Assessment Schedule – 2017

Biology: Demonstrate understanding of trends in human evolution (91606)

Evidence

Q	Evidence	Achievement	Merit	Excellence
ONE	By becoming bipedal, the hands became free and because there were less trees there was less brachiating and a selective pressure to move between forested areas separated by grassland savannahs. The adaptations of hand with the fingers that were shorter with the thumb getting longer, with the finger bones being less curved than those of the *Ardipithecus ramidus*. By using bipedal movement early hominins gained an adaptive advantage because they were able to use their hands for other tasks that would allow them to better survive in this new environment. Because there was a greater selective pressure on the development of the manipulative ability of the hand and less of a need for arboreal movement / brachiating. The trend of the fingers reducing in length and curvature can be observed in the fossil record. The greater curvature and length was more of an advantage when the environment was fully forested and an adaptive advantage was gained by individuals that were able to grasp the branches and swing from branch to branch. When the environment changed, there were new selective forces like predation and the ability to walk efficiently between forested outcrops was an advantage. They could carry young between the forested areas. This would have meant that the young of those hominins could have an advantage at surviving compared to those that did not have this adaptation. They could carry food from one location to the next, which would leave them less vulnerable to predators • Therefore, being better able to survive and reproduce. Having a fully opposable thumb, hominins could more	**Describes two evolutionary trends in the hands shown.** • *H. neanderthal* fingers are shorter/thumb gets relatively longer. • The first metacarpal is connected to the wrist by a saddle joint (or similar) in *H. neanderthal.* • The *H. neanderthal* phalanges/finger bones are straighter compared with the *A. ramidus*. **Precision grip and power grip are described.** • **Precision grip** is the ability to perform fine manipulative movements. • The **power grip** is the ability to have a clamp-like formation in which the fingers and the palm are partly flexed and (counter) pressure is applied by the thumb. **Describes changes in the environment** • The environment changed to cooler and drier/the forest composition changed from fully forested to savannah **Describes adaptive advantages of freeing the**	**Explains how a change in environment may lead to a change in the structure of the hand.** • The cooler drier climate caused a change in vegetation from fully forested areas to forest outcrops dispersed between grasslands reducing the need for arboreal movement or brachiating • Explains that a change in vegetation means that individuals that were better suited to bipedal movement freed up hands to carry things like children, tools and food. **Explains how the evolutionary trends in the hand provide an adaptive advantage** • The saddle joint (or similar) enables the thumb to be brought across the hand to touch the tip of any finger. • The curved phalanges/finger bones act as hook around branches and are better adapted to brachiating. • The precision grip allows better manipulation of objects and accuracy e.g they were better able to develop and use tools because they could more accurately strike the stone in	**Discuss the adaptive advantages that these evolutionary trends to the hand and bipedalism could have provided.** **Discusses the adaptive advantage of bipedal movement.** Because the hominins were no longer in fully forested areas, brachiating was not as important, and individuals that were more efficient at bipedal movement and used less energy moving between the forested outcrops. Moving efficiently between remnant forest was an advantage as they were able to use less energy when travelling and better able to escape predation therefore increasing their survival. The evolution of bipedal movement had a positive feedback (or implied) on the evolution of the hand because as the bipedal movement evolved the hand became free and is able to carry out many different tasks that were not able to be carried out as they were used for brachiating. **Discusses the adaptive advantage of the evolution of the hand.** The functions that make the human hand so distinctive are the ability to firmly grasp objects and improved precision and manoeuvrability. This allows later hominins to engage in more advanced tool-making activities. which led to better access to food. Better supply of nutrient-rich food such as the marrow from bones meant that the early hominins were better able to survive. This means that having the hand adaptation provided a way to gain access to food that can increase the fats and protein that provide the energy required to fuel a large brain. **Explains the change in environment and links to the evolutionary trend in the hand and the adaptive advantage to the survival of the**

