Health & Medicine Genetics & Evolution Ask the Chatbot a Question There are many theories that attempt to explain why humans are bipedal, but none is wholly satisfactory. Increased speed can be ruled out immediately because humans are not very fast runners. Because bipedalism leaves the hands free, some scientists, including Darwin, linked it to tool use, especially tools for defense and hunting—i.e., weapons. This theory is problematic in that the earliest stone artifacts date only to about 3.3 mya, long after hominins had become bipedal, thus requiring an assumption that earlier tools were made of wood or other perishable materials. Twentieth-century theories proposed a wide array of other factors that might have driven the evolution of hominin bipedalism: carrying objects, wading to forage aquatic foods and to avoid shoreline predators, vigilantly standing in tall grass, presenting phallic or other sexual display, following migrant herds on the savanna, and conserving energy (bipedalism expends less energy than quadrupedism). Furthermore, if the early bipeds were regularly exposed to direct midday tropical sunlight, they would benefit from standing upright in two ways: less body surface would be exposed to damaging solar rays, and they would find relief in the cooler air above the ground. Some scientists assume that the pre-bipedal primates were terrestrial quadrupeds, perhaps even knuckle-walkers like modern-day chimpanzees, bonobos and gorillas. Conversely, it is also possible that the first habitual walkers were already well prepared for terrestrial bipedality, having adaptations for running bipedally among branches and boughs, standing upright to forage overhead, and climbing vertical tree trunks and vines. This scenario is suggested by studies of gibbons, which routinely engage in these arboreal activities and virtually never elect to move on the forest floor but, if forced to the ground, run bipedally. Gibbons have relatively long, powerful lower limbs, the same number of lumbar vertebrae that humans have (great apes have fewer), and chests of humanoid configuration. When walking on the ground, gibbons stand up straighter than chimpanzees, which are occasionally bipedal. Moreover, they exert less energy running on the ground than when running bipedally along branches or climbing vertically. Adopting a bipedal stance with full extension of the lower limbs thus would not have been a major challenge, since all apes have this capacity, though there would have been some alteration of the lower limb bones, joints, and ligaments. The foot would probably have gone through the most dramatic change, from a prehensile organ to a heel-supported, propellent one. Increased size and frequent, sustained erect standing on extended lower limbs in order to forage overhanging branches in woodland, thicket, forest edge, and other relatively open habitats would favour the evolution of humanoid hip, knee, and foot structure. While consuming their harvests, bipedal foragers may have squatted often, thereby further selecting for robust heels and for weight distribution between the heel and forefoot and between closely placed feet. Frequent squatting and rising would enhance development of the hamstring, buttock, and anterior thigh muscles (as hip and knee extensors), which are vital for athletic bipedalism. Stretching upward would select for shorter toes and an arched foot. Refinement of the terrestrial bipedal complex probably did not occur until hominins became less dependent upon trees for daytime refuge and other activities and began to forage widely afoot and perhaps to trek seasonally over long distances. Simply increasing body size would increase locomotor efficiency, because larger animals can more effectively use the elastic energy of tendons and muscles, and they also take fewer strides to cover a given distance than a smaller animal would. Indeed, H. rudolfensis (2.4–1.6 mya), H. ergaster (1.9–1.7 mya), and later species of Homo, including H. sapiens (about 315 kya), are notably taller and heavier than Australopithecus and Paranthropus; however, one species of Homo, H. naledi (the oldest known fossils of which date to 335–200 kya) was comparable in size and weight. There is less difference between the sexes in Homo species than in many other primates, largely because the females have become larger. Average size in male Australopithecus (41–51 kg [90–112 pounds]) and Paranthropus (40–49 kg [88–108 pounds]) is comparable to that of male chimpanzees (49 kg). The size of females (30–33, 32–34, and 41 kg, respectively) indicates that there was more difference between the sexes (sexual dimorphism) in these hominins than there is in chimpanzees. Sexual dimorphism in H. rudolfensis (60 versus 51 kg [132 versus 112 pounds]) and H. ergaster (66 versus 56 kg [145 versus 123 pounds]) is comparable to that in H. sapiens (58 versus 49 kg [128 versus 108 pounds]). H. rudolfensis and H. ergaster (1.9–1.5 mya) have long femurs of modern human configuration and internal knee structure like that of H. sapiens; both structures are quite unlike those of chimpanzees and at least some of the smaller tree-climbing primates. This may have been the time also when the distinctive morphology of the human calf muscle (triceps surae) evolved. Unlike those of great apes, it is heavily tendinous, which facilitates its function as an energy-conservant spring during walking and running. heredity: Human evolution The unique epidermal and respiratory mechanisms of H. sapiens may also have developed in conjunction with regular trekking, sprinting, and endurance running as ancestral Homo secured a foothold in open tropical and subtropical environments. There is a rich concentration of sweat glands in our scalp (apes have few or none in theirs), which helps to cool the head, especially the brain, in high temperatures and during vigorous activity. Postcranially, our abundantly vascular and highly sensitive sparsely haired skin is profusely endowed with sweat glands, whose copious secretions cool an extensive surface by evaporation. The distribution of sweat glands is especially strategic for cooling us while running: there is a greater concentration of sweat glands on the front surfaces of the torso and limbs, against which the air passes as we move forward. Consequently, unlike hairy quadrupeds, we do not have to pause to pant in order to avoid overheating. Furthermore, unlike the chests of quadrupeds, those of humans are freed from the stresses of supporting body weight, necessarily coupled with exhalation in running quadrupeds. We can therefore alter our breathing patterns while moving at various speeds, thereby regulating energy expenditure. H. ergaster (1.9–1.5 mya), an African species, is the earliest hominin documented with a human thoracic shape. (This species is classified by some paleoanthropologists as an African subgroup of H. erectus.) The thorax of Neanderthals (H. neanderthalensis) is also essentially like that of H. sapiens, but those of other species of Homo are not known. Click on an image to view larger version & data in a new window The rooting of the Tree of Life, and the relationships of the major lineages, are controversial. The monophyly of Archaea is uncertain, and recent evidence for ancient lateral transfers of genes indicates that a highly complex model is needed to adequately represent the phylogenetic relationships among the major lineages of Life. We hope to provide a comprehensive discussion of these issues on this page soon. For the time being, please refer to the papers listed in the References section. Two alternative views on the relationship of the major lineages (omitting viruses) are shown below The "archaea tree": The "eocyte tree":

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Watch Now human evolution timeline chart, with details on each of the major stages of human evolution.On this page you'll discover how modern humans evolved from the very first primates – animals that shared Earth with the dinosaurs over 80 million years ago.mya = million years agoya = years agoChimpanzees are our closest living relations in the animal kingdom. The human and chimpanzee branches only split around 7 million years ago!Human evolution is the process of gradual genetic change that led, over millions of years, to the development of our species, Homo sapiens.Humans evolved from ape-like animals. We belong to Hominidae, the great ape family, and share a common ancestor with the other living great apes. In other words, if both you and an orangutan went far enough back into your respective family trees, you'd eventually arrive at the same type of animal!The common ancestor of all the great apes is thought to have lived around 20 mya (million years ago), when the great apes branched off from other primates.Around 7 mya, a group of great apes known as Hominini branched off from the other great apes. This group contained the ancestors of humans together with the ancestors of chimpanzees (our closest living relatives).Animals such as Ardipithecus – a chimpanzee-like animal that lived around 5 million years ago (mya) marked the separation of our ancestors from those of today's chimpanzees and bonobos.Ardipithecus still lived in trees and had a relatively small brain compared to ours.As yet more time passed, our ancestors developed larger brains and flatter faces. Their hands became stronger and more dexterous, and they began to walk upright and use tools. These characteristics helped them to survive and are present in modern humans today.The timeline of human evolution below begins with the emergence of the first primates.Primates is the animal group that contains all of today's monkeys and apes (including humans), as well as animals such as lemurs and galagoes.Human Evolution Timeline ChartBelow is a list of the major stages in the human evolutionary timeline.You can click on the links on the colorful title banners) in the timeline below to find out more about a particular stage.(Alternatively, scroll past the timeline to see details on every stage in order.)The very first primates are thought to have appeared during the late Cretaceous Period while dinosaurs were still alive. These early primates were likely small, nocturnal, tree-dwelling animals.Click to discover more about this stage in the human evolution timelineAfter the Cretaceous–Paleogene extinction event which marked the end of the Mesozoic Era and the extinction of the non-avian dinosaurs, mammals became the dominant land vertebrates.Many mammalian groups – including the early primates – underwent rapid changes as they evolved to fill in the niches left empty by the disappearance of the dinosaurs.Click to discover more about this stage in the human evolution timelineShortly (geologically speaking) after the Cretaceous–Paleogene extinction event, a group of primates known as Haplorhini appeared. Early haplorhines were small, arboreal (tree-dwelling) animals that resembled tarsiers. They were the ancestors of today's tarsiers, monkeys and apes – including humans.Click to discover more about this stage in the human evolution timelineSimians – the group of primates to which all monkeys and apes belong – first appeared at some point between 60 and 40 mya.Click to discover more about this stage in the human evolution timelineThe first apes are thought to have appeared around 25 mya in Africa, after having branched off from the old world monkeys. Early apes, such as Proconsul africanus, like the apes of today, lacked tails but still had monkey-like wrists and were unable to swing from branches in the manner of modern apes.The oldest ape fossil comes from Tanzania, in Africa.Click to discover more about this stage in the human evolution timelineAround 18 mya, the apes split into two groups: the gibbons (or lesser apes) of family Hylobatidae; and the great apes of family Hominidae.Click to discover more about this stage in the human evolution timelineThe ancestors of today's orangutans and gorillas gradually separate from the chimpanzee-like animals that are the common ancestors of today's chimpanzees and humans.Click to discover more about this stage in the human evolution timelineThe ancestors of today's chimpanzees separate from the ancestors of today's humans.Click to discover more about this stage in the human evolution timelineThe ancestors of humans become ever-more human-like (and less chimpanzee-like). Two species of Ardipithecus from Ethiopia have reduced canines and a bowl-shaped pelvis that indicates an upright posture.Click to discover more about this stage in the human evolution timelineThe australopithecines were bipedal hominins that evolved in the woodlands and savannas of Africa.Click to discover more about this stage in the human evolution timelineHomo habilis, the oldest-known species to be placed in the genus Homo has a larger brain capacity than its predecessors and is associated with the use of stone tools.Click to discover more about this stage in the human evolution timelineFossils of Homo erectus are found in many places in Asia, Europe and Africa. This early human species travelled widely and was the longest surviving hominin species on earth.Click to discover more about this stage in the human evolution timelineNeanderthals were large-brained hunter-gatherers that evolved in Europe and Asia. They used fire, created art and clothing, and buried their dead in ritualized ways. Although not the direct ancestors of modern Homo sapiens, their genes are present in modern humans of European descent.Click to discover more about this stage in the human evolution timelineThe oldest fossil remains of Homo sapiens yet to be found were discovered at Jebel Irhoud, in Morocco. They are around 315,000 years old.Click to discover more about this stage in the human evolution timelineSometime around 75,000 ya, a small group of people dispersed from East Africa and began to settle outside the continent. Within 50,000 years, their descendants would have spread into Asia, Europe and the Americas.Click to discover more about this stage in the human evolution timelineHuman Evolution Timeline Chart DetailThe first primates would have looked very different to these modern primates.The first primates are thought to have appeared around 85 mya, during the late Cretaceous Period. At this time dinosaurs still walked the Earth.Although there is no fossil evidence of early primate-like mammals from this period, molecular studies of later primates suggest that primate evolution was under way even at this very early time.The first primates would have been small, nocturnal animals that had adapted to climbing trees.Click here to return to the timelineReconstruction of Plesiadapis, an early primate. From the Museo delle Scienze, Trento. Image: MUSE, (cropped / resized by ActiveWild.com), CC BY-SA 3.0The Cretaceous Period ended 66 mya with the Cretaceous–Paleogene extinction event. This catastrophic event caused the extinction of the dinosaurs (that is, all of the dinosaurs that hadn't evolved into birds) and many other species.With the dinosaurs gone, mammals were free to take over the land. The mammals of the time evolved quickly, with many of today's mammal groups making their first appearances during this time – including new primates.The world at that time did not look like it does today. The continents were in different positions and broad-leafed forests covered most of the earth. Even the poles were covered with trees.Adapting to this environment was a group of small, nocturnal primates known as Plesiadapiformes. Their fossils, which date from around 65 mya onwards, have been found in Asia, Europe, North Africa, and especially western North America.They were likely small animals that resembled squirrels. These ancient primates lived in the trees and ate insects. Some had grasping hands but none of them had eyes that faced forwards.Some, such as Plesiadapis, had long, bushy tails.Click here to return to the timelineArchicebus achilles, the oldest-known haplorhine. Image by: Mat Severson, (cropped / resized by ActiveWild.com) CC BY-SA 4.0Around 63 mya (perhaps even earlier; some sources suggest 74 mya), a group of primates known as Haplorhini appeared. This group contained the early ancestors of monkeys, apes (including humans) and tarsiers.Fossils of early haplorhines have been found in North America, Europe, and Asia. They are still the size of squirrels, but their hands have become better adapted for manipulating objects, and their eyes are positioned more towards the front of the skull. This shows they are in the process of developing stereoscopic vision, a characteristic of all modern primates.A fossil of the oldest-known haplorhine species, Archicebus achilles, was found in Hubei Province, China, in 2013. The species resembled a small tarsier, and may be the latest-known primate before Haplorhini split into the simians and the tarsiers.At some time during their development, haplorhines lost the ability to make Vitamin C. Whereas most other mammals are able to produce this essential vitamin, haplorhines (including man) are required to include it in their diets.Click here to return to the timelineAegyptopithecus, an early monkey. Image by Nobu Tamura ( ), (cropped / resized by ActiveWild.com) CC BY-SA 3.0Between 60 and 40 mya the haplorhines split into two branches: tarsiers and simians.The simians are the group of primates to which all monkeys and apes (and therefore humans) belong.The oldest fossils of monkeys come from two sites in Africa; the Fayum Basin in Egypt, and the East African Rift Valley in Tanzania. They had fewer teeth, larger brains and flatter snouts than their ancestors. Their eyes were positioned further to the front of the skull, showing natural selection for stereoscopic vision.Aegyptopithecus zeuxis is an example of an early monkey. The species lived in what is now Egypt around 30 mya. Its morphology indicates that it was arboreal (tree-dwelling) and was able to grasp branches with its hands and feet. Adults weighed around 13 lb. (6 kg) and had a small brain volume of no more than 1.2 cu inches (20 cc).Click here to return to the