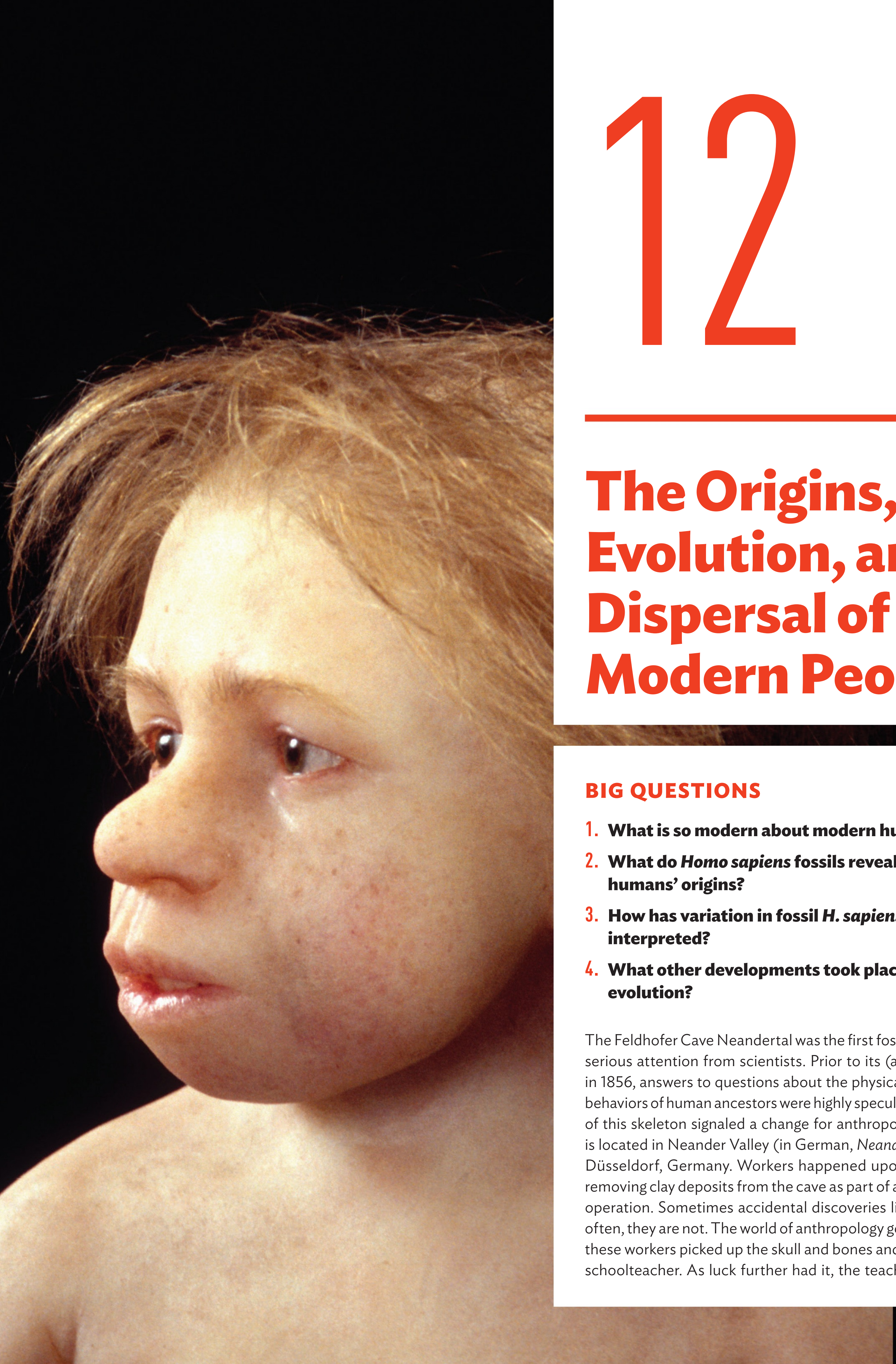


12

The Origins, Evolution, and Dispersal of Modern People

BIG QUESTIONS

1. **What is so modern about modern humans?**
2. **What do *Homo sapiens* fossils reveal about modern humans' origins?**
3. **How has variation in fossil *H. sapiens* been interpreted?**
4. **What other developments took place in *H. sapiens'* evolution?**

The Feldhofer Cave Neandertal was the first fossil hominin to receive serious attention from scientists. Prior to its (accidental) discovery in 1856, answers to questions about the physical characteristics and behaviors of human ancestors were highly speculative. The uncovering of this skeleton signaled a change for anthropology. Feldhofer Cave is located in Neander Valley (in German, *Neander Tal*), which is near Düsseldorf, Germany. Workers happened upon the skeleton while removing clay deposits from the cave as part of a limestone quarrying operation. Sometimes accidental discoveries like this are reported; often, they are not. The world of anthropology got very lucky because these workers picked up the skull and bones and took them to a local schoolteacher. As luck further had it, the teacher recognized these

FIGURE 12.1

Feldhofer Neandertal This Neandertal's DNA has been used recently to test hypotheses concerning the genetic relationship between modern humans and Neandertals.

remains as human and passed them on to the anthropologist Hermann Schaafhausen at the University of Bonn. Schaafhausen studied the remains, quickly reported his findings to the German Natural History Society, and published a description in a leading German scientific journal. He described a skull having some archaic features, distinctive from modern humans'. In particular, the skull was long and low, different from modern people's but with some similarities, such as in brain size (**Figure 12.1**). Moreover, the skeletal remains of extinct Pleistocene animals also found in the cave indicated that this human had lived at the same time as these animals. At the time these breathtaking announcements were made, many authorities believed that humans had appeared very recently in the history of life, certainly postdating extinct animals associated with the great Pleistocene Ice Age.[1]

Schaafhausen and the Neandertal skeleton caught the attention of scientific leaders in Germany and around the world. One of these leaders was the top German anthropologist of the time, Rudolf Virchow (see chapter 1, "How Do We Know: Franz Boas Invents Anthropology, American Style"; **Figure 12.2**). In addition to being a leading authority on evolutionary theory, archaeology, and cultural anthropology, Virchow started the discipline of cell pathology (diseases of cells). He helped found several national scientific organizations and periodicals. He was a medical activist, a political leader known across Germany, and the teacher of others who would become leaders in science and medicine. In short, his pronouncements about the Feldhofer Cave skeleton would be taken very seriously by scientists. After looking carefully at the remains, he summarily dismissed any notion that they belonged to an ancestor of living humans. He argued that their characteristics—a long, low skull and bowed, thick limb bones—were those of some modern human afflicted with rickets and arthritis. Others disagreed. Thomas Henry Huxley (see Figure 2.19) argued that this was a primitive, potentially ancestral human. But Virchow's assessment was convincing to most, setting the course for years. Later, scores of remains showing the same morphology as the Feldhofer Cave skeleton and dating to the same period of the late Pleistocene were found. Eventually, Virchow's pathology hypothesis was rejected, and debate centered on the role of the Feldhofer Cave skeleton and others like it—a group of hominins we call *Neandertals*—in later human evolution.

In this chapter, we will look at *Homo sapiens'* evolution, from its origins in *Homo erectus*

FIGURE 12.2

Rudolf Virchow Virchow made an influential but wrong pronouncement about the Feldhofer Neandertal skeleton. Among his many achievements was being the first researcher to recognize leukemia, a cancer of the blood and of bone marrow.

[1] Excavations at the Feldhofer Cave in 1997 and 2000 produced more than 62 new bone fragments that are part of the original skeleton, part of at least one other adult, and part of a juvenile. Radiocarbon dates on these new bones indicate that this Neandertal site is about 40,000 years old.

to its development into modern humans. Neandertals play a central role in this discussion, which is also based on rich records—of fossils, genetic variation, culture, and behavior—from around the world. First, though, we will explore which aspects of the fossil record indicate the first appearance of modern people. Then, we will examine those aspects to understand just how anthropologists interpret the variation across the bones and teeth of *H. sapiens*.

12.1 What Is So Modern about Modern Humans?

What do physical anthropologists mean by *modern?* This question is very important because the answer to it provides us with the baseline from which to assess the origins, evolution, and geographic distribution of modern *Homo sapiens.* Physical anthropologists define *modern* on the basis of a series of distinctive anatomical characteristics that contrast with *archaic* characteristics found in earlier hominins (**Figure 12.3**). Modern people—people who essentially look like us—tend to have a high and vertical forehead, a round and tall skull, small browridges, a small face, small teeth, and a

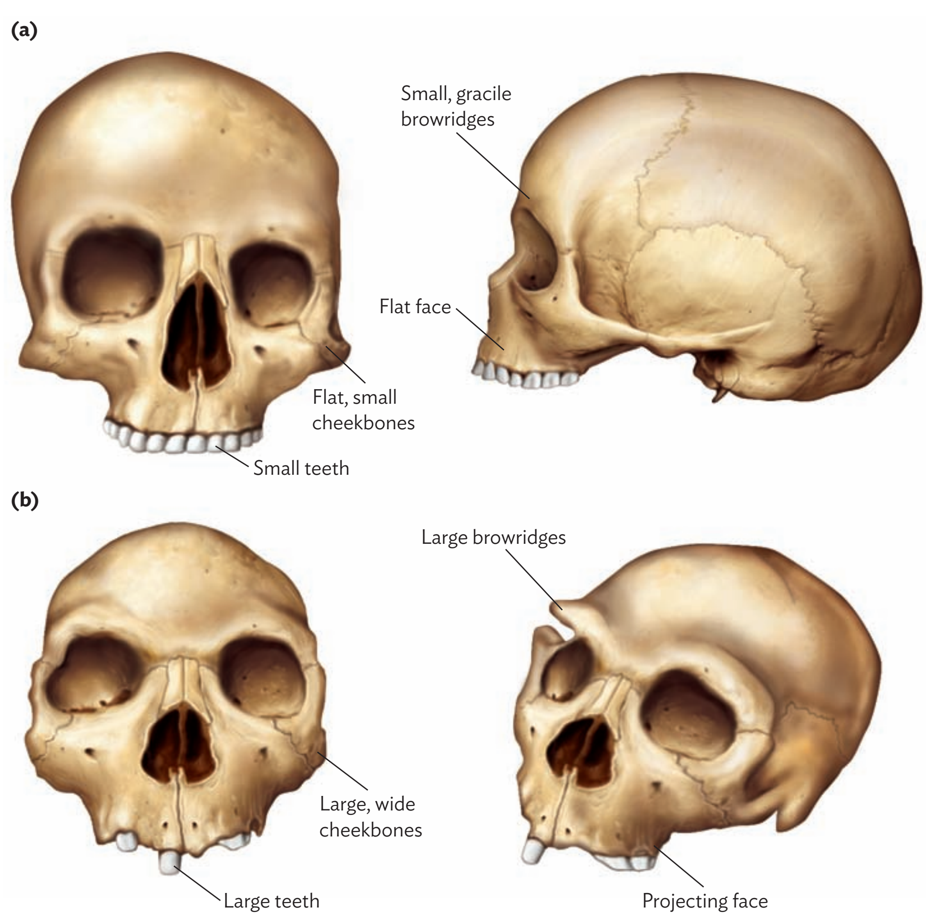


FIGURE 12.3

Modern Human Features **(a)** Anatomically modern *Homo sapiens* possess a unique suite of traits that are absent in **(b)** archaic *H. sapiens.*

projecting chin (anthropologists call the latter a "mental eminence"). Below the neck, modern humans have relatively more gracile, narrower bones than their predecessors. Fossil humans having these cranial and postcranial characteristics are considered modern *H. sapiens*.

The immediate ancestors of modern people—archaic *H. sapiens*—differ from modern *H. sapiens.* Compared to modern *H. sapiens,* archaic *H. sapiens* have a longer and lower skull, a larger browridge, a bigger and more projecting face, a taller and wider nasal aperture (opening for the nose), a more projecting occipital bone (sometimes called an **occipital bun** when referring to Neandertals), larger teeth (especially the front teeth), and no chin. The postcranial bones of archaic *H. sapiens* are thicker than those of modern people.

occipital bun A cranial feature of Neandertals in which the occipital bone projects substantially from the skull's posterior.

Some hominin skeletons dating to the Upper Pleistocene have a mixture of archaic and modern features. The Skhul 5 skeleton from Israel, discussed later in this chapter, is an excellent example of a hominin with both archaic features, including a somewhat forward-projecting face and pronounced browridges, and modern features, such as a distinctive chin and no occipital bun (see Figure 12.38, p. 424). Similarly, the Herto skulls from Ethiopia have a combination of archaic and modern features, although the modern features dominate over the archaic ones (see Figure 12.34, pp. 420–21). The modern characteristics of their skulls indicate that the Skhul and Herto hominins were on the verge of modernity or were very early modern *H. sapiens,* perhaps the earliest in western Asia and Africa, respectively.

12.2 Modern *Homo sapiens:* Single Origin and Global Dispersal or Regional Continuity?

Homo sapiens' evolution begins with the emergence of archaic forms some 500,000–350,000 yBP. These early *H. sapiens* provide the context for modern *H. sapiens'* evolutionary development, which took place at different times in different places. The first modern *H. sapiens* appeared earliest in Africa, by 160,000 yBP, and latest in Europe, by about 35,000 yBP. The transition to fully modern *H. sapiens* was completed globally by about 25,000 yBP.

Two main hypotheses have emerged to explain modern people's origins (**Figure 12.4**). The *Out-of-Africa* hypothesis states that modern *H. sapiens* first evolved in Africa and then spread to Asia and Europe, replacing the indigenous archaic *H. sapiens* populations (Neandertals) living on these two continents. The *Multiregional Continuity* hypothesis regards the transition to modernity as having taken place regionally and without involving replacement. From this point of view, African archaic *H. sapiens* gave rise to African modern *H. sapiens,* Asian archaic *H. sapiens* gave rise to Asian modern *H. sapiens,* and European archaic *H. sapiens* gave rise to European modern *H. sapiens.* Both models seek to explain why today's human beings consist of just one genus and why that genus consists of just one species. The models differ, though, in accounting for that genus and species.

The Out-of-Africa model explains the single species of living humans by emphasizing a single origin of modern people and eventual replacement of archaic *H. sapiens* throughout Africa, Asia, and Europe. A simple story. The Multiregional Continuity model emphasizes the importance of gene flow across population boundaries—separate

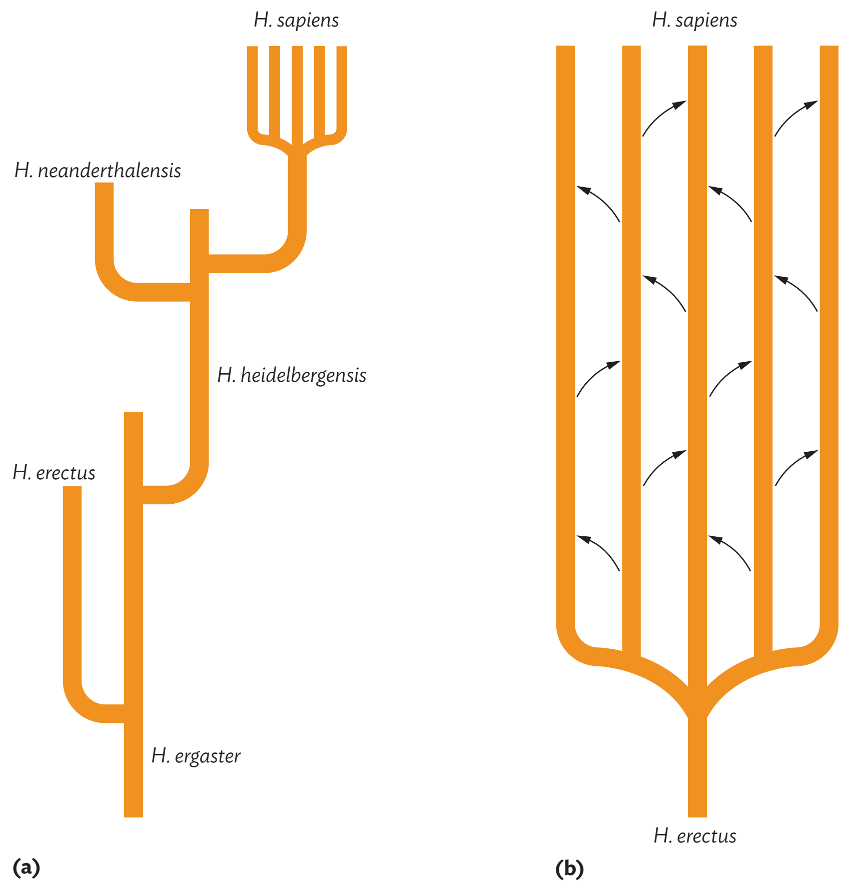


FIGURE 12.4

Out-of-Africa versus Multiregional This important anthropological debate is about modern humans' origins. **(a)** This chart depicts one of the two hypotheses, Out-of-Africa, according to which modern humans originated in Africa and then migrated throughout the world. **(b)** This chart depicts the second hypothesis, Multiregional Continuity, according to which *Homo erectus* evolved into modern *Homo sapiens* in various geographic locations. The arrows represent continuous gene flow throughout human evolution. This hypothesis considers *H. ergaster* and *H. heidelbergensis* to be *H. erectus* and *H. neanderthalensis* to be *H. sapiens.*

species of humanity never arose owing to the constant interbreeding of human groups throughout human evolution. Not such a simple story.

Fossil and genetic records provide a wealth of information about modern human origins. We will now consider these records and draw some conclusions from them. We will then be ready to reassess the two hypotheses and to draw further conclusions about the origins of us—living people.

12.3 What Do *Homo sapiens* Fossils Tell Us about Modern Human Origins?

The fossil remains of archaic *H. sapiens* have been found throughout Africa, Asia, and Europe. In Africa, archaic *H. sapiens* evolved into modern *H. sapiens* at least by 160,000 yBP, perhaps as early as 200,000 yBP. In Asia and Europe, the archaics consisted of an early group and a late group, divided very roughly at about 130,000 yBP. To understand the biological changes involved in hominin groups' evolution, we need to compare some details of a number of key fossils.

Early Archaic *Homo sapiens*

The earliest forms of *H. sapiens* emerged around 350,000 yBP. They have been found in Africa, Asia, and Europe (**Figure 12.5**). Their evolution is clearly out of the earlier *H.*

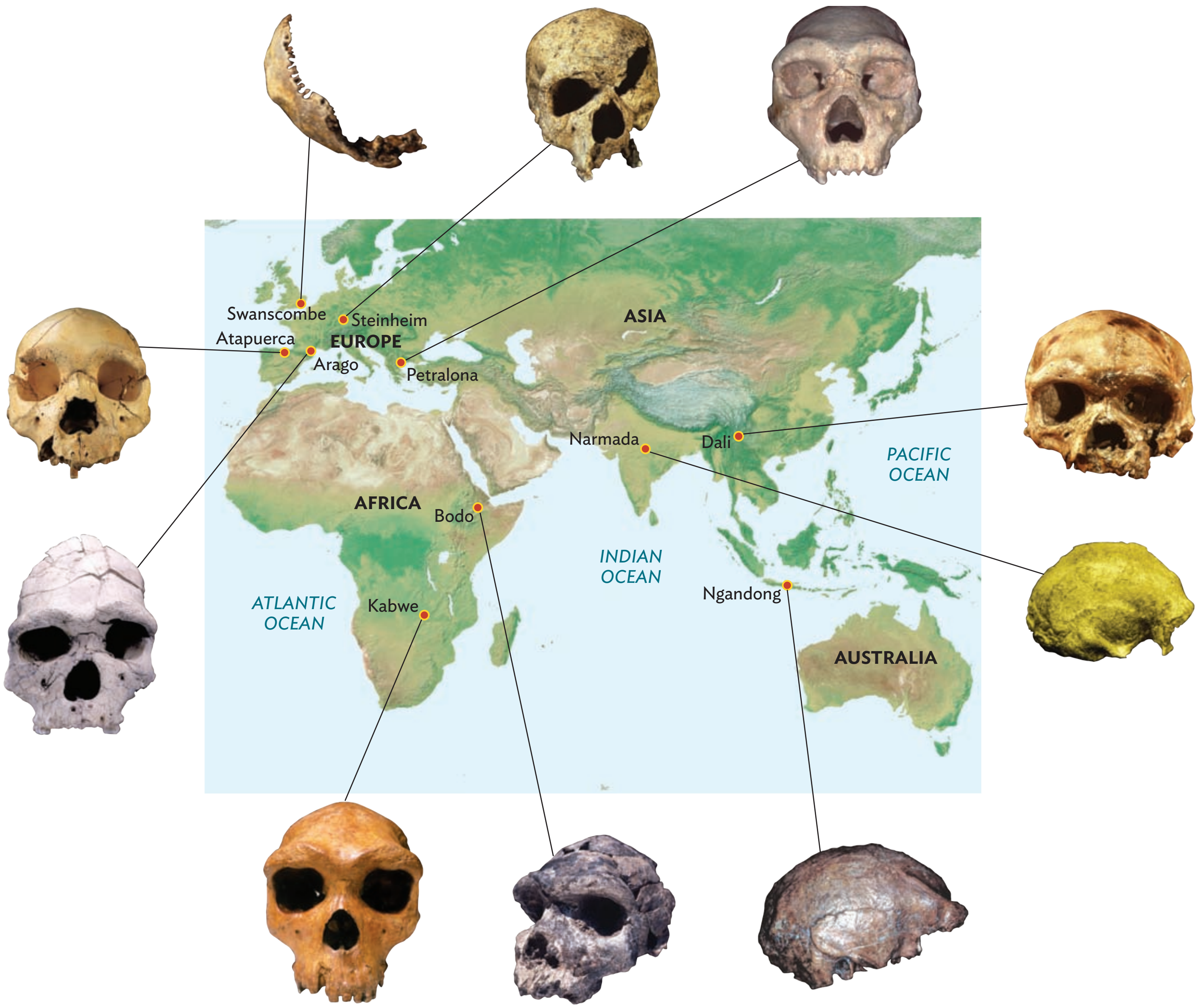


FIGURE 12.5

***Early Archaic* Homo sapiens** This map illustrates some of the sites in Africa, Asia, and Europe where the remains of early archaic *H. sapiens* have been found. (Arago skull photo © David L. Brill, humanoriginsphotos.com)

erectus populations. Anthropologists have documented this evolutionary transition in the three continental settings, noting, for example, the similarly massive browridges in archaic *H. sapiens* and in earlier *H. erectus*. Although quite primitive in key respects, all the fossils representing archaic *H. sapiens* and earlier *H. erectus* show continued reduction in skeletal robusticity, smaller tooth size, expansion in brain size, and increasing cultural complexity.

