13 HOMININ EVOLUTION

UNIT 4 CONTENT

SCIENCE INQUIRY SKILLS

» select, use and/or construct appropriate representations, including phylogenetic trees, to communicate conceptual understanding, solve problems and make predictions

SCIENCE UNDERSTANDING

Hominid evolutionary trends

» determining relatedness and possible evolutionary pathways for hominins uses evidence from comparisons of modern humans and the great apes with fossils of:
  - *Australopithecus afarensis*
  - *Australopithecus africanus*
  - *Paranthropus robustus*
  - *Homo habilis*
  - *Homo erectus*
  - *Homo neanderthalensis*
  - *Homo sapiens*

» tool use is seen in a number of hominin species and the study of these tools provides important insight into the evolution of the human cognitive abilities and lifestyles. Trends are seen in the changes in manufacturing techniques and the materials used in the tool cultures of:
  - *Homo habilis*
  - *Homo erectus*
  - *Homo neanderthalensis*
  - *Homo sapiens*

Source: School Curriculum and Standards Authority, Government of Western Australia

9780170449168

The apes, including humans, have the same basic characteristics and are classified in the family Hominidae. However, humans differ from other apes in their appearance and structure. Each animal species has developed adaptations that help it to survive and reproduce in its particular environment. Humans are no different, and we have developed features that set us apart from the other primates. As such, humans are classified as hominins; they belong to the tribe Hominini.

Hominins differ from other apes in their appearance, structure and behaviour. Most noticeably, hominins are relatively hairless compared with apes, and the structure of their upper and lower limbs allows for a fully bipedal way of walking. Humans stand and walk with an erect posture and a striding gait that is unique. It is not found anywhere else in the animal kingdom.

Hominins also have greater development of the brain, changes in the size and shape of the teeth, development of speech and sexual characteristics, all of which separate them from the other hominids.

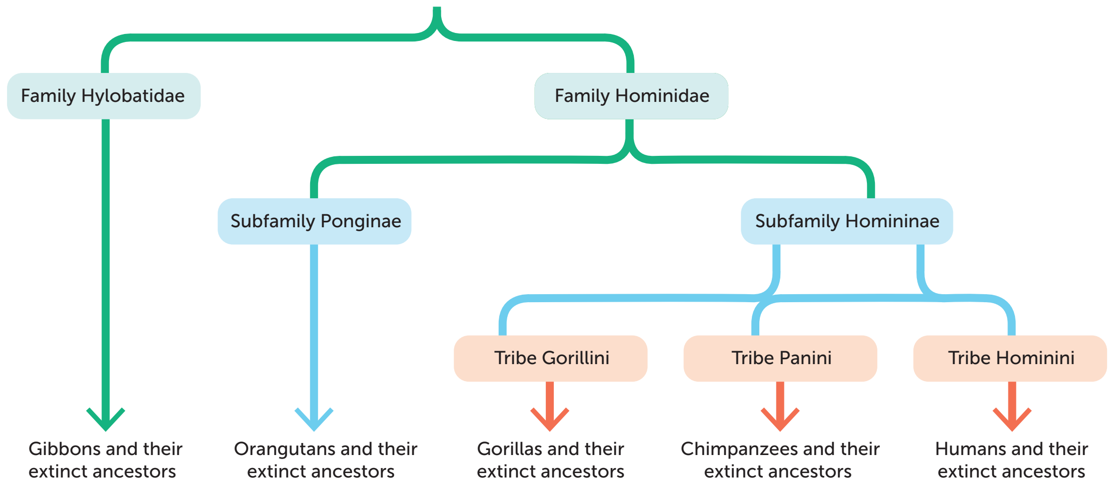


FIGURE 13.1 Classification of apes, including humans

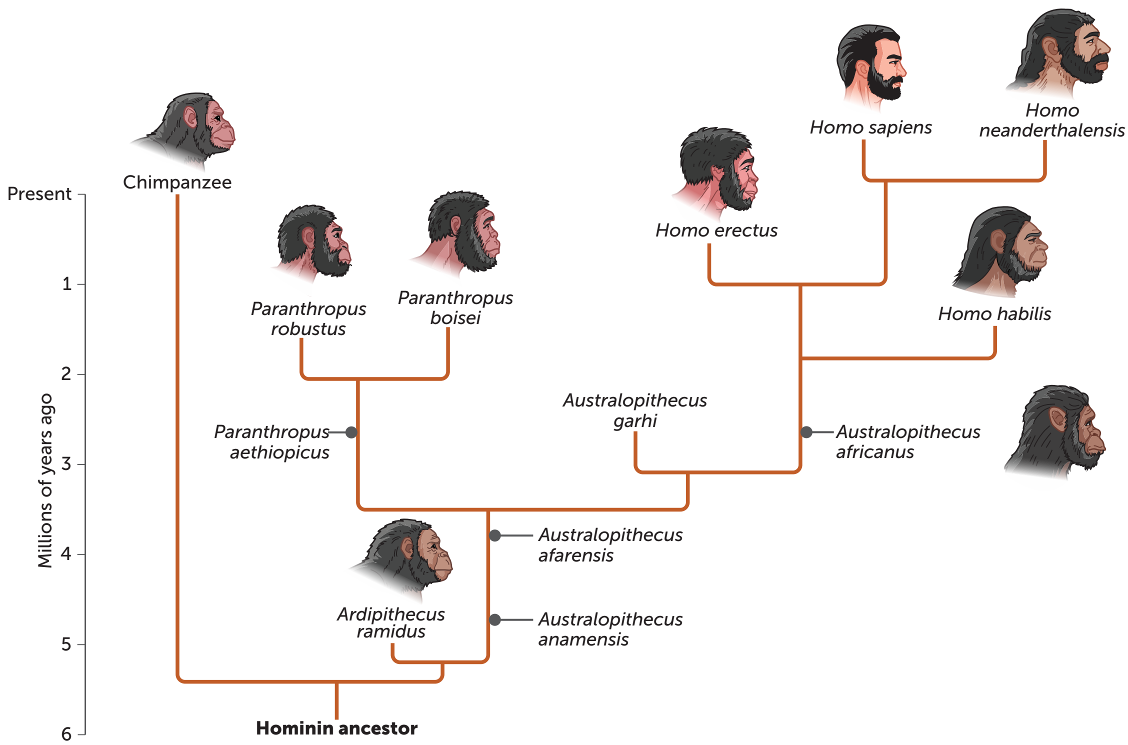


FIGURE 13.2 Illustration reflecting the evolution of hominins

Hominid and hominin
This website discusses the use of the terms 'hominid' and 'hominin'.

An interactive timeline
This website has an interactive timeline with detailed information about hominin evolution.

Throughout this chapter, we will be referring to the extinct ancestors of present-day humans. All hominids share a common ancestor, an ape-like creature. From that ancestral ape the first hominins evolved.

The evolutionary trends described for primates in Chapter 12 continue in the hominins. However, hominins are set apart from the other hominids by some very special adaptations that give them a unique position in the animal kingdom.

In this chapter, we will look at the characteristics of a number of species of hominins that show the evolutionary changes leading to present-day humans.

13.1 EVOLUTIONARY TRENDS IN HOMININS

During human evolution there is a general trend of increasing cranial capacity and skull size along with reduced prognathism. *Homo sapiens* also have a reduced brow ridge compared to earlier species.

