

REVISION: EVOLUTION (66 marks Paper 2)

Artificial selection and Natural Selection

One of the observations Darwin made during his study of pigeons was about artificial selection.

Question 1

Using examples, describe natural and artificial selection and also highlight the differences between these two processes.

Artificial selection

- Organisms of a particular species/any example show a great deal of variation ✓
- Humans ✓/farmers/scientists select organisms
- with a particular desirable characteristic ✓
- and interbreed ✓ them
- with other organisms that also ✓ have the same desirable characteristic
- to improve this characteristic further ✓ in the offspring
- They may also choose organisms with different ✓ desirable characteristics
- to get offspring with a combination ✓ of these desirable characteristics after many generations ✓

Examples: Production of improved fruit ✓/ meat production

Below is another example of artificial selection

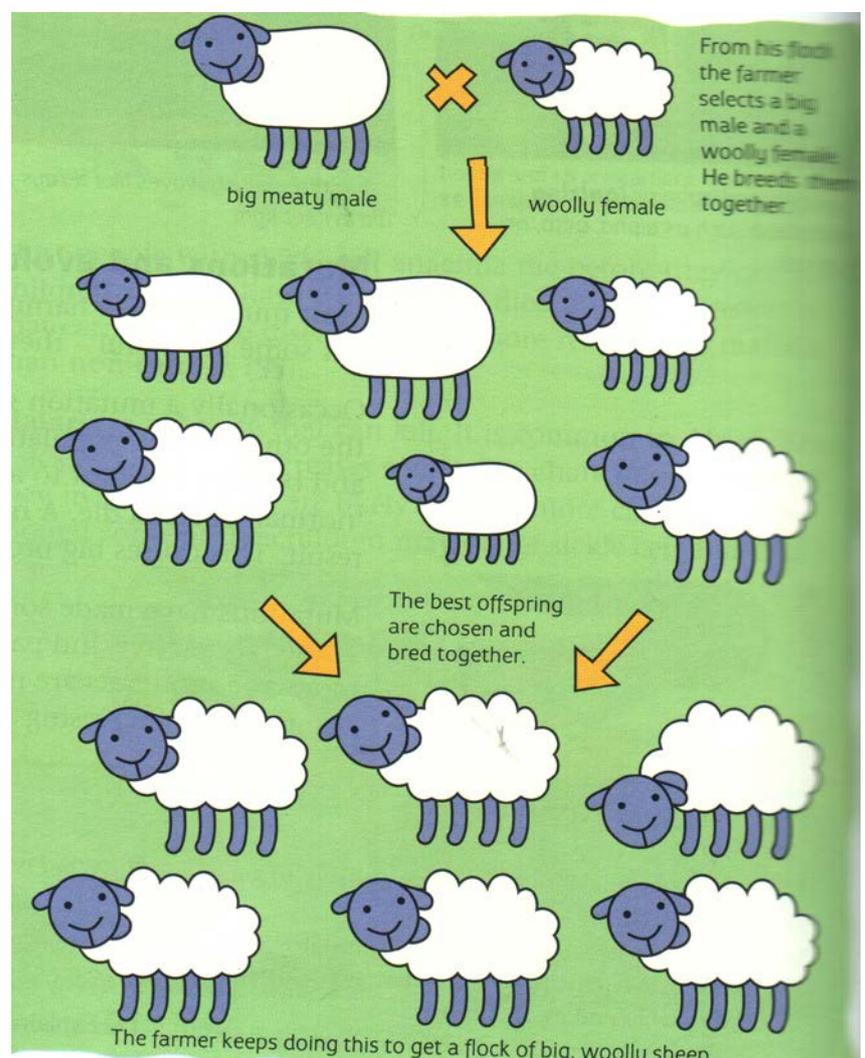
1. Choose the animal or plants that have the best characteristics
2. Breed them with each other
3. Choose the offspring with the best combination of characteristics
4. Allow them to breed with each other
5. Repeat the procedure many times to improve the characteristics

Advantages

- Produced cattle with more meat
- cows that give more milk
- wheat that produces more seeds
- sheep that produce more offspring

Disadvantages

- Usually closely related organisms are bred – leading to inbreeding
- Inbreeding reduces the gene pool of a species
- This could cause the entire species to be wiped out if exposed to a disease against which it has no resistance



Natural Selection

Natural selection e.g. Finches ✓ / or any other example

- Organisms of a particular species (population) shows a great deal of **variation** ✓
- Most species produce a **large number** of offspring
- Some individuals may have characteristics such as small beak size ✓ that are **favourable** ✓ for the environmental conditions
- Others may have characteristics /any example that are **unfavourable** ✓
- These offspring **compete** ✓ with each other for food, shelter, etc.
- Offspring that have **desirable features** for obtaining these resources **will survive** ✓
- Selective pressure by the environment ✓ due to competition / changing environmental conditions
- Organisms with favourable characteristics survive and reproduce ✓ to pass favourable characteristics to their offspring ✓
- while organisms with unfavourable characteristics will die out ✓
- Over time the whole population will have this favourable trait ✓
- the gene pool of the population has changed ✓

Differences between Natural and Artificial selection

Natural selection	Artificial selection
Selective pressure by the environment ✓	Humans select the desirable characteristic ✓
Selection is in response to suitability to the environment ✓	Selection is in response to satisfying human needs ✓
Organisms can survive on their own ✓ in the environment (since they were selected on the basis of their suitability to the environment)	Organisms may often not survive on their own ✓ in the environment (since they were selected on the basis of human needs and not on suitability to the environment)
No human effort/cost involved ✓	Could be labour intensive ✓ /expensive