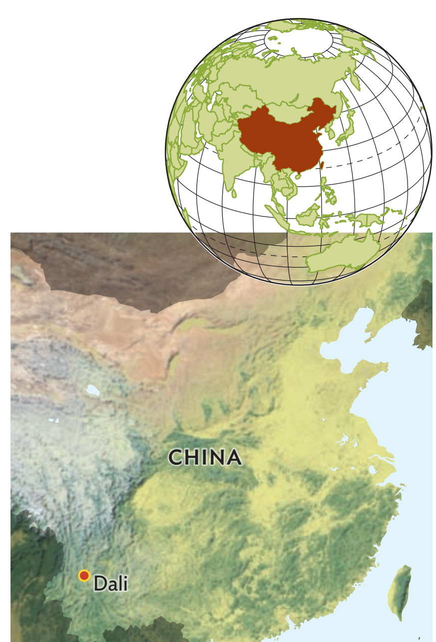
ARCHAIC *HOMO SAPIENS* IN AFRICA (350,000–200,000 YBP) One of several individuals found in the Kabwe (Broken Hill) lead mine in Zambia (formerly Northern Rhodesia) has enormous browridges, but the facial bones and the muscle attachment areas on the back of the skull for the neck muscles are quite small compared with those of *H. erectus* in Africa (**Figure 12.6**). The cranial capacity is about 1,300 cc. The skull is similar in appearance to those of early archaic hominins from Europe. Both the Zambian and the European skulls have *erectus*-like characteristics: a large face, large browridges, and

FIGURE 12.6

Kabwe This archaic *H. sapiens,* also known as "Broken Hill Man" or "Rhodesian Man," was among the first early human fossils discovered in Africa. Found by miners searching for metal deposits in caves, it was originally thought to be less than 40,000 years old.

thick cranial bones. However, archaic *H. sapiens* skulls, like their Asian counterparts, are higher than *H. erectus* skulls, reflecting a brain expansion in the later hominins.

EARLY ARCHAIC *HOMO SAPIENS* IN ASIA AND EUROPE (350,000–130,000 YBP) Some of the best-known fossils representing early archaic *H. sapiens* are from the Ngandong site on the island of Java (**Figure 12.7**). The skulls are represented by the braincases only—the faces are missing. Ngandong 11 has a brain size of about 1,100 cc, well within the range for early archaic *H. sapiens.* The skull is long and low, but compared with its *H. erectus* ancestor, the skull is somewhat higher, reflecting its larger brain. The browridge is massive, certainly of the magnitude of many *H. erectus* examples.



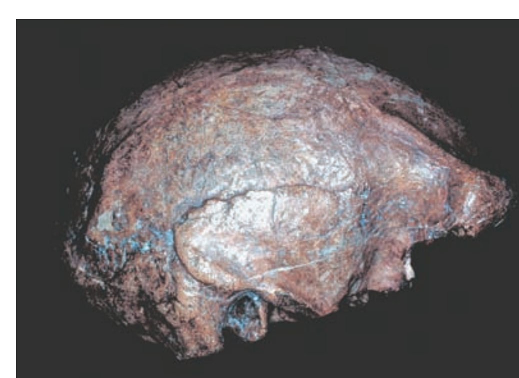


FIGURE 12.7

Ngandong Multiple skulls were found at this site in Java in the 1930s. The brain size of this early archaic *Homo sapiens* falls between that of *Homo erectus* and that of modern humans.

HOW DO WE KNOW

ATAPUERCA,

FOSSIL HOMININ BONANZA

One of the world's most spectacular fossil hominin sites is located in the hills of north-central Spain, about 15 km (9 mi) east of the town of Burgos.

Within a hill called *Sierra de Atapuerca,* a series of limestone caves has been studied for decades by speleologists (scientists who study caves), geologists, archaeologists, and paleontologists. In 1976, the paleontologist Trinidad Torres went into the cave known as *Sima de los Huesos* (meaning "Pit of Bones") in search of Pleistocene cave bear fossils for his doctoral dissertation research. Along with the cave bear bones, he collected a handful of hominin fossils—a mandible, mandible fragments, and teeth—all dating to the Middle Pleistocene. Even if no other fossils had been found at the site, this discovery would have been important, owing to the fact that only a few other hominin fossils from Europe are this old. Sima de los Huesos is among the half-dozen key sites at Atapuerca that have produced a fabulous wealth of fossils, tools, and other indications of human presence dating between 900,000 yBP and the recent past.

Hundreds of fossils, including hominin fossils, were discovered in caves located in these Spanish hills. This place is now a UNESCO World Heritage Site.

At Sima de los Huesos, in deposits dating to 430,000 yBP, excavators led by the paleontologist Juan Luis Arsuaga of Madrid's Complutense University recovered abundant fossils, but the most exciting of a series of spectacular discoveries was the nearly complete skeleton of an adult male, Atapuerca 5, excavated in 1992–94. Nicknamed "Miguelón" by its excavators, the skeleton provides a glimpse at the people of the Middle Pleistocene. In addition to the characteristics seen in the skull (see text and Figure 12.10), the limb bones are extraordinarily thick, indicating that this person led a highly demanding life, at least in terms of physical activity. Like the skull, the limb bones in many ways resemble those of Neandertals, who appeared later in time and in other parts of Europe. These similarities are consistent with the finding by the German paleogeneticist Matthias Meyer, whose analysis of nuclear DNA extracted from Sima de los Huesos bones and teeth shows that these Middle Pleistocene early archaic *Homo sapiens* are related to the Late Pleistocene Neandertals of Europe.

A number of the dentitions from Atapuerca display hypoplasias, or lines of arrested growth on the teeth. Generally, these lines result from periods of sickness, starvation, or both. The relatively low number—about one-third of the people had them—compared with that in other human populations suggests that these people were by and large healthy.

SPAIN

Of the hundreds of bones found in the sites at Atapuerca, some of the most fascinating are from the cave site of Gran Dolina. Dating to about 900,000 yBP, these fossils are evidence for the presence—the earliest—of *Homo erectus* in Europe. Paleoanthropologists found six individuals' remains at the cave's entrance, mixed with numerous stone tools and animal bones. As the paleoanthropologist Yolanda Fernández-Jalvo discovered, many of the hominin bones, like the animal bones, have cutmarks in areas of large muscle attachments. That is, a tool-wielding hominin took a stone knife and sliced flesh off the body. In the process of removing flesh, the stone tool left cutmarks on the bones. Bones with cutmarks include skulls, ribs, vertebrae, and clavicles. Some bones also have impact fractures and breakage, done to extract marrow. The reasons for this flesh removal are of course unknown, but the association with other animal bones indicates that the Gran Dolina people were eating each other. The similar modifications among human bones and animal bones at the cave provide the oldest evidence of cannibalism in human evolution.

A

Beginning in the 1970s, excavations at several cave sites in Sierra de Atapuerca, including Sima de los Huesos and Galeria (shown here), yielded hundreds of bones.

B

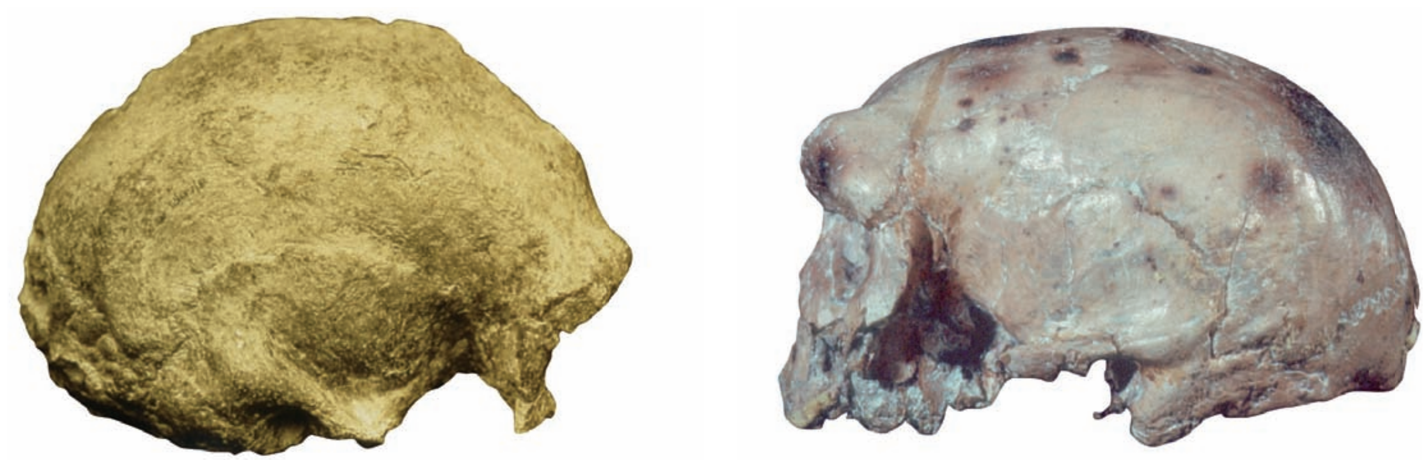
Human remains, the remains of various animals, and numerous tools were recovered from many of these sites.

C

This skeleton is one of six discovered in the Gran Dolina cave.

D

Cutmarks on various bones, including the skull shown here, suggest the soft tissue was removed around the time of death; however, the reason for defleshing is unknown.



(a) **(b)**

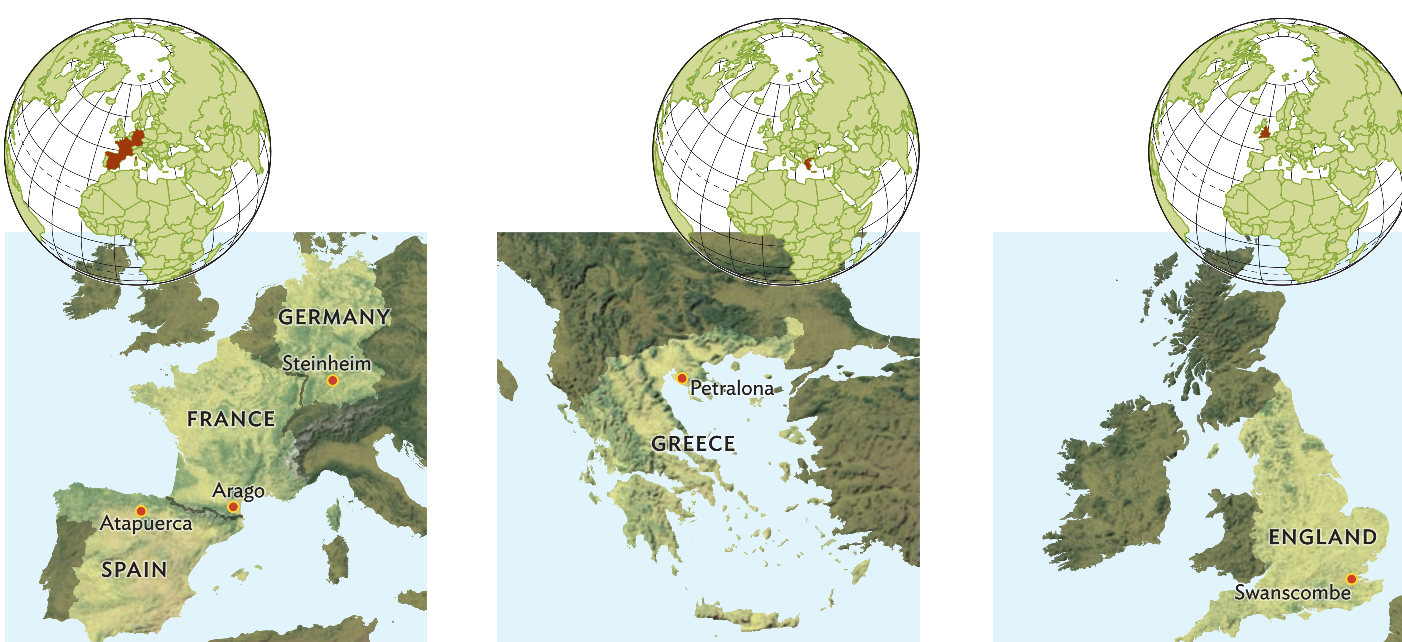
FIGURE 12.8

***Asian Early Archaic* Homo sapiens** Like the Ngandong cranium, the crania of **(a)** Narmada and **(b)** Dali are robust, with thick cranial bones. The cranial capacity, however, indicates the brain size was much larger than in *Homo erectus* but somewhat smaller than in modern humans.

The Ngandong skulls share a number of features with other Asian early archaic *H. sapiens,* especially with Narmada (Madhya Pradesh, India) and Dali (Shaanxi Province, People's Republic of China) skulls (**Figure 12.8**). The crania are large and robust. The browridges are also quite large, although not as large as in *H. erectus*.

In Europe, well-known early archaic *H. sapiens* fossils include a skull and other remains from Arago, France; a skull from Petralona, Greece; a skull from Steinheim, Germany (**Figure 12.9**); and a partial skull from Swanscombe, England. Their average cranial capacity is 1,200 cc. These early archaic *H. sapiens* exhibit larger brains and rounder, more gracile skulls than *H. erectus*.

EARLY ARCHAIC *HOMO SAPIENS'* DIETARY ADAPTATIONS The earliest archaic *H. sapiens* had many of the same kinds of tools and material technology as the earlier



(a) **(b)** **(c)**

FIGURE 12.9

***European Early Archaic* Homo sapiens** Cranial remains from three prominent European sites—**(a)** Arago, **(b)** Petralona, and **(c)** Steinheim—have somewhat larger cranial capacities than other early archaic *H. sapiens*. Although these crania reflect a more modern appearance, they retain primitive features such as larger browridges. (Photo [a] © 1985 David L. Brill, humanoriginsphotos.com)

H. erectus, but *H. sapiens* used much more diverse tools to acquire and process food. Across the group, the face, jaws, and back teeth (premolars and molars) show a general reduction in size. The American physical anthropologist C. Loring Brace hypothesizes that selection for large back teeth lessened as tools became more important for processing food. Simply, with reduced selection, the teeth became smaller. Alternatively, as technological innovation changed the way teeth were used, the teeth may have been under *greater* selection for reduced size. Anthropologists have not reached a consensus on the mechanisms behind the reduction in tooth size except to say that cultural innovation and increased dependence on material culture likely played a role in this fundamental biological change.

At the same time that the importance of the back teeth diminished, the use of the front teeth increased. That is, during this period of human evolution, the incisors and canines underwent heavy wear. For example, in Atapuerca 5 from Spain, the front teeth are worn nearly to where the gums would have been in life (**Figure 12.10**). This evidence tells us that these hominins used their front teeth as a tool, perhaps as a kind of third hand for gripping materials. In European archaic *H. sapiens,* the front teeth show a size increase. The link between heavy use of the front teeth and increase in size of these teeth suggests the likelihood of selection for large front teeth.

FIGURE 12.10

Atapuerca 5 One of many human skeletal remains found in Sima de los Huesos, Atapuerca 5 represents a nearly complete adult male skeleton. Its cranial capacity falls within the range of other Pleistocene humans, but its cranium is unusual in its degree of tooth wear. Notice that the front tooth is worn—that it has very little enamel left.

Late Archaic *Homo sapiens*

The hominins from this period show a continuation of trends begun with early *Homo,* especially increased brain size, reduced tooth size, and decreased skeletal robusticity. However, in far western Asia (the Middle East) and Europe, a new pattern of morphology emerges, reflecting both regional variation and adaptation to cold. This new pattern defines the Neandertals. Neandertal features include wide and tall nasal apertures; a projecting face; an occipital bun; a long, low skull; large front teeth (some with heavy wear); a wide, stocky body; and short limbs.

The fossil record of the late archaic *H. sapiens* is fascinating. For the first time in human evolution, a number of fairly complete skeletons exist, allowing new insights into the biology and behavior of these ancient humans. Moreover, the material culture includes new kinds of tools and reflects new behaviors that are modern in several important ways.

LATE ARCHAIC *HOMO SAPIENS* IN ASIA (60,000–40,000 YBP) For Asian late archaic *H. sapiens,* the record is fullest from sites at the far western end of the continent (**Figure 12.11**). Fossils from Israel form the core of discussions among anthropologists about modern people's emergence in western Asia. This record pertains to Neandertals from Amud, Kebara, and Tabun. The Amud Neandertals date to about 55,000–40,000 yBP and are best known from the complete skeleton of an adult male. He had an enormous brain, measuring some 1,740 cc, larger than earlier humans' and the largest for any fossil hominin (**Figure 12.12**). The Kebara Neandertals date to about 60,000 yBP and are represented by a complete mandible and body skeleton; the legs and cranium are

FIGURE 12.11
***West Asian Late Archaic* Homo sapiens** This map illustrates where late archaic *H. sapiens'* remains have been found in western Asia, along the eastern Mediterranean Sea.

FIGURE 12.12
Amud Neandertal The exceptionally large cranial capacity of the Amud Neandertal indicates that this hominin's brain was at least as large as a modern human's.

missing (**Figure 12.13**). A nearly complete female Neandertal skeleton from Tabun was long thought to date to about the same time, but new thermoluminescence dating indicates that the skeleton may be as old as 170,000 yBP. Like the Amud male, she had a large brain.

The Amud and Tabun skulls have a number of anatomical characteristics that are strongly similar to those of contemporary populations of late archaic *H. sapiens* in Europe. For example, their eye orbits tend to be small and round, their nasal openings are tall and wide, and their faces project forward. These two skulls share a number of modern characteristics, however, such as the lack of the occipital bun and the presence of relatively small teeth.

Some of the most interesting Neandertals are from the Shanidar site in northern Iraq's Kurdistan region. These Neandertals—seven adults and three young children—have provided important insight into the lives, lifestyles, and cultural practices of late archaic *H. sapiens* (**Figure 12.14**). Shanidar 1, an older adult male dating to at least 45,000 yBP, is one of the most complete skeletons from the site (**Figure 12.15**). The face is that of a typical Neandertal, especially in its wide nasal aperture and forward projection. This individual's life history is written in his bones. A fracture on his upper face, well healed at the time of his death, may have been severe enough to cause blindness. Severe arthritis in his feet might have resulted from the constant stresses of traversing difficult, mountainous terrain.

Shanidar 1's upper incisors are severely worn, probably from his use of the front teeth as a tool for grasping and holding objects in the same or a similar way as the much earlier hominin from Atapuerca. This extramasticatory wear on the front teeth is determined by culture—Neandertals used their front teeth as a part of their "tool kit." Use of the front teeth as a tool has remained a hallmark of human behavior into

FIGURE 12.13

Kebara Neandertal The almost complete skeletal torso of this hominin was discovered in Kebara Cave, Israel. Even without a cranium and legs, this is one of the most complete Neandertal skeletons found to date. (Photo © 1985 David L. Brill, humanoriginsphotos.com)

FIGURE 12.14

Shanidar This Iraqi cave site was excavated in the late 1950s by an American archaeological team. Evidence found with the Neandertal skeletons suggests that the Neandertals intentionally buried their dead and possibly performed some type of burial ceremony.

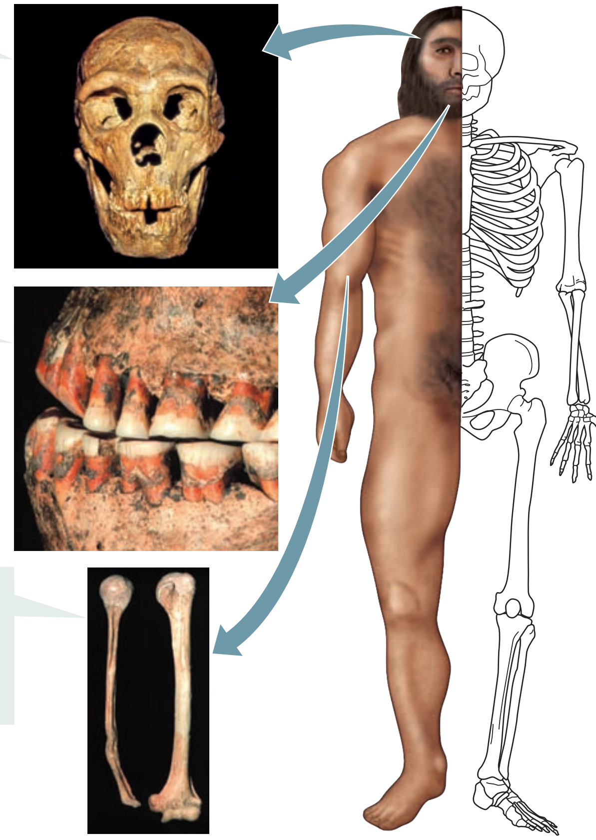


FIGURE 12.15

Shanidar 1 Neandertal The skeleton of this older adult Neandertal tells a life story of injury owing to accidents and violence. The majority of Neandertal skeletons have injuries.

recent times in a wide variety of cultures, including Native Americans who chew plant material to prepare it for basketry.

Shanidar 1 may have had personal reasons for using his front teeth as a tool. When he was excavated by the American archaeologist Ralph Solecki in the late 1950s, his lower right arm was missing. The American physical anthropologist T. Dale Stewart suggested that the lower arm may have been either amputated or accidentally severed right above the elbow. The humerus was severely atrophied, probably owing to disuse of the arm during life. The loss of the use of the arm meant that Shanidar 1 *had* to use his teeth to perform some simple functions, such as eating or making tools. His survival likely depended on the use of his front teeth.

LATE ARCHAIC *HOMO SAPIENS* IN EUROPE (130,000–30,000 YBP) The European late archaic *H. sapiens,* Neandertals, are some of the best-known, most-studied fossil hominins in the world (**Figure 12.16**). Owing to the relative completeness of the fossil record, paleoanthropologists have been able to document and debate the meaning of their physical characteristics. The Neandertal record begins in eastern Europe, at the Krapina site in Croatia, which dates to 130,000 yBP (**Figure 12.17**). The record ends with fossils from Vindija, Croatia, dating to 32,000 yBP or somewhat later.

Like many Neandertal remains, the Krapina fossils were excavated more than a century ago. Not all such early excavations were carefully done. Fortunately, the excavator of the Krapina site—the Croatian paleontologist Dragutin Gorjanović-Kramberger (see Figure 8.14)—was extraordinarily meticulous in his recording of the excavation. During the period in which he excavated the site, 1899–1905, he kept detailed notes

FIGURE 12.16

Neandertal Sites This map illustrates the various locations of Neandertal discoveries throughout southern and middle Europe and the Middle East as well as the suggested boundaries of the Neandertal range.

about where his workers found fossils and stone tools. He was especially careful in recording the stratigraphic locations of the several hundred bones and teeth found at the site.

