Timeline of human evolution

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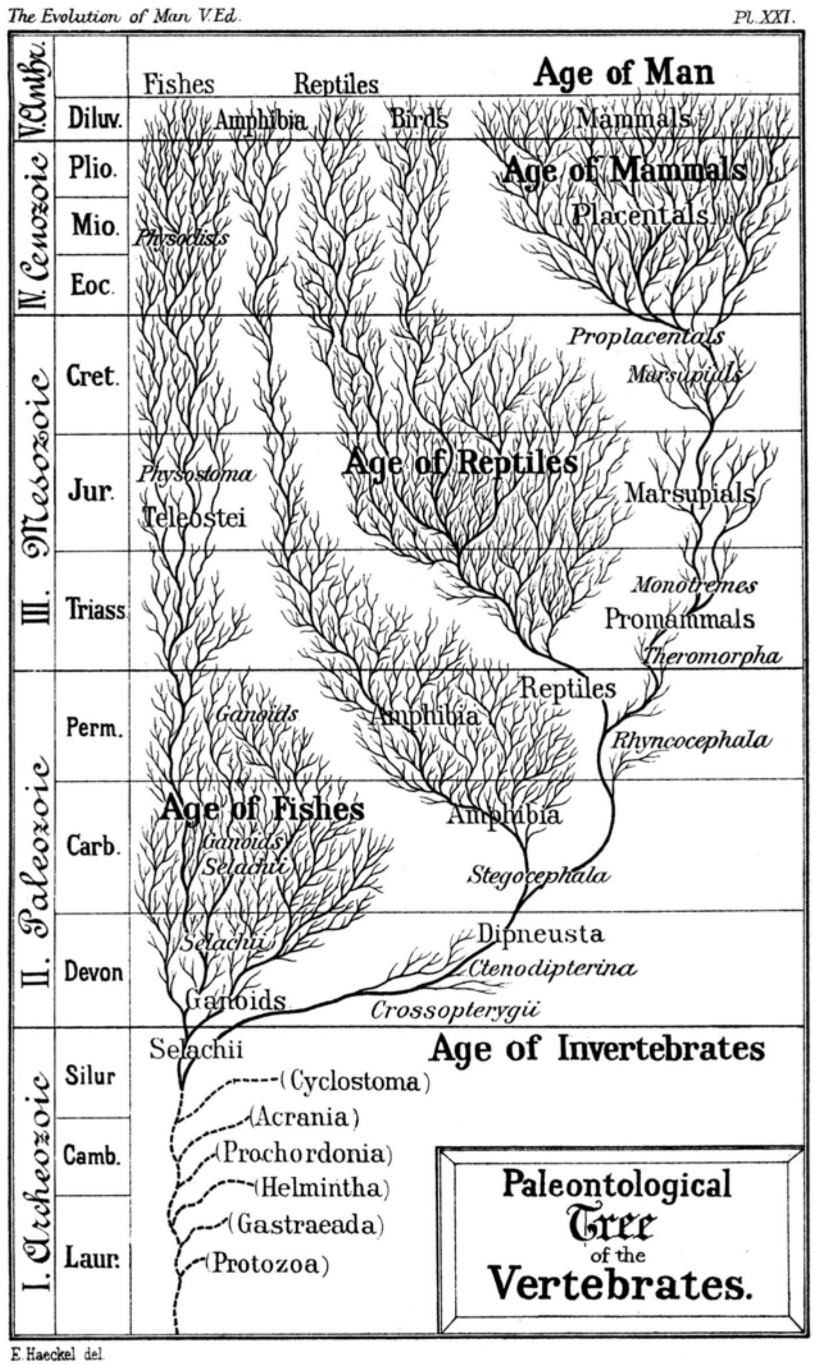

First living beings

4000 mya (million years ago) = 4 billion years ago // The earliest life appears. Further information: Abiogenesis

3900 mya = 3.9 billion yrs ago // Cells resembling prokaryotes appear. This marks the first appearance of photosynthesis // first photosynthesis used sun energy to produce glucose but did not produce oxygen // later a second form of photosynthesis produced glucose and large quantities of oxygen on the earth.

2500 mya = 2.5 billion yrs ago // First organisms to utilize oxygen. By 2400 mya, in what is referred to as the **Great Oxygenation Event**, the pre-oxygen anaerobic forms of life were wiped out by the oxygen consumers.

