

MQHAKAMA SECONDARY SCHOOL

2026 TRIAL EXAMINATION REVISION

COMPILED BY

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PAPER 2

TOPIC	MARKS
EVOLUTION	54
GENETICS AND INHERITANCE	48
DNA-CODE OF LIFE	27
MEIOSIS	21
TOTAL	150

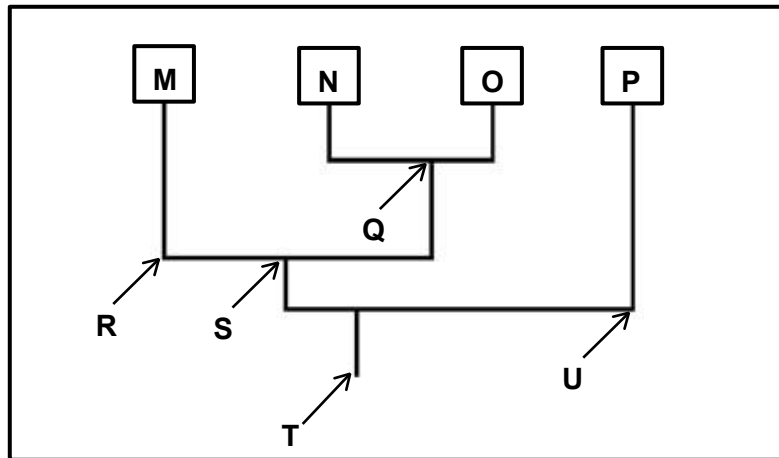
TABLE OF CONTENTS

1. Human evolution.....Page 2 - 15
2. Evolution through natural selection.....Page 18 – 30
3. Genetics and inheritance.....Page 31 - 47
4. DNA-code of life.....Page 48 - 60
5. Meiosis.....Page 61 - 69

HUMAN EVOLUTION

1.1 Name the family to which Humans and African Apes belong (**Hominidae**✓)

1.2



1.2.1 Name the type of diagram illustrated (**Phylogenetic tree/cladogram**

1.2.2 Define phylogenetic tree (**A diagrammatic representation of possible evolutionary relationships amongst species**)✓

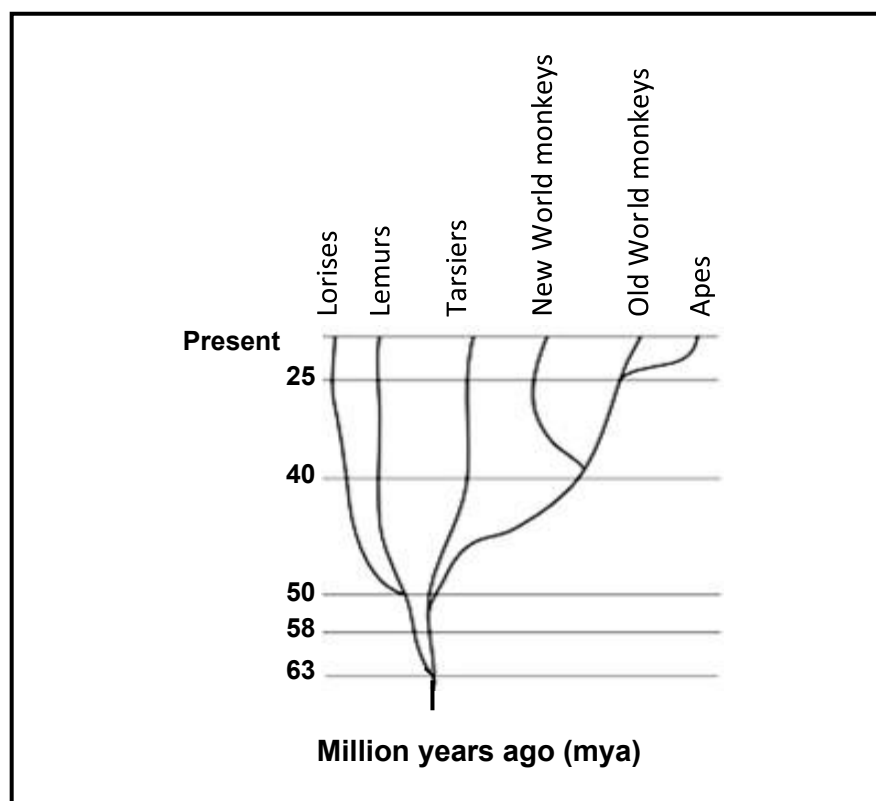
1.2.3 Give only the LETTER of the most recent common ancestor for phyla:

(a) **M** and **O** (Q)✓

(b) **M, N, O** and **P** (T)✓

(c) Phyla that are most closely related. (**N and O**)✓

2. The diagram below shows possible evolutionary relationships among primates.



[Source: <http://dl0.creation.com/articles>]

2.1 How many million years ago did the:

(a) Apes appear on Earth (1)

(b) Common ancestor evolve to form the Tarsiers and Lemurs (1)

2.2 Which TWO species share the most recent common ancestor? (2)

2.3 Which species is most closely related to the Lemur? (1)

(5)

2.1 (a) 25✓ mya (accept 24 to 25) (1)

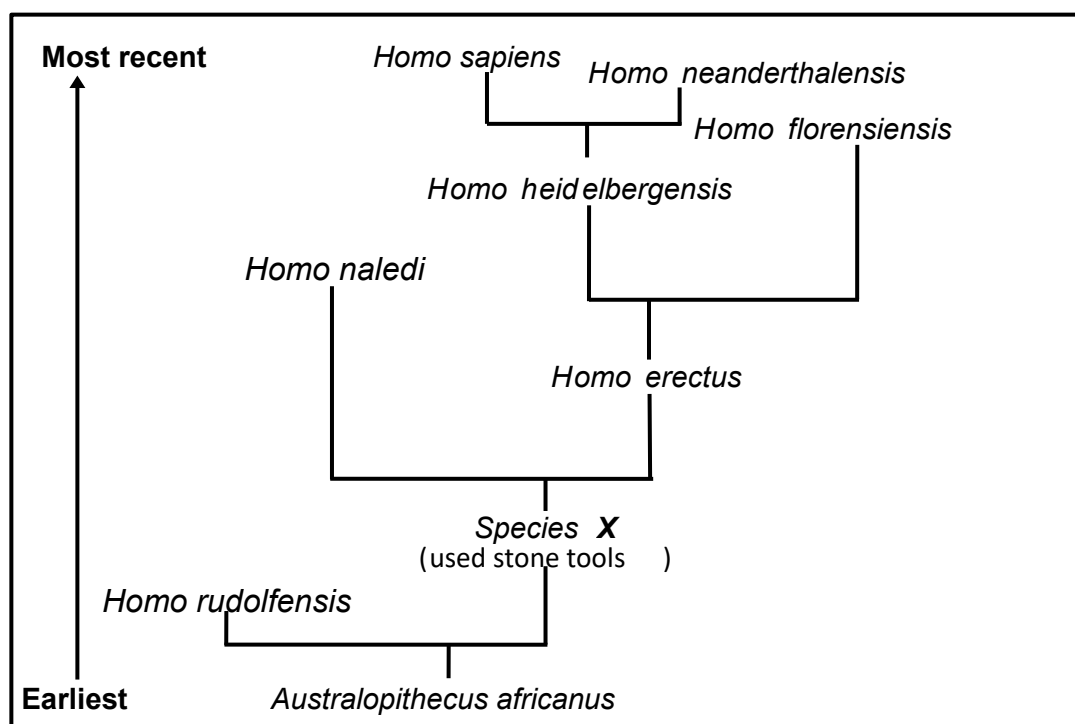
(b) 63✓ mya (1)

2.2 Old World monkeys✓ and apes✓ (2)

2.3 Lorises✓ (1)

(5)

3. The diagram below represents one model of the evolution of some hominids.



3.1 How many genera are represented by the diagram? (1)

3.2 Name the species:

(a) Represented by **X** on the diagram (1)

(b) That shares a common ancestor with *Homo erectus* (1)

3.3 Which species of the genus *Homo* is the only one in existence today? (1)

3.4 Name TWO forms of evidence that would have been used to support the information in the diagram. (2)

(6)

3.1 2✓/Two (1)

3.2 (a) *Homo habilis*✓ (1)

(b) (*Homo*) *naledi*✓ (1)

3.3 (*Homo*) *sapiens*✓ (1)

