

Life Sciences

Part 2

CLASS TEXT & STUDY GUIDE

Liesl Sterrenberg, Helena Fouché & Grace Elliott

GRADE
12
CAPS

3-in-1



THE
ANSWER
SERIES *Your Key to Exam Success*



Grade 12 **Life Sciences** 3-in-1 Part 2 CAPS

CLASS TEXT & STUDY GUIDE

This book is PART 2 of a SET of 2 Life Sciences study guides comprehensively covering the Grade 12 CAPS curriculum.

It contains the 2 Knowledge Areas examined in Paper 2 (National final exam):

- Life at the Molecular, Cellular and Tissue level
- Diversity, Change and Continuity

Key Features:

- Comprehensive, accessible notes per module
- Carefully selected, graded questions and answers per module
- 'Rapid-fire' questions for key concepts and terms
- Clear, explanatory diagrams
- Up-to-date, relevant material

As you work methodically through this study guide, you will become increasingly prepared to achieve excellent results in your exams.



Life Sciences

Part 2

Liesl Sterrenberg, Helena Fouché & Grace Elliott

Also available

GRADE 12 LIFE SCIENCES PART 1

- Life Processes in Plants and Animals



THIS CLASS TEXT & STUDY GUIDE INCLUDES

- 1 Notes
 - Life at the Molecular, Cellular and Tissue level
 - Diversity, Change and Continuity
- 2 Questions & Rapid Fire Questions
- 3 Detailed Memos

ALL
the content
you need
for
PAPER II

E-book
available 

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WHAT IS LIFE SCIENCES?

Life Sciences is the scientific study of living things from molecular level to their interaction with one another and the environment.

- ▶ Living systems exhibit levels of organisation from molecules to biomes.
- ▶ Life on earth is dynamic, with homeostasis maintaining balance at every level of organisation.
- ▶ Life is characterised by changes over time.

AIMS IN LIFE SCIENCES

- Specific Aim 1:** Knowing Life Sciences
(concepts, processes, phenomena, mechanisms, principles, theories, laws, models, etc.)
- Specific Aim 2:** Investigating phenomena in Life Sciences
- Specific Aim 3:** Appreciating and Understanding the History, Importance and Applications of Life Sciences in Society.



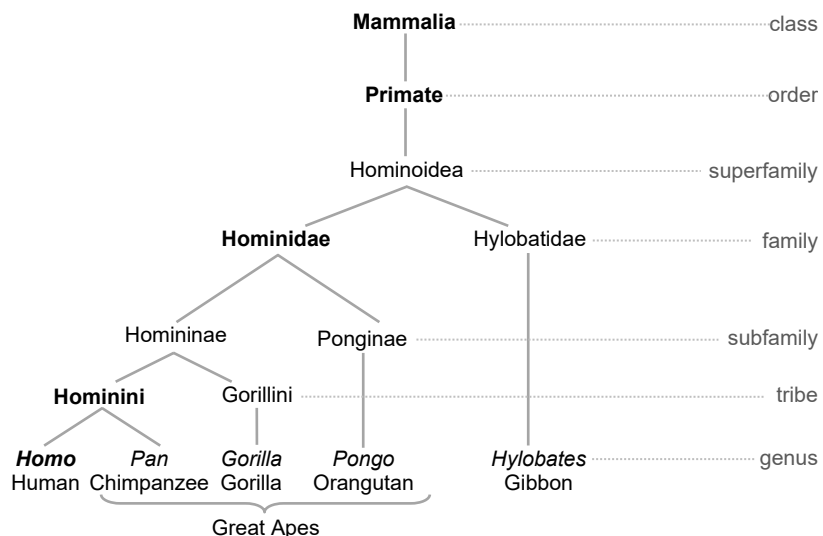
UNIT 2

HUMAN EVOLUTION

THE PLACE OF HUMANS IN THE ANIMAL KINGDOM

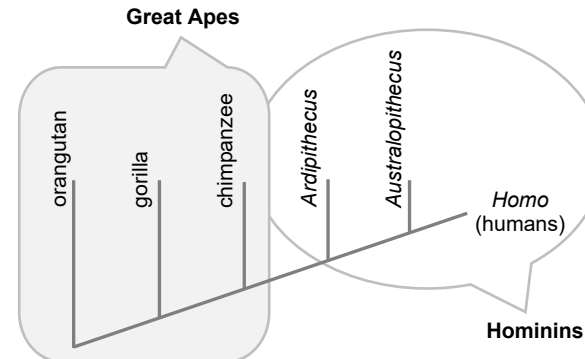
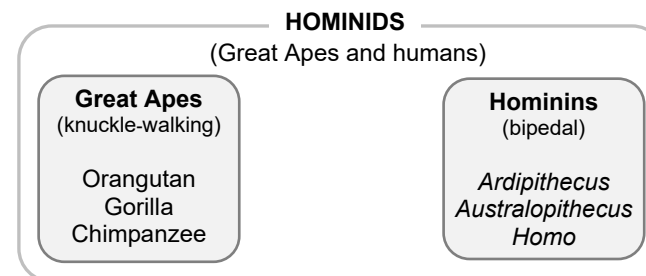
- ▶ Humans are **mammals**, belonging to the class **Mammalia**, because their bodies are covered in hair and they suckle their young. All mammals also have three ossicles (bones) in the middle ear.
- ▶ Humans are classified in the class **Mammalia**, order **Primates**. Primates include humans, apes, orangutans, gorillas and chimpanzees.
- ▶ The order **Primates** includes the superfamily **Hominoidea** that is subdivided into two families, i.e. **Hominidae** (Great Apes and humans) and **Hylobatidae** (gibbons).
- ▶ Family **Hominidae** is divided into two subfamilies, i.e. **Ponginae** and **Homininae**.
- ▶ Some scientists divide the subfamily **Homininae** into two more tribes, i.e. **Hominini** and **Gorillini**.
- ▶ Humans, gorillas and chimpanzees fall under the subfamily **Homininae** and the orangutans are part of **Ponginae**.
- ▶ Humans belong to the genus **Homo**.