	accurately shape tools using the precision grip and power grip; this allowed them to access a wide variety of foods which could provide them with a more energy-rich diet. It also enabled them to carry their tools with them from one geographical location to the next. The evolution of the hand is a result of changes in the environment, which selected for features that promoted bipedalism. Bipedalism freed up the hands, which in turn selected for shorter fingers and longer thumbs. Thus, providing better dexterity and manipulation of the hands, which increased the survival of individuals with these characteristics, which are then better able to survive and therefore reproduce. This is an example of positive feedback where the evolution of the legs and feet had a positive effect on the evolution of the hand by freeing it up to select for adaptations better suited to the change in environment.	**hands or bipedalism** • ability to carry young/improved toolmaking/weapons/carry food or other.	areas where needed. **Explains how bipedalism provides an adaptive advantage** • The environment changed from continuous forest, the selective pressure changed from grasping and climbing used for brachiating individuals with hands, to efficient bipedal movement which required less energy/exploit other niches/see predators/improved thermoregulation.	**<u>individuals</u> with this adaptation for bipedalism caused by changes in the environment.** E.g. the evolution of bipedalism has a positive effect on the evolution of the hand. Due to changes in the climate, the vegetation changed to forested outcrops. This meant that hominins that were better adapted to moving between forested outcrops, were also better adapted to bipedal movement. Bipedalism freed up the hands to carry babies, tools, manipulate tools etc. The individuals with better adaptations suited to the forested outcrops were able to survive and therefore reproduce, reinforcing the best traits suited to the environment.

Not Achieved			**Achievement**		**Merit**		**Excellence**	
NØ = No relevant points	N1 = ONE point.	N2 = TWO points.	A3 = THREE points.	A4 = FOUR points.	M5 = One of the Three ideas	M6 = Two of the three ideas	E7 = ONE of the three ideas	E8 = TWO of the three ideas

Q	**Evidence**	**Achievement**	**Merit**	**Excellence**
TWO	**Biological** (or genetic) evolution occurs through genetic change and reproduction, and involves the transfer of genes from one generation to the next. Compared to **cultural evolution**, which occurs through the development of customs and languages,	**Describes the difference between cultural and biological evolution.** • **Biological** evolution occurs	**Explain the selective pressures that could lead to cultural or biological changes.** • *H.habilis* (or other) was able to scavenge from carcasses using Oldowan tools that	**Analyses how cultural evolution has affected biological evolution on the skull and pelvis of hominins.** • **increased cranial capacity**

