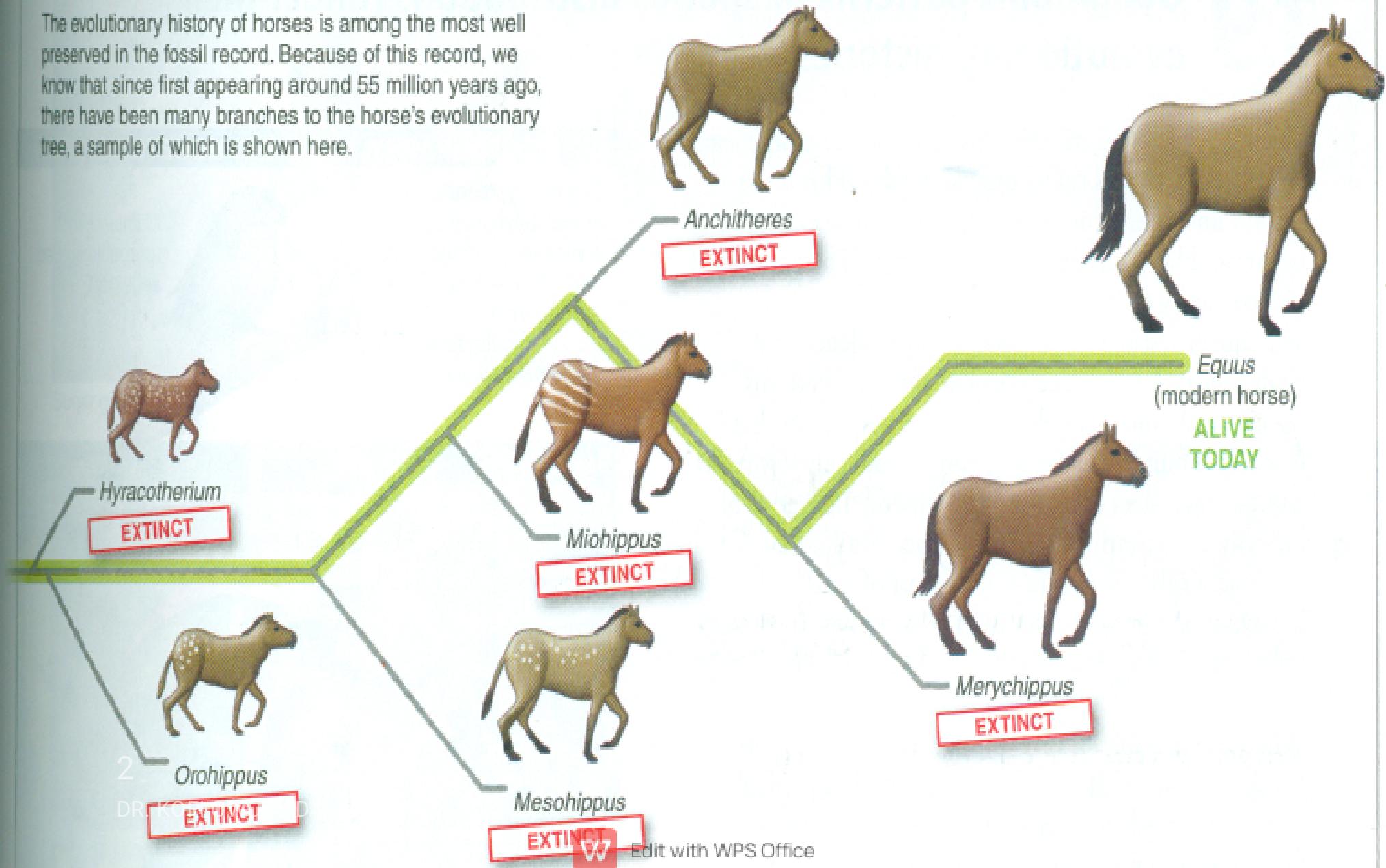


Evolution of horse and man

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POPULATION GENETICS AND
EVOLUTION
LECTURE VII

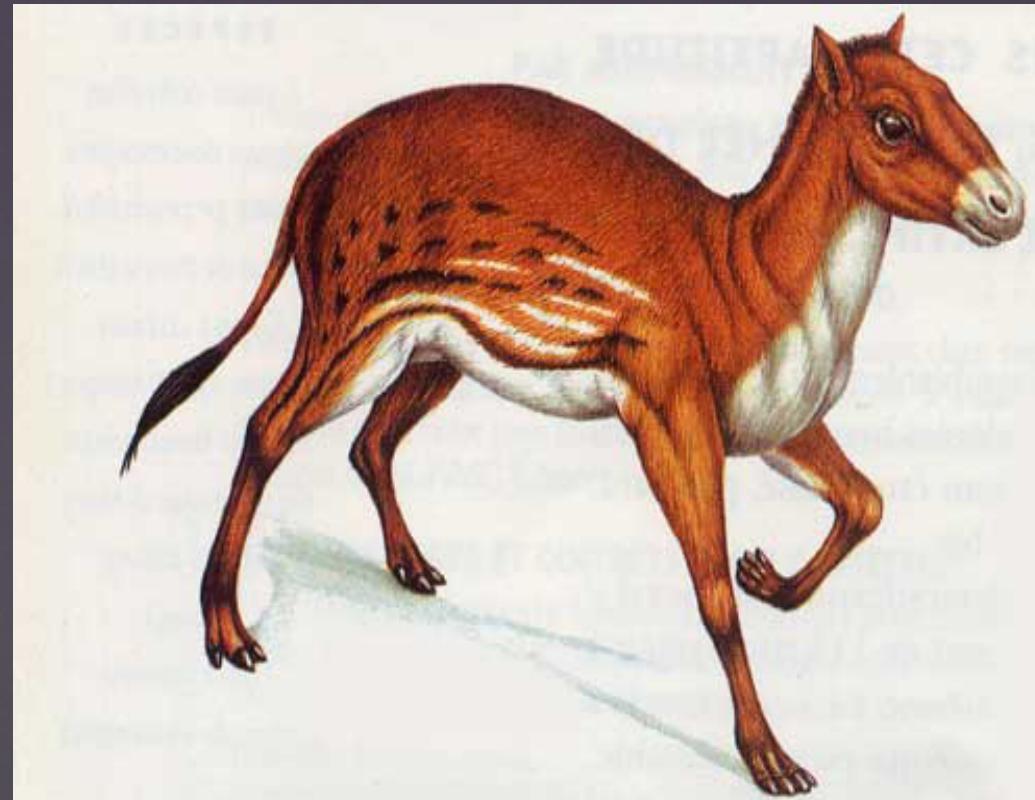
EVOLUTIONARY HISTORY OF HORSES

The evolutionary history of horses is among the most well preserved in the fossil record. Because of this record, we know that since first appearing around 55 million years ago, there have been many branches to the horse's evolutionary tree, a sample of which is shown here.



Common Theory

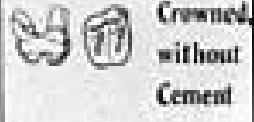
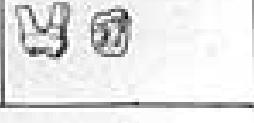
- Horses have evolved from a small dog like creature with many toes to a single hooved animal
- They grew from the size of a dog to the modern horse on average 160cm



Hyracotherium or Eohippus

- The most famous evolutionary diagram showing the gradual growth and changes of the horse

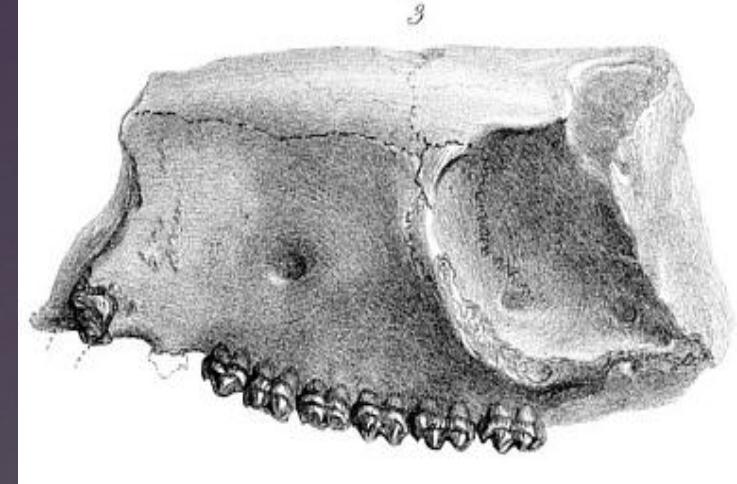
THE EVOLUTION OF THE HORSE.

		Formations in Western United States and Characteristic Type of Horse in Each	Fore Foot	Hind Foot	Teeth
Quaternary or Age of Man	Recent	SHERIDAN BLANCO		One Toe Splints of 2nd and 4th digits	 Long-Crowned, Cement-covered
	Pliocene				
	Miocene	LOUP FORK		Three Toes Side toes not touching the ground	 Three Toes Side toes not touching the ground
		JOHN DAY		Three Toes Side toes touching the ground; splint of 3rd digit	 Three Toes Side toes touching the ground
		WHITE RIVER		Four Toes	 Short-Crowned, without Cement
	Oligocene	UNITA			
		BRIDGER			
		WIND RIVER		Four Toes Splint of 1st digit	 Three Toes Splint of 3rd digit
		WASATCH			
		PUERCO AND TORREJON			
	Eocene	OWUSU-DAAKU			
Age of Reptiles	Cretaceous				
	Jurassic				
	Triassic				
	4				

Hypothetical Ancestors with Five Toes on Each Foot and Teeth like those of Monkeys etc.