Scientific Classification



All members of the family **Hominidae** are known as **hominids** (Great Apes and humans). However, certain sources refer to hominids as only humans and their fossil ancestors (the Great Apes excluded). A new term, **hominins**, is currently used by scientists, which refers to humans and their fossil ancestors.

In this study guide we will use the term **hominin** for bipedal humans and their fossil ancestors. The term **hominid** will be used when reference is made to the Great Apes as well as humans and their fossil ancestors. **Great Apes** are also often referred to as **African Apes**.



A phylogenetic tree to show the evolutionary path of the family Hominidae

A **phylogenetic tree** is a diagram that illustrates the evolutionary relationships between organisms.

Individuals of the genera **Ardipithecus** and **Australopithecus** as well as early **Homo**-species are considered fossil ancestors of modern humans. Modern humans are classified in the genus and species **Homo sapiens**. These three genera have ape-like as well as human characteristics and they are sometimes referred to as 'ape-men'. See p. 117 for a more detailed discussion of these three genera.



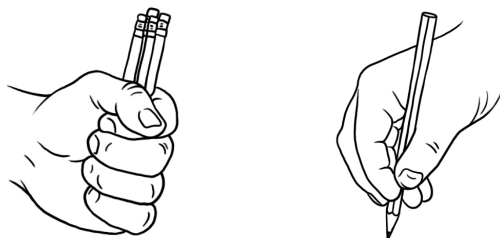
Anatomical similarities between African apes and humans

Humans share the following characteristics with other primates:

- ▶ opposable thumbs that allow monkeys to have a **power grip**, while humans are capable of a **power grip** as well as a **precision grip (fine motor ability)**



Apes: power grip



Humans: power grip and precision grip (fine motor grip)

- ▶ two hands, each with five fingers; and two feet each with five toes
- ▶ long arms that rotate freely as shoulder joints allow movement in all directions
- ▶ naked fingertips and toes ending in flat nails
- ▶ a reduced snout with weakened sense of smell (reduced olfactory brain centres)
- ▶ stereoscopic vision as the eyes face forward providing depth of field - 3D vision
- ▶ eyes have cones (as well as rods) making colour vision possible
- ▶ brain centres that process information from hands and eyes are enlarged
- ▶ no tail
- ▶ sexual dimorphism where males and females are clearly distinguished
- ▶ have molars and premolars with rounded cusps



Anatomical differences between African apes and humans

African apes	Humans
▶ Quadrupedal - knuckle-walkers	▶ Bipedal - walk upright on two legs
▶ Foramen magnum (opening for spinal cord) closer to back of skull	▶ Foramen magnum closer to front of skull
▶ C-shaped vertebral column	▶ S-shaped vertebral column
▶ Arms longer and stronger than legs	▶ Arms shorter and weaker than legs
▶ Knee joints smaller and weaker	▶ Knee joints larger and stronger
▶ Opposable (grasping) big toe with power grip	▶ Non-opposable (forward-thrusting) big toe in line with other toes
▶ Flat feet	▶ Curved foot arch
▶ Long and narrow pelvis	▶ Short and wide pelvis
▶ Smaller, less developed brain	▶ Large, developed brain
▶ Large, prominent canines	▶ Smaller canines; the same size as other teeth
▶ Thin tooth enamel	▶ Thick tooth enamel
▶ Large, prominent jawbone with no chin (prognathism)	▶ Rounded jaw with developed chin (non-prognathism)
▶ Wider, sloping face	▶ Narrow, flat face
▶ Narrow, rectangular palate	▶ Wider, more curved palate
▶ Prominent cranial and brow ridges	▶ Reduced cranial and brow ridges

EVIDENCE OF COMMON ANCESTORS FOR LIVING HOMINIDS (including humans)

- ▶ The evolutionary theory does not state that humans evolved from the chimpanzee or the gorilla, but it proposes that they share a **common ancestor**.
- ▶ Scientists are searching for a common ancestor of all living hominids.
- ▶ The big question scientists have to answer is whether the common ancestor was ape-like or human-like.
- ▶ Remains of earlier hominids are very rare.

- ▶ There are three **main types of evidence** that indicate hominids may have shared a common ancestor:
 - ▶ **Fossil evidence**
 - ▶ **Genetic evidence** (see p. 115)
 - ▶ **Cultural evidence** (see p. 115)

Fossil evidence

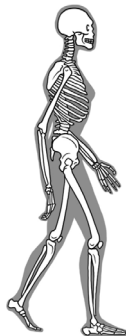
- ▶ Paleontologists study fossils to provide more information on the structure, movement, lifestyle and environment of a particular species.
- ▶ Certain features of hominid fossils indicate how changes occurred over time.
- ▶ Hominid fossils are rarely complete and consist mainly of fragments.
- ▶ Most hominid fossils are teeth, jaw bones or skull fragments.
- ▶ The remains of feet, hands, pelvic bones or vertebral columns are scarce.
- ▶ Long bones, e.g. femurs are more commonly found.
- ▶ In the search for a common ancestor for hominids, palaeontologists look particularly at the following features of hominid fossils:
 - ▶ bipedalism
 - ▶ dentition (teeth)
 - ▶ palate shape
 - ▶ brain size
 - ▶ prognathism
 - ▶ cranial and brow ridges

Bipedalism

- ▶ The greatest observable difference between ape and human fossils lies in the difference in posture and method of locomotion.
- ▶ Apes are four-footed (quadrupedal) with gorillas and chimpanzees demonstrating a particular manner of walking, i.e. knuckle-walking.
- ▶ Humans, however, are bipedal and walk upright.
- ▶ The main features that provide **evidence for bipedalism** are:
 - 1 position of the **foramen magnum**
 - 2 shape of the **spine**
 - 3 shape of the **pelvic girdle**



Chimpanzee (quadrupedal)



Human (bipedal)

- ▶ Hominid fossils show evidence of a transition from quadrupedalism to bipedalism.

Anthropologists have provided various explanations of the advantages for the transition to bipedalism.

