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91606

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NZQA

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MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
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Level 3 Biology, 2016

91606 Demonstrate understanding of trends in human evolution

2.00 p.m. Thursday 10 November 2016
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of trends in human evolution.	Demonstrate in-depth understanding of trends in human evolution.	Demonstrate comprehensive understanding of trends in human evolution.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

If you need more room for any answer, use the extra space provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–15 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Excellence

TOTAL 20

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QUESTION ONE

Documenting similarities and differences between Hominid species is fundamental to understanding their biological and evolutionary relationships. The skulls A and B show some similarities and differences. Anthropologists have agreed that Skull A is older than Skull B.

Skull A

https://blogopithecus.files.wordpress.com/2009/03/tcahd-3d-reconstruction.jpg

Skull B

www.sideshowtoy.com/mas_assets/jpg/KAM05_press01-001.jpg

www.anthrophoto.com/cgi-bin/ImageFolio31//imageFolio.cgi?search=under&img=&cat=&bool=phrase

www.sideshowtoy.com/mas_assets/jpg/KAM05_press02-001.jpg

http://www.dlt.ncssm.edu/tiger/360views/Hominid_Skull-Homo_erectus_PekingMan_1200x900/top-bottom/Hominid_Skull-Homo_erectus_PekingMan-top-900.jp

Discuss the selective forces which would support the evolutionary changes observed in Skull B compared to Skull A.

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In your discussion:

- describe FOUR features that support Skull A being older than Skull B
- explain how these identified features can be linked to evidence of bipedalism, and to the types of food these hominids ate
- discuss how the changes in the skull features have led to evolutionary trends in bipedalism, diet, and intelligence of hominids.

Skull A has a much more pronounced muzzle / prognathism than Skull B - whose facial angle is less sloped. Skull A also has a much larger zygomatic arch for jaw muscles to pass through. The size of molars and canines are reduced in Skull B, and there is no diastema, where Skull A's molars & canines are larger, and has a diastema. Dentition of Skull A follows a horseshoe U shape, while dentition of skull B is much more parabolic. The framen magnum of skull A is slightly further back than Skull B (where it's almost directly centre). Skull A has a smaller cranial capacity than skull A, suggesting its brain was likely smaller. There may be a larger sagittal crest on Skull A.

Evidence of bipedalism can be seen by the framen magnum moving towards the centre of the skull. This shows the head becoming balanced on the shoulders due to standing upright. This led to reduction of neck muscles and the sagittal crest since the head didn't need to be pulled back up by muscle. The change in dentition shows increase of softer, easier to chew foods. The large molars of skull A were likely to chew its tough, fibrous plant diet. The smaller molars of skull B suggests that a smaller proportion of its diet was tough plants and more were meat. This led to redundancy of strong jaws/

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jaw muscles, and so the zygomatic arch reduced in size. The more prominent muscle of skull would have helped withstand chewing forces and reduction of prognathism also suggests less brittle/tough food. Larger cranial capacity would have occured because the jaw/neck muscles and bone mass decreased, allowing more energy and resources to be used for expanding the brain/brain cast. Also increase of protein in diet due to more meat would allow for more brain growth. Increased cranial capacity also showed food being easier to chew. Since calories could be gained faster so there's more energy to power the brain.

As hominins evolved, they transitioned from quadrupeds to habitual bipeds. The shifting of the foramen magnum to the centre of the skull would have facilitated upright posture and also helped balance. Enlargement of brain areas in control of balance and co-ordination (e.g. cerebellum) would also have helped hominins become bipedal and walk more efficiently on two legs.

Larger skull and more developed brain lead to increased dexterity in the hand, and the precision grip was able to further develop. Hand-eye coordination increased and tool manipulation became possible. This led to hominins being able to access food & resources other animals couldn't E.g. Oldowan tools allowed H. habilis to eat highly nutritious bone marrow. It also helped hunting as weapons could be thrown while running, e.g. stone spears. Brain development led to the ability to tend and even

stand fires. Fire could cook the food they ate (softening meat) and kill harmful microbes. This led to increased efficiency in nutrition intake and improved quality of diet.