2100 mya // More complex cells appear: the eukaryotes.

1200 mya = 1.2 billion years ago // Sexual reproduction evolves, leading to faster evolution.

900 million yrs ago //

The choanoflagellates may look similar to the ancestors of the entire animal kingdom, and in particular they may be the direct ancestors of Sponges.

Proterospongia (members of the Choanoflagellata) are the best living examples of what the ancestor of all animals may have looked like. They live in colonies, and show a primitive level of cellular specialization for different tasks.

600 mya // It is thought that the earliest multicellular animal was a sponge-like creature. Sponges are among the simplest of animals, with partially differentiated tissues. Sponges (Porifera) are the phylogenetically oldest animal phylum extant today.

580 mya // Multicellular animal movement may have started with cnidarians. Almost all cnidarians possess nerves and muscles. Because they are the simplest animals to possess them, their direct ancestors were very probably the first animals to use nerves and muscles together. Cnidarians are also the first animals with an actual body of definite form and shape. They have radial symmetry. The first eyes evolved at this time.

550 mya //

Flatworms are the earliest animals to have a brain, and the simplest animals alive to have bilateral symmetry. They are also the simplest animals with organs that form from three germ layers. Most known animal phyla appeared in the fossil record as marine species during the Cambrian explosion.

540 mya // Acorn worms are considered more highly specialised and advanced than other similarly shaped worm-like creatures. They have a circulatory system with a heart that also functions as a kidney. Acorn worms have a gill-like structure used for breathing, a structure similar to that of primitive fish. Acorn worms are thus sometimes said to be a link between vertebrates and invertebrates.

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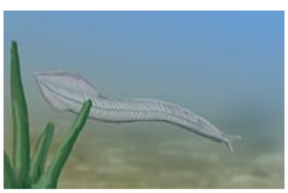
530 Ma // **Chordates**


Pikaia

Pikaia is an iconic ancestor of modern chordates and vertebrates.[4] Other, earlier chordate predecessors include Myllokunmingia fengjiaoa,[5] Haikouella lanceolata,[6] and Haikouichthys ercaicunensis.[7]

The **lancelet**, still living today, retains some characteristics of the primitive chordates. It resembles Pikaia.

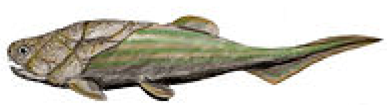
Conodonts are a famous type of early (495 Mya and later) chordate fossil; they have the peculiar teeth of an eel-shaped animal characterized by large eyes, fins with fin rays, chevron-shaped muscles and a notochord. The animal is sometimes called a conodont, and sometimes a conodontophore (conodont-bearer) to avoid confusion.

505 Ma //

 Agnatha

The first vertebrates appear: the ostracoderms, jawless fish related to present-day lampreys and hagfishes. *Haikouichthys* and *Myllokunmingia* are examples of these jawless fish, or Agnatha. (See also prehistoric fish). They were jawless and their internal skeletons were cartilaginous. They lacked the paired (pectoral and pelvic) fins of more advanced fish. They were precursors to the Osteichthyes (bony fish)

480 Ma //



The Placodermi were prehistoric fishes. Placoderms were some of the first jawed fishes (Gnathostomata), their jaws evolving from the first gill arch.[9] A placoderm's head and thorax were covered by articulated armoured plates and the rest of the body was scaled or naked. However, the fossil record indicates that they left no descendents after the end of the Devonian and are less closely related to living bony fishes than sharks are.

410 Ma // The first coelacanth appears;[10] this order of animals had been thought to have no extant members until living specimens were discovered in 1938. It is often referred to as a living fossil.

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390 Ma // **Tetrapods**

Panderichthys

Some fresh water lobe-finned fish (Sarcopterygii) develop legs and give rise to the Tetrapoda.

The first tetrapods evolved in shallow and swampy freshwater habitats.

Primitive tetrapods developed from a lobe-finned fish (an "osteolepid Sarcopterygian"), with a two-lobed brain in a flattened skull, a wide mouth and a short snout, whose upward-facing eyes show that it was a bottom-dweller, and which had already developed adaptations of fins with fleshy bases and bones. (The "living fossil" coelacanth is a related lobe-finned fish without these shallow-water adaptations.) Tetrapod fishes used their fins as paddles in shallow-water habitats choked with plants and detritus. The universal tetrapod characteristics of front limbs that bend backward at the elbow and hind limbs that bend forward at the knee can plausibly be traced to early tetrapods living in shallow water.[11] [11]

Panderichthys is a 90–130 cm (35–50 in) long fish from the Late Devonian period (380 Mya). It has a large tetrapod-like head. *Panderichthys* exhibits features transitional between lobe-finned fishes and early tetrapods.