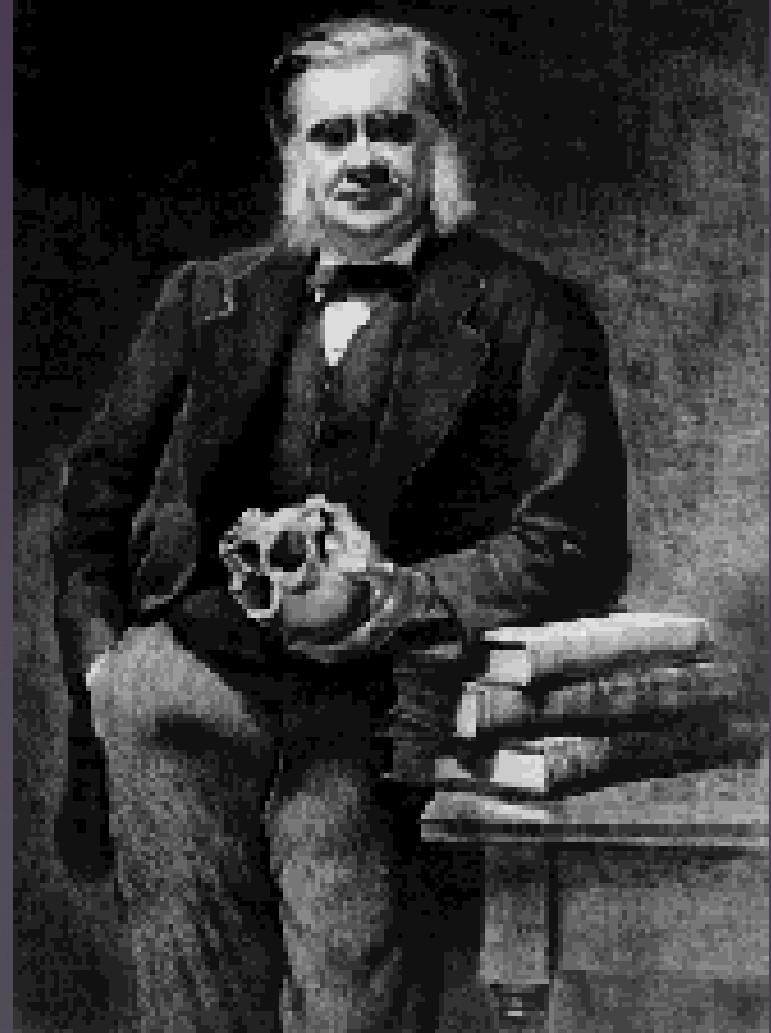


History of Horse

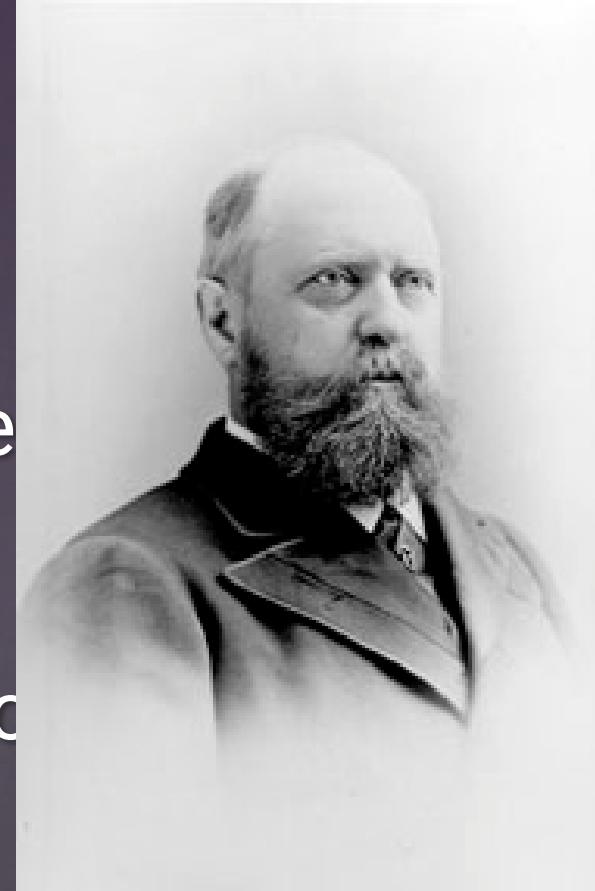


- First fossil found in 1841 in London
- Found by Richard Owen
- It was a small fox like animal skull he called *Hyracotherium*
- No apparent link between this primitive animal and the horse
- Kovalevsky then linked it to the modern horse

- Henry Huxley was a famous palaeontologist
- He was a big fan of *Darwin's Origin of Species* 1859
- He went to America to give a lecture in New York to the *Zoological Society* in 1880
- He met up with O.C. Marsh and they collaborated to form a genealogic diagram of the evolutionary line of the horse for his presentation
- This was then published in the *American Journal of Science* in 1879 - 80



- Marsh used the limited number of fossils he had, which was the most extensive at the time, to form this simple diagram which seemed to be the most correct sequence
- This is now the famous straight evolutionary line of *Hyracotherium* to *Equus* (*anagenesis*)
- This is the sequence that non-evolutionists use to discredit evolution
- In reality the graph is much more “bushy”, with complex branching, that waxes and wanes its way through history (*cladogenesis*)





- Dr. Niles Eldredge, a curator at the American Natural History Museum, commented on the exhibition there
- *"There have been an awful lot of stories, some more imaginative than others, about what the nature of that history [of life] really is. The most famous example, still on exhibit downstairs, is the exhibit on horse evolution prepared perhaps 50 years ago. That has been presented as the literal truth in textbook after textbook. Now I think that is lamentable, particularly when the people who propose those kinds of stories may themselves be aware of the speculative nature of some of that stuff"*

- Other evolutionists have disagreed with the straight line illustration also, such as George Gaylord Simpson [1921-1970] who proposed the cladogenesis model
- The general idea of Huxley and Marsh in a sense is right because the modern horse came from the *Hyracotherium*,
- It is easier for the less scientific audience to understand as the real sequence is complicated and branched



EVOLUTION OF HORSE cont`d

- The evolutionary history of the horse gives a very clear picture of gradual progressive evolution.
- In the entire evolutionary history of animals, none is so beautifully arranged as the horse.
- The record of the evolutionary line of the horse is almost complete.

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Evolution Of Horse Cont`d

- The primary centre of the evolution of the horse was in North America, especially in the region of the Great Plains.
- The history of the horse family equidae began during the Eocene Epoch.
- The evolution of the horse provides a good example of Cope's law (the trend of evolution to lead to larger animals).
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Evolution Of Horse Cont`d

- The fossil lineage of the horse provides a remarkable demonstration of directional succession.
- Horses share a common ancestry with tapirs and rhinoceroses.
- Fossils of *Equus* are found in every continent except Australia and Antarctica.
- *Equus* is the only surviving genus in the once diverse family of horses.
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Evolution Of Horse Cont`d

□ The horse belongs to:

- (a) Phylum Chordata
- (b) Subphylum Vertebrata
- (c) Class Mammalia
- (d) Sub class Eutheria
- (e) Order Perissodactyla
- (f) Sub order Hippomorpha
- (g) Family Equidae
- (h) Genus Equus

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Evolutionary Trends

- (a) An increase in body size.
- (b) An increase in the size and complexity of teeth.
- (c) An increase in the size of the head.
- (d) Reduction in the number of toes on the front foot from four to one.
- (e) Change of foot posture from semiplantigrade to unguligrade.
- (f) Perfection of the hoof.¹⁴

The recorded fossil history of the horse is as follows:

1. *Eohippus*

- (a) It was of lower Eocene and four-toed form.
- (b) It had low crowned teeth.
- (c) It was a forest-dwelling animal that browsed on foliage.