More developed brain areas and increasing intelligence allowed for better cooperation. Individuals could hunt cooperatively, increasing the group's chances of survival. Areas in control of speech (e.g. Broca's and Wernicke's area) allowed development of language. This led to further cultural evolution where individuals could share experience and better relay messages (e.g. food can be found where). Development of brain areas like the frontal lobe increased hominins' ability to analyse and plan. The higher level thinking allowed hominins to out compete other animals and problem solve.

Expansion of cranial vault allowed for more endocranial development which led to further biological and cultural evolution. This further stimulated brain development like a positive ~~feedback~~ loop.

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E7

QUESTION TWO

Homo habilis, *Homo erectus*, and *Homo neanderthalensis* have developed different forms of cultural evolution to help them survive successfully in their ecological niche. Some of these forms of cultural evolution are shown in the pictures below.

Homo habilis
http://earlyman.yolasite.com/homo-habilis.php

Homo neanderthalensis
http://ies.aquiscelenis.climantica.org/2012/02/20/homo-neanderthalensis/

http://hoopermuseum.earthsci.carleton.ca/neanderthal/neanderthal.jpg

Homo erectus
www.erasmatazz.com/library/science/the-phylogeny-of-play.html

www.flashofgold.com/14-events-that-changed-military-history/

Analyse the different aspects of cultural evolution.

In your analysis:

- define cultural evolution
- describe the different forms of cultural evolution associated with *Homo habilis*, *Homo erectus*, and *Homo neanderthalensis*
- explain how these different forms of cultural evolution are adaptive advantages for the species who use them
- discuss the advantages and disadvantages that cultural evolution has had on biological evolution.

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Cultural evolution is the transmission of ideas and beliefs from generation to generation.

Homo habilis is associated with oldowan stone tools. These are simple and have few flakes struck off. These tools allowed H. habilis to cut up meat and smash bones to access the nutritious and protein rich bone marrow. This gave H. habilis a selective advantage as they could exploit new niches others couldn't. And it assisted their scavenger/opportunistic feeding. The extra nutrition would also allow for more brain development.

Homo erectus is associated with acheulean tool culture and with tending fires. Acheulean tools are bifacial, often pear shaped, with many flakes struck off the edges. There was an increase in cutting edge length and the acheulean hand axes allowed H. erectus to butcher animals more efficiently, cut plants/wood, and may even hunt with them. Fire was controlled by H. erectus but mostly started by nature (e.g. lightning). Fire extended activity hours, allowing H. erectus to carry out more home-base activities like plan hunts and make tools. Fire encouraged socialising and communication - e.g. sitting around a fire sharing experiences. Fire allowed for food to be cooked (making it easier to chew) and removed bacteria so survival increased. Fire also helped H. erectus when they ventured out of africa into colder regions like Europe as it provided warmth at night. H. erectus could use fire for protection as it scared off potential predators, so there was reduced chance of being eaten.

Homo neanderthalensis are associated

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with mousterian tools and spiritualty. Mousterian tools were much more complex than its predecessors, and often required multiple steps and lots of planning / forethought. E.g. the levallois technique which required a 'base' to be made, then flakes struck off it. The cutting edge of the flakes produced were much longer and sharper. Mousterian tools allowed for animals to be skinned more efficiently and could be used to make clothing. This was hugely beneficial in cold climate that H. neanderthals lived in as it provided warmth so reduced chances of hypothermia. Mousterian tools were also starting to have wooden handles attached, which produced spears that could be thrown. This increased success in hunting large animals which Neanderthals' diet depended upon. H. neanderthalensis buried their dead, which shows belief in spiritualty or some sort of afterlife. It showed greater care for other individuals and more complex, intangible ideas developing.

Cultural evolution has had huge advantages on biological evolution. The development of tools and fire greatly improved diet, which allowed brain development and specialisation. It also increased the species' chances of survival, by providing protection from predators and assisted in hunting prey. Manipulation of tools increased dexterity of the hand, and helped the thumb become more opposable, which allowed finer tools to be made. One disadvantage of cultural evolution could be due to establishment of settlements and agriculture by H. sapiens. Long term concentration of humans in one area led to increase in diseases and allowed certain diseases to spread from domestrated animals to humans (e.g. swine flu). This however has been mostly overcome with the development of medicine and technology today. But for ancient H. sapien populations, a disease could wipe out a whole tribe.

