

Demonstrate understanding of trends in human evolution

AS91606

When humans are compared to other animals in terms of their structures, chemicals and DNA, they are more similar to a group of animals called primates, than to any other animal group.

Primate features

- 5 fingers on hands and feet
- Prehensile grasping hands and some tails
- Nails and not claws
- Binocular stereoscopic colour vision
- Good hand eye co-ordination
- Wrist, elbows, shoulder and hip joints are mobile
- Enlarged brain
- Bony ridge above eyes for protection
- Usually found in groups, carry out mutual grooming, hierarchies and extended families
- Extended infant care and single birth common
- Have a oestrus cycle in females rather than a definite breeding season
- Snout reduced as they rely less on smell and more on vision
- Posture usually quadrupedal with the ability to sit upright and run bipedal
- Have a generalised dental pattern

Primate groups

- Prosimian, e.g. Tree shrew, Tarsier and Lemur
- New World monkeys e.g. Spider monkey, Cebus – prehensile tail, quadrupedal, strictly arboreal, widely separated nostrils
- Old World monkeys e.g. Baboon, Colobus monkey – tail not prehensile, quadrupedal, some ground living, nostrils close together
- Great apes e.g. Gibbon, Gorilla, Chimpanzee, Orangutan – brachiating, mainly ground living, quadrupedal, flattened nose, bony eye ridges
- Hominins e.g., *Australopithecus*, *Homo erectus*, *H. sapiens* – bipedal due to modified feet, legs etc. large cerebral cortex, reduced canines, nose, chin prominent, reduced eye ridges, highly sensitive skin with body hair short.

Hominoids and Hominin

- Apes, humans and their recent ancestors are classified in the super family **Hominoidea**. They are referred to as the **hominoids** (human – like species)
- While humans and their recent bipedal ancestors are classified as **Hominin**.

Biological evolution vs Cultural evolution

You will be required to discuss these two types of evolution, so it is important that you understand the differences.

- **Biological evolution** occurs through our genes; it can only be passed on genetically and therefore occurs at a slow rate. Biological evolution is strongly linked to all the skeletal changes which have occurred as a result of becoming bipedal.
 - The head – skull features, external and internal
 - Upper limb and our ability to manipulate our hands and shoulders
 - Spine features
 - Lower limb features – hip joint, femur, knee joint, ankle and foot.
- **Cultural evolution** this is the non-genetic passing on of information through teaching of ideas, beliefs and knowledge by learning from other members of the group. Because it occurs through learning and more than one person can be taught at a time, cultural evolution occurs at a faster rate.

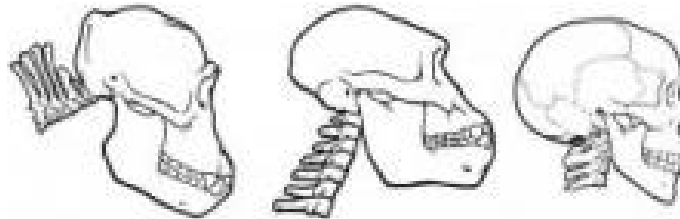
You will be required to discuss the trends of increasing behavioural complexity based on the use of:

- Tools
- Fire
- Shelter and clothing
- Food gathering
- Abstract thought especially communication, language, burial and art
- Domestication of plants and animals

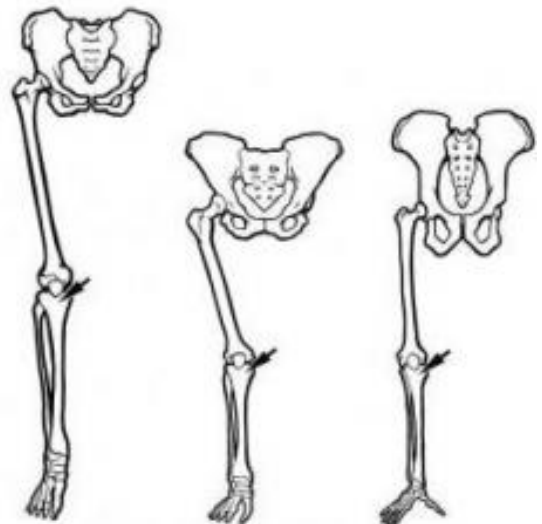
BIOLOGICAL EVOLUTION:

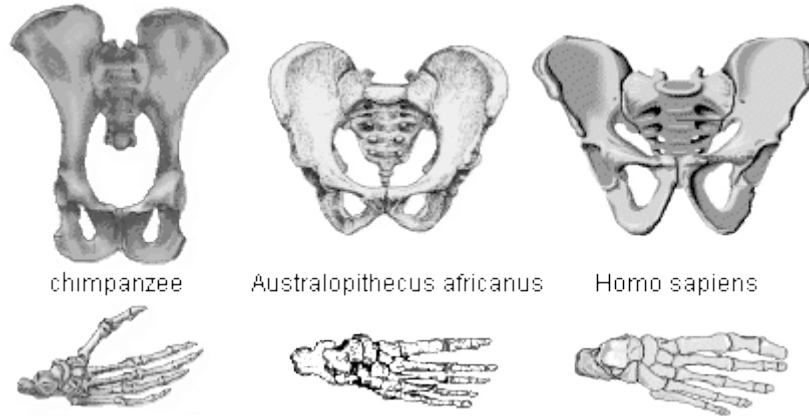
Key differences between Apes and Humans / Bipedal and Quadrapedal.

- Apes have a large **sagittal crest** along the centre top of the skull. This is where the jaw muscles attach to the skull. A large jaw requires larger sagittal crest. In humans this no longer exists.
- Apes have their **foramen magnum** (hole in the underside of the skull where the spinal cord enters) is towards the back of the lower side of the skull. While in humans / bipedal the foramen magnum is more central underneath.



- Apes have very strong neck muscles which attach to the **nuchal crest** on the top back of the skull to prevent the head dropping forward. Humans skulls are balanced above the first vertebrae so we don't have these strong muscles therefore our nuchal crest is absent.
- Apes have large brow ridges with a sloping face. While humans no longer have a brow ridge and the face is flatter.
- Apes have a much smaller brain size 450cm^3 vs 1400cm^3 . Humans cerebral cortex is well developed therefore they have better and higher level of thinking, speech, memory etc. while apes have no specialised area for language
- An apes jaw has parallel sides "U" while humans have a more rounded "bow shaped" jaw.
- Human teeth have thicker enamel and smaller canines, while apes, especially males have very large canines (sexual dimorphism)
- Humans have a "**S**" shaped spine with a shorter straight stiff broader more bowl like **pelvis**. While Apes have a "**C**" shaped spine and a longer narrow **pelvis**.
- Humans knees are angled inwards (**valgus angle**) so the knee sits nearer the centre of gravity. The knee joint is larger. These result in more efficient walking as the organism does not waste energy swinging from side to side and is much more balanced as they walk. In apes the knees bend outwards under the hips as their femur angled into the knee so when they lift one foot off the ground they lose balance. They must lean to one side to counterbalance. This produces a swaying movement as they walk.
- Apes feet have an **opposable big toe** so the foot is able to grab things. Their feet are also flat. Humans have a **forward facing big toe** and their foot is arched which acts as a shock absorber and enables humans to spring off their feet when walking therefore making walking more efficient.





- Apes fingers are more curved with less mobile fingers. Like all primates both can grip objects with a **power grip**, but only humans can also use a **precision grip**.
- Apes hairs are longer and more coarse with few sweat glands while humans have the same numbers of hair but it is much finer and with more sweat glands.

Bipedalism

All primates show a tendency to an upright posture at times - such as when feeding a baby, swinging from trees or just sitting. Humans have taken this to the extreme and walk on two legs all of the time. Prehumans/hominins were bipedal by nearly 4 million years ago. It is thought that being bipedal allowed humans to exploit the ground niches, which probably offered more variety of food at a time when forests were shrinking. It certainly allowed humans to use their hands in ways that no other primate can. This change to bipedalism was probably the most important step in our evolution because it freed the hands, allowing us to take advantage of our larger brain.

