|  |  |  |
| --- | --- | --- |
| |  |  | | --- | --- | | |  | | --- | | *Human Perspectives ATAR Units 3 & 4* | | |

Answers: Chapter 13 Hominin evolution

Questions 13.1

RECALL KNOWLEDGE

**1** Which tribe do humans belong to, and what other species are also in this tribe?

*Answer:* Humans belong to the tribe Hominini. Humans and their extinct ancestors belong to this tribe, the ancestors include *Homo neanderthalensis, Homo erectus, Homo habilis, Paranthropus robustus, Australopithecus africanus* and *Australopithecus afarensis.*

**2** Explain the difference between brain size and cranial capacity.

*Answer:* Brain size is inferred from the cranial capacity as brains are not able to be fossilised. Endocasts made from fossilised skulls are used to calculate the cranial capacity and we know that brains will fill the available cranium space.

**3** State the trend in cranial capacity and convolutions of hominins.

*Answer:* The trend shows a gradual increase in cranial capacity as the hominin species evolved towards modern humans. Convolutions increased in number as did the size of the frontal lobe.

**4** Define ‘endocast’ and describe how it is used to infer the shape of the brain.

*Answer:* An endocast is an impression of the inside of the brain case, made of rock or some other solid material. It can determine the cranial capacity of the cranium and can show the development of the frontal lobe and the number of convolutions.

**5** State the cranial capacity of:

**a** *Australopithecus afarensis*

*Answer:* 430cm3

**b** *Australopithecus africanus*

*Answer:* 457cm3

**c** *Paranthropus robustus*

*Answer:* 542cm3

**d** *Homo habilis*

*Answer:* 590cm3

**e** *Homo erectus*

*Answer:* 1004cm3

**f** *Homo neanderthalensis*

*Answer:* 1485cm3

**g** *Homo sapiens*

*Answer:* 1350cm3

APPLY KNOWLEDGE

**6** Explain why the cranial capacity of a fossilised skull is used to infer brain size.

*Answer:* The brain will fill the cranium, so being able to determine the cranial capacity will allow scientists to estimate the size of the brain.

**7** Explain the relationship between changes in the size of teeth and prognathism.

*Answer:* The size of the teeth has gradually reduced, and the diastema has been lost. The jaw has become smaller with a smaller and thinner mandible. This reduces the prognathism and a trend towards a flatter face.

Questions 13.2

RECALL KNOWLEDGE

**1** Complete the following table for the species listed.

*Answer:*

|  |  |  |  |
| --- | --- | --- | --- |
| **Species** | **Time of existence** | **Height** | **Key physical features** |
| *Australopithecus afarensis* | 3.9 to 2.8 million years ago | Females 105–110cm  Males 150cm | Cranial capacity 430cm3  Low sloping forehead with a sagittal crest, prominent brow ridge  Prognathic jaw, small canines, diastema present  Aligned big toe, long arms, long curved fingers and toes. Short and wide pelvis |
| *Australopithecus africanus* | 3.2 to 2 million years ago | Females 110cm  Males 135cm | Cranial capacity 480cm3  Slightly arched forehead, smaller brow ridge  Prognathic jaw, shorter and smaller incisors and canines, no diastema  Aligned big toe, long arms, less curved fingers and toes. Short and wide pelvis |
| *Paranthropus robustus* | 1.8–1.2 million years ago | Females 100cm  Males 120cm | Cranial capacity 520cm3  Large sagittal crest for chewing muscles  Very large molars and premolars  Prognathic, but less than australopithecines.  Large zygomatic arches, heavy brow ridges, structures for bipedalism |
| *Homo habilis* | 2.3 to 1.5 million years ago | Females 110cm  Males 130cm | Cranial capacity 610cm3  Rounder skull, smaller brow ridge  Moderate prognathism, teeth arranged in a rounder arc.  Relatively short arms and legs  Slightly curved finger bones |
| *Homo erectus* | 2 million to 100 000 years ago | 145cm to 185cm | Cranial capacity 1050cm3  Low sloping forehead, defined brow ridges  Large thick jaw without a chin  Reduced size of molars.  Short stocky body with thinker bones. |
| *Homo neanderthalensis* | 28 000 and 300 000 years ago | Females 156cm  Males 168cm | Cranial capacity 1500cm3  Shorter, more robust skeleton, long and low brain case with an occipital bun at the back of the skull  Thick brow ridges, flared zygomatic arches  Larger, more robust jaw, no chin, larger teeth  Barrel shaped chest |
| *Homo sapiens* | 300 000 years to present | Females 160cm  Males 175cm | Cranial capacity 1350cm3  High brain case, rounded cranium with a forehead  Short jaw, bony chin and smaller teeth  Long legs compared with arms, straight fingers and toes.  Narrow pelvis, bowl shaped from front to back. |