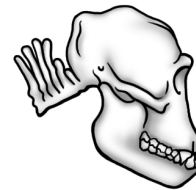
Advantages of bipedalism include:

- ▶ Upright bodies expose a smaller surface area to the sun which reduces risk of overheating while hunting, foraging or escaping predators.
- ▶ Upright bodies expose a larger surface area to air currents which causes cooling and reduces dependency on water.
- ▶ Hands are free to use tools, prepare food, carry young, hunt or fight.
- ▶ Vision extends further over the tall grass to find food or avoid predators.
- ▶ Adaptability to occupy a wider range of habitats.

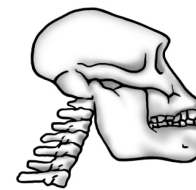
- ▶ For early hominids to become bipedal and walk upright, their skeletons had to change quite considerably.

- ▶ The following **changes in structure** are observed in humans:

- 1 In bipedal humans the **foramen magnum** shifted forward so that the skull rests on top of the vertebral column and the eyes face forward. The foramen magnum is positioned more forward at the base of the skull. In quadrupedal apes the head is positioned in front of the vertebral column with the foramen magnum closer to the back of the skull.



A



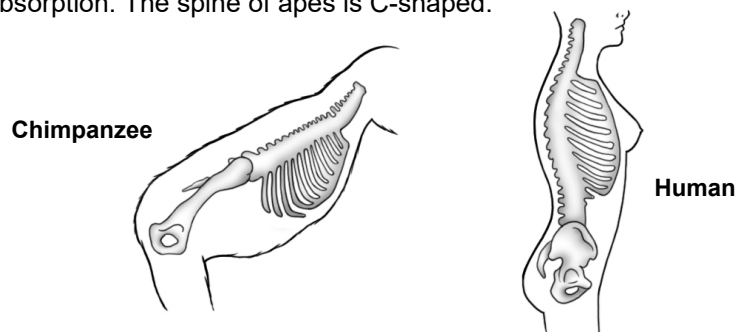
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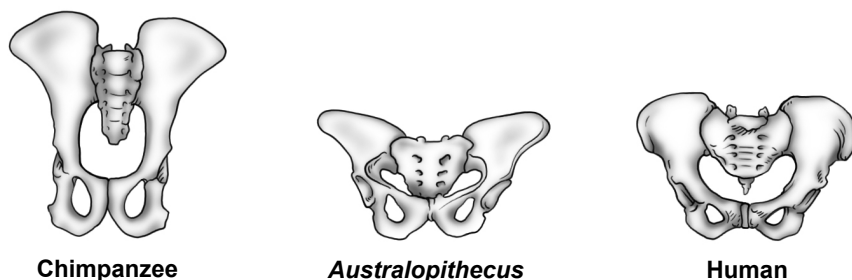
C

- A. Chimpanzees: foramen magnum is positioned at the back of the skull
- B. Early *Homo* species: foramen magnum is positioned closer to the front for stable upright walking
- C. *Homo sapiens*: foramen magnum is positioned more forward, directly above the spine to balance the head above the vertebrae

- 2 The human **spine** (vertebral column) is S-shaped for flexibility and shock absorption. The spine of apes is C-shaped.



- 3 The human **pelvic girdle** has become larger, shorter and wider to support the greater weight due to the upright posture. The pelvic girdles of apes are long and narrow.



Other evidences of bipedalism include:

- ▶ Humans have shorter arms and longer legs, while apes have shorter legs and longer arms.
- ▶ In humans the knee-joints have become larger and stronger to support greater body weight.
- ▶ The human big toe is parallel with the other toes and helps to maintain balance. Apes have opposable big toes with a grasping action for climbing and moving in trees.
- ▶ A foot arch developed in humans, whereas an ape's foot is flat.

The foot arch acts as a shock absorber and enables the rolling action over the ball of the foot which is more energy efficient.



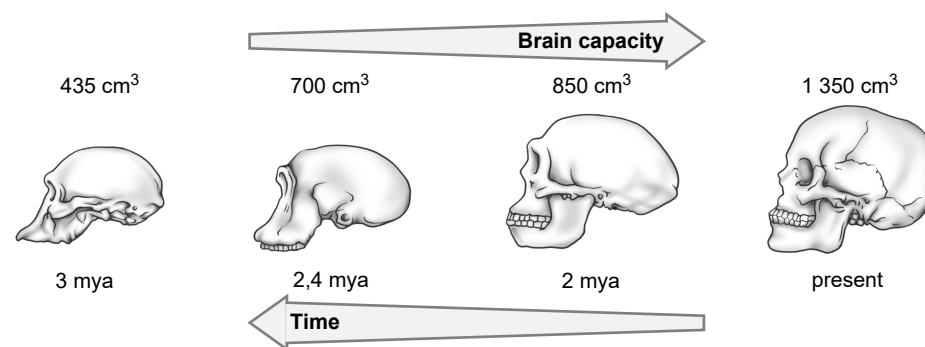
Brain size

- ▶ Hominid fossils indicate that the size of the **cranium** increased in most fossils over time.
- ▶ We may conclude that, in general, the size of the brain (**brain capacity**) or **cranial volume** increased over time.



*The **skull** refers to the bones that form the head including the **cranium** (brain case) and the **facial bones**.*

See the comparative table of brain capacities of the main hominin species on p. 122.



- ▶ The cranium of apes is small and elongated and contains a small, less-developed brain.
- ▶ Chimpanzee brains have an average size of approximately 395 cm³.
- ▶ Humans have a more rounded skull with an enlarged cranium which contains a large, highly developed brain.
- ▶ The average size of the human brain is approximately 1 400 cm³.
- ▶ The more complex human brain gave rise to:
 - › well-developed hand-eye coordination (to make and use tools)
 - › the capacity for language
 - › the use of fire

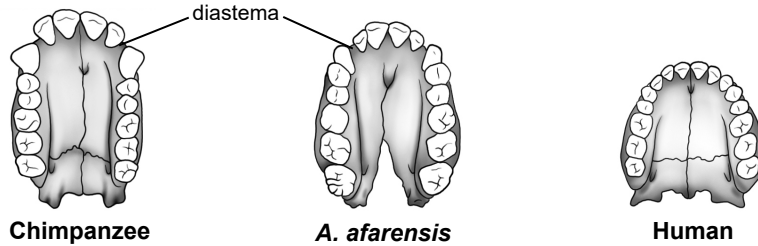


The larger brain contributed to the survival of humans because they could successfully adapt to changing environments.