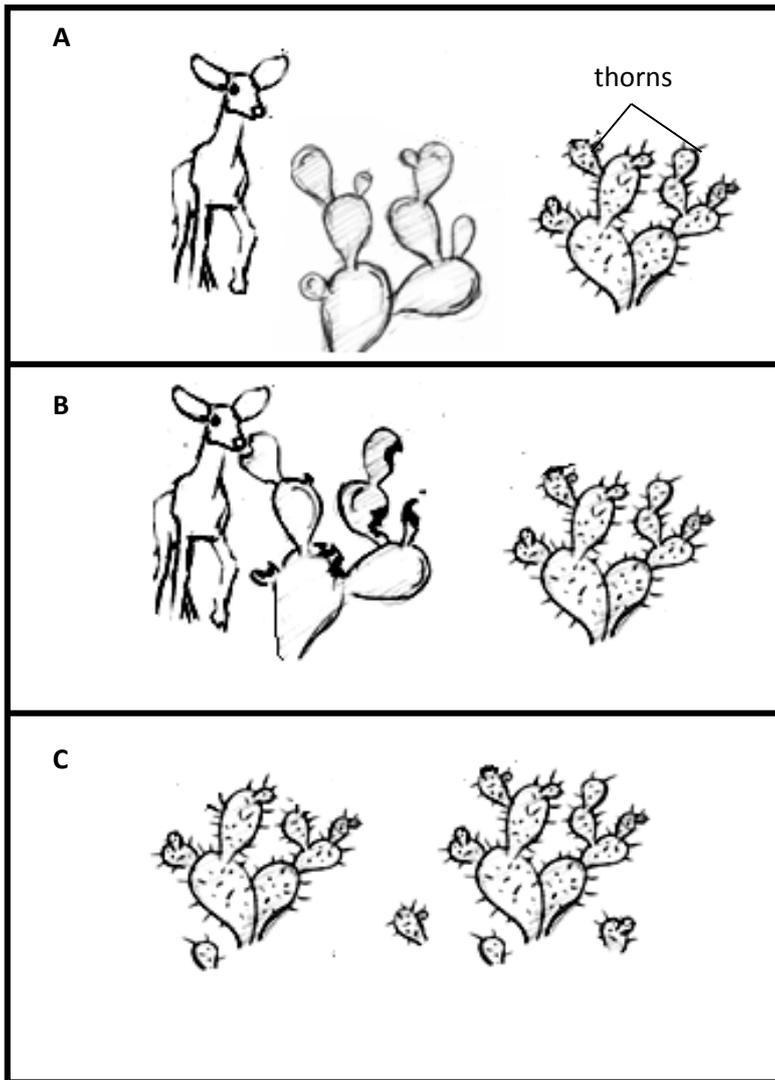
VARIATION

Sources of variation

- Mutation
- Meiosis : - independent assortment / crossing – over
- Random mating
- Chance fertilization

Question 2

Below is a sequence of diagrams (A, B and C) representing the changes in a population of cactus plants on which bucks feed over a period of time.



- 2.1 Which evolutionary process is represented by the above diagrams? (1)
 - 2.2 Using the information in the diagrams A, B and C above to explain the process mentioned that took place over time. (8)
- [9]**

Memo

- 2.1 Natural selection ✓ (still the same species – one variation survive) (1)
- 2.2 population of cactus ✓ has variation/with and without thorns ✓
 cactus with thorns are not eaten by bucks ✓ reproduce ✓ and survive ✓
 cactus without thorns are eaten by bucks ✓, die out ✓
 over time whole population has only cactus with thorns ✓

(8)
[9]

EVOLUTION

All organisms have descended or evolved from a simple common ancestor that lived several billions of years ago. All organisms are genetically related to one another. The genetic changes take place over time and ultimately lead to new species. Evolution is a continuous process and takes place as a result of changes in the environment.

A BRIEF HISTORY OF THE DEVELOPMENT OF THE THEORY OF EVOLUTION

LAMARCK, DARWIN, ELDREDGE AND GOULD

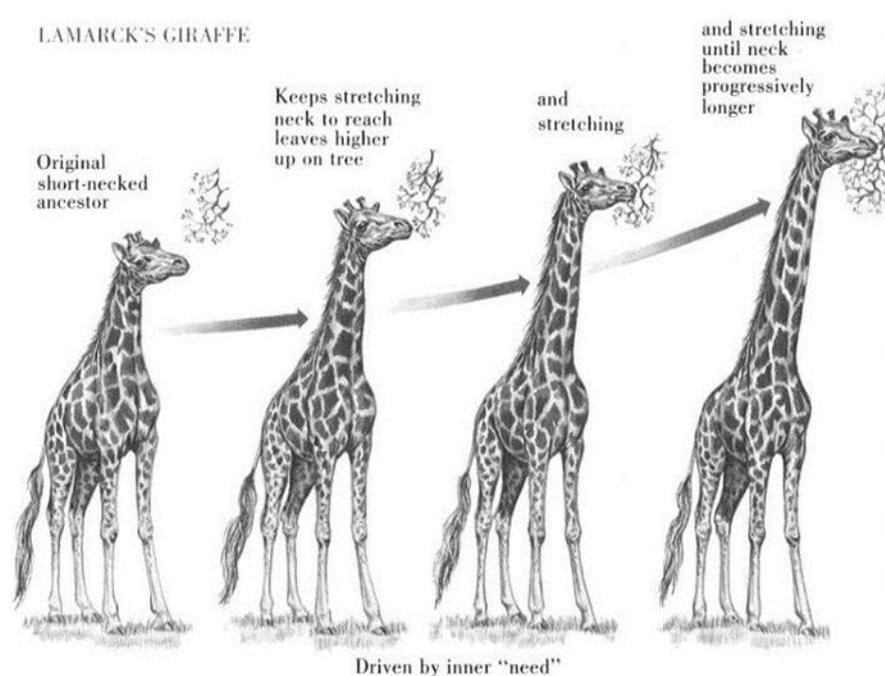
Lamarckism and Darwinism

Examples to illustrate the differences between Darwin's and Lamarck's ideas about the evolution theory.

Jean-Baptista Lamarck (1744-1829)

Lamarck used two 'laws' to explain evolution

- 'Law' of use and disuse – the more an organism uses a muscle or an organ the stronger the muscle or organ will developed
Muscle and organ that were not used would simply disappear after several generations.
- 'Law' of the inheritance of acquired characteristics – the stronger muscle acquired in the organism's life time will be passed on to the next generation.



Outline Lamarck's approach using the giraffe as an example

Lamarck

- All giraffes had short necks originally
- Giraffes frequently stretched/used their necks to reach for leaves of tall trees
- causing their necks to become longer
- The characteristics of long necks acquired in this way
- was then passed on to the next generation
- forming offspring with longer necks than the generation before

Charles Darwin (1809 – 1882)

Considered as the father of evolution.

Published his ideas in '*On the origin of species by means of natural selection*'

His research was based on observations made during his long voyage on the HMS Beagle, between 1831 and 1836.

This made him realise that the Earth is very old and that major changes have taken place over long periods of time.

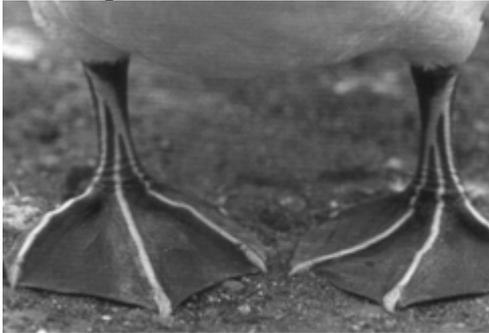
Outline Darwin's approach using the giraffe as an example

Darwin

- As a result of genetic variation in the giraffe population
- some giraffes have longer necks than others
- Environmental change/competition for resources occurred
- causing those with shorter necks to die
- and those with longer necks to survive
- since they could reach the leaves of tall trees
- This is termed natural selection
- The genotype for longer necks
- was passed on to subsequent generations
- In this way each subsequent generation had necks longer than the generation before

Another example:

The diagram below shows the webbed feet of a duck



Webbed Feet

Lamarck

- Lamarck would have stated that ducks initially used their feet only for walking, looking for food on land.
- As food became scarce on land the ducks were forced to search for food in the water.
- The ducks tried to stretch their toes apart in an attempt to achieve an efficient swimming stroke
- As a result the skin between their toes became stretched to form the beginnings of the webbed feet.
- This characteristic was then inherited by the future generations.