The Krapina remains were recovered from a series of strata inside a rockshelter (not quite a cave—a rock overhang provides protection from the elements). The remains are highly fragmentary, making it difficult to identify key physical characteristics. The most complete cranium, Krapina 3, has the typical Neandertal features: round eye orbits, wide space between the eye orbits, wide nasal aperture, and protruding midfacial region (**Figure 12.18**). The Krapina front teeth are the largest of any known fossil hominin. In fact, tooth size comparisons with earlier and later humans in Europe indicate that in these Neandertals, the front teeth had increased and the back teeth had decreased. The front teeth are some of the biggest in human evolution.

The Krapina bones are mostly in fragments. The American anthropologist Tim White has found that some of these fragments display a series of distinctive cutmarks in places where ligaments (the tissue that connects muscle to bone) were severed with stone tools. The location and pattern of cutmarks on the Krapina Neandertal bones are identical to those on animal bones found at the site. That strategically placed cutmarks appear on human and animal bones indicates that these people ate animal *and* human tissue.

FIGURE 12.17

Krapina Croatian paleontologist Dragutin Gorjanovic-Kramberger and his team discovered more than 800 Neandertal fossils at this site. This image shows one of several monuments in present-day Krapina marking where the fossils were found.

FIGURE 12.18

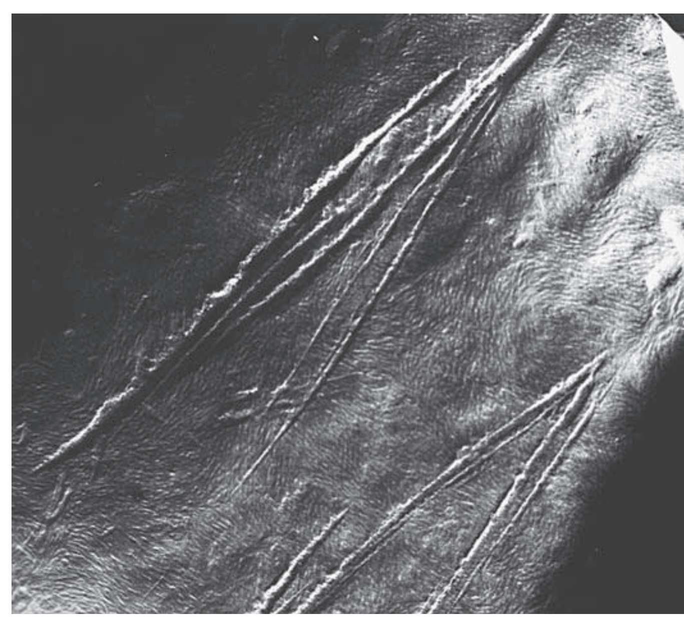
Krapina Neandertal This Krapina cranium has many features associated with Neandertals. Can you identify the key features that characterize it as Neandertal? (Photo © David L. Brill, humanoriginsphotos.com)

The Krapina Neandertals were not the only ones to practice cannibalism. From at least three other sites in Europe—the Moula-Guercy Cave in southeastern France, El Sidrón in northern Spain, and Goyet in Belgium—multiple individuals dating to 100,000 and 45,000 yBP display cutmark patterns very similar to those on animal remains (**Figure 12.19**). The cutmarks on cranial and postcranial bones involved removal of tissue and marrow extraction. Unlike other settings where the processed human and animal bones are mixed, the Neandertal remains at El Sidrón are not associated with animal remains, and they are located in a remote area of a complex system of caves.

Scientists cannot explain why cannibalism was practiced, but perhaps Neandertals ate human flesh to survive severe food shortages during their occupation of Ice Age Europe.

Many Neandertal skeletons, including some of the best known from western Europe, are relatively late, postdating 60,000 yBP. The skeleton from La Chapelle-aux-Saints, France, is especially well known because anthropologists used it as the prototype for all Neandertals in the early twentieth century. It

(a)



(b)

FIGURE 12.19

Moula-Guercy Neandertal fossils from this French cave site show evidence of butchery and, possibly, cannibalism. **(a)** The French archaeologist Alban Defleur examines the fragmentary remains of at least six cannibalized Neandertals. **(b)** Using a scanning electron microscope, researchers were able to closely examine cutmarks from a stone tool on a Neandertal cranial bone.

has the characteristic Neandertal cranial morphology, including a very wide and tall nasal aperture, a projecting midface, an occipital bun, and a low, long skull (**Figure 12.20**).

FIGURE 12.20

La Chapelle-aux-Saints Neandertal Like Shanidar 1, this skull and the associated skeleton shows evidence of healed injuries and arthritis.

THE NEANDERTAL BODY PLAN: ABERRANT OR ADAPTED? The La Chapelle-aux-Saints skeleton is also one of the most complete Neandertals. The skeleton was first described in great detail by the eminent French paleoanthropologist Marcellin Boule (1861–1942) in the early 1900s. Professor Boule's scientific writings tremendously influenced contemporary and later scientists' interpretations of Neandertal phylogeny, behavior, and place in human evolution generally, basically continuing the earlier opinions expressed by Virchow (discussed at the start of this chapter). Boule argued that the Neandertal cranial and postcranial traits were simply too primitive and too different from modern people's to have provided the ancestral basis for later human evolution (**Figure 12.21**). He concluded that the La Chapelle individual must have walked with a bent-kneed gait—as in chimpanzees that walk bipedally—and could not have been able to speak. Simply, in his mind, Neandertals represented some side branch of human evolution—they were too primitive, too stupid, and too aberrant to have evolved into modern humans.

Boule's interpretations led to the prevailing view at the time (still held by some authorities) that Neandertals were evolutionary dead ends, replaced by the emerging modern humans and representing distant cousins of humanity that were not able to survive. In rejecting this view, we should take a closer look at some topics Boule addressed in his study of the La Chapelle skeleton.

One very distinctive feature of Neandertal faces is the *enormous* nasal aperture (**Figure 12.22**). The great size of the nasal aperture in many Neandertal fossils

(a)

(b)

FIGURE 12.21

Neandertal Depictions **(a)** The La Chapelle-aux-Saints skeleton, here fleshed out by an illustrator in 1909, reinforced the notion that Neandertals were too stupid and too brutish to have evolved into modern humans. **(b)** More recent reconstructions show that Neandertals looked very similar to modern humans in many respects. In addition, estimates of brain size put them squarely within the modern human range.

FIGURE 12.22

Nasal Aperture The large nasal aperture of Neandertal crania, such as this cranium from Gibraltar, may have been a cold adaptation.

indicates that these people had huge noses, in both width and projection. Such massive noses were one of the cranial characteristics that led Boule to believe that Neandertals were not related to later humans in an evolutionary sense. However, nasal features are more likely part of an adaptive complex reflecting life in cold climates during the Upper Pleistocene. The shape and size of any nose is an excellent example of the human face's highly adaptable nature, especially in relation to climate. One of the nose's important functions is to transform ambient air—the air breathed in from the atmosphere—into warm, humid air. Large noses have more internal surface area, thus providing an improved means of warming and moistening the cold, dry air that Neandertals breathed regularly. Moreover, the projecting nose typical of Neandertals placed more distance between the cold external environment and the brain, which is temperature-sensitive. Alternatively, the large noses of Neandertals may simply be due to the fact that their faces are so large. Regardless of the circumstances resulting in Neandertals' having large nasal apertures, many people and populations around the world today have wide, big noses, which are integral parts of their robust faces. These attributes are not uniquely Neandertal (**Figure 12.23**).

Other features of Neandertal skeletons are consistent with adaptation to cold. For example, the infraorbital foramina—the small holes in the facial bones located beneath the eye orbits—are larger in European Neandertals than in modern people (**Figure 12.24**). The foramina's increased size is due to the blood vessels that tracked through them having been quite large. The larger blood vessels may have allowed greater blood flow to the face, preventing exposed facial surfaces from freezing.

Most distinctive about the cold-adaptation complex in Neandertals are the shape of the body trunk and the length of the arms and legs. Compared with modern humans, European Neandertals were stocky—the body was short, wide, and deep (**Figure 12.25**). Neandertals' limbs were shorter than earlier or later humans'. This combination—stocky trunk and short limbs—is predicted by Bergmann's and Allen's rules (see "Climate Adaptation: Living on the Margins" in chapter 5). That is, animals that live in cold climates are larger than animals that live in hot climates (Bergmann's rule). The larger body trunk reduces the amount of surface area relative to the body size. This helps promote heat retention. Moreover, animals that live in cold climates have shorter limbs than animals that live in hot climates (Allen's rule). This, too, promotes heat retention in cold settings.

FIGURE 12.23

Modern Human Relatives? Some of the morphological traits associated with Neandertals can be found in modern humans, as illustrated by this photograph of the physical anthropologist Milford Wolpoff facing the reconstructed head of a European Neandertal. Might Neandertals have interbred with modern human ancestors, passing along some of these traits?

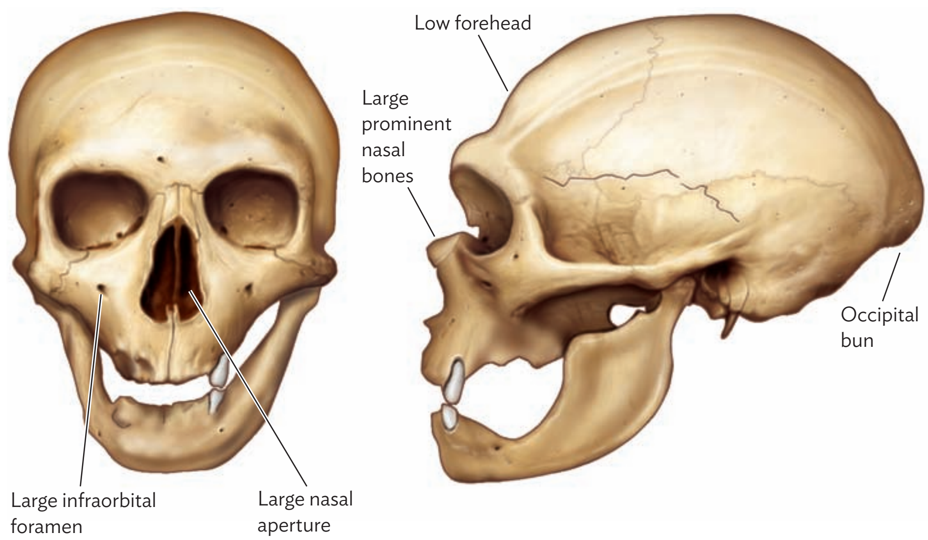


FIGURE 12.24

Cold-Adaptive Traits Large infraorbital foramina are among the Neandertal traits that likely were responses to a cold environment during the later Pleistocene. Note also the distinctive Neandertal traits—low forehead and projecting occipital bone (occipital bun).

Mousterian The stone tool culture in which Neandertals produced tools using the Levallois technique.

Middle Paleolithic The middle part of the Old Stone Age, associated with Mousterian tools, which Neandertals produced using the Levallois technique.

Levallois A distinctive method of stone tool production used during the Middle Paleolithic, in which the core was prepared and flakes removed from the surface before the final tool was detached from the core.

The American physical anthropologist Christopher Ruff has refined these concepts in interpreting human body shape morphology. He discovered that adaptation to heat or cold is not related to a person's height—some heat-adapted populations are quite tall, and some are quite short. Much more important is the width of the body trunk (usually measured at the hips), because the ratio of surface area to body mass is maintained regardless of height (**Figure 12.26**). This finding is borne out by a wide range of populations around the world today: populations living in the same climate all have body trunks of the same width, no matter how their heights vary. Populations living in cold climates always have wide bodies; populations living in warm climates always have narrow bodies. These dimensions are always constant in adaptation to heat or cold. In addition, the ratio of tibia (lower leg) length to femur (upper leg) length differs between people who live in hot climates and people who live in cold climates. Heat-adapted populations have long tibias relative to their femurs (their legs are long), but cold-adapted populations have short tibias relative to their femurs (their legs are short). Neandertals fit the predictions for cold adaptation: their body trunks are wide, and their tibias are short.

NEANDERTAL HUNTING: INEFFICIENT OR SUCCESSFUL? The French paleoanthropologists of the 1800s and early 1900s questioned Neandertals' humanness. They suggested that Neandertals were unintelligent, could not speak, and had a simplistic culture. Put in the vernacular expression, "Their lights were on, but nobody was home." Some paleoanthropologists continue to argue this point, viewing Neandertals as inefficient hunters and not especially well adapted to their environments. A growing body of archaeological and biological evidence, however, demonstrates that Neandertals were not clumsy mental deficients.

Neandertals were associated with the culture known as **Mousterian** or **Middle Paleolithic.** This culture's stone tool technology, lasting from about 300,000–30,000 yBP, includes a complex and distinctive type of flaking called the **Levallois** technique. This technique involves preparing a stone core and then flaking the raw materials for tools from this core (**Figure 12.27**). Contrary to the opinions of early anthropologists, this Neandertal technology was complex and required considerable hand–eye coordination. Moreover, anthropologists are learning that late Neandertals participated fully

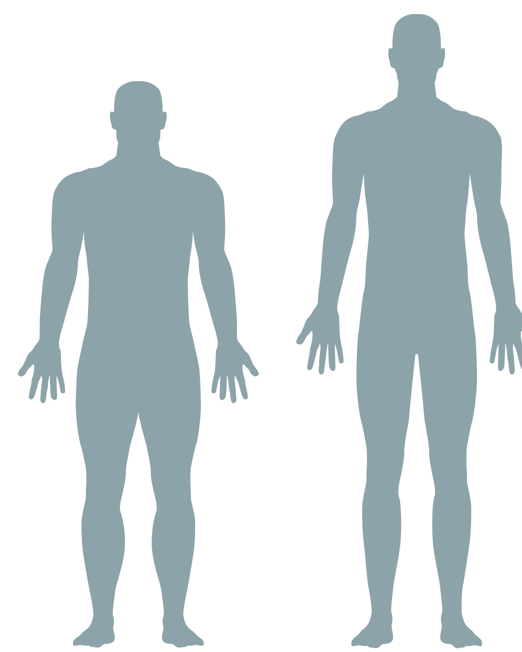


FIGURE 12.25

Neandertal Body Proportions A further adaptation to the cold appears in Neandertals' body proportions (left) compared with early modern humans' (right). Neandertals' much stockier body build reduced heat loss and increased heat retention. Early modern humans' narrower trunk, narrower hips, and longer legs reflected the warmer environment in which these people lived.

FIGURE 12.26

Body Size and Body Shape The refinement of Bergmann's and Allen's rules regarding body size, body shape, and temperature adaptations is illustrated by these body types. The ratio of body surface area to body mass (square centimeters per kilogram) is given below each type. The greater the ratio, the more that body shape and that body size are adaptations to high temperatures. Individuals living in cold environments, such as the modern Inuit, have a lower ratio than individuals living in hot environments, such as the modern Nilotic. Because of their short stature, modern Pygmies appear to contradict Bergmann's and Allen's rules. However, body surface ratio reveals that Pygmies are well adapted to hot environments.

Upper Paleolithic Refers to the most recent part of the Old Stone Age, associated with early modern *Homo sapiens* and characterized by finely crafted stone and other types of tools with various functions.

in the **Upper Paleolithic,** the earliest cultures associated mostly with early modern *H. sapiens* in Europe, producing stone tools that were modern in many respects and certainly as complex as those produced by early modern humans. Moreover, the size, shape, and articulations of the Neandertal hand reflect the kind of precise manual dexterity crucial for the fine crafting of tools (**Figure 12.28**).

If Neandertals were not effective hunters, then they might have been less successful adaptively than modern people. One way to measure hunting success is to determine how much meat Neandertals ate. Butchered animals' bones are abundant in Neandertal habitation sites, indicating that Neandertals hunted the animals and processed the carcasses for food. Suggestive though this evidence is, the mere presence of animal remains does not reveal how *important* animals were in the people's diet. To find out how important meat was in Neandertals' diets, anthropologists have applied the powerful tools of bone chemistry and stable isotope analysis. Measurement of stable isotopes of both nitrogen and carbon in the bones of Neandertals—from Scladina Cave (Belgium), Vindija Cave (Croatia), and Marillac (France)—indicates that Neandertals ate lots of meat, at or nearly at the level of carnivores living at the same

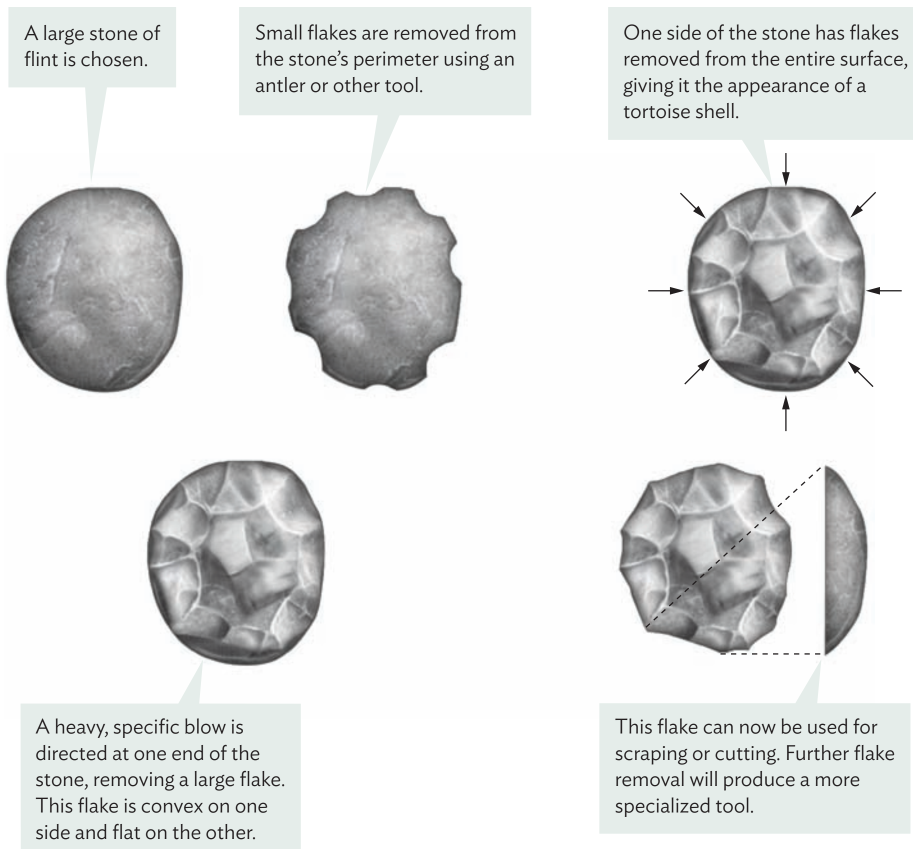


FIGURE 12.27

Levallois Technique To produce the Mousterian tools, Neandertals used a specific technique to remove flakes from flint cores. The use of such a technique indicates that Neandertals could visualize the shape and size of a tool from a stone core, an advanced cognitive ability.

time and place (**Figure 12.29**). The chemical signature of diet, then, is a powerful indicator of Neandertals' effectiveness in acquiring and consuming animal protein. That is, it shows that Neandertals were successful hunters. This is not to say that Neandertals depended wholly on animals as sources of food. Analysis of plant residues

FIGURE 12.28

Mousterian Tools Neandertals made these tools out of flint. The use of such tools would have replaced the use of front teeth as tools, reducing the amount of anterior tooth wear in some later Neandertals. (Photo © David L. Brill, humanoriginsphotos.com)

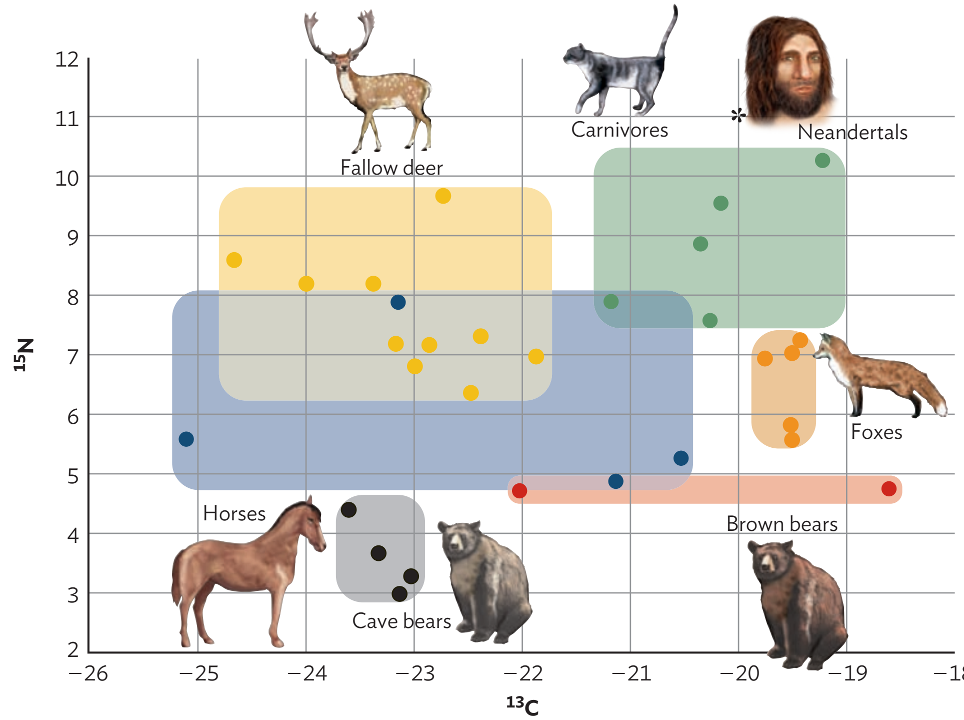


FIGURE 12.29

Neandertal Diet Measures of stable isotopes of both carbon and nitrogen, here labeled ^{13}C and ^{15}N, respectively, can be used to determine the relative amounts of different kinds of foods consumed. This graph shows the isotope values for a variety of herbivores and carnivores. Herbivores generally have lower isotope values than carnivores. Neandertals' isotope values (asterisk) are close to those of known carnivores, indicating that Neandertals ate plenty of meat.

calculus Refers to hardened plaque on teeth; the condition is caused by the minerals from saliva being continually deposited on tooth surfaces.

found in Neandertal tooth **calculus** shows that Neandertals ate a diversity of plants, some of which were cooked. Neandertals might have consumed some of these plants for medicinal purposes. The British archaeologist Karen Hardy and her associates have documented in calculus from El Sidrón the presence of bitter-tasting chemicals that are well-known appetite suppressants. The presence of residues of plants that lack nutritional value indicates that Neandertals might have self-medicated, but we cannot know for sure if they did.