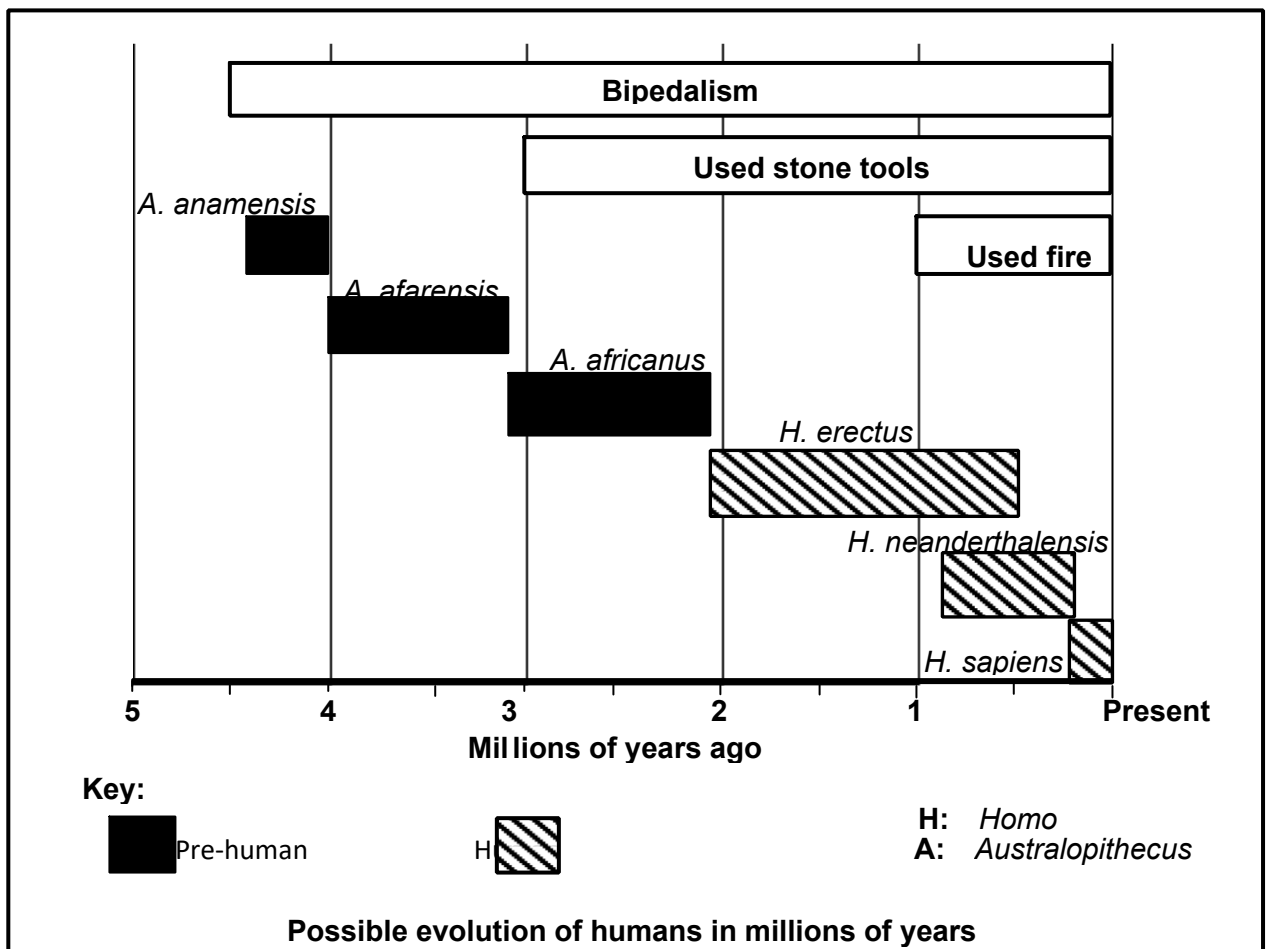
3.4 - Fossil✓evidence

- Cultural✓ evidence

- Genetic✓ evidence

Any (2)

4. The diagram below represents the possible evolution of humans, as well as the time period for the development of bipedalism, the use of fire and the use of tools.



- 4.1 Use the diagram above and identify TWO bipedal organisms that did not use stone tools or fire. (2)
- 4.2 How long after developing the ability to walk on two feet did pre-humans develop the ability to use stone tools? Show ALL working. (3)
- 4.3 Explain the significance of the characteristic of the skull which allowed for the development of the ability to use tools in the *Homo* species. (2)
- 4.4 Explain the relationship between the use of fire and changes in dentition in the *Homo* species. (2)
- (9)

4.1 *A. anamensis*✓ and *A. afarensis* (2)

4.2 (4,5mya – 3mya)✓ = 1,5✓mya✓ (3)

4.3 The cranium increased in size✓ so it could accommodate a larger brain✓ (2)

4.4 Smaller teeth✓/canines in *Homo* species, can chew food that was cooked✓/made soft using fire OR Larger teeth/canines are not necessary ✓ because the food is softer ✓ because of cooking with fire. (2)

SIMILARITIES BETWEEN HUMANS (HOMO SAPIENS) AND AFRICAN APES

❖ **Name FIVE characteristics that humans share with African apes.**

- Eyes in front✓/ Binocular vision / stereoscopic vision
- Freely rotating arms✓
- rotation around elbow joints ✓
- Flat nails instead of claws✓/ bare, sensitive finger tips
- Opposable thumbs✓/precision grip
- upright posture✓
- Long **upper** arms✓
- Large brains✓
- Five digits per limb✓

❖ **Give FOUR characteristics of the upper limbs that humans share with other primates.**

- Freely rotating arms ✓
- Long upper arms✓
- Rotation around elbow joints✓
- Rotation around the wrists ✓
- Opposable thumbs✓
- Bare fingertips/✓ nails instead of claws

• **Give THREE characteristics of the hand that humans share with other primates.**

- Five fingers✓
- Opposable thumbs✓
- nails instead of claws ✓

DIFFERENCES BETWEEN HUMANS (HOMO SAPIENS) AND AFRICAN APES

❖ **Define Bipedalism and Quadrupedal as modes of walking in primates**

- Bipedalism the ability of an organism to walk on two hind limbs
- Quadrupedal walking on all four legs/limbs.

❖ **Explain the advantages and significance of bipedalism for homonids**

- Hands are free ✓ - to pick or carry food, to use tools and handle weapons ✓
- Standing upright ✓ - gives a better, wider view of surroundings. ✓
- Upright posture ✓ – for faster cooling of the body ✓
- Display of male sex organs ✓ - as part of courtship behavior. ✓

❖ **Describe ONE other structural difference between a *bipedal* and a *quadrupedal* organism.**

- The spine ✓
- is S-shaped for the bipedal organism ✓
- and C-shaped for the quadrupedal organism ✓

OR

- The foramen magnum ✓
- is in a more forward position in bipedal organisms ✓
- and in a more backward position in quadrupedal organisms ✓ (3)

❖ **Explain how each of the following skeletal structures have contributed to bipedalism in humans:**

(a) **Foramen magnum**

- Foramen magnum moved to a more forward position✓
- to allow the spinal cord to enter vertically✓ (2)

(b) **Pelvic girdle**

- Pelvic girdle is short and wide✓
- to support the upper body✓ (2)

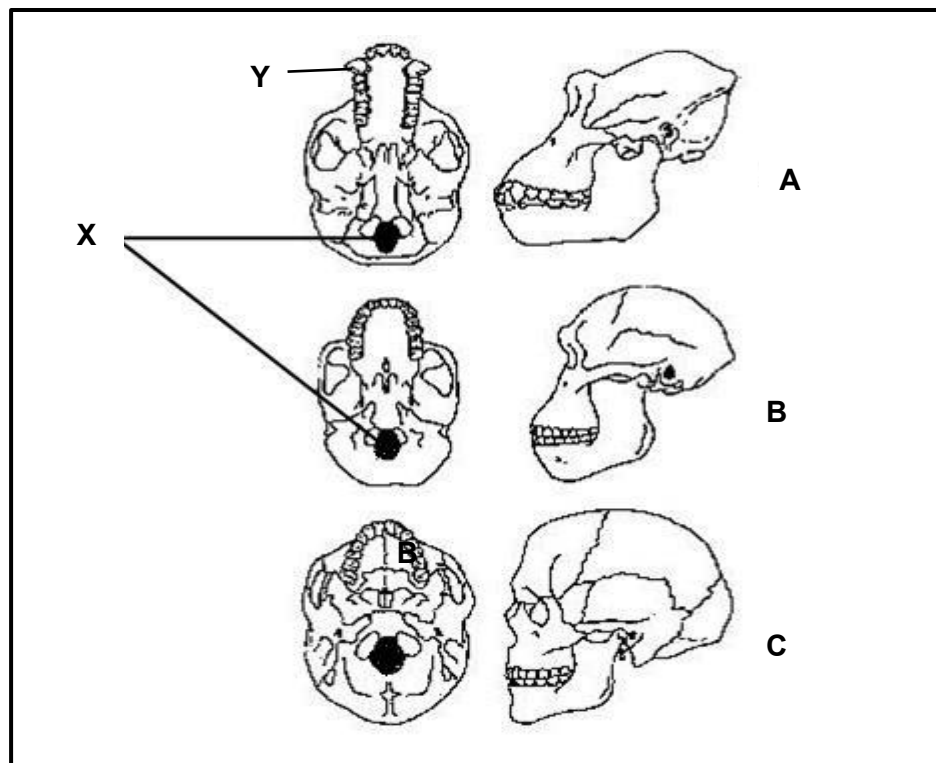
(c) **Spine**

- Spine is more curved✓/S shaped
- to absorb shock/allow flexible movement/support✓ (2)

❖ **Explain the significance of the location of foramen magnum in homo sapiens**

- The foramen magnum is located in a more forward position✓
- showing that organism is bipedal✓
- this allows the spine to extend vertically✓ from the base of the skull
- to balance the body weight in upright walking✓ (3)

5. The diagram below represents the fossilised skulls of three different species of primates. They were either bipedal or quadrupedal (organisms that habitually walk on all four limbs).