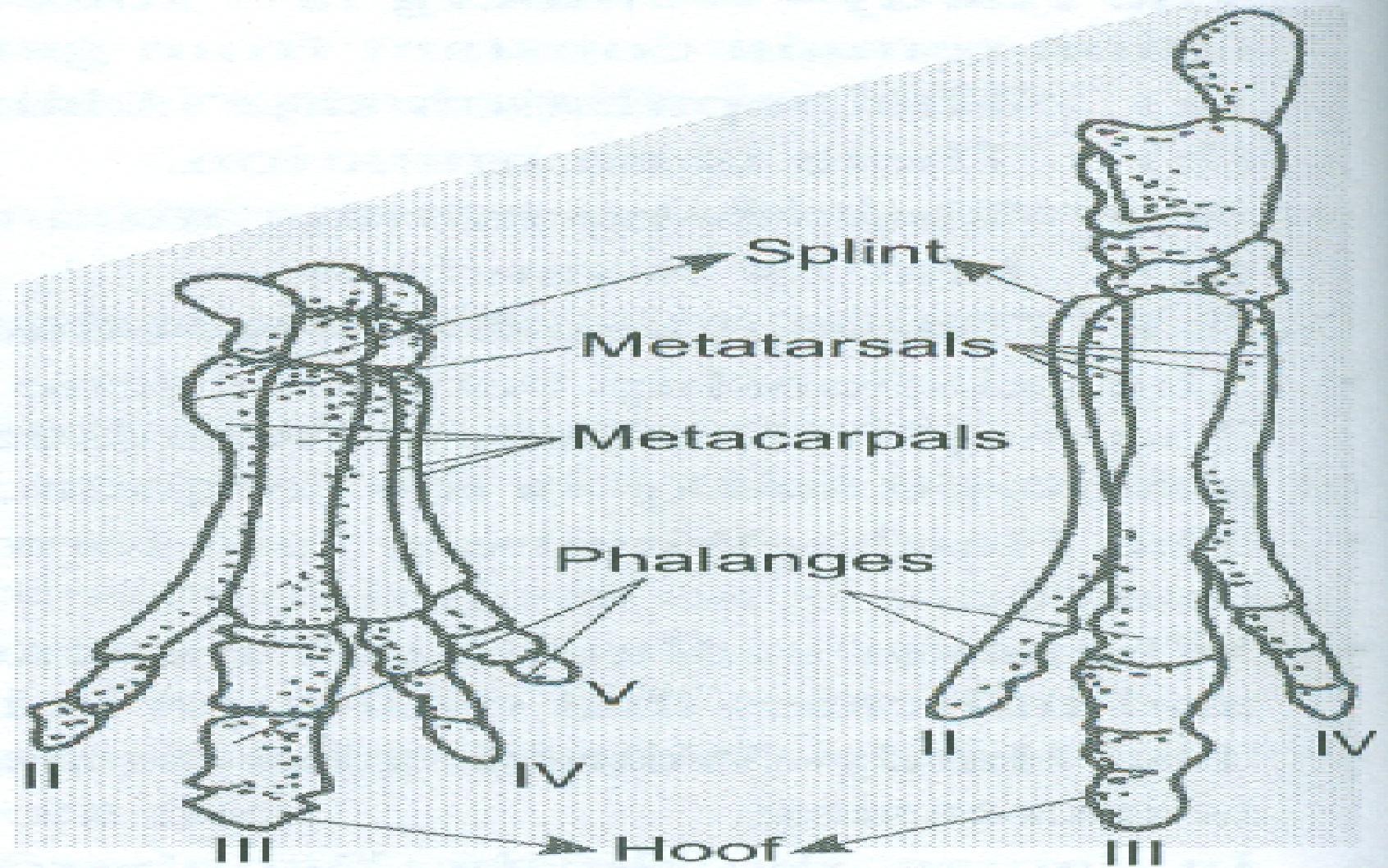


Fig. 4

Bones of forelimb and
hindlimb of *Eohippus*

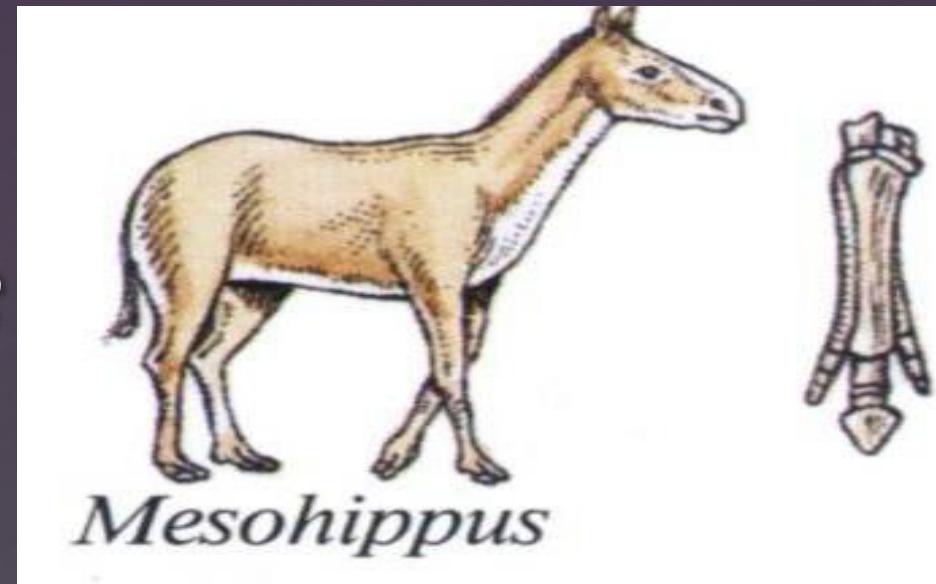
2. Orohippus

- (a) It was of middle Eocene form.
- (b) The forelimbs had four toes while the hind limbs had three toes.
- (c) The middle digits in both the limbs were dominant.
- (d) It was a browser.

3. Epihippus

- (a) It was of upper Eocene form.
- (b) The forelimbs had four digits and the hindlimbs had three digits.
- (c) It was a browser.
- (d) They became extinct by the end of Eocene and were replaced by *Mesohippus*.

4. *Mesohippus*



- (a) It was of sheep-sized Oligocene form.
- (b) It had only three toes on the forefoot.
- (c) The teeth were low crowned
- (d) It became extinct by the end of middle Oligocene epoch.
19

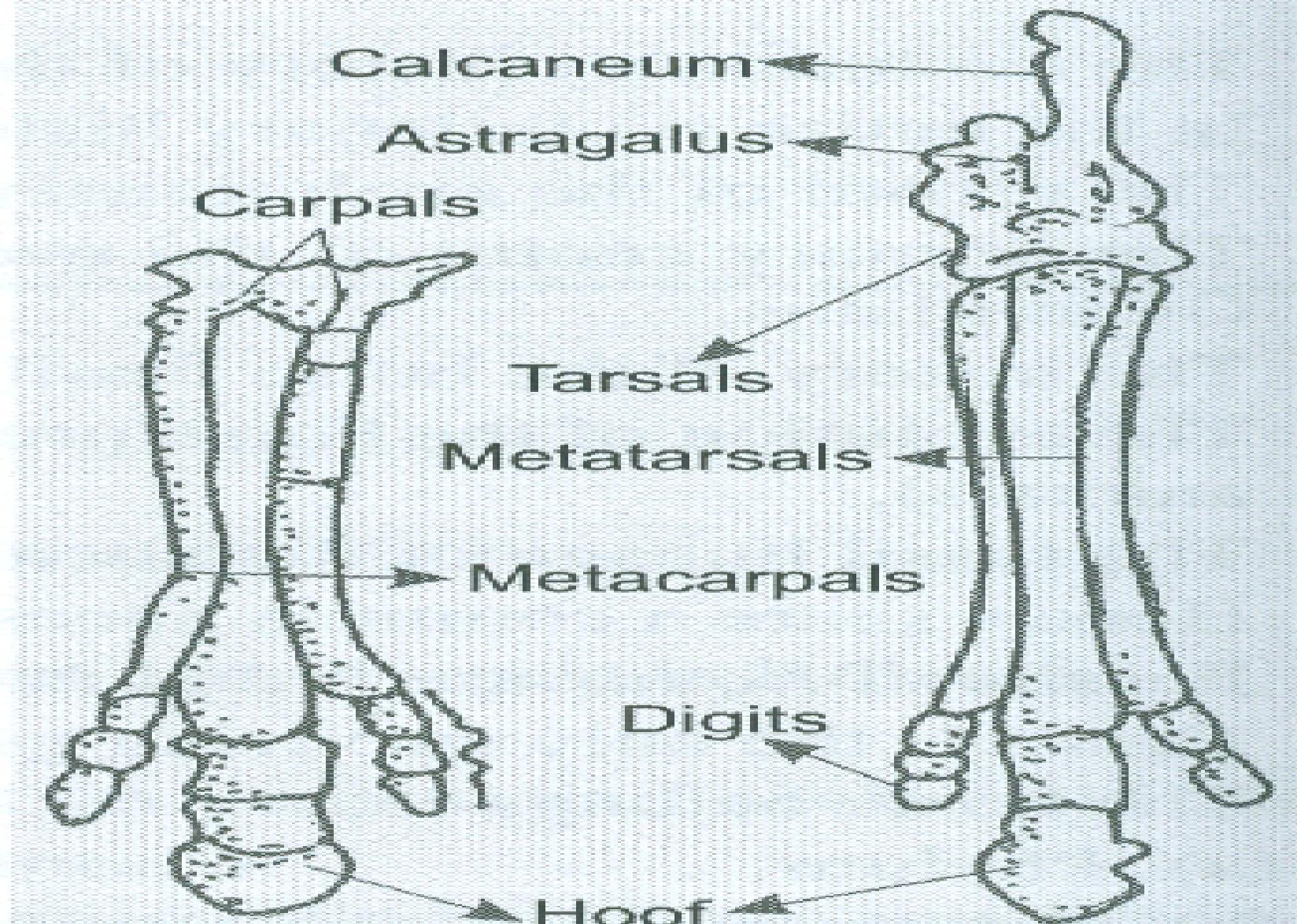


Fig. 5

Bones of forelimb and
hindlimb of *Mesohippus*

Miohippus

- It was of upper Oligocene form.
- The forelimbs and hindlimbs were three toes.
- Toes were broad and spreading.
- The teeth were low crowned and it was a browser.
- It was a forest-dweller.
- *Miohippus* is the ancestor of many equine forms.

