Mammals

- Amniotes are named for the major derived character of the clade, the amniotic egg
  - Which contains specialized membranes that protect the embryo
- Mammals are amniotes that have hair and produce milk
- Mammals, class Mammalia
  - Are represented by more than 5,000 species

A phylogeny of amniotes

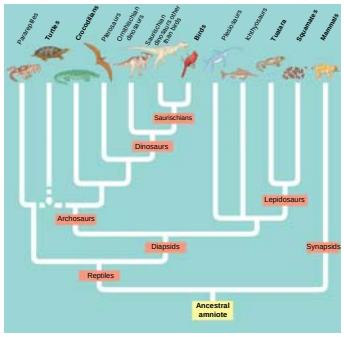


Figure 34.23

- The extraembryonic membranes
  - Have various functions

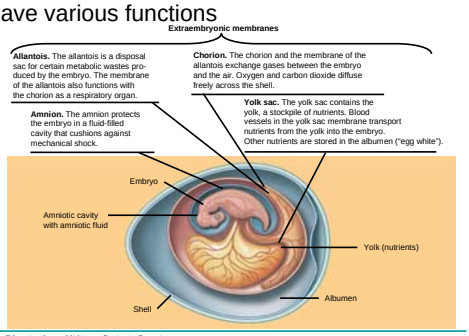


Figure 34.24

Reptiles

- Have scales that create a waterproof barrier
- Lay shelled eggs on land

Figure 34.25

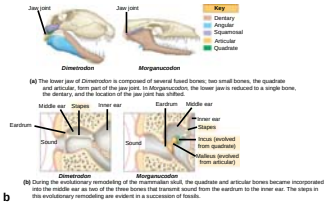
Derived Characters of Mammals

- Mammary glands, which produce milk
  - Are a distinctively mammalian character
- Hair is another mammalian characteristic
- Mammals generally have a larger brain than other vertebrates of equivalent size

Early Evolution of Mammals

- Mammals evolved from synapsids
  - In the late Triassic period

- The jaw was remodeled during the evolution of mammals from nonmammalian synapsids
  - And two of the bones that formerly made of the jaw joint were incorporated into the mammalian middle ear



(a) The lower jaw of *Dimetrodon* is composed of several fused bones; two small bones, the quadrate and articular, form part of the jaw joint. In *Morganucodon*, the lower jaw is reduced to a single bone, the dentary, and the location of the jaw joint has shifted.

(b) During the evolutionary remodeling of the mammalian skull, the quadrate and articular bones became incorporated into the middle ear as two of the three bones that transmit sound from the eardrum to the inner ear. The steps in this evolutionary remodeling are evident in a succession of fossils.

Figure 34.32a, b

- Living lineages of mammals originated in the Jurassic
  - But did not undergo a significant adaptive radiation until after the Cretaceous

Monotremes

- Monotremes
  - Are a small group of egg-laying mammals consisting of echidnas and the platypus

Figure 34.33

Marsupials

- Marsupials
  - Include opossums, kangaroos, and koalas

- A marsupial is born very early in its development
  - And completes its embryonic development while nursing within a maternal pouch called a marsupium

(a) A young brushtail possum. The young of marsupials are born very early in their development. They finish their growth while nursing from a nipple (in their mother's pouch in most species).

Figure 34.34a

- In some species of marsupials, such as the bandicoot
  - The marsupium opens to the rear of the mother's body as opposed to the front, as in other marsupials

(b) Long-nosed bandicoot. Most bandicoots are diggers and burrowers that eat mainly insects but also some small vertebrates and plant material. Their rear-opening pouch helps protect the young from dirt as the mother digs. Other marsupials, such as kangaroos, have a pouch that opens to the front.

Figure 34.34b

- In Australia, convergent evolution
  - Has resulted in a diversity of marsupials that resemble eutherians in other parts of the world

Figure 34.35

Eutherians (Placental Mammals)

- Compared to marsupials
  - Eutherians have a longer period of pregnancy
- Young eutherians
  - Complete their embryonic development within a uterus, joined to the mother by the placenta

- Phylogenetic relationships of mammals

This clade of eutherians evolved in Africa when the continent was isolated from other landmasses. It includes Earth's largest living land animal (the African elephant), as well as species that weigh less than 10 g.

All members of this clade, which underwent an adaptive radiation in South America, belong to the order Xenarthra. One species, the nine-banded armadillo, is found in the southern United States.

This is the largest eutherian clade. It includes the rodents, which make up the largest mammalian order by far, with about 1,770 species. Humans belong to the order Primates.

This diverse clade includes terrestrial and marine mammals as well as bats, the only flying mammals. A growing body of evidence, including Eocene fossils of whales with feet, supports putting whales in the same order (Cetartiodactyla) as pigs, cows, and hippos.