timelineProconsul africanus, an early ape. Image by: Mauricio Antón, published with Alan Turner, (cropped / resized by ActiveWild.com) CC BY 4.0The oldest ape fossil comes from Tanzania, in Africa.The first apes are thought to have appeared sometime in the late Oligocene epoch, after having branched off from the other simians (although the fossil record holds very little evidence of this).Unlike most monkeys, apes do not have tails. Apes also have broad chests and shoulders that allow them to swing from branch to branch (a form of movement known as brachiation). Apes generally have larger brains than monkeys (and most other animals), and several are known to use tools.The oldest known ape fossils derive from the East African Rift Valley in Tanzania and are dated at 25 mya. These fossils were found alongside those of monkeys, indicating that the two groups were well established by that time and probably lived side by side.Proconsul is an example of an early ape. It had no tail but still walked on the tops of branches in the style of old world monkeys, rather than swing below them like modern apes. Four species of these extinct early apes have been found in East Africa.The common ancestor of humans and all other apes is thought to have lived around 20 mya. That common ancestor diverged into different types of apes via the process of speciation.Speciation occurs when a particular group of a species becomes separated from the rest of its kind and then evolves into a new species.Click here to return to the timelineGigantopithecus, an extinct great ape thought to be related to today's orangutans. Image: Concenavator, (cropped / resized by ActiveWild.com), CC BY-SA 4.0Around 18 mya, the apes split into two groups: the gibbons (or lesser apes) of family Hylobatidae; and the great apes of family Hominidae.The great apes of this time were the ancestors of today's gorillas, orangutans, chimps and humans.Click here to return to the timelineA modern-day orangutan.The great apes gradually separate, through speciation, from the lineage that will lead to humans.Around 16 mya, the ancestors of orangutans diverged from the lineage that would lead to humans. These animals would eventually give rise to the modern orangutans that inhabited forests in southeast Asia and southern China, but are now found only in Indonesia.Around 10 mya, the gorilla lineage (animals of genus Gorilla) branched off from the ancestral line of humans and chimpanzees. These were the ancestors of the modern species of gorillas, which are found in central Africa.The lineage leading to humans now consisted only of the ancestral species of chimpanzees and humans; a group known as Hominini.Click here to return to the timelineSkull of Sahelanthropus tchadensis, named "Toumai". This species lived near the time of the divergence between humans and chimps. Photo: Oryctes, (cropped / resized by ActiveWild.com), CC BY-SA 3.0A common ancestor of chimpanzees and humans speciates and gives rise to two evolutionary lines; one line eventually evolves into modern chimpanzees and bonobos; the other leads to modern humans.Chimpanzees (including bonobos) are our closest living relatives in the animal kingdom. The common ancestor of chimps and humans is thought to have lived at some point between 10 and 6 mya. Since fossil evidence does not form easily in tropical forest conditions, the exact nature of this ancestor is not known.At some time, this common ancestor of chimpanzees and humans split via speciation, giving rise to two evolutionary lines: one which would eventually evolve into modern chimpanzees and bonobos; and another which would lead to modern humans.Possible examples of species in the human lineage after its split from the chimpanzees are Sahelanthropus tchadensis (fossils of which were found in Chad and date to about 7 mya) and Orrorin tugenensis (fossils of which were found in Kenya and date to about 6 mya).Two species that lived around the time of the human / chimpanzee split are Sahelanthropus tchadensis (fossils of which were found in Chad and date to about 7 mya) and Orrorin tugenensis (fossils of which were found in Kenya and date to about 6 mya).These species may either have been among the last common ancestors of humans and chimps, or examples human-lineage species after their split from chimpanzees.Click here to return to the timelineArdipithecus ramidus skull. Photo: Tiia Monto, (cropped / resized by ActiveWild.com), CC BY-SA 3.0Two species of Ardipithecus from Ethiopia have reduced canines and a bowl-shaped pelvis that indicates an upright posture.Two species of early hominins, Ardipithecus ramidus and Ardipithecus kadabba, are potentially the earliest-known examples of the human evolutionary linage after the divergence of chimpanzee ancestors.Both species were found in the Afar region of Ethiopia. A. kadabba is dated to 5.6 mya and A. ramidus to about 4.4 mya.Ardipithecus was a forest-dwelling creature. Both the shape of its pelvis and the position of the hole under its skull where the spinal cord enters the brain (the foramen magnum), indicate that it stood upright. Its brain was roughly the size of that of a modern chimpanzee.Click here to return to the timelineModel of Australopithecus afarensis named "Lucy". Photo: Neanderthal-Museum, Mettmann, (cropped / resized by ActiveWild.com), CC BY-SA 4.0The australopithecines were bipedal hominins that evolved in the woodlands and savannas of Africa.The end of the Miocene epoch (5.333 mya) is associated with major climatic changes that saw many forest areas replaced by open woodlands and savannas.The australopithecines are considered the first hominins to move out of a forest environment and evolve on the wooded savannas.Life in an open, grassy habitat had different challenges for the early australopithecines. Their diet changed to include more tough vegetation and less fruit, and their method of locomotion no longer involved climbing trees. They were adapted to walking upright, using a striding motion. Escape from predators was also a problem, since they could no longer find easy refuge in trees.Several Australopithecines of genus Australopithecus have been identified from fossil remains. Species of this genus are considered either to be ancestors of humans, or close relatives of species that were.In general, the species show a mixture of ape-like and human features. They all stood upright and walked bipedally. Their pelvic girdles were adapted for bearing weight, and their hips were wider than those of the modern apes. They were all small, standing no taller than 4 ft 9 in (1.5 m), and had brain volumes similar to, or slightly larger than, those of modern chimpanzees.The oldest australopithecine fossil is that of Australopithecus anamensis, found in northern Kenya and dated at 3.9 mya. Over 100 fossil specimens from 20 individuals have now been found in Kenya and Ethiopia.Another species, Australopithecus afarensis, is known from 400 fossil specimens, mostly found in Ethiopia and Kenya. This species co-existed with A. anamensis for around 100,000 years and had similar characteristics, except that its brain was significantly larger (average of 27 cu inches; 450 cc). It still looked more like an ape than a human, apart from its upright bipedal gait.The most famous A. afarensis fossil is 'Lucy', whose skeleton was discovered in 1974 near Hadar, in Ethiopia. Her fossil remains were dated at 3.2 mya.Australopithecus africanus is a species known only from fossil remains in South Africa. The first specimen was found in 1924, which made it the first early hominin ever discovered. Since then, the fossil remains of many individuals have been excavated, the most complete one being "Little Foot", with 90% of his bones being found intact.Click here to return to the timelineHomo habilis. Image by: Cicero Moraes, (cropped / resized by ActiveWild.com), CC BY-SA 4.0The oldest known species to be placed in the genus Homo has a larger brain capacity and is associated with the use of stone tools.Fossils of Homo habilis, the first hominin placed in the genus Homo, were found in Kenya, Ethiopia and South Africa.It is generally accepted that H. habilis evolved from australopithecine ancestors, but it is not clear where or when this happened.At Olduvai Gorge in Tanzania, where the earliest specimens were discovered, the fossils were associated with the presence of stone tools. This led paleontologists to name the species Homo habilis, meaning "handy man". H. habilis is the first hominin to be associated with stone tool use on a large scale.Homo habilis had a brain capacity of around 36 cu inches (600 cc), which is considerably larger than its australopithecine ancestors. In addition, its face was more upright and flatter, compared to the prognathous (lower jaw protruding) face of other ape-like hominins. It also had smaller teeth and a less pronounced chin.(As a sidenote, the light that we can see from the Andromeda Galaxy began its journey around 2.5 mya; around the same time that Homo habilis first appeared.)Click here to return to the timelineHomo erectus. Photo: ©Neanderthal MuseumFossils of Homo erectus are found in many places in Asia, Europe and Africa. This species travelled widely and was the longest surviving hominin species on earth.It is thought that Homo erectus evolved from Homo habilis about 2 mya. The oldest fossils of H. erectus have been found both in China (dated 2.12 mya) and South Africa (2.04 mya), making it impossible as yet, to determine where H. erectus first evolved.Homo erectus had an average brain capacity of 1000 cc, the largest of any hominin to date. It also had a flat face and human body proportions.Fossils of H. erectus are often associated with Acheulean* stone tools, which are mostly chunky hand axes. This indicates that the wrists and hands of H. erectus had become stronger and more dexterous than those of their predecessors.Homo erectus is also thought to be the first hominin to use fire in a controlled way.* These tools are named after Saint-Acheul, a suburb of Amiens in which they were first discovered.Numerous fossil specimens of H. erectus have been found in Asia (Peking Man, Nanjing Man), Europe (Tautavel Man), southeast Asia (Java Man) and Africa (called Homo ergaster).Many of these fossils have similar ages and it appears that H. erectus moved great distances and settled in different parts of the world during its existence on earth.Homo erectus is the longest surviving of all ancient hominin species. It is a potential ancestor of Homo heidelbergensis, an archaic human first discovered in Germany, which in turn may have been the latest common ancestor of Homo neanderthalensis and modern man.Click here to return to the timelineNeanderthals. Image ©Neanderthal MuseumNeanderthals were large-brained hunter-gatherers that evolved in Europe and Asia. They used fire, created art and clothing, and buried their dead in ritualized ways. They were not the direct ancestors of modern Homo sapiens.Archaic humans of species Homo neanderthalensis, otherwise known as Neanderthals, are well-known from fossil deposits in Europe and Asia.Neanderthals were slightly shorter than the average modern human but had larger brains. They were skilled tool makers and became specialized ice-age hunters. They survived for several hundred thousand years.Although Neanderthals are not the direct ancestors of modern humans, they are our closest known relatives.Scientists believe that Neanderthals and modern humans shared a common ancestor – possibly Homo heidelbergensis – that lived around 800,000 ya.After their appearance in Africa, some modern humans migrated into Europe, where they came into contact with Neanderthals. It is thought that interbreeding took place between the species. Today, people of European origin share as much as 4% of their genes with Neanderthals.The numbers of Neanderthals began to decrease around 50,000 ya, and there is evidence of inbreeding and disease in their populations. Around 35,000 ya, the last group of Neanderthals died out and left our species, Homo sapiens, as the last remaining representative of millions of years of hominin evolution.Click here to return to the timelineA reconstruction of the earliest-known Homo sapiens, discovered at Jebel Irhoud in Morocco. Image ©Neanderthal MuseumThe oldest fossil remains of Homo sapiens yet to be found are from Jebel Irhoud, in Morocco. They are around 315,000 years old. The very oldest fossils of anatomically modern humans, Homo sapiens, were discovered at sites at Jebel Irhoud, Morocco. Others from Ethiopia in East Africa (dated at 196,000 and 160,000 ya), and from South Africa (dated at 259,000 ya), also indicate that our species evolved in Africa at least some time before this.DNA evidence from human chromosomes indicates that H. sapiens may actually have first appeared more than half a million years ago.The five people whose remains were found fossilized at Jebel Irhoud in Morocco, and who represent the oldest known modern humans, looked very much like us. Their faces were flat, like ours, and their teeth and jaws were the same, although slightly larger. They did, however, have more elongated skulls, unlike the rounded skulls of modern humans.Although Homo sapiens evolved in Africa, the species soon began to roam. The oldest fossils of modern humans outside Africa have been found in Greece, and are dated to 210,000 ya. It is thought that several early migrations out of Africa occurred, but that the descendants of these migrants did not survive in the long term.Click here to return to the timelineEarly human. Image ©Neanderthal MuseumSometime around 75,000 ya, a small group of people dispersed from East Africa and began to settle outside the continent, resulting in the lasting spread of modern people throughout the world.It is estimated that a group of fewer than 1000 people crossed the Red Sea Straight into Yemen around 75,000 ya. They gradually populated the southern coasts of Arabia and southeast Asia.Groups of these people also moved northwards and had arrived in Europe by 40,000 ya. The first settlers in Australia arrived around 50,000 ya, and the Americas were populated by 23,000 ya. Within the space of about 50,000 years, Homo sapiens had dispersed all around the world.DNA analysis of living humans indicates that all modern people of non-African ancestry are descended from individuals in the small group that walked out of Africa around 75,000 years ago.Click here to return to the timelineThe timeline above lists some of the most important steps in the fascinating process of human evolution.The timeline of human evolution is produced by analyzing fossilized remains. However, fossilization is an uncommon and unpredictable process. The fossil record has more gaps than fossils; trying to connect them up is like doing a jigsaw puzzle with most of the pieces missing.Although scientists have identified around 20 different species of human ancestors from the fossilized remains of skeletons, the relationships between these ancient hominins are not easy to establish.It is tempting to think that, if we place the fossils in order of age, they will reveal the path of human evolution.But we now know that human evolution is not a chain-like sequence, with one species evolving into the next until the eventual appearance of Homo sapiens.Instead, many early hominin species co-existed and not all gave rise to new species. Many became extinct with no descendants.This makes it difficult to know how relevant each fossil species is in terms of the human evolution timeline.The current understanding is that human ancestors include species of Australopithecus (between 4 and 2 mya), Homo habilis (2.2–2 mya) and Homo erectus (2–0.5 mya).