Parahippus

- It was of lower Miocene form.
- It was in the direct line of equine evolution.
- The third digit in the forelimbs and hindlimbs was more prominent.
- Only the median digit was effective in locomotion.
- The side toes were slender.
- ²² The dentition was of a hyposodont type.

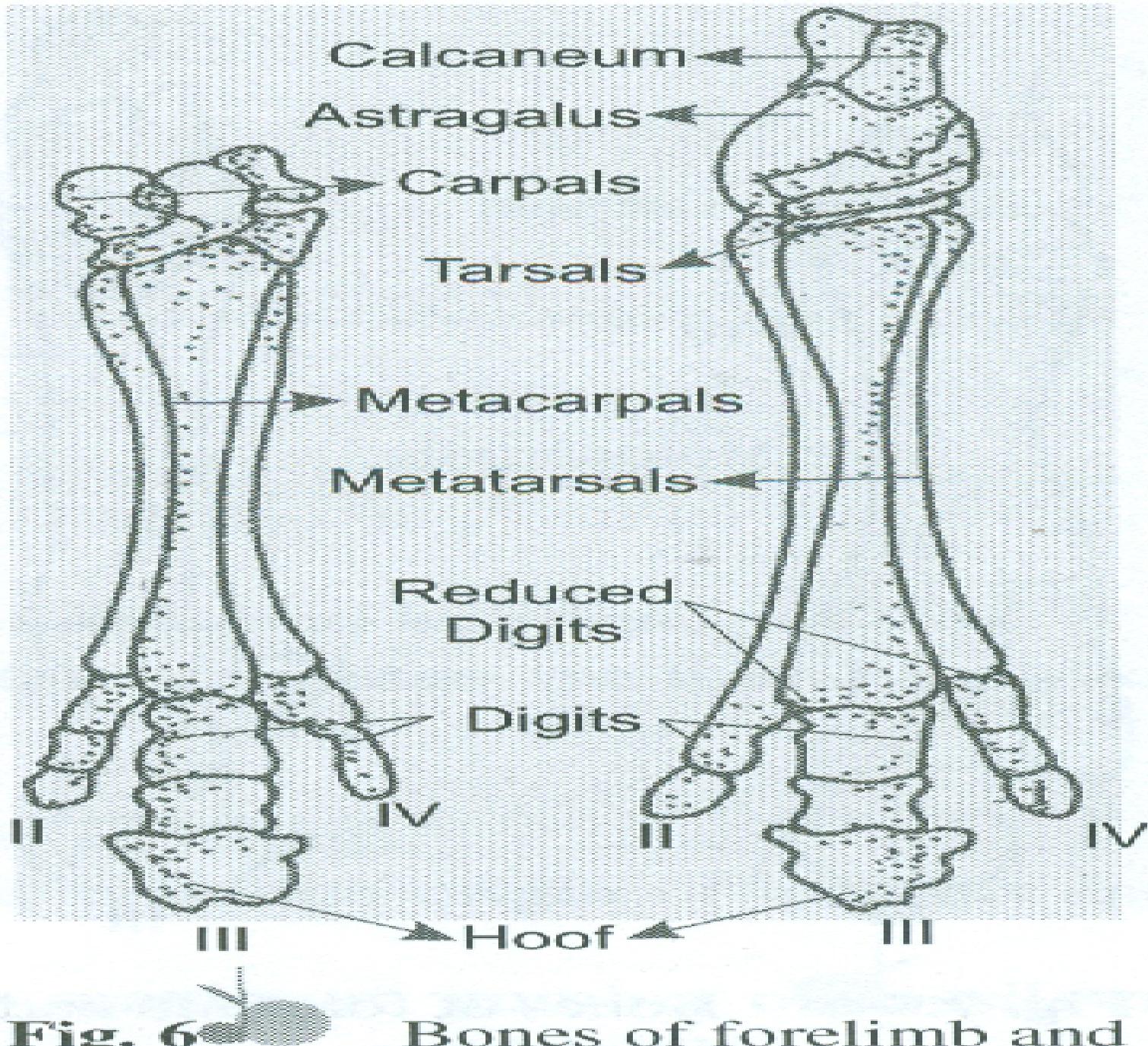


Fig. 6

Bones of forelimb and
hindlimb of *Parahippus*

Merychippus

- a) Merychippus represents a milestone in the evolution of horses
- b) It had a long face.
- c) Its long legs allowed it to escape from predators and migrate over long distances to feed.
- d) It was three-toed but the central one bore the most body weight.

Merychippus cont'd

- e) The teeth were highly crowned, coated in cement and had a more complex chewing surface.
- f) The ligaments of muscles were highly developed.
- g) The footpad was lacking
- h) It was the first of three-toed grazers

Pliohippus

- It was of late Miocene to Pliocene form.
- The side toes became vestigial, although some species are known to have had three toes.
- It was the first single-toed horse.
- It was well adapted for treeless plains.
- It is believed that *Pliohippus* have given rise to *Hippidion* and ²⁶*Onohippidon* genera and *Dinohippus*.



Plessippus

- It was of upper Pliocene form.
- It was one-toed.
- The teeth were like those of the modern horse.

Equus (Modern horse)

- a) It originated in the upper Pliocene epoch.
- b) Some side branches are seen which became extinct in the Pleistocene epoch.
- c) The height is about 60".
- d) There is only one toe in each foot