- 5.1 Label part **X** and the type of teeth at **Y**. (2)
- 5.2 Explain the significance of the **location** of structure **X** in organism **C**. (3)
- 5.3 Which of the skulls (**A**, **B** or **C**) belongs to:

(a) An *Australopithecine* (1)

(b) A quadrupedal primate (1)

- 5.4 Explain how the change in the skull from **B** to **C** could indicate a change in intelligence. (3)

- 5.5 Tabulate TWO observable differences, other than those mentioned in QUESTIONS 5.2 and 5.4, between skulls **B** and **C** that represent trends in human evolution. (5)

(15)

5.1 X - Foramen magnum✓ (1)

Y - Canine✓ (1)

5.2 - The foramen magnum is located in a more forward position✓

- showing that organism C is bipedal✓
- this allows the spine to extend vertically✓from the base of the skull
- to balance the body weight in upright walking✓ (3)

5.3 (a) B✓ (1)

(b) A✓ (1)

5.4 - There is an increase✓

- in the cranium size✓ from organism B to organism C
- This will allow it to house a larger brain✓which suggests greater intelligence (3)

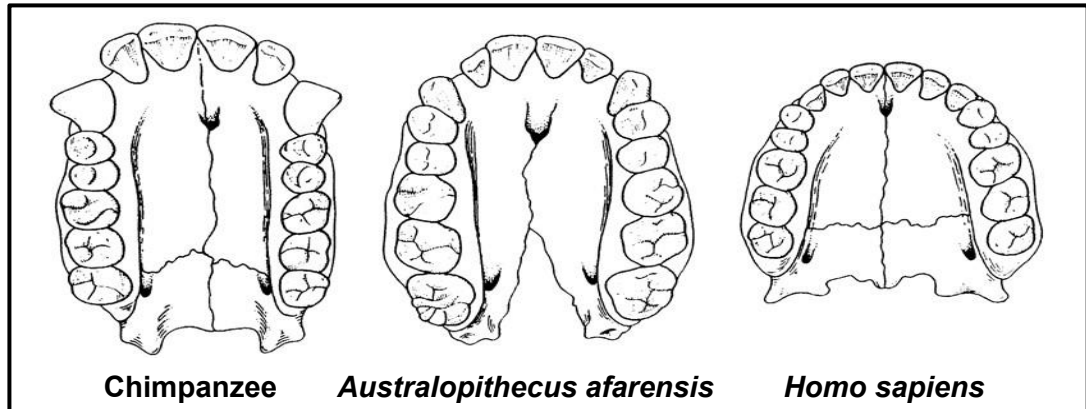
5.5

Skull B	Skull C
Brow ridges pronounced✓	Brow ridges are not as pronounced✓
More protruding jaws✓/larger jaws	Less protruding jaws✓/ smaller jaws

Table1 + (2 x 2) (5)

(15)

6. The diagrams below show the upper jaws of some fossils. These diagrams are drawn to scale.



- 6.1 Describe ONE visible difference between the jaw of a chimpanzee and that of *Homo sapiens* which show trends in human evolution. (2)
- 6.2 Based on the differences in dentition, what conclusion can be made about the change in diet from *Australopithecus afarensis* to *Homo sapiens*? (2)
- 6.3 *Australopithecus* may be described as a transitional species between the chimpanzee and *Homo sapiens*.
- (a) Define a *transitional species*. (1)
- (b) Use ONE visible feature of the jaw to explain why *A. afarensis* may be described as a transitional species. (2)
- (7)

6.1 - The jaw is large in the chimpanzee✓ and small in *Homo sapiens*✓

- The jaw is rectangular in the chimpanzee✓ and rounded in *Homo sapiens*✓
- Large spaces between the teeth in the chimpanzee✓ and small/no spaces in *Homo sapiens*✓

Large canines/teeth in the chimpanzee✓ and small canines in *Homo sapiens*✓ (2)

6.2 - The diet changed from eating raw food✓ in *Australopithecus*

- to a diet of cooked food✓ in *Homo sapiens* (2)

6.3 (a) A transitional species shows intermediate characteristics between two genera/species✓

OR

It has characteristics common to both the ancestor species and the species that follows✓ (1)

(b) The jaw is smaller than that of the chimpanzee but larger than that of *Homo sapiens*✓✓

OR

The canines/ teeth are smaller than those of the chimpanzee but larger than those of *Homo sapiens*✓✓

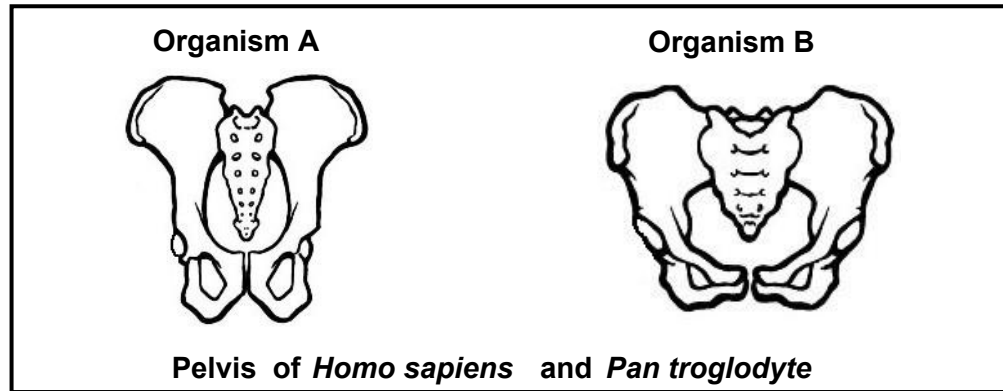
OR

The jaw/ palate shape is more rounded than that of the chimpanzee but less rounded than that of *Homo sapiens*✓✓

Any 1 x 2 (2)

(7)

7. Study the diagrams below showing the pelvis of *Homo sapiens* and *Pan troglodyte* (chimpanzee). The diagrams are not drawn to scale.



7.1 Which organism, **A** or **B**, is bipedal? (1)

7.2 Give ONE observable reason for your answer to QUESTION 7.1.

(2)

7.3 The table below shows the cranial capacities of different species of primates.

Species	Cranial capacity (cm ³)
Chimpanzee	400
Gorilla	550
<i>Australopithecus</i> sp.	500
<i>Homo habilis</i>	650
<i>Homo erectus</i>	1 000
<i>Homo sapiens</i>	1 500

[Adapted from *Advanced Biology*, M Kent, 2000]

State TWO advantages of the large cranial capacity of *Homo sapiens*.

(2)

(5)

7.1 B ✓ (1)

7.2 The pelvis is shorter ✓ compared to its width ✓

OR

- The pelvis is wider ✓ compared to its height ✓ (2)

7.3

- Allows for a bigger brain ✓
- Development of speech ✓ / communication
- Higher intelligence ✓
- Complex behaviour ✓
- Quick processing of information ✓
- Process large amounts of information ✓

(2)
(5)

LINES OF EVIDENCE THAT SUPPORT THE IDEA OF COMMON ANCESTORS FOR LIVING HOMINIDS INCLUDING HUMANS

❖ State THREE lines of evidence

- Fossil evidence ✓
- Genetic evidence ✓
- Cultural evidence ✓

❖ State THREE types of evidence that support the idea that all hominids evolved from a common ancestor.

- Fossil evidence ✓
- Genetic evidence ✓
- Cultural evidence ✓

❖ *Three genera being studied in human evolution:*

- *Ardipithecus* ✓
- *Australopithecus* ✓
- *Homo* ✓

❖ Species studied in human evolution:

- **Australopithecus africanus** ✓
- **Homo habilis**✓
- **Homo erectus**✓
- **Homo sapiens**✓
- (Other species may be mentioned in phylogenetic trees, graphs and extracts)

❖ The first name is genus name e.g **Homo** and the second name, e.g. **erectus** refers to the species name.

GENERA	FOSSIL	SCIENTIST
Australopithecus afarensis	Lucy	Donald Johanson
Australopithecus africanus	Taung child	Raymond Dart
	Mrs Ples	Robert Broom
	Little foot	Ron clarcke
Australopithecus Sediba	karabou	Mathew Burger and Lee Burger
Homo habilis	Nutcracker man	Louis & Mary Leakey
Homo erectus	Java Man	Eugene Dubois
Homo sapiens	Florisbad man,	Frederik Dreyer

❖ Give **THREE** example of an *Australopithecus africanus* fossil found in South Africa.

- Mrs Ples✓
- Taung Child✓
- Little Foot✓

❖ Name **THREE** Homo species, besides *Homo sapiens*, that were found in Africa.

- *H. habilis*✓
- *H. erectus*✓
- *H. naledi* ✓

❖ Describe how cultural evidence is used to support the theory of human evolution. (2)

- Evidence such as tools✓ /weapons/ language/ artefacts
- is used to show advances✓ in human development

OUT OF AFRICA' HYPOTHESIS

❖ State the 'Out of Africa' hypothesis (3)

- All modern humans✓*/*Homo sapiens*
- originated in Africa✓*
- and migrated to other parts✓of the world

❖ State THREE evidence that support the out of Africa Hypothesis (3)

- ❖ Fossil evidence✓
- ❖ Genetic evidence✓
- ❖ Cultural evidence✓

❖ Describe the evidence that supports the 'Out of Africa' hypothesis.

1. FOSSIL EVIDENCE✓

- Fossils of *Ardipithecus* were found **ONLY** in Africa✓
 - Fossils of *Australopithecus* were found **ONLY** in Africa✓
 - The fossils of *Homo habilis* were **ONLY** found in Africa✓
 - The **OLDEST** fossils of *Homo erectus* were found in Africa✓
 - The **OLDEST** fossils of *Homo sapiens* were found in Africa✓
- Max (4)

2. GENETIC EVIDENCE✓

- Mitochondrial DNA✓
 - Is inherited only from the maternal line✓
 - Analysis of mutations ✓ on this mitochondrial DNA
 - shows that the oldest female ancestor were located in Africa✓
 - and that all humans descended from her✓/mitochondrial Eve
 - The Y chromosome shows the paternal line✓
- Max (4)

3. CULTURAL EVIDENCE✓

- The **OLDEST**/most primitive artefacts (tools, cutlery, art , weapons etc.)
- were found in Africa✓

(2)

END!