**2** Which species studied were the first hominin to show bodies similar to modern humans?

*Answer:* *Australopithecus afarensis*

**3** Describe features of fossils of australopithecines that would indicate bipedalism.

*Answer:* A non-opposable robust big toe, the femurs shows convergence towards the knee to create a carrying angle, the pelvic bones show more bowl shape, the foramen magnum is more centrally located and the skull is more rounded at the back .The vertebral column displays an ‘S’ shape curvature.

**4** What is a key feature that will allow the identification of a *Homo neanderthalensis* skull?

*Answer:* The presence of the occipital bun and a larger cranial capacity.

**5** Describe the fingers of both *Homo habilis* and *Homo erectus*. Use this to justify which of the two has a more common ancestor with modern humans.

*Answer:* *Homo habilis* has slightly curved fingers, indicating a strong power grip and the ability to form a precision grip. *Homo erectus* shows modern finger shape and a fossil discovered showed a styloid process where the fingers meet the wrist, indicating an increase in dexterity and the ability to use powerful and precise grips. *Homo erectus* has the more recent common ancestor to modern humans.

**6** Explain why the forehead of *Homo sapiens* is rounder and higher than earlier species.

*Answer:* The forehead protects the more developed frontal lobe seen in *Homo sapiens*.

**7** Describe the features of the skull of a *Homo sapiens*.

*Answer:* The skull of a *Homo sapiens* is shorter from front to back and are rounder at the back. There are less prominent brow ridges, a reduction in the projection of the face and a smaller jaw. They had a large cranial capacity of 1350cm3. The face is relatively broad and short with the orbits of the eyes well separated. The teeth are smaller and a chin has developed.

APPLY KNOWLEDGE

**8** Classify the hominin species of the skull to the right. State the features used in your classification.

*Answer: Australopithecus africanus*. The skull shows significant prognathism, and a thick brow ridge. There is no sagittal crest. The cranial capacity is small, and there is no forehead. These characteristics match *A. africanus*.

**9** Explain how the fossilised Laetoli footprints would have been produced.

*Answer:* The Laetoli footprints would have been made when *A. africanus* walked in wet volcanic ash. Subsequent layers of volcanic ash covered and preserved the footprints.

**10** Explain the relevance of a large sagittal crest in skulls of *Paranthropus robustus*.

*Answer:* The large sagittal crest allows for attachment of jaw muscles. *Paranthropus robustus* had a prognathic jaw and a robust mandible with large cheek teeth and thick enamel suggesting they were herbivores. The muscle attachment is required to chew vegetative matter.

**11** Neanderthals lived in cold, harsh climates. Discuss two physical features that would have evolved in this environment.

*Answer:* Homo neanderthalensis has a prognathic face with the nasal bones projected forward. This is thought to be an adaptation to the cold and dry environment they lived in. The barrel shaped chest with shorter limbs reduces their surface area to volume ratio, indicating a body stature more adapted for retaining heat.

Questions 13.3

RECALL KNOWLEDGE

**1** Describe Oldowan tools.

*Answer:* Oldowan tools are pebble tools, including choppers, scrapers, flakes and chisels.

**2** Name the species known to use Oldowan tools.

*Answer: Homo habilis* made the Oldowan tools. It is possible that *Australopithecus sp.* used the Oldowan tools.

**3** Which species was the first to use fire? List four different ways that fire could have been used.

*Answer:* *Homo erectus* is the first hominin to use fire. Fire was used for warmth, light at night, to protect against predators, to cook food, and potentially to herd animals for easier hunting.

**4** What tool culture did Neanderthals use?

*Answer:* The tool culture associated with *Homo neanderthalensis* is Mousterian industry.

**5** Name and describe the tools used by the Cro-Magnon.

*Answer*: The Cro-Magnon people used blade tools – flakes of stone with roughly parallel sides.