Another indicator of their effective adaptation is the measurement of stress levels. The American physical anthropologist Debbie Guatelli-Steinberg and her associates found that hypoplasias, the stress markers in teeth that reflect growth disruption due to poor diets or poor health, are present in Neandertals but at a frequency no different from that of modern humans. This finding, too, suggests that Neandertals dealt successfully with their environments.

NEANDERTALS BURIED THEIR DEAD In many Neandertal sites, the remains have been found scattered about, commingled and concurrent with living areas. For example, the Krapina Neandertal fossils are fragmentary and were scattered throughout the site. That is, the deceased were treated no differently from food remains or anything else being discarded. In contrast, a significant number of skeletons have been found in pits. That is, excavation of some Neandertal sites in Europe and western Asia has shown that pits had been dug, corpses had been placed in the pits, and the pits had been filled in. For example, the Neandertal skeletons from Spy, Belgium; ones from various sites in France, such as La Chapelle-aux-Saints; several Shanidar individuals; and the Neandertals from Amud and Tabun, both in Israel, were found in burial pits (**Figure 12.30**).

Was burial of the dead a religious or ceremonial activity having significant symbolic meaning for the living? Or was burial simply a means of removing bodies from living spaces? Most of the intentionally buried skeletons were in flexed (fetal-oriented) postures. The hands and arms were carefully positioned, and the bodies were typically on their sides or backs. This vigilant treatment indicates that care was taken to place

FIGURE 12.30

Intentional Burial Like the Shanidar skeletons (among others), the La Chapelle-aux-Saints skeleton, shown here, provides evidence of intentional burial. When this individual was found in a pit, it was the first suggestion that Neandertals cared for their dead in a way similar to modern humans' methods.

the bodies in the prepared pits. The skeletons' postures suggest, therefore, that these burials were not just disposals. They represented purposeful symbolic behavior linking those who died and those who were living.

NEANDERTALS TALKED Fundamental to human behavior is the ability to speak as part of the repertoire of communication. Conversation is a key way that we present information and exchange ideas. Because early anthropologists believed that Neandertals lacked the ability to speak, they argued that Neandertals were not related to modern people in an evolutionary sense. This idea continues to the present. The American linguist Philip Lieberman and the American anatomist Edmund Crelin, for example, have reconstructed the Neandertal vocal tract. Because their reconstruction resembles a modern newborn infant's vocal tract, Lieberman and Crelin conclude that, like human babies, Neandertals could not express the full range of sounds necessary for articulate speech. Although interesting, their reconstruction of the Neandertal vocal tract is conjectural. Based on skulls alone, it necessarily lacks the anatomical parts (soft tissues) important for determining whether Neandertals had speech.

Indeed, one compelling line of evidence suggests that Neandertals were, in fact, able to speak. The Kebara Neandertal skeleton includes the hyoid bone, a part of the neck that can survive from ancient settings. Various muscles and ligaments attach it to the skull, mandible, tongue, larynx, and pharynx, collectively producing speech (**Figure 12.31**). The morphology of the Kebara Neandertal's hyoid is identical to that of a living human's. The Kebara people talked.

Even more convincing evidence that Neandertals spoke are findings from the study of microscopic wear patterns on the surfaces of incisors and canines, especially the study of the relationship with brain laterality. The human brain is distinctive in its laterality: the clearly defined left and right sides are an anatomical marker for the ability to speak. In right-handed humans, the left side of the brain is dominant. The left brain controls right-sided body movements, especially the use of the right hand and right arm. The left brain also controls speech and language production. In left-handed people, these connections are reversed. The right side of the brain is dominant, controls

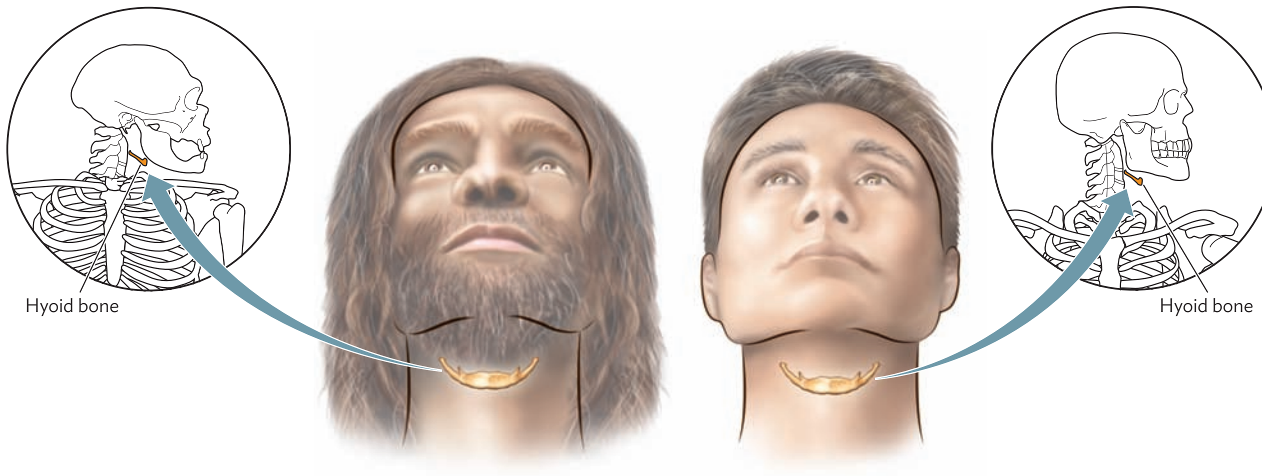


FIGURE 12.31

Did Neandertals Speak? The Kebara skeleton's hyoid is identical to a modern human hyoid, indicating that Neandertals could speak.

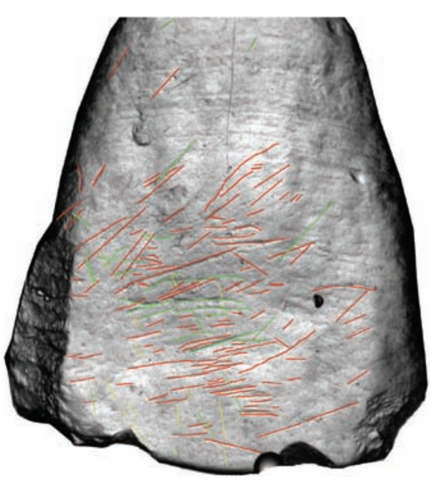


FIGURE 12.32

Handedness in Neandertals Shown here is an upper right first incisor of a Neandertal from the Vindija site in Croatia. The surface has more than 150 scratches (shown in red) produced by a stone tool rubbing against the tooth. Almost all the scratches are angled down toward the person's right. The red lines highlight the main scratches. This person had a left-dominant brain, was right-handed, and possessed the ability to speak.

left-side body movements, and controls areas critical for speech and language. Therefore, evidence of handedness (a preference for the right or left hand) is itself evidence for brain laterality. In fossil hominins, hand preference can be determined by looking at the scratches on the front teeth of fossil hominins.

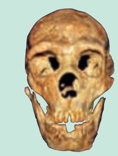
The American physical anthropologist David Frayer and his associates have detected microscopic parallel scratches on the surfaces of upper incisors and canines of many fossil hominins, including Neandertals from Europe. It has long been thought that Neandertals (and lots of other hominins, including modern humans) used a "stuff-and-cut" method of meat processing before chewing the meat. This method consists of cutting a piece of meat by biting one end of it and holding the other end with the left hand, then holding a stone tool with the right hand to cut the meat. Often, cutting meat in this fashion inadvertently scratches the front teeth. When this happens, the scratches on the teeth have a highly distinctive pattern: they are parallel to each other, and they angle downward. When the stuff-and-cut method is performed experimentally, right-handed people end up with tooth scratches that angle downward to the right, and left-handed people end up with scratches that angle downward to the left.

Frayer and his research group examined the scratch patterns on the teeth of 17 Neandertals from different sites, finding that all but two of the Neandertals had scratch patterns consistent with right-handedness (**Figure 12.32**). The two exceptions had just the opposite, consistent with left-handedness. Similarly, in the early archaic *H. sapiens* from Sima de los Huesos dating to 500,000 yBP, all 12 individuals studied had the scratch pattern associated with handedness. The conclusion is simple: because Neandertals uniformly exhibited handedness, we know they had brain laterality. (As with modern humans today, most Neandertals and their predecessors had left-dominant brains and were right-handed.) And because they had brain laterality, we can conclude that Neandertals talked.

Genetic evidence also supports the notion that Neandertals spoke. The German geneticist Johannes Krause and his team successfully identified the *FOXP2* gene—a gene strongly implicated in the production of speech—from Neandertal bone samples from the El Sidrón site. Although it is not *the* gene for speech, it is part of a complex of genetic variation found in modern humans. Its presence in these late archaic *H. sapiens* indicates that Neandertals talked.

CONCEPT CHECK

Archaic *Homo sapiens*



Archaic *H. sapiens* are the first of our species, beginning some 350,000 yBP globally and evolving locally from earlier *H. erectus* populations. After 150,000 yBP, regional patterns of diversity emerge, followed by simultaneous occupation of Europe by late archaic *H. sapiens* (Neandertals) and early modern *H. sapiens* by 40,000 yBP.

Locations (sites)*	Africa (Kabwe) Asia (Ngandong, Dali, Narmada, *Amud, Kebara, Tabun, Shanidar*) Europe (Sima de los Huesos, Swanscombe, Steinheim, Petralona, Arago, *Feldhofer Cave,* Atapuerca, *Spy, Krapina, Vindija, Moula-Guercy, La Chapelle-aux-Saints, Scladina Cave, Marillac, Les Rochers, Engis, El Sidrón, Monte Lessini, Teshik Tash*)
Chronology	350,000–30,000 yBP
Biology	Mixture of *H. erectus* and *H. sapiens* characteristics 1,200 cc cranial capacity early 1,500 cc cranial capacity late Both skulls and skeletons less robust than modern humans Reduced tooth size, but most of reduction in premolars and molars (front teeth increase in size) Appearance of Neandertal morphology after 130,000 yBP in Middle East and Europe (long, low skull; wide, large nose; large front teeth with common heavy wear; forward-projecting face; no chin; wide body trunk; short limbs) Distinctive mtDNA structure Distinctive nDNA structure but overlapping with living humans'
Culture and behavior	Some evidence of housing structures Large-game hunting Fishing and use of aquatic resources after 100,000 yBP More advanced form of Acheulian early Mousterian late (Europe) Increased use of various raw materials besides stone after 100,000 yBP Skilled tool production Burial of deceased after 100,000 yBP Symbolic behavior Social care of sick and injured Articulate speech likely

*Sites mentioned in text; italics denote sites where Neandertal (late archaic *H. sapiens*) remains have been found.

NEANDERTALS USED SYMBOLS Burial of the dead is only one of the countless contexts in which modern humans use symbolism. Think, for example, of all the signs, images, and codes you encounter every day, from the letters on this page to any jewelry you wear to your friend's tattoo. Decorative items such as perforated shells, some stained with pigments of various colors, have been well documented in the earlier Paleolithic in Africa and the Middle East, dating to 120,000—70,000 yBP. A number of anthropologists have suggested that Neandertals differed from modern *H. sapiens* in that they lacked symbolic behavior. This lack, in turn, is seen as a feature of Neandertals' purported cognitive inferiority to *H. sapiens*. However, the Spanish archaeologist João Zilhão and his colleagues have recently discovered clear evidence of symbolic behavior at two sites in Spain that date to 50,000 yBP. At Cueva de los Aviones and Cueva Antón, perforated marine shells similar to those in Africa and the Middle East had been painted with naturally occurring pigments, especially red, yellow, and orange. These shells were likely strung around an individual's neck. These body ornaments are evidence that Neandertals used symbolism at least 10,000 years before the appearance of modern *H. sapiens* in Europe. In addition, red ochre—a pigment derived from the mineral hematite—was used by hominins at least by 250,000 yBP in a range of European hominin contexts. Neandertals used symbols to communicate ideas and expressions.

The key point of this discussion of Neandertal characteristics—relating to climate adaptation, material culture, efficiency in hunting strategies, access to animal protein, treatment of the deceased, and the use of speech and symbolism—is that Neandertals likely were not weird humanlike primates, less adaptable and less intelligent than modern humans. The record shows that their behaviors, both in form and in symbol, were similar to modern humans'. The size and robusticity of their long bones show that Neandertals were highly physically active, more so than living humans. Such cultural and biological features reflect Neandertals' success in adapting to environmental circumstances of the Upper Pleistocene, not evolutionary failure. The empirical evidence disproves arguments that Neandertals were less than human.

Early Modern *Homo sapiens*

Modern *H. sapiens* from the Upper Pleistocene are represented in the fossil record throughout Africa, Asia, and Europe. During this time, hominins moved into other areas of the world. Later in this period, they spread into regions with extreme environments, such as the arctic tundra of Siberia in northern Asia. It was a time of significant increases in population size, increased ability through cultural means of adapting to

Table 12.1 Timeline for Major Upper Paleolithic Cultures of Europe

The Aurignacian (45,000–30,000 yBP)
• Associated with the first anatomically modern humans in Europe
The Gravettian (30,000–20,000 yBP)
• The Perigordian in France
• Earliest art, in the form of carved figurines
• Lagar Velho burial in Portugal
The Solutrean (21,000–17,000 yBP)
• France and Spain during the last glacial peak
• Made very fine stone points
The Magdalenian (17,000–12,000 yBP)
• Successful hunters of reindeer and horses
• Spread out across Europe as conditions improved at the end of the Ice Age
• Made many of the spectacular paintings and carvings

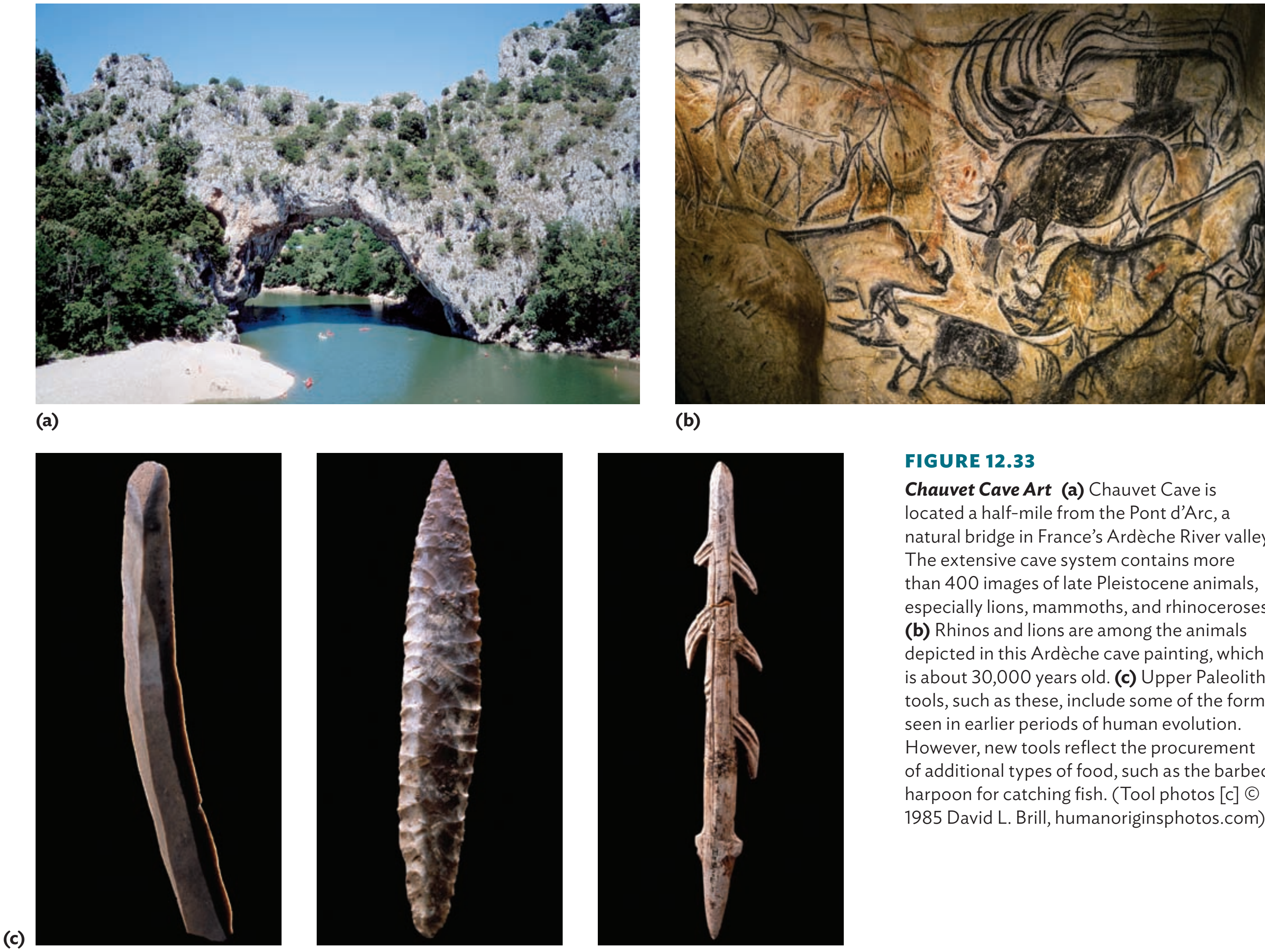
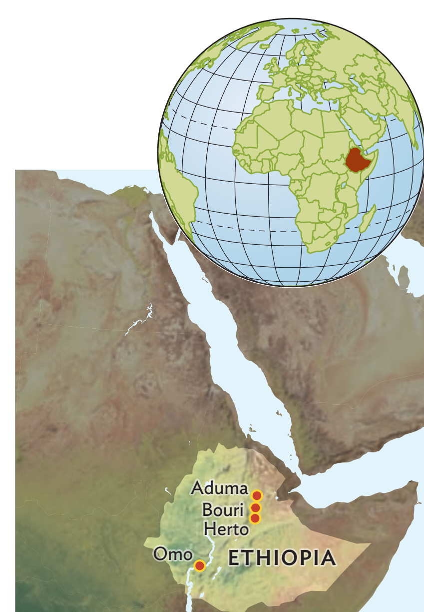


FIGURE 12.33

Chauvet Cave Art **(a)** Chauvet Cave is located a half-mile from the Pont d'Arc, a natural bridge in France's Ardèche River valley. The extensive cave system contains more than 400 images of late Pleistocene animals, especially lions, mammoths, and rhinoceroses. **(b)** Rhinos and lions are among the animals depicted in this Ardèche cave painting, which is about 30,000 years old. **(c)** Upper Paleolithic tools, such as these, include some of the forms seen in earlier periods of human evolution. However, new tools reflect the procurement of additional types of food, such as the barbed harpoon for catching fish. (Tool photos [c] © 1985 David L. Brill, humanoriginsphotos.com)

new and difficult landscapes, and the development of new technologies and subsistence strategies. (**Table 12.1** lists the four major Upper Paleolithic cultures of Europe and important events associated with each.) The cultures of the later Pleistocene, grouped in the Upper Paleolithic, are also known from their stunning imagery, including hundreds of artistic works in caves throughout Europe but concentrated especially in France and Spain (**Figure 12.33**). This period of human evolution also includes the universal appearance of the modern anatomical characteristics discussed at the beginning of this chapter. That is, in comparison with early archaic *H. sapiens*, there is a clear trend of increasing brain size and decreasing face, tooth, and jaw size and robusticity (**Table 12.2**). In addition, the postcranial bones become more gracile. Modern humans' evolution started much earlier in Africa than in Europe and Asia.



EARLY MODERN *HOMO SAPIENS* IN AFRICA (200,000–6,000 YBP) The African record for early *H. sapiens* is especially important because it includes the earliest evidence of modern people's anatomical characteristics. Crucially important fossil hominins from this time come from the Herto, Aduma, and Bouri sites in Ethiopia's Middle Awash Valley and from Omo in southern Ethiopia. The remains from Herto—partial skulls of two adults and of a child, dating to 160,000–154,000 yBP—show a

ANTHROPOLOGY MATTERS

INJURY, OCCUPATION,

Learning about the Past from the Living

Humans' injury patterns tell quite a lot about particular societies' behavior, especially with regard to the risks of specific lifestyles or of specific occupations.

Some lifestyles and occupations are relatively risk-free. For example, office workers tend to suffer few injuries, aside from carpal tunnel syndrome, in which a nerve to the wrist is somehow squeezed and hampers hand function. Some lifestyles and occupations are prone to producing injuries, however. For example, construction workers, dancers, and professional football players are subject to fractures and joint injuries and are susceptible to arthritis.

Forensic anthropologists will examine a skeleton carefully to see what kinds of injuries the person sustained in life, assessing behavior patterns or a kind of occupation (or both) that may have caused the injuries. Specific bone injuries have been used to identify remains and to solve murders.

The American anthropologists Thomas Berger and Erik Trinkaus have noticed that Neandertal fossils tend to show lots of injuries. In fact, nearly every complete Neandertal skeleton displays some traumatic injury. For example, the Shanidar 1 skeleton (see "Late Archaic *Homo sapiens* in Asia (60,000–40,000 yBP)" earlier in the chapter) has numerous head injuries. Injuries around the left eye orbit may have been so severe that they affected this adult male's balance and even blinded that eye.

Most Neandertal injuries are in the upper body and the head. Given this very obvious pattern, Berger and Trinkaus compared the trauma in Neandertals with statistical data on injury patterns for various occupations, using workers' compensation and other records. They found a close match between the Neandertal injury pattern and an injury pattern associated with

cranial capacity of about 1,450 cc, close to the average for modern humans (**Figure 12.34**). In addition, many of the characteristics are essentially modern, including a relatively tall cranium, a vertical forehead, smaller browridges, and a nonprojecting face. Among the archaic features are significant browridges (though the trend is toward smaller) and a relatively long face. These remains may be from the earliest modern people in Africa or at least close to the earliest. German paleoanthropologist Günter Bräuer argues that modernization in Africa first took place in East Africa. The remains' overall appearance indicates that modern people emerged in Africa long before their arrival in Europe and western Asia. The remains from Omo may be as old as 195,000 yBP. If so, they are the oldest evidence of anatomically modern humans.