Dentition (teeth)

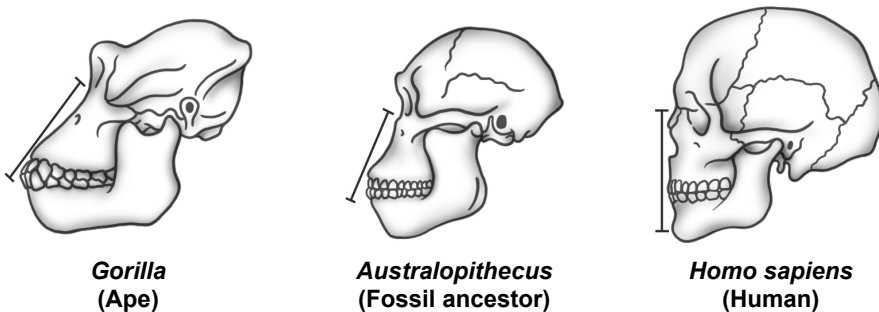
- ▶ The size of teeth decreased with the course of evolution.



- ▶ Apes have large prominent canines that are larger than other teeth.
- ▶ In apes, there is a large gap (diastema) between the incisors and the canines. It provides space for the protruding canines on the opposite jaw so that the mouth can close.
- ▶ The human canines are the same size as the other teeth.
- ▶ The diastema disappeared completely over time.
- ▶ The tooth enamel became thicker over time. In apes it is very thin, in hominins it is thicker and in humans it is very thick.

Prognathism

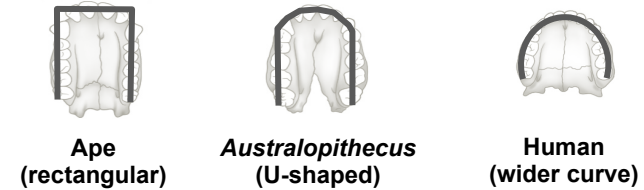
- ▶ Apes have large, protruding jaws (snout or muzzle) without a chin.
- ▶ Their jaws protrude beyond the upper part of the face, which results in a sloping face.
- ▶ As the teeth become smaller over time, so the jaws become less protruding (non-prognathism) and more rounded. The face appears flatter and less sloping.



- ▶ Humans have a narrow, flat face with rounded jaws and a protruding chin.
- ▶ The forehead appears more vertical as a result of the larger cranium that contains a larger brain.

Palate shape

- ▶ The palate in apes is narrow and rectangular and became more U-shaped over time in early hominins (*Australopithecus*).
- ▶ In humans the palate became wider and more curved.



The curved palate of modern humans aided the development of speech.



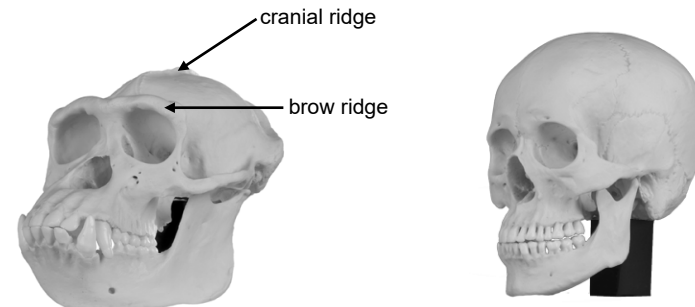
Cranial and brow ridges

- ▶ Apes have prominent cranial and brow ridges for attachment of well-developed chewing muscles.



Male gorillas have the most prominent cranial ridges of any of the living hominids.

- ▶ As evolution progressed over time, both cranial and brow ridges decreased in size.
- ▶ Cranial ridges began to disappear in early hominins, but brow ridges were still well developed.
- ▶ Cranial and brow ridges are completely reduced in humans.



Chimpanzee skull with prominent cranial and brow ridges

Human skull with completely reduced cranial and brow ridges

Genetic evidence

- ▶ Besides fossils, the field of genetics is another source of evidence of common ancestors for living hominids.
- ▶ DNA comparisons are made between living hominids, as DNA breaks down in dead cells and it is very rare to extract DNA from a fossil.

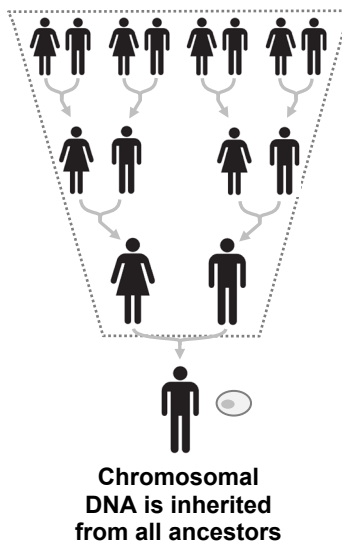
Remember: Living hominids include orangutan, gorilla, chimpanzee and humans.



- ▶ Organisms contain two types of DNA:
 - ▶ **chromosomal DNA** (in the nucleus)
 - ▶ **mitochondrial DNA** (mtDNA in the mitochondria)

Chromosomal DNA

- ▶ Chromosomal DNA occurs in the nuclei of all cells and contains all the genetic information coding for the characteristics of the organism.
- ▶ Chromosomal DNA is transferred by both parents (mother and father) to their offspring, thus chromosomal DNA is inherited from all ancestors.
- ▶ A comparison of the chromosomal DNA of living hominids may determine how closely related they are.
- ▶ The more similarities found in the DNA, the closer the relationship.
- ▶ Although every person is unique, 99,9% of all human DNA is identical, only a 0,1% variation.
- ▶ This small genetic variation is evidence of the close relationship between all humans.
- ▶ 98% of human DNA corresponds with chimpanzee DNA, which makes them the closest related hominid to humans.