**6** Explain how the use of tools from the following cultures are related to the changes in cranial capacity of hominins: Oldowan, Acheulian, Mousterian, Aurignacian, Solutrean and Magdalenian.

*Answer:*

Oldowan: Used by *Homo habilis*. They used tools to scavenge meat from carcasses and breaking open bones to access bone marrow. The cranial capacity increased to 610cm3.

Acheulian: Used by *Homo erectus*. These tools were flaked around all the edges to form bi-faced lumps, tear-drop in shape. They were used as hand axes and were used to hunt and butcher animals. The cranial capacity increased to 1000cm3.

Mousterian: Used by *Homo neanderthalensis*. These tools were manufactured using the Levallois technique. This is a slow, labour-intensive process requiring planning and foresight. These tools could be hafted, broadening the use and increased effectiveness of the tools. The cranial capacity increased to 1500cm3.

Aurignacian, Solutrean and Magdalenian: Used by *Homo sapiens*. Aurignacian tools are blade tools, effective in cutting and easy to handle. Solutrean culture are laurel-leaf and willow-leaf points made by carefully retouching blades made by pressure flaking. These would have taken many hours of intricate skill to produce. Magdalenian culture is known for the dominance of bone and antler tools. The bone and antler tools were produced by a burin, a tool used to manufacture other tools. The cranial capacity increased to 1350cm3.

APPLY KNOWLEDGE

**7** State the name of the tool culture of the tool shown below. Justify your answer.

*Answer:* Mousterian tools. It is a flake tool.

**8** Explain how Mousterian tools differ from Acheulian tools.

*Answer:* Mousterian tools are produced from the Levallois technique, where a piece of stone is trimmed into a disc-shaped core, and then struck by another piece of stone to produce flakes that were flat on one side and had sharp edges. Acheulian tools are produced by flaking all around the edges, first in one direction then in the other until they roughly formed a two-faced lump, approximately teardrop in shape.

**9** We can say that the environment influenced *Homo habilis*, but *Homo sapiens* influenced the environment. Relate this statement to the tools used by the two species.

*Answer:* *Homo habilis* produced simple pebble tools, allowing them to access meat from carcasses and bone marrow. They did not use sophisticated or intricate tools and were opportunistic in their meat scavenging and eating. *Homo habilis* did not alter their environment to suit them.

*Homo sapiens* produced a range of tools to access different food sources. They used fire as a means of communication to hunt and gather food to provide for the tribe. As tool technology increased, more food sources were accessed, domestication of plants and a surplus of food was generated. *Homo sapiens* exploited a range of food sources, and were able to fuel a larger brain, including a significant frontal lobe where higher order thinking, planning and learning occurs. *Homo sapiens* were able to manipulate their environment to their benefit.

Chapter 13 Activities

Activity 13.1 Investigating cranial capacity and phylogenetic trees

**What to do**

**2** Consider which species may have become extinct and which species may have evolved into one or more other species. Draw up a phylogenetic tree to show the possible evolutionary relationships between the species in the table. Remember, there is no such thing as a correct tree. Scientists themselves cannot agree on all the relationships.

*Answer*: Responses will vary, especially with the evolutionary relationships that students may present. All students should start with *Ardepithecus ramidus* at the bottom of the tree as the common ancestor. Most will probably then show a connection with *Australopithecus afarensis*; from there one would expect students to show branches to the gracile forms of australopithecines, the robust forms, and to early *Homo*. Considerable variation would then be expected on the way students linked the various member of the genus *Homo*.

ACTIVITY 13.2 Investigating hominid skulls

**Discussion**

**1** The canine teeth have drastically reduced in size from great apes to modern humans. Explain why this might be.

*Answer*: As modern humans became increasingly bipedal, they gained greater ease of use with their hands. This meant the grasping function of long canines became less necessary, therefore a drastic decrease in canine teeth size occurred.

**2** Explain why the face has become progressively flatter over the evolution of hominids.

*Answer*: The face flattening in hominins is partially the result of a decreased need for the grasping function of long canines.

**3** Describe how the position of the foramen magnum relates to body posture and locomotion.

*Answer*: An erect posture, associated with bipedalism, will result in foramen magnum that is more forward and under the skull. This is because the skull is balanced on top of the spinal column. A semi-erect posture, associated with apes, will result in a foramen magnum that is positioned towards the rear section of the skull.