EVOLUTION THROUGH NATURAL SELECTION

- Refers to how species changed over time as some traits help organism to survive and reproduce in a favorable environment. E.g giraffes with long necks, resistant bacteria, plants with long roots etc.
- Lamarckism, Darwinism and Punctuated equilibrium are the main theories that explain evolution in organisms in different ways.
- The distribution of species into different parts of the world is called Biogeography✓
- Some geological events like volcanic eruption resulted in total disappearance of a species from earth called Extinction✓
- The process by which all individuals of a particular species die out so that not even a single one exists Extinction✓
- It refers to organisms that no longer exist on earth Extinction✓
- After these geological events only the fossils left as evidence
- Fossils are mineralised remains of organisms that have lived in the past.
- These fossils were found and analysed by palaeontologists✓
- Scientist who only studies fossils Palaeontologist✓
- The study of fossils is called Palaeontology✓

❖ Differentiate between hypothesis and theory

(2)

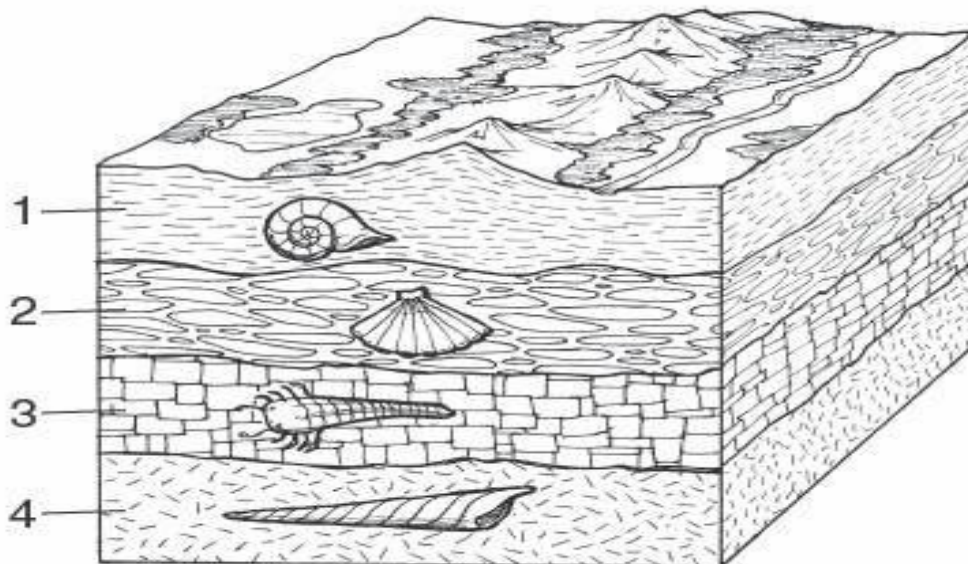
- A tentative explanation of a phenomenon that can be tested Hypothesis✓
- A testable statement that can be accepted or rejected Hypothesis✓
- Theory✓ is an explanation of an observation that is supported by facts, models and laws

❖ Differentiate between evolution and biological evolution

- **Evolution** refers to changes that living organisms undergone over a long period of time. *e.g foramen magnum, spine, pelvic girdle, canines, cranium*

- **Biological evolution** means that all present-day forms of life have descended from and are related to, those that lived in the past✓ they may look different because they became modified from one generation to another.
- The change in the genetic composition of a species over time **Biological evolution**✓

QUESTIONS:



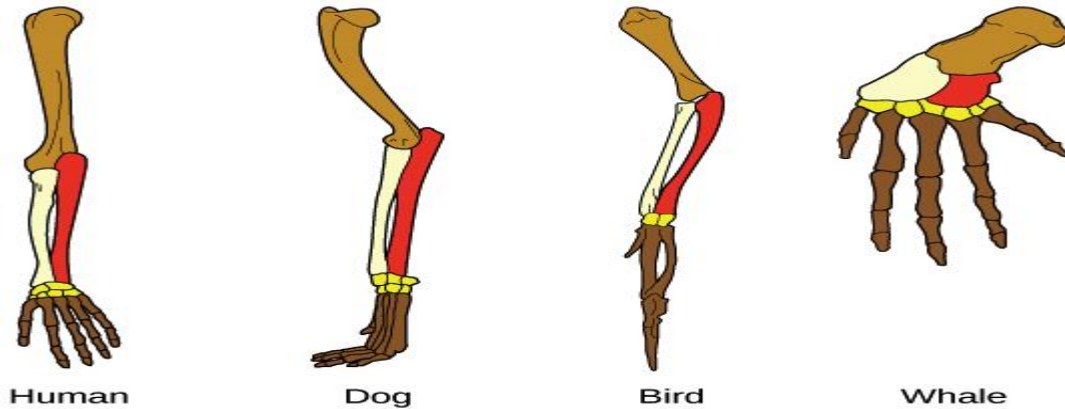
1.1 State the evidence for evolution shown by the diagram above (1)

- **Fossil record**✓

1.2 Which number represents the oldest layer? (1)

- **4**✓

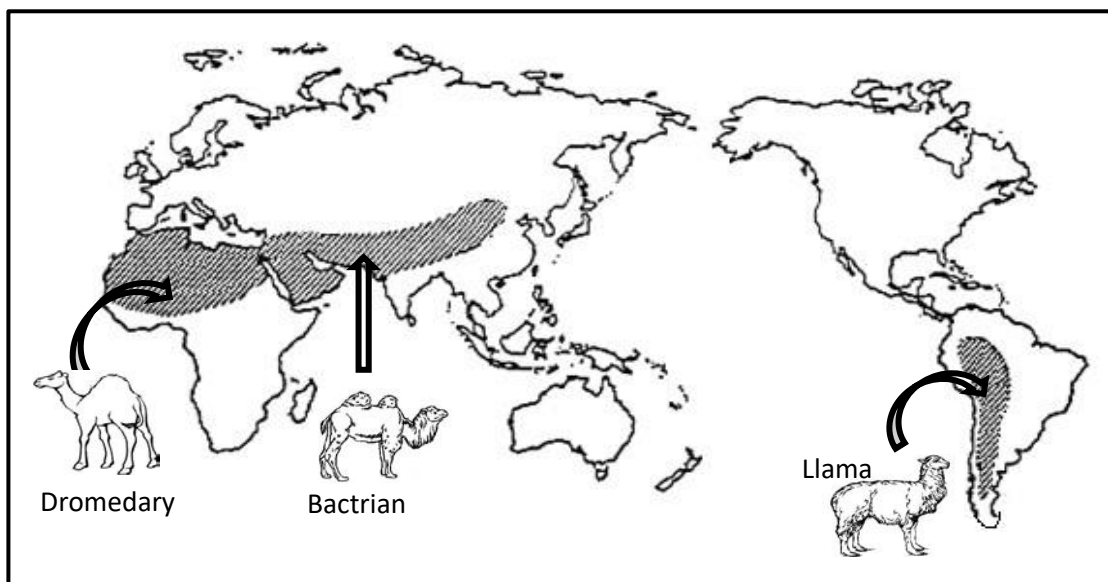
2. Name and describe the evidence for evolution shown by the diagram below (3)



Modification by descent (homologous structures)✓

- Similar structures but perform different functions✓
- are inherited from common ancestor✓
- Structures in different organisms that have a similar basic plan which suggests that they share a common ancestor **Homologous**✓

3. The diagram below shows the distribution of members of the camel family on the different continents. The arrows indicate the current distribution of the animals.



[Adapted from <http://www.ck12.org>]

BIOGEOGRAPHY

- Species from different parts of the world may show some similarities in structures✓
- Closely related species tend to be found in the same geographic region✓

❖ VARIATION IN ORGANISMS

- **Variation** - refers to any phenotypic differences in organisms of the same species

❖ List FIVE sources of variation in organisms (5)

1. **Crossing over** ✓
2. **Random arrangement of chromosomes**✓
3. **Random fertilisation** ✓
4. **Random mating** ✓
5. **Mutation** ✓

❖ **Differentiate between continuous variation and discontinuous variation.**

Continuous variation occurs when there is a **range** of phenotypes for the same characteristic✓

- Continue to change throughout your life.
- An examples of continuous variation in humans: body weight ✓, height✓, skin colour✓

Discontinuous variation type of variation in a population with no intermediate phenotypes

- Are fixed in life /Do not change throughout your life.
- For example :gender can either male or female, blood group, fingerprints

LARMARKISM:**❖ Describe the TWO principles (laws) that Lamarck used to explain evolution.****➤ 'Law' of use and disuse✓**

- As an organism **uses** a structure or organ more frequently, it becomes better developed or enlarged. ✓
- If an organism **does not use** a structure or organ frequently, it becomes less developed or reduced in size and may totally disappear✓

➤ 'Law' of the inheritance of acquired characteristics ✓

- Characteristics developed during the life of an individual (acquired characteristics) can be passed on to their offspring✓
- Lamarck also explained that organisms could inherit these changed structures from their parents.✓

❖ Give TWO reasons why most scientists reject Lamarck's theory.