Darwin

- Darwin would have stated that there was a great deal of variation amongst the phenotypes of the individuals of the duck population
- Some ducks had a little skin attached between their toes.
- As food became scarce on land the ducks were forced to search for food in the water.
- Those ducks which had more skin attached between their toes were able to perform a swimming action to secure food from a watery environment.
- Those that were not able to do this died.
- Those that survived reproduced and produced offspring with a large amount of skin between their toes
- Over a period of time the skin became so prominent as found in the webbed feet of ducks today

Gradualism

Charles Darwin, described evolution as a gradual process driven by natural selection. This process is slow since it requires many generations for these small changes to be realized in a speciation event. This led Darwin to believe that evolution happens gradually with the accumulation of small changes over long periods of time.

Tabulate differences between Darwin and Lamarck

Darwin	Lamarck
There was variation in the necks of the giraffe at the beginning (there were short and long necks)	All the giraffes had short necks initially
Genetics causes variation	Environment causes change
Chance occurrence - Environment selected which genes survived	Deterministic - Organism tried to adapt to environment

Why is Lamarck's theory not acceptable?

Acquired characteristics cannot be passed from one generation to the next

OR

Organisms did not evolve because they wanted to evolve/Lamarck's theory is deterministic

NILES ELDREDGE AND STEPHEN JAY GOULD (1972 -)

Niles Eldredge of the American Museum of Natural History and Stephen Jay Gould of Harvard University described **Punctuated Equilibrium** in 1972.

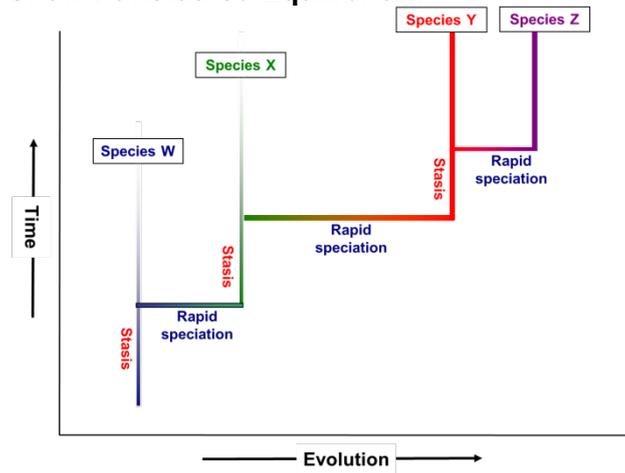
Punctuated Equilibrium and **gradualism** are concerned with evolutionary rate. Niles Edridge and Stephen Jay Gould (1972) contended that some species are stable (show stasis) throughout much of their evolutionary history, and that when a small daughter population becomes geographically isolated from its parent species, they can evolve quite rapidly into a new species (punctuated equilibrium).

Eldredge and Gould claim that there were **long periods of stasis** (4-10 million years) involving **little evolutionary change**. Then occasional **rapid** (as short as 5,000 - 50,000 years) **formation of new species** by means of natural selection.

If a **small group** of a species should **get isolated** from the main population in an **area** where its **habitat does not exist**. **Rapid change** could take place to bring the population back to equilibrium (stasis), but it is **no longer the same species**.

Large evolutionary change is attributed to relatively rapid spurts of change followed by long period of little or no change. First 3 billion years very **gradual** until the (habitats were destroyed) when the **evolutionary rates soared**.

Graphic representation to show Punctuated Equilibrium



Question 3

- 3 Distinguish between the history, concepts and the persons involved in describing gradualism and punctuated equilibrium [8]

Memo

- 3 In the 1860's ✓ Darwin ✓ described evolutionary changes as a slow, ✓ continuous ✓ process. This was later called gradualism
 In the 1970's ✓ Eldredge and Gould ✓ observed that sometimes evolutionary changes happens very rapidly ✓ (5, 000 to 50, 000 years) and then long periods of **stasis** ✓ (4-10 million years) involving little evolutionary change. This was called punctuated equilibrium. (8)

PROCESS OF SPECIATION

Species

A group of similar organisms that is able to interbreed to produce fertile offspring. Each species has its own unique gene pool. Gene flow takes place between these organisms during fertilisation.

Speciation – Emergence or formation of new species

Darwin described evolution through **natural selection** in which species **change slowly** over many generation. Sometimes the changes of evolution are so great that **a completely new species population** is formed. The new species population can't **interbreed** with the **original population**. This process is called speciation.

Consequences of emergency of new species population by natural selection:

1. No gene flow between the different species populations,
2. The populations become reproductively isolated, because they can't interbreed.

Process of speciation due to geographic isolation (Allopatric speciation)

Speciation can happen when the original population is physically separated (called a barrier) into two or more populations.

The examples of physically barriers and examples that the curriculum prescribe are the following

1. Galapagos islands – separated by the sea / oceans. These volcanic islands appeared in the Pacific Ocean about 5 million years ago.
 - 1.1 The examples on these islands mentioned in the curriculum that illustrate speciation are the Galapagos finches and the Galapagos tortoises

- 2 Gondwana split up and separated from each other by continental drift to form the southern continents such as South America, South Africa, Australia and New Zealand and the large island Madagascar.
 - 2.1 The examples are the *Protea* genera and the different Baobab trees

The curriculum requires only **ONE** to be studied. But you have to familiarise yourself with all four, because any of the four or any other example can be asked during the examination. Question 5 provides you with a generic memorandum (all the **key words** that you need to include in your answer).