	and involves the transfer of information either within a generation or across many generations. The cranial capacity increases from *Australopithecus africanus* to *Homo sapiens*. This occurred as a result of positive feedback where the use of tools led *Homo erectus* to eat meat and bone marrow which provided the fats and energy required to support a larger brain. The brain is 2% of the body mass but uses 20% of the body's energy. The development of the tools had a positive effect on the biological evolution of the brain because as the tools became more worked and specialised, the food source became more protein (meat) rich. This in turn allowed the forebrain to expand, which is the area responsible for abstract thought, which helps with the development of the tools. Another related advancement in cultural evolution was the use of fire. As food was cooked, it denatured protein and made the food softer, reinforcing less chewing and a selective pressure against having a large jaw, jaw muscles, zygomatic arch and brow ridge, which relieves the pressure of chewing hard materials. This therefore affected the biological evolution of the skull . The brain expansion which is positively affected by cultural evolution also developed the Broca's area associated with *Homo habilis*. This area of the brain assists with controlling the muscles that make sound for speech. The Wernicke's area was developed in *Homo erectus* and assists with sound recognition (recognising speech). As both of these areas developed, the ability to communicate increased, and therefore their ability to transfer knowledge improved. This is another positive feedback loop where cultural evolution of communication increases cooperation, leading to more advanced tools, which leads to more successful hunting and division of labour, which leads to a higher quality diet and ultimately brain expansion. The pelvis becomes thicker, wider, and more bowl shaped from *Australopithecus afarensis* to *Homo sapiens*.	through genetic change and reproduction, and involves the transfer of genes from one generation to the next • **Cultural evolution** The transmission of knowledge from generation to generation by teaching/learning or passing on of information that is not genetically derived. • Describes one difference between BE and CE. (any **two** of the above) **Describes the trends in biological evolution of the skull and hips.** • The cranial capacity increases from *A.africanus* to *H. sapiens*. • The pelvis become thicker/larger/wider from *A. africanus* to *H.sapiens*. • A reduction in the size of the brow ridge/jaw etc from *A. africanus* to *H.sapiens*. **Describes the trends in cultural evolution** • Increased complexity in technology/improved communication for transmission of ideas or similar.	were made by striking the chopper with a few blows to get a rough edge to get access to high energy bone marrow/protein which allowed for the expansion of the cranium. • Use of fire by *H.erectus* to cook their food, which would cause it to become softer AND this would reduce the amount of chewing, reducing the selection pressure for a large jaw/large jaw muscle/large zygomatic arch/large brow ridge. • As the tools became more refined from *H.habil*is using Oldowan tools to *H.sapiens* using Upper paleolithic tools, this increased access to food sources/food softening. This allowed for the reduction on the brow ridge as the muscles and large jaw were not required, (because the grinding and chewing was decreasing). This allowed for the expansion of the forebrain/cranium. • The increase in skull size allowed for the expansion of the forebrain. This provided the evolving species with greater abstract thought. This means that the evolving species were better able to use and develop tools. • They also developed speech with the development of the Broca's area, and recognition of speech with the development of the Wernicke's. The development of these regions of the brain proceeded before cultural evolution occurred for the communication required for the transmission of ideas. • As the pelvis became more bowl-shaped, that assisted in supporting internal organs while standing upright which helped reduce the stress of the upper body • The wider/larger pelvis allows for the birth of babies with larger heads which was was necessary due to the increase in skull size. • The strong pelvis supports large muscles that move legs during walking. This means	**through development of tool technology (positive feedback).** Because the early hominins had larger brow ridge, which was required to process hard fibrous plant-based material, they needed a large jaw and large jaw muscles to crush and grind their food. As the technology and tools developed, they were able to process and access softer, more nutrient-rich foods, the brow ridge became more reduced and this made brain expansion possible. Because of the expansion of the forebrain the ability of abstract thought also increased, this is evident in the complexity of the tools that were developed. To work a stone tool to have a biface / two sides, allows better access to softer and fat rich foods. This is an example of positive feedback loop where the tool culture developed and leads to greater access to fats and proteins in the diet. This then leads to greater development of the brain as this provides a selective advantage. • **Trade-off between efficient bipedal movement and large brain size.** The pelvic bones show that members of this *H. erectus* had a narrower pelvis and pelvic canal than ours. This implies that their babies were smaller-brained at birth; it also suggests that *erectus* may have been more efficient at walking than *sapiens*. This means that there was a selective advantage of having a

	Because the upper body is balanced above, the pelvis is wider and thicker, which reduces the stress by spreading it out over a greater surface (wider). It also provides a greater surface area for the attachment of large gluteal muscles required for bipedal movement. As the brain developed in response to the positive feedback caused by cultural evolution, the pelvic girdle was also affected because as the brain size increases, the pelvic girdle must also increase to allow the birth of larger brained offspring. The adaptive advantage for a larger brain must outweigh the adaptive advantage of efficiency of bipedal movement. This is because *Homo erectus* had a narrower gait and were **more efficient** at bipedal locomotion than modern humans. Modern humans, however, have a bigger brain, which allows for better abstract thought and communication. It also allows for better hunting practices and development of better tools, all becoming very energy-efficient and having the ability to better survive changes in the environment.		that the species that used bipedalism were more efficient at walking and used less energy up to *Homo erectus*. • As the hips got wider in *Homo sapiens*, they became less efficient at bipedal movement than *Homo erectus.* However, they could have offspring with larger heads, which was a greater adaptive advantage than efficiency of walking, because they could better plan and communicate etc.	larger brain over the efficiency of bipedalism. This would suggest that the cultural evolution of language, fire, tools, abstract thought and division of labour provides a greater selective advantage than having efficient bipedal movement and therefore narrow hips.