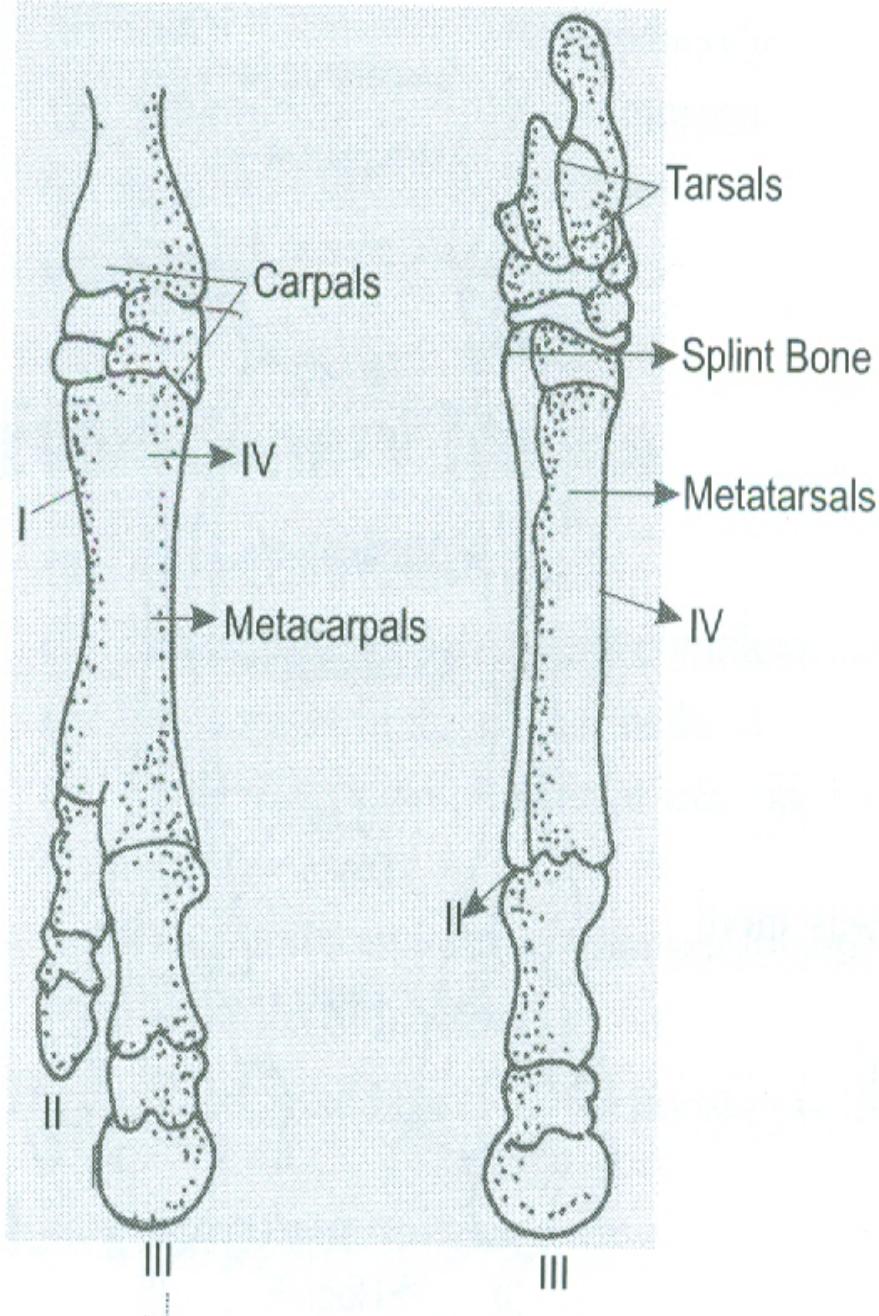


Fig. 7. Bones of forelimb and hindlimb of *Pliohippus*

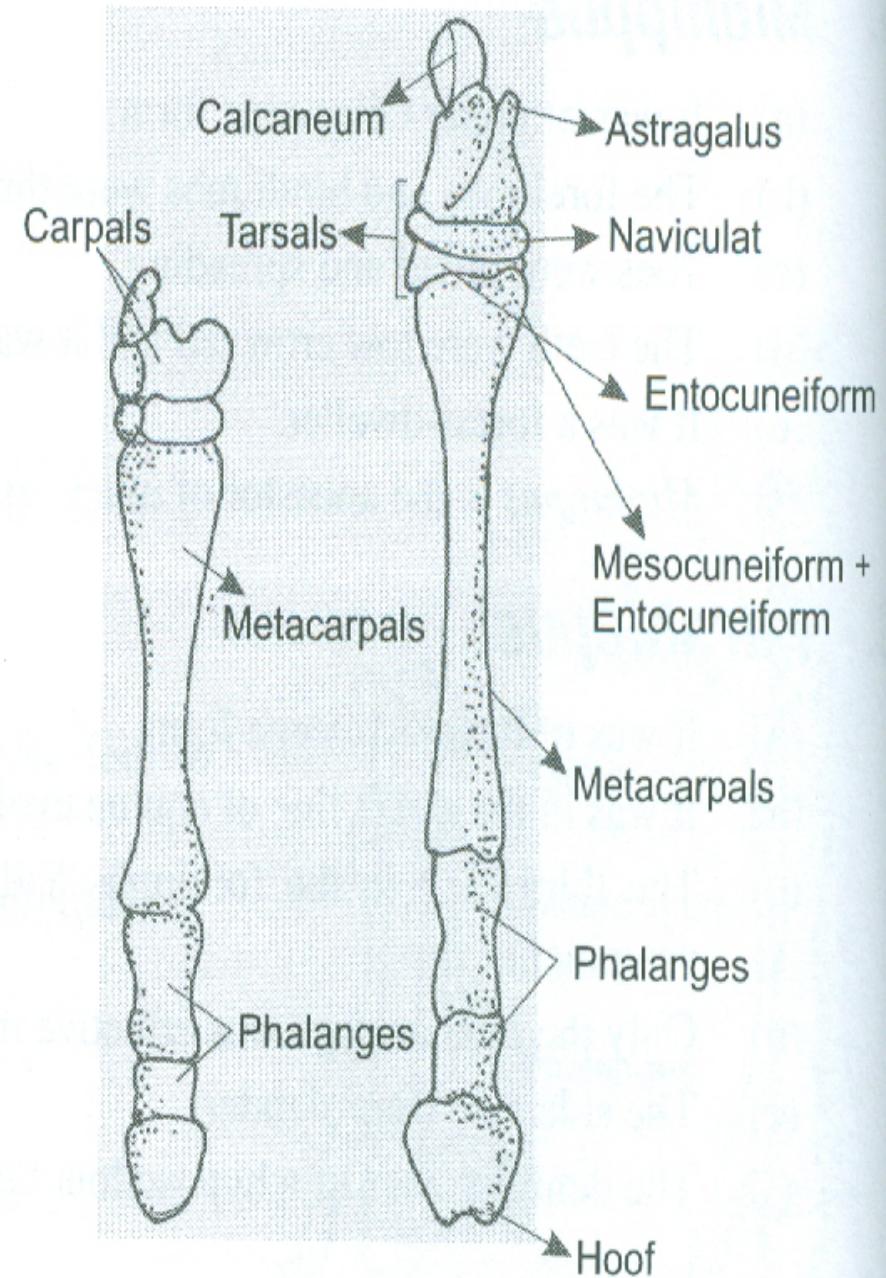


Fig. 8. Bones of forelimb and hindlimb *Equus*

- e) A well-developed hoof is present.
- f) The molars have a very long crown.
- g) It has a large brain with grooved cerebral hemispheres.



There is a huge variety in modern horses but most of this is due to selective breeding rather than evolution

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The evolution of the horse involves changes in height, toes and teeth as well as it becoming a grazer from a browser. Species of *Equus* lived from 5 million years ago until the present times. The horse was domesticated about 3,000 years ago and had profound impact on human history.

EVOLUTION OF MAN

- The fossil records of primates are fragmentary.
- All primates, including humans, must have had a common ancestry.
- According to Pough *et al.* (1996) 'Man descended from arboreal ancestors that lived in early tertiary forests about 65 million years ago'.

- Arboreal, shrew-like insectivores show the first indications of the evolutionary line of primates.
- Ancestral lemurs and lorises showed some remarkable features of primate evolution.
- Tarsius was more advanced and showed characteristics intermediate between lemurs and anthropoids.

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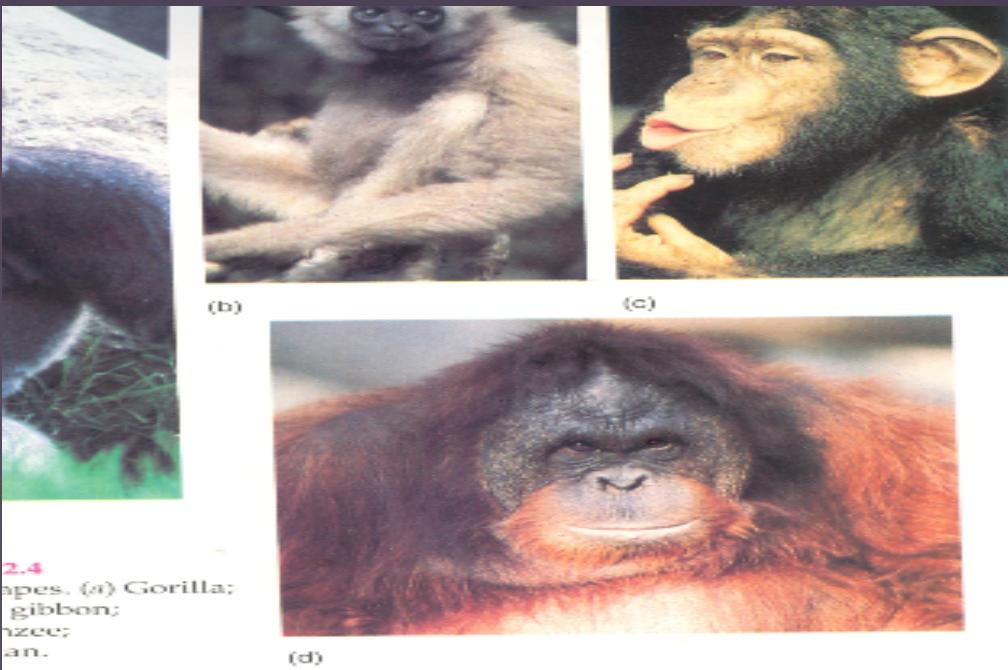


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- Humans belong to:
 - (a) Phylum Chordata
 - (b) Subphylum Vertebrata
 - (c) Class Mammalia
 - (d) Subclass Eutheria
 - (e) Order Primates
 - (f) Sub-order Anthropoidea
 - (g) Family Hominidae
 - (h) Genus *Homo*
 - (i) Specie *sapiens*

The anthropoid ancestors of humans:

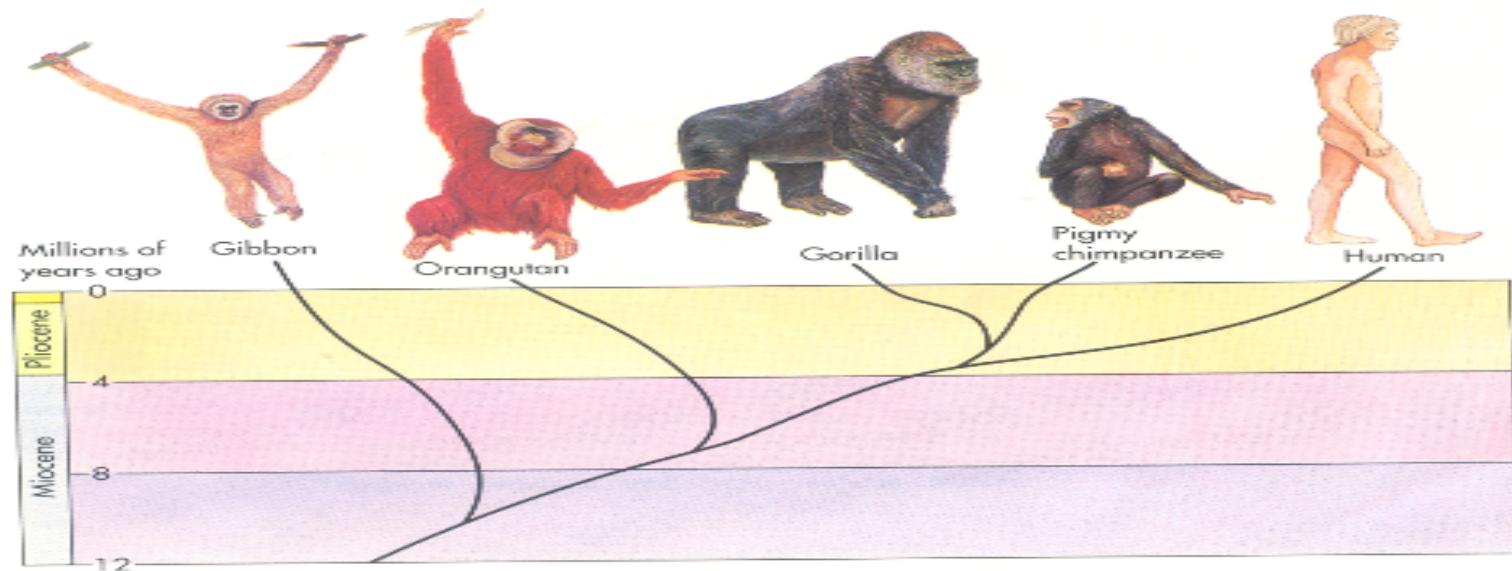
- The evolutionary line of the old world monkey led to the evolution of apes and humans.
- Four types of apes are found today, among which the gibbon and the orangutan are found in Asia while the gorilla and the chimpanzee are found in Africa.
- The gibbon is the smallest ape while the gorilla is the largest.