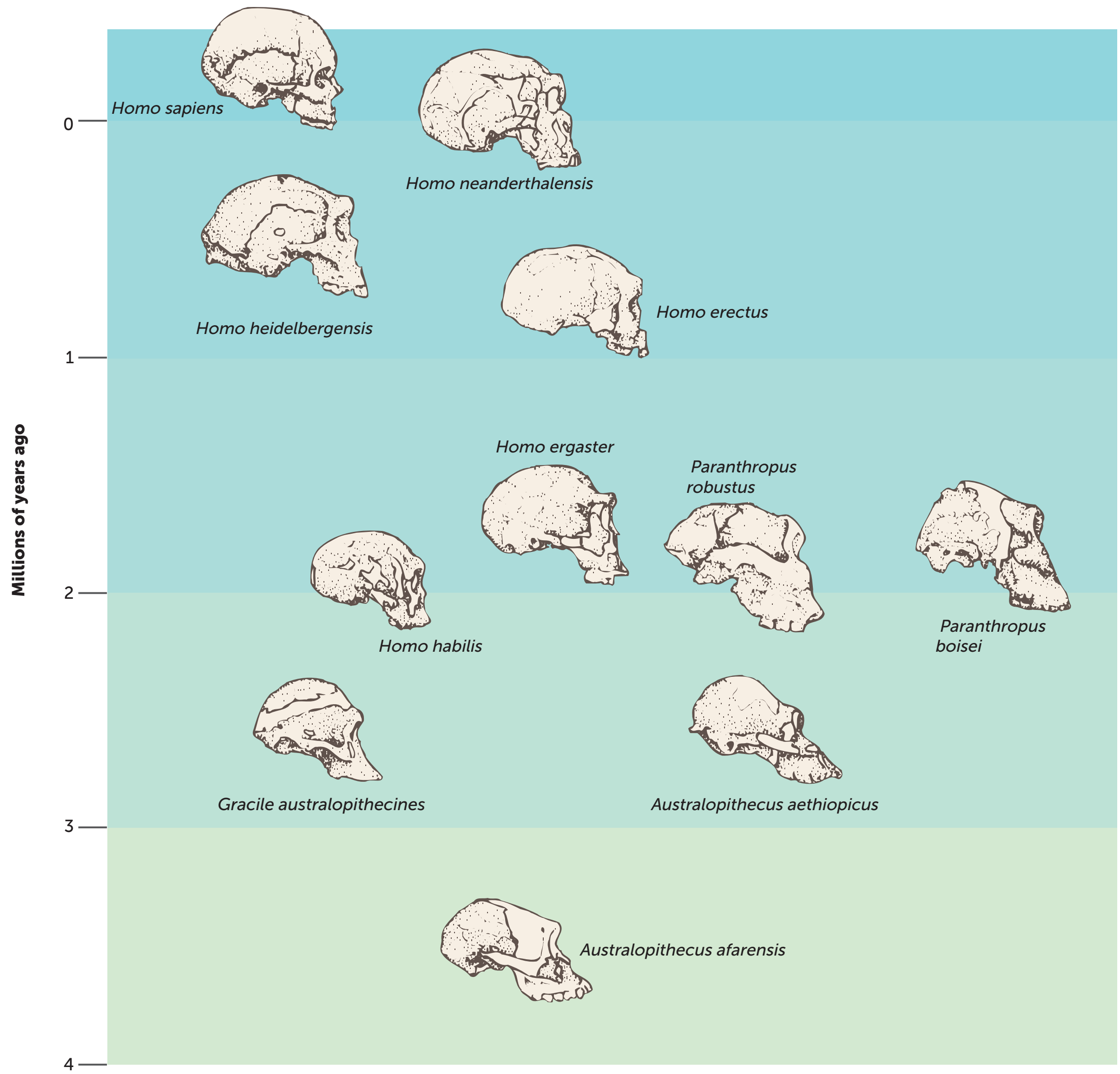


Figure 13.3 Fossil hominin skulls from different time periods. Note the increased cranial capacity and reduced prognathism from the early australopithecines to modern humans.

Relative size of the cerebral cortex

Unlike bipedalism, which was well established in early hominins, the gradual increase in the size of the cranium to house a larger and more complex brain is an evolutionary trend in hominins. **Endocasts** have been used to calculate the **cranial capacity** of fossilised skulls. This has enabled scientists to infer that early hominins such as *Australopithecus afarensis* had a cranium that was much closer in size to that of modern apes than modern humans.

Subsequent fossil evidence confirmed a gradual increase in cranial capacity as the hominin species evolved towards modern humans. The average brain size of the first australopithecine fossils found placed them within the range of modern gorillas. However, the body weight of these fossil australopithecines was probably only a third that of the gorilla, so their *relative* brain size lay somewhere between that of chimpanzees and modern humans.

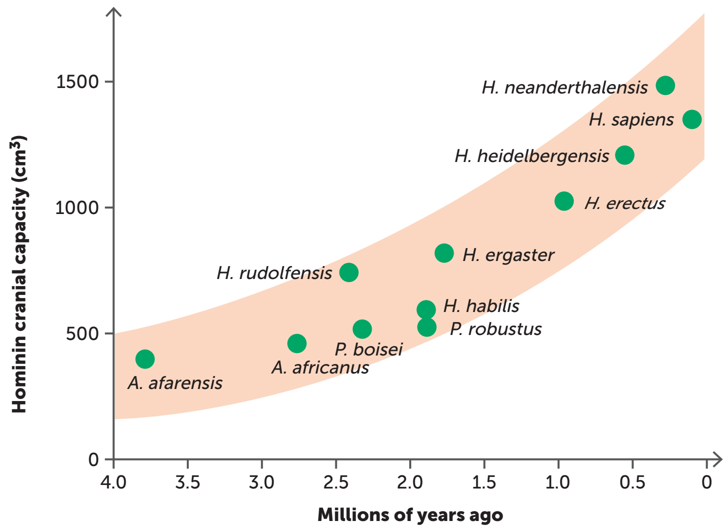


FIGURE 13.4 Graph demonstrating the gradual increase in cranial capacity of hominins over time. Average cranial capacity is shown for each species.

The endocasts of australopithecines also indicate that their foramen magnum was more forward than it is in the apes, and the skull more rounded at the back.

Sometimes only fragments of fossil skulls are found. Without an endocast, determining cranial capacity is very difficult, and even experts vary in their estimates. For example, when the first specimen of *Homo habilis* was discovered in Olduvai Gorge, Tanzania, in 1960, three different anthropologists gave three varying estimates for the cranial capacity: 590 cubic centimetres (cm^3), 647 cm^3 and 710 cm^3. Such a range of figures from an examination of the same material shows that estimates of cranial capacity must be treated with caution. The averages listed in Table 13.1 must be considered approximations at best.

TABLE 13.1 Hominin cranial capacities

HOMININ	CRANIAL CAPACITY (cm^3) (ESTIMATE OF BRAIN SIZE)
Australopithecus afarensis	430
Australopithecus africanus	457
Australopithecus garhi	450
*Paranthropus boisei**	491
*Paranthropus robustus**	542
Homo habilis	590
Homo rudolfensis	774
Homo ergaster	800
Homo erectus	1004
Homo heidelbergensis	1226
Homo neanderthalensis	1485
Homo sapiens	1350

Note: *Many classification schemes include the genus *Paranthropus* in the genus *Australopithecus*.

Activity 13.1
Investigating cranial capacity and phylogenetic trees

Fossil endocasts reveal more than just an increase in cranial capacity. A gradual increase in the number of convolutions and the size of the frontal lobe is also evident. These trends can be seen in *Homo erectus* fossils. Over the period of time that this species lived on Earth, the cranial capacity of *H. erectus* increased from about 750 cm^3 to 1250 cm^3. As the brain case expanded, the face tended to become flatter and a noticeable forehead began to develop in the later members of the species. This was probably due to an expanding frontal lobe.

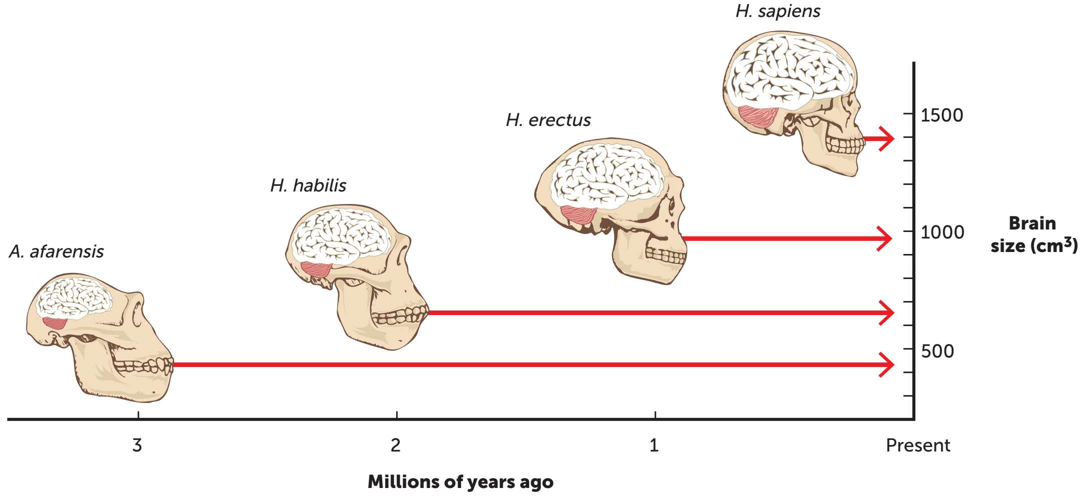


FIGURE 13.5 The increase in brain size in four hominin species over time. Note the marked expansion of the frontal region.

Increasing brain size
This website provides information on the increase in brain size in hominins.

Prognathism and dentition

The change in the dental arcade of hominins is another discernible evolutionary trend. Early hominins, such as *Australopithecus afarensis*, had a lower jaw and face that was more like that of other apes. The teeth were large and there was a distinct gap between the canines and the incisors, with the rows of teeth parallel rather than curved. However, by the time of *Homo habilis*, the molar and premolar teeth had become smaller and narrower, but the canines were still prominent, as can be seen in the fossil in Figure 13.6.

The trend towards smaller molars and a decrease in the robustness of the teeth continued in *Homo erectus* and is noticeable in modern humans. Humans that lived about 100 000 years ago had teeth that were about 10% larger than humans of today. Modern humans also appear to be gradually losing their wisdom teeth (the third molar), with an increasing number of people having no wisdom teeth at all.

Figure 13.7 shows the gradual enlargement of the cranial portion of the skull to accommodate the increasing size of the frontal region of the brain. This led to a more distinct forehead and to a reduction in prognathism and in the size of the brow ridge.

FIGURE 13.6 Fossil skull of *Homo habilis*

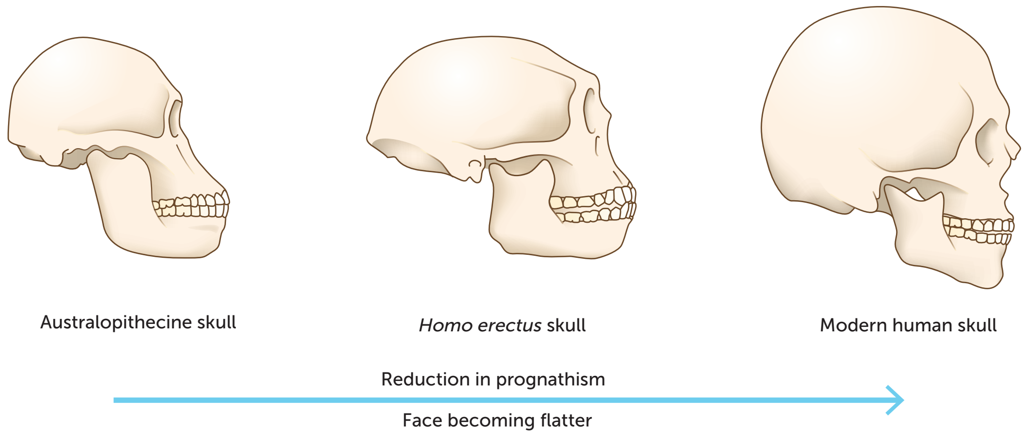


FIGURE 13.7 The evolutionary trend towards a flatter face

Reduction of prognathism
This website provides an excellent series of images illustrating the reduction in prognathism in hominins over time.