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Health & Medicine Genetics & Evolution Ask the Chatbot a Question human evolutionThe divergence of humans and great apes from a common ancestor.It is generally agreed that the taproot of the human family shrub is to be found among apelike species of the Middle Miocene Epoch (roughly 16–11.6 mya) or Late Miocene Epoch (11.6–5.3 mya). Genetic data based on molecular clock estimates support a Late Miocene ancestry. Various Eurasian and African Miocene primates have been advocated as possible ancestors to the early hominins, which came on the scene during the Pliocene Epoch (5.3–2.6 mya). Though there is no consensus among experts, the primates suggested include Kenyapithecus, Griphopithecus, Dryopithecus, Graecopithecus (Ouranopithecus), Samburupithecus, Sahelanthropus, and Orrorin. Kenyapithecus inhabited Kenya and Griphopithecus lived in central Europe and Turkey from about 16–14 mya. Dryopithecus is best known from western and central Europe, where it lived from 13 to possibly 8 mya. Graecopithecus lived in northern and southern Greece about 9 mya, at roughly the same time as Samburupithecus in northern Kenya. Sahelanthropus inhabited Chad between 7 and 6 million years ago. Orrorin was from central Kenya 6 mya. Among these, the most likely ancestor of great apes and humans may be either Kenyapithecus or Griphopithecus. Among evolutionary models that stress the Eurasian species, some consider Graecopithecus to be ancestral only to the human lineage, containing Australopithecus, Paranthropus, and Homo, whereas others entertain the possibility that Graecopithecus is close to the great-ape ancestry of Pan (chimpanzees and bonobos) and Gorilla as well. In the former model, Dryopithecus is ancestral to Pan and Gorilla. On the other hand, others would have Dryopithecus ancestral to Pan and Australopithecus on the way to Homo, with Graecopithecus ancestral to Gorilla. This morphology-based model mirrors results of some molecular studies, which show chimpanzees, bonobos, and humans to be more closely related to one another than any of them is to gorillas; orangutans (Pongo) are more distantly related. In a phylogenetic model that emphasizes African Miocene species, Samburupithecus is ancestral to Australopithecus, Paranthropus, and Orrorin, and Orrorin begets Au. afarensis, which is ancestral to Homo. The Miocene Epoch was characterized by major global climatic changes that led to more seasonal conditions with increasingly colder winters north of the Equator. By the Late Miocene, in many regions inhabited by apelike primates, evergreen broad-leaved forests were replaced by open woodlands, shrublands, grasslands, and mosaic habitats, sometimes with denser-canopied forests bordering lakes, rivers, and streams. Such diverse environments stimulated novel adaptations involving locomotion in many types of animals, including primates. In addition, there were a larger variety and greater numbers of antelope, pigs, monkeys, giraffes, elephants, and other animals for adventurous hominins to scavenge and perhaps kill. But large cats, dogs, and hyenas also flourished in the new environments; they not only would provide meat for scavenging hominins but also would compete with and probably prey upon them. In any case, our ancestors were not strictly or even heavily carnivorous. Instead, a diet that relied on tough, abrasive vegetation, including seeds, stems, nuts, fruits, leaves, and tubers, is suggested by primate remains bearing large premolar and molar teeth with thick enamel. Behaviour and morphology associated with locomotion also responded to the shift from arboreal to terrestrial life. The development of bipedalism enabled hominins to establish new niches in forests, closed woodlands, open woodlands, and even more open areas over a span of at least 4.5 million years. Indeed, obligate terrestrial bipedalism (that is, the ability and necessity of walking only on the lower limbs) is the defining trait required for classification in the human tribe, Hominini. Bipedalism is not unique to humans, though our particular form of it is. Whereas most other mammalian bipeds hop or waddle, we stride. H. sapiens is the only mammal that is adapted exclusively to bipedal striding. Unlike most other mammalian orders, the primates have hind-limb-dominated locomotion. Accordingly, human bipedalism is a natural development from the basic arboreal primate body plan, in which the hind limbs are used to move about and sitting upright is common during feeding and rest. The initial changes toward an upright posture were probably related more to standing, reaching, and squatting than to extended periods of walking and running. Human beings stand with fully extended hip and knee joints, such that the thighbones are aligned with their respective leg bones to form continuous vertical columns. To walk, one simply tilts forward slightly and then keeps up with the displaced centre of mass, which is located within the pelvis. The large muscle masses of the human lower limbs power our locomotion and enable a person to rise from squatting and sitting postures. Body mass is transferred through the pelvis, thighs, and legs to the heels, balls of the feet, and toes. Remarkably little muscular effort is expended to stand in place. Indeed, our large buttock, anterior thigh, and calf muscles are virtually unused when we stand still. Instead of muscular contraction, the human bipedal stance depends more on the way in which joints are constructed and on strategically located ligaments that hold the joints in position. Fortunately for paleoanthropologists, some bones show dramatic signs of how a given hominin carried itself, and the adaptation to obligate terrestrial bipedalism led to notable anatomic differences between hominins and great apes. These differences are readily identified in fossils, particularly those of the pelvis and lower limbs. Although we are bipedal, our pelvis is oriented like that of quadrupedal primates. The early bipedal hominins assumed erect trunk posture by bending the spine upward, particularly in the lower back (lumbar region). In order to transfer full upper-body mass to the lower limbs and to reposition muscles so that one could walk without assistance from the upper limbs and without wobbling from side to side, changes were required in the pelvis—particularly in the ilia (the large, blade-shaped bones on either side), the ischia (protuberances on which body rests when sitting), and the sacrum (a wedge-shaped bone formed by the fusing of vertebrae). Hominin hip bones have short ilia with large areas that articulate with a short, broad sacrum. Conversely, great-ape hip bones have long ilia with small sacral articular areas, and sacra of the great apes are long and narrow. The human pelvis is unique among primates in having the ilia curved forward so that the inner surfaces face one another instead of being aligned sideways, as in apes and other quadrupeds. Curved ilia situate some of the gluteal muscles on the side of the hip joint, where they steady the pelvis as the foot swings forward during a step. This special mechanism allows us to walk smoothly, with only slight oscillations of the pelvis and without gross side-to-side motions of the upper body. Humans have short ischia (and long lower limbs), facilitating speedy actions of the hamstring muscles, which extend the thigh at the hip joint, while great apes have long ischia (and short hind limbs), which give them powerful hip extension for climbing up trees. Characteristically, a human thighbone is long and has a very large, globular head and a short, round neck; at the knee a prominent lateral ridge buttresses the groove in which the kneecap lies. The femurs are farther apart at the hips than at the knees and slant toward the midline to keep the knees close together. This angle allows anthropologists to diagnose bipedalism even if the fossil is only the knee end of a femur. The femurs of quadrupedal great apes, on the other hand, do not converge toward the knees, and the femoral shafts lack telltale angling. Human feet are distinct from those of apes and monkeys. This is not surprising, since in humans the feet must support and propel the entire body on their own instead of sharing the load with the forelimbs. In humans the heel is very robust, and the great toe is permanently aligned with the four diminutive lateral toes. Unlike other primate feet, which have a mobile midfoot, the human foot possesses (if not requires) a stable arch to give it strength. Accordingly, human footprints are unique and are readily distinguished from those of other animals. Health & Medicine Genetics & Evolution Ask the Chatbot a Question hominid fossil sitesA selection of locations in sub-Saharan Africa where hominid fossils have been found. The section Background and beginnings in the Miocene describes certain global climatic changes that reduced forested areas and induced more open terrestrial biomes during the late Miocene Epoch (11.2–5.3 mya). During the succeeding Pliocene Epoch (5.3–2.6 mya) these changes only intensified. In Africa, primates diversified. In Eurasia, contrarily, hominins disappeared by the beginning of the Pliocene. The only descendants of Late Miocene primates in Asia are the extinct Early-Middle Pleistocene Gigantopithecus blacki of southern China and northern Vietnam and the present-day orangutans and gibbons of South and Southeast Asia. It is reasonable to expect that the increased variety and shifting distribution of African biomes stimulated new hominin lifeways, some of which led to survival and others of which did not. Insofar as habitats have been (or can be) discerned from evidence found with the Pliocene hominin species, hominins inhabited a variety of biomes in eastern, central, and southern Africa. In central Ethiopia, Ar. ramidus is associated with faunal and floral remains indicating a woodland habitat. Later remains, in northern Ethiopia, indicate Au. afarensis inhabited a mosaic of riverine forest, lowland woodland, savanna, and dry bushland. In northern Kenya Au. anamensis lived in dry open woodland or bushland with a gallery forest along a nearby river. In central Chad the northernmost and westernmost species, Au. bahrelghazali, appears to have lived in a mosaic of open and wooded biomes near a river. Mammalian fossils from Lomekwi, northern Kenya, indicate that Kenyanthropus platyops inhabited a relatively well-watered area of forest or closed woodland or the forest edge between them. The habitat of the 3.5-million-year-old Laetoli hominins in northern Tanzania was arguably a mosaic of open grassland and more-closed woodland. The area may have been wetter than it is now. No permanent water source has been identified for the Laetoli area during the Pliocene. Later in the Pliocene, Au. garhi was active on broad, grassy plains bordering a lake in central Ethiopia. Models of the habitat of Au. africanus, based on fauna from the two major South African cave sites—Sterkfontein and Makapansgat—stress closed-canopy wooded conditions: either dry woodland with grasslands nearby or subtropical forest. During the tenures of H. habilis and P. boisei at Olduvai Gorge, northern Tanzania, the climate changed from moist to dry and again to moist before a long dry span that began two million years ago. Specimens of both of these Olduvai hominins are mostly from the shore of an ancient saline, alkaline lake. At Koobi Fora, northern Kenya, specimens of H. habilis have been more commonly found in lake-margin deposits, while those of P. boisei are equally common in river and lake-margin sediments. Fossil pollen indicates that highland forest was nearby and that near the lake there were grassy areas and dense woodland and shrubland. At Konso, southern Ethiopia, P. boisei lived in a grassland habitat. Elsewhere in eastern Africa, P. aethiopicus was associated with closed habitats. The South African cave sites (Swartkrans, Kromdraai, and Drimolen) of P. robustus are associated with open and even arid habitats, but these may not reflect its actual foraging preference. One of the more profound effects of Pliocene habitat changes was honing the energy-conservant bipedal stride at the time that Homo species deployed out of Africa and into Eurasia. Shortly after Homo evolved in Africa, some species ventured to temperate biomes in Eurasia and then to subtropical and tropical biomes in South and Southeast Asia. Subsequently there was a migration back to Africa, perhaps as early as 1.8–0.9 mya. This hemispheric dispersion of Homo is associated with elaboration of stone tool kits, increased brain size, and reduction in size of the jaws and teeth—all of which are the subject of the next section. Primates are hand-to-mouth feeders that pluck and catch items selectively by hand before ingesting them. Without tools, emergent hominins would have relied on the versatility and strength of their hands to collect food and on their teeth and jaws alone to process it. Unless they used tools to fashion carrying devices such as bags from animal skins, they would have needed a reliable source of water nearby, and they would also have been limited in the types and number of objects that they could transport through their range. In addition to transporting objects and water, there is the more obvious utility of animal skins in protecting against night chills, rain, and strong sunshine. Sharp-edged stones, even small flakes, would be a boon to early hominins who learned how to select and make them for cutting hides, meat, sticks, and other plant material. Stones also would assist in pounding open hard-shelled fruits and nuts, bones for marrow, and skulls for brains. There may have been a span when early hominins used naturally occurring stones and other objects as tools and weapons, much as some wild chimpanzees do today. Before hominins controlled fire and either built sturdy shelters on the ground or effectively defended caves and rock shelters, they may have constructed platforms in trees for daily activities as well as night lodging. Raw materials, stone hammers, cutting tools, and sticks and stones for defense could be stored in the trees to be used repeatedly. Handheld rocks, clubs, and long stabbing sticks, spears, or other missiles would constitute a formidable defense, especially if employed from the vantage of a tree platform. What was the first human species?Learn about early species in the genus Homo and scholarly debates over what defines being human.See all videos for this articleBy about 3.3 million years ago, some hominins were making and using simple stone artifacts in eastern Africa. The tools—primitive hammers, anvils, and cutting tools—predate the emergence of the oldest confirmed specimens of Homo by nearly 1 million years, and paleontologists speculate that they were likely constructed by members of Australopithecus or Kenyanthropus, who then inhabited the region. Because the earliest stone artifacts were of such simple construction and because chimpanzees, orangutans, and capuchin monkeys today can employ stones, stems, vines, and sticks to extract nutritious morsels from protective covers, one need not expect that early hominin toolmakers displayed modern hand structure and exquisite motor control. Nonetheless, the unique structure of the human hand is readily explained by a substantial history of producing and using increasingly complex tool kits and other artifacts. (Attributing specific advancements in artifact manufacture to the threefold increase in brain size between Pliocene hominins and H. sapiens is a much more difficult hypothesis to support, as will be discussed later in this section.) The features of human hands are easily distinguishable from those of the great apes, and they underpin our refined manipulatory abilities. The most complex adaptations of the human hand involve the thumb, wherein a unique, fully independent muscle (the flexor pollicis longus) gives this digit remarkable strength in pinch and power grips. The fingertips are broad and equipped with highly sensitive pads of skin. The proportional lengths of the thumb and other fingers give us an opposable thumb with precise, firm contact between its tip and the ends of each of the other fingers. A special saddle joint and associated ligaments at the base of the thumb facilitate refined rotation. Special configurations of joints at the bases of the fifth, fourth, and second fingers facilitate tip-to-tip precision grips with the thumb. Asymmetry of the heads of the second and fifth palm bones induces rotation of the articulated fingers during opposition with the thumb. Finally, numerous modifications of the small muscles in the hand are associated with fine control of the thumb and fingers. Au. afarensis is the earliest hominin species for which there are sufficient fossil hand bones to assess manipulatory capabilities. They were capable of gripping sticks and stones firmly for vigorous pounding and throwing, but they lacked a fully developed human power grip that would allow cylindrical objects to be held between the partly flexed fingers and the palm, with counterpressure being applied by the thumb. There are insufficient specimens to assess fine manipulation in Australopithecus, but there is no reason to believe that they were less capable than modern chimpanzees. Chimpanzees and other apes have remarkable precision of grip, even though the tapered thumb tip must be pressed against the side of the index finger and cannot be apposed securely to any of the fingertips. Hand bones assigned to a 1.8-million-year-old specimen of H. habilis from Olduvai Gorge in northern Tanzania represent an advance over those of A. afarensis in features related to tool use. Tools similar to those found at Olduvai are found associated with H. habilis from other parts of eastern Africa as well. The tips of its thumb and fingers were flat, and there is evidence for a strong flexor pollicis longus muscle and a saddle joint at the base of the thumb. Hand bones arguably assigned to P. robustus or Homo from Swartkrans, South Africa, confirm that by about 1.8 mya one or more hominin species had highly developed thumbs and flat fingertips. Hominin hand bones from 2.8–2.5-million-year-old cave deposits at Sterkfontein, South Africa, may be evidence that the hands of A. africanus were somewhat more advanced for stone tool use, but no artifact has been found in association with them. Younger Sterkfontein deposits (2.0–1.5 mya) contain stone artifacts and remains of a Homo species. Because of an absence of fossils, it is not possible to track certain refinements in hand structure that must have evolved in conjunction with innovations in tool manufacture and use during the heydays of H. rudolfensis, H. ergaster (1.9–1.5 mya), and H. erectus (1.7–0.2 mya), as well as H. antecessor (1.0–0.8 mya) and H. heidelbergensis (600–200 kya). Only prehistoric and modern H. sapiens and H. neanderthalensis are fully represented by hand skeletons. A discussion regarding the future of Palaeos has just started as of this writing (2020-06-07) over on the Facebook page. The gist is that sustainable funding to keep the lights on and advance the site is a necessity best resolved early than late. As such we're trying to find if there's enough audience for that and which avenues to take for that possible support. Much obliged for your consideration. Palaeos is currently undergoing a major revision (hence many links won't be working yet), but hopefully everything should be fixed and ready soon. As such the site administrators would request people who find these lines to keep quiet about the site until we are ready to announce it publicly. Thank you for your courtesy.Considering the recent actions of one of us (RFVS), it could be said that the jig is up. We're providing more manageable means for extensive feedback here. For that feedback of the immediate kind, please refer to our Facebook page. | Classification | Plant Evolution | Animal Evolution | Homology | For many people animals are perhaps the most familiar, and most interesting, of living things. This may be because we are animals ourselves. As such, we have a number of features in common with all the organisms placed in the animal kingdom, and these common features indicate that we have a shared evolutionary history. All animals and plants are classified as multicellular eukaryotes: their bodies are made up of large numbers of cells, and microscopic inspection of these cells reveals that they contain a nucleus and a number of other organelles. Compared