Question 4

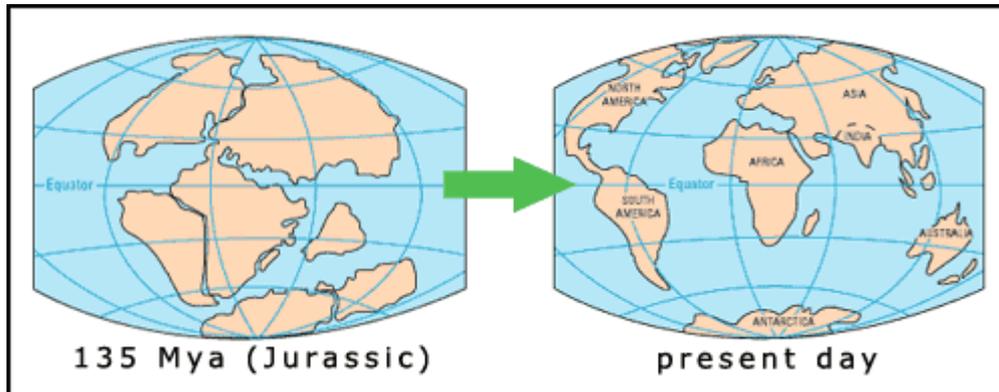
Describe how a single species can form new species.

Answer - **generic example – all the key words**

- A population of species shows a great deal of **variation** ✓
- If a population **splits/divides** ✓ into two or more populations by means of a **physical barrier** ✓.
- There is now **no gene flow** ✓ between the two populations.
- Since each population may be exposed to **different environmental conditions** ✓,
- **Natural selection** ✓ occurs **independently** ✓ in each of the two populations
- The **desired traits** ✓ that **survive** ✓ are different for the two or populations
- Over many generations ✓ the individuals of the two populations become **very different** ✓ from each other
- **genotypically and phenotypically** ✓.
- Even if the two populations were **to mix again** ✓,
- they will not be able **to interbreed** ✓ with each other, thus becoming **different species** ✓ / one or both of the populations becomes a new species

QUESTION 5

5 Study the following set of drawings and answer the question that follows.



5.1 Describe how the Proteus species in South Africa and Australia evolved in different species. (15)

Memo

6.1 Allopatric speciation ✓

- There was genetic variation ✓ within the original *proteus* species population on Gondwana land ✓
- because of continental drift ✓ the proteus population from the main land separates ✓ into two groups
- each of the proteus groups live on two different continents /South Africa and Australia ✓
- living under different environmental conditions ✓
- The proteus species underwent natural selection ✓ independently ✓ on each continent
- Only those proteus species with the favourable characteristic ✓ that was better suited ✓ / on each specific continent survived ✓
- Continued natural selection over many generations ✓
- resulted in each continent having species that were very different ✓ genotypically and phenotypically ✓ from species of the other continent
- These differences prevented them from interbreeding ✓ leading to the formation of new species ✓ on each continent

[12]

Question 7

Describe how the Baobabs trees in South Africa and Madagascar evolved in different species.



Memo

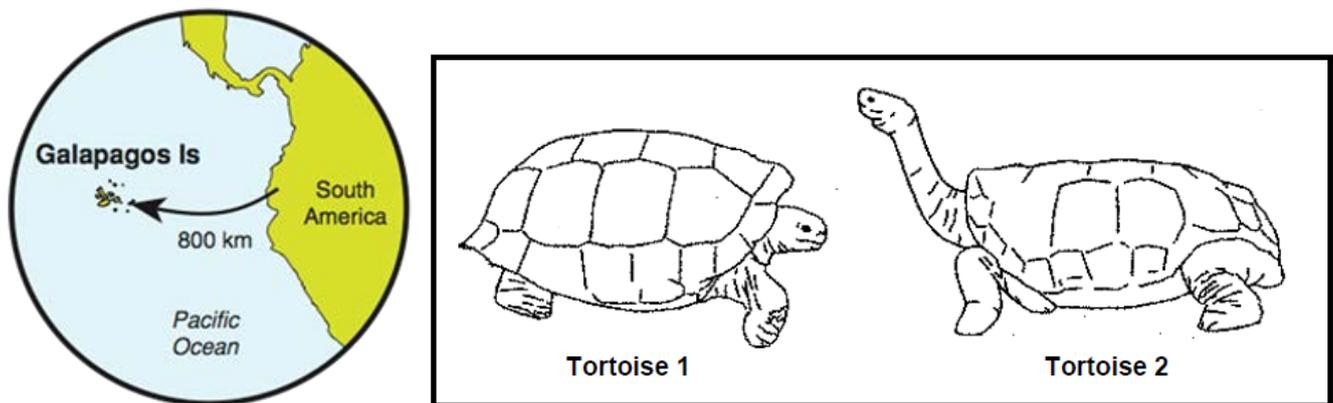
Allopatric speciation✓

- There was genetic variation✓ within the original Baobab tree population on Gondwana land✓
- because of continental drift✓ the Baobabs trees population from the main land separates ✓ into two groups
- each of the Baobabs trees groups live on two different continents /South Africa and Madagascar✓
- living under different environmental conditions✓
- The Baobabs trees underwent natural selection✓ independently✓ on each continent
- Only those Baobabs trees species with the favourable characteristic✓ that was better suited✓/ on each specific continent survived✓
- Continued natural selection over many generations ✓
- resulted in each continent having species that were very different ✓ genotypically and phenotypically ✓ from species of the other continent
- These differences prevented them from interbreeding✓ leading to the formation of new species ✓ on each continent

[12]

Question 8

Study the diagram below and answer the questions that follow.

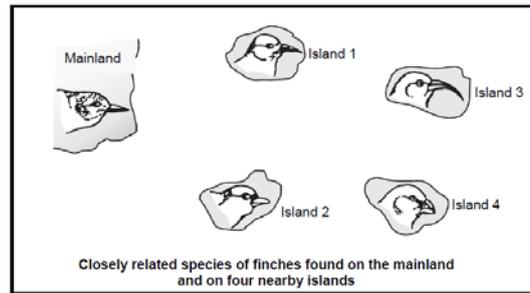


- 8.1 Darwin noticed different species of tortoises on the Galapagos Islands. Two of these tortoises, which are drawn to scale, are shown above. The two species of tortoises shown above lived on different islands. Darwin suggested that they might have evolved from a common ancestor. Explain how this could have occurred.