Not Achieved			**Achievement**		**Merit**		**Excellence**	
NØ = no response; no relevant evidence.	N1 = 1 point, from Achievement.	N2 = 2 points from Achievement.	A3 = 3 points.	A4 = 4 points.	M5 = 1 Pelvis **AND** 1 larger skull advantage	M6 = 2 Pelvis **AND** 1 larger skull advantage (or visa versa)	E7 = 1 positive feedback linked to brain expansion, 'cultural' linked to reinforce biological evolution **or** trade off idea	E8 = E7 **and** trade off in efficiency of bipedalism in *H.erectus* and humans.

Q	Evidence	Achievement	Merit	Excellence
THREE	The **replacement theory** is based on the idea that *H. erectus* left Africa and that outside of Africa these early hominins evolved in to *H. neanderthalensis*. But that these earlier hominins (*H. neanderthalensis or other*) were replaced by modern humans that evolved in eastern Africa and then migrated north into Europe. Compared with the **multiregional theory**, which is based on the idea that as *H. erectus* (*H. ergaster*) migrated out of Africa they evolved into modern humans in the different regions that they migrated to simultaneously as there was interbreeding occurring between populations, allowing for gene flow to occur. The one type of evidence that supports the replacement theory is fossil evidence because transitional fossils are found (of *Homo ergaster*) which suggests a gradual enlargement of the brain (encephalisation) was occurring among archaic *Homo* species in Africa, which supports the theory of evolutionary change, specific to Africa. Other features such as teeth, jaw and development of a chin also are found in the fossil record as evidence of changes in fossils found in Africa. **Compared** with incomplete fossil evidence from outside of Africa, but the multi-regional theory suggests that fossil finds represent intermediates between *H.erectus*, Neanderthals and modern *H. sapiens* – that physical difference between these groups represent regional differences. E.g. some modern cold-adapted populations have similar features to the *H. neanderthalensis* – this means that many species cannot be classified because of the regional differences of a single species. Although both the replacement and the multiregional theories use fossil evidence, they interpret the evidence so differently. When using fossil evidence it cannot be determined if the two groups of interest fit the species definition of	**Describes the replacement theory.** • That *H. sapiens* developed in (east) Africa • The earlier hominins (*H erectus* and *H. neanderthalensis*) are replaced over time by modern *H. sapiens.* **Evidence** • Oldest fossil is found in Africa (Ethiopia) • Mitochondria are inherited from the mother only (mtDNA). • Y chromosome is inherited from father only. **Describes the multiregional theory.** • *H. erectus* left Africa and dispersed into different areas in Europe and these populations slowly evolved into modern *H. sapiens* in their separate regions. • Interbreeding between adjacent populations **Evidence** • Intermediate fossils between *H. erectus, H. neanderthalensis* and modern H. *sapiens* – that physical difference between these groups represent regional differences.	**Explains evidence that support the replacement theory.** • Explains that the oldest *H. sapiens* fossil was found in Africa – this means it must have evolved first in Africa. • Transitional fossils are found (of *Homo ergaster*) which suggests a gradual enlargement of the brain (or other skulls features) was occurring among archaic Homo species in Africa, which supports change specific to Africa • Explains that mtDNA, passed on through females, mutates at a steady rate. Through genetic comparisons of dates of mutations states that all maternal lineages can be traced back to one individual woman that lived 200 000 years ago (also known as mitochondrial Eve). • Y chromosome DNA can be used to trace paternal ancestry to approximately 140,000 Y.A (theoretical Adam). This is useful because the Y chromosome does not recombine with X chromosome therefore can only change by mutation. • Modern humans descended from archaic *Homo* populations living in Africa because of the diversity seen in the mtDNA in African populations, as these populations have had more time to accumulate these mutations OR explains that DNA shows that genetic variation decreases the further away from Africa which allows more time for mutations to accumulate in the populations as they are older. **Explains evidence that support the multiregional hypothesis.** • Explains that fossil finds represent intermediates between *H. erectus, H. neanderthalensis* and modern H. *sapiens* –	**Compares the replacement hypothesis with the multiregional hypothesis.** **Similarities** • Both theories support the idea that *H. erectus* migrated out of Africa because the fossil evidence of finding *H. erectus* outside of Africa. This means they both agree that modern humans evolved from *H. erectus* (*ergaster* still conjecture that *ergaster* was a separate species from *erectus*). • Both use genetic and fossil evidence to support their theories. **Compares differences supported by evidence from any of the following:** • The replacement theory uses transition forms within a species to show that there is an evolutionary change, e.g. skull size allowing for brain expansion • The multiregional theory, which suggests that although there are differences in fossil morphologies, these differences are due to regional difference and that they are actually the same species and interbreeding could and did occur. • The oldest modern fossil is found in Africa which suggests that modern humans developed first in Africa which the multiregional theory does not have fossils dating to this date, where we would expect fossils of the same date to be found throughout Europe; as yet no fossils have been found outside of Africa to support this.