Activity 13.2
Investigating hominid skulls

Table 13.2 summarises the anatomical trends in human evolution.

TABLE 13.2 Anatomical trends in hominin evolution

ANATOMICAL FEATURE	CHARACTERISTICS MORE APE-LIKE (CONSIDERED TO BE MORE PRIMITIVE)	CHARACTERISTICS MORE HUMAN-LIKE (CONSIDERED TO BE MORE MODERN)
Skull	Thicker bones forming cranium Face large compared to cranial size Smaller cranial capacity Heavier brow ridges No forehead or sloping forehead Lower cranium Less prominent cheek bones Possible saggital crest on top of skull Foramen magnum towards back of skull (post-central)	Thinner bones forming cranium Face small compared to cranial size Larger cranial capacity Brow ridges reduced or absent Increasingly larger and more vertical forehead More dome-shaped cranium More prominent cheek bones No crest on top of skull Foramen magnum under centre of skull
Mandible and teeth	More prognathic jaw Larger jaw Heavier, thicker mandible No chin Larger teeth, especially molars Diastema present Canine teeth more prominent Difference between size of incisors and molars	Flatter face Smaller jaw More slender, thinner mandible Increasingly definite chin Smaller teeth No diastema Canine teeth less prominent More even teeth/\little difference in size of incisors and molars
Torso	Narrower pelvis Back (lumbar) vertebrae less wedge-shaped Wide, barrel-shaped ribcage	Broader pelvis Lumbar vertebrae more wedge-shaped Smaller ribcage
Upper limbs	Shorter thumb that is less mobile Fingers longer and more curved	Longer thumb with increased opposability Fingers straighter and shorter
Lower limbs	Femurs more parallel Arms longer than legs	Femurs sloping inwards towards the knee Arms shorter than legs

Key concept

Evolutionary changes in hominins include an increased cranial capacity and convolutions, as well as a decreased size of the teeth, diastema and prognathism.

Questions 13.1

RECALL KNOWLEDGE

1 Which tribe do humans belong to, and what other species are also in this tribe?
2 Explain the difference between brain size and cranial capacity.
3 State the trend in cranial capacity and convolutions of hominins.
4 Define 'endocast' and describe how it is used to infer the shape of the brain.
5 State the cranial capacity of:
   a *Australopithecus afarensis*
   b *Australopithecus africanus*
   c *Paranthropus robustus*
   d *Homo habilis*
   e *Homo erectus*
   f *Homo neanderthalensis*
   g *Homo sapiens*

APPLY KNOWLEDGE

6 Explain why the cranial capacity of a fossilised skull is used to infer brain size.
7 Explain the relationship between changes in the size of teeth and prognathism.

13.2 COMPARISON OF HOMININ SPECIES

Genus *Australopithecus*

Fossil evidence of australopithecines

The first australopithecine fossil was found in southern Africa in the early 1920s. Like many early fossil discoveries, it was a chance event. Raymond Dart, a young Australian anatomist, had his attention drawn to fossil baboon skulls being found in limeworks at Taung, north-west of Kimberley in South Africa. Dart asked the manager of the limeworks to send him any interesting fossils, which he did, sending a box full of limestone pieces containing bones. On clearing away the limestone, Dart was surprised to find the whole face, jaws and teeth of what appeared to be an ape. However, it was like no other ape: although it was a juvenile, Dart realised that the face was not as protruding as that of an ape, and the teeth, especially the first molars, were more like those of humans. The skull was more rounded, and there was no brow ridge (Figure 13.8). Dart's account of his discovery was published in *Nature early* in 1925. In his article, Dart suggested that the skull should be named *Australopithecus africanus*, 'the southern ape of Africa', and that it be put in a new family midway between apes and humans.


Alamy Stock Photo/The Natural history Museum

FIGURE 13.8 The Taung skull: Side view of a cast of the original fossil material

The Laetoli footprints are evidence that early hominins existed over 3 million years ago. Although there have been a number of interpretations of these footprints, with different numbers and sexes for the individuals who made them, most scientists agree that they were made by *Australopithecus afarensis* (a separate species of australopithecines) 3.56 million years ago. Features of the footprints that indicate a bipedal form of locomotion include a deep impression showing the heel hitting the ground first, the lateral transmission of weight from the heel to the ball of the foot, a well-developed longitudinal arch, a big toe that was parallel to the other digits, and a deep impression where the toe pushed the foot forward for the next stride.

Another important discovery was the fossil remains known as 'Lucy', which were found in the Hadar region of Ethiopia (see Figure 11.1 in Chapter 11), along with several hundred fossil fragments. The fragments are thought to be of individuals who lived and died near a now-vanished lake between 3 and 3.6 million years ago. 'Lucy' is a female skeleton that was 40% complete. 'Lucy' has been classified as *Australopithecus afarensis* based on evidence gained from the dental arcades, the size of the canines and the prominence of the cusps on the cheek teeth.


Science Photo Library/John Reader

FIGURE 13.9 The Laetoli footprints – footprints made in volcanic ash 3.56 million years ago. More than 3 million years ago, the ancestors of modern humans were walking in very much the same way that we do today.

Finding 'Lucy'
This website provides an interesting video on the discovery of this fossil.

Features of australopithecines

From the fossil evidence so far accumulated, it has been possible to construct a clear picture of the physical features of *Australopithecus*. Many of these resemble the features of later hominins. The teeth are typically those of a hominin: the canines are short and non-projecting, resembling the incisors, in sharp contrast to those of other apes. Together the incisors and canines make a row of cutting teeth, and there is no gap between them and the following premolars. The teeth are in the parabolic shape distinctive of the hominids.

FIGURE 13.10 Reconstruction of an australopithecine skull

The facial profile of the australopithecines has a low forehead, and a more projecting upper and lower jaw than more modern hominin profiles. The average brain size is around 480 cm^3, which is within the range of that of modern gorillas. However, the australopithecine's body weight was probably only a third that of the gorilla, and so their relative brain size lies somewhere between that of chimpanzees and modern humans.

Considering the evidence from fossil bones and fossil footprints, it is safe to assume that these early hominins were truly bipedal, even though their gait would not have been quite the same as that of modern humans. The femur, pelvis and carrying angle in australopithecines are much more like those of a human than an ape, as Figure 13.11 indicates. The pelvic and foot bones are typically hominin, with the foot possessing a non-opposable, strongly built, robust big toe. Additionally, the foramen magnum was more forward than it is in the other apes, and the skull more rounded at the back. Finally, the vertebral column displays the typical hominin 'S'-shaped curvature, which, together with the central position of the foramen magnum, indicates an erect stance.

Bones of the hand suggest that the thumb was shorter and less mobile than that of modern humans, and the fingers more heavily built, features indicating that the hand was better adapted for the power grip than the precision grip. This may indicate an arboreal lifestyle.

Australopithecus species

While there are many similarities between all australopithecines, there are also some variations, indicating the evolutionary changes. These are summarised in Table 13.3.

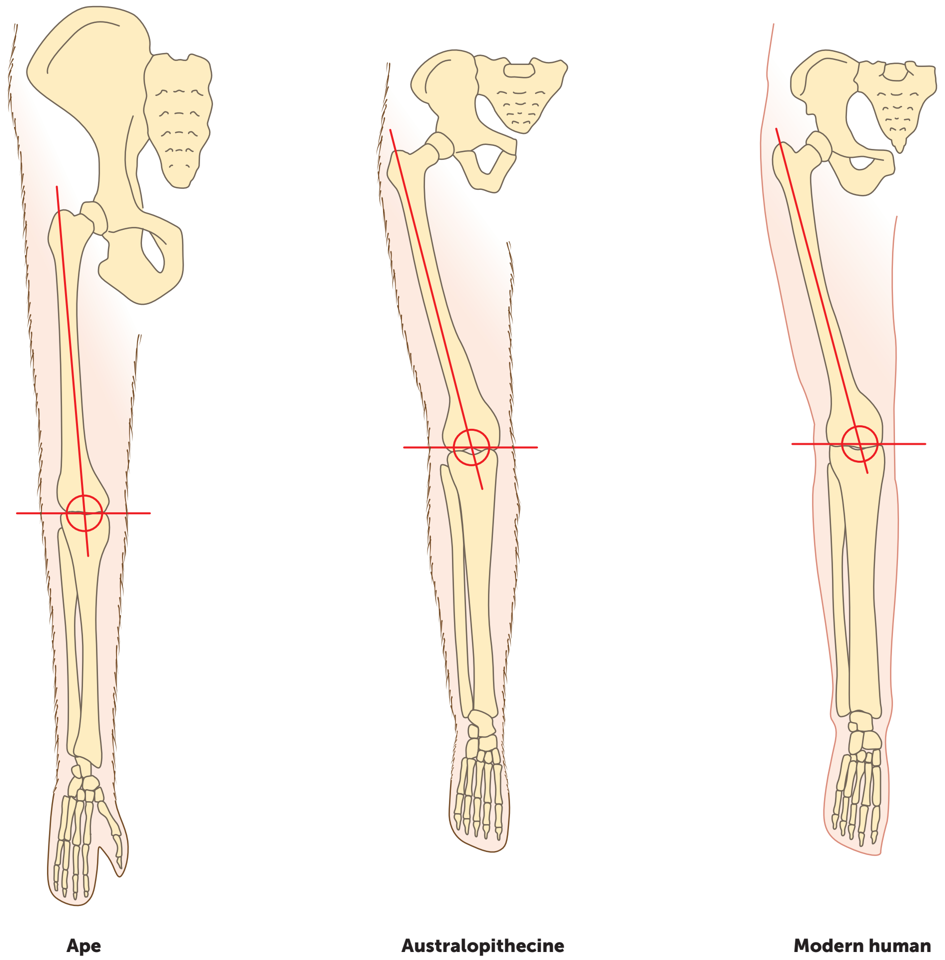


FIGURE 13.11 Australopithecines, like modern humans, had the femur angled so that the foot was under the centre of gravity, allowing bipedal locomotion with the striding gait. The femur of other apes is not angled in this way, so they sway from side to side when walking erect.