**4** Certain areas of the braincase enlarged before others in our evolution. Describe how the areas enlarged throughout our evolution.

*Answer*: The rear portions of the braincase are the first to emerge. The top and forward portions enlarge at a later point.

**5** What traits differentiate modern apes and modern humans?

*Answer*: The most notable differences between humans and modern apes are the fact that humans stand upright and are bipedal. Additionally, humans have a larger brain, making them capable of language and abstract thought. Unlike apes, humans have the ability to manufacture and use complex tools. Human jaw bones are much smaller and they have a shorter digestive tract.

**6** Using your measurements and the facial features you observed as evidence, do you think modern humans or modern apes are more closely related to extinct hominids? Explain your answer.

*Answer*: Student answers will vary. However, students should identify some features in the skulls as being like that of humans, such as reduced jaw bones, smaller canine teeth and a lack of heavy brow ridges. Skulls with the foramen magnum located underneath the skull, and more towards the centre of the skull are more similar to humans. Similarly, a larger brain cavity suggests a closer resemblance to humans.

Skulls with large canines, small brain cavities and evidence of some quadrupedal movement are more likely closer related to apes.

**7** Imagine you found the remains of a skull that only contained the mandible. Is this enough evidence to determine if it belonged to a modern human, early hominid or ape? Explain your answer.

*Answer*: Student answers will vary. However, a shorter mandible (lower jaw) suggests modern humans, while a larger jaw suggests the earliest hominins.

ACTIVITY 13.3 Investigating evidence for human evolution

**What to do**

**1** What fossils were discovered?

**2** Where and when were the fossils found?

**3** What was the scientific name given to the fossil finds at the time of their discovery?

**4** What was the significance of the finds at the time? Did they raise any controversy in the scientific community?

**5** What is the significance of the fossils today, given that much more fossil evidence is available for study?

*Answer:*

|  |  |  |
| --- | --- | --- |
|  | **Dart** | **Dubois** |
| Fossils found | Small skull; natural endocast | Skull cap, femur, teeth |
| Where found | Taung in South Africa | Java in Indonesia |
| When found | 1924 | 1891 |
| Fossil name | *Australopithecus africanus*  ‘The Taung Child’ | *Pithecanthropus erectus*, now known as *Homo erectus*  ‘Java Man’ |
| Significance at time of find | Dart thought that the juvenile skull was the link between apes and humans. He was heavily criticised, because the skull showed bipedalism (position of foramen magnum) and not an enlarged brain. At the time it was thought the increase in brain size came before bipedalism | Thought to be intermediate between modern humans and the common ancestor of apes and humans |
| Current significance | *Australopithecus africanus* is considered to be a direct ancestor of modern humans | *Homo erectus* is considered a direct ancestor of modern humans Debate continues as to whether the femur and skull belong to the same individual. |

**6** Other scientists who made significant contributions in the early days of the search for human origins were Robert Broom and Louis and Mary Leakey. Research the work of each of these people.

*Answer:*

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Robert Broom** | **Louis Leakey** | **Mary Leakey** |
| Fossils found | Purchased a jaw fragment containing a tooth from a quarry worker; found more skull fragments at site | Cranium | Jaws, teeth, part of a child’s postcranial skeleton, footprints |
| Where found | Kromdraai in South Africa | Olduvai Gorge in Tanzania (found by Mary Leakey, but described by Louis) | Laetoli in Tanzania |
| When found | 1938 | 1959 | 1974–1979 |
| Fossil name | *Paranthropus robustus* | *Zinjanthropus*  ‘Nutcracker Man’ | *Australopithecus afarensis* |
| Significance at time of find | Became the type specimen for the species | Skull specialised for heavy chewing; sometimes referred to as ‘Nutcracker Man’, because it had the biggest, flattest cheek teeth with the thickest  enamel of any known hominin; thought to be the first hominin to use tools | Used as a type specimen; most complete dentition found for early hominids; footprints indicated bipedal locomotion |
| Current significance | Is the type specimen for the species | Now referred to as *Paranthropus boisei* (or *Australopithecus boisei*) and considered a side branch of hominin evolution; have the largest teeth of any hominin | Used as a type specimen; also studied *Homo habilis* and found that it was not an Australopithecine as first thought |

ACTIVITY 13.4 Are humans unique?