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M6

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QUESTION THREE

Modern humans began to migrate out of Africa around 100 000 years ago. Map 1 below shows the migration paths that modern humans took.

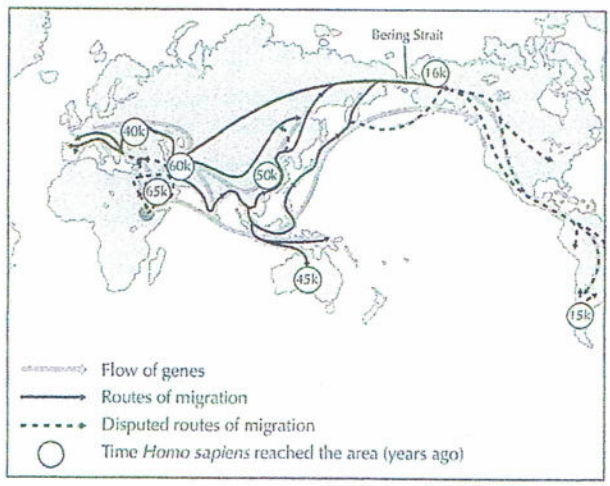
As humans moved through Europe and Asia they would have met these earlier hominins, like the Neanderthals in Europe and Denisovans in Asia (Map 2).

Scientists analysed the genetic information of more than 1 500 people from all around the world, and determined that ancestors of modern humans interbred (admixture) with Neanderthals and Denisovans.

Today, the genetic makeup of most people born outside Sub-Saharan Africa is 1 to 4 percent Neanderthal. The Denisovans also left Africa early, and like their Neanderthal relatives, they interbred with *Homo sapiens*.

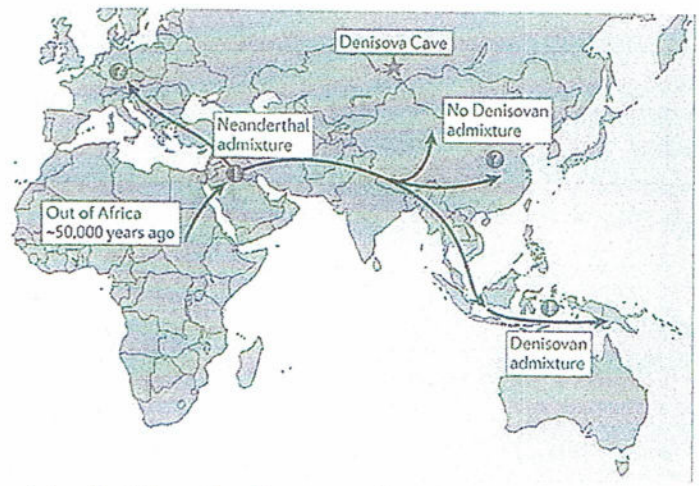
The Tibetan people have a variant of the EPAS1 gene that allows them to deal with low oxygen with fewer red blood cells than the rest of us. Their blood stays thin and healthy 4.8 kilometres up. This gene can be traced back to the Denisovans; they shared this gene with people who now live in Tibet.

HLA is a gene that helps white blood cells destroy micro-organism intruders in our bodies. Researchers believe people carrying this gene can thank Neanderthals and Denisovans for it, as these hominins had already adapted to infections and diseases found outside Africa.



Map 1. Migration Routes of *Homo sapiens*

Adapted from: Sinclair, Anna Roberts & M. *Level 3 Biology Study Guide*, 3rd Edition. ESA Study Guide



Map 2. Migration Route and Regions of Admixture

http://www.nature.com/nrg/journal/v12/n9/fig_tab/nrg3029_F4.html#figure-title-history/

Discuss the advantages and disadvantages of taking the various migration routes, and the possible effects that this has had on cultural and biological evolution.