TABLE 13.3 A comparison of *Australopithecus afarensis* and *Australopithecus africanus*

	Australopithecus afarensis	*Australopithecus africanus*
Time of existence	3.9 and 2.8 million years ago	3.2 to 2 million years ago
Location	East Africa	Southern Africa
Height	Female: 105–110 cm Males: 150 cm	Female: 110 cm Males: 135 cm
Brain	430 cm^3	480 cm^3
Skull	Low, sloping forehead Prominent brow ridges Short sagittal crest in males	Slightly arched forehead Smaller brow ridge
Teeth and jaw	Prognathic jaw Small canine teeth (but larger than *A. africanus*) Diastema present	Prognathic jaw Shorter and smaller incisors and canines Large molar and premolars No diastema
Limbs	Big toe not opposable Long arms, although shorter than the legs Long curved fingers and toes Features for bipedalism	Big toe not opposable Long arms, although shorter than the legs Some curvature of the finger and toe bones Features for bipedalism
Pelvis	Short and wide pelvis	Short and wide pelvis, less rounded than in modern humans

Australopithecus afarensis
This website has more information about *Australopithecus afarensis*.

Australopithecus africanus
This website has more information about *Australopithecus africanus*.

Paranthropus robustus

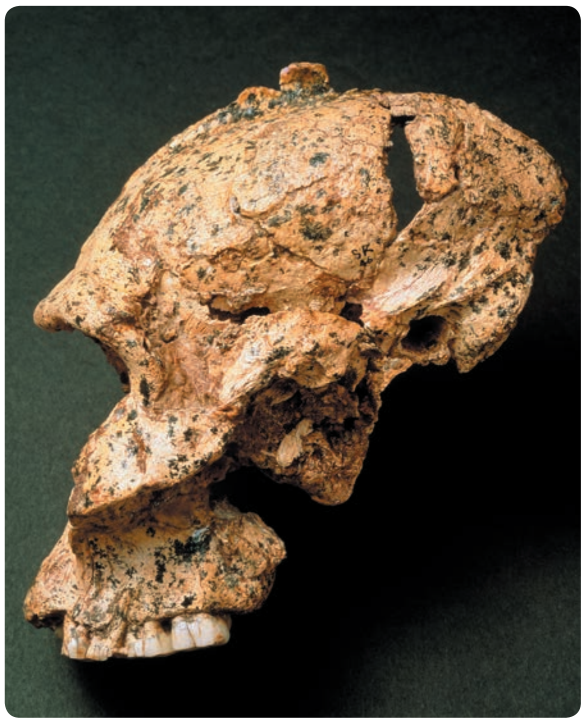
Robert Broom discovered a fossil jaw fragment and molar in 1938 with large molars and a strongly built jaw. This was different from the features of the human species known at that point. This led Broom to believe it was evidence of another species, *Paranthropus robustus*.

Individuals in the *Paranthropus robustus* existed in South Africa about 1.8–1.2 million years ago. The species has been extinct for more that 1 million years. It is thought that they are not an ancestor of modern humans, but instead formed part of an evolutionary branch with no descendants. This can be seen in the phylogenetic tree in Figure 13.2.

Paranthropus robustus used to be classified as a robust australopithecine based on the robust jaw and skull. However, it is now considered to be a separate genus.

Given that they were originally classified as australopithecines, it makes sense that *Paranthropus robustus* share many of the same characteristics as australopithecines. Some of the key features of *P. robustus* are:

- females' height of approximately 1 m and males' height of approximately 1.2 m
- cranial capacity of 520 cm^3
- large sagittal crest for attachment of strong chewing muscles
- very large molars and premolars, with small incisors and canines by comparison
- prognathism, although less than australopithecines
- wide, dish-shaped face with large zygomatic arches
- heavy brow ridges
- structures for bipedalism.



Science Photo Library/John Reader

FIGURE 13.12 A fossil of *Paranthropus robustus* found in 1936

***Paranthropus* genus**
This website has more information about *Paranthropus* genus.

Homo habilis

In 1964, Dr Louis Leakey published an account of a new species of *Homo* found at Olduvai Gorge in East Africa. Together with two colleagues, Professor Phillip Tobias and Dr John Napier, he had found a jaw, two cranial fragments, and several post-cranial remains dating back to 1.75 million years BP. They gave the new species the name *Homo habilis*, or 'handy human', to indicate that it was adept at tool making. Usually the announcement of something 'new' in science causes other authorities in the field to question the interpretations of the discoveries. The case of *H. habilis* was no different. Many authorities considered it to be nothing more than an advanced australopithecine, or an East African variant of *Australopithecus africanus*. However, *H. habilis* had a larger brain and smaller teeth than the australopithecines, suggesting that their diet included meat. They were taller than the gracile forms and stood more erect. At the time of its discovery it was thought to be the earliest tool user.

Homo habilis lived between 2.3 and 1.5 million years ago in eastern and southern Africa. Individuals show features between apes and humans. These include:

- females' height of 110 cm and males' height of 130 cm
- brain size of 610 cm^3
- rounder skull
- small brow ridge
- central foramen magnum
- moderate prognathism
- teeth arranged in a rounder arc
- relatively short legs and long arms
- slightly curved finger bones, indicating a strong power grip
- able to form a precision grip.

Homo habilis
This website provides more information about, and images of, *Homo habilis*.

Science Photo Library/Natural History Museum, London

FIGURE 13.13 Cast of a *Homo habilis* skull discovered in 1973 in Kenya

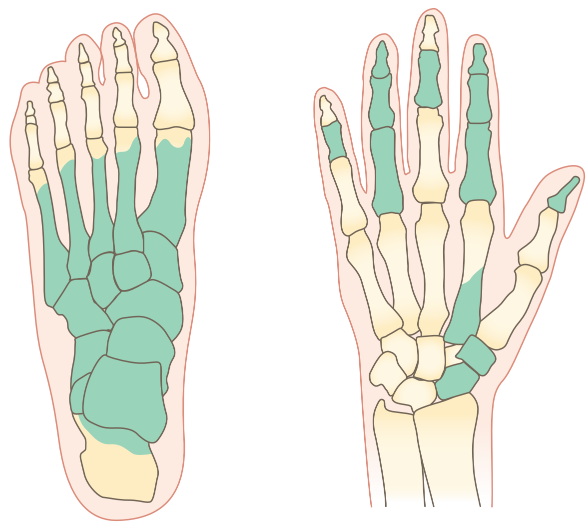


FIGURE 13.14 Hand and foot fossil bones (shown shaded) of *Homo habilis;* they resemble those of modern hominins. There is evidence of heavy musculature, indicating a powerful grip

Homo erectus

Homo erectus were the first humans to show modern, human-like bodies, indicating a life on the ground rather than in the trees.

In 1927, Dr Davidson Black announced that he had found a new species, which he called *Sinanthropus pekinensis*, or Chinese human of Peking (now known as Beijing). This is why the fossil is known as 'Peking Man'.

Peking Man
This website suggests that 'Peking Man' may have been more sophisticated than was once thought.

Alamy Stock Photo/imageBROKER

FIGURE 13.15 Reconstruction of a *Homo erectus* skull based on fossil remains found at Zhoukoudian Cave in China

Black's announcement came after the study of teeth found in a limestone cave near Zhoukoudian, south of Beijing. Two years later the first skull was found; in the years to follow, four more skulls, plus skull fragments, lower jaws and teeth, were discovered. These fossils are now included in the species *Homo erectus*, and they are still some of the best examples ever found. Unfortunately, during World War II the original fossils were lost, but good plaster casts had been made of them and each had been extensively described in the scientific literature, so the material may still be studied today.

When compared to fossils of earlier human species, the brain of the Beijing specimens was considerably larger, with an average size of 1075 cm^3, and some aspects of the skull showed more modern features. The curve of the dental arcade was shorter and more rounded in front. The jaw was shorter and more compact, and suggested that a chin was beginning to form. Finally, the teeth were very modern and indicated a diet much like that of humans today. Evidence of the use of fire was also found in the cave, together with the remains of small, quartz, flake-like tools and animal bones.