- There is **no enough evidence** to show that Acquired characteristics are inherited✓
- Organisms did not evolve because they want to evolve✓ (due to changes in the environment)
- There is no evidence that structures used more frequently become more developed or vice versa

❖ Application of Lamarckism in nature using the development of longer necks in modern giraffes as an example

- All giraffes had short necks originally✓.
- These giraffes frequently **stretched** their necks.✓
- To reach the leaves that were available only higher up on the trees.✓
- As a result, their necks became longer.✓
- The characteristic of long necks acquired in this way was then **passed** on to the next generation.✓

DARWINISM:

❖ **Describe the process of natural selection. (Generic description)**

- Organisms produce a **large number** of offspring✓
- There is **variation**✓ amongst the offspring
- Some have **favourable** characteristics and some **do not**✓
- When there is a **change** in the environmental conditions✓/ there is **competition**
- organisms with favourable characteristics, **survive**✓
- whilst organisms with unfavourable characteristics, **die**✓
- The organisms that survive, **reproduce**✓
- and **pass on the allele** for the favourable characteristic to their offspring✓
- The next generation will therefore have a **higher proportion** of individuals with the **favourable characteristic**✓

❖ **Application of Darwinism in nature using the development of longer necks in modern giraffes as an example.**

- As a result of **genetic variation** in the giraffe population.
- some **giraffes** had **longer necks** and others **shorter necks**
- A **competition** for food occurred
- Giraffes with **shorter necks** were unable to reach the leaves that were available only higher up on the trees and they died
- The giraffes with **longer necks** were able to reach the **leaves of tall trees and they survived.**
- This is termed **natural selection**
- The allele for **longer necks** was passed on to subsequent generations
- The next generation will therefore have a **higher proportion** of individuals with longer necks

❖ **Tabulate THREE differences between Lamarckism and Darwinism**

Lamarckism	Darwinism
Variation of the offspring occurs when individuals in the population change✓	Variation in the offspring is inherited✓
Change occurs because of adaptation to the environment✓/Law of use and disuse/ deterministic theory	Natural selection – individuals best suited to the environment survive✓
Individuals in the population change✓	The population as a whole changes✓
Acquired characteristics are inherited by offspring✓	Characteristics are passed from one generation to another as to survive in the environment. ✓

❖ **Punctuated equilibrium** is a hypothesis that explains the speed at which evolution takes place through natural selection:

- According to punctuated equilibrium, evolution involves long periods of time where species **do not change** or **change very little** (known as equilibrium).
- This alternates with (is punctuated by) short periods of time where rapid changes occur.
- Type of evolution involving long periods of time when species do not change and short periods of rapid change **Punctuated equilibrium**✓
- An explanation describing evolution as consisting of long phases of little change alternating with short phases of rapid change **Punctuated equilibrium**✓

❖ **Darwin's ideas about gradualism compared to Punctuated Equilibrium**

- Darwin believed that evolution takes place through an
- accumulation of small✓
- gradual changes that occur over a long period of time✓
- supported by transitional forms in fossil record✓
- Punctuated equilibrium suggested that evolution sometimes involves long periods of

time where species do not change✓/very little change occurs

- This alternates with short periods of time where rapid changes occur✓
- New species are formed in a short period of time✓
- supported by the absence of transitional forms✓ (Max 4)

❖ **ARTIFICIAL SELECTION/SELECTIVE**

- Refers to the breeding of plants and animals over many generations in order to achieve a desirable characteristic for humans.✓
- For example, increased quality and **quantity of milk** produced by cows, or **drought resistance** plant and increased **sugar content** in sugar cane.

❖ **Use an example to describe selective breeding/artificial selection. (5)**

- E.g. farm animals, crops, dogs✓
- Organisms of a species show variations✓
- Humans select✓organisms with traits
- which will be beneficial to them✓
- Interbreeds them✓with other organisms with the
- same desired characteristics✓
- to get the desired features✓
- choose the offspring with the best combination of characteristics✓
- allow them to breed with each other✓
- repeat the process to improve the desired characteristics✓

❖ **Tabulate TWO differences between artificial selection and natural selection**

Natural selection	Artificial selection
The environment or nature is the selective force✓	Humans represent a selective force✓
Selection is in response to suitability to the environment✓(vegetation eaten by cow)	Selection is in response to satisfying human needs✓
Occurs within species✓(cows mate with a bulls)	May involve one or more species✓(mule)
No cost involve✓	May involve large costs ✓

Slow process that takes many generations✓	Faster process✓
Organisms with less suitable characteristic die	It is not necessarily beneficial for the organism✓

❖ **EVOLUTION IN PRESENT TIMES**

- Evolution is always happening and still happening
- Scientists can use rapidly producing organisms such as **insects** and **bacteria** to observe current evolution.
- These organisms evolve quickly and show some **variations** due to **mutations**.

❖ **Describe the Evolution of resistance in insects to pesticides by Natural Selection**

- Before use of DDT, the mosquitoes showed genetic variation✓
- Most mosquitoes died✓ if sprayed with DDT
- Few would survive✓ and do not die if sprayed
- Those susceptible to DDT die✓
- DDT resistant mosquitoes become naturally selected✓
- They produce✓ DDT resistant offspring
- If sprayed, DDT resistant do not✓ die and those susceptible become eliminated
- DDT no✓ longer effective in killing mosquitoes

❖ **Describe how the bacteria(mycobacterium) developed antibiotic resistance through natural selection.**

There was variation/mutation in the bacteria (Mycobacterium) population □

- Some bacteria were resistant ✓ to the antibiotics and others were not ✓
- When bacteria were exposed to the antibiotics □
- Those that were not antibiotic-resistant did not survive ✓ /died
- Those that were resistant to the antibiotics survived ✓ and reproduced ✓
- and passed the allele for antibiotic resistance to their offspring □
- The next generation had a higher proportion of bacteria with antibiotic resistance ✓

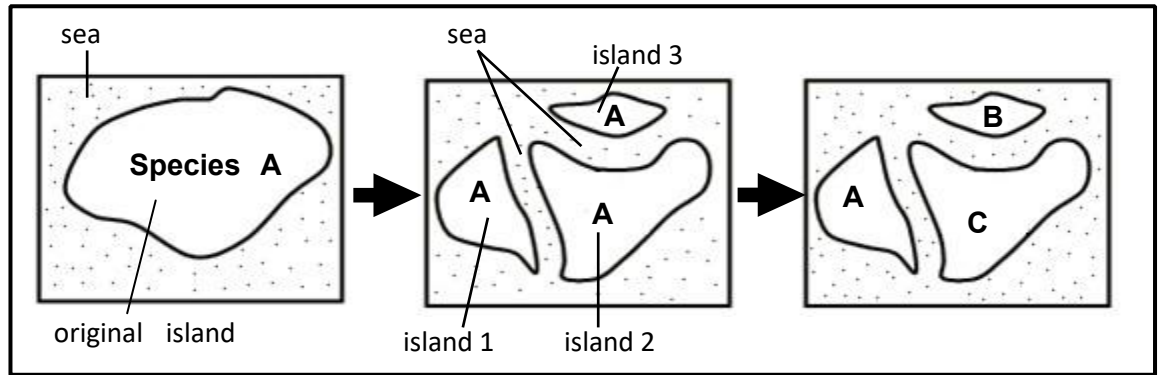
❖ **SPECIATION**

- The formation of a new species is called **speciation**

❖ **Describe speciation through geographic isolation** (6)

- If a population of a single species ✓
- becomes separated by a geographical barrier ✓ (sea, river, mountain, lake)
- then the population **splits** ✓ into two.
- There is now **no gene flow** ✓ between the two populations.
- Since each population may be exposed **to different environmental** conditions/the selection pressure may be different ✓
- 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 interbreed. ✓
- The two populations are now **different species.** ✓

4. The diagrams below represent the process of speciation in tortoises.
Over a period of time species **B** and **C** evolved from species **A**.



- 4.1 Explain why species **A** continued to exist on island 1. (2)
 4.2 Describe how species **B** and **C** evolved from species **A**. (6)
(8)

4.1 - Conditions/example on the island probably remained the same✓

- so they experienced the same selection pressure✓
- species A was already suited to those conditions✓

Any 2 (2)

4.3 -The original species was separated✓ into three/different populations

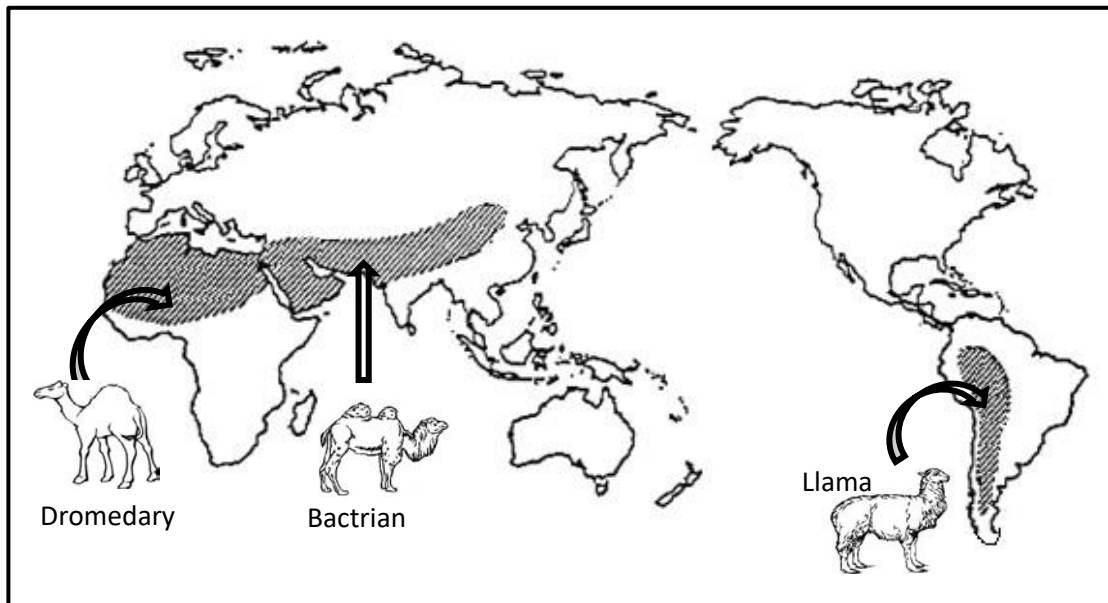
-by the sea✓*

- which acted as a geographical barrier✓
- There was no gene flow✓ between the populations
- Each population was exposed to different environmental conditions✓
- Natural selection occurred independently✓ in each population
- and the individuals of each population became different✓ from each other over time
- genotypically✓/phenotypically
- Even if the three populations were to mix again✓
- they would not be able to reproduce with each other✓/interbreed

1 *Compulsory mark + Any 5 (6)

(8)

5. The diagram below shows the distribution of members of the camel family on the different continents. The arrows indicate the current distribution of the animals.



