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93101Q

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Scholarship 2006
Biology

9.30 am Thursday 7 December 2006
Time allowed: Three hours
Total marks: 24

QUESTION BOOKLET

Answer ALL questions.

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

Start each question on a NEW page. Number each question carefully.

Check that this booklet has pages 2–6 in the correct order.

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

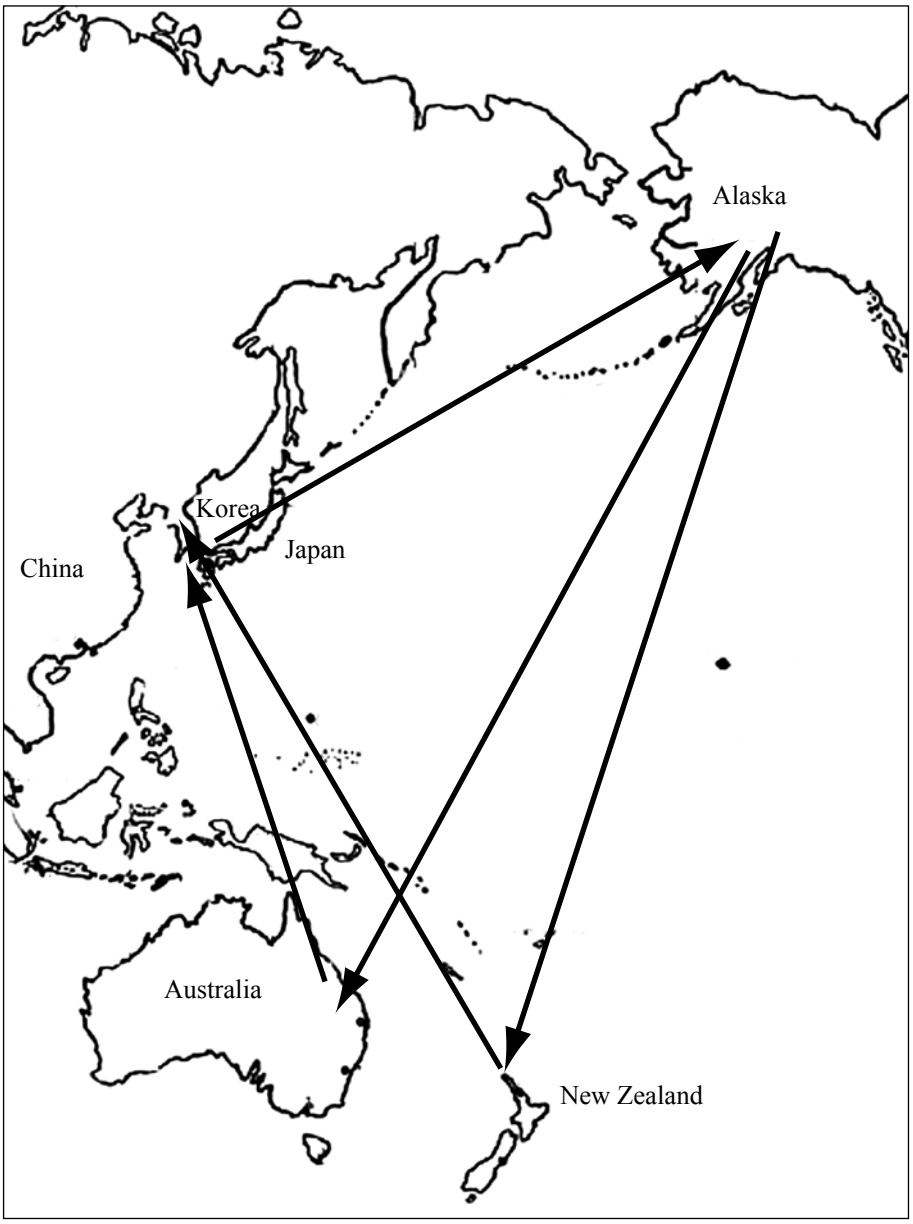
You have three hours to complete this examination.

QUESTION ONE

The bar-tailed godwit, *Limosa lapponica baueri*, or kuaka, is a wading shorebird seen on marshy estuaries and wetlands during the New Zealand summer. Populations of this species embark on some of the longest migrations known amongst migratory animals.

