

A. Overview of sequence

1. We find the first fish in the Ordovician (500-430 Ma), the first amphibians in the Devonian (395-345 Ma), the first reptiles in the Carboniferous (345-280 Ma), all in the Paleozoic.
2. Pelycosauria. The type of reptile called Pelycosauria evolved during the last half of the Carboniferous. Pelycosaurs were one of the first reptilian groups, and they diversified into many herbivore and carnivore types. The pelycosaurs also seem to have experimented with control of body temperature. They had standard lizard posture (the half-pushup) and the characteristic "waddle-walk" of present day lizards.
3. Therapsids. The pelycosauria gave rise to the therapsida in the middle of the Permian, the therapsids quickly took over from the pelycosaurs. During the last half of the Permian, and, surviving the great extinction, the first half of the Triassic, the large land animals were the therapsids. The therapsids are also called the "mammal-like reptiles". The therapsids were highly successful creatures, both herbivorous and carnivorous. Therapsids probably controlled their body temperatures internally, their legs were more under their bodies, they had varied dentition, and they had a more mammal-like jaw.
4. Mammals. true mammals evolved from therapsids in the late Triassic, as the rise of the dinosaurs drove the therapsids to extinction. As thecodonts evolved into archosaurs and then dinosaurs in the early Triassic, they took over, eliminated the remaining therapsids, and drove mammals to small sizes, as they remained throughout the Jurassic and Cretaceous. Only with the sudden extinction of the dinosaurs, did mammals start growing large again, and thus while the Mesozoic is the "Age of Dinosaurs", the Cenozoic is the "Age of Mammals". The dinosaurs left only birds as their descendants.
5. Modern mammals owe their mammal-like characteristics to the pressure put on therapsids and early mammals by the Mesozoic dominance of the dinosaurs. For over 120 MY, dinosaurs ruled the earth. The Mesozoic mammals were mostly rat-like, trying to eke out a living under the onslaught of the dinosaurs. Pretend that you are a lone person trying to eke out a living with all the armed forces of the United States trying to hunt you down, and you have some idea of what our mammalian ancestors faced living under the dinosaurs. Our 3-D senses of hearing, sight and smell developed as responses to living under the domination of dinosaurs — the only way to survive was to outsmart them, and so our brains and senses grew bigger and bigger.
6. Primates are first found in the late Cretaceous, and are small, big-eyed, big-brained mammals, still little different from rats, though arboreal (live in trees).

7. The dinosaurs were killed off by the end-Cretaceous asteroid, but at least not all of the primitive primates were killed off. In the end-Cretaceous extinction, the smaller the organism, the better chance of surviving the extinction event. With no dinosaurs to worry about, the primitive mammals underwent explosive adaptive radiation, and in a short while filled every ecological niche vacated by the dinosaurs. Primates split into many groups, some growing larger, some staying small.
8. About 45 Ma, the lines leading the New World and Old World monkeys diverged (New World = prehensile tails; Old World = non-prehensile tails as one difference)
9. The Great Apes diverged from the rest of the Old World monkeys about 33 Ma. Great Apes were tree-dwelling, more or less tailless, and spread in the Old World. The lines leading to Orangutans split from the rest of the great apes about 17 Ma, the line leading to Gorillas about 10 Ma, and lines leading to humans and chimps split about 6 Ma.
10. The hominid lineage developed exclusively in Africa until the emergence of *Homo erectus* about 1.7 Ma. The first known hominid was *Ardipithecus ramidus*, about 4.4 Ma, but it is unclear whether *Ardipithecus* was in the line that eventually led to modern humans. *Australopithecus anamensis*, which lived about 4.2-3.9 Ma, was bipedal and apparently ancestral to *Australopithecus afarensis* ("Lucy"), which lived 3.8 - 2.8 Ma.
11. *Australopithecus africanus* probably descended from *A. afarensis*, and lived about 3 - 2 Ma. There is dispute about whether this is a separate species, or whether the earlier ones should be included in *A. afarensis* and the later ones in *Homo habilis*.
12. *Homo habilis* lived from about 2.2 - 1.6 Ma. With *Homo habilis*, brain size started to increase. *H. habilis* used crudely flaked stone tools called choppers.
13. *Homo erectus* started out in Africa about 1.6 Ma, and existed until about 400,000 years ago in Africa. (*Homo erectus* persisted until maybe 250,000 years ago in China and 100,000 years ago in Java) *Homo erectus* migrated out of Africa to the rest of the Old World (specimens found in Africa, Java, China, the Middle East, and Europe), used fairly sophisticated stone tools, and controlled fire. The most recent specimens of *Homo erectus* had essentially modern brain sizes.
14. *Homo erectus* apparently evolved into the archaic form of *Homo sapiens* in Africa about 400,000 years ago. The Neanderthal variety of *Homo sapiens* appeared in Europe from 130,000 - 30,000 years ago, and the fully modern form of *Homo sapiens* appeared in Africa and Europe about 30,000 years ago.

15. The replacement of *Homo erectus* and archaic *Homo sapiens* by modern humans may not have occurred simultaneously (within 5,000 years) throughout the world. In some cases, modern humans may have directly replaced and/or bred out late *H. erectus*, in others places modern humans replaced and/or bred out Neanderthals, in other places we replaced and/or bred out archaic *Homo sapiens*.
16. The weight of molecular evidence, however, points to a relatively recent origin for all modern humans in Africa about ~156,000 years ago. Ethnic differentiation among modern human populations would have occurred during the last 100,000 years or so.
17. Fully modern humans really took off after the last ice age (in the last 10,000 years), developing metalworking, cities, etc. Pyramids in Egypt are almost 7,000 years old. Got to New World over 10,000 years ago, perhaps 40,000 years ago.

Show Don Johanssen video (~150 min.)

Show slides of major Australopithecines and hominids.

Show slide of timeline.

Show slide of great apes chromosomal differences (?).

Students to know the following:

*A. afarensis* — bipedal, small brain, 3.8 - 2.8 Ma, lived in Africa.

*A. africanus* — bipedal, small brain, 3 - 2 Ma, lived in Africa.

*H. habilis* — bipedal, larger brain, crude stone tools, 2.2 - 1.6 Ma, lived in Africa.

*H. erectus* — bipedal, up to modern brain size, good stone tools, fire, 1.6 - 0.4 Ma, migrated throughout Old World.

*H. sapiens* — 0.4 Ma to present. Archaic and Neanderthal forms, as well as fully modern form. Fully modern form from about 30,000 years ago. Culture took off after last ice age. Got to New World at least 10,000 years ago, perhaps 40,000 years ago.