Memo

- 8.1
- On each island there was variation (long and short necks) ✓ in the population of tortoises lived under different environmental conditions / different sources of food ✓
 - After a period of time each group of tortoises underwent natural selection✓ independently ✓
 - On each island only those tortoises with the characteristics✓ (long or short neck) favourable for its own conditions survived✓
 - Continued natural selection resulted✓ in each island having tortoises that are very different from each other✓ they differed genotypically and phenotypically ✓
 - Reproductive isolating mechanisms prevented them from interbreeding✓ even if they are allowed to mix i.e. each is a separate species ✓

8.2 The diagram below shows five closely related species of finches found on the mainland and on four nearby islands.



Describe how the different species on the four islands evolved over many generations from the original ancestor on the mainland. (8)

Memo

Finch population had variation ✓/ different beak sizes
 The population was separated by a geographical ✓/ physical barrier/ seas between the islands
 Allopatric ✓/ speciation took place
 As the separate islands had different environmental conditions ✓/ have
 different vegetation/ different food for finches
 Each group underwent natural selection ✓/ independently
 And developed differently ✓
 Genotypically and phenotypically ✓
 No gene flow ✓/ between the populations / reproduction between the different populations cannot
 Occur even if they are allowed to mix
 Resulting in new species being formed ✓

EVOLUTION IN PRESENT TIMES

Resistance to insecticides in insects

Mosquito population had variation ✓/ resistant to DDT and others not resistant
 Mosquitoes that were resistant to DDT survive ✓/ and reproduce ✓/ offspring
 Mosquitoes that were not resistant to DDT died ✓
 DDT also killed birds and fish ✓/ that naturally prey ✓/ on mosquitoes
 Gene pool ✓/ of Mosquito population changed

The same happened with resistance to antibiotics in various bacteria and HIV resistance to anti-retrovirals

Question 8

Explain, in terms of natural selection, how mosquitoes may develop resistance to DDT. (8)

Memo

- More mosquitoes are produced than can survive. ✓
- There is genetic variation ✓/ amongst the mosquitoes.
- Some mosquitoes may be naturally resistant to DDT ✓
- When DDT is applied ✓
- those that are resistant survive ✓
- and they then reproduce, ✓
- passing the allele for resistance to the offspring ✓
- Those that are not resistant, die ✓

- and their alleles are lost from the population. ✓
- The number of DDT-resistant mosquitoes therefore increases over the generations ✓.

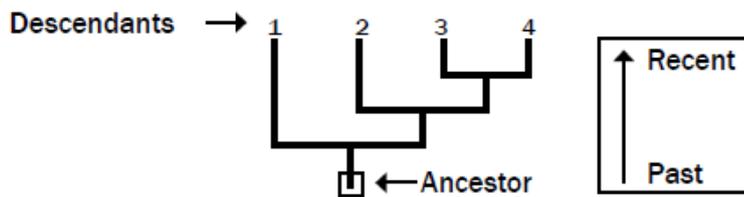
HUMAN EVOLUTION

A phylogenetic tree (or evolutionary tree) represents the possible evolutionary relationships among a set of organisms or groups of organisms. The tips of the tree represent descendants (often species) and the points where the tree branches represent the common ancestors of those descendants.

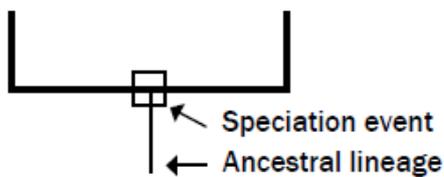


Hints on interpreting phylogenetic trees

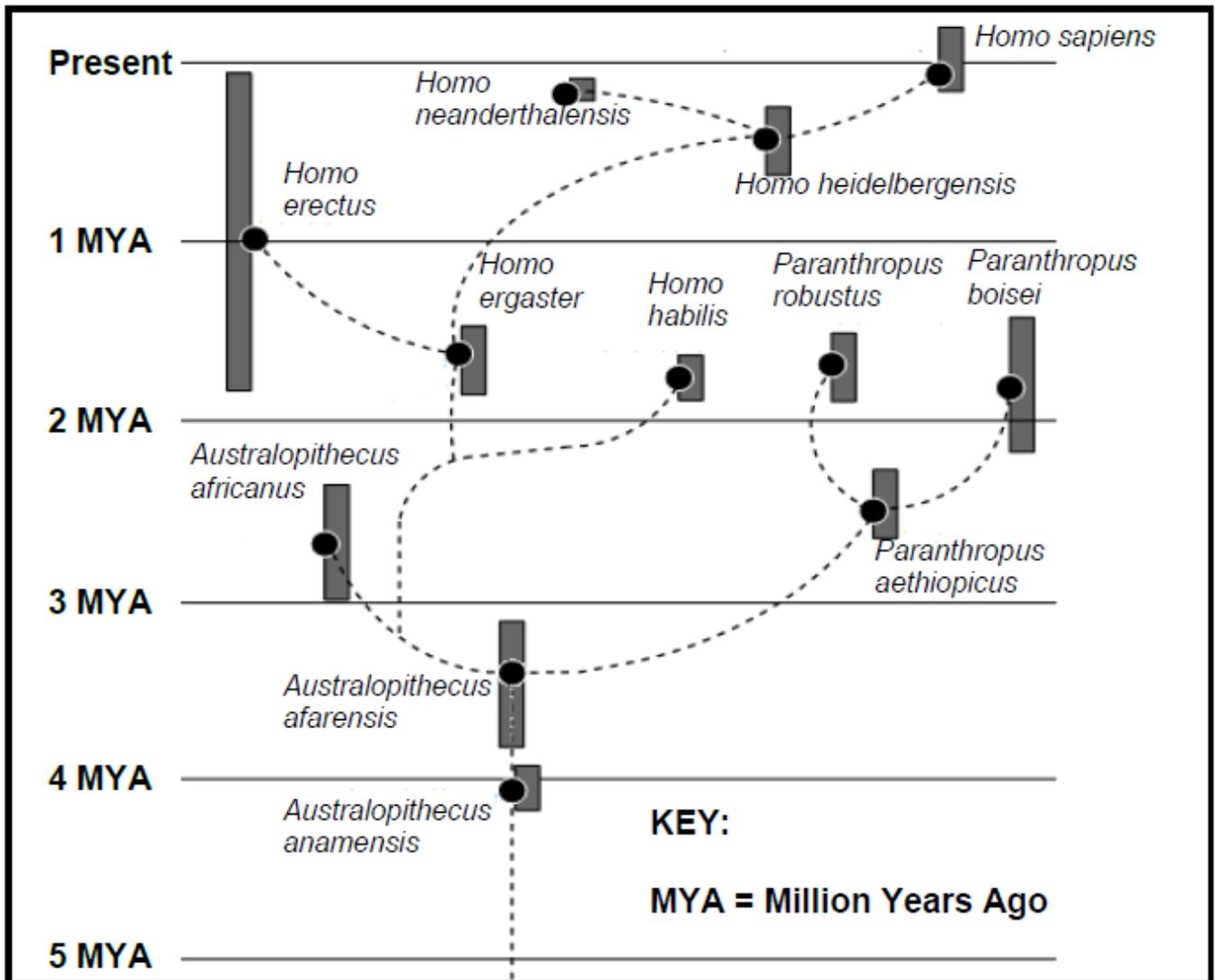
Reading a phylogenetic tree is similar to understanding a family tree. The root of the tree represents the **ancestor** and the tips of the branches represent the **descendants** of that ancestor. As you move from the root of the tree to its tips, you are moving forward in time.



When speciation occurs, it is represented as branching on the tree.
A single ancestral lineage gives rise to two or more daughter lineages.