With a partner, try to draw up a list of features that are unique to humans. Consider all aspects of humanity in your discussion – physical characteristics, behaviour, human achievements and others. Do some of the features selected follow an evolutionary trend? Are these features likely to evolve further in the future?

Have a class discussion of the lists proposed by the various pairs in the class and try to agree on a class list. Be prepared to criticise others but do so in a constructive way. It is more important to be involved in actively thinking about the topic than in arriving at a correct answer. In fact, there may be very few points on which the whole class will agree.

*Answer*: Students will suggest a range of characteristics that may, or may not, be correct, but will contribute to stimulating discussion. The points listed below are not necessarily unique to humans, but could be used as starting points for a class discussion.

• Striding gait

• Large and complex brain, especially the cerebrum

• Precision grip

• Complex culture that is communicated to each succeeding generation

• Sophisticated tool use including highly complex technology

• Ethics and values, or a moral sense

• Religious belief

• Spoken and written language

• Abstract thought and symbolism

• Sharing information

See <http://www.psychologytoday.com/blog/minds-animals/200907/are-humans-unique> for an article that could also be used in class debate.

Activity 13.5 Examining chimpanzees, Neanderthals and humans

**What to do**

**1** Based on the information in the table, which individual is most closely related to the Neanderthal and which is the least closely related?

*Answer*: The most closely related is human 1, because there are fewer nucleotide differences in the mitochondrial DNA than any of the other individuals. The least related is chimpanzee 1, because it has more nucleotide differences than any of the other individuals.

**2** The Neanderthal mitochondrial DNA was extracted from a fossil 25 000 years old. What other information obtained from the fossil would be valuable in determining the evolutionary relationships of the Neanderthal with chimpanzees and humans?

*Answer*: Where it was found – type of sediment and associated fossils that could give a guide to climatic conditions; what was found with the fossil – artefacts, bones from other species, charcoal, evidence of shelter; cranial capacity – and shape of cranium; shape of jaw; tooth size and arrangement; structure of pelvis and lower limb.

**3** What dating methods could be used to determine the absolute age of the Neanderthal fossil?

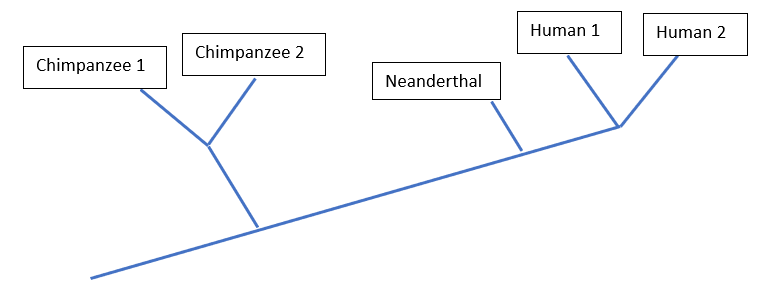
*Answer*: If the fossil was 25 000 years old, radio-carbon dating could have been used.

**4** What methods could have been used to determine a relative age for the Neanderthal fossil?

*Answer*: Stratigraphy (the principle of superposition) and/or fluorine dating could provide an age relative to other items found in the area.

**5** Use the data to draw a phylogenetic tree for these species.

*Answer:*



Chapter 13 Review questions

Recall

**1** Describe the main physical features of the genus *Australopithecus*.

*Answer:*

• Skull: low forehead; projecting upper and lower jaw; skull rounded at the back

• Brain: an average of 480 cm3; more human-like than ape-like

• Teeth: typically hominin being smaller than the apes; canines short and non-projecting and together with the incisors form a row of cutting teeth; lack a diastema, the teeth in the jaw form a parabolic shape

• Limbs: limb bones suggest bipedalism; pelvic and foot bones typically hominin; non-opposable big toe; thumb shorter and less mobile than later hominins

• Vertebral column: displays the curvature typical of hominins; foramen magnum more forward in position than in the apes

There were two main variants of australopithecines – gracile species and robust species. The robust forms were much bigger in size and about 30 cm taller and 40 kg heavier than gracile individuals. In addition, robust forms had large, broad molar teeth that contrasted sharply with their smaller canines and incisors. The robust forms had powerful chewing muscles that attached a large jawbone to the skull and, as a result, they possessed massive bony crests on the skull for the attachment of these muscles.