The difference of 2% between human and chimpanzee DNA appears insignificant, but humans have about 3 billion nucleotide pairs (see p. 4) in the DNA of ONE cell. So a difference of 2% involves 60 million nucleotide pairs per cell. This puts the differences between species in perspective.



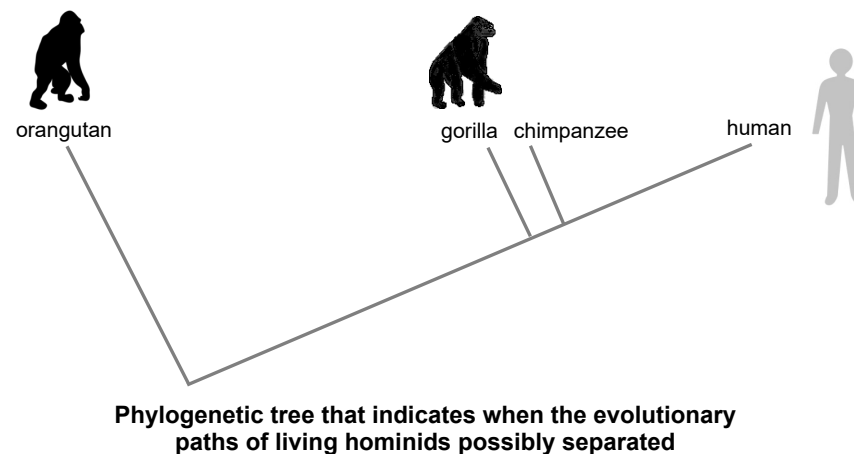
- ▶ This genetic evidence in DNA supports Darwin's idea that humans and apes share a common ancestor.

Mitochondrial DNA (mtDNA)



In Module 1, Unit 3: Genetics and inheritance, p. 41 you were introduced to mtDNA. Read through this section to refresh your memory.

- ▶ By comparing the mtDNA of living hominids, scientists can attempt to determine when the evolutionary paths of humans and African apes separated.
- ▶ If there are many differences, the separation occurred earlier.
- ▶ This means there was more time for mutations to occur so there is more variation.
- ▶ If there are fewer differences, the separation occurred more recently.
- ▶ There was thus less time for mutations to occur and there is less variation.
- ▶ In this way, scientists determined that a common ancestor for all living hominids may have existed 15 mya and that the evolutionary paths of humans and chimpanzees separated about 6 mya.



Cultural evidence: tools

- ▶ The production and use of tools and other cultural practices like fire-making, burial rites, art and hunting techniques are suggested as further evidence of common ancestors for living hominids.
- ▶ The development of speech and language is another cultural change that distinguishes modern humans from primates.

- ▶ Improved communication and social interaction in a community were crucial for effective hunting and defence.

This section focuses on the range of tools found in fossil sites.



- ▶ Tool-making is associated with increased intelligence and well-developed hands.
- ▶ The part of the brain responsible for coordinating the movement of the hands is much larger in humans than in other primates.



Scientists are not sure if the use of tools stimulated brain development or an enlarged brain facilitated the use of tools.

- ▶ Although apes are known to use a variety of objects like sticks and stones as tools to access food, they do not, however, make tools.

Apes often use sharp stones to break bones to get at the bone marrow.



- ▶ The **Homo** genus has a fine motor grip that enabled them to design and produce their own tools.

NB: *Australopithecus* genus (also known as ape-men) are not associated with tool-making.

- ▶ Most of the tools found in fossil-rich areas are made of stone.
- ▶ Although hominids may have used tools composed of other materials like bone, ivory or wood, most would have decomposed over time.
- ▶ Tools vary from simple, sharp stones to carefully sculpted cutting blades.
- ▶ It is sometimes difficult to distinguish between deliberately shaped stone tools and stones that happen to be suitably shaped for cutting.



*Various early **Homo** species are named in the following section. You will be introduced to the **Homo** genus in more detail later in the module on p. 120.*



- ▶ The first hominids that probably made and used tools were **Homo habilis** (handy man).
- ▶ The main advantage of tool technology is access to a wider variety of food including harder plant materials and meat.
- ▶ They could kill larger prey and improve preparation of food material for cooking and eating.

2,6 - 1,5 mya

- ▶ The oldest known tools that may have been used for butchering meat were found in Tanzania and Ethiopia. The oldest stone tools in Southern Africa were found in the Sterkfontein caves.
- ▶ These tools are associated with **Homo habilis**.
- ▶ All these simple tools are often formed with a single blow.
- ▶ The tools include:
 - ▶ **Choppers:** It is a hard rock core from which sharp-edged **flakes** were cut using a larger, harder rock, the **hammerstone**.
 - ▶ **Flakes:** These are simple, thin, sharp stones cut from a hard rock core and used to cut meat from bone.
 - ▶ **Scrapers:** These are smaller flakes that were used to clean and prepare hide (animal skins) for making clothes or shelter.



Making a chopper

1,5 mya - 250 000 years ago

- ▶ A more advanced tool-making tradition is characterised by roughly made hand-axes originally found in France.
- ▶ The **Homo** species, **Homo erectus** and **Homo ergaster** probably developed these tools.
- ▶ All these tools are made by reworking existing tools and show signs of repetitive flaking to shape the edges.
- ▶ The tools were heavier, larger and shaped with stone, wood and bone.
- ▶ Tools include:
 - ▶ **Hand axes:**
 - They are oval-shaped with a pointed end and sharpened on both edges.



*As both sides of the stones are sharpened, they are known as **bifacial tools**.*

- They are shaped using soft and hard hammering tools.
- They were used for cutting wood and killing large animals.

- ▶ **Picks:** thick, pointed stones
- ▶ **Cleavers:** large cutting tool with long, wide 'blade' section



Different hand axes in early tool culture

250 000 - 50 000 years ago

- ▶ Finely made stone tools that are more regular in shape were first found in France. More refined bone tools were also found in Blombos Cave dating to around 80 000 years.
- ▶ These tools included flakes, scrapers and points that were possibly used by **Homo neanderthalensis** and **Homo sapiens**.
- ▶ Hand axes from this time period had more carefully shaped blades.
- ▶ These tools formed part of sophisticated **tool kits**.