to prokaryotic organisms such as bacteria, plants and animals have a relatively recent evolutionary origin. DNA evidence suggests that the first eukaryotes evolved from prokaryotes, between 2500 and 1000 million years ago. That is, eukaryotes as a taxon date from the Proterozoic Era, the final Era of the Precambrian. Fossils of both simple unicellular and more complex multicellular organisms are found in abundance in rocks from this period of time. In fact, the name "Proterozoic" means "early life". Plants and animals both owe their origins to endosymbiosis, a process where one cell ingests another, but for some reason then fails to digest it. The evidence for this lies in the way their cells function. Both plant and animal rely on structures called mitochondria to release energy in their cells, using aerobic respiration to produce the energy-carrying molecule ATP. There is considerable evidence that mitochondria evolved from free-living aerobic bacteria: they are the size of bacterial cells; they divide independently of the cell by binary fission; they have their own genome in the form of a single circular DNA molecule; their ribosomes are more similar to those of bacteria than to the ribosomes found in the eukaryote cell's cytoplasm; and like chloroplasts they are enclosed by a double membrane as would be expected if they derived from bacterial cells engulfed by another cell. Like the plants, animals evolved in the sea. And that is where they remained for at least 600 million years. This is because, in the absence of a protective ozone layer, the land was bathed in lethal levels of UV radiation. Once photosynthesis had raised atmospheric oxygen levels high enough, the ozone layer formed, meaning that it was then possible for living things to venture onto the land. The oldest fossil evidence of multicellular animals, or metazoans, is burrows that appear to have been made by smooth, wormlike organisms. Such trace fossils have been found in rocks from China, Canada, and India, but they tell us little about the animals that made them apart from their basic shape. Between 620 and 550 million years ago (during the Vendian Period) relatively large, complex, soft-bodied multicellular animals appear in the fossil record for the first time. While found in several localities around the world, this particular group of animals is generally known as the Ediacaran fauna, after the site in Australia where they were first discovered. The Ediacaran animals are puzzling in that there is little or no evidence of any skeletal hard parts i.e. they were soft-bodied organisms, and while some of them may have belonged to groups that survive today others don't seem to bear any relationship to animals we know. Although many of the Ediacaran organisms have been compared to modern-day jellyfish or worms, they have also been described as resembling a mattress, with tough outer walls around fluid-filled internal cavities - rather like a sponge. As a group, Ediacaran animals had a flat, quilted appearance and many showed radial symmetry. They ranged in size form 1cm to >1m, and have been classified into three main groups on the basis of their shape: discoidal, frond-like, or ovate-elongate. The large variety of Ediacaran animals is significant, as it suggests there must have been a lengthy period of evolution prior to their first appearance in the fossil record. The Ediacaran animals disappear from the fossil record at the end of the Vendian (544 million years ago). In their place we find representatives of almost all the modern phyla recognised today: sponges, jellyfish and corals, flatworms, molluscs, annelid worms, insects, echinoderms and chordates, plus many "lesser" phyla such as nemertean worms. These "modern" organisms appear relatively quickly in the geological time scale, and their abrupt appearance is often described as the "Cambrian explosion" however, bear in mind that the fossil record of the "explosion" is spread over about 30 million years. I keep taking things out of brackets because it is interesting relevant and memorable One of the most famous assemblages of Cambrian fossils comes from the Burgess Shale of British Colombia. The rocks of the Burgess Shale were laid down in the middle Cambrian, when the "explosion" had already been underway for several million years. They contain familiar animals such as trilobites, molluscs and echinoderms, but also the first appearance of brachiopods, and some odd animals, e.g. Opabinia, that may have belonged to extinct phyla. Even an early chordate, Pikaia, has been found in this fossil assemblage. The Burgess Shale fossils are important, not only for their evidence of early variety among animal forms, but also because both soft parts of animals and their hard bodies (i.e. the whole animal) is preserved, and animals that were entirely soft-bodied. Preservation of soft-bodied organisms is rare, and in this case seems to have occurred when the animals were rapidly buried in a mudslide down into deep, anaerobic waters, where there was little bacterial decay. Prior to the discovery of this fossil assemblage, early in the 20th century, there was no evidence of soft-bodied animals from the Cambrian (remember that this is before the Ediacaran fauna were found). These fossils also provide good evidence of predatory animals (e.g. Anomalocaris), and therefore of complex predator-prey relationships. They also give insights into how evolution might have progressed relatively early in the history of multicellular animals, and in fact some authors view the Cambrian as a period of extreme "experimentation" and diversity. The cause of the proliferation of animal forms in the Cambrian is a matter of considerable debate among scientists. Some point to the increase in atmospheric oxygen levels that began around 2000 million years ago, supporting a higher metabolic rate and allowing the evolution of larger organisms and more complex body structures. Changed ocean chemistry would have played a part here, allowing for the first time the development of hard body parts such as teeth and supporting skeletons based on calcium carbonate (CaCO3), and also supporting higher levels of primary production as a result of increased concentrations of phosphates and nitrates. The mass extinction that marked the end of the Vendian period would have opened up ecological niches that the new animals exploited, as would habitat changes wrought by continental drift. Genetic factors were also crucial. Recent research suggests that the period prior to the Cambrian explosion saw the gradual evolution of a "genetic tool kit" of genes (the homeobox or "hox" genes) that govern developmental processes. Once assembled, this genetic tool kit enabled an unprecedented period of evolutionary experimentation -- and competition. Many forms seen in the fossil record of the Cambrian disappeared without trace. Future evolutionary change was then limited to acting on the body plans that remained in existence. Recently many scientists have begun to question whether the Cambrian explosion was a real event, or a reflection of the patchiness of this ancient fossil record. Genetic data suggest that multicellular animals evolved around 1000 million years ago; this is supported by fossil embryos from rocks in China that date back 600 million years. These embryos are more complex than those of simple organisms such as sponges and jellyfish, which suggests that multicellular animals must have evolved much further back in time. In addition, trilobites were a very diverse group even early in the Cambrian, and some scientists suggest that this indicates that the arthropod group must have had a much earlier evolutionary origin. Whatever their origins, animals may have ventured onto land early in the Cambrian. Previously scientists believed that animals did not begin to colonise the land until the Silurian (440 - 410 million years ago). However, the 2002 discovery of the footprints of animals that scuttled about on sand dunes about 530 million years ago has changed this view. These animals were arthropods, and resembled centipedes about the size of crayfish. They probably didn't live on land, instead coming ashore to mate or evade predators. At this time the only land plants appear to have resembled mosses . Animals continued to diversify in the Ordovician seas (505 - 440 million years ago). They were mostly invertebrates, including graptolites , which were stick-like branching colonies of tiny animals, together with brachiopods, trilobites, cephalopods, corals, crinoids and conodonts. We now place the conodonts with the chordates, but for a long time they were known only by their tiny, but very common, teeth. In terms of number of species invertebrates were by far the most common Ordovician animals - as they still are today. However, members of another taxon were also evolving in the Ordovician seas. These were the fish. Like the conodonts, fish are members of the chordate phylum because they display certain defining characteristics: a dorsal stiffening rod called the notochord, a dorsal nerve cord, pharyngeal gill slits and a tail that extends beyond the anus. However, fish are placed in the subphylum Vertebrata , because they also show the development of skeletal features such as a backbone, skull, and limb bones. Not all the modern groups of fish were represented in the Ordovician oceans. At this time only the jawless fish had evolved from a chordate ancestor. The sharks and their relatives and two extinct groups, the placoderms (which had bony plates covering their heads) and the acanthodians (the first known jawed vertebrates, with a skeleton of cartilage) made their appearance in the Silurian. However, neither the sharks nor the agnathans became common until the Devonian. The other two living lineages, the ray-finned (e.g. carp and kahawai) and the lobe-finned fish (e.g. lungfish and the coelacanth), evolved during the Devonian period. Agnathans, or jawless fish, were the earliest fish: an excellent fossil of Haikouichthys ercaicunensis dates back about 530 million years, to the Cambrian. Previously the earliest-known agnathans were dated to around 480 million years ago. Agnathans have traditionally been placed with the vertebrates due to the presence of a skull, although the modern forms such as hagfish lack a vertebral column. The earliest agnathans were Ostracoderms. They were bottom-feeders and were almost entirely covered in armour plates. When the sharks and bony fish began to evolve, around 450 million years ago, most ostracoderms became extinct. Only the lineage that produced the modern hagfish and lampreys survived. Fish continued to evolve during the Silurian period (440 - 410 million years ago). At the same time some groups of plants and animals took a major step as they colonised the land for the first time. We are not sure why this advance occurred, but it was probably the result of competition in the marine ecosystems, plus the opportunity to escape predators and the availability of new terrestrial niches. Arthropods, which had ventured temporarily onto land 100 million years earlier, were the first animals to become more permanent colonists. Fossil footprints made in the sandy flats surrounding temporary lakes dating back about 420 million years have been found in Western Australia. The arthropods were pre-adapted to life on land. By the time they moved ashore, they had already evolved lighter bodies and slim, strong legs that could support them against the pull of gravity. Their hard outer exoskeletons provided protection and would help to retain water, although the development of a waxy, waterproof cuticle was necessary for efficient water conservation. Spiders, centipedes and mites were among the earliest land animals. Some of them were giants: the largest was Slimonia, the size of a man and a relative of the scorpions. This animal was still too big and too heavy and the walking legs too small to venture onto land for any length of time and so they lived in marginal marine (deltaic) environments. These early land animals had to solve the same problems that plants faced when they moved to the land: water conservation, gas exchange, reproduction and dispersal, and the fact that water no longer buoyed them up against the pull of gravity. Like plants, animals evolved waterproof external layers, internal gas exchange systems, ways of reproducting that did not involve water, and strong support systems (endoskeletons and exoskeletons) that allowed them to move about on land. Remember that not all animal taxa were equally successful in solving these problems. By the Devonian period two major animal groups dominated the land: the tetrapods (4-legged terrestrial vertebrates) and the arthropods, including arachnids and wingless insects. The first tetrapods were amphibians, such as Ichthyostega, and were closely related to a group of fish known as lobe-finned fish e.g. Eusthenopteron . Once thought to be extinct, the coelacanth is a living representative of this group. Eusthenopteron had a number of exaptations that pre-adapted it to life on land: it had limbs (with digits) that allowed it to move around on the bottom of pools, lungs - which meant it could gulp air at the surface, and the beginnings of a neck. This last is important as a terrestrial predator cannot rely on water current to bring food into its mouth, but must move its head to catch prey. And the bones in Eusthenopteron's fins are almost identical to those in the limbs of the earliest amphibians, an example of homology. Ichthyostega's skull was almost identical to that of the lobe-finned fish Eusthenopteron, a definite neck separated its body from its head, and it retained a deep tail with fins. While Ichthyostega had four strong limbs, the form of its hind legs suggests that it did not spend all its time on land. All modern tetrapods have a maximum of 5 digits on each limb, and are thus said to have a pentadactyl limb. For a long time scientists believed that pentadactyly was the ancestral state for tetrapods. However, careful examination of the fossils of early amphibians such as Ichthyostega and Acanthostega has revealed the presence of up to 8 toes on each foot! In addition, these early amphibians were large-bodied animals with strong bodies and prominent ribs - quite different in appearance from modern representatives such as frogs and axolotls. It was originally believed that the tetrapods evolved during periods of drought, when the ability to move between pools would be an advantage. The animals would also have been able to take advantage of terrestrial prey, such as arthropods. Juvenile animals could avoid predation by the land-based adults by living in shallow water. However, fossil and geological evidence tells us that the early tetrapods lived in lagoons in tropical regions, so that drought was not an issue. They were unlikely to be feeding on land: arthropods are small and fast-moving, unlikely prey for large, sluggish amphibians. But amphibians that laid their eggs on land, rather than in water, would be at a selective advantage, avoiding predation by aquatic vertebrates (such as other amphibians and fish) on gametes, eggs and hatchlings. Even today some amphibians e.g. the Eleutherodactylid frogs of Australia and Indonesia lay their eggs in soil on the land. However, they must still be in a moist environment, and the size of the egg is restricted to less than 1.5cm in diameter. This is because the egg is dependent on diffusion alone for gas exchange, and means that the embryo must develop rapidly into a food-seeking larval form rather than undergo prolonged development within the egg. In the Devonian seas, brachiopods had become a dominant invertebrate group, while the fish continued to evolve, with sharks becoming the dominant marine vertebrates. The placoderms and acanthodian fish were quite diverse during the Devonian, but their numbers then dwindled rapidly and both groups became extinct by the end of the Carboniferous period. Lobe-finned fish also peaked in numbers during the Devonian. One of the greatest evolutionary innovations of the Carboniferous period (360 - 268 million years ago) was the amniotic egg, which allowed early reptiles to move away from waterside habitats and colonise dry regions. The amniotic egg allowed the ancestors of birds, mammals, and reptiles to reproduce on land by preventing the embryo inside from drying out, so eggs could be laid away from the water. It also meant that in contrast to the amphibians the reptiles could produce fewer eggs at any one time, because there was less risk of predation on the eggs. Reptiles don't go through a larval food-seeking stage, but undergo direct development into a miniature adult form while in the egg, and fertilisation is internal. The earliest date for development of the amniotic egg is about 320 million years ago. However, reptiles didn't undergo any major adaptive radiation for another 20 million years. Current thinking is that these early amniotes were still spending time in the water and came ashore mainly to lay their eggs, rather than to feed. It wasn't until the evolution of herbivory that new reptile groups appeared, able to take advantage of the abundant plant life of the Carboniferous. Early reptiles belonged to a group called the cotylosaurs. Hylonomus and Paleothyris were two members of this group. They were small, lizard-sized animals with amphibian-like skulls, shoulders, pelvis and limbs, and intermediate teeth and vertebrae. The rest of the skeleton was reptilian. Many of these new "reptilian" features are also seen in little, modern, amphibians (which may also have direct-developing eggs laid on land e.g. New Zealand's leiopelmid frogs, so perhaps these features were simply associated with the small body size of the first reptiles. A major transition in the evolution of life occurred when mammals evolved from one lineage of reptiles. This transition began during the Permian (286 - 248 million years ago), when the reptile group that included Dimetrodon gave rise to the "beast-faced" therapsids. (The other major branching, the "lizard-faced" sauropsids, gave rise