**2** Describe the features evident from a study of the skull of each of the following species.

**a** *Australopithecus afarensis*

*Answer:*  A study of the skull of *Australopithecus afarensis* indicates:

* A cranial capacity of 430cm3
* Low, sloping forehead
* Prominent brow ridges
* Short sagittal crest in males
* Prognathic jaw
* Small canine teeth
* Diastema present

**b** *Australopithecus africanus*

*Answer:*  A study of the skull of *Australopithecus africanus* indicates:

* A cranial capacity of 480cm3
* Slightly arched forehead
* Smaller brow ridge
* Prognathic jaw
* Shorter and small incisors and canine teeth
* No diastema present
* Large molars and premolars

**c** *Homo habilis*

*Answer:*  A study of the skull of *Homo habilis* indicates:

* A cranial capacity of 610cm3
* Rounder skull
* Smaller brow ridge
* Central foramen magnum
* Moderately prognathic jaw
* Teeth arranged in a rounder arc
* Smaller teeth

**d** *Homo erectus*

*Answer*: A study of the skull of *Homo erectus* indicates:

* a long, low profile
* an increase in cranial capacity of around 900 cubic centimetres
* a protruding jaw, but less so than in *H. habilis*
* thick brow ridges
* teeth that were smaller than *Homo habilis*.

**e** *Homo neanderthalensis*

*Answer:*  A study of the skull of *Homo neanderthalensis* indicates:

* A cranial capacity of 1500cm3
* Long and low brain case
* Occipital bun at the back of the skull
* Thick brow ridges
* Receding forehead, elongates skull
* Flared zygomatic arches
* Depression at back of skull for neck muscle attachment
* Larger, more robust jaw
* Lacking a chin
* Larger teeth

**f** *Homo sapiens*

*Answer:*  A study of the skull of *Homo sapiens* indicates:

* A cranial capacity of 1350cm3
* Shorter base and high brain case
* Distinct forehead
* Short jaw, bony chin
* Small teeth

**3** List the differences between Neanderthals and modern humans.

*Answer*: Compared to modern humans, Neanderthals had:

• large faces, a low forehead and heavy brow ridges

• a slightly larger and differently shaped brain

• a ‘bun’ shape to the back of the skull

• distinctive prognathism

• the lack of a definite chin

• a wider, larger nose

• short stature and a rugged appearance

• thick neck muscles

• a barrel shaped chest

• short and heavily jointed limbs, with powerful muscles.

**4** Describe the physical appearance of Cro-Magnon people.

*Answer*: Compared to the Neanderthals, Cro-Magnon people had skulls that were shorter from front to back, higher in the region of the top of the skull, and rounder at the back. They also possessed less prominent brow ridges, showed a reduction in prognathism, had a smaller jaw with smaller teeth, and a chin.

**5 a** What was the importance of meat eating to the future survival and evolution of the hominins?

*Answer*: Meat eating became important in providing higher energy requirements and the fats needed for bigger hominins with larger, more complex brains. The complex fats needed for brain growth are difficult to obtain on a vegetarian diet.

**b** How did tool manufacture and use contribute to this survival?

*Answer*: Tools were probably first used to hack away meat from scavenged carcasses, and then used in the hunting and slaughtering of animals. In this way more food would have been obtained than in just trying to rip flesh from bones with the bare hands. Tools were possibly also used in defence from predators.

**6** *Homo erectus* appears to be the first hominin to have used fire in a systematic way. List the ways in which fire could have improved their way of life, giving examples where appropriate.

*Answer*: Use of fire could have assisted hominins in the following ways.

• Hunting – directing and trapping animals to kill for food

• Deterrent – keep predators away

• Light – increased the length of the day which allowed for increased social activity at night – leading to cultural activities and rituals around the fire

• Warmth – allowed survival in cold environments

• Cooking – increasing safety of food, taste and digestibility, and the range of foods that could be eaten

**7** Describe the significant cultural advance that occurred with the development of the Mousterian tool-making industry.

*Answer*: Mousterian tool culture was characterised by the production of flakes of stone from a disc-shaped core. Flakes were used for preparing animal hides and making clothing. In this indirect way, Mousterian tools enabled Neanderthals to live in colder climates.