Refined tools gave access to better food, clothing and shelter which lead to more complex and comfortable lifestyles.

100 000 years ago - recent human history

- ▶ In the last 100 000 years, humans learned to design small stone flakes into shapes for composite tools like refined spearheads and knives with improved, longer blades.
- ▶ Smaller blades also known as **microliths** formed part of arrowheads and fish hooks.
- ▶ **Homo sapiens** also domesticated animals (cattle, sheep, horses, donkeys) and cultivated fruit and vegetables to provide for their needs.
- ▶ This led to a more settled existence and the establishment of villages and towns.
- ▶ **Homo sapiens** produced clothing and various art forms: e.g. drawings, ornaments, sculptures and jewellery.
- ▶ More modern **Homo sapiens** also utilised different metals (copper, bronze, iron) in their advancing technology.

MAJOR PHASES IN THE HOMINID EVOLUTION (from 6 mya to present)

- ▶ The main **hominin** genera within the **hominid** group are the following:
 - ▶ **Ardipithecus**
 - ▶ **Australopithecus**
 - ▶ **Homo**
- ▶ The timeline of human evolution probably began 6 - 7 million years ago.

Scientists disagree and differ widely about the origins of humans. This study guide aims to provide a broad overview of the scientific evidence available and the conclusions of various scientists based on this data.



ARDIPITHECUS

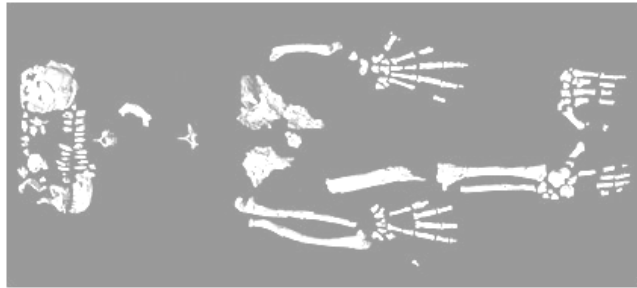
- ▶ **Ardipithecus ramidus** was an early hominin that lived approximately 5,8 - 4,4 million years ago.
- ▶ About 17 **Ardipithecus** fossils were found in the Afar valley of Ethiopia in 1993.
- ▶ These beings show **intermediate characteristics** (ape-like as well as australopithecine characteristics) indicating that **Ardipithecus** could be a **transitional form** between the apes and **Australopithecus**.

General characteristics of **Ardipithecus**

- ▶ Probably bipedal.
- ▶ Foramen magnum positioned more forward at the base of the skull than in apes.
- ▶ Pelvis is wider at the top, and narrow and long at the bottom as in apes.
- ▶ Long arms (almost as long as the legs) for climbing trees.
- ▶ Opposable, grasping big toe as in apes.
- ▶ Small brain capacity of approximately 300 - 350 cm³.
- ▶ Ape-like teeth, but smaller canines and molars; a diastema is present.

- ▶ Protruding jaw (snout/muzzle) without a chin.
- ▶ Sloped face.
- ▶ Palate is narrow and rectangular.
- ▶ Small brow ridges.

The structure of the feet, pelvis, legs and hands indicated that **Ardipithecus** was bipedal on the ground, but quadrupedal when climbing trees.



An incomplete skeleton of an **Ardipithecus** fossil

AUSTRALOPITHECUS

- ▶ Australopithecines are regarded as the first bipedal primates.
- ▶ Australopithecines ('ape-men') may be considered **transitional species** between apes and *Homo sapiens* as they have some **intermediate characteristics** (both ape-like and human-like characteristics).
- ▶ The genus name *Australopithecus* literally means 'southern ape'.



Individuals belonging to this genus are called **australopithecines**.

- ▶ It is estimated that australopithecines lived in Africa between 4,5 and 1,4 million years ago.
- ▶ During this time the African forests increasingly made way for sparse woodlands, grasslands and savannas.
- ▶ *Australopithecus* fossils were found mainly in Eastern and Southern Africa.

General characteristics of *Australopithecus*

- ▶ Bipedalism and upright walking.
- ▶ Foramen magnum is positioned more forward at the base of the skull.

- ▶ Pelvis is short and wide.
- ▶ Long arms for tree climbing.
- ▶ Fingers long and curved; non-opposable big toe.
- ▶ Brain capacity larger than that of the apes, approximately 380 - 500 cm³.
- ▶ Teeth more human-like; smaller canines than apes, but larger than humans; small diastema.
- ▶ Protruding jaw without a chin.
- ▶ Sloping face (less sloping than in apes).
- ▶ U-shaped palate.
- ▶ Large brow ridges.
- ▶ The 3,8 million year old footprints discovered in Laetoli, Tanzania are one of the oldest fossils indicating evidence of bipedalism of *Australopithecus*.
- ▶ *Australopithecus* probably developed simultaneously with the *Homo* genus and is therefore not regarded as a human ancestor.
- ▶ Various *Australopithecus* fossils of different species have already been found in Africa.
- ▶ The following five well-known australopithecines are discussed:
 - › Taung child
 - › Mrs Ples
 - › Lucy
 - › Little Foot
 - › *Australopithecus sediba*

Although australopithecines were bipedal, they also climbed trees.



Footprints that confirm bipedalism in *Australopithecus*

Taung child (*Australopithecus africanus*)

- ▶ In 1924 the fossil skull of a hominin was found by Professor Raymond Dart at Taung, northwest of Kimberley.
- ▶ It was the skull of a child of about 3 - 4 years old.
- ▶ The skull had human as well as ape-like characteristics:
 - a small brain capacity (340 cm³) similar to apes
 - small human-like teeth
 - foramen magnum in a more forward position, indicating bipedalism
- ▶ The Taung skull is classified under *Australopithecus africanus*, who lived about 2 - 3 million years ago.