22.4
apes. (a) Gorilla;
gibbon;
chimpanzee;
an.

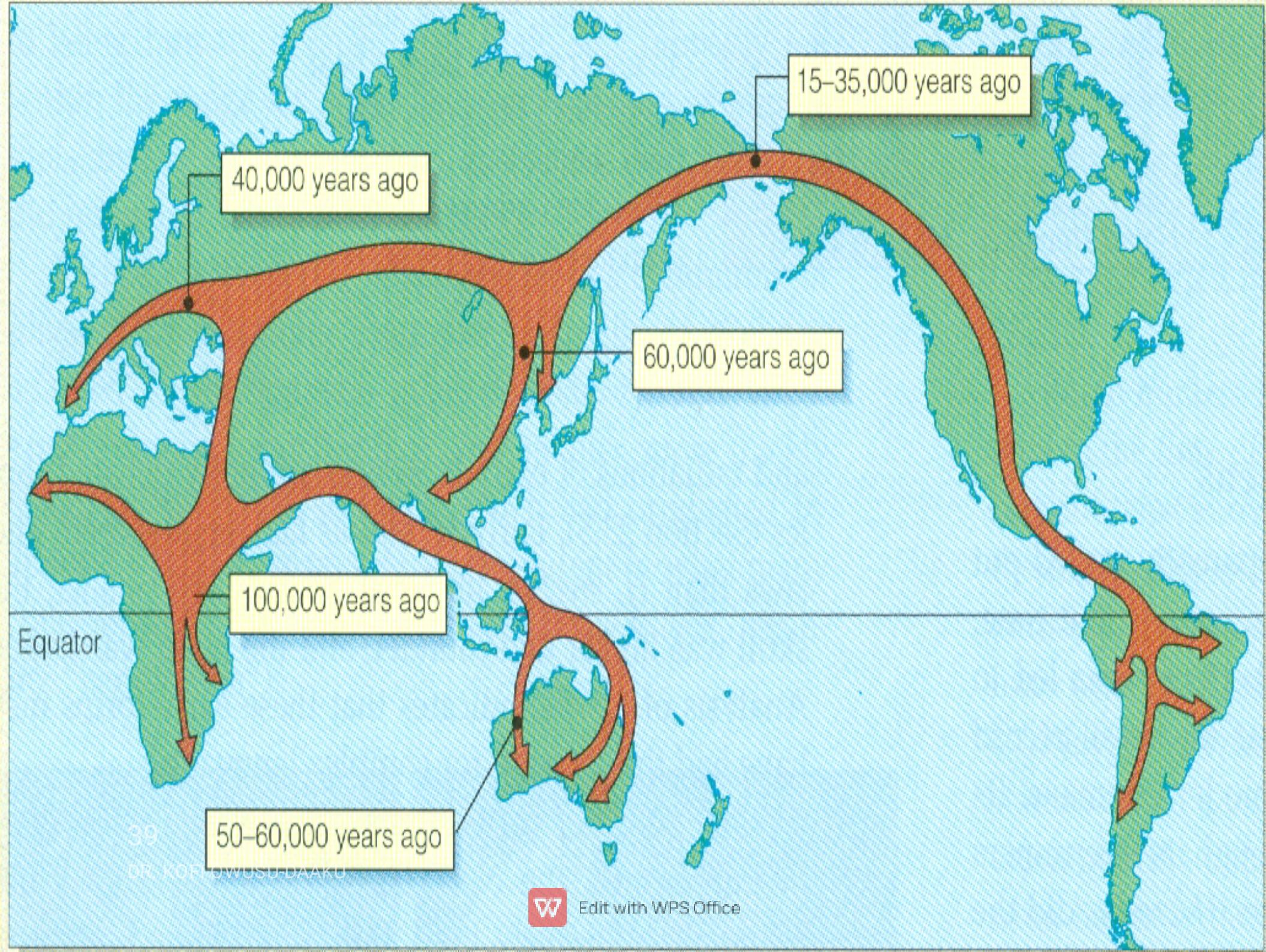
With the exception of the gibbon, which is small, all living apes are larger than monkeys. Apes exhibit the most adaptable behavior of any mammal except human beings. Once common, they are rare today. The living apes are confined to relatively small areas in Africa and Asia (figure 22.4). Apes never inhabited the North American continent. Apes and humans are collectively referred to as *hominoids*.

Studies of ape DNA have told us a great deal about how they evolved. The most primitive apes, the line leading to gibbons, diverged from other apes about 10 million years ago, while orangutans split off about eight million years ago. The key split between the *hominids* (lineage of humans) and the line leading to gorillas and chimpanzees occurred only about five million years ago (figure 22.5). Because the split was so recent, the genes of humans and chimpanzees have not had time to evolve many differences. Human and chimpanzee DNAs differ in less than 3% of their nucleotide sequences. Your hemoglobin molecule and that of a chimpanzee differ in only a single amino acid!



22.5
evolution of living
apes and

- The chimpanzee is considered to be the closest relative of modern human beings.
- Chromosome numbers and banding pattern studies have revealed the common origin of humans and chimpanzees.
- Central Africa is regarded as the centre of evolution of humans, as maximum number of fossils of primitive humans has been excavated from that region.



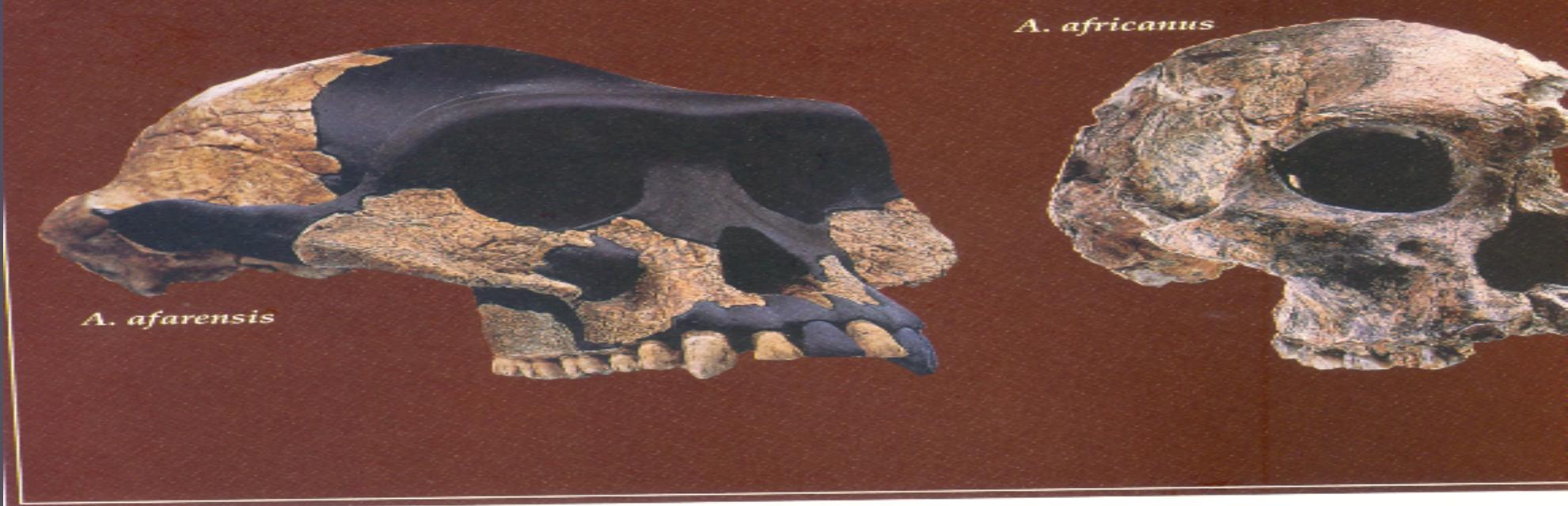
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FIGURE 22.8 NEARLY HUMAN . . .



THE FIRST HUMANS

objectives

①

Compare and contrast
Homo habilis and
Homo erectus.

②

List the distinctive
characteristics of Java
man and Peking man.

③

Explain the success of
Homo erectus.

You are a member of the third and only surviving species of humans, *Homo sapiens*. Our two ancestors, *Homo habilis* and *Homo erectus* have long since gone extinct. The first humans evolved from australopithecine ancestors about two million years ago, only to be replaced later by a second, "improved" version of human that moved out of Africa and spread across the earth (figure 22.9).

African Origin: *Homo habilis*
In the early 1960s more hominid fossils were discovered close to the site where *A. boisei* had been unearthed. Scattered among these bones were stone tools, though the fossils were badly crushed. A painstaking reconstruction of the pieces suggested a skull with a braincase volume of about 640 cc, much larger than the australopithecine range of 400–500 cc.

