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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

Scholarship 2017 Biology

9.30 a.m. Monday 20 November 2017
Time allowed: Three hours
Total marks: 24

QUESTION BOOKLET

There are **THREE** questions in this booklet. Answer **ALL** questions.

Write your answers in Answer Booklet 93101A.

Start your answer to each question on a new page. Carefully number each question.

Check that this booklet has pages 2–6 in the correct order and that none of these pages is blank.

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

QUESTION ONE: KĀKĀPŌ

Kākāpō (*Strigops habroptilus*) are large, flightless, long-lived, nocturnal parrots endemic to New Zealand. The feathers are a mossy, mottled green colour providing cryptic colouration. When disturbed, the birds freeze. All kākāpō have a distinctive sweet ‘musky’ smell. Their diet is herbivorous.



<http://kakaporecovery.org.nz/sirocco/>

Kākāpō are lek breeders with males calling (‘booming’) from track and bowl systems. Breeding coincides with the production of large numbers of seeds (‘masting’) from large canopy trees, such as rimu and beech. Masting occurs only every four years or so.

Both sexes are polygamous. After mating, females form nests in secluded spots within hollow trees or under logs. One to four eggs may be laid in a clutch, with only the females incubating the eggs and feeding the chick(s) for many months. Nests are very smelly. Researchers have found that unless females weigh between 1.5 – 1.7 kg a disproportionate number of male chicks are produced.

Kākāpō were once widespread throughout all of New Zealand. The arrival of Māori, and then Europeans, had a large impact on the distribution and population numbers of kākāpō. By the 1970s, only one small population was known to exist. This population was in Fiordland and was composed of 19 male birds. A larger population of about 200 kākāpō was then discovered in the southern section of Rakiura/Stewart Island. Feral cats subsequently halved this population. All the remaining kākāpō on Rakiura/Stewart Island and Fiordland were then captured and translocated to predator-free offshore islands. The total population reached an all-time low of 50 birds during the 1990s, resulting in the kākāpō becoming one of the world’s most critically endangered species, therefore at high risk of extinction.

Today all kākāpō are located on three islands – Whenua Hou/Codfish Island off the coast of Rakiura/Stewart Island, Anchor Island in Fiordland, and Hauturu-o-Toi/Little Barrier off Auckland. As a result of a very intense conservation effort the total kākāpō population reached 154 birds in 2016. Of the Fiordland kākāpō, only one, known as Richard Henry, has bred, leaving three descendants, one female named Kuia and two males named Sinbad and Gulliver. At 18 years old, Kuia bred for the first time, producing two offspring. Neither of her two brothers has yet bred.

Researchers have found that about 40% of all kākāpō eggs laid are infertile. In 2016 a total of 123 eggs were laid, of which 64 (52%) were infertile. There were then further losses from inviable embryos. Of the 47 chicks that hatched, only 36 survived to fledge. In recent years, several young kākāpō have unexpectedly and suddenly died. Rooster, a young male, died at four years old and an autopsy revealed a fungal infection throughout his body.

A project now exists to sequence then analyse the genome of all the kākāpō population. The first genome sequenced was completed in January 2016, and it is currently being analysed. Sequencing of the genomes of the 50 birds in the founding population was scheduled to be completed in late 2016. Researchers are particularly interested in the range of alleles for a group of genes called the major histocompatibility complex (MHC). These genes code for proteins found on the surfaces of cells that help the immune system recognise foreign substances.

Question

Analyse the information provided in the resource material and integrate it with your biological knowledge to discuss:

- how the reproductive behaviour AND genetic factors of the kākāpō account for its critically endangered status
- how genome sequencing and analysis may be used in managing kākāpō populations to try to ensure that kākāpō do not become extinct.

QUESTION TWO: KIWI EVOLUTION

Until the arrival of humans in New Zealand (Māori in about 1300; Europeans in about 1800), there were no land mammals apart from species of bat. Consequently birds evolved to fill the vacant niches occupied by mammals on other continents. The range of bird types in New Zealand included predatory birds such as falcons and the Haast's eagle, as well as herbivorous birds such as the large moa. Moa were all diurnal, flightless birds with at least nine species of varying sizes found in large numbers throughout New Zealand. They occupied all habitats from coastal to subalpine regions.

Kiwi, like moa, belong to the ratite group of birds, and are endemic to New Zealand. Recent research has suggested that the ancestor of the kiwi was a flighted bird that arrived in New Zealand some 60 – 50 million years ago. Today, five species of kiwi have been identified, with different varieties existing within the brown kiwi (4 varieties) and the tokoeka (3 varieties).