Bar-tailed godwits breed in Alaska, spending the non-breeding season in New Zealand and eastern Australia (see map opposite). The journey from New Zealand to Alaska – a distance of up to 13 000 km – is completed in two stages. It begins in March, when the birds fly to South Korea, Japan or China. Here, they spend some time on feeding grounds (called staging sites) that may be shared with other migratory species, before leaving for Alaska in May. The birds return to New Zealand in September and October, taking a direct, non-stop route over the Pacific Ocean – a flight of approximately 11 000 km that takes 6 – 10 days. This southward migration begins about one month earlier than that of other migratory species.

Before each migration begins, flocks of godwits congregate at leaving sites and feed continuously. At the time of departure, up to 45% of their body weight is fat. Adult birds accumulate more fat than juveniles. The timing of the migratory flights coincides with weather systems, in both northern and southern hemispheres, that generate favourable tail winds.



Migratory routes of bar-tailed godwits throughout the Pacific Ocean.

Discuss the biological concepts associated with the migration of the **bar-tailed godwit**. In your discussion, consider:

- the biological mechanisms involved in the preparation for, and during the migration
- the benefits and risks of migration to the birds
- how this behaviour may have evolved.

QUESTION TWO

Casein is the main protein in milk. There are three types of casein, one of which is **beta casein**.

Beta casein comes in two main variants called **A1** and **A2**. The order of amino acids in each variant is identical except for the **67th** amino acid in the chain (see diagram below). In A1 beta casein, the 67th amino acid is histidine (His), while in A2 beta casein it is proline (Pro). Scientists believe that A2 was the original form of beta casein.

Amino acid sequences in A1 and A2 beta casein.
N.Z. Herald, April 7th 2003

Cows' milk that contains A1 beta casein is called **A1 milk**, while milk that contains A2 beta casein is called **A2 milk**. In New Zealand, 30% – 40% of dairy cows produce pure A2 milk. The rest produce **either** pure A1 milk **or** milk that is a mixture of both A1 and A2. From these figures, it can be calculated that the current frequency of the A1 allele is around 37%.

There are several breeds of dairy cow. Each breed has a combination of desirable characteristics that has been obtained through selective breeding. For example, the proportion of fat or protein in the milk, the amount of milk produced by the females, the breeding success of the females. Different breeds produce different types of milk in relation to beta casein. Some breeds produce mainly A1 milk, while other breeds produce mainly A2 milk. Recent research has suggested that there may be health benefits to humans in drinking A2 milk, as opposed to drinking A1 milk.

Discuss the genetics involved in the **inheritance** of the alleles responsible for the A1 and A2 casein proteins in the milk of dairy cows. In your discussion, consider the following:

- how the allele for A1 milk would have entered the gene pool
- the pattern of inheritance shown by A1 and A2 milk
- possible explanations for the current frequency of the A1 allele in the gene pool.