Some key features of *Homo erectus* are:

- varied height, ranging from 145 cm to 185 cm
- short, stocky body with thicker bones, suggesting a demanding lifestyle
- average cranial capacity of 1050 cm^3
- low, sloping forehead
- defined brow ridges
- large, thick jaw without a chin
- reduced size of molars.

Homo neanderthalensis

The first recognised fossils of Neanderthal people were found in 1856 in a cave in the Neander Valley, near Düsseldorf, Germany. Since then a great many more fossils of this type have been found throughout Europe, Asia and northern Africa. Interpretations of data from the fossils have varied in the past, but fossils found in the 1990s suggest that the Neanderthals were only a side-branch along the pathway to modern humans. This was confirmed when, in 1997, molecular biologists extracted some DNA from a Neanderthal fossil and compared it with that of modern humans. They concluded that the Neanderthals were a distinct biological species, *Homo neanderthalensis*. They existed in Europe during the last of the ice ages and were adapted to that particularly harsh type of environment. At some time in the past, the lineage diverged, with one branch leading to Neanderthals and another to modern humans. Exactly when, and how, this split took place we do not know, but there is considerable evidence that for a time Neanderthals and *Homo sapiens* lived together in Europe.

Science Photo Library/Javier Trueba/MSF

FIGURE 13.16 Neanderthal skull showing the 'bun' shape at the back

Neanderthals, while clearly human, had many features that evolved due to a cold, harsh climate. They had big faces, low but large skulls, and heavy brow ridges. The brain was slightly larger than the average for humans today, and its shape was different. The back of the skull was drawn out in a 'bun' shape, the lower jaw lacked a definite chin, and the cheeks were swept back to give a streamlined appearance. These features can be seen in Figure 13.17, where the skull of *Homo neanderthalensis* is compared with those of *H. erectus* and *H. sapiens*. Note how it appears to have some features of both. The robust nature of the Neanderthal skull echoes the physical appearance of *H. erectus*, while the much larger brain of the Neanderthals is considered a modern feature. Peculiar to the Neanderthals is the forward thrust to the face, or prognathism, accentuated by the way the nasal bone projects forward. It is believed that the Neanderthal nose projected more than the modern human nose and was much wider. This larger, wider nose is thought to have been an adaptation for life in seasonally cold and dry environments.

Homo neanderthalensis
This website has more information about *Homo neanderthalensis*.

Neanderthal brains: Bigger, not necessarily better
This article compares the brains of Neanderthals and modern humans.

9780170449168

Science Photo Library/Christina Brodie, Visuals Unlimited

FIGURE 13.17 Skulls of *Homo erectus* (left), *Homo neanderthalensis* (centre) and a modern human (right)

The Neanderthals were short in stature, males being probably a little more than 1.5 metres in height, and females a little shorter. The limbs were short and heavily jointed with powerful muscles, so they would have appeared much more heavily built than modern humans. A barrel-shaped chest and thick neck muscles would have added to the rugged appearance. On top of this solid frame was a large skull containing a brain that was, on average, slightly larger than normal for modern humans, averaging 1485 cm^3, compared to 1350 cm^3 for modern humans. It has been suggested that the additional brain capacity was probably required for control of the extra muscles. Apart from these differences in physical characteristics, Neanderthals would have walked, run and used their hands in much the same way as modern humans. Table 13.4 summarises the key features of *Homo neanderthalensis*.

Homo sapiens

When the first fossils of modern humans were found in Europe, no one realised their significance or importance. It was not until 1868 that fossils of this type attracted the attention of scientists. In that year a number of skeletons were found at Cro-Magnon, under an overhanging cliff near the village of Les Eyzies in France. These fossils, of what are now called the **Cro-Magnon people**, were discovered by workmen constructing a railway. The site revealed the remains of more than five people, together with animal bones, seashells in the form of necklaces, and stone tools. The stone tools were similar to those that had been found at Aurignac, tools that had become known as Aurignacian. Later discoveries suggested that these fossils were part of a once-widespread population distributed throughout Europe from 40 000 to about 12 000 years ago. The best records of this habitation date from 25 000 years ago and occur in Spain, the French Pyrenees and the Dordogne Valley in France.

Cro-Magnon people were members of our own species, *Homo sapiens*, and they possessed features far more modern than those of Neanderthals. In particular, their skulls tended to be shorter from front to back, higher in the region of the top of the skull and rounder at the back. Besides these, other features included less prominent brow ridges, a reduction in the projection of the face, and a smaller jaw, as can be seen in Figure 13.18. They had large brains, around 1350 cm^3 on average, housed in skulls that were long from front to back. The face was relatively broad and short, with the orbits, or eye sockets, well separated. The teeth also tended to be smaller and a chin had developed.

Science Photo Library/Natural History Museum, London

FIGURE 13.18 Cro-Magnon skull

Human lineage
This website provides an interactive timeline showing our hominin ancestors.

Table 13.4 shows the key information about *Homo neanderthalensis* and *Homo sapiens*.

TABLE 13.4 A comparison of *Homo neanderthalensis* and *Homo sapiens*

	Homo neanderthalensis	*Homo sapiens*
Time of existence	Between 28 000 and 300 000 years ago	300 000 years ago to present
Location	Europe and the Middle East	Worldwide
Body type	Shorter, more robust and muscular than modern humans Wider shoulders	Short, slender trunks and long limbs
Height	Females: 156 cm Males: 168 cm	Females: 160 cm Males: 175 cm
Brain	1500 cm^3	1350 cm^3
Skull	Long and low brain case Occipital bun at the back of the skull Thick brow ridges Receding forehead, elongated skull Flared zygomatic arches Depression at back of skull for neck muscle attachment	Short base and high brain case
Teeth and jaw	Larger, more robust prognathic jaw Lacking a chin Larger teeth	Short jaw Bony chin Small teeth
Limbs	Thick limbs with large joints Shorter	Long legs compared with the arms Straight fingers and toes
Pelvis	Wider pelvis	
Ribcage	Barrel-shaped	Less barrel-shaped

Key concept

During the evolution of hominins, there has been a general increase in cranial capacity and height along with a decrease in prognathism and brow ridges.

Questions 13.2

RECALL KNOWLEDGE

1 Complete the following table for the species listed.

SPECIES	TIME OF EXISTENCE	HEIGHT	KEY PHYSICAL FEATURES
Australopithecus afarensis			
Australopithecus africanus			
Paranthropus robustus			
Homo habilis			
Homo erectus			
Homo neanderthalensis			
Homo sapiens			

2 Which species studied were the first hominin to show bodies similar to modern humans?
3 Describe features of fossils of australopithecines that would indicate bipedalism.
4 What is a key feature that will allow the identification of a *Homo neanderthalensis* skull?

WS **13.1 Human evolution**

Activity 13.3 Investigating evidence for human evolution

Activity 13.4 Are humans unique?

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.
6 Explain why the forehead of *Homo sapiens* is rounder and higher than earlier species.
7 Describe the features of the skull of a *Homo sapiens*.

APPLY KNOWLEDGE

8 Classify the hominin species of the skull to the right. State the features used in your classification.
9 Explain how the fossilised Laetoli footprints would have been produced.
10 Explain the relevance of a large sagittal crest in skulls of *Paranthropus robustus*.
11 Neanderthals lived in cold, harsh climates. Discuss two physical features that would have evolved in this environment.

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13.3 CULTURAL EVOLUTION

Anthropologists, people who study human societies and their development, may define **culture** as anything that is learnt. Thus, activities such as making stone tools, hunting techniques, food preparation, using language and making art are all part of culture.

Just as the physical characteristics of hominins evolved over time, hominin culture has also evolved. Cultural development was an important means of overcoming some of the environmental challenges faced by early humans. This **cultural evolution** can be seen in the gradual improvement in tools, better methods of obtaining food, increased sophistication of language and a host of other changes culminating in the highly complex culture that we have today.

Tool use by australopithecines

The areas once occupied by australopithecines reveal the existence of **home bases**, from where hunters and foragers went out to search for food. No evidence of the use of fire by australopithecines has been found to date, but tool use does appear to have been common. A range of **pebble tools** have been found, including choppers, scrapers, flakes and chisels. These vary from about the size of a tennis ball (choppers) to that of a marble (scrapers and flakes), and are frequently referred to as **Oldowan tools**, after the site where they were first discovered. To use the scrapers effectively, the precision grip must have been employed. Tools of this type have been found at sites dating back 2.5 million years.

Alamy Stock Photo/The Natural history Museum

FIGURE 13.19 Oldowan choppers

This early tool making marked the start of a change in the way hominins interacted with their environment. They used items present in their surroundings, such as pebbles, sticks and plant material. However, there is no evidence suggesting that they changed these tools. These simple pebble tools enabled the australopithecines to exploit the resources in their environment more effectively and were the first stage in a succession of cultural changes still going on today.

Tool use by australopithecines enabled them to exploit a broader range of habitats, so they were eventually able to leave Africa and colonise other continents. Evidence suggests that the australopithecines began to disperse from Africa around 2 million years ago.

Tool use by *Homo habilis*

Homo habilis continued to use Oldowan tools. Some of these were sharpened or shaped by striking one stone with another. These would have been used for activities such as skinning animals, chopping up meat, breaking open bones, crushing plants and digging up edible plant roots.

Homo habilis lived in grasslands and were hunter-gatherers. Their diet would have been primarily plant material, with supplementary meat from either scavenging or hunting. The meat would have provided the complex fats needed for brain growth. This corresponds with the evidence of an increase in cranial capacity.