AND BEHAVIOR

a specific occupation in the United States. The Neandertal pattern resembles that of rodeo athletes, the people who ride angry broncos and bulls as a form of sport! Rodeo riders have lots of head and neck injuries resulting from the obvious—they get tossed off animals and sometimes land on their own heads and upper bodies. Does this similarity mean that Neandertals rode animals, either for sport or for transportation? Quite unlikely. Because Neandertals hunted with spears, Berger and Trinkaus suggest that they would have placed themselves in close proximity to the large animals they were hunting. Neandertal injuries, Berger and Trinkaus hypothesize, derived from contacts with enraged animals during hunts. Just like rodeo riding and other physically challenging pursuits, life for these Pleistocene hunters was tough! *Anthropology matters!*

The Neandertal injury pattern is similar to that of American rodeo riders, such as this tumbling bull rider. By comparing Neandertals and modern humans, anthropologists can gain insight into the physical risks Neandertals faced.

However, their dating is uncertain because the fossils were not positioned in the geologic context as clearly as the Herto fossils were.

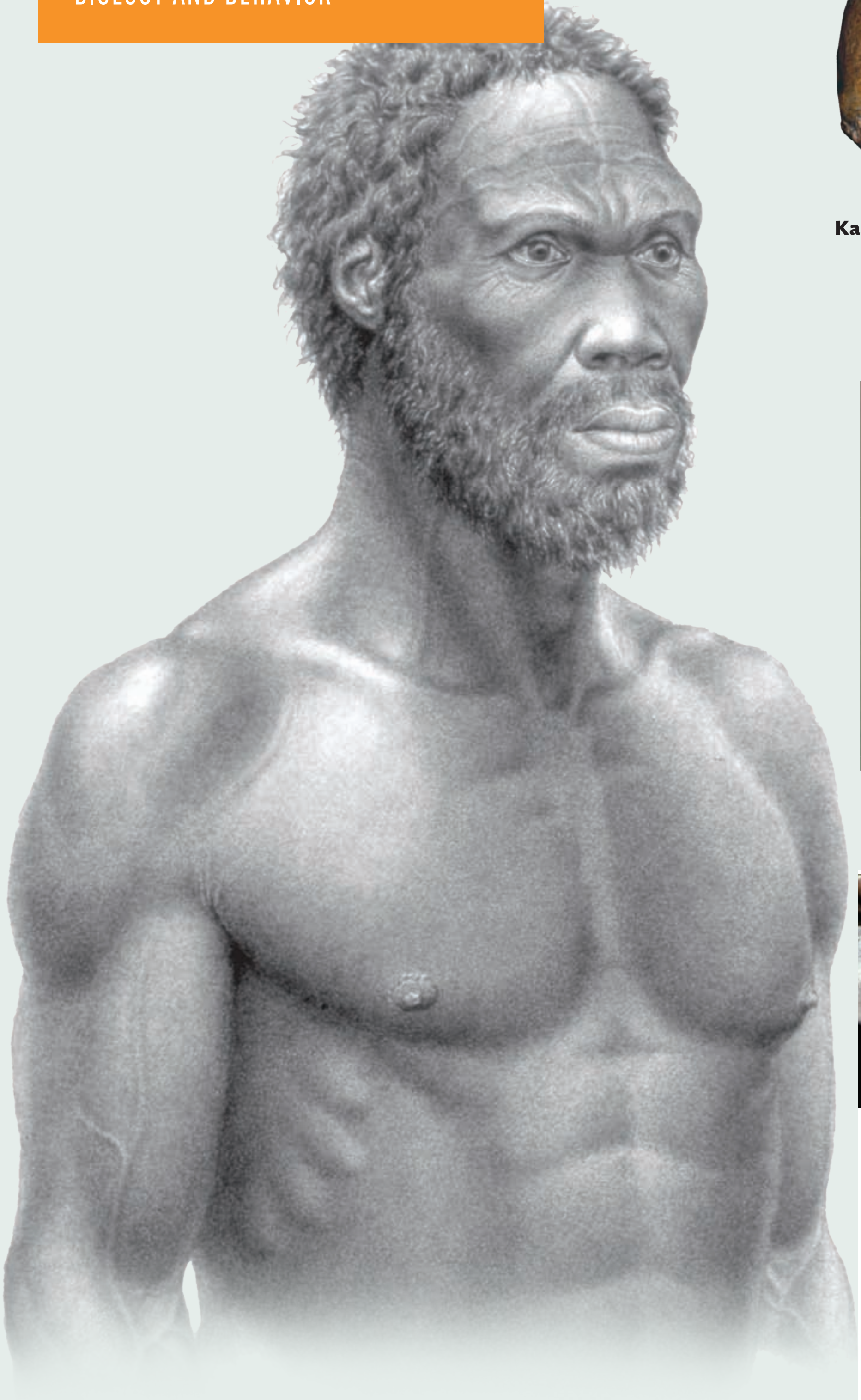
Belonging to later contexts are the partial skulls from Aduma and Bouri, dating to about 105,000–80,000 yBP. Like the Herto skulls, these skulls have both premodern and modern characteristics. However, the most complete Aduma skull is modern in nearly every characteristic.

Skulls from two key locations in southern Africa provide important information about early modern *H. sapiens* that date to after 100,000 yBP. Among the fragmentary remains from Klasies River Mouth Cave, anthropologists have documented the presence of a chin, a distinctively modern characteristic, that dates to at least 90,000 yBP

12.34

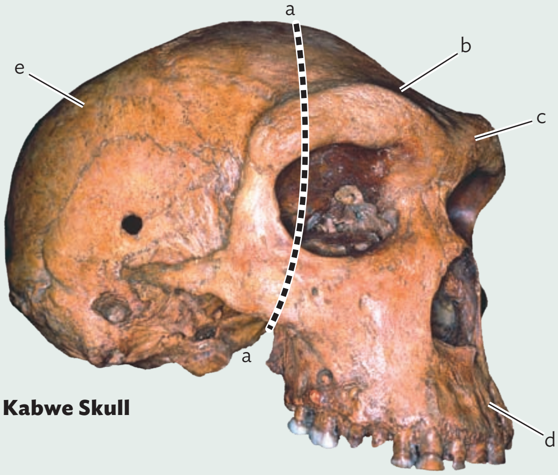
The First Modern Humans:

BIOLOGY AND BEHAVIOR



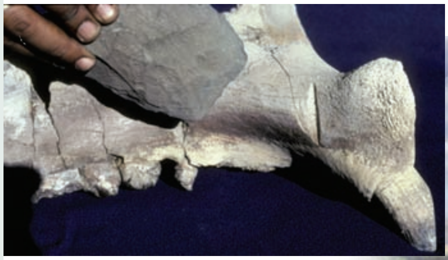
Herto Reconstruction

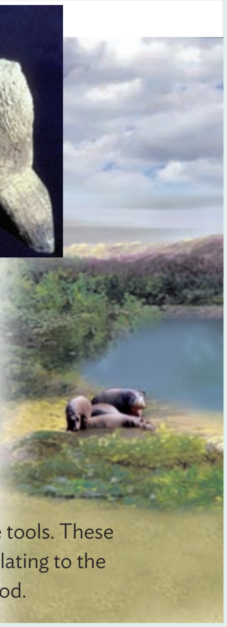
BIOLOGY: ANATOMY OF THE FIRST MODERN HUMANS



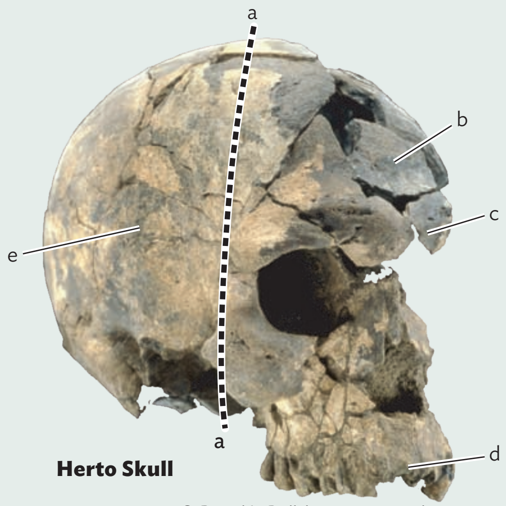
Kabwe Skull

BEHAVIOR: HUNTING AND BUTCHERING





These early modern *Homo sapiens* were skilled hunters. They produced sophisticated stone tools (above) used for killing and butchering large game, such as hippopotamuses living along lake margins. At the Herto site, Tim White, Berhane Asfaw, Giday Wolde Gabriel, Yonas Beyene, and their team found more than 600 stone tools. These tools had multiple functions, mostly relating to the killing and butchering of animals for food.

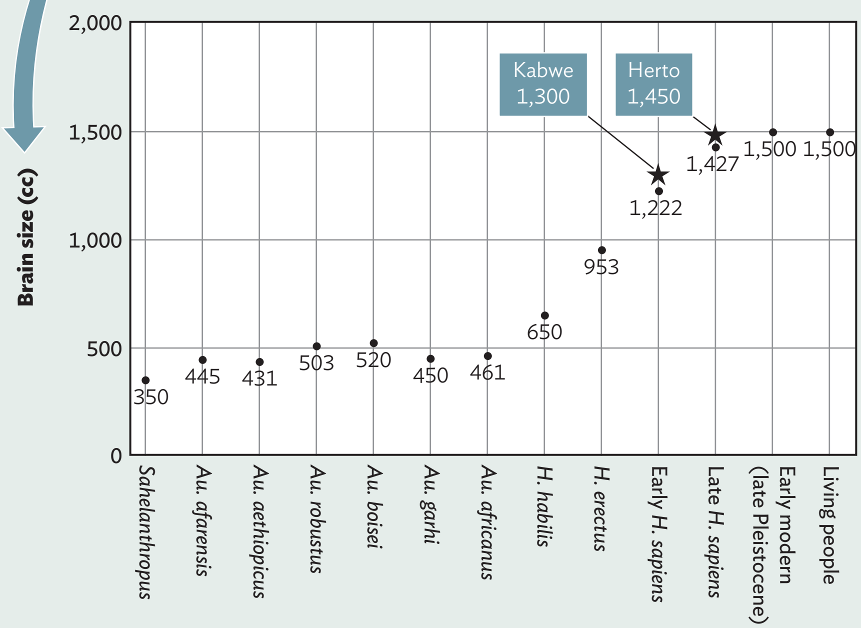


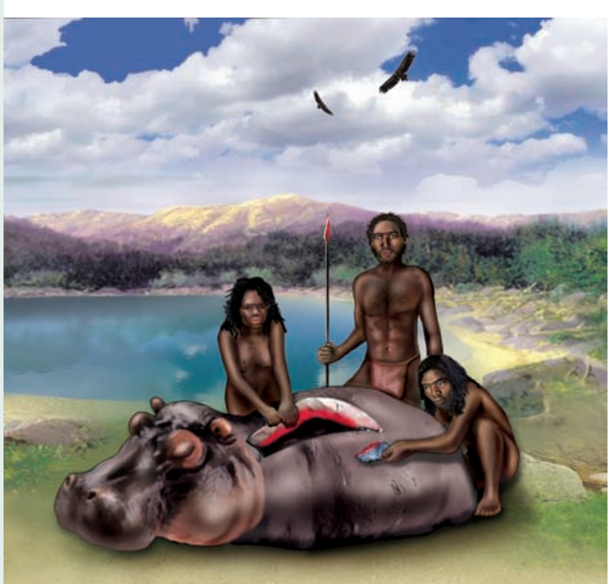
Herto Skull

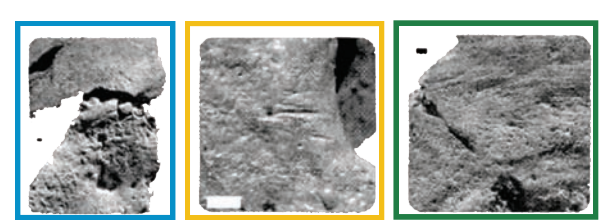
	Skull characteristics	Kabwe 300,000 yBP	Herto 160,000 yBP
a	Braincase	Shorter	Taller
b	Forehead	Less vertical	More vertical
c	Browridge	Larger	Smaller
d	Face	Projecting	Retracted
e	Brain size	Smaller	Larger

Near the village of Herto, in the Middle Awash region of Ethiopia, the paleoanthropology team discovered hundreds of hominid skull fragments dating to about 160,000 yBP. When pieced together, the skull proved to be remarkably modern (see the drawing on the facing page). In contrast to earlier hominids, such as Kabwe (found in Zambia and dating to 300,000 yBP), Herto has a tall braincase, a vertical forehead, small browridges, a retracted face, and a large brain. In combination, these are definitive characteristics of modern people. White and his team had found the first modern human.

HOMO SAPIENS' BIG BRAINS EVOLVE

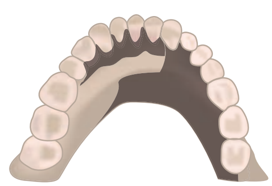


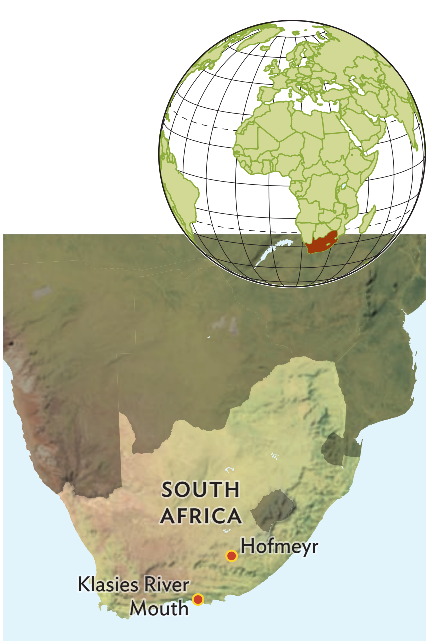




Paleoanthropologists are learning that the stone tools used by the Herto people for butchering animals were also used for other purposes. The skull bones from a second adult display cutmarks made by stone tools on the face, front, side, and back, all created when flesh was removed from the skull (see the black-and-white photos at the right). This could have been done as part of some ancient ritual. The cutmarks are similar to ones found in skulls from New Guinea and from other places where the people were known to have practiced cannibalism.

Table 12.2 Trends from Early Archaic *Homo sapiens* to Early Modern *Homo sapiens*

	Archaic H. sapiens	→	*Early* Modern H. sapiens
Brain	1,200 cc	Increase in size	1,500 cc
Face		Decrease in size and robusticity	
Teeth and jaws		Decrease in size	

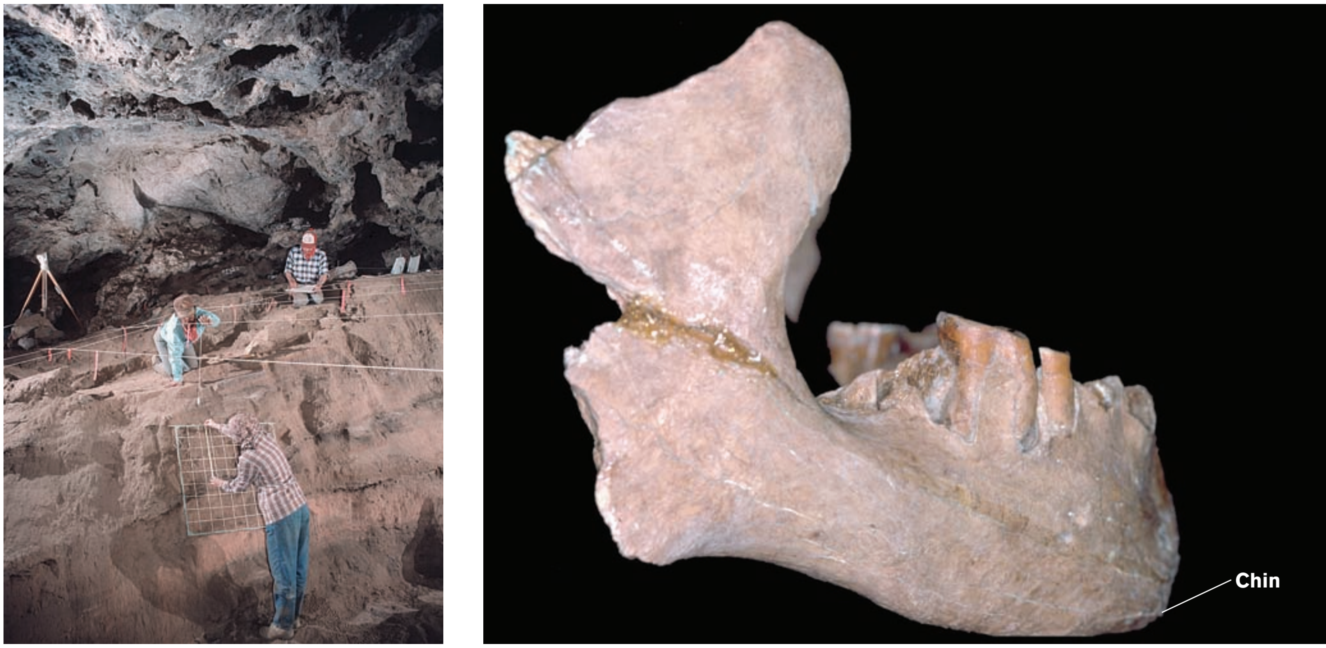


(**Figure 12.35**). A nearly complete skull from Hofmeyr, dating to 36,000 yBP, bears a striking resemblance to Pleistocene modern Europeans.

Throughout the Pleistocene and well into the early Holocene, African hominins, although modern, retained some robusticity. For example, the skulls from Lothagam, Kenya, dating to the Holocene (ca. 9,000–6,000 yBP), are robust compared with living East Africans' (**Figure 12.36**). During this period, a number of characteristics seen in the region's living populations were present, such as wide noses. At Wadi Kubbaniya and Wadi Halfa, both in the Nile Valley, populations have some very robust characteristics, such as flaring cheekbones and well-developed browridges. These features contrast sharply with the gracile facial features seen later in the Holocene and in living people (these features are discussed further in chapter 13).

Similarly, the earlier Holocene skulls (ca. 9,500 yBP) found at Gobero, Niger, are long, low, and robust compared with later Holocene skulls from the same place (**Figure 12.37**). A later population of incipient pastoralists may have replaced the earlier hunter-gatherers. However, the reduction in robusticity more likely reflects evolution that occurred in this setting (see chapter 13).

EARLY MODERN *HOMO SAPIENS* IN ASIA (100,000–18,000 YBP) The earliest modern *H. sapiens* in Asia are best represented by fossils from western Asia, in fact from the same region as the Amud and Kebara Neandertals in Israel. The 90,000-year-old remains from Skhul have distinctively modern characteristics, suggesting that the people living there were modern *H. sapiens*. Among the most prominent remains from the site are several male skulls, of which Skhul 5 is the most complete. That the Skhul 5



(a) (b)

FIGURE 12.35

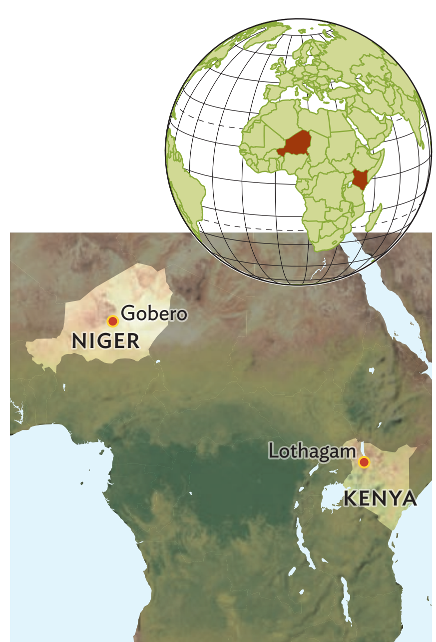
Klasies River Mouth Cave **(a)** Excavations at this site in southern Africa revealed evidence of early modern *Homo sapiens.* **(b)** One of the most important features found on these cranial remains is a chin on the mandible of this early modern *Homo sapiens* from South Africa.

cranium dates to before the Amud fossils indicates modern humans lived in the region before Neandertals (**Figure 12.38**).

Remains of the earliest modern people from eastern Asia are very scarce. Some of these remains are purported to be older than 60,000 yBP. At Zhiren Cave in south China, two molars and a partial mandible dating to at least 100,000 yBP show a combination of

FIGURE 12.36

Lothagam Skull This Kenyan cranium illustrates early modern humans' rather robust nature. Note the projection both of the lower part of the front of the skull and of the mandible.



(a) (b)

FIGURE 12.37

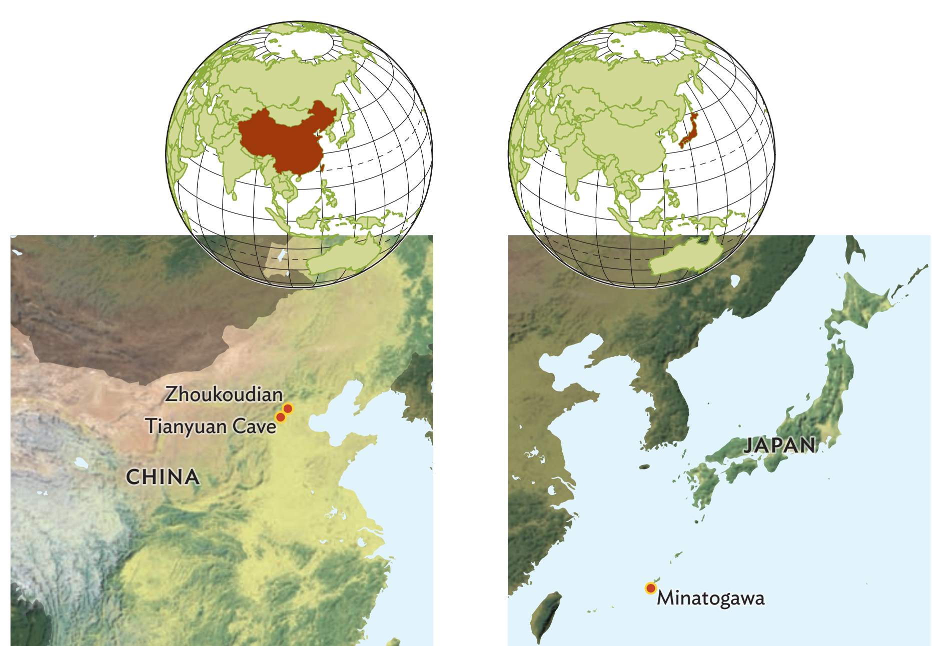
Gobero Crania **(a)** This adult male cranium from Gobero, dating to about 9,500 yBP, is long and low and has a wide, flat face. **(b)** In contrast, this adult male cranium, from the same site but dating to about 6,500 yBP (the middle Holocene), is high and has a narrow, gracile face. These differences could be due to local evolutionary change or the later arrival of a new population in the region having different craniofacial characteristics.