- 8 The phylogenetic tree below shows one interpretation of the origin of humans. The dotted lines indicate the possible evolutionary relationships, and the vertical bars show the period during which the organisms are believed to have existed on earth.



- 8.1 Use the diagram to identify ONE organism that may have competed with *Homo heidelbergensis* for resources. (1)
- 8.2 Identify the common ancestor that gave rise to both *Paranthropus* and *Homo*. (1)
- 8.3 For what period of time did *A. africanus* exist on Earth? Show all working. (3)
- 8.4 Name ONE piece of evidence that could be used to prove that *A. africanus* existed during the time period calculated in QUESTION 8.3. (1)
- 8.5 Which organism, *H. ergaster* or *H. neanderthalensis*, is more closely related to modern-day humans? (1)
- 8.6 Explain your answer to QUESTION 8.4 using information in the diagram. (2)

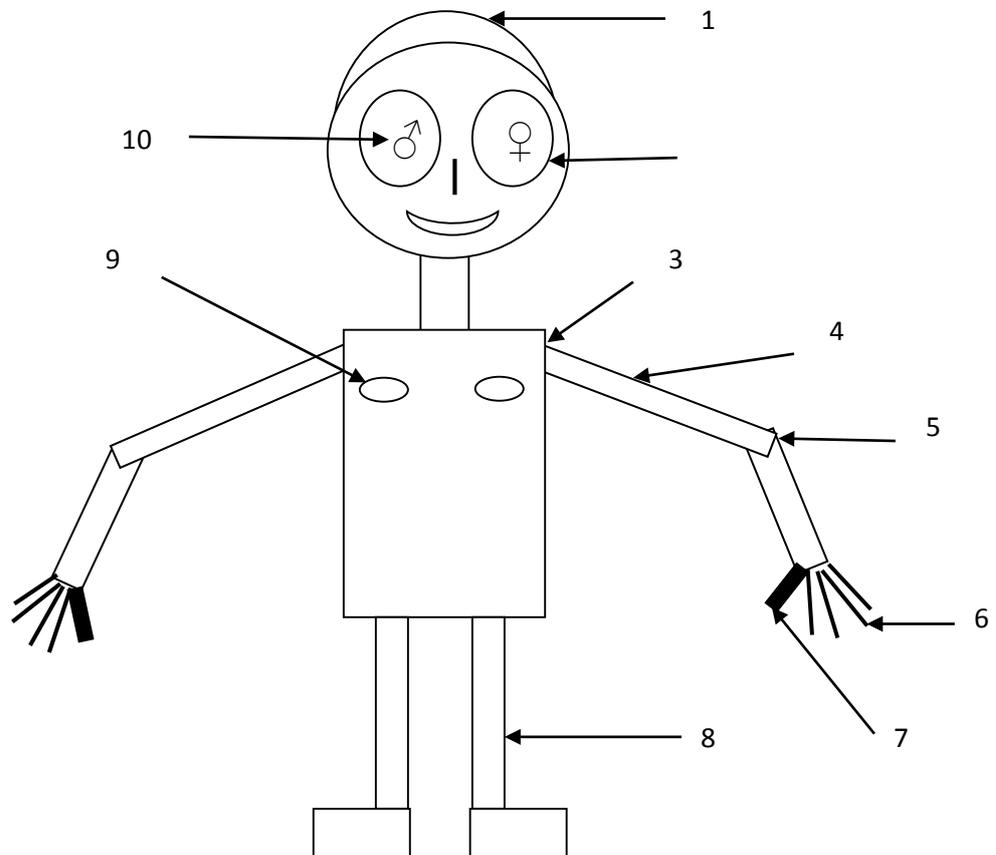
Memo

- 8.1 *H. erectus* ✓ (1)
- 8.2 *A. afarensis* ✓ (1)
- 8.3 3 mya – 2,4 ✓ mya = 0,6 ✓ my ✓
OR
3 mya – 2,3 ✓ mya = 0,7 ✓ my ✓ (3)

- 8.4 Fossils ✓ (1)
8.5 H. neanderthalensis ✓ (1)
8.6 H. neanderthalensis and H. sapiens share a common ✓ ancestor ✓
OR
Both evolved ✓ from H heidelbergensis ✓ (2)

SIMILARITIES BETWEEN *HOMO SAPIENS* AND OTHER PRIMATES

- The following similarities are required by the syllabus
 - Upright posture ✓
 - Long upper arms ✓
 - Freely rotating arms ✓
 - Elbow joints allowing rotation of forearm ✓
 - Rotate hands at least 180° ✓
 - Flat nails instead of claws ✓ / bare finger tips
 - Opposable thumbs ✓ which work in opposite direction to their fingers
 - Large brains/skulls compared to their body mass ✓
 - Eyes in front ✓ / binocular vision / stereoscopic vision
 - Eyes with cones ✓ / colour vision
 - Sexual dimorphism ✓ / distinct differences between male and female
 - Olfactory brain centres reduced ✓ / reduced sense of smell
 - Parts of the brain that process information from the hands and eyes are enlarged ✓
 - Two mammary glands only ✓