Typically, hunter-gatherers would have worked in groups, with specific members being responsible for different tasks. Those collecting food would have brought it back to the home base to share among the members. This indicates a social organisation in *Homo habilis*. Communication within the group would have been important, and thus pressure for development of a spoken language would have increased. There is some evidence that early *Homo* had a bulge in the speech-producing area of the brain, but the larynx may not have been capable of making complex sounds.

Evidence that early *Homo* was both a hunter and a scavenger of meat comes from animal bones found at fossil sites. A number of the bones show cut marks made by stone tools. With the naked eye it is difficult to distinguish between cut marks made by stone tools and those made by the teeth of a carnivore. However, examination under high magnification shows a clear distinction between the two. In Figure 13.20, notice how the tooth has left a broad, smooth groove on the bone, whereas the stone tool has made smaller, parallel grooves in the main cut. When interpreting the meat-eating behaviour of these early hominins, it is important to determine which cut marks were made first. Were they scavenging the remains of prey killed by carnivores, or were they consuming meat from animals they had killed and butchered? The bones recovered suggest that they were engaged in both activities. It is likely that *Homo habilis* were more scavengers and that as *Homo* evolved, hunting became more important.

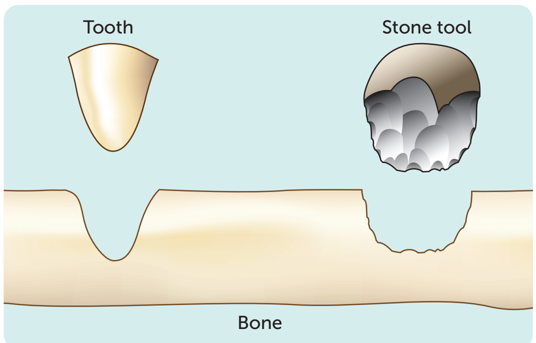

FIGURE 13.20 Difference in the marking patterns on bone produced by a tooth and by a stone tool

Tool use by *Homo erectus*

By the time of *Homo erectus*, the effect of the environment as a selective agent was diminishing. These hominins were now modifying the environment to suit their own purposes. The use of fire, the building of shelters and a range of sophisticated tools had enabled *H. erectus* to become more independent of the environment.

Science Photo Library/Pascal Goetgheluck

FIGURE 13.21 Acheulian hand axe

Tools manufactured by *H. erectus* were flaked around all of the edges, first in one direction and then in the other, until they formed roughly two-faced (bi-faced) lumps, approximately teardrop in shape. These tools were used as hand axes and are usually referred to as **Acheulian tools**, after the site at St Acheul in France where they were first discovered.

The discovery of a site on the Riviera in France in 1966 revealed much about the life of *H. erectus* in Europe 400 000 years ago. The site, called Terra Amata, contained 21 levels of habitation. Among important discoveries were the imprint of an adult foot, evidence of fire use and signs that *H. erectus* had constructed huts for shelter.

Terra Amata
This website gives more information about Terra Amata.

Evidence from sites in other parts of the world reinforces the idea that *H. erectus* was a skilful hunter, employing a variety of techniques to capture game. At Olorgesailie, in south-western Kenya, the site of a massive slaughter of baboons has been located. This hunt must have been organised well in advance, as stones and tools had been carried to the site from up to 33 kilometres away. Organisation like this also indicates that, half a million years ago, *H. erectus* was capable of logical thought and had the ability to communicate and work with others in an organised and efficient manner.

In Spain, at Torralba and Ambrona, evidence indicates that hominins lit fires to drive elephants into swamps where they were trapped and butchered. It appears that this driving technique was also employed at Olduvai Gorge, in Africa, to trap antelopes and pigs. Once captured, the animals were butchered using tools made from bone and stone. The butchery marks on the surface of fossil bones indicate that, as time passed, *H. erectus* became more systematic in the use of tools. This suggests an increasing commitment to routine meat eating.

Tool-manufacturing sites were also found in France, and they included tools made from both stone and bone. However, no fossil hominins were found. The remains of animals indicated that hunting was important, and the predominance of deer bones suggested that the inhabitants preferred this type of meat. The presence of some fish bones indicated that these hominins also fished from time to time.

FIGURE 13.22 The production of flake tools: **a** and **b** show preparation of the core, and **c** shows how a large number of flakes can be produced

The life of *H. erectus* was significantly influenced by the use of fire. It was the first step towards manipulation of the environment to suit human needs. Fire helped keep predators away, gave warmth and light at night, and may have been used to stampede animals. The warmth from a fire would have been important for migrating groups moving into Europe and Asia during the bitter cold of the ice ages. Fire also enabled cooking, which increased the range of foods that could be eaten by improving flavour and digestibility. It would also have made some foods safer to eat, either by destroying the early stages of parasites such as tapeworms, which may be present in meat, or by detoxifying some plant foods.

Cultural changes such as the use of fire and the manufacture of tools would have influenced the social organisation of *H. erectus*. Greater emphasis must have been placed on mutual cooperation, and a complex society began to be established in which the care of the young would have gradually become increasingly important. A relatively complex spoken language could also have arisen by this time, but this is, of course, impossible to establish from the fossil record.

Tool use by *Homo neanderthalensis*

By the time of later hominins such as *Homo neanderthalensis*, further cultural advances had greatly diminished the importance of the environment in determining how and where they lived. Tool making now involved the production of stone flakes that could then be trimmed to form various cutting, scraping, piercing and gouging tools. Commonly referred to as the '**Mousterian industry**', after Le Moustier in France where the first flake tools were found, these tools showed a cultural advance over the Acheulian hand axe. A piece of stone was first trimmed into a disc-shaped core, and then struck by another piece of stone to produce the flakes that were flat on one side and had sharp edges. This technique is known as the **Levallois technique**. It is a slow, labour-intensive process that requires planning and foresight.

Levallois technique
This website includes an animation of the Levallois technique.

The flake tools could also be joined on to a handle, spear or arrow in a process called **hafting**. This broadened the use and increased the effectiveness of the tools. For example, spears could be used for hunting larger animals, hand axes could be used for cutting up animals or wood, while other tools could be used to make tools.

The Lavallois technique and hafting required planning and the ability to foresee possible outcomes. This indicates a significant development in the cognition of the species. This behavioural evolution coincides with the evolutionary trend in increased cranial capacity, which is likely possible due to the increased importance of meat in the diet.

Flake tools enabled people living in colder climates to become good clothes makers. Numerous scraping tools for preparing animal hides have been found at Neanderthal sites.

FIGURE 13.23 Neanderthal tools

The cultural advances of Neanderthals were not limited to tool making. There is strong evidence that Neanderthals buried their dead, leading to the suggestion that they believed in life after death. Ceremonial burial also seems to have been practised. At one site, the grave of a youth was surrounded by wild goat horns that had been thrust into the ground with the pointed ends downwards. At another site, a man had been buried on a bed of flowers. The shoulder blade, collarbone and upper right arm bone were all underdeveloped and there were no lower arm bones. Perhaps the man had been born with a withered right arm that had been successfully amputated above the elbow. It is likely that Neanderthals cared for disabled members of their group and had developed a social system for sharing food and other resources.

Tool use by *Homo sapiens*

Around 50 000 years ago, new technologies associated with modern humans – finer blades and projectile weapons – began to appear. Scientists can only speculate on what triggered this technological spurt. Some have suggested that there was a mutation that affected the brains of a group of anatomically modern humans living either in Africa or in the Middle East. This may have resulted in new neurological connections that gave them new abilities. Perhaps it permitted fully articulate speech, so these people could pass on information more efficiently.

Whatever the cause, around 40 000 years ago modern humans moved into Europe. They brought with them innovations such as clothing, which had been sewn, and better shelters. This allowed them to survive the cold of glacial Europe, previously the exclusive domain of Neanderthals. The populations of both peoples were small and scattered. But while modern humans began to thrive, Neanderthal populations gradually decreased.

These modern humans became well established in Europe and were the makers of blade tools – flakes of stone with roughly parallel sides. Known as the Cro-Magnon people, they had large brains housed in skulls that were long from front to back, similar to the present people of Western and Northern Europe. Cro-Magnon people were essentially hunters and gatherers, relying mainly on the hunting of herd animals that occupied the open plains. They mastered the art of hunting animals such as bison, mammoth and reindeer, often by stampeding them over cliffs or into narrow ravines. Besides being a source of meat, these animals also provided skins, which served as clothing or shelter.

FIGURE 13.24 Aurignacian blade shown from three angles

There is evidence to suggest that the fat from these animals was used for oil lamps, and that their bones and ivory were used to make tools.

When the first fossil remains were found at Cro-Magnon in 1868, the tools found with them were similar to those found eight years earlier at Aurignac, which had become known as **Aurignacian tools**. These were blades made by removing long, flat rectangles from the core stone, which were easy to handle and effective in cutting.

Besides the Aurignacian tool culture, two other cultures are associated with later Cro-Magnon people: the Solutrean and the Magdalenian. The **Solutrean culture** was characterised by beautifully made willow-leaf and laurel-leaf points. These were made by carefully retouching blades produced from the original stone core by pressure flaking. The laurel-leaf point illustrated in Figure 13.25 must have taken many hours of intricate skill to produce and is thought to have been an ornament, or perhaps a symbol of the tool maker's craft, as it would have served little practical purpose.

The **Magdalenian** cultural period, which followed the Solutrean, was named after the rock shelter of La Madeleine in France. This culture is known for the dominance of bone and antler tools over those of flint and stone, and for the works of art that were produced during this period. The bone and antler tools were made using a burin, or chisel-like cutter, a tool used for the manufacture of other tools. This was a significant advance in tool making: humans had devised a tool for making other tools. To make the burin, a blade was shaped so that it had a sharp cutting point. With this, bone, antler and ivory could be cut to make a range of tools, from fine needles to barbed spear points and spear throwers.