to birds and modern reptiles). These mammal-like reptiles in turn gave rise to the cynodonts e.g. Thrinaxodon during the Triassic period. This lineage provides an excellent series of transitional fossils. The development of a key mammalian trait, the presence of only a single bone in the lower jaw (compared to several in reptiles) can be traced in the fossil history of this group. It includes the excellent transitional fossils, Diarthrognathus and Morganucodon, whose lower jaws have both reptilian and mammalian articulations with the upper. Other novel features found in this lineage include the development of different kinds of teeth (a feature known as heterodonty), the beginnings of a secondary palate, and enlargement of the dentary bone in the lower jaw. Legs are held directly underneath the body, an evolutionary advance that occurred independently in the ancestors of the dinosaurs. The end of the Permian was marked by perhaps the greatest mass extinction ever to occur. Some estimates suggest that up to 90% of the species then living became extinct. (Recent research has suggested that this event, like the better-known end-Cretaceous event, was caused by the impact of an asteroid.) During the subsequent Triassic period (248 - 213 million years ago), the survivors of that event radiated into the large number of now-vacant ecological niches. However, at the end of the Permian it was the dinosaurs, not the mammal-like reptiles, which took advantage of the newly available terrestrial niches to diversify into the dominant land vertebrates. In the sea, the ray-finned fish began the major adaptive radiation that would see them become the most species-rich of all vertebrate classes. One major change, in the group of reptiles that gave rise to the dinosaurs, was in the animals' posture. This changed from the usual "sprawling" mode, where the limbs jut sideways, to an erect posture, with the limbs held directly under the body. This had major implications for locomotion, as it allowed much more energy-efficient movement. The dinosaurs , or "terrible lizards", fall into two major groups on the basis of their hip structure: the saurischians (or "lizard-hipped" dinosaurs) and the ornithischians (misleadingly known as the "bird-hipped" dinosaurs). Ornithischians include Triceratops, Iguanodon, Hadrosaurus, and Stegosaurus). Saurischians are further subdivided into theropods (such as Coelophysis and Tyrannosaurus rex) and sauropods (e.g. Apatosaurus). Most scientists agree that birds evolved from theropod dinosaurs. Although the dinosaurs and their immediate ancestors dominated the world's terrestrial ecosystems during the Triassic, mammals continued to evolve during this time. Mammals are advanced synapsids. Synapsida is one of two great branches of the amniote family tree. Amniotes are the group of animals that produce an amniotic egg i.e. the reptiles, birds, and mammals. The other major amniote group, the Diapsida, includes the birds and all living and extinct reptiles other than the turtles and tortoises. Turtles and tortoises belong in a third group of amniotes, the Anapsida. Members of these groups are classified on the basis of the number of openings in the temporal region of the skull. Synapsids are characterised by having a pair of extra openings in the skull behind the eyes. This opening gave the synapsids (and similarly the diapsids, which have two pairs of openings) stronger jaw muscles and better biting ability than earlier animals. (The jaw muscles of a synapsid are anchored to the edges of the skull opening). Pelycosaurs (like Dimetrodon and Edaphosaurus) were early synapsids; they were mammal-like reptiles. Later synapsids include the therapsids and the cynodonts , which lived during the Triassic. Cynodonts possessed many mammalian features, including the reduction or complete absence of lumbar ribs implying the presence of a diaphragm; well-developed canine teeth, the development of a bony secondary palate so that air and food had separate passages to the back of the throat; increased size of the dentary - the main bone in the lower jaw; and holes for nerves and blood vessels in the lower jaw, suggesting the presence of whiskers. By 125 million years ago the mammals had already become a diverse group of organisms. Some of them would have resembled today's monotremes (e.g. platypus and echidna), but early marsupials (a group that includes modern kangaroos and possums) were also present. Until recently it was thought that placental mammals (the group to which most living mammals belong) had a much later evolutionary origin. However, recent fossil finds and DNA evidence suggest that the placental mammals are much older, perhaps evolving more than 105 million years ago. Note that the marsupial and placental mammals provide some excellent examples of convergent evolution , where organisms that are not particularly closely related have evolved similar body forms in response to similar environmental pressures. However, despite the fact that the mammals had what many people regard as "advanced" features, they were still only minor players on the world stage. As the world entered the Jurassic period (213 - 145 million years ago), the dominant animals on land, in the sea, and in the air, were the reptiles. Dinosaurs, more numerous and more extraordinary than those of the Triassic, were the chief land animals; crocodiles, ichthyosaurs, and plesiosaurs ruled the sea, while the air was inhabited by the pterosaurs. In 1861 an intriguing fossil was found in the Jurassic Solnhofen Limestone of southern Germany, a source of rare but exceptionally well-preserved fossils. Given the name Archeopteryx lithographica the fossil appeared to combine features of both birds and reptiles: a reptilian skeleton, accompanied by the clear impression of feathers. This made the find highly significant as it had the potential to support the Darwinians in the debate that was raging following the 1859 publication of "On the origin of species". While it was originally described as simply a feathered reptile, Archaeopteryx has long been regarded as a transitional form between birds and reptiles, making it one of the most important fossils ever discovered. Until relatively recently it was also the earliest known bird. Lately, scientists have realised that Archaeopteryx bears even more resemblance to the Maniraptora, a group of dinosaurs that includes the infamous velociraptors of "Jurassic Park", than to modern birds. Thus the Archaeopteryx provides a strong phylogenetic link between the two groups. Fossil birds have been discovered in China that are even older than Archaeopteryx, and other discoveries of feathered dinosaurs support the theory that theropods evolved feathers for insulation and thermo-regulation before birds used them for flight. This is an example of an exaptation. Closer examination of the early history of birds provides a good example of the concept that evolution is neither linear nor progressive. The bird lineage is messy, with a variety of "experimental" forms appearing. Not all achieved powered flight, and some looked quite unlike modern birds e.g. Microraptor gui, which appears to have been a gliding animal and had asymmetric flight feathers on all four limbs, while its skeleton is essentially that of a small dromaeosaur. Archaeopteryx itself did not belong to the lineage from which modern birds (Neornithes) have evolved, but was a member of the now-extinct Enantiornithes. A reconstruction of the avian family tree would show a many-branched bush, not a single straight trunk. Dinosaurs spread throughout the world - including New Zealand, which had its own dinosaur fauna - during the Jurassic, but during the subsequent Cretaceous period (145 - 65 million years ago) they were declining in species diversity. In fact, many of the typically Mesozoic organisms - such as ammonites, belemnites, gymnosperms, ichthyosaurs, plesiosaurs, and pterosaurs - were in decline at this time, despite the fact that they were still giving rise to new species. The origin of flowering plants (the angiosperms) during the early Cretaceous triggered a major adaptive radiation among the insects: new groups, such as butterflies, moths, ants and bees arose and flourished. These insects drank the nectar from the flowers and acted as pollinating agents in the process. The mass extinction at the end of the Cretaceous period, 65 million years ago, wiped out the dinosaurs along with every other land animal that weighed much more than 25 kg. This cleared the way for the expansion of the mammals on land. In the sea at this time, the fish again became the dominant vertebrate taxon. At the beginning of the Palaeocene epoch (65 - 55.5 million years ago) the world was without larger-sized terrestrial animals. This unique situation was the starting point for the great evolutionary diversification of the mammals, which up until then had been nocturnal animals the size of small rodents. By the end of the epoch, mammals occupied many of the vacant ecological niches. While mammal fossils from this period of time are scarce, and often consist largely of their characteristic teeth, we know that small, rodent-like insectivorous mammals roamed the forests, the first large herbivorous mammals were browsing on the abundant vegetation, and carnivorous mammals were stalking their prey. The oldest confirmed primate fossils date to about 60 million years ago, in the mid-Palaeocene. The early primates evolved from archaic nocturnal insectivores, something like shrews, and resembled lemurs or tarsiers (the prosimians). They were probably arboreal, living in tropical or subtropical forests. Many of their characteristic features are well suited for this habitat: hands specialised for grasping, rotating shoulder joints, and stereoscopic vision. They also have a relatively large brain size and nails on their digits, instead of claws. The earliest known fossils of most of the modern orders of mammals appear in a brief period during the early Eocene (55.5 - 33.7 million years ago). Both groups of modern hoofed animals, the Artiodactyla ("even-toed" taxa such as cows and pigs) and Perrisodactyla ("odd-toed" taxa, including the horses), became widespread throughout North America and Europe. The evolutionary history of the horses is particularly well understood: Stephen Jay Gould (1983) provides an excellent discussion of it in his book "Hens' teeth and horses' toes". At the same time as the mammals were diversifying on land, they were also returning to the sea. The evolutionary transitions that led to the whales have been closely studied in recent years, with extensive fossil finds from India, Pakistan, and the Middle East. These fossils chronicle the change from the land-dwelling mesonychids, which are the likely ancestors of whales, through animals such as Ambulocetus , which was still a tetrapod but which also has such whale-like features as an ear capsule isolated from the rest of its skull, to the primitive whales called the Archaeocetes. The trend towards a cooler global climate that occurred during the Oligocene epoch (33.7 - 23.8 million years ago) saw the appearance of the grasses, which were to extend into vast grasslands during the subsequent Miocene (23.8 - 5.3 million years ago). This change in vegetation drove the evolution of browsing animals, such as more modern horses, with teeth that could deal with the high silica content of the grasses. The cooling climate trend also affected the oceans, with a decline in the number of marine plankton and invertebrates. While DNA evidence suggests that the great apes evolved during the Oligocene, abundant fossils do not appear until the Miocene. Hominids, on the evolutionary line leading to humans, first appear in the fossil record in the Pliocene (5.3 - 1.8 million years ago). The story of human evolution is covered here - Human Evolution material. New Zealand, by virtue of its isolation and its relatively recent geological development, was not the centre of any novel evolutionary development. However, many of the species that date back to Gondwanaland, or that arrived more recently as migrants, have undergone significant adaptive radiation in their new homeland. Some of the best examples of this can be related to the major ecological changes that accompanied the Pleistocene Ice Ages. Throughout the Pleistocene there were about twenty cycles of cold glacial ("Ice Age") and warm interglacial periods at intervals of about 100,000 years. During the Ice Ages glaciers dominated the landscape, snow and ice extended into the lowlands, transporting huge quantities of rock with them. During these periods the South Island was extensively glaciated, and there were small glaciers on the Tararua Ranges and Central Plateau. Because a lot of water was locked up in ice, the sea levels dropped during the glacials (up to 135m lower than at present). Extensive land bridges joined the main and many offshore islands, allowing the migration of plants and animals. During the warmer periods large areas became submerged again under water. These repeated episodes of environmental fragmentation drove rapid adaptive radiation in many NZ species, especially (but not exclusively) the alpine plants. For example, speciation patterns in the native Placostylus flax snails of Northland can be related to changes in sea level. Originally 2-3 species were widespread at a time of low sea levels. Rising seas at the end of the glacial period isolated these as populations on offshore islands, where differential natural selection pressures led to the evolution of a greater number of separate species. The distribution of land snails such as Powelliphanta in Marlborough and the southern North Island also offers evidence for the presence of land bridges and the possibility of future speciation. The same varieties are found both north and south of Cook Strait, implying a continuous land bridge in the past as the animals die in salt water. The fact that no further speciation has occurred in this case suggests that the land bridge was recently submerged by rising seas, perhaps only 10,000 years ago. New Zealand Example For more information on NZ examples of evolution, click here. Reference Books Chambers, P. (2002) Bones of Contention: the fossil that shook science; John Murray, London Cowen, R. (1995) History of Life (2nd edition); Blackwell Scientific Publications Gould, Stephen Jay (1983) Hen's teeth and Horses' toes Strickberger, Monroe B. (2000) "Evolution" (3rd edition), published by Jones & Bartlett Share — copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt — remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution — You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Health & Medicine Genetics & Evolution Ask the Chatbot a Question human evolution, the process by which human beings developed on Earth from now-extinct primates. Viewed zoologically, we humans are Homo sapiens, a culture-bearing upright-walking species that lives on the ground and very likely first evolved in Africa about 315,000 years ago. We are now the only living members of what many zoologists refer to as the human tribe, Hominini, but there is abundant fossil evidence to indicate that we were preceded for millions of years by other hominins, such as Ardipithecus, Australopithecus, and other species of Homo, and that our species also lived for a time contemporaneously with at least one other member of our genus, H. neanderthalensis (the Neanderthals). In addition, we and our predecessors have always shared Earth with other apelike primates, from the modern-day gorilla to the long-extinct Dryopithecus. That we and the extinct hominins are somehow related and that we and the apes, both living and extinct, are also somehow related is accepted by anthropologists and biologists everywhere. Yet the exact nature of our evolutionary relationships has been the subject of debate and investigation since the great British naturalist Charles Darwin published his monumental books On the Origin of Species (1859) and The Descent of Man (1871). Darwin never claimed, as some of his Victorian contemporaries insisted he had, that "man was descended from the apes," and modern scientists would view such a statement as a useless simplification—just as they would dismiss any popular notions that a certain extinct species is the "missing link" between humans and the apes. There is theoretically, however, a common ancestor that existed millions of years ago. This ancestral species does not constitute a "missing link" along a lineage but rather a node for divergence into separate lineages. This ancient primate has not been identified and may never be known with certainty, because fossil relationships are unclear even within the human lineage, which is more recent. In fact, the human "family tree" may be better described as a "family bush," within which it is impossible to connect a full chronological series of species, leading to Homo sapiens, that experts can agree upon.