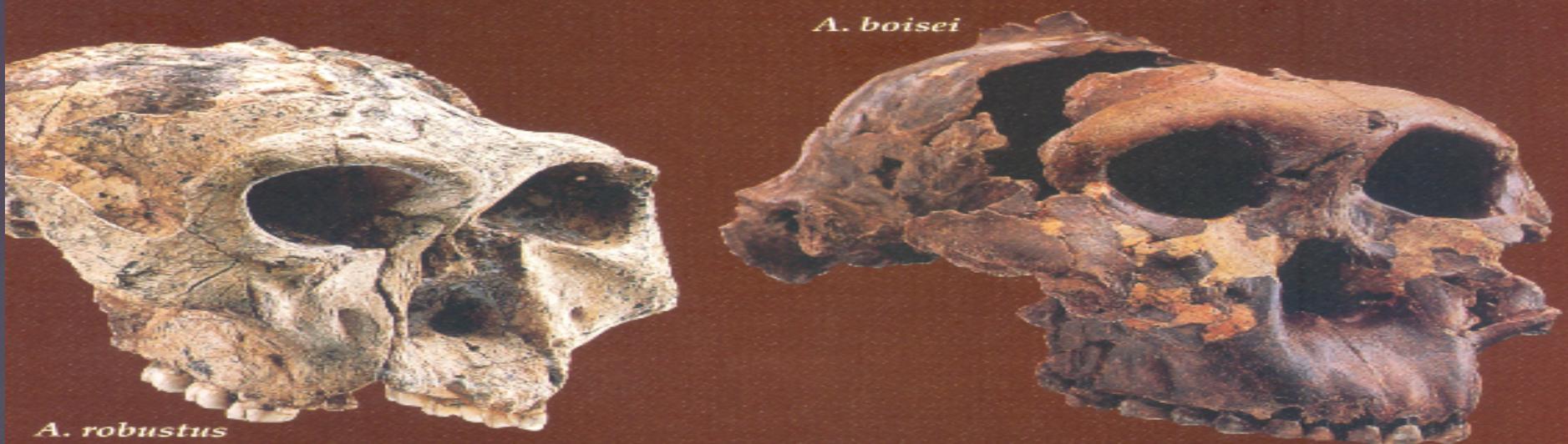


FIGURE 22.9
The path of human evolution was many early branches. *Australopithecus robustus* and *A. boisei* seem to represent evolutionary dead ends, with living descendants. Whether *A. africanus* was ancestral to *Australopithecus robustus*, as in (a), or to *Homo* as well, as in (b), is currently in dispute.

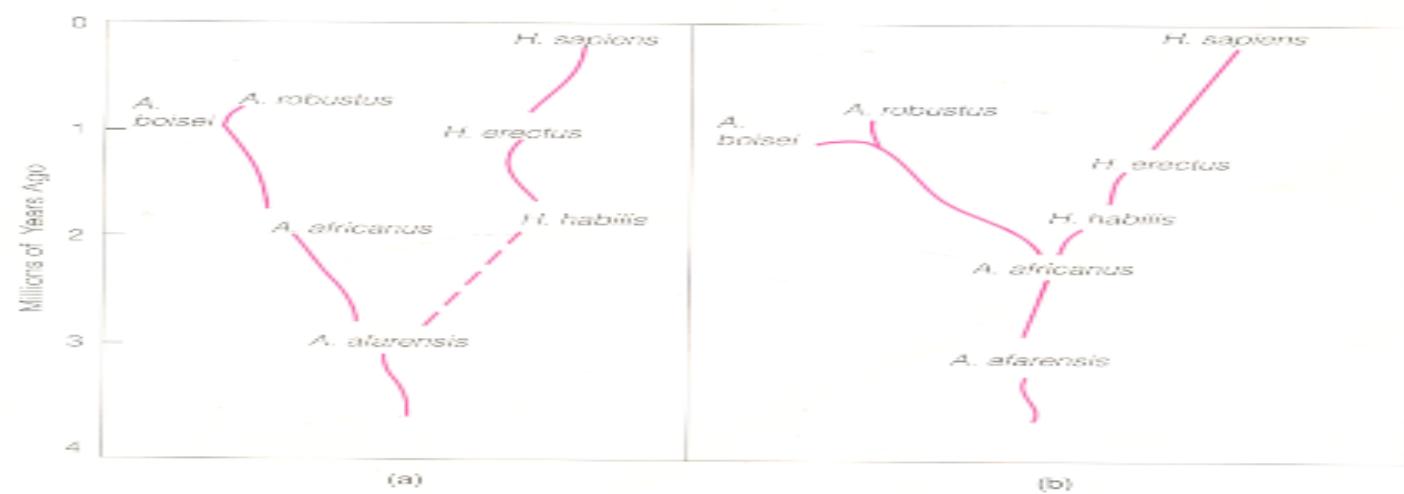
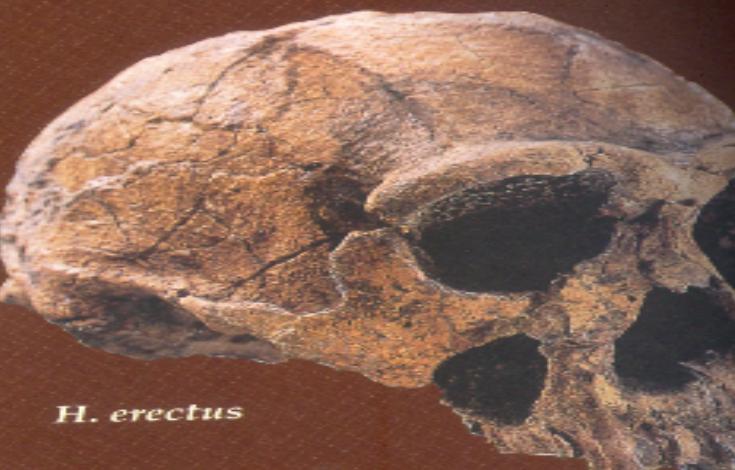


FIGURE 22.12 OUR OWN SPECIES . . .

H. habilis



H. erectus

OUR OWN SPECIES

b j e c t i v e s

①

Describe the evolutionary background of *Homo sapiens*.

②

Describe the evolutionary history of Neanderthal man.

③

Describe the evolutionary history of Cro-Magnon man.

We come to the end of our evolutionary journey with the appearance about 500,000 years ago of *Homo sapiens* ("wise man"), our own species. Actually, we are newcomers to the human family, not having been around nearly as long as *H. erectus* was. Still, we have changed quite a bit since those first days.

Out of Africa Again: *Homo sapiens*

The origin of human races is a much-debated point among the scientists who study human evolution. Many have argued that the different races evolved from *H. erectus* independently, each adapted to

a different place—Orientals in Asia, Caucasians in Europe, aborigines in Australia, and so on. Others have felt it unlikely that the same species would evolve more than once, and argue that the races of humans appeared after our species evolved from *H. erectus*. Recently, scientists studying DNA within human mitochondria have added fuel to the fire of this controversy. Examining mitochondrial DNA from living humans all over the world, they argue that all the races of humans indeed originated from one *H. sapiens* ancestor. Where? You guessed it. Africa.

The reason these scientists looked at mitochondrial DNA to study evolution is that the DNA within mitochondria is transmitted only by females. (Human

Evolutionary Trends

- Shifting from arboreal life to ground life
- Towards erect postures and freeing of hand
- Bipedal locomotion
- Increase in cranial capacity and complexity of brain
- Reduction in the size of canines and incisors
- Development of the chin

Evolutionary Trends

- Loss of jaw power
- Development of intelligence
- Forward shifting of the foramen magnum
- Orthognathous skull with high forehead without projecting eyebrow ridges
- Lack of simian gap and simian shelf

Early Evolution of Primates

- Evolution of human apes began in the Oligocene epoch and a common stock has been recognised, called *Propliopithecus*.
- In the Miocene epoch, a group of ape humans called *Dryopithecus* had evolved.

- Humans, gorillas and other apes originated diverging from *Dryopithecus*.
- *Dryopithecus* had broadened jaws, semi-erect gait, large canines and five-cusped molars.

Australopithecus

- Australopithecus was the immediate forerunner of the genus *Homo*.
- Its fossil was discovered by Dart (1924), who named it the 'southern ape'.
- It had a mosaic form of humans and apes, and can therefore be considered a connecting link between humans and apes.

1. Human Characteristics of *Australopithecus*

- Erect posture and bipedal locomotion.
- Dental arch with smoothly rounded parabola.
- Vertebral column with a distinct lumber curve.

- The simian gap was absent and canine teeth were not projecting over the head.
- Foramen magnum forward under the base of the skull.
- They used weapons made of bones.

2. Ape Characteristics of *Austra/opitheDUS*

- The teeth were larger than modern humans.
- The face was prognathous.
- Eyebrow ridges projected over the eyes.
- Cranial capacity was 450 to 600 cc.