Advantages of bipedalism

- **Carrying young** - Human females do not have enough hair to grasp, nor do their babies have prehensile feet to hang on, so females must carry their young. This requires free arms. A hominin that had a less opposable big toe would have been less good at clinging onto 'mum' so its mother would have had to rely more on its legs to walk so she could carry her baby. This would select any feature that made her better at bipedalism, such as a less opposable big toe. This, in turn, would make the young less able to grasp mum and more dependent on being carried.

This is called **positive feedback**, where one change reinforces another changes effects. Once started, positive feedback would produce very rapid change.

- **Free hands** are free to carry objects e.g. food, tools etc. this meant more food could be carried back to their "house" site for sharing
- **Heat regulation** Bipedalism raises the body surface higher above the ground, where there is more wind and cooler temperatures. Greater wind flow means more heat loss by convection. Bipedalism also conserves body water by needing less evaporation to cool down. Standing upright also reduces direct solar exposure during the time of day when the solar radiation is most intense. The brain is especially sensitive to increased temperature, so we have kept hair on the head to reduce the heating effect of the sun.
- Standing upright allows animals to see predators more easily - remember that primates use smell much less than other mammals.
- By being bipedal less energy is needed to move long distances as the bipedal motion is more efficient.

Disadvantages of being bipedal

- Giving birth to a larger headed baby means babies are born helpless and birth is painful. Because babies are born so helpless they require a lot of parental care. Takes about a year before a baby can walk.
- Humans are prone to back ache due to the “S” shaped spine.

The “Naked Ape”

- We are the only naked ape
- Current theories do not link nakedness to climate change as first thought. Now they think very early hominins still lived in forest. But the key ideas below still hold true
 - Hair on the head is used to reduce heat loss and to reflect heat off the head therefore helping keep the brain at the correct temperature
 - By having reduced body hair the control of parasites became easier which was important when hominins started living in home bases
 - By having shorter hair and well developed sweat glands all over our body we increased heat loss which helped keep us cool.

Key players

Australopithecus afarensis - also called Lucy

- 3.9 to 3 MYA (million years ago)
- First bipedal ancestor
- They are very sexually dimorphic meaning the males and females were different sized
- Possibly scavenged meat or caught small pray but mainly ate nuts, fruits, tubers etc
- Did not use tools
- Lived in dry, open lands and wooded area of Africa
- Didn't have articulated speech
- Lived in groups

Homo habilis - also called Handy man

- 2.4 to 1.5 MYA
- First thought to have **speech** but no voice box so just grunts
- More sophisticated brain with a bulge in the Broca's area (speech area)
- Successful **hunters**, killing a wide range of animals in a cooperative manner
- Used simple stone tools called **Oldawan**, round stones with one end chipped
- Used hands and tool to club, throw, butcher, dig etc
- Made **simple shelters**
- Lived in groups
- Ate meat therefore more protein therefore better brain development

Homo erectus - also called Upright man

- 1MYA to 300,000 years ago
- First to use **fire**
- **First to leave Africa**
- re Had a larger brain, probably more advanced speech but still not complete sounds
- Able to co-operate and teach
- Use of **fire** → cooked food → softens food for easier digestion → jaw, teeth, zygomatic arch decreased in size
- Because of fire they could inhabit newer colder environments and could extend day length therefore more time for everything else (teaching, planning hunts and creation of better tools)
- Fire killed bacteria and parasites therefore increased survival rates
- Tools called **Acheulian** or **tear drops** stones, double edged hand axes. Also used bamboo to make containers and rafts
- Increased brain development due to diet → curiosity → explored new areas
- Population increased → some moved to new areas to survive
- Built shelters – huts with wooden poles

Homo heidelbergensis - also called archaic Homo sapiens

- 300,000 years ago
- Fossils found in Africa, Europe and Asia
- Next species to move throughout the length and northern breath of Africa and beyond
- Used fire
- Hunted large prey → rich diet → increased body size
- Were cannibals
- Used **Acheulian** tools
- Built shelters

Homo neanderthalensis - also called Neanderthals

- 230,000 to 28,000 years ago
- Thick heavy boned, short limbs – a bit like Eskimos
- Intelligent, able to adapt to extremes of weather
- Lived in caves and built low stone walls at entrance
- Made large hearths with flat stones and used them like hot plates
- Dressed in hides for clothing
- Stampeded herds over cliffs and into bogs
- Fine stone tools called **Mousterian**, flakes, scrapers and spears. They attached handles to stone tools
- **Buried their dead** – often with tools, flowers and they were sometimes decorated with **red ochre** (red clay) showing they believed in the **"afterlife"**
- Strong social bonds as they looked after their old and sick
- Cannibals
- All died out → evolutionary dead end (maybe?)