(Read T. H. Huxley's 1875 Britannica essay on evolution & biology.)The primary resource for detailing the path of human evolution will always be fossil specimens. Certainly, the trove of fossils from Africa and Eurasia indicates that, unlike today, more than one species of our family has lived at the same time for most of human history. The nature of specific fossil specimens and species can be accurately described, as can the location where they were found and the period of time when they lived; but questions of how species lived and why they might have either died out or evolved into other species can only be addressed by formulating scenarios, albeit scientifically informed ones. These scenarios are based on contextual information gleaned from localities where the fossils were collected. In devising such scenarios and filling in the human family bush, researchers must consult a large and diverse array of fossils, and they must also employ refined excavation methods and records, geochemical dating techniques, and data from other specialized fields such as genetics, ecology and paleoecology, and ethology (animal behaviour)—in short, all the tools of the multidisciplinary science of paleoanthropology.This article is a discussion of the broad career of the human tribe from its probable beginnings millions of years ago in the Miocene Epoch (23 million to 5.3 million years ago [mya]) to the development of tool-based and symbolically structured modern human culture only tens of thousands of years ago, during the geologically recent Pleistocene Epoch (about 2.6 million to 11,700 years ago). Particular attention is paid to the fossil evidence for this history and to the principal models of evolution that have gained the most credence in the scientific community.See the article evolution for a full explanation of evolutionary theory, including its main proponents both before and after Darwin, its arousal of both resistance and acceptance in society, and the scientific tools used to investigate the theory and prove its validity. Humans, or Homo sapiens, are a species of upright-walking beings known for their cultural diversity, inhabiting the Earth's surface. Believed to have originated in Africa around 315,000 years ago, human evolution is a complex process involving the development of traits such as bipedalism and language, along with interbreeding with other hominin species.This evolution of humans is not a linear progression but rather a complex web of interactions and adaptations. Scientists study bones, stone tools, genes, and environmental conditions to understand how Homo sapiens emerged from earlier hominin ancestors and relatives, shedding light on our evolutionary journey. In this article, we will study the evolution of humans, characteristics, and stages of evolution. History of Human Evolution The term "human" originates from the Latin word "humanus," derived from "homo." The distinction of humans from gorillas was only recognized after 1859, coinciding with the publication of Charles Darwin's "On the Origin of Species." Darwin further explored human evolution in his 1871 book "The Descent of Man, and Selection in Relation to Sex" applying the concepts of evolution and sexual selection to human species.Humans evolved gradually. The course of evolution of man included a progression of changes that can make those species either adjust to the ongoing climate or become wiped out. Charles Darwin introduced thetheory of evolution by natural selection in his work "On the Origin of Species". Evolution is understood as genetic changes occurring in populations over generations. Ardipithecus is considered one of the earliest ancestors in human evolution, marking significant milestones in our species' development.Evolution of HumanCharacteristics of Evolution of HumansThe skulls were smaller in size than that of the current man.The volume of the brain between 600-700 c.c.Human had higher brows than in chimps and the face had more prominent facial structure.Distinct edges of the forehead were clear and easily identifiable.The occipital condyles were ventrally positioned The back of the skull was round in shape. They have huge jaws with small incisors.It additionally had enormous and spatulate canines Stages of Human EvolutionEvolution of man occured through several stages explained below:DryopithecusDryopithecus lived in Europe approximately 12.5 to 11 million years ago (Mya) and is considered one of the earliest known ancestors of humans. Discovered in 1856, Dryopithecus fossils have also been found in parts of Africa, Asia, and Europe. It is believed that Dryopithecus migrated from Europe or Western Asia to Africa. Scientists theorize that the evolution of humans began with Dryopithecus. AustralopithecusThey evolved in eastern Africa around 4 million years ago. There are different types of Australopithecus species present, including Australopithecus anamensis, Australopithecus afarensis, Australopithecus robustus, and Australopithecus africanus.Australopithecus anamensis – lived around 3.8 to 4.2 million years ago, the oldest species.Australopithecus afarensis – lived around 2.9 to 3.9 million years ago in east AfricaAustralopithecus robustus – lived around 0.87 to 2.2 million years ago in southern Africa.Australopithecus africanus – lived around 3.6 million years ago.RamapithecusIt is an extinct hominid species that lived around 14 to 8 million years ago in Asia, primarily in present-day India and Pakistan. Initially thought to be a direct ancestor of humans due to its dental and jaw similarities. But further researches has led to debates about its exact position in the human evolutionary tree. While some scientists still consider Ramapithecus as a potential ancestor, others suggest it may belong to a separate lineage or be more closely related to modern orangutans. Despite uncertainties, studying Ramapithecus provides valuable insights into the complex evolutionary history of humans and their primate relatives.Homo Habilis Homo habilis lived around 1.4 Ma.to 2.8 million years ago. The name homo habilis in Latin signifies 'handyman'. They made tools from stone and bones which got the name. They were upstanding. Homo habilis was adjusted to living on trees.Homo ErectusHomo erectus was found in 1891, on the Indonesian island of Java. They possesed a bigger brain and were upstanding. Additionally, may have utilized fire to cook meat. Homo erectus lived around 1.8 million years to a long time back. They utilized instrument tools including quartz, made of bones and wood. Homo erectus are cave occupants, they have diminished intestinal length and they are in a bigger populace.Homo neanderthalensisNeanderthals, who lived in Europe and Asia around 400,000 to 28,000 years ago, had larger brains and bodies compared to modern humans. They were well adapted to cold climates, with robust features like large heads and jaws, and they were physically strong. Neanderthals were carnivores and evidence from their time shows they were skilled hunters. They lived in caves, often in groups, and cooperatively hunted for food.Homo sapiensHomo sapiens, or early modern humans, are characterized by their advanced cognitive abilities. The term sapiens, derived from Latin, denotes 'wise' or 'intelligent.' Unlike Neanderthals, Homo sapiens showed remarkable advancements in tool-making and artistic expression. They were omnivorous, capable of producing art, and had a reduced brain size of around 1300 cc. Their jaws were smaller, and the skull was more rounded compared to earlier hominids. Homo sapiens obtained food primarily through hunting. Conclusion - Human Evolution The evolution of humans is a gradual journey that spans millions of years, from our early ancestors to modern Homo sapiens. Through the process of natural selection and adaptation to changing environments, man has evolved remarkable traits such as advanced cognitive abilities, tool-making skills, and social behaviors. By studying the stages of human evolution, we gain valuable insights into our origins and understand how we are connected to other living organisms on Earth. As we continue our research on stages of evolution, the story of human evolution becomes more clear. Also Read: CBSE Notes for Class 10 Science Covalent Bond What are Hydrocarbons? Chemical Properties of Carbon Compounds Classification of Organic Compounds Cleansing Action of Soaps and Detergents Nutrition In Human Beings - Carbohydrates, Vitamins, Proteins and Fats Respiration Body Fluids and Circulation Means of Transportation In Plants Human Excretory System Excretion In Plants - Definition, Types, Transpiration, Examples Human Nervous System - Structure, Function, and Types Reflex Action Brain Anatomy: Structure, Parts, and Function Coordination in Plants Movement Due to Growth in Plants Hormones In Animals Heredity How do the Traits and Characters get expressed? Evolution - Introduction, Causes, Need, Examples Acquired and Inherited Traits - Definition, Differences, Examples Speciation and Evolution Basis of Classification Tracing Evolutionary Relationships Fossils Evolution Of Humans - History, Stages, Characteristics, FAQs Reflection of Light Refraction of Light Spherical Mirrors Image Formation by Spherical Mirror Image Formation in Convex Mirror Sign Convention for Spherical Mirrors Mirror Formula and Magnification Refractive Index Image Formation by Lenses Lens Sign Convention Lens Formula and Magnification Power of a lens Health & Medicine Genetics & Evolution Ask the Chatbot a Question The combined effects of improved cutting, pounding, and grinding tools and techniques and the use of fire for cooking surely contributed to a documented reduction in the size of hominin jaws and teeth over the past 2.5 to 5 million years, but it is impossible to relate them precisely. It is not known when hominins gained control over fire or which species may have employed it thereafter for food preparation, warmth, or protection against predators. It is very difficult to discern whether a fire was deliberately produced by hominins or occurred naturally. For example, in a wildfire, burned-out tree stumps might leave circular accumulations of charcoal residue that could be mistaken for hearths, whereas campfires built by mobile hominins would leave no lasting evidence. Concentrations of charcoal, burned bones, seeds, and artifacts in China and France suggest that H. erectus, H. heidelbergensis, or both used fire as early as 460 kya. Certainly some Middle and Late Paleolithic peoples controlled fire, but hearths are rare until 100 kya. If claims for control of fire in South Africa 1.5 mya are confirmed, P. robustus or H. ergaster would be the first fire keepers. At first glance early hominin skulls appear to be more like those of apes than humans. Whereas humans have small jaws and a large braincase, great apes have a small braincase and large jaws. In addition, the canine teeth of apes are large and pointed and project beyond the other teeth, whereas those of humans are relatively small and nonprojecting. Indeed, human canines are unique in being incisorlike, and the front lower premolar tooth is bicuspid. In apes and in many monkeys, however, the lower premolar is unicuspid and hones the upper canine tooth to razor sharpness. replica skull of LucyReconstructed replica of the skull of "Lucy," a 3.2-million-year-old Australopithecus afarensis found by anthropologist Donald Johanson in 1974 at Hadar, Ethiopia.In male Australopithecus and Paranthropus the large chewing muscles needed to power their deep, robust, jaws were attached to prominent crests on the braincase and to flaring arches of bone on the face and sides of the skull. Over time the rear teeth of Paranthropus increased in size while the incisors and canines shrank. Accordingly, P. robustus and P. boisei have relatively flat faces and nonprotruding jaws. Australopithecus species also had large rear teeth, but their faces were more protruding because the incisors and canines were not as reduced as those of Paranthropus. Over time the rear teeth progressively increased in size from A. anamensis to A. africanus and H. habilis, with A. afarensis intermediate between A. anamensis and the younger species of Australopithecus. When compared with estimated body size, the pattern of increased tooth size over time is confirmed for Paranthropus. Tooth wear patterns in A. afarensis indicate that it may have stripped vegetal foods by manually pulling them across the front teeth. The robust-skulled Paranthropus may have eaten tougher foods than did gracile-skulled Australopithecus. Additionally, some paleoanthropologists believe that Paranthropus was vegetarian, while A. africanus had more meat in its diet. Dental morphology and wear patterns indicate that in South Africa P. robustus ate hard foods and that Kenyan P. boisei chewed whole pods and fruits with hard coatings and tough seeds, though they probably did not chew quantities of grass seed, leaves, or bone. Unlike those of Paranthropus and Australopithecus, the teeth of Homo became smaller over time. H. rudolfensis has large rear teeth, even relative to estimated body size, but H. ergaster approaches the modern human condition. Concomitantly, the face of H. rudolfensis is more like that of Australopithecus than H. ergaster. One expects this trend to be related somehow to changes in diet or techniques of food preparation, but evidence to support this link is not available in the archaeological record. "For about 4 million years, human evolution has been a long, long process. From the early hominids to modern humans, we are in the process of evolving at this very moment." Mammals existed during the era of dinosaurs. But they kept a low profile and remained small and fury like a hamster. After the extinction of the dinosaurs, this marked the Age of Mammals. Because dinosaurs went extinct, mammals emerged as the largest land animals at this time. Hominids were the early proto-humans. They were known for sharpening objects with silicon rocks. They began to master the use of their hands and fingers. Let's explore these early hominids (proto-humans), each species, and where they evolved geographically. Australopithecus Afarensis was the earliest form of hominids, which archaeologists dug up fossils in the Afar Triangle of Africa, hence the name "Afarensis". Australopithecus afarensis is an extinct hominin species that lived approximately 3.9 to 2.9 million years ago during the Pliocene and early Pleistocene epochs. They are believed to be among the earliest hominins, with a mixture of ape-like and human-like features. The most famous individual of this species is "Lucy," a nearly complete skeleton discovered in Ethiopia in 1974. Australopithecus afarensis had a small brain relative to modern humans, indicating limited cognitive abilities. They were bipedal, walking on two legs, which is a significant adaptation in hominin evolution. The species likely lived in wooded environments and had a diverse diet, including both plant and animal-based foods. Australopithecus afarensis individuals were relatively small in stature, with males and females exhibiting sexual dimorphism in body size. Fossil evidence suggests they used tools, but their tool-making capabilities were limited compared to later hominin species. Australopithecus Africanus is the first of the early ape species classified as hominids. Australopithecus africanus is an extinct hominin species that lived between 3.5 and 2.4 million years ago in Southern Africa during the Pliocene and Pleistocene epochs. It is known for being one of the first hominins to be discovered and described from Africa. Australopithecus Africanus had a combination of ape-like and human-like features, such as a small brain size relative to modern humans and a bipedal upright posture. These hominins likely lived in woodlands and grasslands, which influenced their diet, consisting of both plant and animal foods. Although they were not advanced tool users, they may have used simple tools, such as rocks and sticks, for various purposes. Australopithecus africanus individuals had a facial structure that resembled apes more closely than modern humans, with a projecting face and pronounced brow ridges. About 2.35 – 1.5 million years ago, Homo Habilis had larger brains which helped their survival. Homo habilis, which means "handy man," is an extinct species of early humans that lived approximately 2.4 to 1.4 million years ago during the early Pleistocene epoch. They were among the first members of the Homo genus and are considered one of our direct ancestors. Homo habilis exhibited significant advancements compared to earlier hominins, including the use of tools, which is reflected in their nickname. The Olduvai Gorge in Tanzania is a significant archaeological site where many Homo habilis fossils and stone tools have been discovered. Their brain size was larger than that of earlier hominins but still smaller than modern humans, suggesting some cognitive development. Homo habilis had a more upright posture and a bipedal gait, allowing them to walk on two legs efficiently. Their diet likely consisted of a variety of foods, including plant materials and scavenged or hunted animals. The species played a crucial role in the transition from australopithecines to more advanced Homo species like Homo erectus. While they primarily used simple stone tools, their ability to fashion and use tools marked a significant milestone in human evolution. Homo Rudolfensis is an extinct hominin species that lived during the Pliocene and Pleistocene epochs, around 2.4 million years ago. This species is known from fossil remains discovered near Lake Turkana in Kenya, specifically at Koobi Fora. The exact classification of Homo Rudolfensis is debated, and some researchers consider it a distinct species, while others propose it may be a variation of Homo habilis. Fossil evidence of Homo Rudolfensis includes a relatively large and rounded braincase, indicating a larger brain size compared to earlier hominins. They exhibited a more human-like facial structure and dental characteristics, but the overall body size and limb proportions were still primitive. Homo Rudolfensis is associated with the use of simple stone tools, suggesting some level of toolmaking and tool use. Homo Gautengensis is a proposed hominin species that is not widely accepted by the scientific community. It is hypothesized Homo Gautengensis to have lived around 2 million years ago in South Africa. Fossil evidence for this species is sparse and contentious, making it difficult to establish its place in human evolutionary history. Some researchers suggest that Homo Gautengensis may represent a regional variation or a subgroup within the broader category of early Homo. Like other early Homo species, it likely had a relatively small brain size compared to modern humans but exhibited some adaptations associated with bipedalism. Homo Gautengensis had big teeth for chewing plants, consumed more vegetables, and likely had smaller brains. They also may have used fire and stone tools. Homo Ergaster is an extinct hominin species that lived approximately 1.6 to 1.3 million years ago during the early Pleistocene epoch. The nickname for Homo Ergaster is "Workingman" because they built