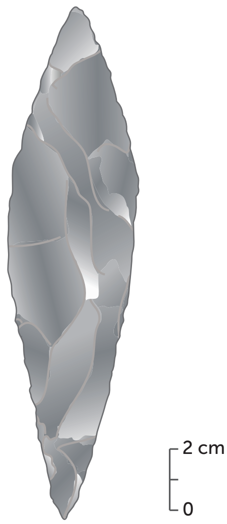

FIGURE 13.25 Solutrean 'laurel-leaf' blade

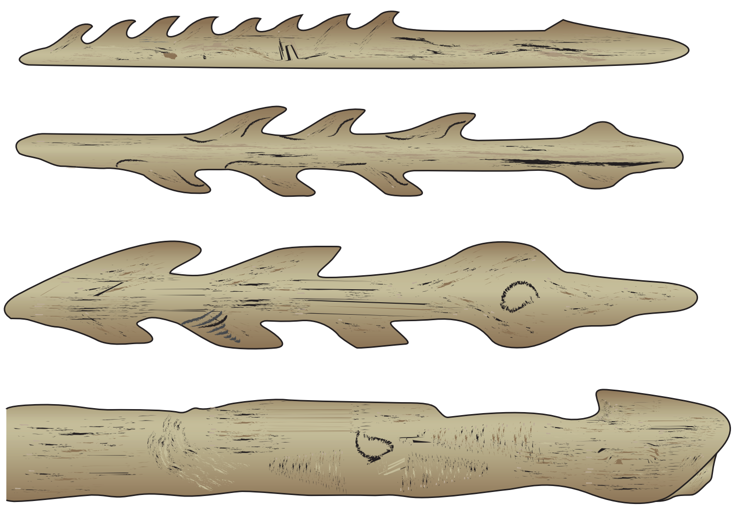

FIGURE 13.26 Magdalenian barbed points and spear thrower (bottom) made of bone or antler

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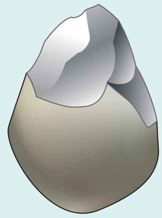
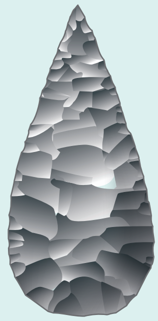
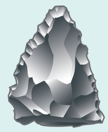
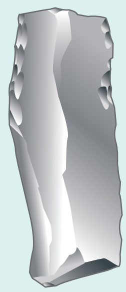
TABLE 13.5 Simplified table showing approximate age ranges and cultural periods of hominins

COMMON NAME	SCIENTIFIC NAME	APPROXIMATE AGE RANGE (YEARS BP)	TYPE, LOCATION	CULTURAL PERIOD	EXAMPLE
Australopithecines Handy man	*Australopithecus* sp. *Homo habilis*	2.6–1.7 million	Olduvai, Africa	Oldowan	
Homo erectus	*Homo erectus*	1.7 million–200 000	St Acheul, France	Acheulian	
Neanderthal	*Homo neanderthalensis*	200 000–40 000	Le Moustier, France	Mousterian – manufacture of flake tools	
Cro-Magnon	*Homo sapiens*	43 000–26 000	Aurignac, France	Aurignacian – manufacture of blade tools	
Cro-Magnon	*Homo sapiens*	22 000–19 000	Solutré, France	Solutrean – pressure flaking to retouch blades	
Cro-Magnon	*Homo sapiens*	18 000–12 000	La Madeleine, France	Magdalenian – predominance of bone and antler tools, and artwork	

Note: Tool cultures frequently persisted longer than shown; for example, a simple pebble tool would have been used by modern humans if this was all that was needed for a task. Age ranges are approximations, as different ages are associated with different sites.

Human evolution
This website provides a comprehensive description of human evolution, narrated by noted anthropologist Donald Johanson. Click on 'Launch the documentary'.

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Trends in tools

13.2 Cultural evolution of hominins

During the course of human evolution, some general trends are evident:

- increased manipulation of materials
- increased complexity of tools
- greater variety of materials being used to make tools
- improved workmanship and development of equipment needed to manufacture the tools
- increased specialisation of tools.

These trends, alongside structural changes during evolution, allow us to infer changes in lifestyles. Collaboration would have increased, requiring effective communication. Members within a group would have developed more specific roles and skills. Planning and creativity became important, and humans started manipulating the environment to meet their needs.

Activity 13.5
Examining chimpanzees, Neanderthals and humans

Key concept

During hominin evolution the use of tools also evolved from using tools that they found, such as pebbles, to sharpening edges to making flakes or structures from materials such as bone.

Questions 13.3

RECALL KNOWLEDGE

1 Describe Oldowan tools.
2 Name the species known to use Oldowan tools.
3 Which species was the first to use fire? List four different ways that fire could have been used.
4 What tool culture did Neanderthals use?
5 Name and describe the tools used by the Cro-Magnon.
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.

APPLY KNOWLEDGE

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

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8 Explain how Mousterian tools differ from Acheulian tools.
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.

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CHAPTER 13 ACTIVITIES

ACTIVITY 13.1 Investigating cranial capacity and phylogenetic trees

The subfamily Homininae includes humans, chimpanzees and gorillas, and their extinct ancestors. One of those extinct ancestors was *Ardipithecus ramidus*, who lived around 4.4 to 4.2 million years ago and who many scientists believe gave rise to the australopithecines and therefore could be a direct ancestor of modern humans. Even if *A. ramidus* is not on our direct evolutionary line, it must have been closely related to the direct ancestor, and was probably similar in appearance and adaptation.

Estimates of the cranial capacity of *A. ramidus* are between 300 and 350 cm^3, similar in size to modern female chimpanzees.

In this activity, you will use the information on cranial capacity in Table 13.1 to construct a phylogenetic tree of the hominins.

What to do

1. Assume that *A. ramidus* is the common ancestor of all the other species.
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.
3. Once you have constructed your tree, go to the 'Understanding evolution' weblink to see how your tree compares with the information provided on that page.

Understanding evolution

SOUTHERN Biological Developed exclusively by Southern Biological

ACTIVITY 13.2 Investigating hominid skulls

Aim

To analyse various hominid/primate skulls

This is an excellent opportunity for you to explore various anatomical adaptations that have emerged in hominids over their evolution.

Time requirement: 45 minutes

You will need

Pan troglodytes (chimpanzee) (modern) skull; Gorilla (gorilla) (modern) skull; *Homo sapiens* (human) (modern) skull; *Homo neanderthalensis* (Neanderthal man) (120 000–30 000 years ago) skull; *Homo erectus* (upright man) (2.0 million years ago) skull; *Australopithecus boisei* (2.3–1.2 million years ago) skull; *Australopithecus afarensis* ('Lucy') (4.0 million years ago) skull; tape measure (in millimetres)

Risks

WHAT ARE THE RISKS IN THIS INVESTIGATION?	HOW CAN YOU MANAGE THESE RISKS TO STAY SAFE?
Skulls may have sharp edges.	Handle with care and do not run fingers over skull teeth.

What to do

Examining the braincase

1. Examine the frontal bone (forehead) of each of the skulls and determine if they appear more vertical or flatter. Ensure the skull eyes are oriented forward while doing this.
2. Examine above the orbital and determine if a supraorbital (brow ridge) is present. If so, see if the brow ridge is continuous or divided in the middle.
3. Measure the width of the braincase at the widest point. Make all measurements in millimetres.
4. Look for evidence of a sagittal crest running lengthwise along the midline of the top of the skull. Identify if it is prominent, present or absent.
5. Measure the distance between the front teeth and the front ridge of the foramen magnum.
6. Examine behind the ear of the skull and determine if the mastoid process is fairly flat or noticeably protruding.
7. Record the results of your observations by copying and completing Table 1.

Examining the facial structure

1. Position the skull so that it is facing you. Examine the nasal bones. Identify whether they are flat or protruding.
2. Measure the maximum breadth (width) of the nasal opening.
3. Measure the maximum height of the nasal opening.
4. Starting at the outside of the back molars, measure the width of the maxilla (the upper jaw).
5. The bizygomatic breadth is the width of the face from the widest part of one zygomatic arch to the widest part of the other zygomatic arch. Measure this distance.
6. Record the results of your observations by copying and completing Table 2.

Examining the dentition (teeth)

1. Examine the dental arcade (the shape made by the rows of teeth in the upper jaw). Observe the teeth towards the back and identify whether the teeth on each side of the jaw are parallel or diverging.
2. Reposition the skull so that you are viewing it from the side. Examine the incisors and identify if they are vertical or angled forward.
3. Measure the width of the incisors on the left side of the jaw and then measure the incisors on the right side of the jaw. Add the width of all incisors together to determine the combined width.
4. Examine the maxilla (upper jaw) and mandible (lower jaw) together. Identify whether the canine teeth project above or below the chewing surfaces of the other teeth.
5. See if you can identify a canine diastema (a gap on the medial side of the canine).
6. Measure from the back of the last molar to the front of the first premolar on the left side of the jaw. This will give you a measurement of the chewing surface of the teeth.
7. Record the results of your observations by copying and completing Table 3.