Homo sapiens - also called Cro–magnon man

- 160,000 to now
- Earliest ones in Europe called Cro–magnon man
- Brain smaller than Neanderthals
- Skilled hunters often following migrating animals
- Made bone and flint tools, used spears and spear throwers, maybe bows and arrows
- Tools had fine points and blades
- Made fish hooks and needles
- Tools called **Upper Palaeolithic**
- Engraved and painted walls of caves and carved statues
- Had imagination

Advantages of Fire:

- Cooking makes food softer and easier to digest and eat.
- Kills many microbes (bacteria, fungi and parasites) reducing the risk of disease
- Fire detoxifies some plant toxins making the cooked food safe to eat e.g. potatoes
- Fire helps keep predators away allowing safety and gathering stability
- Source of warmth allowing *Homo erectus* to exploit new, cooler areas with more resources
- Having a source of light extended day length therefore more time to make tools, plan hunts etc. → hunts became more successful → didn't have hunt each day → more "free time" for social interactions
- Fire used to harden wooden spear points, therefore leading to better tools

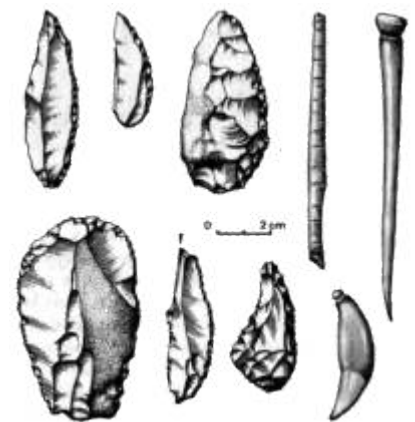
Development of technology: Tools

Very early tools most likely sticks and bones used to dig and get things out of holes

- **Oldowan** first used by *Homo habilis*
 - Very simple tools with a few flakes removed
 - Used to chop and scrap



- **Acheulian** first used by *Homo erectus* and *Archaic Homo sapiens*
 - Bi-faced, teardrop shaped which had been carefully crafted to a standard design
 - Much more crafted than oldowan as more chips remove
 - Tools took much longer to craft with on average 65 blows per tool
 - Used as hand-axes and cleavers
 - Made for specific jobs e.g. basic design altered to make scrapers etc.
- **Mousterian** first used by Neanderthals
 - Sophisticated tools which were finely worked, made of stone but often had other materials attached for more accurate handling
 - These tools require high levels of skills and time to learn and make e.g. spear, axes, scrapers etc.
- **Upper Paleolithic** first used by *Homo sapiens* and *Neanderthals*
 - Tool making techniques were further refined
 - Most flake edges were sharpened for cutting
 - Had a large variety of tools for many different jobs
 - Tools shaped to fit into handles
 - Tools not just made of stone many other materials used including bone, antlers, guts plant fibres etc.
 - Tools included things like needles, ropes, nets, snares etc.
 - These tools allowed hunters to kill much larger prey and process it quickly, as well as allowed them to preserve the food
 - Animal hides would be stretched over wood to make tent type structures, they also made cloths out of the hides



Farming and domestication of animals

- Early humans were **nomadic** hunter-gathers, relying on what was present in the environment and moving as the population grew or resources ran out. Later they followed the herds around eventually they became less nomadic
- This gave early humans a greater variety of food which was of a better quality and close by
- First animals to be domesticated were dogs then goats, sheep and pigs
- First plants were wild wheat about 18,000 years ago. Then millet, rice, soya beans, yams, maize, beans, cotton etc.
- As this happened their dwellings became more permanent and larger