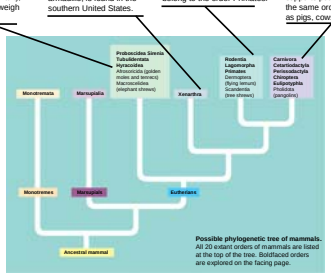


Figure 34.36

- The major eutherian orders

Figure 34.36

Primates

- The mammalian order Primates include
  - Lemurs, tarsiers, monkeys, and apes
- Humans are members of the ape group

Derived Characters of Primates

- Most primates
  - Have hands and feet adapted for grasping
- Primates also have
  - A large brain and short jaws
  - Forward-looking eyes close together on the face, providing depth perception
  - Well-developed parental care and complex social behavior
  - A fully opposable thumb

Living Primates

- There are three main groups of living primates
  - The lemurs of Madagascar and the lorises and pottos of tropical Africa and southern Asia

Figure 34.37

Slender loris

(*Loris tardigradus*)

pottos

- The tarsiers of Southeast Asia

- The anthropoids, which include monkeys and hominids worldwide

- The oldest known anthropoid fossils, about 45 million years old
  - Indicate that tarsiers are more closely related to anthropoids

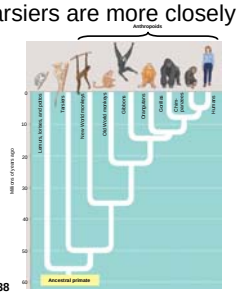


Figure 34.38

- The fossil record indicates that monkeys
  - First appeared in the New World (South America) during the Oligocene
- The first monkeys
  - Evolved in the Old World (Africa and Asia)

- New World and Old World monkeys
  - Underwent separate adaptive radiations during their many millions of years of separation

(a) New World monkeys, such as spider monkeys (shown here), squirrel monkeys, and capuchins, have a prehensile tail and nostrils that open to the sides.

(b) Old World monkeys lack a prehensile tail, and their nostrils open downward. This group includes macaques (shown here), mandrills, baboons, and rhesus monkeys.

Figure 34.39a, b

- The other group of anthropoids, the hominoids
  - Consists of primates informally called apes

(a) Gibbons, such as this Muller's gibbon, are found only in southeastern Asia. Their very long arms and fingers are adaptations for brachiation.

(b) Orangutans are shy, solitary apes that live in the rain forests of Sumatra and Borneo. They spend most of their time in trees; note the foot adapted for grasping and the opposable thumb.

(c) Gorillas are the largest apes: some males are almost 2 m tall and weigh about 200 kg. Found only in Africa, these herbivores usually live in groups of up to about 20 individuals.

(d) Chimpanzees live in tropical Africa. They feed and sleep in trees but also spend a great deal of time on the ground. Chimpanzees are intelligent, communicative, and social.

(e) Bonobos are closely related to chimpanzees but are smaller. They survive today only in the African nation of Congo.

Figure 34.40a–e

- Hominoids
  - Diverged from Old World monkeys about 20–25 million years ago

- Humans are bipedal hominoids with a large brain
- *Homo sapiens* is about 160,000 years old
  - Which is very young considering that life has existed on Earth for at least 3.5 billion years

Derived Characters of Hominids

- A number of characters distinguish humans from other hominoids
  - Upright posture and bipedal locomotion
  - Larger brains
  - Language capabilities
  - Symbolic thought
  - The manufacture and use of complex tools
  - Shortened jaw

The Earliest Humans

- The study of human origins
  - Is known as paleoanthropology

- Paleoanthropologists have discovered fossils of approximately 20 species of extinct hominoids
  - That are more closely related to humans than to chimpanzees

- These species are known as hominids

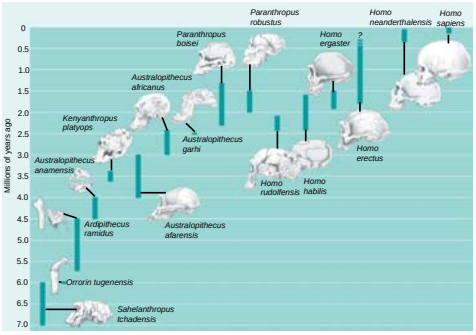


Figure 34.41

- Hominids originated in Africa
  - Approximately 6–7 million years ago
- Early hominids
  - Had a small brain, but probably walked upright, exhibiting mosaic evolution

- Two common misconceptions of early hominids include
  - Thinking of them as chimpanzees
  - Imagining human evolution as a ladder leading directly to *Homo sapiens*

Australopiths

- Australopiths are a paraphyletic assemblage of hominids
  - That lived between 4 and 2 million years ago

- Some species walked fully erect
  - And had human-like hands and teeth

(a) Lucy, a 3.24-million-year-old skeleton, represents the hominid species *Australopithecus afarensis*.

(b) The Laetoli footprints, more than 3.5 million years old, confirm that upright posture evolved quite early in hominid history.

(c) An artist's reconstruction of what *A. afarensis* may have looked like.

Figure 34.42a–c

Bipedalism

- Hominids began to walk long distances on two legs
  - About 1.9 million years ago

Tool Use

- The oldest evidence of tool use—cut marks on animal bones
  - Is 2.5 million years old

Early *Homo*

- The earliest fossils that paleoanthropologists place in our genus *Homo*
  - Are those of the species *Homo habilis*, ranging in age from about 2.4 to 1.6 million years
- Stone tools have been found with *H. habilis*
  - Giving this species its name, which means "handy man"

- *Homo ergaster*
  - Was the first fully bipedal, large-brained hominid
  - Existed between 1.9 and 1.6 million years

Figure 34.43

- *Homo erectus*
  - Originated in Africa approximately 1.8 million years ago
  - Was the first hominid to leave Africa

Neanderthals

- Neanderthals, *Homo neanderthalensis*
  - Lived in Europe and the Near East from 200,000 to 30,000 years ago
  - Were large, thick-browed hominids
  - Became extinct a few thousand years after the arrival of *Homo sapiens* in Europe

Homo sapiens

- *Homo sapiens*
  - Appeared in Africa at least 160,000 years ago

Figure 34.44

- The oldest fossils of *Homo sapiens* outside Africa
  - Date back about 50,000 years ago

- The rapid expansion of our species
  - May have been preceded by changes to the brain that made symbolic thought and other cognitive innovations possible

Figure 34.45