Section F: Primates and the Evolution of *Homo sapiens*

1. Primate evolution provides a context for understanding human origins
2. Humanity is one very young twig on the vertebrate tree
1. Primate evolution provides a context for understanding human origins

- Primates are difficult to define unambiguously in terms of morphological attributes.
  - Most primates have hands and feet adapted for grasping.
  - Relative to other mammals, they have large brains and short jaws.
  - They have flat nails on their digits, rather than narrow claws.
  - Primates also have relatively well-developed parental care and relatively complex social behavior.
• The earliest primates were probably tree dwellers, shaped by natural selection for arboreal life.

• The grasping hands and feet of primates are adaptations for hanging on to tree branches.

• All modern primates, except *Homo*, have a big toe that is widely separated from the other toes.

• The thumb is relatively mobile and separate from the fingers in *all* primates, but a *fully opposable thumb* is found only in anthropoid primates.

• The unique dexterity of humans, aided by distinctive bone structure at the thumb base, represents descent with modification from ancestral hands adapted for life in the trees.
• Other primate features also originated as adaptations for tree dwelling.
  • The overlapping fields of vision of the two eyes enhance depth perception, an obvious advantage when brachiating.
  • Excellent hand-eye coordination is also important for arboreal maneuvering.
• Primates are divided into two subgroups.

• The Prosimii (**prosimians**), probably resemble early arboreal primates and include the lemurs of Madagascar and the lorises, pottos, and tarsiers of tropical Africa and southern Asia.

• The Anthropoidea (**anthropoids**) include moneys, apes, and humans.

Fig. 34.34
• The oldest known anthropoid fossils, from about 45 million years ago, support the hypothesis that tarsiers are the prosimians most closely related to anthropoids.
• By about 40 million years ago, monkeys were established in Africa, Asia, and South America.

• The Old World and New World monkeys underwent separate adaptive radiations.

• All New World monkeys are arboreal, but Old world monkeys include arboreal and ground-dwelling species.

• New World monkeys have prehensile tails and nostrils that open to the side, while Old world species lack prehensile tails and their nostrils open downward.

Fig. 34.36
• In addition to monkeys, the anthropoid suborder also includes four genera of apes: *Hylobates* (gibbons), *Pongo* (orangutans, *Gorilla* (gorillas), and *Pan* (chimpanzees and bonobos).

• Modern apes are confined exclusively to the tropical regions of the Old World.

• They evolved from Old World monkeys about 25-30 million years ago.
• With the exception of gibbons, modern apes are larger than monkeys, with relatively long arms and short legs, and no tails,

• Although all apes are capable of brachiating, only gibbons and orangutans are primarily arboreal.

• Social organization varies among the genera, with gorilla and chimpanzees highly social.

• Apes have relatively larger brains than monkeys, and their behavior is more flexible.
2. Humanity is one very young twig on the vertebrate tree

- In the continuity of life spanning over 3.5 billion years, humans and apes have shared ancestry for all but the last few million years.

- **Paleoanthropology** is the study of human origins and evolution.
  
  - Paleoanthropology focuses on the tiny fraction of geologic time during which humans and chimpanzees diverged from a common ancestor.
Paleoanthropologists use two words that are easy to confuse but which have distinct meanings.

- **Hominoid** is a term referring to great apes and humans collectively.
- **Hominid** has a narrow meaning, confined to those twigs of the evolutionary tree that are more closely related to us than any other living species.

There are two main groups of hominids: the australopithecines, which came first and are all extinct, and members of the genus *Homo*, with all species extinct except one: *Homo sapiens*. 
• Paleoanthropology has a checkered history with many misconceptions about human evolution generated during the early part of the twentieth century that still persist in the minds of the general public, long after these myths have been debunked by fossil discoveries.

• First, our ancestors were not chimpanzees or any other modern apes.
  
  • Chimpanzees and humans represent two divergent branches of the hominoid tree that evolved from a common ancestor that was neither a chimpanzee nor a human.
• Second, human evolution did not occur as a ladder with a series of steps leading directly from an ancestral hominoid to *Homo sapiens*.

• If human evolution is a parade, then many splinter groups traveled down dead ends and several different human species coexisted.

• Human phylogeny is more like a multibranched bush with our species as the tip of the only surviving twig.
• Third, the various human characteristics, such as upright posture and an enlarged brain, did not evolved in unison.
  • Different features evolved at different rates, called mosaic evolution.
  • Our pedigree includes ancestors who walked upright but had brains much less developed than ours.
• After dismissing some of the folklore on human evolution, we must admit that many questions about our own ancestry remains.
• Our anthropoid ancestors of 30 - 35 million year ago were still tree dwellers.