Trackway impressions made by something that resembles *Ichthyostega*'s limbs were formed 390 Ma in Polish marine tidal sediments. This suggests tetrapod evolution is older than the dated fossils of *Panderichthys* through to *Ichthyostega*.

Lungfishes retain some characteristics of the early Tetrapoda. One example is the Queensland Lungfish.

375 Ma //

Tiktaalik is a genus of sarcopterygian (lobe-finned) fishes from the late Devonian with many tetrapod-like features. It shows a clear link between *Panderichthys* and *Acanthostega*.

365 Ma //

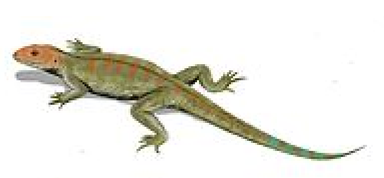
 

Ichthyostega

Acanthostega is an extinct amphibian, among the **first animals to have recognizable limbs**. It is a **candidate for being one of the first vertebrates to be capable of coming onto land**. It lacked wrists, and was generally poorly adapted for life on land. The limbs could not support the animal's weight. Acanthostega had both lungs and gills, also indicating it was a link between lobe-finned fish and terrestrial vertebrates.

Ichthyostega is an early tetrapod. Being one of the first animals with legs, arms, and finger bones, *Ichthyostega* is seen as a hybrid between a fish and an amphibian. *Ichthyostega* had legs but its limbs probably weren't used for walking. They may have spent very brief periods out of water and would have used their legs to paw their way through the mud.[12]

360 Mya. // **Amphibia were the first four-legged animals to develop lungs** which may have evolved from Hynerpeton . Amphibians living today still retain many haracteristics of the early tetrapods.



Hylonomus

From amphibians came the first reptiles: *Hylonomus* is the earliest known reptile. It was 20 cm (8 in) long (including the tail) and probably would have looked rather similar to modern lizards. It had small sharp teeth and probably ate millipedes and early insects. It is a precursor of later Amniotes and mammal-like reptiles. **Alpha keratin first evolves here which is used in claws in modern lizards and birds, and hair in mammals**.[13]

Evolution of the amniotic egg gives rise to the Amniota, reptiles that can reproduce on land and lay eggs on dry land. They did not need to return to water for reproduction. This adaptation gave them the capability to colonize the uplands for the first time.

Reptiles have advanced nervous systems, compared to amphibians. They have **twelve pairs of cranial nerves.**

256 Ma // Mammals

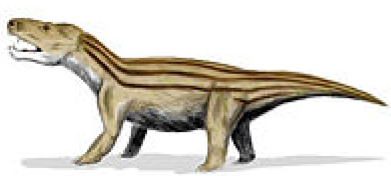

Phthinosuchus, an early Therapsid

Shortly after the appearance of the first reptiles, two branches split off. One branch is the Sauropsids, from which come the **modern reptiles and birds**. The other branch is Synapsida, from which come **modern mammals**. Both had temporal fenestrae, a pair of holes in their skulls behind the eyes, which were used to increase the space for jaw muscles. Synapsids had one opening on each side, while diapsids had two.

The earliest **mammal-like reptiles** are the pelycosaurs. The pelycosaurs were the first animals to have temporal fenestrae. Pelycosaurs are not therapsids but soon they gave rise to them. The Therapsida were the direct ancestor of mammals.

The therapsids have temporal fenestrae larger and more mammal-like than pelycosaurs, their teeth show more serial differentiation, and later forms had evolved a secondary palate. A secondary palate enables the animal to eat and breathe at the same time and is a sign of a more active, perhaps warm-blooded, way of life

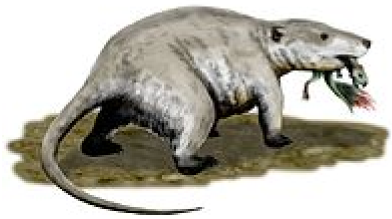
220 Ma //


Cynognathus

One sub-group of therapsids, the cynodonts, evolved more mammal-like characteristics.