Explain

**8** Describe the significance of the Laetoli footprints and explain why they were such an important discovery.

*Answer*: These footprints were evidence for early hominins walking in a similar way to modern-day humans over 3 million years ago. They give evidence for bipedalism and help determine a date for the evolution of this method of walking.

**9** Explain how hafting changed the use of stone tools.

*Answer*: Hafting became more common during the Upper Palaeolithic and Middle Palaeolithic times. It involves attaching an artefact, like a stone tool, onto a haft (handle or strap). This makes the artefact more useful by allowing it to be shot, thrown or used with more effective leverage. Hafting is a significant milestone as it is both an improvement on the technology of the time, and showed progression of the human mind towards more complex tool making.

**10** Most of the major changes in human evolution from *Homo erectus* to modern *Homo sapiens*, identifiable from fossil evidence, are confined to the head. Identify five of these changes and explain their significance.

*Answer*:

• The shape of the skull tends to be shorter from front to back, and higher in the region at the top, to allow for an increase in the brain size without interfering with the balance of the skull on the spinal column.

• The back of modern skull is more rounded with a reduction in the size of the neck muscles contributing to a highly mobile head.

• The face is flatter with a projecting nose bone in modern *H. sapiens* to compensate for the smaller jaw and teeth.

• The forehead is more vertical and the brow ridge, if at all present, is limited to allow for the increase in the frontal lobes of the brain.

• The jaw is relatively lightly built in modern humans and the presence of a chin adds to its strength; the reduction in the size of the jaw is a consequence of smaller teeth and the refined diet of modern humans.

• The shortened jaw of modern humans has resulted in a parabolic curve for the arrangement of the teeth.

• The incisors and canines in modern humans are noticeably smaller than in *H. erectus* as a result of the more refined diet.

Apply

**11** What assumptions are made when scientists infer the degree of intelligence from the cranial capacity of a skull?

*Answer*: When inferring the degree of intelligence from the cranial capacity of a skull, a scientist is assuming that the brain occupied all the space available in the skull and, more importantly, that an increase in the size of a brain indicates an increase in intelligence.

**12** In the past, anthropologists have put a great deal of emphasis on the importance of the cranial capacity when defining the tribe Hominini. Does this seem reasonable, considering the hominins discussed in this and the previous chapter? What other physical features are important in a discussion of human evolution?

*Answer*: The increase in cranial capacity is an important feature of the tribe Hominini, but the importance of the development of the free striding gait along with an erect stance must not be overlooked. All hominins display this characteristic, and it was well established in the early, smaller brained members of the tribe. On the other hand, cranial capacity, shows more of an evolutionary trend, increasing markedly from early examples to modern humans.

Besides bipedalism, students may mention other features of the skull such as brow ridges and the forehead, the mobility of the thumb, the refinement of the precision grip, the size and shape of the teeth, the shape of the jaw, and the absence of a diastema.

**13** There is growing evidence that, like many of the other mammals, the pathway to modern humans may have many more species existing at a particular time than was once thought. If this is the case, how would it have been possible for closely related species to have lived on Earth at the same time? Describe a possible situation where three species of early *Homo* lived in the same region of Africa.

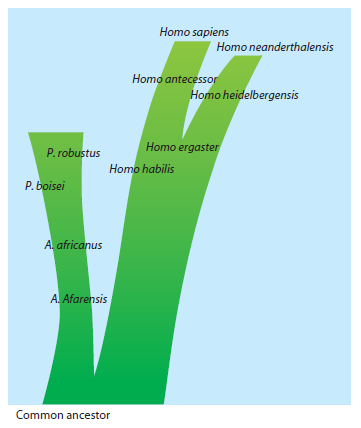
*Answer*: Early species of *Homo* would have formed very small groups and probably occupied a home range that provided the food and other materials required for survival. Such small groups probably had little chance of interacting over the vast African landscape, in much the same way as groups of other mammalian species would have done.

**14** Describe the conditions that may have led to Neanderthals developing their characteristic anatomical features.

*Answer*: Besides the rugged features of the skull, Neanderthals were short in stature with thick neck muscles, the limbs being short and heavily jointed with powerful musculature, and the chest barrel shaped. These rugged features are thought to have evolved for survival in the harsh conditions of the last ice ages in Europe. They were also adept big game hunters, and their rugged features may have assisted them in the hunt.