more sophisticated stone tools (archaeologists often discovered hand-axes and cleavers near skeletons found). Fossil evidence for Homo Ergaster is primarily associated with sites in Africa, such as Koobi Fora in Kenya and Dmanisi in Georgia. They are considered one of the early members of the Homo genus and represent an important transitional species between earlier hominins like Homo habilis and later ones like Homo erectus. Homo Ergaster is known for its more modern and human-like characteristics, including a relatively larger brain size and a more developed body structure for endurance running. They exhibited a pronounced reduction in facial prognathism (forward projection of the face) compared to earlier hominins. Homo Ergaster is associated with the Acheulean stone tool industry, characterized by the creation of bifacial handaxes and cleavers. Their hunting and scavenging abilities, along with the use of fire, likely played a crucial role in their survival and expansion. Homo Erectus lived approximately 1.3 million to 0.7 years ago and was found along the southern coast of Asia. They are considered one of the first hominin species to have expanded out of Africa and colonized different parts of the world. Fossil evidence for Homo Erectus has been found in various locations, including Africa, Asia, and Indonesia. Homo Erectus is characterized by a more modern and human-like anatomy compared to earlier hominins. They had a larger brain size because they were believed to eat more meat. They are believed to have been the first hominin species to use fire deliberately, which had significant implications for cooking, warmth, and protection. Homo Erectus is considered a crucial transitional species in human evolution, bridging the gap between earlier hominins and anatomically modern humans. Their migration out of Africa is a significant milestone in human prehistory, leading to the colonization of different regions and adaptation to diverse environments. Homo Erectus Pekinesis existed 1.25 – 0.3 million years ago and their fossils were mostly found near Beijing (Peking). Homo Erectus Pekinensis is a subspecies of Homo erectus and is best known for the discovery of fossils in Zhoukoudian (Choukoutien), near Beijing, China. Fossils of Peking Man were discovered in the 1920s and 1930s and played a significant role in our understanding of human evolution. They are associated with the use of tools and evidence of fire use, suggesting advanced cognitive and cultural abilities. They are known as "Peking Man" because these fossils were mostly found near Beijing (Peking). These extinct hominids were known to have heavy brow ridges and the use of stone tools. The study of Peking Man contributed to our understanding of hominin dispersal and adaptation to different environments, particularly in East Asia. Homo Antecessor is recognized as "Human Pioneer" due to the belief they belonged to the first human population in Europe. Homo Antecessor is an extinct hominin species that lived during the Lower Pleistocene epoch, approximately 1.2 million to 650,000 years ago. Fossil evidence for Homo Antecessor was discovered at the Gran Dolina site in Atapuerca, Spain, and at other locations in Europe. The name "antecessor" means "pioneer" or "ancestor" in Latin, reflecting its position as a possible common ancestor to both Neanderthals and modern humans. This species is characterized by a combination of primitive and more advanced features. It had a relatively small brain size but showed evidence of tool use and possibly meat consumption. The discovery of cut marks on animal bones at the Atapuerca site suggests that Homo Antecessor was involved in butchery and hunting activities. Some researchers suggest that Homo Antecessor may have been one of the first hominins to inhabit Europe, making it an important part of the continent's prehistory. About 1.0 – 0.15 million years ago, scientists discovered this type of hominid in Indonesia on the island of Java. Homo Erectus Soloensis is a subspecies of Homo Erectus known from fossil remains found in the Solo River region of Java, Indonesia. These fossils were discovered in the 1930s and are sometimes referred to as "Solo Man" or "Ngandong Man" after the nearby Ngandong village. Homo erectus soloensis is estimated to have lived around 150,000 to 1,000,000 years ago during the Middle and Late Pleistocene. The fossils include skullcaps, teeth, and other skeletal elements, providing insights into the anatomy of this subspecies. Like other Homo erectus populations, Homo erectus soloensis is characterized by a relatively large brain size compared to earlier hominins. They are associated with the use of Acheulean stone tools, which are more advanced than the tools used by earlier hominins. Evidence of fire use has also been found at some sites, suggesting an ability to control and control fire. About 0.7-0.4 million years ago, Homo Heidelbergensis existed in both Africa and Europe. But archaeologists found fossils of Homo Heidelbergensis near Heidelberg Germany (hence the name). Homo Heidelbergensis is an extinct hominin species that lived during the Middle Pleistocene period, approximately 700,000 to 400,000 years ago. Fossil evidence for Homo heidelbergensis has been found at various sites across Africa, Europe, and possibly Asia, indicating a wide geographic distribution. This species exhibits a mix of primitive and more advanced anatomical features. They had a larger brain size compared to earlier hominins, suggesting increased cognitive abilities. Homo Heidelbergensis is associated with the development of more sophisticated stone tools, including handaxes and cleavers, which are characteristic of the Acheulean industry. Some researchers believe they are most notable for possibly burying their dead. They were likely skilled hunters and gatherers, capable of using fire and building simple shelters. The species demonstrates adaptations to various environments, from temperate regions in Europe to more tropical climates in Africa. There is uncertainty about Homo Helmei compared to other hominin species. About 0.4 – 0.2 million years ago, Homo Helmei existed only for a short period of time. Homo Helmei is theorized to have displayed a unique combination of physical traits, blending features from different known hominin species. Although they are a speculative hominin species, researchers propose they are known for their out-of-Africa movement and that their brain volume is slightly larger than modern humans. Research is still being developed to improve our understanding of Homo Helmei. Homo Neanderthalensis, or Neanderthals, is an extinct species of hominins closely related to modern humans (Homo sapiens). Neanderthals lived in Eurasia and Africa from approximately 500,000 to 25,000 years ago. They had a robust build with stocky bodies, adapted for cold climates. Prominent features included a large brow ridge, strong jaw, and a wide nose. Evidence suggests they had the ability to speak and may have used complex language. Neanderthals were skilled hunters and gatherers, using tools such as spears and handaxes. They lived in small, close-knit groups and had social structures. Evidence of burial practices suggests a degree of ritual and symbolic behavior. Studies have shown that some modern humans of non-African descent carry small percentages of Neanderthal DNA, indicating limited interbreeding between the two species. About 160-40 thousand years ago, the "doubly wise man" was the recent form of modern humans “homo sapiens sapiens”. Homo sapiens is the only surviving species in the Homo genus and the only extant hominin species. Homo sapiens were known for their artistic talents in cave paintings and clay work. They made hooks and spears to catch fish and invented the spear thrower. Thus, it made them better hunters because they could hunt from a distance. They have a high forehead, less prominent brow ridges, a rounded skull, and a vertical face. Modern humans have a complex vocal apparatus that allows for advanced language and communication. Homo sapiens coexisted with other hominin species, including Neanderthals and Denisovans, for some time. Homo sapiens is the only surviving hominin species, and their success is attributed to their unique combination of cognitive abilities, culture, and adaptability, which allowed them to thrive and become the dominant species on Earth. Since about 4 million years ago, humans have evolved from early hominids to modern humans. Here are 14 species examples from human evolution now extinct. Apes remained in trees as their primary food source. Eventually, grass began to spread in places like the African Savannah. Because there were fewer trees, this forced apes to walk to new food sources. With their heads above the grass to see predators, apes evolved by walking on two legs. It also helped to have their hands available when they were traveling. So here we are at this point in human evolution. Do you have any general questions about the theory of evolution? Please send us your comments and questions below.Subscribe to our newsletter: Written by Mahak JalanLast Updated On: 19 Oct 2023Published On: 13 Jan 2019 Table of Contents (click to expand) The Sahelanthropus Tchadensis is the earliest known ancestor of the Homo Sapiens, dating back to 7 million years ago. Since then, there has been a gradual evolution leading up to the modern day Homo Sapiens. Some of the notable steps in this evolution include the development of bipedalism (walking on two legs), the reduction in size of canine teeth, the increase in brain size, and the development of arboreal capabilities (the ability to swing from trees). The world is approximately 4.5 billion years old, and Homo sapiens have been around for about 200,000-300,000 years of that. Obviously, we have evolved quite a bit since the most primitive apes. Humans and chimpanzees shared a common lineage up until approximately 7-13 million years ago. After our last shared ancestor, one line branched off into beings that were bipedal, i.e., walked on 2 legs, rather than quadrupedal, i.e., walking on 4 limbs. Before attempting to establish a timeline of the events and changes that led to the formation of ‘us’, we must understand that establishing an exact date is impossible. It’s not like we can just walk up to ancient people and ask them for their life history, and they didn’t exactly maintain records either. So how do we do it? The simple answer – fossils. Scientists use fossils and relics to date these different ancestors’ history and create a timeline of our evolution. It is important to remember here that whenever new information comes to light, and with the further progression of science, timelines may change to better explain and accommodate all of our findings. This is why most estimates have a broad window, ranging from a couple thousand years to a few million years. Keeping this in mind, let’s try to understand the timeline of evolution for modern humans. Modern humans are scientifically called Homo sapiens. Homo is the genus and sapiens is the species. Homo sapiens are the only members of the Homo genus that are currently alive, and we have obviously come a long way from our four-legged brothers. From the trees, they came down to the land, and gradually began walking on all four limbs. Further evolution resulted in features like grasping big toes, shorter arms, etc. and eventually resulted in the form that you see in the mirror every day. Recommended Video for you:What Separates Humans From Animals? This species lived about 7 million years ago, and had characteristics of both chimpanzees and humans. From reconstructions of their heads, it can be seen that they look very ape-like. Also, while evidence suggests that they walked upright on 2 feet, there is not enough clarity on that matter. However, they are majorly accepted as the oldest species of hominids. Hominids are members of the Hominidae family, which is the family to which humans belong. Sahelanthropus tchadensis also had a small brain, closer in size to that of the chimpanzee. Sahelanthropus tchadensis (Image Credit: Flickr) This species lived about 6.2-5.8 million years ago. While it displays certain morphological similarities to Homo sapiens, like the femur, which points to bipedalism, and thickened enamel on the teeth, the jury is still out on whether it fits in the timeline of our evolution. If it is considered a direct ancestor of humans, then the position of certain other species in our timeline, specifically Australopithecus, is jeopardized. For a long time, Australopithecus has been assumed to be an important step in our evolution, so more proof is required to dethrone it. Apart from this, the fossils of Orrorin tugenensis also suggest that it survived in the dry evergreen forests. This goes against the most popular assumption that humans evolved in the savannas. Ardipithecus is the first species that definitely exhibited bipedalism. It showed some distinctive features that are also found in modern humans. Apart from walking upright on 2 legs, it also had a big, grasping toe. This species had a small brain, closer to that of chimpanzees, and its canines were reduced in size. Its reconstructed pelvis suggests that it could walk on 2 legs, as well as climb trees. There are a few discrepancies about when it existed. The earlier estimate was about 4.4 million years ago, but a second estimate of 5.8 million years was later provided. However, this newer figure is not widely accepted. Ardipithecus (Image Credit: Flickr) This genus is one the most popularly known genus in the evolution of humans. They existed from about 4.2 – 3.9 million years ago, up to approximately 2.5 million years ago. There are approximately 7 accepted species in this genus, the most popular of which is Australopithecus afarensis. This species lived for about 900,000 years, and the remains of over 300 individuals of this species have been found. The brain size of this species was about one-third that of humans. They had flat noses and protruding lower jaws. Their teeth were small, like those of modern humans. They had long, strong arms suitable for swinging from trees, but they regularly walked on 2 feet. Their ability to be arboreal and tree-swinging helped them to survive climate changes. Australopithecus afarensis (Photo Credit : Wikimedia Commons) The young ones of this species grew faster than modern humans, and therefore had shorter periods of care and guidance by their parents. Another species of this genus was Au. africanus. They were similar to Au. afarensis, but they had bigger brains in a more rounded cranium. They also had smaller teeth. As this genus evolved, they began exhibiting more features similar to homo sapiens, such as shorter teeth, molars and pre-molars, a broad lower chest, and other features of our skeletal system. One species, Au. sediba, exhibited a peculiar form of walking. It apparently turned its foot inward with each stride. This suggests that upright walking evolved in more than one pathway. This genus is also known as the robust australopithecine, and there is ongoing debate if the species should belong to the Australopithecus genus or should exist in a separate genus of Paranthropus. What is clear, however, is that they descended from Australopithecines. These species had more features similar to those of modern humans, as compared to their immediate ancestors. Mainly, they had stronger jaws and employed the use of muscles for chewing. They had flared cheekbones and bigger brains. They also had quite a thick layer of enamel on their teeth. Paranthropus boisei (Photo Credit : Cicero Moraes/Wikimedia Commons) Finally, we come to the genus to which we belong. This genus came about 2.4 million years ago, and Homo sapiens are currently the only living members. The first species in this genus, Homo habilis, existed about 2.4 – 1.4 million years ago. They are credited with the first use of stone tools; but scientists have found stone tools from before their time as well. Another important species of this genus is Homo erectus. They are the oldest species with features and proportions that are very similar to modern humans. They had short arms and long legs, which marked the end of tree-swinging abilities and showed that these individuals were not arboreal. Studies also strongly suggest that they cared for the weaker and older beings in their groups. Homo erectus was also the first species to expand their demography outside Africa, although it is unclear as to whether they reached Europe. Existing about 700,000 to 200,000 years ago, Homo heidelbergensis was the first species to live in colder climates. They also lived at a time where there was the definitive use of fire. They were the first species who regularly hunted larger animals and built simple shelters of wood and rocks. They had a comparatively flatter face, and possessed very prominent brow ridges. Homo heidelbergensis (Image Credit: Flickr) Homo neanderthalensis are the closest species to us as modern humans. They lived about 400,000 to 40,000 years ago and closely resembled us in appearance. They wore clothes, lived in shelters and had relatively sophisticated tools. They hunted regularly, and also consumed plants. Evidence suggests that they would bury their dead, often even giving offerings of flowers. They also made ornaments. All the H. neanderthalensis fossils have been discovered in Europe. Homo neanderthalensis (Photo Credit : Matteo De Stefano/Wikimedia Commons) There is another species in this genus, known as the Denisovans. They still haven’t been classified properly, but they seem to have existed around the time of H. neanderthalensis. There is also evidence that suggests there was interbreeding within these groups, which led to variations. According to current estimates, Homo sapiens arose about 300,000 years ago. The best way to establish a rough idea of their appearance would be to simply look in the mirror. A number of these species existed at the same time, because the appearance of a new species did not mean the immediate extinction of the previous ones. As we have seen in the