Brown kiwi
(*Apteryx mantelli*)



<http://nzbirdsonline.org.nz/species/north-island-brown-kiwi>

Distribution: within the North Island.

Varieties: Northland, Coromandel, Western, and Eastern.

Little spotted kiwi
(*Apteryx owenii*)



<http://nzbirdsonline.org.nz/species/little-spotted-kiwi>

Distribution: exist only on several offshore islands and mainland sanctuaries as a result of relocation by humans for conservation purposes.

Great spotted kiwi
(*Apteryx haastii*)



<http://nzbirdsonline.org.nz/species/great-spotted-kiwi>

Distribution: in the northwest South Island and Arthur's Pass.

Rowi
(*Apteryx rowi*)



<http://nzbirdsonline.org.nz/species/okarito-brown-kiwi>

Distribution: on the West Coast of the South Island.

Tokoeka
(*Apteryx australis*)



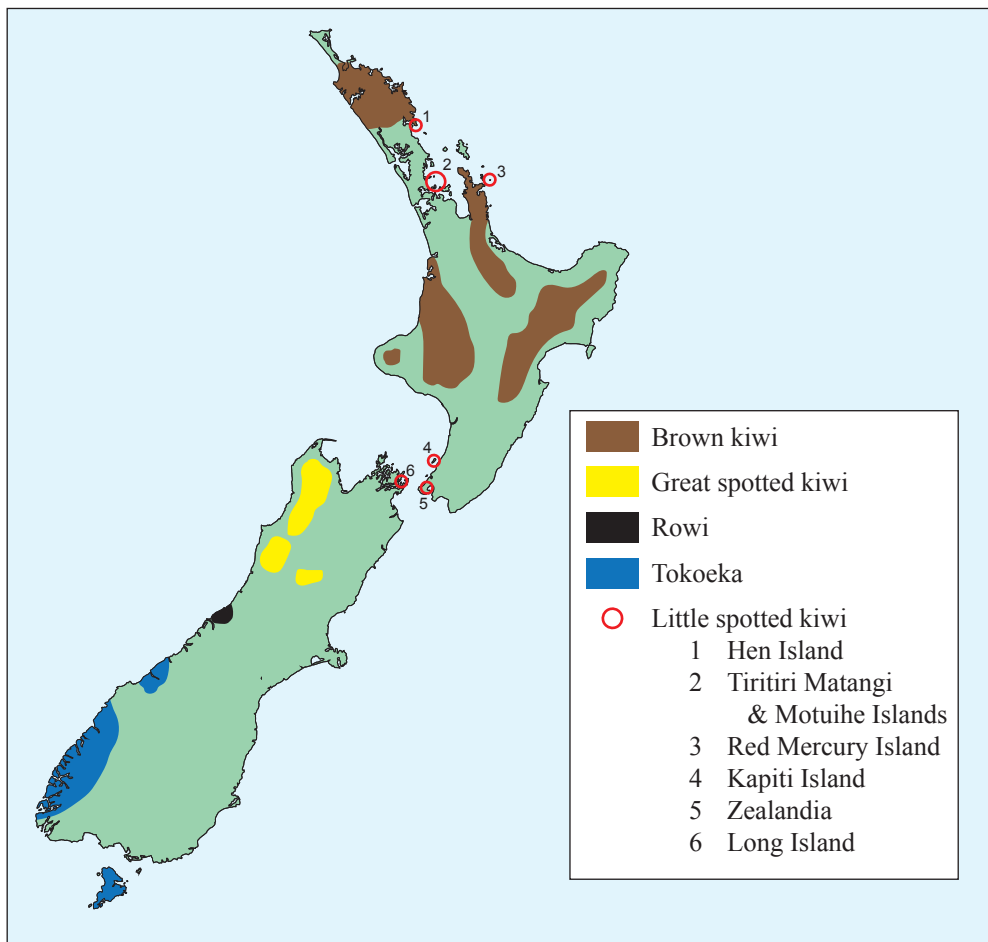
<http://nzbirdsonline.org.nz/species/southern-brown-kiwi>

Distribution: within the South Island.

Varieties: Fiordland, Haast, and Rakiura / Stewart Island.

Kiwi were once widespread throughout New Zealand, but over millions of years became confined to specific locations.