Advantages of farming

- Food supply easier to obtain with a much more dependable food source
- Fewer people died of starvation
- Fewer people needed to work at providing food for many
- Specialised skills able to be developed by those not involved in getting food and while living in a permanent settlement meaning they get better at their "job" benefiting the whole group
- As people became more skilled at farming they developed more permanent settlements at the best sites near sources of water. They were able to produce more food than they needed so traded with other people for other things they needed.
- As a result of this they had more time to develop other skills such as art, pottery etc.
- Made technological advances (e.g. wheel, plough, hoe) which eventually led to the Industrial Revolution

Disadvantages of farming

- Their diet was restricted to what they could grow
- They become more dependent on the weather for their crop growth
- Because there was a higher population disease carrying and disease causing organisms flourished as they had more people closer together to infect e.g. rats, fleas, viruses etc.
- Growing crops etc. is quite time consuming
- People begin to fight over ownership of animals and territory

Dispersal

- H. erectus moved out of Africa to other parts of the World relatively quickly.
- This movement was most likely linked to climate change about 1 MYA: when the climate cooled resulting in dropping sea levels, exposing new land (making land bridges) and causing forest to shrink and be replaced by open savannahs (grasslands)
- Because of climate change new food supplies became available and those organism which could adapt to this changing climate survived

There are two main hypotheses about the origin and dispersal of modern H. sapiens: Multi-regional and Out of Africa. Both these hypothesis agree that humans originated in Africa

Multi-regional

Also called Parallel evolution OR regional Continuity

- This states that some H. erectus left Africa about 1.8 MYA and spread to Europe and Asia
- In the three areas H. erectus evolved parallel into H. sapiens, with some genetic contact and gene flow between populations in the different areas;
H. sapiens evolved simultaneously in the 3 continents



Evidence to support this hypothesis

- Some transitional fossils have been found in many places esp the Asian fossils which show a clear transition from older hominid to modern H sapiens
- High levels of gene flow would be needed for this hypothesis to be correct which is not very likely

This hypothesis is highly questioned based on the more recent genetic research especially the use of mtDNA and Y chromosome DNA (see below). For this hypothesis to be correct current humans would have large genetic variation. However when mtDNA (mitochondrial DNA) and Y chromosome DNA is analysed there was less variation than expected. This means they didn't leave Africa until much later

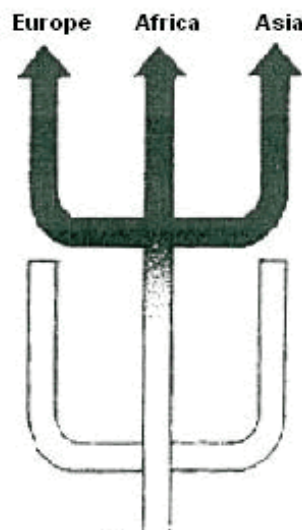
Out of Africa

Also called replacement hypothesis

- This hypothesis states that we left Africa as H sapiens much later about 200,000YA. So we evolved from H erectus in Africa
- They spread gradually replacing/ killing off making other hominin species extinct as they came upon them

NOTE: this was the second movement out of Africa as some H erectus left Africa about 1.8MYA but they became extinct outside of Africa due to the harsh environments at the time. Those that remained in Africa evolved into H sapiens and left much later.

- Every person who is not of African descent is related to a single group of about 200 people who left Africa and crossed the Red Sea
- These movements were made possible by an ice age which caused sea level to drop