• By about 20 million years ago, the climate became drier and the forests of what is now Africa and Asia contracted and the savanna habitat increased.
  • Some of the major evolutionary changes leading to our species may have occurred as our ancestors came to live less in the trees and spent more time walking on the ground in more open habitats.

• The fossil record and comparisons of DNA between human and chimpanzees indicate that they diverged from a common hominoid ancestor only about 5 - 7 million years ago.
Human evolution is marked by the evolution of several major features.

- **Brain Size.** Based on skull measurements, researchers have estimated that brain size in hominoids tripled over the past 6 million years.
  - It increased from about 400-450 cm$^3$ in hominoids (and similar to modern chimpanzees) to about 1,300 cm$^3$ in modern humans.

- **Jaw Shape.** Our hominoid ancestors had longer jaws - **prognathic jaws** - than those of modern humans.
  - This resulted in a flatter face with more pronounced chins.
  - There were also changes in dentition.
• **Bipedal Posture.** Based on fossil skeletons, it is clear that our hominoid ancestors walked on all four limbs when on the ground, like modern apes.

  • The evolution of bipedal posture - upright posture and two-legged walking - is associated with key skeletal modifications seen in early hominid fossils.

• **Reduced Size Differences Between the Sexes.** In hominoids, a size difference between females and males is a major feature of sexual dimorphism.

  • On average, male gorillas and orangutans are twice as heavy as females and male chimps and bonobos are about 1.35 times heavier than females.

  • In humans, males *average* about 1.2 times the weight of females.
• **Some Key Changes in Family Structure.** Fossils are effective at documenting evolutionary changes in morphological features, but not changes in social behavior.

• Insights into social behavior are derived from comparisons between humans and other extant hominoids.

• In contrast to most ape species, monogamy, with long-term pair-bonding between mates, prevails in most human cultures.

• Newborn humans infants are exceptionally dependent on their mothers, and the duration of parental care (and opportunities for enhanced learning) is much longer in humans than in other hominoids.
• All known hominid (human) fossils older than about 1.5 million years are from eastern and southern Africa.
  • Most consist of teeth and fragments of jaws, skulls, and other skeletal pieces, with a few spectacular exceptions.
  • Researchers must try to reconstruct human phylogeny from an incomplete record, revising their hypotheses to account for new fossil evidence and data from new research strategies such as molecular systematics.
• The various pre-*Homo* hominids are classified in the genus *Australopithecus* (“southern ape”) and are known as australopithecines.

• The first australopithecine, *A. africanus*, was discovered in 1924 by Raymond Dart in a quarry in South Africa.

• From this and other skeletons, *A. africanus* probably walked fully erect and had humanlike hands and teeth.

• However, the brain was only about one-third the size of a modern human’s brain.
In 1974, a new fossil, about 40% complete, was discovered in the Afar region of Ethiopia.

This fossil, nicknamed “Lucy,” was described as a new species, *A. afarensis*. 
Based on this fossil and other discoveries, this species had a brain the size of a chimpanzee, a prognathic jaw, longer arms (for some level of arboreal locomotion), and sexual dimorphism more apelike than human.

However, the pelvis and skull bones and fossil tracks showed that *A. afarensis* walked bipedally.
• In the past few years, paleoanthropologists have found hominid species that predate *A. afarensis*.

• The oldest fossil that is unambiguously more human than ape is *Australopithecus anamensis*, which lived over 4 million years ago.

• Other fossils of putative hominids go back 6 million years, closer to the ape-human split that molecular systematists estimate occurred about 5 - 7 million years ago.
• One key question in paleoanthropology is which of the australopithicines were evolutionary dead ends and which were either on, or close to, the phylogenetic lineage that led to the \textit{Homo} branch.

• Two lineages appeared after \textit{A. afarensis}: the “robust” australopithecines with sturdy skulls and powerful jaws and teeth for grinding and chewing hard, tough foods; and the “gracile” australopithecines with lighter feeding equipment adapted for softer foods.

• Most researchers agree that the robust australopithecines were an evolutionary dead end, and that the ancestors of \textit{Homo} were among the gracile australopithecines.
• The earliest fossils that anthropologists place in our genus, *Homo*, are classified as *Homo habilis*.

• These fossils range in age from 2.5 to 1.6 million years old.