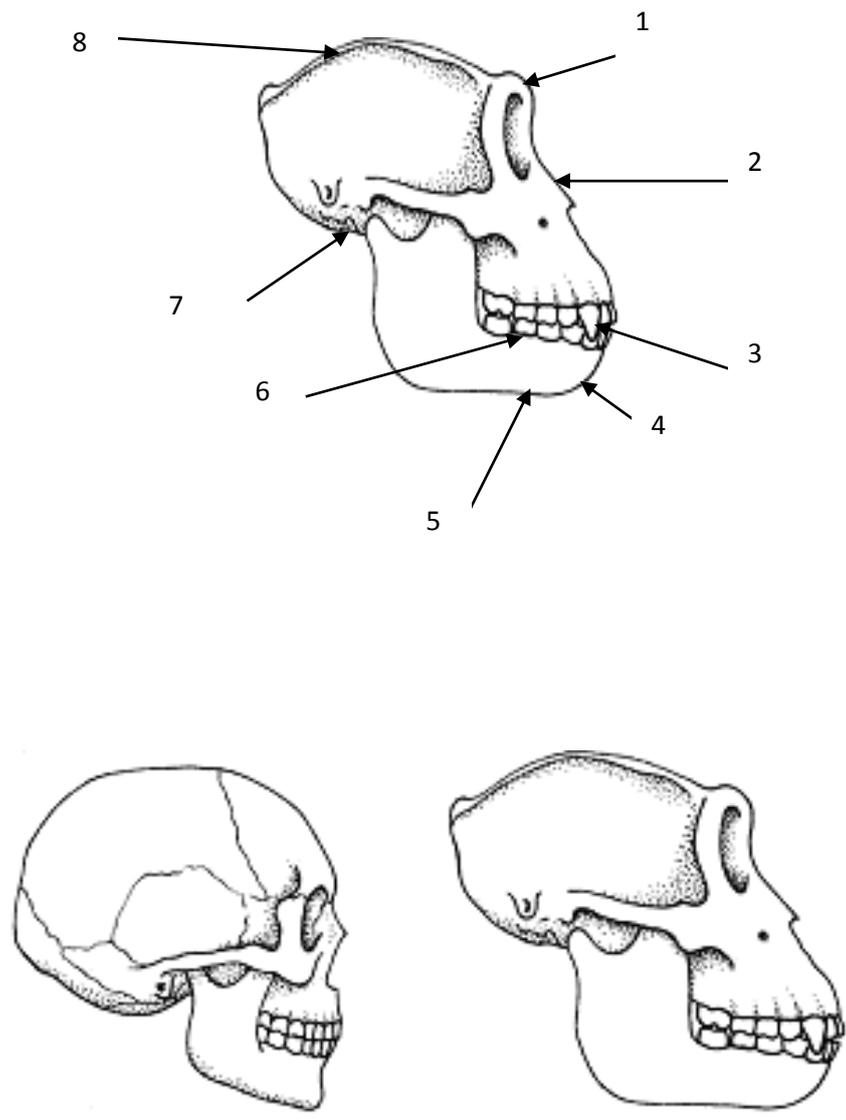
DIFFERENCES BETWEEN HOMO SAPIENS AND OTHER PRIMATES

Anatomical differences between the African apes, Ape-like man and humans, as it applies to the following characteristics:

- Bipedalism (foramen magnum, shorter arms and longer legs, spine and pelvic girdle, feet (arches))
 - Brain size – larger frontal part - communication
 - Teeth (dentition) African apes eat tough, fibrous materials (fruits and nuts) and Humans eat softer food /meat/more proteins for the development of the brain
 - Prognathism (large jaw muscles for chewing to smaller jaw muscles for softer food)
 - Palate shape
 - Cranial ridges
 - Brow ridges
- } All to do with large strong jaw muscles for chewing

- The 2nd and 3rd column below contains the differences that are required by the syllabus
- The differences below relate to the head. To this must be included the posture of the organism (bipedal vs quadrupedal) and difference in the development of language.

FEATURE	<i>Homo sapiens</i>	<i>Other primates</i>
Cranium	1. Larger cranium✓/brain	1. Smaller cranium ✓/brain
Face	2. Flat face✓/ Forehead slope less backwards	2. Face sloping✓/ Foreheads slope much backwards
Foramen Magnum	3. Foramen magnum forward✓/bottom of the skull	3. Foramen magnum at the back of the skull✓
Brow Ridges	4. Brow ridges are not as pronounced✓	4. Brow ridges pronounced✓
Canines	5. Smaller canines✓	5. Larger canines✓
Spaces between teeth	6. Smaller spaces between the teeth	6. Larger spaces between the teeth
Arrangement of teeth	7. Jaws with teeth on a gentle/round curve✓	7. Jaws with teeth in a rectangular/U shape✓
Jaws	8. Less protruding jaws✓	8. More protruding jaws✓/ prognathous
Chin	9. Lower jaw has a well-developed chin✓	9. Lower jaw has poorly developed chin✓



QUESTION 9

It is thought that modern humans evolved gradually from ape-like beings (*Australopithecus sp.*) over millions of years through speciation.

Describe how a single species can form new species, and explain how the differences in the skulls and other parts of the skeleton of primitive ape-like beings and modern humans support the idea that the general trend in human evolution has been towards bipedalism and a change in diet from tough, fibrous materials (fruits and nuts) to softer food /meat/more proteins.

Content: 17

Synthesis: 3

Memo of question 9

The development of a new species

- If a population splits into two populations√
- There is now no gene flow between the two populations. √
- Since each population may be exposed to different environmental conditions√,
- Natural selection occurs independently in each of the two populations√
- such that the individuals of the two populations become very different from each other√
- genotypically and phenotypically√.
- Even if the two populations were to mix again√,
- they will not be able to reproduce with each other√ thus becoming different species

(any 5)

The development of bipedalism

- The backward position of the foramen magnum on the skull√,
- the narrow pelvis√
- and the less-curved spine√
- indicates that the ape-like beings were quadrupedal√
- The forward position of the foramen magnum on the skull√
- carry the head vertically √
- the wider pelvis√ / cup-shaped
- support the internal organs √
- and the curved spine√
- able to carry the weight of the body √ / keep centre of gravity over the pelvis
- shorter arms and longer legs to be able to walk on two legs √
- indicates that modern humans are bipedal

(any 6)

Change in the diet from tough, fibrous materials (fruits, barks from trees and nuts) to softer food /meat/more proteins

- The large teeth, especially the canines√
- as well as the large and long jaws√
- which makes the skull prognathous√

- as well as cranial/brow ridges associated with large muscles that operate the jaws[✓]
- indicate that the ape-like beings ate raw food that required a great amount of processing[✓]/tearing, biting and chewing.
- The smaller teeth, including the canines[✓]
- as well as the smaller jaw size[✓]
- which makes the skull less prognathous[✓]
- as well as the absence of cranial/brow ridges due to the presence of smaller muscles for chewing[✓]
- indicate that modern humans rely on a diet of soft food that does not require the same amount of processing[✓]/tearing, biting and chewing.

(any 6)
Content: (17)
Synthesis: (3)
(20)

Question 10

Describe the structural changes to the skull that characterise the evolution of modern humans from their ape-like ancestors, and explain the significance of these changes.

Content: (17)
Synthesis: (3)

Memo

Foramen magnum

- The foramen magnum was in a more backward position in the ape-like beings^{✓^F}
- but in a forward/ central/ ventral position in modern humans^{✓^F}

Significance

- This represents a change from quadrupedalism in ape-like beings^{✓^S}
- To bipedalism/(walking upright) in modern humans^{✓^S}, leading to the following in modern humans:
 - Increased awareness of the environment^{✓^S} in sensing danger/food
 - Freeing of the hands to use implements^{✓^S}/ carry objects/ weapons/ offspring
 - Exposure of a large surface area for thermoregulation^{✓^S}/losing body heat to surroundings in hot conditions/reducing overheating
 - Display of sex organs /breasts as part of courtship behaviour^{✓^S}

Cranium

- Modern humans have a larger cranium^{✓^F} *than the ape-like beings*^{✓^F}
- Modern humans have a less sloping forehead^{✓^F} *than the ape-like beings*^{✓^F}
- More space for the frontal area of the brain ^{✓^F}
- Modern humans have a cranium that is more rounded^{✓^F} *than the ape-like beings*^{✓^F}