Distribution of kiwi in New Zealand today



All kiwi share similar structures and behaviour despite distinct genetic differences between the species. Through evolution they became flightless and nocturnal ground dwellers, nesting in burrows. Kiwi probe for invertebrates such as earthworms and insect larvae in the soil using their long beak, but also feed on wētā, centipedes, and spiders. This diet is supplemented by feeding on plant material such as fruit, seeds, and leaves. The very long beak has nostrils located at the tip, along with sensory pits that detect vibrations; the top of the beak and the face have long tactile whiskers. Areas of the brain associated with sight have become greatly reduced, while those associated with touch and smell have become greatly enlarged. The feathers are rather shaggy and hair-like, and coloured in shades of brown. Distinct differences in size and colour are displayed in the varieties of tokoeka.

Question

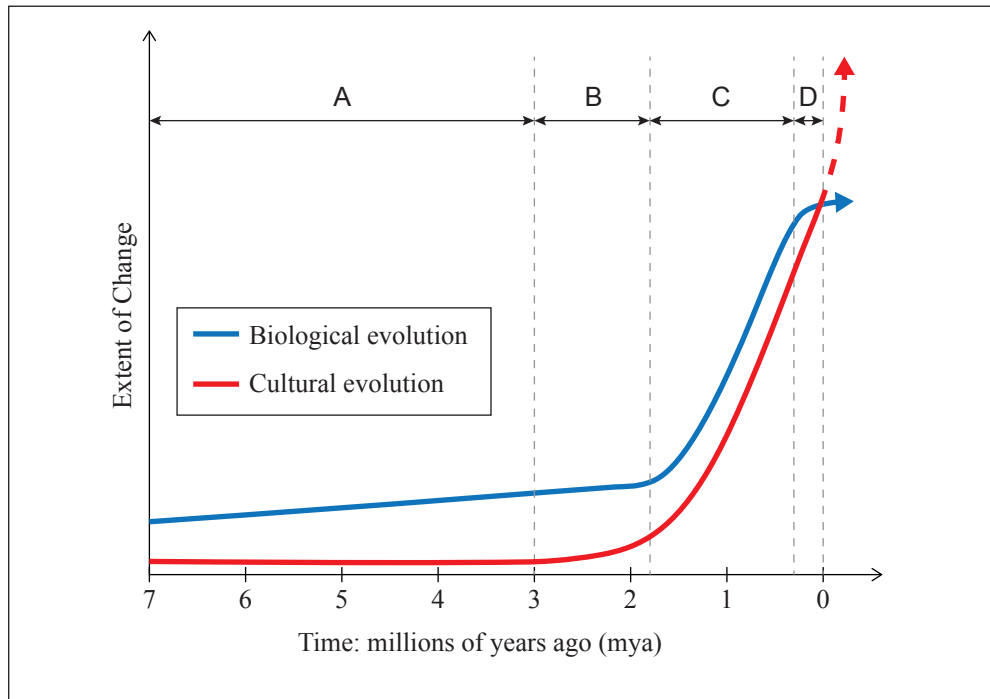
Analyse the information provided in the resource material and integrate it with your biological knowledge to discuss:

- the evolution of the distinctive niche of the kiwi
- how changes in the land mass of New Zealand have contributed to the evolution of the 5 different species of kiwi within New Zealand, and the presence of different varieties of brown and tokoeka kiwi.

QUESTION THREE: *HOMO ERECTUS* – A PIVOTAL SPECIES?

Biological evolution and cultural evolution have occurred at different rates during hominin evolution.

Graph showing extent of change in the biological and cultural evolution of hominins



One of the first hominin fossils found was in Asia and called ‘Java man’. Their fossils were subsequently classified as *Homo erectus*, ‘upright man’. *H. erectus* was a hominin that lived between about 1.8 mya and 300 000 ya (timespan C on the graph above). Since then many other hominin fossils of similar age have been found in Europe and Africa. Some paleoanthropologists classify these fossils as being one diverse species, *H. erectus*, which had spread throughout Asia, Africa, and Europe. However, other paleoanthropologists suggest they are from several different species: *H. erectus* in Asia, *H. ergaster* in Africa, and *H. georgicus*/*H. rudolfensis* in Europe.

To avoid confusion when answering the question that follows, consider *H. erectus* to be a single, diverse species that existed in Asia, Africa, and Europe.

H. erectus is considered to be a pivotal species in the evolution of modern humans.

Question

Analyse the information provided in the resource material and integrate it with your biological knowledge to:

- compare and account for the differences in the rate of change for biological and cultural evolution shown by the graph. Refer to each of the timespans indicated (A, B, C, D) in your comparisons
- analyse the biological and cultural evolution of *H. erectus* to discuss why *H. erectus* could be considered a pivotal species in the evolution of modern humans.