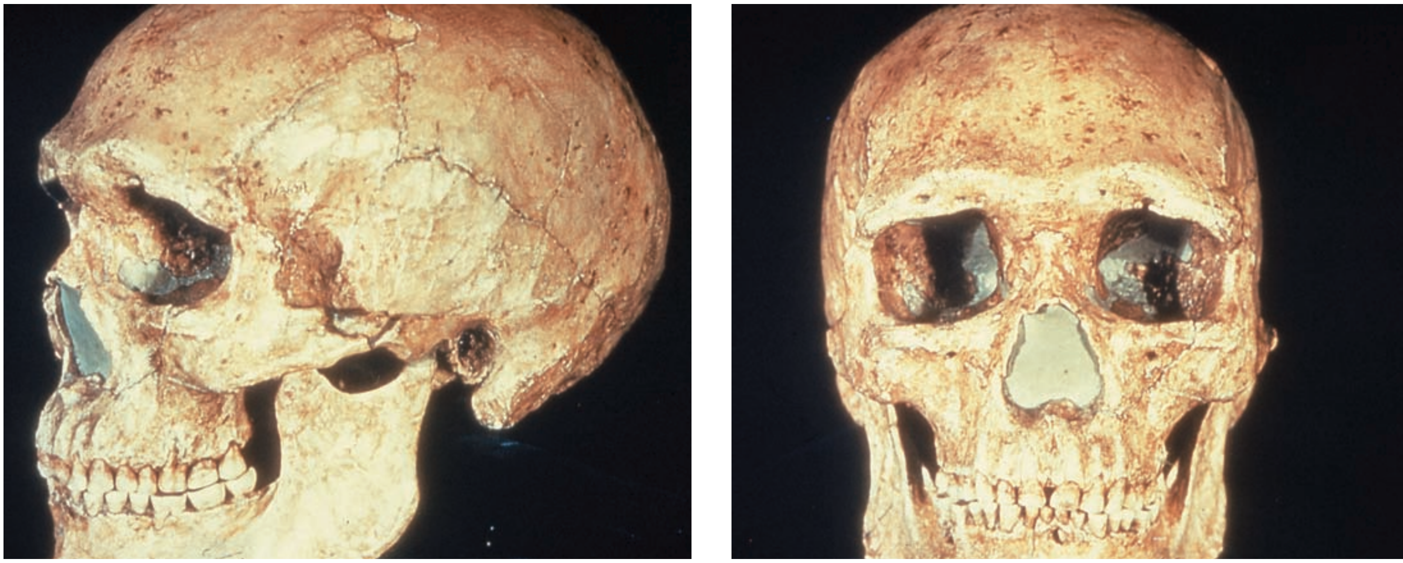
archaic and modern features. The mandible is relatively thick, like that of other archaic *H. sapiens,* but it has a chin like that of modern *H. sapiens.* Although not a fully modern *H. sapiens,* it is certainly a hominin that shows transitional characteristics leading to anatomical modernity. Other evidence for modern *H. sapiens* dates to 80,000 yBP from Fuyan Cave in south China. Although represented by just teeth, the morphology and relatively small size provides evidence for the presence of distinctively modern people in southern Asia, roughly contemporary with eastern Asia.

The earliest most complete fossil remains are a mandible and partial skeleton, dating to about 41,000 yBP, from Tianyuan Cave, China, and a skull dating to about 46,000 yBP from Tam Pa Ling Cave, Laos. Like the Zhiren Cave remains, these fossils have both archaic and modern features. For example, the Tam Pa Ling skull lacks a prominent

FIGURE 12.38

Skhul Cranium This skull possesses many characteristics associated with modern humans, including a chin, a less projecting face, small and gracile cheeks, and a high, vertical forehead. The browridges are still distinct but are much reduced compared with those of archaic *Homo sapiens.* (Photo © 1985 David L. Brill, humanoriginsphotos.com)





(a) (b)

FIGURE 12.39

***Zoukoudian Crania* (a, b)** One skull recovered from Zhoukoudian shows several modern human traits, but overall these crania are more robust than their modern Asian counterparts. In the older area of this site, the famous *Homo erectus* fossils were found prior to World War II.

supraorbital torus, a feature that is quite modern. Better known are three skulls from the Upper Cave at Zhoukoudian, China, dating to 29,000–24,000 yBP (**Figure 12.39**; this site is discussed further in chapter 11). The Upper Cave skulls are robust compared with living Asians', but the facial flatness is characteristic of native eastern Asians today. Similarly, the early modern people from Minatogawa (Okinawa), Japan, dating to about 18,000 yBP, are gracile but retain thick cranial bones and large browridges, especially compared with those of the later Holocene populations in eastern Asia.

ON THE MARGIN OF MODERNITY IN SOUTHEAST ASIA: *HOMO FLORESIENSIS* The discovery of skeletal remains dating to between 100,000 and 60,000 yBP from Liang Bua Cave on the island of Flores, Indonesia, may challenge long-standing conclusions about the evolution of modern people in far eastern Asia. In 2003, scientists found a skeleton with highly unusual characteristics (**Figure 12.40**). Dubbed the "Hobbit" by the popular press, this hominin had an extremely tiny brain (400 cc) and skull and stood only slightly above 1 m (3.3 ft). Anthropologists disagree on how to interpret these and other characteristics. The Australian anthropologists Peter Brown and Michael Morwood and colleagues regard the skeleton as evidence for the long-term presence of an archaic species of hominin, distinctive from modern people. In fact, they consider it a newfound species of *Homo,* which they call ***Homo floresiensis.*** In their interpretation of this dwarf species' existence, a group of primitive humans became isolated earlier in human evolution, and their isolation led to a unique pattern of biological variation.

Homo floresiensis Dubbed the "Hobbit" for its diminutive size, a possible new species of *Homo* found in Liang Bua Cave on the Indonesian island of Flores.

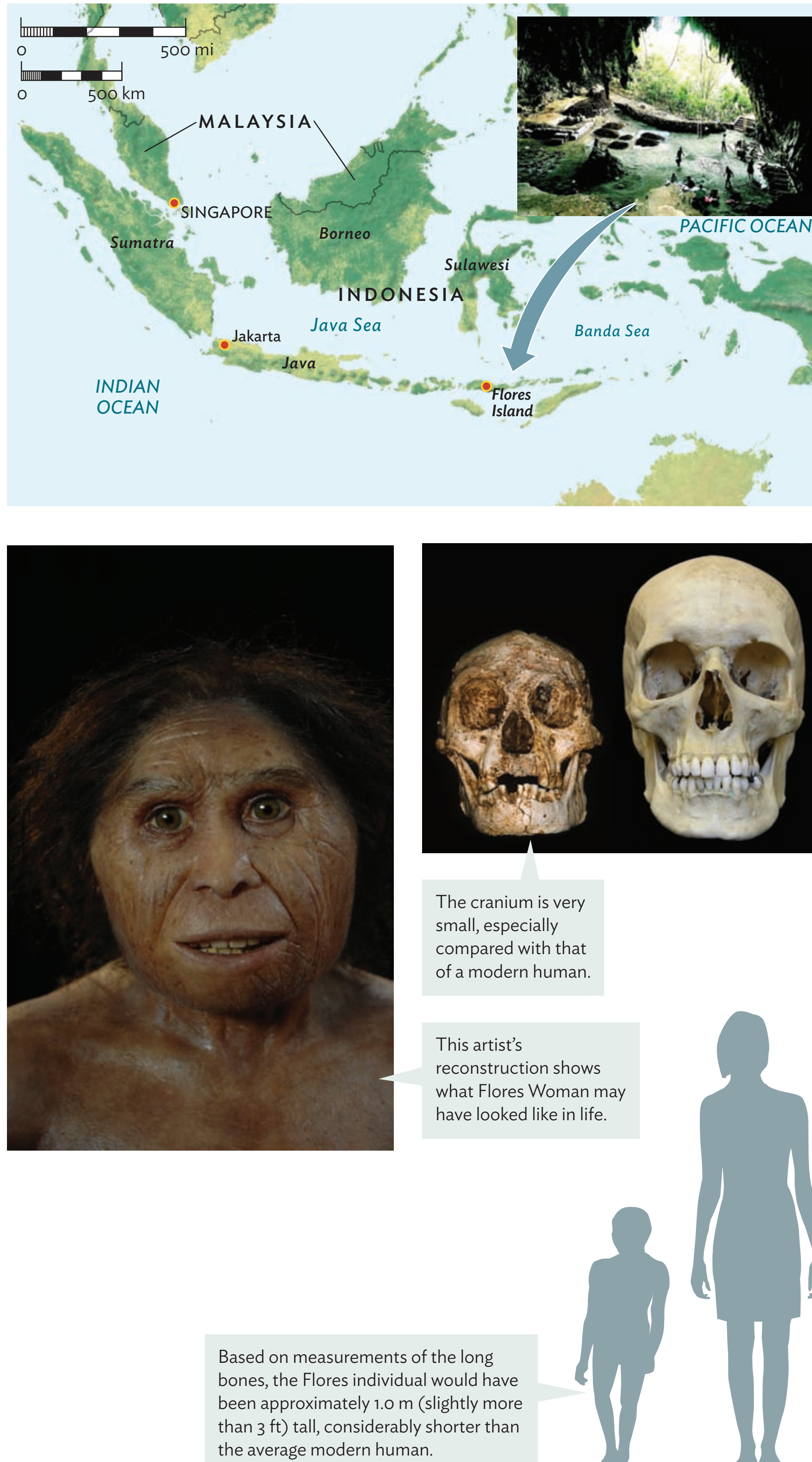
Alternatively, the Indonesian paleoanthropologist Teuku Jacob and colleagues argue that this hominin was not part of a different species but a modern human who suffered from **microcephaly** or some other genetic or developmental abnormality. They point out that some cranial features of *H. floresiensis* are within the modern range of variation seen in living populations from the larger region. In addition, some of the creature's anatomical characteristics (such as a small or absent chin and rotated premolars) resemble those of populations now living in the immediate region.

microcephaly A condition in which the cranium is abnormally small and the brain is underdeveloped.

There are strengths to both arguments for interpreting the remains of the hominin

FIGURE 12.40

Flores Woman A recent discovery on Flores Island, Indonesia, has become the source of much debate in anthropology. Some researchers believe this "Hobbit" represents a group of early hominins that evolved in isolation in the far western Pacific region. Others believe this skeleton belonged to a modern human who had some developmental or genetic abnormality. (Reconstruction photo [left] © 2007 Photographer P. Plailly/E. Daynès/Eurelios/Look at Sciences—Reconstruction Elisabeth Daynès, Paris)



from Liang Bua. However, the discovery of an earlier dwarf hominin from Mata Menge, also from Flores and dating to 700,000 years ago (see Chapter 11, pp. 386–87), suggests both the validity of a new species having deep temporal roots in the region and the strong possibility for an earlier ancestor of this hominin. Moreover, the similarities in tooth and body size of the Liang Bua and Mata Menge hominins argue for an ancestral-descendant relationship. Regardless of their interpretation, the hominin from Liang Bua and its predecessor dwarf hominin from Mata Menge represent a highly unusual morphology at the extremes of hominin variation in the middle to late Pleistocene.

EARLY MODERN *HOMO SAPIENS* IN EUROPE (35,000–15,000 YBP) Early modern people are known from various places throughout Europe. The earliest modern *H. sapiens* in Europe is from Peştera cu Oase, Romania, and dates to 35,000 yBP. The Oase 2 skull from that site is distinctively modern, contrasting with Neandertals that lived during the same time. For example, Oase 2 has very reduced browridges and a generally gracile appearance. Almost as old are remains from Mladeč, Předmostí, and Dolni Vestonice, all in the Czech Republic, dating to 35,000–26,000 yBP. The half-dozen Mladeč skulls (35,000 yBP) show remarkable variability, including a mix of Neandertal characteristics in some (occipital bun, low skull, large browridges, large front teeth, and thick bone) and modern characteristics in others (nonprojecting face, narrow nasal opening). The Předmostí and Dolni Vestonice skulls retain a few Neandertal characteristics, but they are clearly more modern in appearance than the Mladeč people (**Figure 12.41**). Some Neandertal features persist well into recent times in eastern Europe, especially in the facial region (**Figure 12.42**).

Western Europe has virtually no fossil record for the earliest modern people, those contemporary with the populations represented by the Mladeč and Předmostí fossils. The skeleton of a five-year-old child from Lagar Velho, Portugal, dating to 24,000 yBP,

(a)

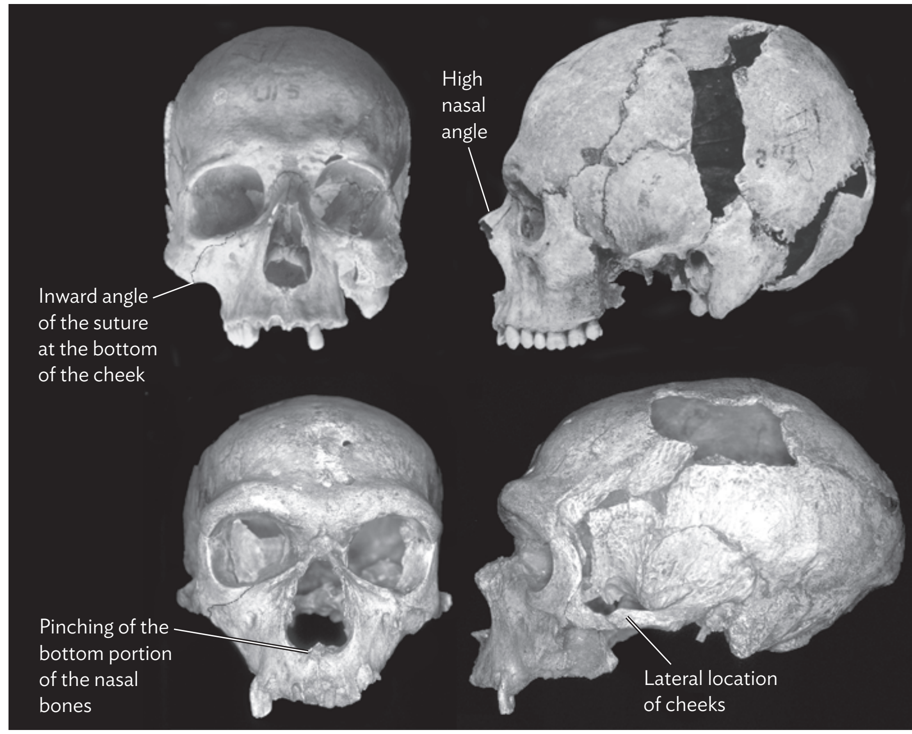
(b)

FIGURE 12.41

Dolni Vestonice Skull **(a, b)** This cranium, from Dolni Vestonice, combines modern human and Neandertal characteristics.

FIGURE 12.42

Neandertal Traits in Modern Humans The La Chapelle-aux-Saints cranium (bottom; see also Figure 12.20) and a modern Croatian cranium (top) share four major facial similarities.

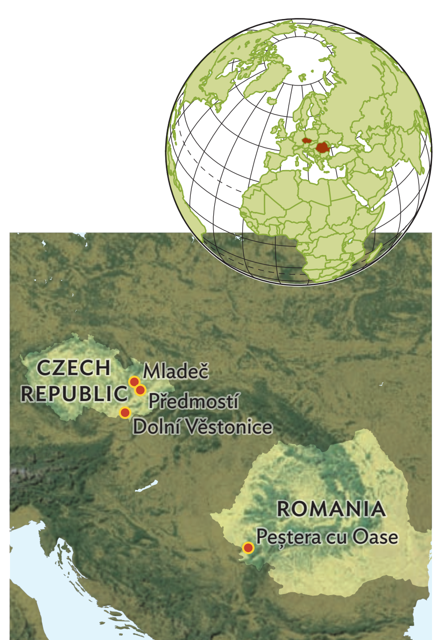


has a number of archaic, Neandertal-like cranial and postcranial features, such as its limb proportions and robusticity (**Figure 12.43**).

The best-known western European representatives of early modern people are the remains of a half-dozen individuals from Cro-Magnon, in Dordogne, France, and remains from the Grimaldi Caves, in the Italian Riviera region, all of these dating to about 30,000–25,000 yBP. The Cro-Magnon remains are often presented as the archetypical example of the earliest modern people, but in fact people varied considerably

FIGURE 12.43

Lagar Velho This skeleton of a child was discovered at a rockshelter site in Portugal's Lapedo Valley.



(b)

(a)

FIGURE 12.44

Cro-Magnon **(a, b)** In 1868, a geologist discovered skeletons in a rockshelter in Cro-Magnon, France. These remains are anatomically modern, with a number of features distinct from Neandertals', including a high and vertical forehead, flat browridges, a much narrower nasal aperture, and an overall gracile skull. (Photos © David L. Brill, humanoriginsphotos.com)

during this time. Collectively, though, both ensembles of skeletons from western Europe have distinctively modern features: vertical forehead, narrow nasal aperture, and small browridges (**Figure 12.44**). In addition, unlike Neandertals, their tibias are long and their body trunks are narrow. Like Neandertals, these people lived in cold climates of the late Pleistocene, but their very different body morphology suggests adaptation to warmer climates. (The implications of these skeletal features for the origins of modern *H. sapiens* are discussed later in this chapter.)

Overall, comparisons of earlier with later early modern *H. sapiens* in Europe indicate a trend toward gracilization—the faces, jaws, and teeth became smaller and the faces became less projecting. In addition, comparison of early and late Upper Paleolithic heights reconstructed from the long bones shows that the later early modern people were shorter. The decrease in the height of early modern people may have been caused, at the very end of the Pleistocene, by both a decrease in the quality of nutrition and resource stress. That is, during the last 20,000 years of the Pleistocene, food procurement intensified—more effort was put into acquiring and processing food for the same amount of caloric intake as before. This change may have occurred because human population size was increasing, placing increased pressure on food resources. An outcome of this change was a global increase in the range of foods eaten. Archaeological evidence shows that the later early modern humans hunted and collected smaller and less desirable (because not as protein-rich) foods, such as small vertebrates, fish, shellfish, and plants. As the American anthropologist Trent Holiday has also shown, the late Upper Paleolithic people had wider body trunks and shorter legs than the early Upper Paleolithic people. The morphological shift indicates an adaptation to cold during the late Upper Paleolithic, a highly dynamic period of human adaptation and evolution.

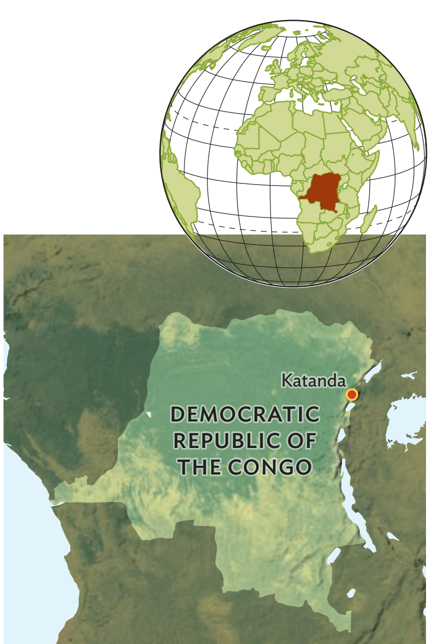
CONCEPT CHECK

Early Modern *Homo Sapiens*

Early modern *H. sapiens* occurred first in Africa, and later in Asia and Europe. The peopling of Europe, Asia, and Africa by only modern *H. sapiens* was complete by 25,000 yBP.

Locations (sites)*	Africa (Herto, Aduma, Bouri, Omo, Klasies River Mouth Cave, Lothagam, Wadi Kubbaniya, Wadi Halfa) Asia (Skhul 5, Tianyuan, Minatogawa) Europe (Peştera cu Oase, Mladeč, Předmostí, Dolni Vestonice, Cro-Magnon, Grimaldi)
Chronology	160,000 yBP in Africa 90,000 yBP in western Asia 35,000 yBP in eastern Asia 32,000 yBP in Europe
Biology	Vertical forehead, high skull, rounder skull, reduced facial robusticity, smaller teeth, reduced midfacial prognathism, 1,500 cc cranial capacity Heat-adapted body morphology (small trunk, long limbs)
Culture and behavior	Upper Paleolithic Increased visible symbolic behavior (cave art) Burial of deceased with grave goods Decreased hunting, increased fishing, aquatic foods, likely more plants, and reduced focus on big-game animals Technology changes reflect increased focus on fishing (e.g., bone harpoons)

*Sites mentioned in text.



Modern Behavioral and Cultural Transitions

Anthropologists are learning that various behavioral and cultural practices developed at different places and different times in the later Pleistocene, culminating in full modernity in *H. sapiens* globally. In many respects, the fossil record and the cultural record show that modern behaviors and practices began, biologically and culturally, in Africa. For example, fishing and the use of aquatic resources as an important part of diet are first documented at Katanda, in the Democratic Republic of Congo, where early modern *H. sapiens* were exploiting huge catfish by at least 75,000 yBP. This development is part of a larger package of behaviors associated with modern humans, including more specialized kinds of hunting, wider employment of raw materials (such as bone) for producing tools, advanced blade technology, and trade (**Figure 12.45**). However, as

FIGURE 12.45

Modern Human Tools Early modern humans used a variety of specialized tools, including bone tools shaped for specific purposes. Dating between 35,000 and 18,000 yBP, tools made from bone from Ma'anshan Cave are the oldest in China.

discussed earlier (see "Neandertals Used Symbols"), symbolic behavior and cognitive advancement were also present in Europe, albeit later than in Africa. The successful adaptation of symbolically advanced late archaic *H. sapiens*—the Neandertals—in Europe shows that the story of later evolving humans is complex. Neandertals were fundamentally no different from modern *H. sapiens,* especially in regard to a number of behaviors—burial of the dead, speech, and symbolism—that remain with us today.