The jaws of cynodonts resemble modern mammal jaws. **It is very likely that this group of animals contains a species which is the direct ancestor of all modern mammals.**

220 Ma //



Repenomamus

From Eucynodontia (cynodonts) came the first mammals. Most early mammals were small shrew-like animals that fed on insects. Although there is no evidence in the fossil record, it is likely that these animals had a constant body temperature and milk glands for their young. The neocortex region of the brain first evolved in mammals and thus is unique to them.

Monotremes are an egg-laying group of mammals represented amongst modern animals by the platypus and Echidna. Recent genome sequencing of the platypus indicates that its sex genes are closer to those of birds than to those of the therian (live birthing) mammals. Comparing this to other mammals, it can be inferred that the first mammals to gain gender differentiation through the existence or lack of SRY gene (found in the y-Chromosome) evolved after the monotreme lineage split off.

160 Ma //

Juramaia sinensis[16] is the earliest known eutherian mammal fossil.

100 Ma // Last common ancestor of mice and humans (base of the clade Euarchontoglires).

63 Ma // Primates


Plesiadapis

Primates diverge into suborders Strepsirrhini (wet-nosed primates) and Haplorrhini (dry-nosed primates). Strepsirrhini contain most of the prosimians; modern examples include the lemurs and lorises. The haplorrhines include the three living groups: prosimian tarsiers, simian monkeys, and apes. One of the earliest haplorrhines is *Teilhardina asiatica*, a mouse-sized, diurnal creature with *Aegyptopithecus*

Haplorrhini splits into infraorders Platyrrhini and Catarrhini. Platyrrhines, New World monkeys, have prehensile tails and males are color blind. They may have migrated to South America on a raft of vegetation across the relatively narrow Atlantic ocean (approx. 700 km). Catarrhines mostly stayed in Africa as the two continents drifted apart. Possible early ancestors of catarrhines include *Aegyptopithecus* and *Saadanius*.

25 Ma //


*Proconsul*Catarrhini splits into 2 superfamilies, Old World monkeys (Cercopithecoidea) and apes (Hominoidea). Our trichromatic color vision had its genetic origins in this period.

Proconsul was an early genus of catarrhine primates. They had a mixture of Old World monkey and ape characteristics. *Proconsul*'s monkey-like features include thin tooth enamel, a light build with a narrow chest and short forelimbs, and an arboreal quadrupedal lifestyle. Its ape-like features are its lack of a tail, ape-like elbows, and a slightly larger brain relative to body size.

Proconsul africanus is a possible ancestor of both great and lesser apes, including humans.

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15 Ma // Hominidae (great apes) speciate from the ancestors of the gibbon (lesser apes).

13 Ma // Homininae ancestors speciate from the ancestors of the orangutan.[18]

Pierolapithecus catalaunicus is believed to be a common ancestor of humans and the other great apes, or at least a species that brings us closer to a common ancestor than any previous fossil discovery. It had the special adaptations for tree climbing as do present-day humans and other great apes: a wide, flat rib cage, a stiff lower spine, flexible wrists, and shoulder blades that lie along its back.

10 Ma // The lineage currently represented by humans and the *Pan* genus (common chimpanzees and bonobos) speciates from the ancestors of the gorillas.

7 Ma // Hominina


Sahelanthropus tchadensis

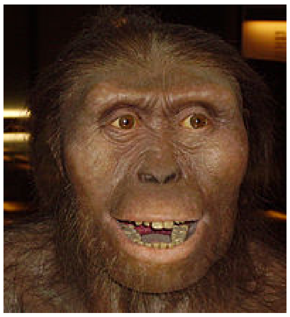
The Hominina, a subtribe of Hominini who are closely related to or ancestors to humans, speciate from the ancestors of the chimpanzees. Both chimpanzees and humans have a larynx that repositions during the first two years of life to a spot between the pharynx and the lungs, indicating that the common ancestors have this feature, a precondition for vocalized speech in humans.

The latest common ancestor of humans and chimpanzees lived around the time of *Sahelanthropus tchadensis*, ca. 7 Ma; and *S. tchadensis* is sometimes claimed to be that last common ancestor of humans and chimpanzees, but the claim has not been established. The earliest known representative from the ancestral human line post-dating the separation with the chimpanzee lines is *Orrorin tugenensis* (Millennium Man, Kenya; ca. 6 Ma).