In your discussion:

- describe the reasons for dispersal to other regions, and identify the benefits gained from the dispersal
- explain how changes in the environment could have influenced the migration routes used
- explain how the evidence of mtDNA and DNA analysis support the 'out of Africa' dispersal model
- discuss how admixture (interbreeding of two previously isolated populations) could have helped with dispersal.

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Competition for resources such as food would prompt humans to disperse out of Africa. The population numbers in Africa could have gotten so large that they competed excessively with other species or intraspecific. Since H. sapiens early on were still relatively nomadic, shortage of resources would prompt them to leave & and find a new place with more resources. Climate change in Africa could have led to dispersal by opening up routes previously inaccessible (e.g. Saharan desert) or made certain resources more scarce. Dispersal allowed for humans to have larger territories so more food, and also reduced intraspecific competition. It allowed humans to explore new niches and also discover new types of food.

Climate changes such as ice ages would have produced land bridges that allowed access to new continents. E.g. a land bridge across the Bering Strait allowed for human migration 16kya. Warming climate and rising sea levels would remove land bridges, making certain areas inaccessible. Cold climate or extensive freezing over would delay human migration, or force them to travel a different way. For example Europe was mostly frozen with ice and very cold during the ice age so migration of humans immediately after they left Africa 65kya followed the south-east coastal route towards Australia instead of directly north into Europe. Then as climate warmed, Europe became more tolerable / accessible so 40kya humans entered Europe.

mtDNA is passed directly from mother to child so it doesn't undergo meiosis. And it mutates at a much faster rate than nuclear DNA, so is helpful for tracking short term evolution. There is most

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genetic variation in the African population, suggesting all non-African humans dispersed out of Africa after humans evolved in Africa from H. erectus. Because African H. sapiens have had the largest time to accumulate mutations (which occur randomly) so they naturally have the most variation. Also all other humans must be descended from founder populations that left Africa, so the ancestral founder's populations' allele frequencies would be non-representative of the original population. It's possible that certain alleles were missed out by the founder's populations, or non-existant in non-African humans. The most recent common ancestor of modern humans is traced back to around 150 kya. This supports the out of Africa hypothesis because had European, Asian, and African humans evolved simultaneously and independently from H. erectus which dispersed around 2mya, the common ancestor would be much older.

Admixture between Tibetans and Denisovans introduced the EPAS1 gene variant that allows better survival at high altitudes (prevents blood thickening at high altitude). This provides a selective advantage and would have assisted humans populate higher altitudes such as Tibet. The HLA gene which was also introduced to the human gene pool by interbreeding with the Neanderthals and Denisovans help white blood cells destroy micro-organisms intruders. Increased immunity from infections and diseases also help the individuals chances of survival. So the allele frequency of these two alleles would increase. Admixture would have introduced other alleles similar to EPAS1 and HLA variant which help humans survive out of Africa. So it would assist in humans populating other continents such as Europe and Asia. Interbreeding may also have reduced competition and agression between humans and Denisovans/Neanderthals since they're viewed as potential mates rather than competition, further aiding dispersal.

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Extra paper if required.
Write the question number(s) if applicable.

QUESTION NUMBER

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Annotated Exemplar Biology Level 3, 91606

Excellence exemplar 2016

Subject:	Biology	Standard:	91606	Total score:	20

Q	Grade score	Annotation
1	E7	To gain E7 the candidate discussed the changes in skull structure which result in a larger cranial capacity for brain expansion. To attain an E8 the candidate also needed to discuss how the centralised foramen magnum has reduced the energy needed to support the large neck muscles and this now available energy could be used to run the high energy demanding larger brain.
2	M6	The candidate correctly explained in depth the adaptive advantages for each of the tool cultures and associated each correctly with the 3 hominins. To gain Excellence the candidate needed to clearly identify and discuss an advantage or disadvantage that this form of cultural evolution had on biological evolution.
3	E7	The candidate discussed in depth the advantages and disadvantages of how environmental conditions affected the various dispersal routes taken by H. sapiens through Asia and Europe. In order to gain E8 the candidate needed to clarify that for admixture to be a selective advantage the two alleles (HLA and /or EPAS1) needed to be inherited / passed on to future generations of H. sapiens.