case of the Denisovans, Neanderthals and Homo sapiens, there was also interbreeding between them. According to some scientists, this is the cause behind the variations between the different races currently existing on Earth. That being said, there are still plenty of unanswered questions about our ancestors, as well as discrepancies in the timeline. Time estimates are constantly changing, so please don’t hold me responsible, it depends on which source you trust! In time, however, hopefully we can get more concrete answers to the fascinating questions of our origin! References (click to expand) Mahak Jalan has a BSc degree in Zoology from Mumbai University in India. She loves animals, books and biology. She has a general assumption that everyone shares her enthusiasm about the human body! An introvert by nature, she finds solace in music and writing. Related Videos Health & Medicine Genetics & Evolution Ask the Chatbot a Question Laetoli footprintsA trail of footprints, probably left by Australopithecus afarensis individuals some 3.5 million years ago, at Laetoli, northern Tanzania.By 3.5 million years ago at least one hominin species, Au. afarensis, was an adept walker. In addition to anatomic evidence from this time, there is also a 27.5-metre (90-foot) trackway produced by three individuals who walked at a leisurely pace on moist volcanic ash at Laetoli in northern Tanzania. In all observable features of foot shape and walking pattern, they are astonishingly similar to those of habitually barefoot people who live in the tropics today. Nevertheless, although the feet of the Laetoli hominins appear to be strikingly human, one should not assume that other parts of their bodies were as similar to ours. The fragmentary femoral remains found in Kenya of six-million-year-old Orrorin tugenensis indicate to some experts that they too were bipeds. Ar. ramidus (5.8–4.4 mya), a primate from Aramis, central Ethiopia, and one of the two fossil species of Ardipithecus, was also bipedal. In this case the evidence comes from the foramen magnum, the hole in the skull through which the spinal cord enters. In Ardipithecus this opening is similar to ours in being located centrally under the skull instead of at the rear of it. A rear-facing foramen magnum indicates a stooped posture, whereas a downward-facing hole positions the skull atop the spinal column. Other characteristics indicative of bipedalism in Ardipithecus include an increased tarsal region in each foot and a pelvic structure with muscle-to-bone attachment sites comparable to later, bipedal hominins. In addition, the leg bone of Au. anamensis from northern Kenya (4.2–3.9 mya) attests to its bipedalism. All hominins living at the time of the Laetoli track makers were probably obligate bipeds when on the ground, but some of them (including some younger species) exhibit features that argue for regular arboreal climbing, probably for food, rest, nightly lodging, and predator avoidance. Hadar, in northern Ethiopia, has yielded a trove of remains of A. afarensis (3.8–2.9 mya). They include many parts of the locomotor skeleton that reveal a bipedal habit: short ilia, a wide and stout sacrum, and femoral angling, among other features. At the same time, the curved fingers and toes, laterally flared ilia, and short femurs with long upper limbs, as well as the configuration of its rib cage, indicate that they could readily climb and maneuver in trees. A. bahrelghazali (3.5–3.0 mya) of central Chad and Kenyanthropus platyops (3.5 mya) from northern Kenya are represented solely by teeth and by skull and jaw fragments from which positional behaviour cannot be inferred. Parts of the locomotor skeletons of later hominins such as A. africanus (3.3–2.4 mya) and Paranthropus robustus (1.8–1.5 mya) of South Africa do not differ markedly from those of A. afarensis. The locomotor skeleton of eastern African P. boisei (2.2–1.3 mya) is poorly known, but there is no reason to assume that it was different from other Paranthropus species. Bouri, a 2.5-million-year-old site in central Ethiopia, yielded arm and leg bones that are contemporaneous with craniodental remains of A. garhi. The femur is elongated relative to the humerus, as in H. sapiens, but, unlike the human forearm, that of the fossil specimen is relatively long. Thus, by 2.5 mya at least one hominin species had developed the long femurs of striding bipeds, though it retained long forearms like arboreally active Australopithecus and Paranthropus. H. habilis (2.0–1.5 mya), best known from Olduvai Gorge, Tanzania, exhibits small teeth and a large brain, but it has long upper limbs (especially the forearms), short femurs, curved finger bones, and other chimpanzee-like traits that indicate a mélange of arboreal and terrestrial adaptations. Because of these similarities, some investigators classify H. habilis in genus Australopithecus as Au. habilis. The pelvis of H. heidelbergensis (600,000–200,000 years ago, or 600–200 kya) and that of Neanderthals (200–30 kya) are distinct from the pelvis of H. sapiens in some features that recall those of Australopithecus. The pelvis is broad, with ilia flaring out to the side. The femoral necks are also relatively long. These features are related to stabilizing the pelvis in stocky bipedal hominins. The pelvises of both H. heidelbergensis and Neanderthals could accommodate a wider birth canal. This feature is important because they may have had notably larger brains (about 1,200 grams [2.65 pounds] and 1,400 grams [3.09 pounds], respectively) than earlier hominins did—a trait that is reflected in the size of the fetal skull. Regrettably, development of foot structure in early Homo—i.e., between A. afarensis and Neanderthals—is virtually undocumented by skeletal evidence. The oldest footprints indicative of contemporary foot function, however, have been found in Ileret, Kenya. These prints have been dated at 1.51 to 1.53 mya, and their size and depth suggest that they were made by H. ergaster or H. erectus. Therefore, it is safe to assume that by about 1.53 mya the uniquely human locomotor and associated cooling systems were basically established. Subsequent alterations in pelvic shape may be related to the passage of larger-brained babies through the birth canal. September 30, 2008 Explore Evolution claims: both Darwin's and Haeckel's comparisons left out the earliest stages of development.* Whether this omission was intentional is a matter of some debate. Eggs, cleavage stages, and gastrula stage embryos Vertebrate embryos (in the modern definition - after fertilization) have a number of stages such as the cleavage and gastrula stages which precede the embryos shown in Haeckel's diagram. Darwin's Use of Embryonic Drawings Nick Matzke at Panda's Thumb has pointed out that comparisons of these earlier stage embryos are actually shown in Anthropogenie. Indeed, Anthropogenie has over 20 figures showing gastrula embryos from different groups. This does not reconcile with Explore Evolution's implication that Haeckel intended to deceive his readers. Shown below are Plates 2 and 3 from Anthropogenie comparing eggs, cleavage stages, and gastrula stage embryos from different animals. As discussed earlier, Haeckel used von Baer's convention for embryo as the stage in which a body form is first apparent. Instead of describing these earliest stages of development as "embryos", Haeckel uses terms which include "keim" (meaning "germ"). For example, morula embryos are called "maulbeerkeim", and blastula embryos are referred as "blasenkeim". In Descent of Man (1871), Darwin compared drawings of a human and dog embryo at the same stage (originally from Bischoff and from Ecker). However, nowhere does Darwin imply that this is the earliest stage of development. In fact, because dogs and humans are mammals and have very small eggs, their earliest stages of development are extremely similar. So it is absurd to suggest that Darwin purposefully left out the earliest embryonic stages of humans and dogs in order to mislead his readers. Human Evolution Research Human Evolution Evidence Behavior Primate Behavior Footprints Stone Tools Getting Food Carrying & Storing Oldest Pottery Pottery Fragment Hearths & Shelters Fire-Altered Stone Tools Terra Amata Shelter Burial Qafzeh: Oldest Intentional Burial Recording Information Assyrian Cylinder Seal Blombos Ocher Plaque Ishango Bone Making Clothing Bone Awls Bone and Ivory Needles Art & Music Human Fossils Species Fossils Mystery Skull Interactive Shanidar 3 - Neanderthal Skeleton 3D Collection Artifacts Fossils Primates Genetics Dating Human Evolution Timeline Interactive Human Family Tree Snapshots in Time Swartkrans, South Africa Olorgesailie, Kenya Shanidar, Iraq Human Characteristics Education Exhibit About Us Multimedia Slideshows Bronze Statues Reconstructed Faces Videos Audio Explore University of Waikato's rich history and vibrant community. From our humble beginnings to global recognition, discover our journey. The relationships among Australopithecus, K. platyops, Paranthropus, and the direct ancestors of Homo are unknown. Because of its early date and geographic location, A. anamensis may be the common ancestor of A. afarensis, A. garhi, K. platyops, and perhaps the Laetoli Pliocene hominins of eastern Africa, A. bahrelghazali of central Africa, and A. africanus of southern Africa. A. afarensis in turn may be ancestral to P. aethiopicus, which begat P. boisei in eastern Africa and P. robustus in southern Africa. Ledi-Geraru jawboneAmerican anthropologist Brian A. Villmoare holding a replica of the Ledi-Geraru jawbone. The actual mandible, found in Ethiopia and dated to 2.8 million–2.75 million years ago, is the oldest fossil associated with the genus Homo.Factors indicating H. rudolfensis as ancestral to later species of Homo are its absolute brain size, large body, and lower limb morphology. These features clearly foreshadow younger species of Homo in Africa and Eurasia. However, a mandible discovered in the Ledi-Geraru area of the Awash River valley in 2013 may point toward a different ancestor—one that clearly belongs to the genus Homo. The mandible provides evidence that dental features associated with later Homo (such as smaller teeth and a much-reduced chin) appeared as early as 2.8 million years ago, well in advance of the advent of H. rudolfensis. While some paleontologists have been quick to associate the specimen with H. habilis, others are considering the possibility that it belongs to a new species of Homo. Our ancestry becomes no clearer as the candidates are narrowed to Homo species exclusively. Among paleoanthropologists who accept it as a species distinct from H. erectus, H. ergaster is most often proposed as the ancestor of Homo species of the Pleistocene Epoch. H. heidelbergensis may have arisen from H. ergaster, H. erectus, or H. antecessor, and any or none of them could have been ancestors of H. neanderthalensis and H. sapiens. Neanderthal populations, particularly as represented by specimens from western Europe, probably were not ancestral to modern humans. H. naledi continues to be the subject of much debate. The oldest fossils of this species are only a few hundred thousand years old; however, several of its morphological traits are very similar to those of Australopithecus, and thus many paleontologists suggest that H. naledi evolved in parallel with H. sapiens. Theorists use fossil remains, genetic traits of modern people around the world, and archaeological and anatomical indicators of cognitive, linguistic, and technological capabilities to support their models of recent human evolution, but no single theory provides definitive resolution of how H. sapiens came to be. The limitations of empirical evidence confound efforts to discern whether distinctive features and lineages developed gradually or over periods of stasis punctuated by rapid change (a theory known as punctuated equilibrium). There are claims for about 20 fossil hominin species over the course of the last six million years, but they are assessed on a case-by-case basis. For example, it appears that Neanderthals (H. neanderthalensis) were a dead end for two ancestral species (H. antecessor and H. heidelbergensis) that changed gradually in Europe from about 700 kya to 30 kya. H. sapiens may have evolved similarly through a series of species represented by African specimens, but other theorists envision a dramatic shift in cognitive capacity and behaviour that qualifies instead as a punctuational change. This change would have occurred in one small African population and would have been followed by a long period of stasis that continues to the present. Such a scenario is not unprecedented, as A. afarensis was a capable biped that appears to have emerged suddenly and persisted for nearly one million years. There are four basic models that purport to explain the evolution of H. sapiens between about 315 and 30 kya. At one extreme is multiregional evolution, or the regional continuity model. At the other is the African replacement, or “out of Africa,” model. Intermediate are the African hybridization-and-replacement model and the assimilation model. All but the multiregional model maintain that H. sapiens evolved solely in Africa and then deployed to Eurasia and eventually the Americas and Oceania. Both of the replacement models argue that anatomically modern emigrants replaced resident Eurasian and Australasian species of H. sapiens with little or no hybridization. The hybridization-and-replacement model proposes some interbreeding with archaic indigenous populations but with relatively minor effects. Assimilation maintains continuity between archaic and modern humans, most notably in some areas of Eurasia, where gene flow and local selective factors would also produce morphological changes. In this model, unity of the species was maintained by periodic interbreeding across wide areas. Multiregionalists reject the idea that H. sapiens evolved uniquely in Africa. Instead, they advocate that discrete archaic populations of Homo evolved locally in Africa, Asia, and Europe. Throughout their tenures, both the archaic and descendant populations interbred with contemporaries from other areas. The African replacement model has gained the widest acceptance owing mainly to genetic data (particularly mitochondrial DNA) from existing populations. This model is consistent with the realization that modern humans cannot be classified into subspecies or races, and it recognizes that all populations of present-day humans share the same potential. Such a tangled line of descent is not surprising given the nomadic lifestyles enabled by bipedalism. There appear to have been successive migrations of hominin species out of Africa, with evolution of new species in Eurasia and occasional migrations back into Africa. For instance, H. ergaster may have been the first hominin to reach Eurasia. Some of its descendants could have moved quickly to East and Southeast Asia, where they begat H. erectus. Others may have evolved into H. heidelbergensis, which populated Europe sparsely and then returned to Africa. Some paleoanthropologists claim that H. antecessor, found in 800,000-year-old cave deposits at Gran Dolina, Sierra de Atapuerca, Spain, was a direct ancestor of H. neanderthalensis via H. heidelbergensis, which is represented by 300,000-year-old specimens from Sima de los Huesos in the Sierra de Atapuerca. Further, they propose that H. antecessor, from million-year-old deposits in Eritrea, is a direct ancestor of H. sapiens in Africa. Neanderthals probably evolved in Europe at least partially in response to cold climatic conditions and then migrated to western Asia, where they may have encountered H. sapiens in the Levant. There is no skeletal evidence that they reached the African continent or moved much farther east than Uzbekistan in Central Asia. Features of Neanderthals that argue for adaptation to seasonally frigid biomes include stocky torsos, short limbs (particularly the forearms and legs), and distinctive facial structure. The middle of the face protrudes, the teeth are set forward, the enlarged cheekbones sweep backward, and the nasal passages are voluminous. If Neanderthals wore animal furs and other insulating materials on their heads and bodies while keeping vigorously active in frigid weather, the large nasal chamber would help to cool the blood and prevent overheating the brain, while clothing would reduce the risk of frostbite. The nasal chamber might also conserve moisture during exhalation. Fossil specimens obtained from the Omo site in Ethiopia (which have been dated to 195 kya) indicate that anatomically modern H. sapiens were present sometime around 200 kya in eastern Africa. The oldest known remains, however, appear at the Jebel Irhoud site in Morocco and date to 315 kya. This evidence suggests that the species might not have emerged in eastern Africa or that it was not confined to the region. Molecular genetic data suggest that early H. sapiens passed through a population bottleneck—that is, a period when they were rare creatures—before rapidly spreading throughout the Old World. H. sapiens migrated to southern China between 120 kya and 80 kya and Europe about 45–43 kya. They replaced indigenous hominin species in Eurasia, and then, as sea levels dropped during glacial periods, adventurous individuals went to sea in watercraft, populating Australia about 65–50 kya and oceanic islands during the most recent 3,000 years. While there is a great deal of evidence pointing to H. sapiens migrating to the Americas by about 14–13.3 kya, the oldest firm evidence places the arrival of H. sapiens in the southwestern United States by 23–21 kya. Some of the extensive variation in bodily proportions, external features, and blood chemistry of modern peoples may reflect adjustments to biomes over geologically short time spans. However, molecular genetic studies show that genomic differences between even far-flung peoples are minuscule compared with variations within each local population. Accordingly, for modern H. sapiens, race is a mere cultural construct with no biological basis.