12.4 How Has the Biological Variation in Fossil *Homo sapiens* Been Interpreted?

At the beginning of this chapter, you read about the two key models that anthropologists use to explain modern *H. sapiens'* origins: the Out-of-Africa model and the Multiregional Continuity model. After having learned what the fossil record reveals about the variation in late archaic *H. sapiens,* you should be starting to see what this record reveals about modern humans' origins. Now remember the question posed at the beginning of this chapter: *Which of the two models best explains modern* H. sapiens' *origins?*

The European fossil record from 40,000–30,000 yBP provides clues about modern *H. sapiens'* origins in Europe. The earliest modern *H. sapiens* were present as early as 35,000 yBP at Mladeč (Czech Republic) and at Peştera cu Oase (Romania). The latest archaic *H. sapiens,* the Neandertals, survived until at least 32,000 yBP or so at Vindija

(Croatia). The overlap in dates between Neandertals and early modern humans indicates that the two groups coexisted in eastern Europe for at least several thousand years. This finding argues against the Multiregional Continuity model, which sees archaic *H. sapiens* as having evolved locally into modern *H. sapiens.* That the earliest modern *H. sapiens* had clear Neandertal features (such as the occipital bun) indicates interbreeding between Neandertals and early modern people. This finding argues against the Out-of-Africa model, which sees no gene flow between Neandertals and early modern humans. We will now see if the genetic record provides additional insight into modern *H. sapiens'* origins in Europe.

Ancient DNA: Interbreeding between Neandertals and Early Modern People?

Analysis of mitochondrial DNA (mtDNA), the DNA inherited only via the mother, offers potential clues about modern people's origins (mtDNA is among the topics of chapter 3). Comparisons of mtDNA from more than a dozen Neandertal skeletons—from Engis and Scladina in Belgium, Les Rochers de Villeneuve and La Chapelle-aux-Saints in France, Monte Lessini in Italy, El Sidrón in Spain, Feldhofer Cave in Germany, Mezmaiskaya in Russia, Teshik Tash in Uzbekistan, and Vindija Cave in Croatia—with that of early modern humans and living humans shows *similarity* among Neandertals and *dissimilarity* between Neandertals and modern humans. The German molecular geneticist Matthias Krings and his associates found, for example, that 27 mtDNA base pairs of a sequence of 378 base pairs from the Feldhofer Cave Neandertal differ completely from living Europeans'. In contrast, living human populations have an average of just eight differences among them. These genetic differences seem to support the hypothesis that no gene flow occurred between Neandertals and modern humans during the later Pleistocene and, importantly, that Neandertals contributed none of their genetic material to the modern human gene pool. Neandertals underwent extinction, pure and simple. However, the extinction hypothesis may not be the best one. That is, mtDNA is just a tiny part of the human genome and reflects only a small fraction of the genetic code. The failure of one part of the genome to survive to the present does not mean that the entire genome became extinct. Moreover, it is possible that mtDNA lineages have been lost owing to genetic drift. Simply, much more of the genome is needed to have a more complete picture.

Only recently has the remarkable scientific technology been available to analyze nuclear DNA to reconstruct the Neandertal genome. Such a reconstruction would make it possible to address the important question of the Neandertal contribution (if any) to the modern human genome. In a breakthrough study led by Swedish geneticist Svante Pääbo, a new technology applied to the analysis of three female Neandertal bones from Vindija Cave at last has provided the sequence of 4 billion base pairs representing the Neandertal genome. Pääbo and his team used *high-throughput DNA sequencing,* a technology through which much of a genome can be sequenced from a compilation of various genome fragments recovered from fossil bones. The results are breathtaking: Eurasians and Neandertals share between 1% and 4% of their nuclear DNA, an indication of a small but significant admixture. Given that Africans share no nuclear DNA with Neandertals, the admixture occurred between early modern Europeans and Neandertals after early modern people left Africa. People living today outside of Africa have DNA that likely originated from Neandertals. In that sense, the Neandertals are still with us! In fact, new studies of nuclear DNA in Neandertals shows the presence of alleles indicating risk for disease. In this way, Neandertal biology has contributed to shaping the biology of modern *H.sapiens*.

But early modern *H. sapiens* may not have interbred with just Neandertals. Beginning in 2010, analysis of mitochondrial and nuclear DNA recovered from a hominin hand bone, foot bone, and a few teeth dating to 40,000 yBP from Denisova Cave, in southern Siberia, revealed a hominin genome that is neither Neandertal nor modern human. Svante Pääbo and his team, who reconstructed the Denisovan genome, expected to find a genome that was either Neandertal or modern human, but they came up with something very different from both. The only similarity they could find with living people is from populations living in Melanesia (New Guinea and Bougainville Islands) and China. These findings suggest that genetic diversity in late Pleistocene Europe is more complex than previously thought. Namely, the genome came to include contributions from some widespread populations that modern humans encountered as they migrated throughout Europe (the Neandertals) and from some very isolated people (the Denisovans). The Denisovans are likely archaic *H. sapiens* sharing a common origin with Neandertals. However, because paleoanthropologists have found only a few bones and teeth, we do not know what the Denisovans looked like. The genetic evidence strongly suggests that modern humans migrated from Africa and interbred with hominin species beyond just Neandertals. In fact, the European continent appears to have been inhabited by various isolated peoples. As research continues, the picture of genetic variation in humans on the evolutionary pathway toward modernity becomes increasingly complex.

Living People's Genetic Record: Settling the Debate on Modern Human Origins

Living people's genetic record helps settle the question about whether the Out-of-Africa model or the Multiregional Continuity model explains modern *H. sapiens'* origins. The American geneticist and molecular biologist Rebecca Cann and her collaborators have found that sub-Saharan African populations are more genetically diverse than populations from any other region of the world. That is, genes of people living south of the Sahara Desert today are more variable in frequency than are genes of people living in Europe, Asia, the Americas, and Australia (**Figure 12.46**). This pattern is also present in the phenotypic variation of anatomical characteristics (for example, cranial measurements).

Two explanations exist for Africa's greater genetic diversity. First, a population or group of populations that has been around a long time will have accumulated more mutations—hence, greater genetic variation—than a population or group of populations that has been around a short time. Therefore, Africa's greater genetic diversity may mean that modern people have existed longer there than in Asia or Europe.

On the basis of their assessment of mutation rates, Cann's group came up with a figure of 200,000 yBP for the first early modern *H. sapiens'* appearance, and this date is consistent with the earliest record of modern *H. sapiens* in Africa. Calculations based on other sources of genetic material, such as from the Y chromosome, provide broadly similar results.

The alternative explanation for Africa's greater genetic diversity lies in its population structure compared with that of other continents. The American anthropological geneticist John Relethford observes that population size tremendously influences genetic diversity. As discussed in chapter 3, if the breeding population is small, genetic drift is a potentially powerful force for altering gene frequencies. Over time, genetic drift reduces genetic diversity in a small population (such as might have been the case in Europe and Asia). For example, if a group of 10 people splits off from a group of 1,000 people, the two resulting groups will show very different patterns of gene frequency change. The smaller population will be less variable, whereas its parent population

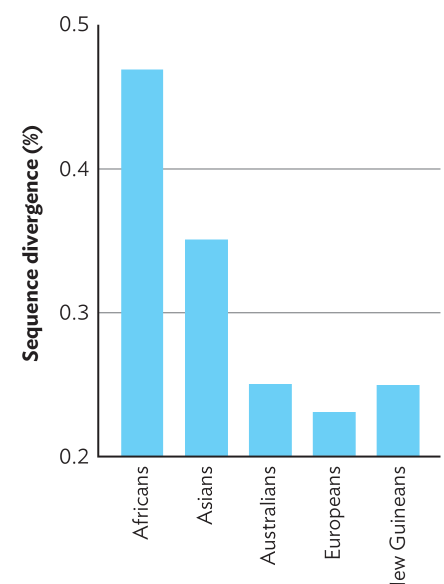


FIGURE 12.46

Genetic Diversity Patterns of genetic diversity have been used to assess the Out-of-Africa and Multiregional Continuity models of modern humans' origins. This graph shows genetic diversity within several major geographic groups, expressed as the average amount of genetic sequence divergence in percent. Note the much greater genetic diversity in Africans compared with other groups. (Source: Cann, R. L., M. Stoneking, and A. Wilson. 1987. Mitochondrial DNA and human evolution. *Nature* 325: 31–36.)

will be more variable. Relethford argues that because in the remote past Africa had a significantly larger breeding population size than other continents did, Africa now has greater genetic diversity.

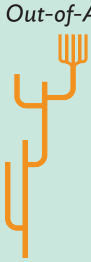
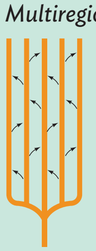
12.5 Assimilation Model for Modern Human Variation: Neandertals Are Still with Us

The more modern characteristics of East African skeletons from the Upper Pleistocene (for example, Herto) provide compelling evidence that modern variation originated in Africa. The fossil record and the genetic record indicate, however, that neither

CONCEPT CHECK

Models for Explaining Modern *Homo sapiens'* Origins

With more complete and growing fossil and genetic records of human evolution, it is now possible to weigh the strengths and weaknesses of hypotheses that best explain the origins of modern *Homo sapiens*.

Model	Features	Proponent
Out-of-Africa 	Modern biology, behavior, and culture originated in Africa. Modern humans spread from Africa to Europe after 50,000 yBP. Modern humans replaced all populations once arriving in Europe, with no gene flow.	Christopher Stringer
Multiregional Continuity 	Modern humans evolved from earlier archaic populations in their respective regions (Africa, Europe, Asia). Throughout evolution, there is always significant gene flow on the borders of populations. There is continuity of morphology in all regions of the globe.	Milford Wolpoff
Assimilation 	Modern humans first evolved in Africa, then spread to Europe and Asia. Once they arrived in Europe and Asia, modern humans underwent gene flow with Neandertals.	Fred Smith, Erik Trinkaus

the Out-of-Africa model nor the Multiregional Continuity model adequately explains modern humans' origins. The Out-of-Africa model correctly accounts for the origin of modern human variation, but it incorrectly asserts that no gene flow occurred between Neandertals and modern *H. sapiens.* The Multiregional Continuity model is not correct about modern *H. sapiens'* regional development. However, it is correct about gene flow and the notion that Neandertals have contributed to modern *H. sapiens'* gene pool.

In other words, elements of both models explain the emergence and evolution of fully modern people worldwide in the Upper Pleistocene. That is, sometime within 200,000–100,000 yBP, a population of modern heat-adapted *H. sapiens* migrated from Africa to Europe and Asia. Once arriving in Europe, this population encountered members of their species—the Neandertals—who were as behaviorally and technologically complex as they. Neandertals, cold-adapted people, had evolved from earlier *H. sapiens* populations in Europe—the early archaic *H. sapiens*—and they interbred with the newly arrived modern *H. sapiens.* Therefore, Neandertals' disappearance after 30,000 yBP or so likely resulted not from their extinction but from their *assimilation* by much larger, more genetically diverse populations of modern humans migrating into Europe from Africa during the late Pleistocene (**Figure 12.47**). Neandertals contributed to the gene pool of today's European and European-descended populations, leaving their genetic, behavioral, and adaptive legacy with modern humans in Europe and in Asia.

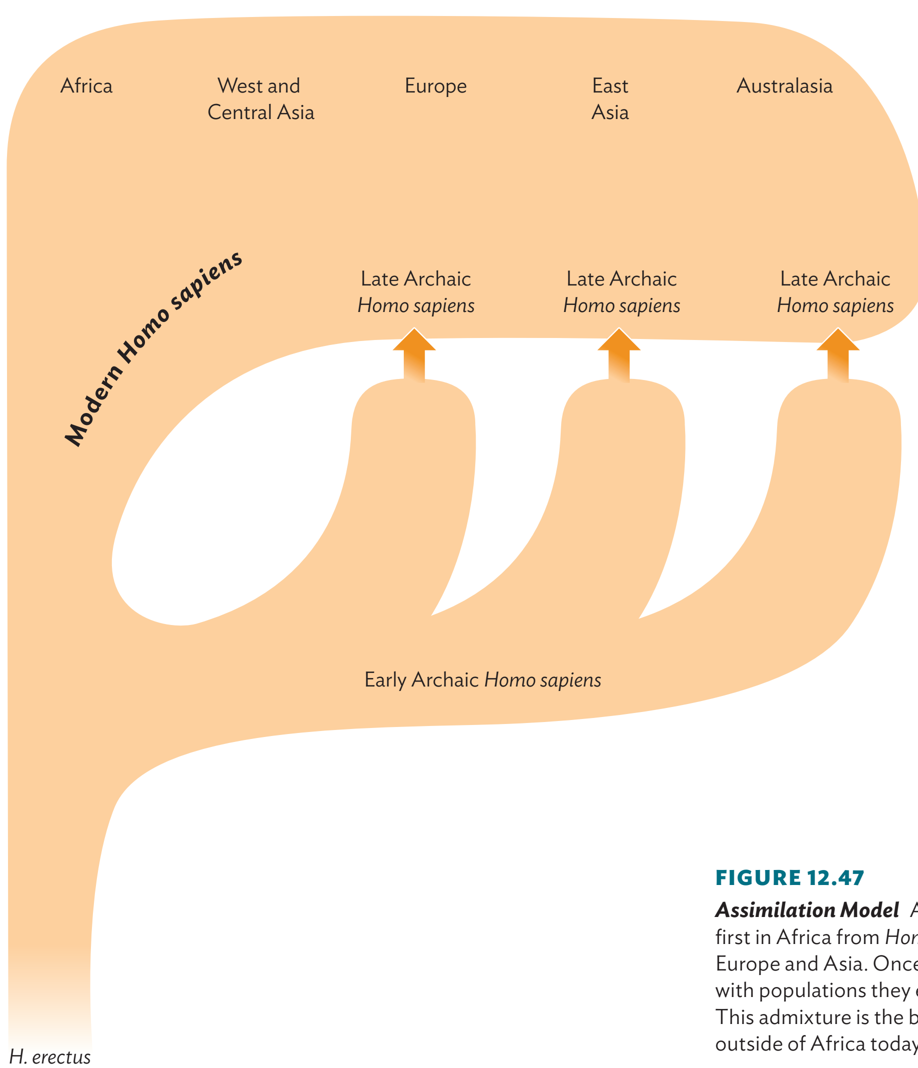


FIGURE 12.47

Assimilation Model According to this model, modern *Homo sapiens* evolved first in Africa from *Homo erectus*. Groups of *Homo sapiens* then spread to Europe and Asia. Once in Europe and Asia, these modern *H. sapiens* interbred with populations they encountered, the late archaic *H. sapiens* (Neandertals). This admixture is the biological foundation for modern *H. sapiens* living outside of Africa today.

12.6 Modern Humans' Other Migrations: Colonization of Australia, the Pacific, and the Americas

This chapter and the preceding one have emphasized migration's critical importance in human evolution. In the first wave out of Africa, *H. erectus* spread rapidly throughout Asia and Europe. In the second wave out of Africa, early modern *H. sapiens* assimilated and eventually replaced the descendants of *H. erectus* in Asia and Europe. The last 50,000 years of the Pleistocene saw fully modern people spread not only into Asia and Europe but also to continents that had previously not been occupied by people. Prior to 50,000 yBP, humans occupied only three of the six inhabitable continents: Africa, Asia, and Europe. After 50,000 yBP, populations migrated from the southeastern fringes of Asia to Australia, eventually fanning out from west to east across the hundreds of islands that dot the Pacific Ocean. In the last few millennia of the Pleistocene, humans spread to the Americas (**Figure 12.48**). These movements, and their accompanying adaptations to unfamiliar environments, are no less a part of human evolution than are bipedalism, language use, and all the other key developments discussed in this chapter and chapter 11.

FIGURE 12.48

Modern Humans' Migrations Another major research question in physical anthropology focuses on modern humans' spread from Asia to Australia, the Pacific, North America, and South America. This map shows modern humans' migration patterns from southern Asia **(1a–6a)** and eastern Asia **(1b–3b)** beginning in the late Pleistocene: **(1a)** earliest migration of modern *Homo sapiens* into Australia (Lake Mungo; ~50,000–40,000 yBP); **(2a)** earliest evidence of modern human occupation of New Guinea and adjacent islands (Bobongara; ~35,000 yBP); **(3a)** earliest evidence of modern human occupation of Tasmania (Warreen Cave; ~33,000 yBP); **(4a)** early expansion into Oceania (Mariana Islands; ~1500 BC); **(5a)** oceanic expansion into western Polynesia (Tonga and Samoa; ~1000 BC); **(6a)** expansion into eastern Polynesia (Cook Islands; ~AD 700); **(1b)** earliest evidence for expansion from northeast Asia into North America (Beringia; ~15,500 yBP—or Clovis, New Mexico; ~12,000 yBP); **(3b)** proposed coastal route for colonization of the New World and South America (Monte Verde, Chile; ~14,500 yBP).

What motivated these early modern people to move? Among the multiple reasons, four are most important: population increase, disappearance of food resources, increased competition with neighbors for remaining resources, and climate deterioration. That is, a population's resources—food especially—are available in finite quantities. As Relethford has shown through genetic studies, African populations expanded rapidly during the late Pleistocene. These increases, as populations outgrew their carrying capacities, were the prime force stimulating anatomically modern people to move into Asia and Europe. Similarly, as population size expanded in Asia and Europe, humans continued to move and began to occupy vast regions of the globe.

Beginning in the very late Pleistocene, eastern Asia became the stepping-off point for migrations to previously unoccupied continents. Southeast Asia served as the stepping-off point for the movements to Australia and across the Pacific as people eventually occupied most of the 20,000–30,000 islands between Australia and the Americas. Northeast Asia served as the stepping-off point for the spread to North America and South America.

Down Under and Beyond: The Australian and Pacific Migrations

In the late Pleistocene, sea levels were considerably lower than they are today, by as much as 90 m (300 ft), exposing land surfaces now submerged by water and making them available for human occupation and movement between landmasses. Australia, New Guinea, and Tasmania constituted a single landmass, which we call *Greater Australia* (**Figure 12.49**). The islands of Sulawesi, Borneo, and Java were connected

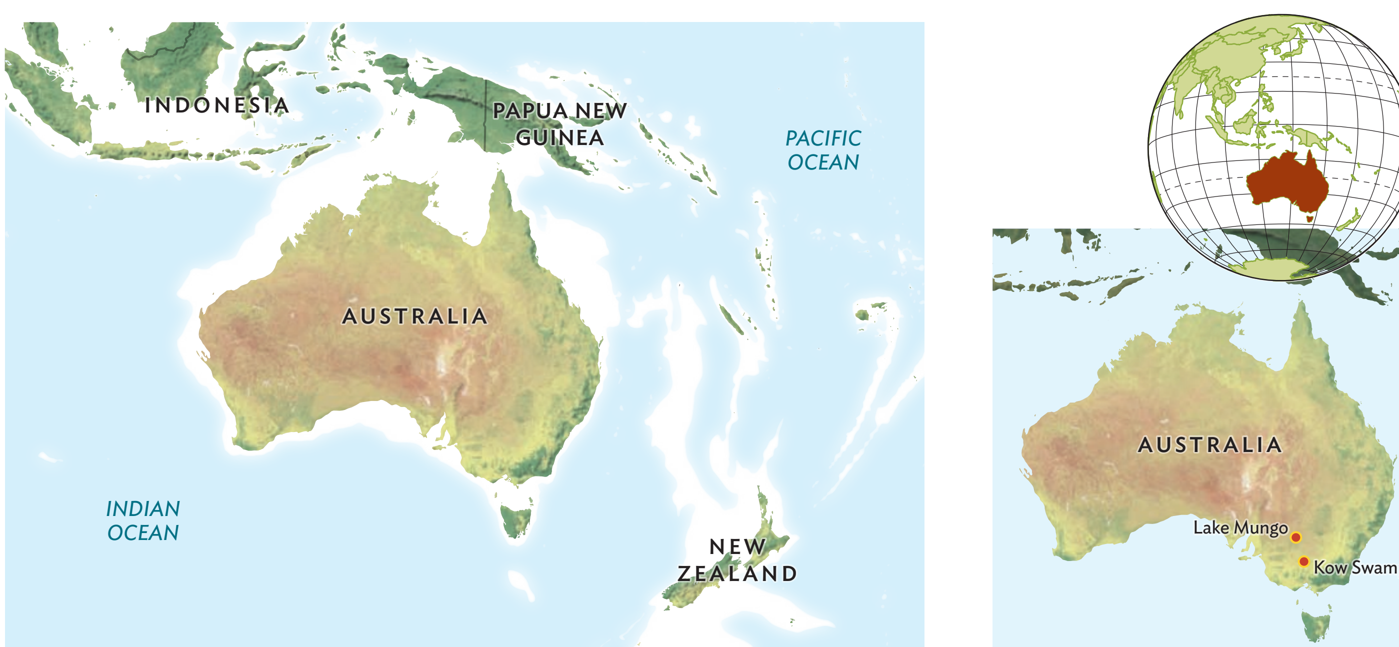


FIGURE 12.49

Land Bridge During the late Pleistocene, temperatures were much cooler and a great amount of seawater was locked in glaciers. As a result, sea levels were at their lowest, exposing shallow land, such as the Sunda shelf in southeast Asia. On this map, the exposed land is white. Some of it connected the islands of southeast Asia (Borneo, Java, and Sumatra) with the Asian mainland, and some of it connected Australia with New Guinea and Tasmania. Despite the increased land area, traveling to Australia would have still required a sea voyage; however, there was much less distance between southeast Asia and Australia. Modern researchers are unable to investigate evidence of the people who once inhabited the areas that are now underwater.

to mainland Asia. Even at the peak of the late Pleistocene's coldest period, when sea levels were at their lowest, a considerable distance of open water separated Greater Australia from Asia. At least 70 km (43.5 mi) of open water separated Sulawesi and Borneo from Australia. To traverse open water from southeastern Asia to Australia, late Pleistocene humans would have needed sophisticated boating technology and equally sophisticated navigational skills. No evidence of such technology and skills has been found. Modern humans seem to have had simply enough know-how to reach Australia, which they ultimately colonized.

FIGURE 12.50
Lake Mungo This Australian site has yielded the oldest human skeleton in Australia.

The earliest archaeological evidence of humans in Australia is from Lake Mungo, in western New South Wales, dating to about 42,000 yBP (**Figure 12.50**). The two skulls from Lake Mungo, from an adult male and an adult female, have modern characteristics: the skulls are high and have rounded foreheads with small browridges. In overall appearance, the skulls resemble ones from Kow Swamp in Victoria's Murray River valley, which date to 13,000–9,000 yBP (**Figure 12.51**). However, the Kow Swamp skulls are more robust, with larger browridges, larger and more robust faces, and lower foreheads than the Lake Mungo skulls. These early Australians share features with *H. erectus* and later Indonesian hominins, especially in the facial skeleton, such as in the shape of the eye orbits. These anatomical similarities suggest a common genetic origin, thereby indicating regional continuity of human populations and their biological evolution.