[Adapted from <http://www.ck12.org>]

5.1 Explain how speciation of camels may have occurred.

(6)

5.1 The common ancestor✓/original camel population

- was separated✓ into different populations
- ***by the sea✓/due to continental drift**
- There was no gene flow✓ between the populations
- Each population was exposed to different environmental conditions✓
- Natural selection occurred independently✓ in each population
- The individuals of each population became different✓ from each other over time
- genotypically and phenotypically✓
- Even if the three populations were to mix again✓
- they would not be able to interbreed✓

Any 5+*1 compulsory (6)

❖ **REPRODUCTIVE ISOLATING BARRIERS (keep species separated)**

- This refers to factors that prevent two species from breeding and producing viable, fertile offspring

❖ **Describe FIVE reproductive isolating mechanisms that keep species separate**

Breeding at different times of the year✓

- One species is fertile when the other is not✓
- Two species breeding at different seasons, their chances of mating are reduced✓
- Different species will have different breeding seasons✓
- in the case of plants, will flower at different times of the year, in order to prevent cross-pollination✓

Species-specific courtship behaviour✓

- Courtship behaviour is a physical or chemical signal that an organism is ready to mate
- Courtship behaviour of one species will not attract other species✓
- includes singing elaborate mating songs ,mating dances etc✓
- Some animals do not attract individuals of other species even if they are closely related✓

Adaptation to different pollinators✓

- Pollinator of one species is not adapted to pollinate another species✓
- Some closely related species of plants have different appearances that attract different pollinating agents preventing cross-pollination between different species✓

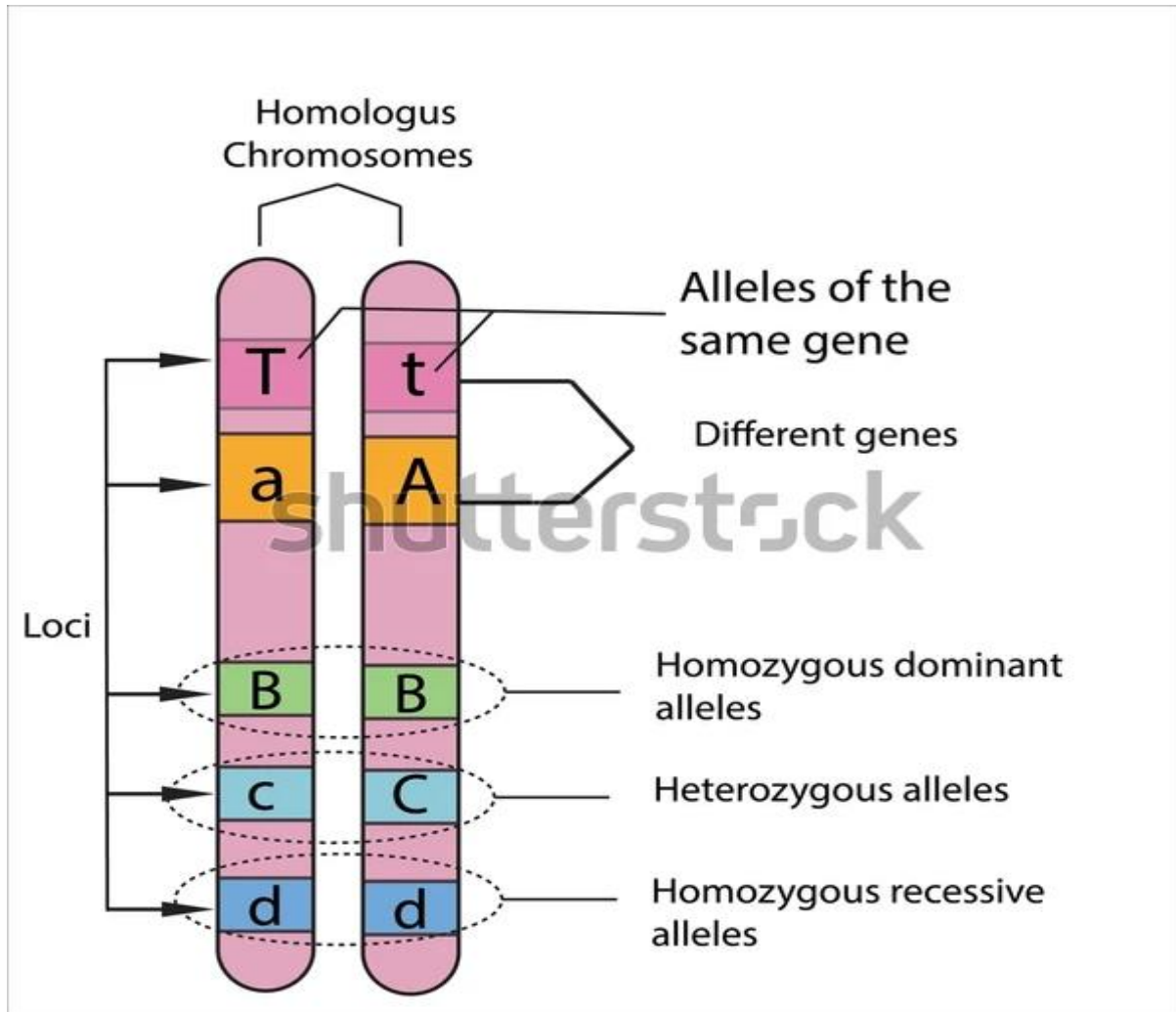
Infertile offspring✓

- Some closely-related species may mate and produce infertile offspring✓
- horse and a donkey producing a mule✓
- A new species cannot form because they cannot produce fertile offspring✓

Prevention of fertilisation

- Other species use contraceptive methods to prevent fertilization✓

GENETICS AND INHERITANCE

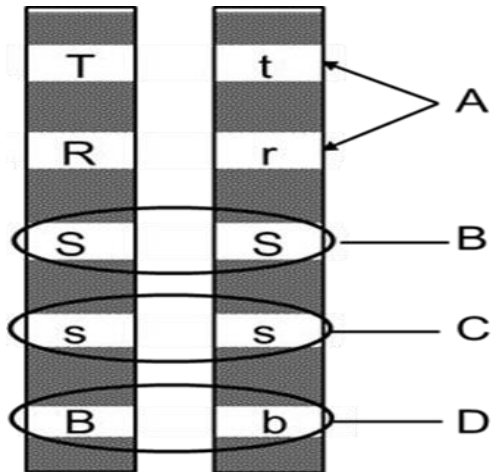


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- Two chromosomes (maternal and paternal)
- Five genes (section of a chromosome that carry a characteristic eg height)
- Five Loci (exact position of a gene in a chromosome)
- One Homozygous dominant alleles (upper case and are the same)
- One Homozygous recessive alleles (lower case and are the same)
- Three Heterozygous alleles (Upper case and lower case and are different)
- Genotype are represented by two alleles e. Tt
- Light skin colour in humans is an example of Phenotype

ACTIVITY 1

- 1.1 The paired letters in the diagram below represent alleles of a gene.
A number of genes for different characteristics are shown.



Write down the relevant letter (A – D) for:

- The homozygous dominant state _____ (1)
 - Two alleles from different genes _____ (1)
 - The homozygous recessive state _____ (1)
 - The heterozygous state _____ (1)
- 1.2 State the terms that describe a pair of alleles that are:
- the same? _____ (1)
 - different? _____ (1)
- 1.3 State how many of the following:
- Chromosomes _____ (1)
 - Genes _____ (1)
 - Loci _____ (1)
 - Homozygous alleles _____ (1)
 - Heterozygous allele _____ (1)

1.4 In humans the allele for short fingers (brachydactyly), represented by **B**, is dominant over the allele for normal fingers (**b**). and the allele for curly hair (**H**) is dominant over the allele for straight hair (**h**).

Fill in the phenotype and alleles

Phenotype	Genotype
short fingers	1.4.1 _____ and _____
Normal fingers	1.4.2 _____
curly hair	1.4.3 _____ and _____
Straight hair	1.4.4 _____

Genotype	Phenotype
BBHH	
BbHh	
Bbhh	
bbHh	
bbHH	
BBhh	
bbhh	

1.5 Give the genotype of the gamete produced by;

- | | |
|----------|-----|
| (a) Bbhh | (2) |
| (b) bbHH | (2) |
| (c) BbHh | (2) |
| (d) bbhh | (2) |

ACTIVITY 2

In plants the allele for small fruit (**b**) is recessive to the allele for big fruit (**B**) and the allele for yellow fruit colour (**g**) is recessive to the allele for green fruit (**G**).

Use a Punnet square to determine the genotypes and phenotypes the offspring with a ratio of 9:3:3:1

GAMETES				

ACTIVITY 3

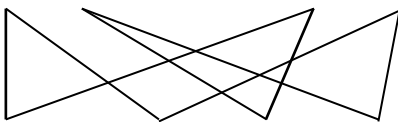
3.1 Who is the father of genetic _____ (1)

3.2 Differentiate between two types of inheritance

_____ (1)

_____ (1)

3.3 In rabbits the dominant allele (**B**) produces black fur and the recessive allele (**b**) produces white fur. Study the table below showing the genotypes of four rabbits. Determine the possible genotypes and phenotypes of when a heterozygous black fur rabbit is crossed with a white fur rabbit (6)

Layout of a genetic diagram					Explanation	
P2	Phenotype		x	✓	Visible trait is the phenotype e.g. tallness, shortness, etc.	
	Genotype		x	✓		
	Meiosis	Gametes		x	✓	The genetic make-up of the individual is its genotype e.g. TT or Tt or tt
	Fertilisation					
F2	Genotype			✓	The alleles segregate (or separate) during meiosis to form gametes. Each gamete has only	
	Phenotype			✓		
P ₁ and F ₁ ✓						
Meiosis and fertilisation✓						
OR						

P₁	Phenotype		x	✓	one copy of each allele During fertilisation the individual gets one allele of the gene from each parent The matrix box used to determine the results of fertilisation is called a Punnet square									
Meiosis	Genotype		x	✓										
	Gametes		x	✓										
Fertilisation														
	<table border="1"> <tr> <td>Gametes</td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> </tr> </table>				Gametes									
Gametes														
F₁	Phenotype	✓												
	Genotype	✓												
P ₁ and F ₁ ✓ fertilisation✓														
Meiosis and fe														

In rabbits the dominant allele (**B**) produces black fur and the recessive allele (**b**) produces white fur. Study the table below showing the genotypes of four rabbits.