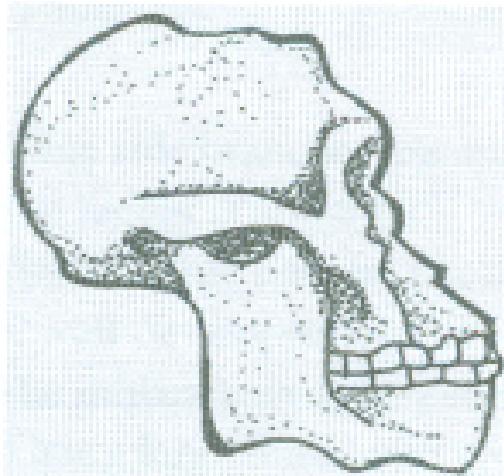
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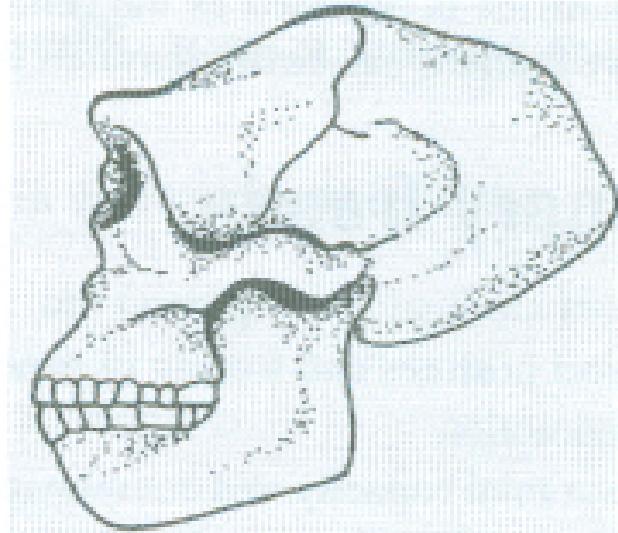
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□ There were several types of *Australopithecus*, like the gracile type (*A. africanus*), the robust type (*A. robust*) and the lucy (*A. afferensis*). The gracile type had a lightly body structure indicating an omnivorous form, but the robust type had strong cheek teeth, indicating an herbivorous diet.



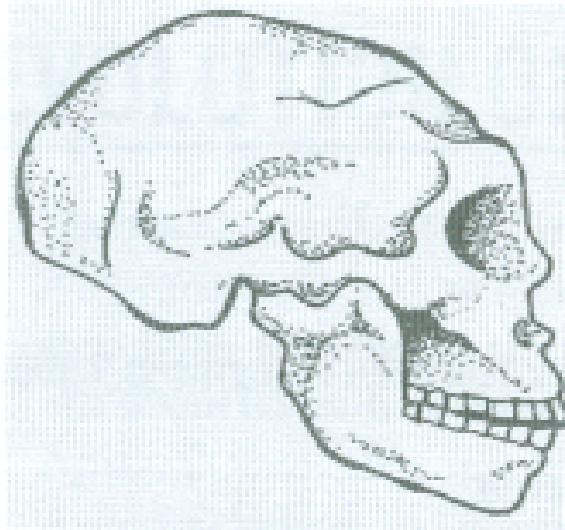
Australopithecus

Fig. 9 Skull of *Australopithecus*



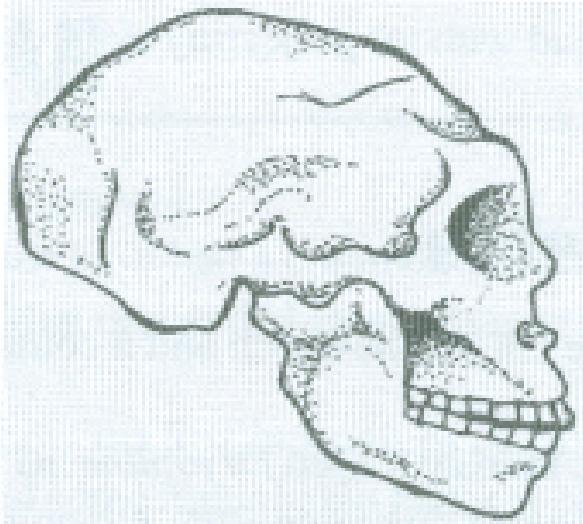
Pithecanthropus

Fig. 10 Skull of *Pithecanthropus*



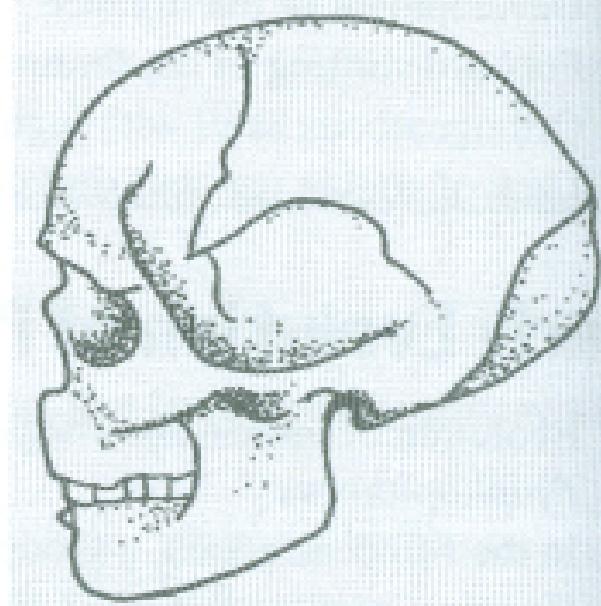
Neanderthal

Fig. 11 Skull of *Neanderthal*



Cro-Magnon

Fig. 12 Edit *Skull of Cro-Magnon*



Homo Sapiens

Fig. 13 Skull of *Homo sapiens*

III. Origin of Genus *Homo* *(Homo Erectus)*

- In the middle of Pleistocene epoch, the Java human and the Peking human originated. As both shared common basic features, they were included in the genus *Homo erectus*.

- They had the following characteristics:
 - (a) Habitually erect and bipedal
 - (b) Skull flat with little or no forehead
 - (c) Large prognathous jaws
 - (d) Broad nasal aperture
 - (e) Larger teeth and eyebrow ridges

- (t) No simian shelf
- (g) No chin
- (h) Cranial capacity 725 cc to 90 cc
(Java man) and 915 cc to 1225 cc
(Peking man)
- (i) Used fires for protection and cooking

- (j) *Homo erectus* represents a level of organisation that permits its possessors to spread into new niches
- (k) *Homo erectus* was not only confined to Asia but also spread through Africa as *Homo habilis*

III. Origin of *Homo Sapiens*

- The *Homo erectus* gradually evolved into *Homo sapiens*. In this transitional event, two types of humans were found in later deposits of the Pleistocene epoch.
- Of these, one was identified as the primitive human called the *Neanderthal man*, who has been labelled as *Homo sapiens neanderthalensis* and the other, the modern human being called *Homo sapiens sapiens*.

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Homo Sapiens Neanderthalensis

- ❑ Its fossil was discovered by C Fuhlrott (1856) from the Neandertal river valley (Germany).
- ❑ They were abundant in Europe.
- ❑ Their forehead was low and slanting.
- ❑ They had heavy eyebrow ridges.
- ❑ They had a long prognathous and narrow face.
- ❑ Cranial capacity was about 1200 cc to 1600 cc.

- They lived in caves.
- They buried dead bodies. The burial of the dead reveals the emergence of religious beliefs in human records.
- They were capable of big game hunting.
- They used tools.
- Neanderthal humans were succeeded by *Homo sapiens* of modern times; the first of these were Cro Magnon humans.

Homo Sapiens Fossilis (Cro-Magnon man)

- They were taller than Neanderthal man.
- They had teeth and jaws like modern humans.
- Their cranial capacity was 1600 cc.
- They had an orthognathous skull.
- The appendicular skeleton is adapted for an upright posture and gait.
- The foramen magnum faces directly downwards.



H. neanderthalensis
(Neanderthal)



H. sapiens
(Cro-Magnon)

carry many mitochondria within them that become part of a new baby, while sperm contribute no mitochondria to the new baby. Sperm carry their mitochondria wrapped around their tails, and so do not inject them into the ovum during fertilization.) It is thus possible to trace particular versions of a mitochondrial gene back through a family tree, from mother to grandmother to great-grandmother.

Human races evolved only recently in the evolutionary scale, and not enough time has yet elapsed for a large number of variations to accumulate, so the exact human tree cannot be reliably traced using this approach. However, some differences are evident, and it turns out that the greatest number of different mitochondrial DNA sequences occur among modern Africans. Because DNA accumulates mutations over time, the oldest DNA should show the largest number of mutations. This result argues that humans have been living in Africa longer than on any other continent. While there is no firm consensus among researchers yet, this line of

investigation appears to suggest that our species evolved in Africa, and that the races of living humans evolved after that, not independently from separate species of *H. erectus*. If this is correct, our species was born in Africa, and from there spread to all parts of the world, retracing the path taken by *H. erectus* half a million years earlier (figure 22.13).

Neanderthal Man

H. sapiens first appeared in Europe as *H. erectus* was becoming rarer, about 130,000 years ago. The first fossils of *H. sapiens* were found in 1856 in the Neander Valley of Germany. Thus these early European humans were called Neanderthals (*thal* means "valley" in old German). Compared with ourselves, the European Neanderthals were powerfully built, short, and stocky. Their skulls were massive, with protruding faces and heavy bony ridges over the brows. Their brains were even larger than those of modern humans.

- They used to domesticate dogs and hunt in groups.
- From the Cro-Magnon man, due to a great cultural evolution, the modern human (*Homo sapien sapiens*) has resulted. Modern human beings are still acquiring more complex structures and their evolution is still a work in progress.

Critical Thinking: You Decide

- In 1992 the frozen body of a stone age man was discovered in the Australian Alps. Although this “Iceman” died about 5,300 years ago, his body is amazingly intact and researchers have begun to analyse DNA extracts from bits of his tissue. Can this studies tell us something about early human evolution? Explain your reasoning.

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