These early Australians also bear a strong similarity to native people who inhabit the continent today; the anatomical evidence indicates an ancestral-descendant relationship. However, mtDNA from the Lake Mungo and Kow Swamp skeletons differs substantially from that of living native Australians. Based on the mtDNA evidence alone, one might conclude that the ancient populations represented by the Lake Mungo and Kow Swamp skeletons were not ancestral to living native Australians, but this conclusion runs counter to a range of cultural and archaeological evidence. As with the Neandertal mtDNA lineages discussed earlier, a more likely explanation for the disparity between ancient and modern genes in Australia is that the mtDNA sequence in ancient anatomically modern people has not survived to the present. This Australian evidence is an important example of the very different evolutionary pathways that mtDNA and anatomical evolution can take. The fossil remains show continuity with modern native people of Australia, but the mtDNA lineage went extinct at some point after 40,000 yBP.

Southeast Asia is also the point of origin for populations that eventually dispersed throughout the Pacific Ocean. Unlike Australia, which was settled by 40,000 yBP, most of the Pacific islands extending from east of New Guinea to Easter Island were not settled until well after 5,000 yBP. In fact, east of the Solomon Islands, settlement across the vast Pacific did not begin until after about 1500 BC, ending with humans' arrival on Easter Island around AD 600.

shovel-shaped incisors A dental trait, commonly found among Native Americans and Asians, in which the incisors' posterior aspect has varying degrees of concavity.

FIGURE 12.51
Kow Swamp This Australian site has yielded skeletons much more robust than those discovered at Lake Mungo. In fact, Alan Thorne, who excavated the skull, originally believed the remains to be a *Homo erectus* skeleton rather than a modern human skeleton.

Arrival in the Western Hemisphere: The First Americans

The American physical anthropologist Aleš Hrdlička first noted the remarkable similarity in the shapes of the upper incisors of eastern Asian and Native American peoples, past and present. He observed that Asians and Native Americans have **shovel-shaped incisors** (**Figure 12.52**). In these incisors and many other dental features, the American anthropologists Albert Dahlberg and Christy Turner have identified a common ancestry for eastern Asians and Native Americans. Common ancestry is supported by the fact that most Native Americans today have exclusively blood type O. Moreover, the alleles for this blood type are present with only limited variation. It is highly likely, therefore, that the founding population had these characteristics.

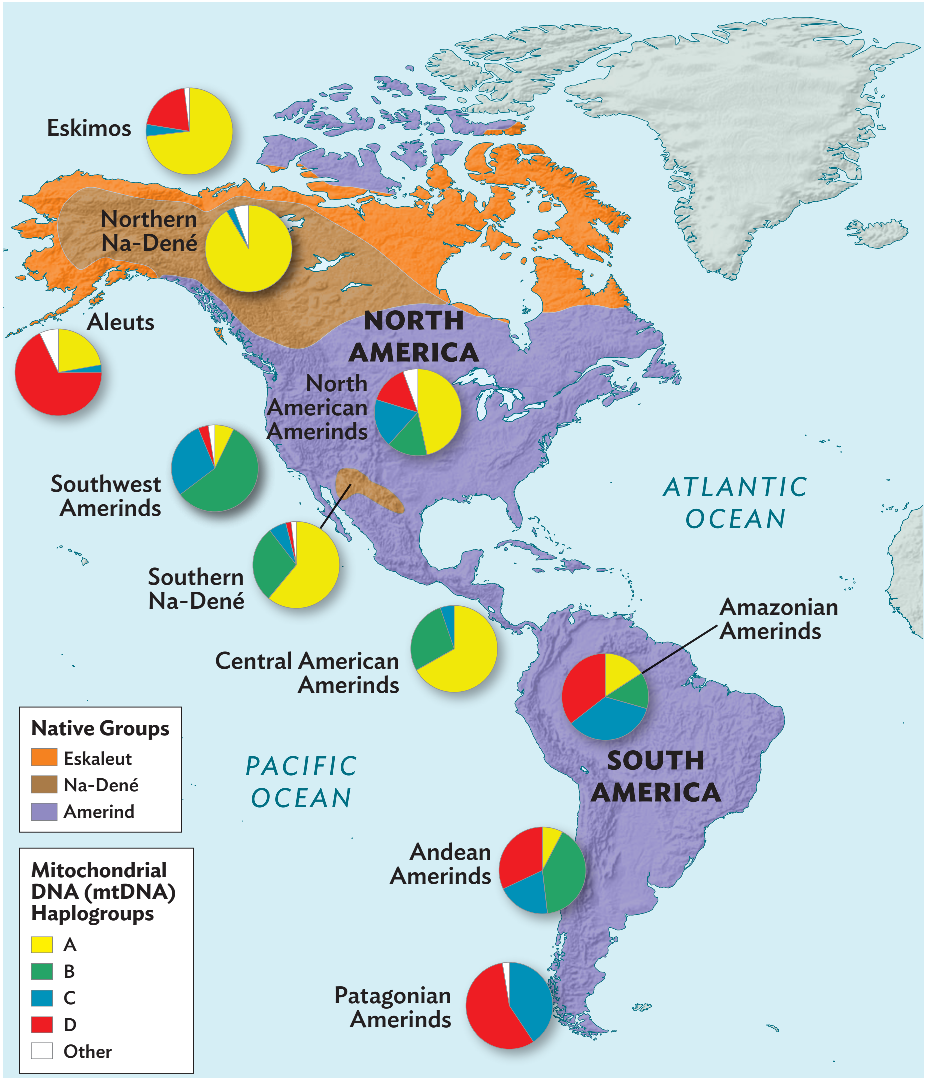


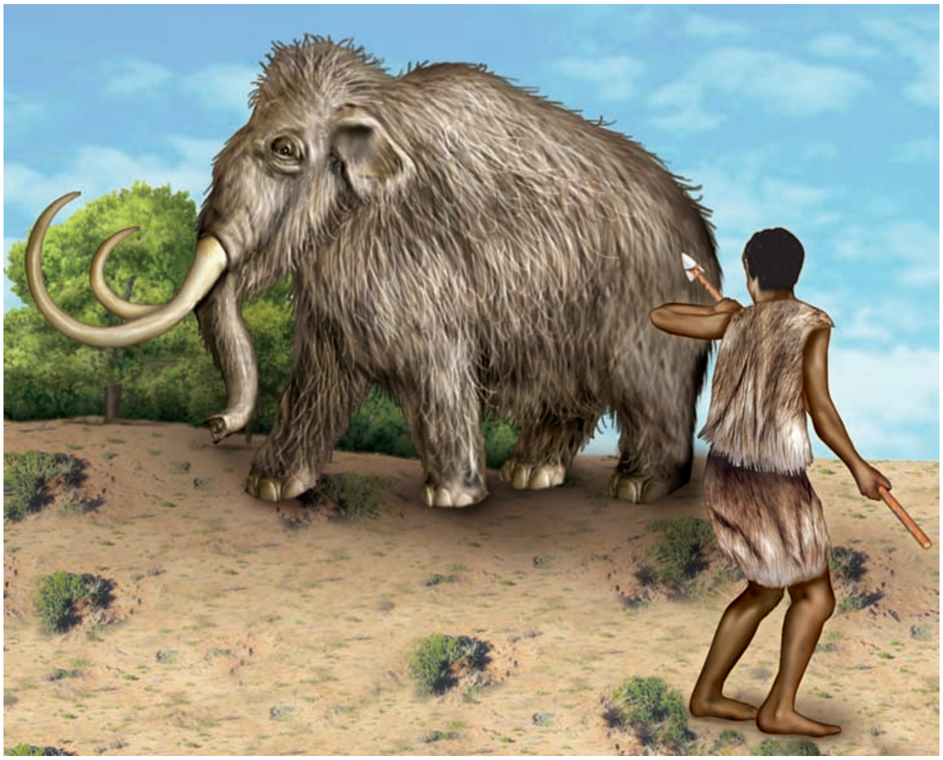
FIGURE 12.52

Shovel-Shaped Incisors A dental characteristic often found in East Asians is the shoveled appearance of the back, or lingual side, of the incisors. That this trait has also been found in Native Americans likely reflects their descent from East Asians.

FIGURE 12.53

Native American Mitochondrial DNA (mtDNA) Studies of mtDNA haplogroups in Native Americans have yielded information about human migrations from Asia to the Americas. This map shows the relative amount of each haplogroup in various native groups (the Eskaleut, the Na-Dené, and the Amerind).

Additional clues about the peopling of the Americas appear in modern and ancient Native Americans' mtDNA. For 95% of living Native Americans throughout North America and South America, mtDNA falls into any one of four haplogroups—A, B, C, or D. (As discussed in chapter 3, mtDNA is inherited just from the mother, so the haplogroup unit reflects the maternal line of inheritance.) Notably, the same pattern of four main haplogroups has been found in mtDNA recovered from ancient Native American skeletons. This sharing of haplogroups by modern people and ancient skeletons indicates a common founding ancestry for present and past Native Americans. Moreover, Native Americans share haplogroups with northeastern Asians. The evidence indicates that the haplogroups were present in Asians who migrated to the Americas (**Figure 12.53**). The presence of all four groups throughout the Americas and the great similarity of the nucleotide sequences suggest that they share a common ancestry in a single founding population that arrived in the Americas from Asia via one migration. Consistent with the mtDNA evidence from skeletal remains is the emerging record provided by the sequencing of the nuclear DNA from a Paleoindian young boy's skeleton from Anzick, Montana, dating to the late Pleistocene (ca. 12,700 yBP). The strong similarity of the genome with that of native people today indicates that the person was



(a)

(b)

FIGURE 12.54

Paleoindians **(a)** This first group of inhabitants in the Americas likely hunted a variety of megafauna, such as the mammoth shown here and a wide range of other animals. **(b)** The tools the Paleoindians hunted with included a specialized, fluted projectile point, which we call a *Folsom point.* An extraordinary amount of skill was required to make this tool.

part of the earliest wave of migration giving rise to all indigenous groups in North and South America. Research by the American anthropological geneticist Connie Mulligan and her colleagues suggests that the founding population consisted of only about 800 people. The dental and the genetic evidence points to northeast Asia during the late Pleistocene for native New World people's origin.

This northeastern Asian origin indicates that in contrast to Australia's founding populations, who were adapted to tropical, wet climates, the Americas' founding populations were adapted to cold, dry climates. Both migrations indicate that these founding humans were adapted to extreme environments at the margins of human capabilities.

In contrast to the migrations to Australia and the Pacific, where the founders traveled across open seas, migrations to the Americas occurred via a land route or along the deglaciated Pacific coastline. If it was a land route, it was likely across the Bering land bridge (which we call *Beringea*), connecting Siberia and Alaska. Like those in the western Pacific Ocean, this land route was created when sea levels reached a low point during the later Pleistocene, exposing areas of land that are now submerged.

Genetic dating based on mutation rates of mtDNA and Y chromosomes, as well as single nucleotide polymorphisms (SNPs; see chapter 4), indicates that the migration from Asia to the Americas likely took place by 15,000 yBP. The genetic dating is consistent with the dates on the earliest archaeological sites in the Americas, such as from the Page-Ladson site in Florida, dating to 14,550 yBP. The genetic findings indicate that one early migration resulted in the ancestral population for most Native Americans of North America and South America today. The uniform distribution of haplotypes across the Americas indicates that the migration was a rapid process and not a slow diffusion. Two other smaller and much later migrations from Asia yielded the founding populations of (1) Na-Dené speakers of northwestern North America and the Navajo and Apache of the southwestern United States and (2) the speakers of Eskimo-Aleut languages, respectively. In North America, the earliest well-documented archaeological record of habitation and material culture (especially stone artifacts) dates to around 11,500 yBP. The earliest people associated with this and other early cultures are called **Paleoindians.** They are well known from stone artifacts, especially large spear points associated with pre-Clovis, **Clovis,** and later **Folsom** cultures. The Paleoindians hunted various animals, but they are best known for hunting **megafauna,** the large Pleistocene game such as the mammoth, steppe bison, and reindeer/caribou, and processing the meat from these animals for food (**Figure 12.54**).

Pleistocene megafauna became extinct by the early Holocene, and some evidence suggests that in the Americas and Australia, humans hunted these large animals to extinction. It seems unlikely, however, that small numbers of humans could have killed so many animals in such a short time. These extinctions were more likely due to climate change at the end of the Pleistocene and the changes in habitats frequented by large mammals. If humans' hunting during the late Pleistocene and early Holocene was involved, it played a very minor part.

The Paleoindians differed anatomically from recent Native Americans. The Paleoindians' skulls were relatively long and narrow, and their faces were robust, with large attachment areas for the masticatory muscles. In contrast, many late prehistoric and living Native Americans have short, round skulls with gracile faces. For example, the Paleoindian skull from Kennewick, Washington, dating to 8,400 yBP, is long and narrow; the face and jaws are robust (**Figure 12.55**). These differences between the Paleoindians and modern Native Americans have been interpreted to mean either that the Paleoindians are not the living Native Americans' ancestors or, alternatively, that the Paleoindians are the living Native Americans' ancestors but cranial morphology has changed due to evolutionary forces and other processes over the past 10,000 years in the Americas (discussed further in chapter 13).

In 2015, Danish paleogeneticist Eske Willerslev and his team at the Natural History Museum of Denmark discovered that the genetic variation—autosomal, mtDNA, and Y-chromosomal—is strongly similar between Kennewick Man and recent Native Americans, which makes it unlikely that Paleoindians are not the ancestors of modern Native Americans. That is, the ancestral-descendant genetic relationship supports the hypothesis that the cranial morphology evolved *in situ* and was shaped by later processes, such as those involving use of the face and jaws in mastication. This record is consistent with study of Paleoindians from the Yucatán Peninsula in Mexico showing different morphology in Paleoindians than in later populations, yet with clear genetic links between the earlier and later populations. Overall, this important record—fossil and genetic—shows that Paleoindians have a different cranial morphology than modern Native Americans, but with clear genetic ties between the two. In summary: Like all other populations you have read about in this book, populations native to the Americas have evolved.

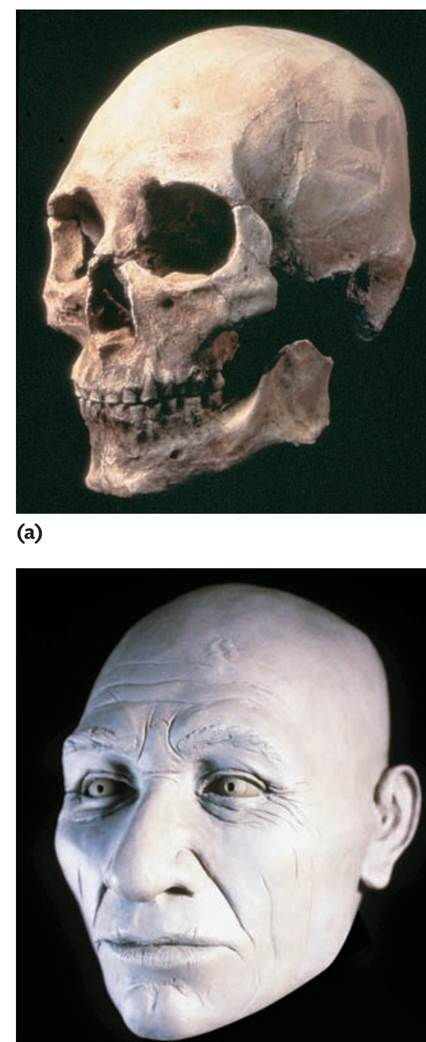
Modern humans' emergence and subsequent dispersal around the globe marks a remarkable period of population expansion and behavioral and biological diversification. The geographic biological diversity in the world today was likely well in place by the end of the Pleistocene. The rapid expansion of human population size resulted in increased types of foods eaten. The adoption and increased use of fish and aquatic life in general during the late Pleistocene likely reflects humans' need for alternative foods as population size expanded. Such dietary expansion set the stage for one of the most dramatic adaptive shifts in human evolution, the shift from eating plants that were gathered and animals that were hunted to eating plants and animals that were both domesticated. In the next chapter, we will look at this important transition's biological implications for humans over the past 10,000 years of our evolution.

Paleoindians The earliest hominin inhabitants of the Americas; they likely migrated from Asia and are associated with the Clovis and Folsom stone tool cultures in North America and comparable stone tool cultures in South America.

Clovis Earliest Native American ("Paleoindian") culture of North America; technology known for large, fluted, bifacial stone projectile points used as spear points for big-game hunting.

Folsom Early Native American (immediately following Clovis) culture of North America; technology known for large, fluted, bifacial projectile points used as spear points for big-game hunting.

megafauna General term for the large game animals hunted by pre-Holocene and early Holocene humans.



(a)

(b)

FIGURE 12.55

Kennewick Man **(a)** Discovered on the banks of the Columbia River, Kennewick Man represents the Paleoindians. **(b)** This artist's reconstruction shows the Paleoindians' likely facial appearance.

CHAPTER 12 REVIEW

ANSWERING THE BIG QUESTIONS

1. **What is so modern about modern humans?**
   - Distinguishing characteristics of modern humans include small faces, jaws, and teeth; a vertical and high forehead; narrow nasal apertures and body trunks; and long legs.
2. **What do *Homo sapiens* fossils reveal about modern humans' origins?**
   - Early archaic *H. sapiens* evolved from *Homo erectus*.
   - In Africa, nearly modern people evolved 200,000–150,000 yBP. After 130,000 yBP, an archaic form of *H. sapiens* called Neandertals occupied western Asia and then Europe.
   - From about 40,000–30,000 yBP, multiple hominin groups occupied Europe: Neandertals, modern *H. sapiens*, and Denisovans.
3. **How has variation in fossil *H. sapiens* been interpreted?**
   - The Out-of-Africa model argues that modern *H. sapiens* migrated from Africa to Asia and Europe, replacing native late archaic *H. sapiens*, including Neandertals.
   - The Multiregional Continuity model argues that modern *H. sapiens* arose regionally in each of the three inhabited continents: Africa, Asia, and Europe.
   - Physical characteristics and DNA in fossils Neandertals were assimilated through admixture with early modern *H. sapiens* and did not go extinct.
4. **What other developments took place in *H. sapiens'* evolution?**
   - More advanced tools, diet diversification, and symbolism appeared first in Africa and later in Europe and Asia.
   - Neandertals were likely capable of articulate speech.
   - Neandertals and contemporary humans were the first species to intentionally bury their dead.
   - Fully modern humans migrated to Australia by 40,000 yBP and to North and South America by 15,000 yBP.
   - Modern human populations globally have evolved in significant ways morphologically since the late Pleistocene, as established by the ancient DNA record.

KEY TERMS

calculus
Clovis
Folsom
Homo floresiensis
Levallois
megafauna
microcephaly
Middle Paleolithic
Mousterian
occipital bun
Paleoindians
shovel-shaped incisors
Upper Paleolithic

STUDY QUIZ

1. **What distinguishes early archaic *Homo sapiens* from *H. erectus*?**
   a. presence in Asia and Europe
   b. loss of large browridges
   c. development of a projecting chin
   d. reduction in skeletal robusticity
2. **What aspect of Neandertal culture supports their intelligence?**
   a. their simpler Mousterian stone.
   b. inefficient hunting techniques.
   c. no communicating by speech.
   d. symbolic burial rituals.
3. **Modern *H. sapiens* most likely evolved**
   a. from archaic *H. sapiens* already living in Africa, Asia, and Europe.
   b. in Africa and replaced archaic *H. sapiens* in Asia and Europe.
   c. in Asia and Europe and replaced archaic *H. sapiens* in Africa.
   d. in Africa and assimilated archaic *H. sapiens* in Asia and Europe.
4. **How did modern *H. sapiens* reach North and South America?**
   a. They crossed the Pacific Ocean from Australia.
   b. They migrated from southeast Asia via the Pacific islands.
   c. They migrated from northeastern Asia along the Bering land bridge.
   d. They traveled from southern Africa through Antarctica.
5. ***Homo floresiensis* has NOT been proposed to be**
   a. a modern human with a developmental abnormality.
   b. within the range of variation of local human populations.
   c. an isolated descendant of an earlier hominin species.
   d. a descendant of modern humans.

REVIEW THIS CHAPTER WITH PERSONALIZED, INTERACTIVE QUESTIONS THROUGH DIGITAL.WWNORTON.COM/OURORIGINS4

EVOLUTION REVIEW

THE ORIGINS OF MODERN PEOPLE

Synopsis Since some of the earliest discoveries of hominin fossils, such as that of the Neandertal skull found in Germany in 1856, physical anthropologists have uncovered an amazing amount of information about our evolutionary past. Fossil discoveries, as well as the application of new technologies in genetic research, have helped clarify the relationship between anatomically modern humans and our evolutionary cousins, the Neandertals. These results have also helped determine the most likely scenario for the origin and subsequent global dispersal of our own species, *Homo sapiens,* from approximately 200,000 yBP to the present. The remarkable discoveries made and rigorous scientific study performed by paleoanthropologists continue to inform our understanding of what it means to be human.

Q1. Provide two examples of anatomical features that physical anthropologists consider to be "modern" when defining modern humans as a species (*H. sapiens*). Also, identify two ways in which these "modern" features contrast with the morphological characteristics present in earlier members of the genus *Homo.*

Q2. As discussed in chapter 5, modern human variation is highly influenced by environmental factors. Describe three cranial and postcranial features of Neandertal skeletons that are likely adaptations to the cold climates of Upper Pleistocene Europe.

Q3. Many early descriptions and modern popular depictions portray Neandertals as particularly primitive in comparison to modern humans. Summarize the aspects of Neandertal behavior and culture that strongly counter the assumption that they were simplistic, cognitively deficient evolutionary failures.

Q4. Contrast the Out-of-Africa and Multiregional Continuity models for explaining the origins of anatomically modern *H. sapiens.* Using both fossil and genetic evidence, outline how neither model by itself adequately explains modern human origins but how elements of both contribute to the Assimilation model.

Hint Consider the genetic evidence from both fossil specimens and living human populations.

Q5. More than 1.5 million years after *Homo erectus* became the first hominin species to migrate out of Africa, modern *H. sapiens* also spread from Africa to Europe and Asia and from there to Australia and the Americas. What kinds of environmental pressures contributed to the dispersal of modern *H. sapiens* across all regions of the globe? What do the migrations of modern humans into Australia (at least 40,000 yBP) and the Americas (at least 15,000 yBP) tell us about the range of human variation and adaptability in the past? How does this compare to the diversity we see in human populations today?

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