Rabbit	1	2	3	4
Genotype	BB	Bb	Bb	bb

2.1 What are the phenotypes for rabbits:

- (a) 1 _____ (1)
 (b) 2 _____ (1)
 (c) 3 _____ (1)
 (d) 4 _____ (1)

2.2 State the genotypic ratio that is shown in the table above. _____ (1)

2.3 Give only the numbers of the rabbits that are pure breed _____ (2)

2.4 Give only the numbers of the rabbits that are hybrid _____ (2)

State Mendel's Law of Dominance

- When two homozygous organisms with contrasting characteristics are crossed, all the individuals of the F1 generation will display the dominant trait
- An individual that is heterozygous for a particular characteristic will have the dominant trait as the phenotype.

❖ THREE TYPES OF DOMINANCE:

- **Complete dominance** Rr
- **Incomplete dominance** (new third phenotype which is intermediate) RW
- **Codominance** (combination of the other two phenotypes) RW

❖ SEX DETERMINATION

❖ Describe how men determine the sex of an individual (3)

- Men determine the sex of the baby depending on whether their sperm cell is carrying an X or Y chromosome.✓
- An X chromosome combines with the female's X chromosome to make a baby girl (XX)✓
- Y chromosome will combine with the female's X chromosome to make a boy (XY)✓

❖ INHERITANCE OF SEX-LINKED CHARACTERISTICS

- **Haemophilia** and **colour blindness** are sex-linked genetic disorders.

GENOTYPE	PHENOTYPE
$X^H X^H$	Normal female
$X^H X^h$	Normal female(carrier)
$X^h X^h$	Haemophiliac female
$X^H Y$	Normal male
$X^h Y$	Haemophiliac male

3.A normal male marries a female with haemophilia. Determine the possible genotypes and phenotypes of their children.

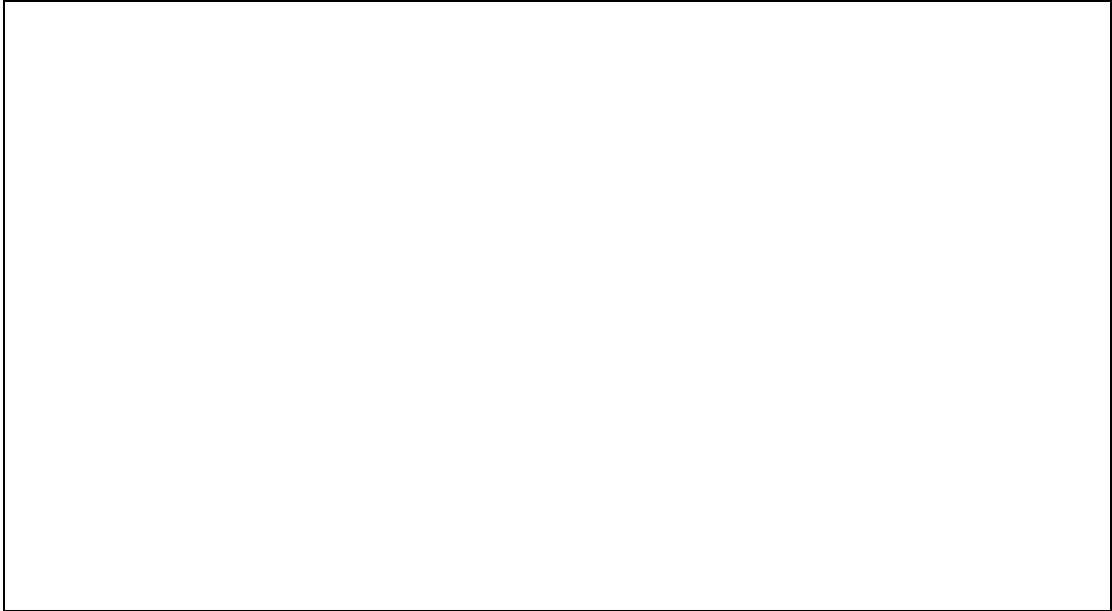
❖ **BLOOD GROUPING**

- three alleles controlling blood groups I^A, I^B, i
- these are called **multiple Alleles**

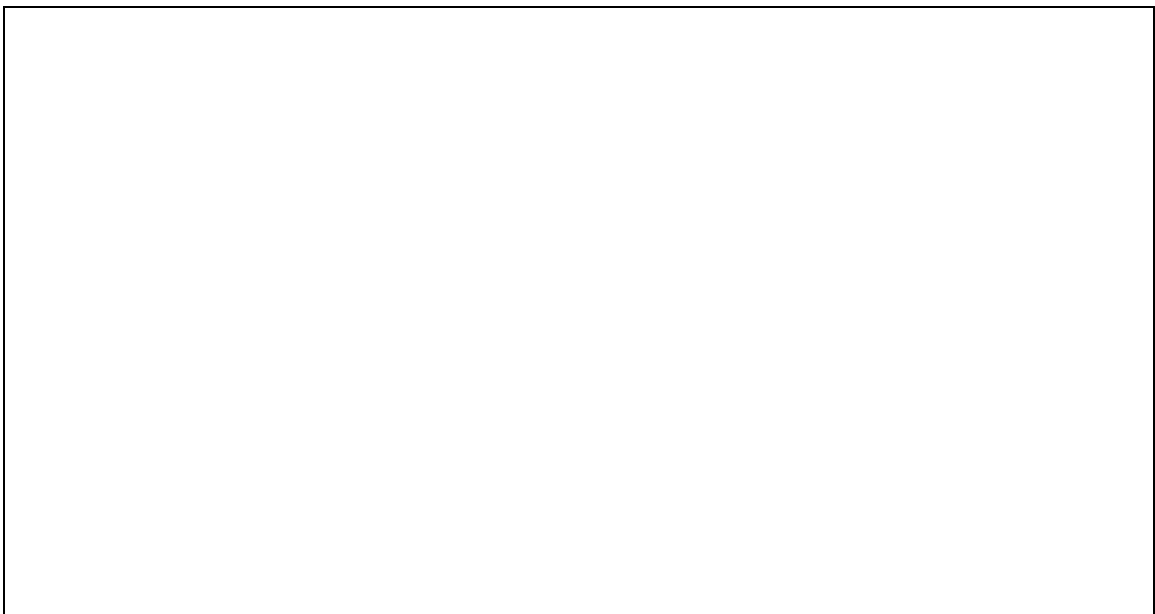
PHENOTYPE	GENOTYPE	CONDITION
A	$I^A I^A$	homozygous
A	$I^A i$	heterozygous
B	$I^B I^B$	homozygous
B	$I^B i$	heterozygous
AB	$I^A I^B$	Co-dominant
O	ii	Homozygous recessive

ACTIVITY 4

- 5.1 If the child has blood group **O** and the mother blood group **A**, could the man with blood group **AB** be the father of that child? Use a genetic diagram to explain your answer. (6)



- 5.2 A man has blood group **A** and his wife blood group **B**. Use a genetic diagram to show how it is possible for them to have a child with blood group **O**.? (6)



❖ **Explain how blood grouping is used in paternity testing.**

- The blood group of a child is determined by the alleles received from both parents✓
- The blood group of the mother, the child and the possible father is determined✓
- If the blood group of the mother and possible father cannot lead to the blood group of the child✓
- the man is not the father✓
- If the blood group of the mother and the possible father can lead to the blood group of the child✓
- the man might be the father✓

❖ **Explain why blood test maybe controversial in solving paternity test?**

- blood test alone is not effective and conclusive, since many men have the same blood group✓
- Therefore, further DNA profiling has to be conducted, because everybody except for identical twins has a unique DNA profile✓

❖ **DIHYBRID GENETIC CROSS**

ACTIVITY 5

In humans the allele for short fingers (brachydactyly), represented by **B**, is dominant over the allele for normal fingers (**b**). The allele for curly hair (**H**) is dominant over the allele for straight hair (**h**).

Andrew, with genotype **Bbhh**, married Susan, with genotype **bbHh**.

5.1 State how the phenotypes of Andrew and Susan differ from each other. (2)

5.2 Give ALL the possible genotypes of the gametes produced by Andrew. (2)

5.3 Give ALL the possible genotypes of the gametes produced by Susan. (2)

5.4 Give the genotypes of parents that will produce a ratio of 9:3:3:1 (1)

(7)

ACTIVITY 6

In rabbits, fluffy tails (**F**) are dominant to unfluffy tails (**f**). Brown fur (**B**) is dominant to white fur (**b**). Two rabbits who are heterozygous for both traits are crossed.

The Punnet diagram below shows the possible gametes produced by each parent.

	FB	Fb	fB	fb
FB	FFBB	X	FfBB	FfBb
Fb	FFBb	FFbb	FfBb	Ffbb
fB	FfBB	FfBb	ffBB	Y
fb	FfBb	Ffbb	ffBb	ffbb

6.1 (a) State the type of cross represented above. (1)

(b) Give a reason for your answer to QUESTION 7.1(a). (1)

6.2 How many offspring have unfluffy tails and white fur? (1)

6.3 Identify the:

(a) Phenotype of offspring **X** (1)

(b) Genotype of offspring **Y** (1)

(5)

❖ **MENDEL'S LAWS**

✓ **The Law of Dominance**

- When two homozygous organisms with contrasting characteristics are crossed, all the individuals of the F1 generation will display the dominant trait
- An individual that is heterozygous for a particular characteristic will have the dominant trait as the phenotype.