Significance

- This allowed space for a larger brain^{✓^S} in humans *than in ape-like beings*^{✓^S}, making the following possible:

- Better co-ordination of movement^{✓^S}
- Processing of a large amount of information^{✓^S}
- Processing information faster^{✓^S}
- Development of spoken and written languages to communicate^{✓^S}

Jaws

- Humans have smaller jaws^{✓^F} *than the ape-like beings*^{✓^F}
- Humans have jaws that are non-prognathous^{✓^F} / flat face compared to the jaws of ape-like beings which are prognathous^{✓^F} / sloping face
- Humans have C-shaped jaws^{✓^F} / jaws that are gently curved compared to the U shaped jaws^{✓^F} in the ape-like beings

Significance

- This corresponds with a change in diet from hard, raw food^{✓^S} in the ape-like beings
- To softer, cooked/meat/ more proteins food^{✓^S} in humans

Dentition/Teeth

- In ape-like beings there are gaps^{✓^F} / diastema between incisors and canines
- but no gaps^{✓^F} between the teeth in humans
- Humans have smaller teeth^{✓^F} / incisors and canines *than the ape-like beings*^{✓^F}
- Humans have flatter molars and pre-molars^{✓^F} *than the ape-like beings*^{✓^F}

Significance

- This corresponds with the decreased need to bite and tear^{✓^S}
- and an increased need to grind and chew^{✓^S} in humans in view of the change in diet to soft, cooked food^{✓^S}

The use of the checklist below for assessing the presentation of the essay question must be used and explained to the learners.

R = relevant information

L = logical sequence of answers

C = comprehension

Assessing the presentation of the essay

Criterion	Relevance (R)	Logical sequence (L)	Comprehensive (C)
Generally	All information provided is relevant to the topic	Ideas are arranged in a logical/cause-effect sequence	All aspects required by the essay have been sufficiently addressed
In this essay	Only information relevant to the <i>structural changes</i> or <i>significance</i> is given (there is no irrelevant information)	Generally each significance is appropriately linked to the relevant structural change to the skull	At least 3 structural changes described together with the significance of each
Mark	1	1	1

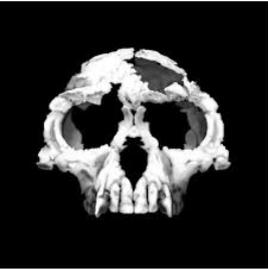
R✓

L✓

C✓

Major Genera in hominid evolution

The table below shows the characteristics of different genera and the main species (as obtained from a study of their fossils) that are thought to be in the line that led to the evolution of modern humans. The fossils are discussed within the order in which they appeared on Earth (as calculated by the age of the fossil using dating techniques).

Genus and species	When existed (million years ago – mya)	Fossil site	Discovered by	Characteristics
<i>Ardipithecus</i> species (<i>Earliest Ape-like Man</i>)				<ul style="list-style-type: none"> • Small hominid weighed about 50 kg – found 17 hominin fossils – intermediate between apes and humans
<p><i>Ardipithecus ramidus</i></p> 	4,4 million years ago (mya)	North-East Ethiopia / Middle Awash region of Ethiopia / Rift Valley	Tim White	<ul style="list-style-type: none"> • Brain size: small brain about 300 – 350 cm³ • Position of foramen magnum forward • Very prognathous and Heavy brow ridges • Teeth show that they eat mainly plant material and fruit (intermediate between apes and humans) • Pelvis structure – intermediate bipedal and tree climbing (big toe was able to grip like a thumb – although feet were rigid for walking)

Genus and species	When existed (million years ago – mya)	Fossil site	Discovered by	Characteristics
<i>Australopithecus species (Southern Ape-like Man)</i>				<ul style="list-style-type: none"> • Small bodies and small brains • Large-toothed hominins • Fully bipedal • Transition forms – mixture of ape-like and human features • Several different species have been found in East Africa
<p><i>Australopithecus afarensis</i></p> 	4 – 2, 7 mya	Ethiopia, Kenya, Tanzania	Donald Johanson (1974)	<ul style="list-style-type: none"> • Brain size: small brain about 375 – 550 cm³ • Position of foramen magnum forward • Very prognathous • Heavy brow ridges • Canines large and pointed • Long arms • No cranial ridge • Rigid feet

<p><i>Australopithecus africanus</i> (Taung Child)</p> 	<p>3 – 2 mya</p>	<p>Taung, Sterkfontein</p>	<p>Raymond Dart (1925)</p>	<ul style="list-style-type: none"> • Brain size: about 428 – 625 cm³ • Position of foramen magnum forward • Prognathous • Brow ridges • Teeth large, canines short • Long arms • No cranial ridge • Rigid feet
<p><i>Australopithecus sediba</i></p> 	<p>1,9 – 1,8 mya</p>	<p>Malapa Cave – part of the Cradle of Humankind</p>	<p>Lee Burger (2008 - 2012)</p>	<ul style="list-style-type: none"> • Brain size: about 420 cm³ • Position of foramen magnum forward • Less prognathous • Brow ridges • Teeth large, canines short • Long arms • No cranial ridge • Rigid feet

Homo Species				<ul style="list-style-type: none"> • Large brain, increased frontal part of brain (at least 600 cm³) • High fore head • Smaller less specialised teeth • Flatter face • Arms shorter • Legs longer
<p><i>Homo habilis</i> (Handy man – first tool maker)</p> 	2,2 – 1,6 mya	Olduvai Gorge in Tanzania	Louis and Mary Leakey (1963)	<ul style="list-style-type: none"> • Brain size: 650 cm³ • Less prognathous • Smaller eye sockets • Brow ridges • Large teeth, canines not long • Long arms associated with tree dwellers • No cranial ridge • Foot had an arch
<p><i>Homo erectus</i></p>  <p style="text-align: right; color: blue;">Homo Erectus</p>	2 – 0,4 mya	<p>Java in Indonesia (1891) and then Swartkrans (1969)</p> <p>Fossils found in North, East and South Africa as well as Europe and Asia</p>	Eugene Dubois	<ul style="list-style-type: none"> • Brain size: 900 cm³ • Prognathous • Brow ridges • Cranial ridges • Short canines • Longer legs • Shorter arms

Genus and species	When existed (million years ago – mya)	Fossil site	Discovered by	Characteristics
<p><i>Homo sapiens</i></p> 	200 000 mya - present	Makapansgat in Limpopo, Border cave in KZN, Blombos cave in the Western Cape	Tim White	<ul style="list-style-type: none"> • Brain size: 1 200 – 1 800 cm³ • Flat face • Distinct chin • No brow ridges • Small teeth • Short arms • Rigid feet with an arch

Tommy Botha
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