4.4 Ma // *Ardipithecus* is, or may be, a very early hominin genus (tribe Hominini and subtribe Hominina). Two species are described in the literature: *A. ramidus*, which lived about 4.4 million years ago[19] during the early Pliocene, and *A. kadabba*, dated to approximately 5.6 million years ago[20] (late Miocene). *A. ramidus* had a small brain, measuring between 300 and 350 cm^3. This is about the same size as the modern bonobo and female common chimpanzee brain; it is much smaller than the brain of australopithecines like Lucy (400 to 550 cm^3) and slightly over a fifth the size of the modern *Homo sapiens* brain.

Ardipithecus was arboreal, meaning it **lived largely in the forest** where it competed with other forest animals for food, no doubt including the contemporary ancestor of the chimpanzees. Ardipithecus was probably bipedal as evidenced by its bowl shaped pelvis, the angle of its foramen magnum and its thinner wrist bones, though its **feet were still adapted for grasping rather than walking for long distances.**

3.6 Ma //

 *Australopithecus afarensis*

A member of the *Australopithecus afarensis* left **human-like footprints on volcanic ash** in Laetoli, Kenya (Northern Tanzania), providing strong evidence of **full-time bipedalism**.

Australopithecus afarensis lived between 3.9 and 2.9 million years ago, and is considered one of the **earliest hominins**---those species that developed and comprised the lineage of ''Homo'' and ''Homo's'' closest relatives after the split from the line of the chimpanzees.

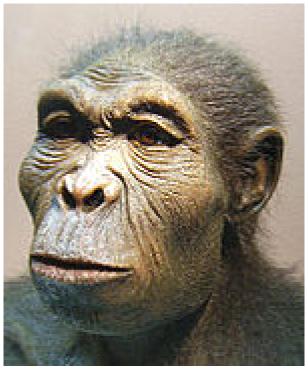
It is thought that *A. afarensis* was **ancestral to both the genus *Australopithecus* and the genus *Homo***. Compared to the modern and extinct great apes, *A. afarensis* had reduced canines and molars, although they were still relatively larger than in modern humans. *A. afarensis* also has a relatively small brain size (380–430 cm^3) and a prognathic (i.e. projecting anteriorly) face.

Australopithecines have been found in savannah environments; from scavenging opportunities, they probably developed their diet to include meat. Analyses of *Australopithecus africanus* lower vertebrae suggests that these bones changed in females to support bipedalism even during pregnancy.

3.5-3.3 Ma // , a possible ancestor of *Homo*, emerges from the *Australopithecus* genus. Stone tools are deliberately constructed.

3 Ma // *Kenyanthropus platyops* The bipedal australopithecines (a genus of the Hominina subtribe) evolve in the savannas of Africa being hunted by *Dinofelis*. **Loss of body hair occurs from 3 to 2 Ma,** in parallel with the development of full bipedalism

2.8 Ma // Homo

 *Homo habilis*

Homo appears in East Africa; with most **Australopithecines they are considered the first hominins —** that is, *they are designated as those earliest humans and human relatives or ancestors to rise after splitting from the lineage of Pan, the chimpanzees.* Others consider the genus *Pan* as hominins also, and perhaps the first hominins.

Sophisticated stone tools mark the beginning of the Lower Paleolithic.

Homo habilis appears—the first, or one of the first, hominins to **master stone tool technology**. Stone tool implements also found along with *Australopithecus garhi*, dated to a slightly earlier period.

Homo habilis, although significantly different of anatomy and physiology, is thought to be the ancestor of *Homo ergaster*, or African *Homo erectus*; but it is also **known to have coexisted with *Homo erectus* for some one-half million years** (until about 1.5 Ma).

Further information: Homo rudolfensis

1.8 Ma // Homo erectus

 A reconstruction of *Homo erectus*

Homo erectus evolves in Africa. *Homo erectus* would bear a **striking resemblance to modern humans,** but had a brain about 74 percent of the size of modern man. Its forehead is less sloping than that of *Homo habilis* and the teeth are smaller.

Homo ergaster, known as African *Homo erectus*, and other hominin species such as *Homo georgicus*, *Homo pekinensis*, *Homo heidelbergensis* are often put under the umbrella species name of *Homo erectus*.[22] Starting with *Homo georgicus*—found in what is now the Republic of Georgia, dated at 1.8 Ma—the pelvis and backbone grew more human-like, which would enable *H. georgicus* to cover very long distances and to follow herds of prey animals; this is the oldest fossil of a hominin found outside of Africa.

