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93101Q

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Scholarship 2005
Biology

9.30 am Saturday 3 December 2005
Time allowed: Three hours
Total marks: 30

QUESTION BOOKLET

Answer ALL questions.

You should write ALL your answers in the Answer Booklet 93101A.

Show ALL working. Start each question on a NEW page. Number each question carefully.

Check that this booklet has pages 2–5 in the correct order.

You are advised to spend approximately 60 minutes on each question.

YOU MAY KEEP THIS BOOKLET AT THE END OF THE EXAMINATION.

QUESTION ONE (14 marks)

In 1983 a woman in America discovered a pregnant cat with very short legs (see below). The short legs were later found to be the result of a mutated allele, which caused the shortening and bowing of the long bones. A similar effect is seen in the corgi and dachshund dog breeds.

When the cat gave birth, half the litter of kittens had the very short legs and half had normal legs. Selective breeding was used to establish a population of pure-breeding short-legged cats, as molecular biology techniques such as transgenesis and cloning were not yet advanced enough to be used. This breed of cat is now known as Munchkin.

[FOR COPYRIGHT REASONS, THIS RESOURCE CANNOT BE REPRODUCED HERE. SEE BELOW.]

A Munchkin cat

http://www.pusscats.com/Munchkin_Cats

(a) Explain how each of the following methods could have been used to produce the Munchkin breed from the original female cat:

(i) selective breeding

(ii) molecular biology techniques. (6 marks)

(b) Compare and contrast the effectiveness of using selective breeding with molecular biology techniques to produce a new breed of animal such as the Munchkin cat. (8 marks)

QUESTION TWO (8 marks)

The social behaviours found in a number of animal species have evolved as a result of the survival advantage they bring to the species.

Compare and contrast the behaviours used by social animals and discuss how these behaviours aid the survival of these animal species. Refer to named animal groups in your answer. You may choose to consider animals such as ants, bees, chimpanzees, baboons, lions, penguins, pūkeko or any other social animal in your answer.

QUESTION THREE (8 marks)

New Zealand lies on the boundary of two continental plates and has been isolated by oceanic barriers for the last 60–80 million years. The Southern Alps formed as a result of the movement between these two plates over the last five million years. The rise of the Alps changed the weather patterns, resulting in the west coast of the South Island being much wetter than the east coast. The uplift of the Alps also changed the soils in the regions.

Between 1.6 million years ago and 10 000 years ago New Zealand was exposed to, and affected by, cold glacial and warmer interglacial periods. These caused the sea levels to fluctuate by up to 135 metres. In the glacial periods, forests retreated from the mountains towards the coasts.

Hebe species are found throughout the country, particularly on the banks of lowland streams and rivers and in the alpine (above the treeline) and subalpine zones of the mountains.

It has been proposed that the ancestral form of the current *Hebe* species arrived as a single introduction, most likely from Australia, about five million years ago. The closest modern species to this ancestor is thought to be *H. cupressoides*.

The patterns of diversification of the *Hebe* species suggest a rapid radiation following establishment. The ancient founder population that gave rise to the *Hebe* complex in New Zealand was most likely small, and perhaps arose from a single seed. The initial populations were later fragmented by changing sea levels, mountain building and glaciation.

The combined influences of inbreeding, genetic drift and strong selection acting on small populations have probably played a major role in the rapid diversification of the *Hebe* species. Chromosomal changes related to aneuploidy and polyploidy have also been observed.

Examples of whipcord forms	**[FOR COPYRIGHT REASONS, THIS RESOURCE CANNOT BE REPRODUCED HERE. SEE BELOW.]** *H. cupressoides* — *H. ochracea* — *H. cheesemanii* A semiwhipcord
Examples of larger leaf forms	**[FOR COPYRIGHT REASONS, THIS RESOURCE CANNOT BE REPRODUCED HERE. SEE BELOW.]** *H. elliptica* — *H. salicifolia*

Diagrams of five different species of *Hebe* showing diversity in morphology.
Diagrams are not drawn to the same scale.

A L Poole and N M Adams, *Trees and Shrubs of New Zealand*, 1964, Government Printer Wellington

Species	Habitat conditions	Morphology	Chromosome number (n)
H. cupressoides	Subalpine east of the main mountains of the South Island.	Whipcord plant with scale-like leaves that grows up to 2 m tall.	21
H. cheesemanii	Rocks on drier mountains of the South Island.	Semi-whipcord plant; shrub up to 0.3 m tall.	21
H. ochracea	Mountains of the north-west South Island.	Whipcord plant, erect spreading shrub up to 0.6 m tall.	62
H. hectorii	Wet subalpine scrub and tussock of the South Island.	Whipcord plant; erect, rigid plant that grows up to 0.75 m tall.	20
H. imbricata	Drier mountains of the South Island.	Whipcord plant; erect, much branched rounded shrub up to 0.6 m tall.	20
H. salicifolia	Lowland to mountains in the South Island; widespread except near the coast in Marlborough Sounds.	Leaves 5–15 cm long; shrub up to 5 m tall.	20
H. speciosa	Exposed sea cliffs on western side of both main islands.	Leaves 5–10 cm long; rounded shrub up to 2 m tall.	20
H. cockayniana	Wet subalpine scrubland and grasslands in south-west South Island.	Leaves 1–2 cm long; erect much branched shrub up to 1 m tall.	20
H. elliptica	Coastal.	Leaves 1.5–4 cm long; bushy shrub up to 2 m tall.	20
H. topiaria	Wet subalpine areas of the South Island.	Leaves about 1 cm long; compact neatly rounded bushy shrub up to 2 m tall.	61
H. gracillima	Damp swampy places in the South Island.	Leaves 1–2 cm long; shrub up to 2 m tall.	40
H. venustula	Subalpine mostly North Island.	Leaves 1–2 cm long; erect bushy shrub up to 1.5 m tall.	60
H. stricta	Common in lowland and subalpine areas, mostly on banks in the North Island.	Leaves 4–5 cm long; woody shrub up to 4 m tall.	20
H. odora	Common usually in wet ground, alpine and subalpine.	Leaves 1–2 cm long; variable shrub up to 1.5 m tall.	21
H. haastii	Drier mountains of the South Island.	Leaves 0.6–1.3 cm long; very low growing shrub up to 0.3 m tall.	21
H. societatis	Subalpine small plant zone in north-west South Island.	Leaves 1–2.5 cm long; subshrub that grows up to 0.3 m tall.	21
H. crenulata	Subalpine shrubland and tussock grassland, often in shallow or rocky soils of northern South Island.	Leaves 0.6–1.9 cm long; spreading low shrub up to 1 m tall.	40
H. dilatata	Grasslands to rocky screes of southern South Island.	Leaves 1–2.5 cm long; subshrub that grows up to 0.3 m tall.	60
H. raoulii	Drier mountains and hills of the South Island.	Leaves 0.6–2.5 cm long; small low growing shrub up to 0.3 m tall.	21

Table 1 Summary of characteristics of key *Hebe* species

Discuss the evidence for the role of each of the following in the evolution and diversification of the *Hebe* species in New Zealand:

- selection pressures generated by environmental changes resulting from mountain building and glaciation
- mutations, particularly aneuploidy and / or polyploidy
- genetic drift and / or the Founder effect
- adaptive radiation and / or convergence
- sympatric and / or allopatric speciation.

Your answer needs to address all the bullet points. Where there are two concepts for one bullet point it is not essential that both concepts are covered. Headings may be used.