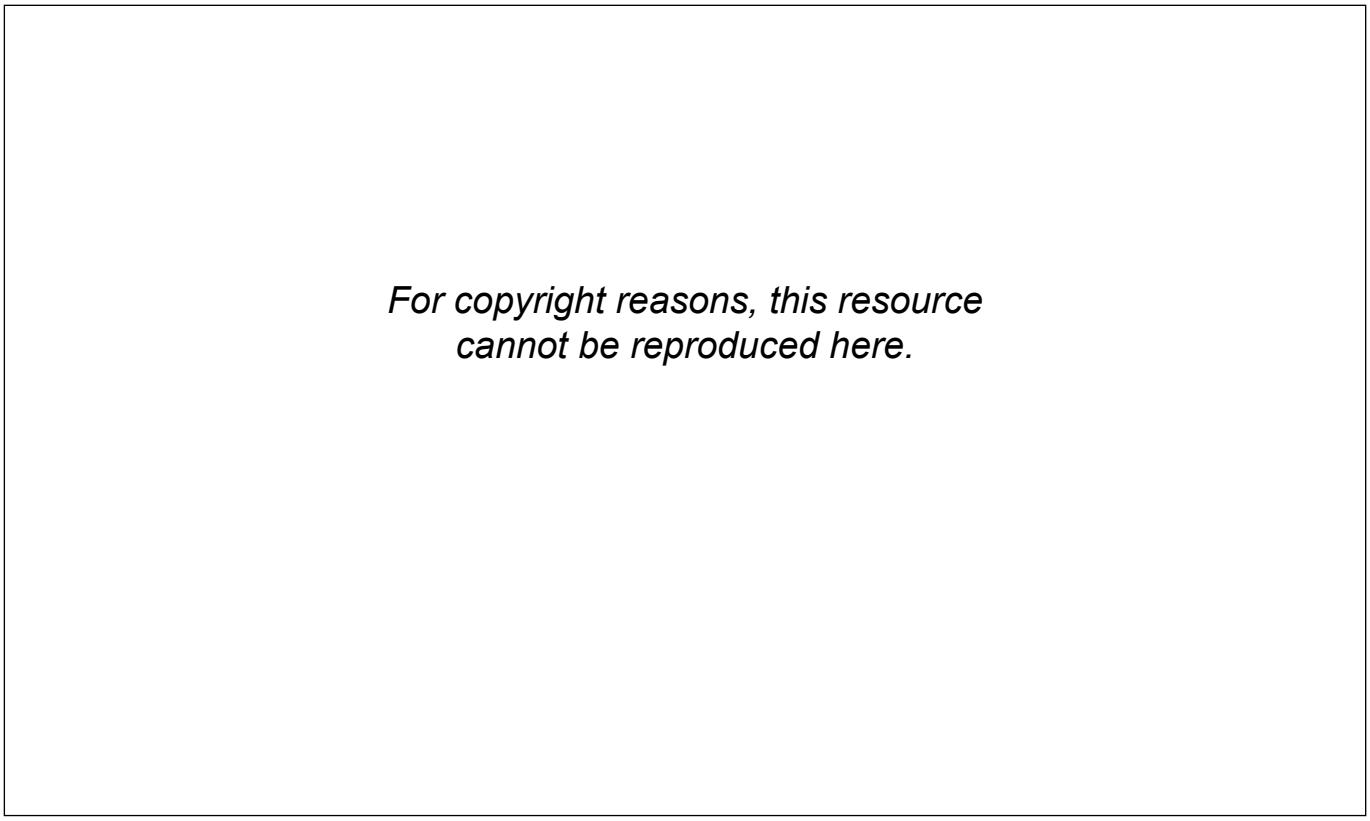
The following mRNA – Amino Acid table may assist you in answering the question.

First Letter	Second Letter: U	Second Letter: C	Second Letter: A	Second Letter: G	Third Letter
U	**UUU** Phe	**UCU** Ser	**UAU** Tyr	**UGU** Cys	U
	UUC Phe	**UCC** Ser	**UAC** Tyr	**UGC** Cys	C
	UUA Leu	**UCA** Ser	**UAA** STOP	**UGA** STOP	A
	UUG Leu	**UCG** Ser	**UAG** STOP	**UGG** Try	G
C	**CUU** Leu	**CCU** Pro	**CAU** His	**CGU** Arg	U
	CUC Leu	**CCC** Pro	**CAC** His	**CGC** Arg	C
	CUA Leu	**CCA** Pro	**CAA** Gln	**CGA** Arg	A
	CUG Leu	**CCG** Pro	**CAG** Gln	**CGG** Arg	G
A	**AUU** Iso	**ACU** Thr	**AAU** Asn	**AGU** Ser	U
	AUC Iso	**ACC** Thr	**AAC** Asn	**AGC** Ser	C
	AUA Iso	**ACA** Thr	**AAA** Lys	**AGA** Arg	A
	AUG Met	**ACG** Thr	**AAG** Lys	**AGG** Arg	G
G	**GUU** Val	**GCU** Ala	**GAU** Asp	**GGU** Gly	U
	GUC Val	**GCC** Ala	**GAC** Asp	**GGC** Gly	C
	GUA Val	**GCA** Ala	**GAA** Glu	**GGA** Gly	A
	GUG Val	**GCG** Ala	**GAG** Glu	**GGG** Gly	G

mRNA-amino acid table

QUESTION THREE

The phylogeny below represents a widely-accepted model of human evolution.



Adapted from *Scientific American*, February 2005.

Hominin phylogeny

Although there are differences in interpretation of the evidence, it is generally accepted that human biological evolution has not been a linear progression from one species to the next. In fact, there are now thought to have been between 5 and 7 hominin genera, and at several points there have been 2 or more species and / or genera in existence at the same time.

Significant factors involved in the biological evolution of humans include:

- genetic drift
- natural selection
- cultural evolution.

Using selected **named hominins**, discuss how each of these three factors has contributed to the biological evolution of humans.