	being able to sexually reproduce and have fertile offspring. The replacement theory uses mtDNA analysis to support the idea that the oldest living modern human came from Africa by using a molecular clock based on the number of mutations accumulated as the rate of mutation occurs at a constant rate. **Whereas** the multi-regional theory uses mtDNA evidence of subspecies like the chimpanzee to show that differences in mtDNA can vary greatly so that *H. neanderthalensis* and *H. sapiens* may have been the same species and gene flow could occur between these groups. The Y-chromosome analysis supports the idea that the oldest living modern human came from Africa by using a molecular clock based on the number of mutations accumulated in the Y-chromosome, as the rate of mutation occurs at a constant rate. **Whereas** the multi-regional theory shows a later expansion back into Africa from Asia, demonstrating there was gene flow (interbreeding) between regions in both directions. As more sources of evidence are discovered, a better picture of the true method of dispersal will be determined, and theories may change based on the best evidence available at the time.		that physical difference between these groups represent regional differences. E.g. some modern cold-adapted populations have similar features to the Neaderthals this means that many species cannot be classified because of the regional differences of a single species. • Explains that while *H. neanderthalensis* mtDNA is substantially different from modern humans, in some cases the differences are less than those observed between chimpanzee subspecies. This suggests that the Neanderthals were different subspecies but belonged to the same species as anatomically modern humans. • Y chromosome analysis indicated a later expansion back into Africa from Asia, demonstrating there was gene flow (interbreeding) between regions in both directions. • Genetic evidence supporting interbreeding between modern *H. sapiens* and *H. neanderthalensis* which also indicated gene flow **Challenges using fossil evidence** • Difficult to tell if they fit the species definition of being able to sexually reproduce and have fertile offspring. • Fossil finds along with tools/dwellings can be misleading as different fossil species might have used the same tools. • New finds like *H.naledi* might show discrepancies with anatomical features and the dating method, which means that some species have an older date but relatively more recent anatomical features.	• The replacement theory uses mtDNA analysis to support the idea that the oldest living modern human came from Africa by using a molecular clock based on the number of mutations accumulated as the rate of mutation occurs at a constant rate. • The multi-regional theory is mtDNA evidence of subspecies like the chimpanzee to show that differences in mtDNA can vary greatly so that *H. neanderthalensis*, H. *sapiens* may have been the same species and gene flow could occur between these groups. • Replacement theory supports the idea that the oldest living modern human came from Africa by using a molecular clock based on the number of mutations accumulated in the Y-chromosome as the rate of mutation occurs at a constant rate. • The multi-regional theory shows that a later expansion back into Africa from Asia, demonstrating there was gene flow (interbreeding) between regions in both directions.

Not Achieved			Achievement		Merit		Excellence	
NØ = no response; no relevant evidence.	N1 = 1 point from Achievement.	N2 = 2 points from Achievement.	A3 = 3 points.	A4 = 4 points.	M5 = **explains 1** kind of evidence for **both** the replacement and the multiregional hypothesis.**AND** 1 challenge of using fossil evidence.	M6 = **explains 2** kinds of evidence from the RT and 1 kind of evidence from the MR (or vice versa) **AND** 1 challenge of using fossil evidence.	E7 = One similarity and one difference.	E8 = more than one similarity and difference.

Cut Scores

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