Taung skull

Mrs Ples (*Australopithecus africanus*)

- ▶ In 1947 a complete adult skull and various bones were found by Dr Robert Broom in the Sterkfontein Caves in South Africa.
- ▶ This skull was about 2 - 3 million years old and was also classified as *Australopithecus africanus*.
- ▶ A smaller brain capacity similar to that of a chimpanzee.
- ▶ From the position of the foramen magnum it could be deduced that Mrs Ples was bipedal and walked upright.
- ▶ The jaws indicated that there were no protruding canines, and the dentition indicated a diet of mainly plant material with little meat.



Mrs Ples has been called the missing link numerous times, but is actually only **one** of the links in the many branches of the human evolutionary chain.



Mrs Ples

Lucy (*Australopithecus afarensis*)

- ▶ Lucy is a fossilised female skeleton found by Donald Johanson at Hadar in the Afar valley, Ethiopia in 1974.
- ▶ The skeleton dates back 3,5 million years.
- ▶ The shape of the pelvis indicated that Lucy was female.
- ▶ The skeleton was about 1 m long and showed evidence of bipedalism.
- ▶ The face had ape-like characteristics, i.e. a low forehead, flat nose, protruding lower jaw and large canines.
- ▶ The arms were long and the legs short.
- ▶ The brain capacity of 400 cm³ was similar to that of apes.



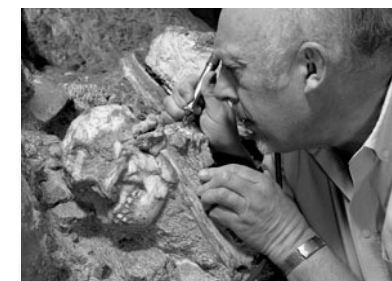
Lucy fossil skeleton

Australopithecus africanus - 'southern ape of Africa'
Australopithecus afarensis - 'southern ape of Afar'



Little Foot (*Australopithecus species*)

- ▶ In 1994 the ankle and foot bones of an australopithecine fossil was discovered in the Sterkfontein Caves by the palaeoanthropologist Dr Ron Clarke and the complete skeleton was revealed in December 2018.
- ▶ The adult female fossil was named Little Foot. It is considered the most complete and oldest fossil hominin ever discovered.
- ▶ Little Foot is considered bipedal because of the position of the foramen magnum more forward and the longer human-like legs.
- ▶ The arms are shorter with smaller hands resembling modern humans.
- ▶ Little Foot has an ape-like smaller brain.



Dr. Ron Clarke with Little Foot

The Little Foot skeleton is 90% complete, whereas the well-known Lucy skeleton is only 40% complete.



palaeontology - the study of plant and animal fossils

anthropology - the study of the origin and social relationships of humankind

archaeology - the study of artefacts left behind by early human populations

palaeoanthropology - the study of human evolution by studying fossils of humans and artefacts



The Sterkfontein Caves are limestone caves situated northwest of Johannesburg. The largest number of hominin fossils in the world are found here. More than 700 ape-like hominin fossils have already been discovered. It is known as the **Cradle of Humankind** because scientists believe that this region could be the site of human origin.

Australopithecus sediba

- ▶ In 2008 two fossils, those of a young woman and boy, were discovered in the Cradle of Humankind in the Malapa area by Professor Lee Berger and his 9-year-old son, Matthew.



This was the first time that a new hominin species had been found in South Africa since Dr Robert Broom discovered Mrs Ples in Sterkfontein in 1947.



- ▶ These fossils represent a new species, *Australopithecus sediba*, which was announced to the world in April 2010.
- ▶ The fossils are between 1,7 and 2 million years old.
- ▶ *Australopithecus sediba* is considered a transitional fossil between the older *Australopithecus africanus* and the first *Homo* species, and possibly gave rise to the origin of modern humans.
- ▶ *Australopithecus sediba* has a small brain and large brow ridges in comparison to modern humans, but the shape indicates a more advanced brain than that of other australopithecines.

- ▶ Early australopithecines were able to walk upright, but could not run fast or walk for long distances.
- ▶ Similarly, *Australopithecus sediba* had long arms and short hands adapted for tree climbing, while the pelvis was similar to that of early *Homo* species and adapted for walking long distances.
- ▶ Professor Berger and his colleagues believe that *Australopithecus sediba* could probably be the ancestor of modern humans.



*Matthew Berger (Professor Berger's son) found the fossil of the young boy and it was named **Karabo**.*

HOMO

- ▶ The genus *Homo* appeared in Africa about 2,2 million years ago.

General characteristics of *Homo*

- ▶ Bipedalism with upright walking.
- ▶ More forward foramen magnum at the base of the skull, directly above the vertebral column.
- ▶ Pelvis is short and wide.
- ▶ Legs are long in relation to arms; longer femurs for greater stride.
- ▶ Short, straight toes; non-opposable big toe; enlarged heel bone; opposable thumb.
- ▶ Larger brain with a brain capacity of approximately 600 - 1 400 cm³.
- ▶ Smaller teeth (no protruding canines), no diastema.
- ▶ Jaws more rounded with a prominent chin in *Homo sapiens*; older species have protruding jaws.
- ▶ Flat face.
- ▶ Wide, curved palate.
- ▶ No brow ridges in *Homo sapiens*; older species have large brow ridges.

Differences between genera *Australopithecus* and *Homo*

- ▶ The brain of *Homo* was much larger and better developed. *Homo* could make and use tools, make fire and develop language.
- ▶ The skull of *Homo* was more human-like with less prominent brow ridges, a flatter face, smaller teeth and a more rounded jawbone.

- ▶ The following *Homo* species are discussed:

- ▶ *Homo habilis*
- ▶ *Homo erectus*
- ▶ *Homo neanderthalensis*
- ▶ *Homo sapiens*

Homo habilis

- ▶ *Homo habilis* lived in Africa, together with other *Australopithecus* species, about 2,2 - 1,6 million years ago.
- ▶ *Australopithecus africanus* probably gave rise to *Homo habilis*.
- ▶ In 1960 a *Homo habilis* fossil was discovered in Tanzania.
- ▶ The body of *Homo habilis* was smaller than that of *Australopithecus* and it was ape-like.
- ▶ They also had a larger brain (640 cm³) than *Australopithecus*, which meant they had better skills in using their hands to make tools.
- ▶ *Homo habilis* was the first group that used stone tools.