Studying your results

1. Copy and complete the tables below. Include a row for each specimen.

TABLE 1 Examining the braincase

SPECIMEN	FOREHEAD	BROW RIDGE (PRESENCE)	BROW RIDGE (CONTINUOUS OR DIVIDED)	BRAINCASE	SAGITTAL CREST	FORAMEN MAGNUM	MASTOID

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TABLE 2 Examining the facial structure

SPECIMEN	NASAL BONES	NASAL OPENING WIDTH	NASAL OPENING HEIGHT	MAXILLA WIDTH	BIZYGOMATIC BREADTH

TABLE 3 Examining the dentition (teeth)

SPECIMEN	DENTAL ARCADE	INCISORS	INCISORS WIDTH	CANINE	DIASTEMA	CHEWING SURFACE

2 Draw a graph of one characteristic (e.g. presence of brow ridge) from each table. Draw 'specimen' on the *x*-axis and arrange in order from great apes to modern humans.

Discussion

1 The canine teeth have drastically reduced in size from great apes to modern humans. Explain why this might be.
2 Explain why the face has become progressively flatter over the evolution of hominids.
3 Describe how the position of the foramen magnum relates to body posture and locomotion.
4 Certain areas of the braincase enlarged before others in our evolution. Describe how the areas enlarged throughout our evolution.
5 What traits differentiate modern apes and modern humans?
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.
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.

ACTIVITY 13.3 Investigating evidence for human evolution

Eugène Dubois was an anatomist who enlisted in the Dutch army so that he could go to Sumatra (in Indonesia) to look for fossils of human ancestors. Remarkably, Dubois found what he was looking for: a tooth, part of a skull and a thighbone that were clearly not from modern humans.

Dubois' discoveries generated great interest in human origins and raised awareness of the importance of fossil material. One fossil that proved to be significant was taken to the Australian anatomist Raymond Dart, who was working at the University of Witwatersrand in Johannesburg in the 1920s.

What to do

Use a variety of research techniques to investigate the evidence for human evolution that Dubois and Dart discovered, and to answer the following questions.

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?
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.

ACTIVITY 13.4 Are humans unique?

Modern humans like to think of themselves as unique. We consider ourselves to be different from (and perhaps superior to) all other species of animals. But are we unique? What separates us from other animals, especially the other primates?

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.

ACTIVITY 13.5 Examining chimpanzees, Neanderthals and humans

This activity will enable you to use knowledge gained to examine the relationship between chimpanzees, Neanderthals and modern humans. The following table indicates the number of nucleotide (or base) differences between a region of mitochondrial DNA in two chimpanzees, a Neanderthal and two humans.

	HUMAN 2	CHIMPANZEE 1	CHIMPANZEE 2	NEANDERTHAL
Human 1	15	77	76	20
Human 2		79	80	27
Chimpanzee 1			23	72
Chimpanzee 2				71

What to do

Answer the questions below. As you answer the questions, refer to the table and to previous chapters where necessary.

1 Based on the information in the table, which individual is most closely related to the Neanderthal and which is the least closely related?
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?
3 What dating methods could be used to determine the absolute age of the Neanderthal fossil?
4 What methods could have been used to determine a relative age for the Neanderthal fossil?
5 Use the data to draw a phylogenetic tree for these species.

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CHAPTER 13 SUMMARY

- Humans are hominins, being bipedal walkers and having less hair and a greater development of brain, speech and sexual characteristics than other hominids.
- During the evolution of hominins, the cranial capacity has gradually increased. There has also been an increase in the number of convolutions of the cerebral cortex and the size of the frontal lobe. This corresponds to a reduction in prognathism and the development of a forehead.
- Early hominins had a lower jaw and a face similar to the great apes. During evolution, the teeth became smaller. As they take up less space, this results in a flatter face.
- Fossil evidence of *Australopithecus afarensis* and *Australopithecus africanus* includes the Taung skull, Laetoli footprints and 'Lucy'.
- Australopithecines had short canines and a lack of diastema, with the teeth arranged in a parabolic shape. They had a low forehead and a projecting lower jaw. Their average cranial capacity was 480 cm^3. Their foramen magnum was more central than in other apes, and the skull more rounded at the back. Australopithecines were bipedal, with a non-opposable big toe and an 'S'-shaped spine. The fingers were heavily built and more suitable for a power grip than a precision grip.
- *Australopithecus afarensis* existed 3.9–2.8 million years ago, earlier than *Australopithecus africanus*, who existed 3.2–2.0 million years ago. They showed fewer evolutionary changes.
- *Paranthropus robustus* are thought to form a branch in hominin evolution, living 1.8–1.2 million years ago. They were robust with a large sagittal crest with strong chewing muscles and molars. They had a larger cranial capacity, with an average of 520 cm^3 and a wide, dish-shaped face with less prognathism.
- *Homo habilis* had a larger brain (610 cm^3) and smaller teeth than the australopithecines. When compared to the australopithecines, their skulls were rounder, the foramen magnum central, the dental arcade rounder and with less prognathism. The arms of *Homo habilis* were long and the legs short. The fingers were slightly curved, indicating a power grip. However, they were also capable of a precision grip.
- *Homo erectus* showed features more similar to modern humans than previous species, showing further evolutionary changes. Their cranial capacity was 1050 cm^3, their forehead low and sloping, and their jaw large, thick and rounded, without a chin. The molar teeth were smaller, indicating a diet similar to that of modern humans. *Homo erectus* were the first species to use fire.
- *Homo neanderthalensis* were an evolutionary branch who existed in Europe during the ice age. They were short in stature with a heavier build than modern humans. They had big faces, low but large skulls, heavy brow ridges and an occipital bun at the back of the skull. Their cranial capacity was larger than that of modern humans at 1485 cm^3. The face of Neanderthals showed greater prognathism than modern humans due to the nasal bones projecting forward.
- Cro-Magnon people were early *Homo sapiens*. Their skulls were shorter from front to back and higher than the skulls of Neanderthals. They also showed reduced brow ridges and prognathism, and brains averaging 1350 cm^3.
- Australopithecines used Oldawan tools – pebble tools that include choppers, scrapers, flakes and chisels. While they used the tools, they did not make or change them.
- *Homo habilis* continued to use Oldawan tools, but they sharpened or shaped them to be able to use them to hunt and scavenge.

- *Homo erectus* used Acheulian tools – tools made by flaking the edges of stones in both directions – for hunting and fishing. *Homo erectus* also used fire and built shelters, allowing them to be independent of the environment.
- *Homo neanderthalensis* used Mousterian tools – flake tools produced by striking a disc of stone using the Lavallois technique. This allowed them to make clothes. They also attached the tools to handles, spears and arrows, increasing their use and effectiveness – for example, for hunting larger animals. Neanderthals buried and honoured their dead. It is also likely that they cared for less-abled individuals and shared food and resources.
- *Homo sapiens* developed fully articulate speech, leading to more effective communication. Their clothing and shelter became more sophisticated. The early *Homo sapiens*, the Cro-Magnon people, were hunters and gatherers. They used the animals for meat to eat, their fat for fuel, bones for tools, and the skin for clothing and shelter. Their tools were known as Aurignacian tools – tools made by removing long, flat rectangles from the core stone that are used as blades.
- Later Cro-Magnon people were part of the Solutrean culture. This is characterised by willow-leaf and laurel-leaf points. They were also part of the Magdalenian culture, which used bone and antlers that were modified by other tools. They also created art pieces.
- During evolution, tool use and construction has increased in complexity.

CHAPTER 13 GLOSSARY

Acheulian tool A type of hand axe that was flaked all around the edges, first in one direction, and then in the other, until it formed a roughly two-faced lump, approximately teardrop in shape; associated with *Homo erectus*

Aurignacian tool The tool culture of stone, bone and antler associated with early Cro-Magnon people

Cranial capacity The volume of that part of the skull that is occupied by the brain

Cro-Magnon people The first anatomically modern people found in Europe

Cultural evolution Cultural development that occurs as a means of overcoming environmental and other challenges

Culture Anything that is learnt

Endocast An impression of the inside of the brain case, either artificial or natural, made of rock or some other solid material

Hafting The process of attaching a stone tool to a handle, spear or arrow

Home base A camp site to which prehistoric hunters brought back food for sharing with other members of their group

Lavallois technique The process of producing a flake from a stone core; flakes normally had a flat side and sharp cutting edges

Magdalenian A prehistoric culture known for a predominance of bone and antler over flint and stone tools, and for the works of art they produced

Mousterian industry Describes a tool characterised by the careful preparation of a stone core from which a large number of flakes could be removed; associated with *Homo neanderthalensis*

Oldowan tool A very simple tool made by removing several flakes from a stone; the stone tool culture of *Homo habilis*

Pebble tool A stone tool made by chipping flakes off a rounded pebble

Solutrean culture The stone tool culture characterised by pressure flaking stones to produce beautifully made willow-leaf and laurel-leaf points; associated with the later Cro-Magnon people

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CHAPTER 13 REVIEW QUESTIONS

Recall

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

2 Describe the features evident from a study of the skull of each of the following species.
   a *Australopithecus afarensis*
   b *Australopithecus africanus*
   c *Homo habilis*
   d *Homo erectus*
   e *Homo neanderthalensis*
   f *Homo sapiens*

3 List the differences between Neanderthals and modern humans.

4 Describe the physical appearance of Cro-Magnon people.

5 a What was the importance of meat eating to the future survival and evolution of the hominins?
   b How did tool manufacture and use contribute to this survival?

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.

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

Explain

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

9 Explain how hafting changed the use of stone tools.

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.

Apply

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

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?

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.

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

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.

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

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.

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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*.

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

Extend

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

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

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