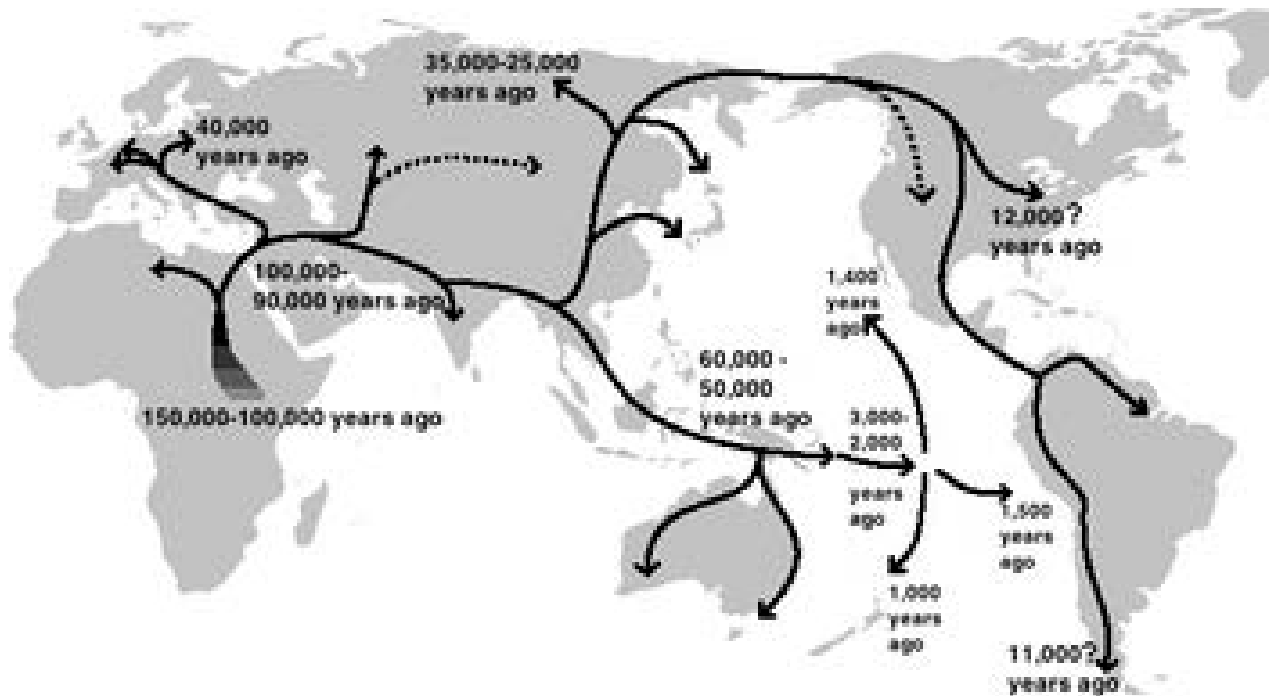


Evidence to support this hypothesis

- All modern humans have similar genes and nuclear sequences. If parallel evolution had occurred there would be much greater variation in humans genetic makeup
- mtDNA (mitochondrial DNA) are passed down the female line unchanged except by mutation.

NOTE mtDNA is replicated independently of the rest of the cell's DNA therefore does not get altered by crossing over etc. (mtDNA has been used because it is passed on from **mother to child** and is not changed due to meiosis). Mutations occur at a steady rate in mtDNA and can be used to estimate how long ago two species shared a common ancestor.

- Y chromosome can be used in the same way but this is passed down the male line without being altered.
- When both mtDNA and Y chromosome DNA was analysed it was observed that the DNA has been highly conserved (hasn't changed much). Therefore it has been predicted that "Mitochondrial Eve" left Africa much later, about 100,000 YA
- People that live in Africa have the greatest genetic variation as they have been around for the longest time and have had more time to develop genetic diversity. The greatest variability is found within African populations which are the oldest. There is less genetic diversity in Asian and European populations, which suggests they are not as old as African populations.
- Using mtDNA and Y chromosome DNA the map below shows the dispersal of H sapiens out of Africa



- Modern Europeans share between 1 and 4 per cent of their genes with Neanderthals, from this it is thought that there was an overlap of Neanderthals and modern humans in space and time resulting in the possibility of interbreeding. Evidence both for and against interbreeding have been put forth based on the analysis of modern human DNA. This analysis has lead scientists to believe modern humans last exchanged genes between 37,000 and 86,000 years ago
- Stone axes and sharp flint arrowheads of both branches of the human race were discovered in the limestone caves at the Nahal Me'arot nature reserve at Mount Carmel in Haifa. None of the bones uncovered at the World Heritage site had lethal wounds, which suggested to researchers that prehistoric men lived in peace with Neanderthals 80,000 years ago. Many believed peaceful cross-breeding was more likely than the result of rape attacks
- Below are flint arrowheads found at the site used by both H sapiens and Neanderthals