Control of fire by early humans is achieved about 1.5 Ma by *Homo ergaster*. *Homo ergaster* reaches a height of around 1.9 metres (6.2 ft). **Evolution of dark skin**, which is linked to the loss of body hair in human ancestors, is complete by **1.2 Ma.**

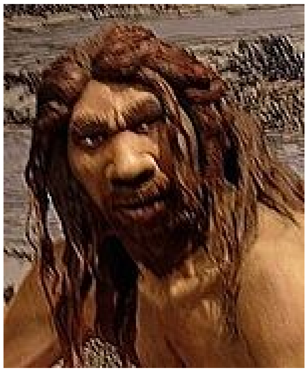
Homo pekinensis first appears in Asia around 700 ka but, according to the theory of a recent African origin of modern humans, they could not be ancestors to modern humans, but rather, were an offshoot cousin species from *Homo erectus*. *Homo heidelbergensis* was a very large hominin that developed a more advanced complement of cutting tools and may have hunted big game such as horses

1.2 Ma // *Homo antecessor*

Homo antecessor **may be a common ancestor of humans and Neanderthals**.[23][24] At present estimate, humans have approximately 20,000–25,000 genes and share 99% of their DNA with the now extinct Neanderthal [25] and 95-99% of their DNA with their closest living evolutionary relative, the chimpanzees.[26][27]

The human variant of the **FOXP2 gene** (linked to the control of speech) has been found to be identical in Neanderthals.[28] It can therefore be deduced that *Homo antecessor* would also have had the human FOXP2 gene.

600 ka // Homo heidelbergensis

 *Homo heidelbergensis*

Three 1.5 m (5 ft) tall *Homo heidelbergensis* left footprints in powdery volcanic ash solidified in Italy. *Homo heidelbergensis* may be a common ancestor of humans and Neanderthals.[29] It is morphologically very similar to *Homo erectus* but *Homo heidelbergensis* had a larger brain-case, about 93% the size of that of *Homo sapiens*. The holotype of the species was tall, 1.8 m (6 ft) and more muscular than modern humans.

Beginning of the Middle Paleolithic.

200 ka // Omo1 and Omo2 sites, (Omo River, Ethiopia), yield the earliest fossil evidence for anatomically modern *Homo sapiens*. By a 2015 study, the **hypothetical man Y-chromosomal Adam** is estimated to have lived in East Africa about 250 ka. He would be the most recent common ancestor from whom all male human Y chromosomes are descended.

160 ka // *Homo sapiens* (*Homo sapiens idaltu*) in Ethiopia, Awash River (near present-day Herto village) practice mortuary rituals and butcher hippopotami. Potential earliest evidence of anatomical and behavioral modernity consistent with the continuity hypothesis including use of red ochre and fishing.[32]

The hypothetical woman **Mitochondrial Eve is estimated to have lived in East Africa between 99 and 200 ka;** she would be the most recent female ancestor common to all mitochondrial lineages in humans alive today. Note that there is no evidence of any characteristic or genetic drift that significantly differentiated her from the contemporary social group she lived with at the time. Her ancestors as well as her contemporaries were *Homo sapiens*.

90 ka // Appearance of mitochondrial haplogroup (mt-haplogroup) L2.

60 ka // Appearance of mt-haplogroups M and N, which participated in a migration out of Africa. *Homo sapiens* who leave Africa in this wave may have interbred with the Neanderthals they encounter.

50 ka // Behavioral modernity develops, according to the "great leap forward" theory.[35]

Migration to South Asia. M168 mutation (carried by all non-African males). Beginning of the Upper Paleolithic.

Appearance of mt-haplogroups U and K.

40 ka // Migration to Australia[36] and Europe; Cro-Magnon develops in Europe.

25 ka - 40 ka // The independent Neanderthal lineage dies out. Appearance of: Y-Haplogroup R2; mt-haplogroups J and X.

10-20 ka // Beginning of the Mesolithic / Holocene. Appearance of: Y-Haplogroup R1a; mt-haplogroups V and T. **Evolution of light skin in Europeans** (SLC24A5).

***Homo floresiensis* dies out, leaving *Homo sapiens* as the only living species of the genus *Homo*.**