The name *Homo habilis* literally means 'handy man'.



Homo erectus

- ▶ *Homo erectus* is a species that is closer to modern humans than to *Australopithecus*.
- ▶ *Homo erectus* literally means 'upright man' and they lived 1,8 - 0,3 million years ago.
- ▶ They were probably the first hominins to migrate from Africa to Europe and Asia.
- ▶ The most complete *Homo erectus* fossil is 1,5 million years old and was found near Lake Turkana in Kenya. It is known as the **Turkana boy**.



Other well-known *Homo erectus* fossils that have been found include the **Peking man**, discovered in China (400 000 years old), and the **Java man** fossil skull (700 000 years old) found in Java, Indonesia.

- ▶ *Homo erectus* had large bodies, similar to those of modern humans.
- ▶ Their skulls were thick with low, prominent foreheads, heavy brow ridges and no chin.
- ▶ Both jaws were relatively massive with large teeth.
- ▶ Their brain capacity was about 1 000 cm³.
- ▶ *Homo erectus* made and used stone and bone tools.
- ▶ They were successful hunters and the first species that learned to use fire.



Homo neanderthalensis

- ▶ The Neanderthals were a group of people that lived between approximately 230 000 and 30 000 years ago in Europe and Western Asia.
- ▶ The first fossil was discovered in 1856 in the Neander Valley in Germany.
- ▶ Their skulls were long and flat, with a low forehead, broad nose and a prominent brow ridge above the eyes.
- ▶ Although their brains were larger than *Homo sapiens*, language was not well developed and their technological development was limited.
- ▶ They were hunters, wore clothes made from animal skins, built shelters in caves and used fire.
- ▶ They buried their dead, which is an indication of some form of spiritual life or advanced culture.



Homo sapiens



- ▶ This group is considered to be the direct ancestors of modern humans.
- ▶ Presumably, *Homo sapiens* appeared about 200 000 years ago.
- ▶ It is claimed that the appearance of *Homo sapiens* resulted in the disappearance of the Neanderthals.
- ▶ *Homo sapiens* developed better skills and had more advanced technology.

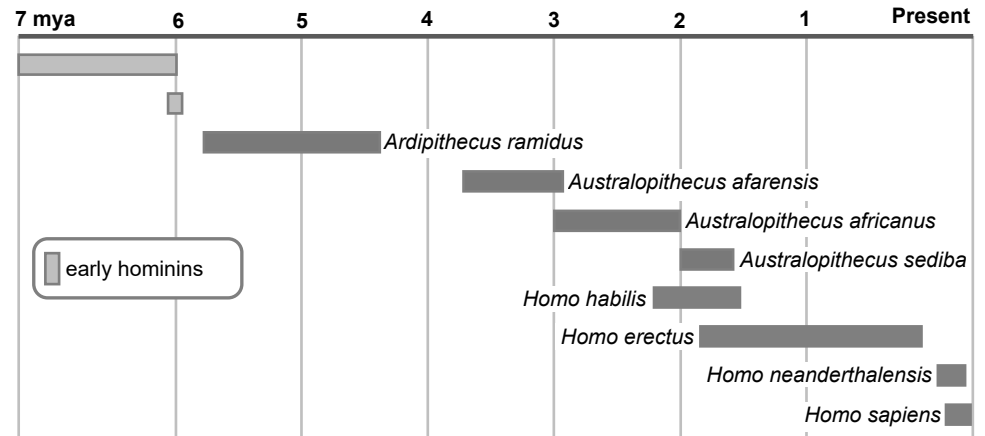
- ▶ Therefore modern humans are not directly related to *Homo neanderthalensis*.
- ▶ *Homo sapiens* used tools made from bone as well as stone, which included spears, arrows, bows and hooks for fishing.
- ▶ Their clothes were made mainly from leather and plant material.
- ▶ They lived in tents and formed communities.
- ▶ As hunters they followed the annual animal migrations in the summer.
- ▶ They developed agriculture and cultivated the land.
- ▶ They wore jewellery and decorated their bodies with paint.
- ▶ They developed rituals that were linked to hunting, births and deaths.
- ▶ Like the Neanderthals, they buried their dead which indicates a development of advanced culture and spiritual rituals.

Sometimes modern humans are referred to as ***Homo sapiens sapiens***, a subspecies of ***Homo sapiens***.



- ▶ Due to a large brain capacity of about 1 400 cm³, modern humans have the ability to change their environment to suit their needs, unlike early *Homo* species who could not change their environments and therefore became extinct.
- ▶ Today, modern humans are on the brink of the sixth extinction as a result of their own destructive impact on the environment.

Comparative table of the average brain capacity of the most important hominin species	
Hominin species	Average brain capacity (in cm ³)
<i>Australopithecus afarensis</i>	440
<i>Australopithecus africanus</i>	450
<i>Australopithecus sediba</i>	500
<i>Homo habilis</i>	640
<i>Homo erectus</i>	1 000
<i>Homo neanderthalensis</i>	1 500
Modern <i>Homo sapiens</i>	1 400



Timeline to illustrate evolution of hominins



It is not necessary to memorise this timeline. You may, however, be expected to interpret it in an exam question.

'OUT OF AFRICA' HYPOTHESIS

There are different hypotheses about the place where humans originated. The 'Out of Africa' hypothesis has the most support from scientists. It is also called the 'Replacement' hypothesis.



- ▶ The 'Out of Africa' hypothesis states: All modern humans / *Homo sapiens* originated in Africa about 200 000 years ago and migrated to other parts of the world about 50 000 years ago.
- ▶ These early *Homo sapiens* had a higher level of technological skills, were better adapted to their new environment and out-competed other *Homo* species, e.g. *Homo neanderthalensis* which originated in Europe.
- ▶ This resulted in the more successful *Homo sapiens* replacing *Homo erectus* in Asia and Indonesia and *Homo neanderthalensis* in Europe.

Homo erectus was one of the earliest hominins in Africa. They were the first *Homo* species to leave Africa about 1,8 mya and became established in Europe, Asia and Indonesia.