• This species had less prognathic jaws and larger brains (about 600 - 750 cm\(^3\)) than australopithecines.

• In some cases, anthropologists have found sharp stone tools with these fossils, indicating that some hominids had started to use their brains and hands to fashion tools.
• A remarkably complete fossil of a young hominid known as “Turkana Boy” indicates that even larger brains had evolved by 1.6 million years ago.

• The body had a brain that would probably be over 900 cm$^3$ in an adult of his species, a size between that of $H. \text{habilis}$ and $H. \text{erectus}$. 

Fig. 34.40
• *Homo erectus* was the first hominid species to migrate out of Africa, colonizing Asia and Europe.
  
  • They lived from about 1.8 million to 500,000 years ago.

  • Fossils from Asia are known by such names as “Beijing man” and “Java Man”.

  • In Europe, *H. erectus* gave rise to the humans known as Neanderthals.

  • Compared to *H. habilis*, *H. erectus* was taller, had a larger brain (averaging about 1,100 cm³), and had about the same level of sexual dimorphism as modern humans.
• The term Neanderthal is now used for humans who lived throughout Europe from about 200,000 to 40,000 years ago.
  • Fossilized skulls indicate that Neanderthals had brains as large as ours, though somewhat different in shape.
  • Neanderthals were generally more heavily built than modern humans.
Controversy surrounds the classification of fossils of the humans that lived in Europe, Asia, and Africa from about 500,000 to 100,000 years ago.

- One school of researchers refers to all the regional forms as “archaic *Homo sapiens,*” with subspecies names for the regional variants.
- The other school restricts the name *Homo sapiens* to later fossils and gives separate species names to the regional fossils.
- This difference reflects a debate between advocates of alternative hypotheses for the origin of modern humans.
Two alternative hypotheses have been proposed for the origin of **anatomically modern humans.**

In the **multiregional hypothesis**, fully modern humans evolved in parallel from the local populations of *H. erectus.***

In this view, the great genetic similarity of all modern people is the product of occasional interbreeding between neighboring populations.
• The other hypothesis, the “Out of Africa” or replacement hypothesis, argues that all *Homo sapiens* throughout the world evolved from a second major migration out of Africa that occurred about 100,000 years ago.

• This migration completely replaced all the regional populations of *Homo* derived from the first hominid migrations.
Both hypotheses recognize the fossil evidence for humanity’s African origin.

The multiregional hypothesis places that last common ancestor in Africa over 1.5 million years ago, when *H. erectus* began migrating to other parts of the world about 100,000 years ago.

According to the replacement hypothesis, all of the world’s populations diverged from anatomically modern *Homo sapiens* that evolved from an African *H. erectus* population and then migrated throughout the world.

All of the regional descendents of *H. erectus* are therefore evolutionary dead ends.
• A compromise alternative to these extremes suggests that *Homo sapiens* originated and then dispersed from Africa 100,000 years ago.

• These individuals then interbred with the regional descendents of the earlier *H. erectus* migration.

• This hypothesis predicts that the genomes of indigenous people from around the world today should reflect a complex mix of ancestries.
So far, the genetic data have mostly supported the replacement hypothesis.

- Using changes in mitochondrial DNA (mtDNA) among human populations as a molecular clock, research have reported a time of genetic divergence of about 100,000 years ago.
  - This is supported by nuclear genetic markers.
  - The mtDNA extracted from Neanderthal bones fall completely outside the range of mtDNA for modern Europeans.
  - These data suggest that Neanderthals contributed nothing to the ancestry of anatomically modern humans in Europe.
• To choose among these competing hypotheses, comparisons of Y chromosomes in 2001 provide perhaps the most important genetic data so far.

  • The Y chromosome is passed from male to male through the generations of a family with a minimum of crossing over with the X chromosome.

  • The diversity among Y chromosomes is limited to mutations.

  • By comparing the Y chromosomes of males from various geographic regions, researchers were able to infer divergence from a common African ancestor less than 100,000 years ago.
• So far, the fossil evidence has been less one-sided than the genetic data in testing the alternative hypotheses.

• The western European fossil evidence is consistent with total replacement of Neanderthals about 40,000 years ago by anatomically modern humans, known as Cro-Magnons.

• There were no intermediates suggesting interbreeding between Neanderthals and the later arrivals.

• However, fossil evidence from outside Europe is more ambiguous, with some paleoanthropologists interpreting some Asian fossils as intermediates between older fossils of *H. erectus* and the skeletal features of modern Asians.