** by geographical feature (water); **different selection pressures** in the different areas led to changes; changes accumulated until reproductive isolation / different species / subspecies.

Two 'E' points on next page

							• Kākā migrated to the two offshore islands / Norfolk & Chatham Islands due to competition on the mainland. Because of the **founder effect / genetic drift / not having suitable alleles**, and were **vulnerable** to environmental change, which lead to their **extinction.** • Discusses the impact of a recent event on kākā species. Eg: The loss of as many as three generations of female breeding kākā will reduce genetic diversity and leave the population vulnerable to the effects of a **reduced gene pool**. **AND** Conservation measures will not be able to increase the gene pool. **OR** the reduced gene pool increases susceptibility to environmental effects such as disease (OR alternative argument based on why at risk).	
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Cut Scores

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