**15** Compile a phylogenetic tree for the evolution of hominins from the early australopithecines to modern humans. List evidence in support of your evolutionary pathway and discuss any points of disagreement that others may have with it.

*Answer*: Student responses will vary – one possible tree is shown below. Encourage students to avoid joining species with straight lines as they should realise the phylogenetic tree is indicating an evolutionary trend. Students should list evidence that is credible and based more on modern DNA and protein analyses than simple anatomical structure where possible.



**16** Why do scientists believe that the laurel-leaf blade may have been an ornament rather than a spear-point?

*Answer*: Laurel leaf blades were so finely crafted and delicate that they would have broken if used in the way that other tools would have been used.

**17** Australopithecines may have been the first hominins to manufacture tools for a specific purpose. Describe the significance of this development in food gathering for later hominin evolution.

*Answer*: As Australopithecines became more dependent on tools for survival, natural selection would have favoured a more efficient precision grip. Tool use would have allowed them to make use of a wider range of habitats, and thus an increased range of foods could be gathered. It therefore became possible to migrate out of Africa into Europe and Asia. These new environments would have presented new physical and intellectual challenges. Individuals with larger brains and better problem-solving skills would have been more likely to survive and so, with natural selection, a larger brain would have evolved.

**18** There is some speculation among scientists that the large brain of *Homo erectus* would have required offspring to be born at a very early stage to allow the passage of the large head through a relatively narrow birth canal. Discuss the implications that the care of helpless young would have had for the social behaviour of *Homo erectus*.

*Answer*: Monogamy, or a family group situation, would have been needed so that the mother and her helpless infant could be nurtured. Childbirth would have meant that new mothers could no longer be productive members of the group, so that cooperative behaviour would have been essential. Establishment of a home base may also have been necessary, because it would be difficult to constantly carry small helpless infants from place to place and to ensure their survival.

**19** Briefly outline the technological advances in tool making from the early Oldowan industry to that of Magdalenian times.

*Answer*:

• Earliest tools are Oldowan. Rounded pebbles with one or two pieces chipped off.

• Acheulian tools were used by *H. erectus*. They are large hand axes chipped around all edges into a teardrop shape.

• Mousterian tools were used by Neanderthals. These were the first flake tools produced by striking flakes of stone off a larger core using another piece of stone. Flakes were then sharpened or shaped into a variety of tools.

• Aurignacian tools, made by early Cro-Magnon people, were mostly chipped to form blades.

• Solutrean tools are very finely chipped, and may have been ornamental rather than functional.

• Magdalenian tools produced by later Cro-Magnon people were mostly made from antler and bone, rather than stone. The antler and bone were worked using a stone burin – a tool for making other tools. The making of a tool to make other tools was a major cultural step.

Extend

**20** Who was ‘Lucy’, and why is she such an important ‘person’ in present theories of hominin evolution?

*Answer*: Lucy was the nickname given to a 40% complete, female *Australopithecus afarensis* skeleton that was found in the Hadar region of Ethiopia in November 1974. The age of the skeletal material is considered to be over three million years, making it the oldest hominin ever found at that time.

The completeness of the skeleton enabled the discoverers to determine that she walked upright, strengthening the idea that bipedalism was a unique feature of hominins.

**21** For the past 100 000 years at least, hominins have adapted culturally to environmental change. Does natural selection affect cultural characteristics?

*Answer*: Cultural characteristics are not inherited; they are learnt. Thus, the selection of favourable alleles is not directly involved in cultural evolution. However, the ability to learn is inherited, so natural selection could be indirectly involved. Epigenetic factors (see *Human Perspectives ATAR Units 1&2*) could also be involved in the inheritance of some cultural characteristics.

**22** Evidence suggests that *H. erectus* used fire to illuminate caves and other forms of shelter. To use fire effectively, they must have developed ways of lighting a fire and maintaining it for long periods. Use references to find out how early hominins may have lit fires and kept them burning.

*Answer*: The first fires were caused naturally, by lightning strikes, and would have been evident to early hominins. Early hominins would have seen how animals responded to the fire and the interaction and foraging in the wake of a fire. It is likely they discovered hotspots, with cooked, burnt or undercooked animals, leading them to use the hotspots to continue cooking the animal meat, this is called fire foraging. These hotspots may have been transported as smouldering kindling, to start new fires. Building a hearth to maintain fire led to basecamps. The ability to make fire using friction was a much later development.