✓ **Mendel's Principle of Segregation**

- An organism possesses two 'factors' which separate or segregate so that each gamete contains only one of these 'factors'
- Each trait is controlled by two factors (now known as alleles) situated on homologous chromosomes.
- When gametes form during meiosis, the two factors (alleles) are separated or segregated. A gamete contains one of the two factors (alleles) from each parent.

✓ **Mendel's Principle of Independent Assortment**

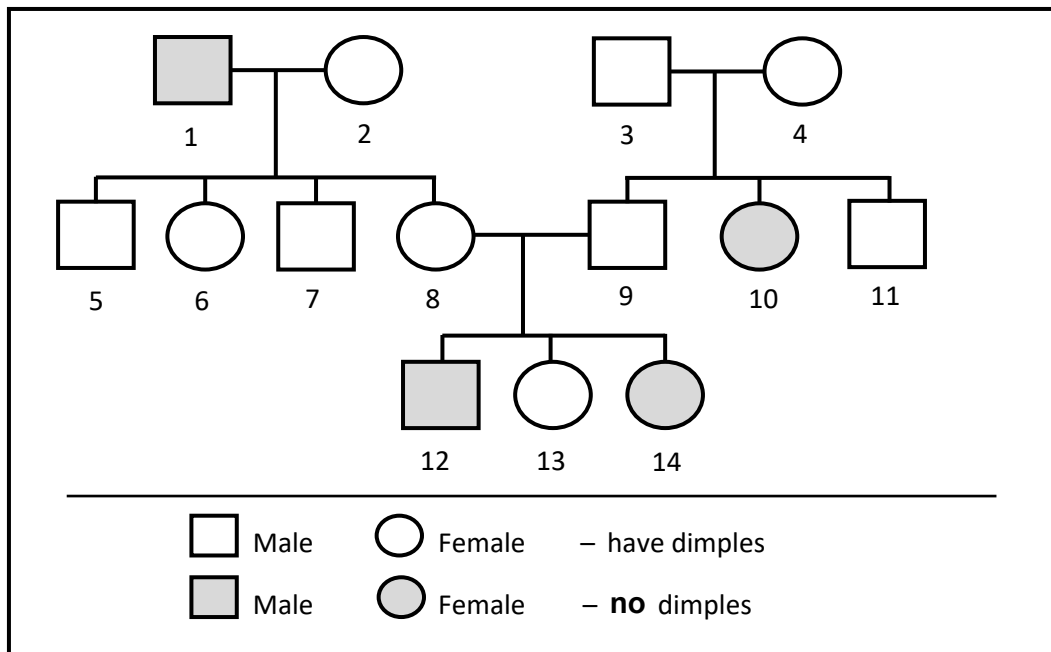
- The various 'factors' controlling the different characteristics are separate entities, not influencing each other in any way, and sorting themselves out independently during gamete formation.

❖ **GENETIC LINEAGES/PEDIGREE DIAGRAM**

- Study phenotypes over generations e.g freckles, dimples

ACTIVITY 7

Use the pedigree diagram below to answer the questions about dimples (small depressions on the cheeks when smiling). The dimple allele (**D**) controls whether a person has dimples or does not have dimples. The allele for having dimples is dominant to the allele for not having dimples (**d**).



7.1 How many family members have dimples? _____(1)

7.2 What is the genotype of the individuals?

a) **3** _____(1)

b) **4** _____(1)

7.3 State whether the following individuals are homozygous or heterozygous for having dimples:

a) **2** _____(1)

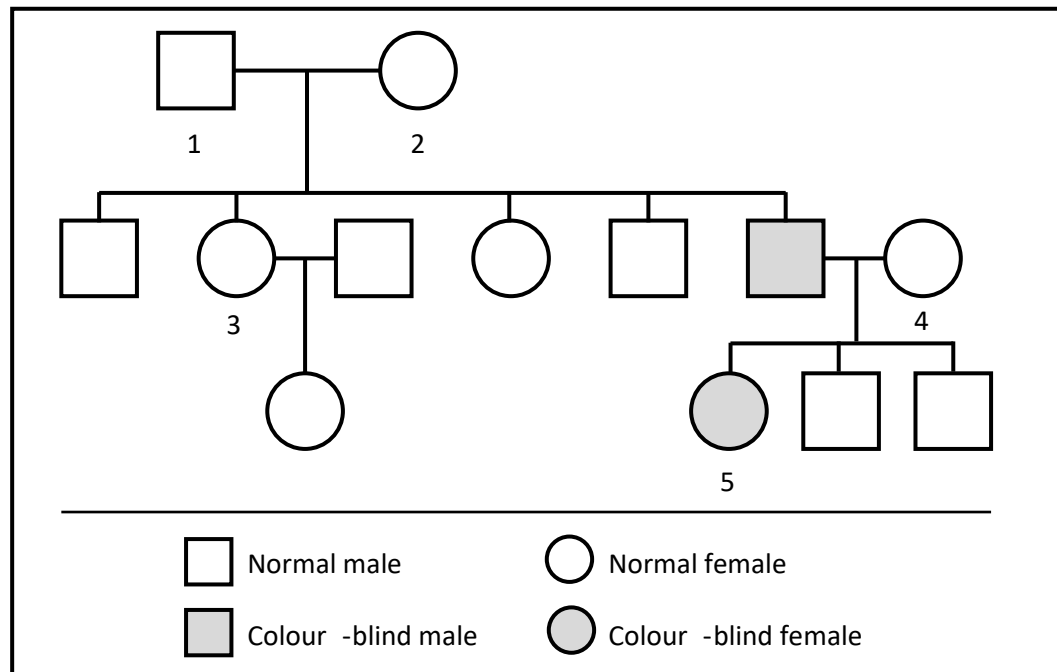
b) **9** _____(1)

7.4 State the family relationship between individual **12** and individual **2**.

_____(1)
(6)

ACTIVITY 8

The pedigree diagram below shows the inheritance of colour-blindness (also called Daltonism) in a family. Colour-blindness is sex-linked and is caused by a recessive allele (**d**). The ability to see colour normally is caused by a dominant allele (**D**).



Inheritance of colour -blindness

8.1 How many of the male offspring of parents 1 and 2 were normal? (1)

8.2 What percentage of males in this pedigree diagram are affected? Show your workings. (2)

8.3 State the genotype of

a) Individual 2 _____ (1)

b) Individual 5 _____ (1)

8.4 If individual 5 marries a normal male, what percentage of their daughters will have an allele for colour-blindness, but will not be colourblind? (1)

(6)

❖ MUTATIONS

- A mutation is caused by a permanent change to the DNA of a cell.
- Mutations can be harmless, harmful or useful.

❖ GENETIC ENGINEERING OR MODIFICATION

- **Genetic engineering** or modification is the deliberate modification of **traits** of an organism by manipulating its genetic material using biotechnology.
- This can be **done in both plants and animals** and involve the use of **micro-organisms such as bacteria**.

❖ List steps involved in genetic modification:

- Desirable gene is identified✓
- It is extracted from a donor organism✓
- It is then inserted into another organism✓
- The organism displays the desired characteristics.✓

Example 1

When we want all plants that are drought resistant:

- Drought resistant gene is identified✓
- The gene is extracted from a donor plant with that gene.✓
- It is then inserted in a crop plant.✓
- The crop plant becomes resistant to drought✓
- The crop plant is then planted to produce more crops that are drought resistant.✓

❖ State the advantages of genetic modification(benefits)

- Produce medication and other resources faster.✓
- Increases crop yield in plants✓
- Improves the quality of human life✓

❖ State the disadvantages of genetic modification(against)

- it is an expensive process✓
- Humans are interfering with nature✓
- Potential health impacts are unknown✓

- People may be allergic to the inserted gene✓
- The possibility of error is great as the process is complex.✓

❖ **CLONING**

- Is the production of individuals which are genetically **identical** to the one from which is was produced. E.g cows, sheep, rabbits may be cloned.✓

❖ **Describe the procedure involved in cloning: e.g in sheep**

- The ovum from sheep A is removed by surgery(less wool)
- The haploid nucleus of this ovum from sheep A is removed(n)less wool
- A diploid somatic cell from sheep B is removed (2n)more wool
- The nucleus of this cell from sheep B is carefully removed(2n)more wool
- The nucleus of sheep B is inserted into the ovum of sheep A(electric shock)
- Then, the ovum(**blastocyst stage**) with diploid number of chromosomes is inserted back into sheep A.

❖ **Briefly describe the process of cloning.**

- The nucleus of an ovum is removed ✓and replaced with
- the nucleus of a somatic donor cell/✓diploid donor cell
- The zygote is stimulated✓
- for mitosis✓to occur
- The embryo is then placed into the uterus of an adult female✓

OR

- Plants may be cloned by vegetative reproduction✓/asexual reproduction /tissue culture/grafting
- A plant with the desired characteristics is selected✓
- A vegetative part of the “parent” plant structure is removed✓/(examples) and placed inside a growth medium✓/(examples) and allowed to grow

❖ STEM CELLS

- Are undifferentiated cells that have the potential to differentiate to form any tissue or organ in the body. ✓

Sources of stem cells

- Embryos/Blastocysts ✓ can form any cell in the body
- Umbilical cord/Placenta ✓
- Bone marrow ✓
- Menstrual blood ✓

Uses of stem cells

- to replace damaged cells ✓
- to treat certain genetic disorders ✓
- spinal cord injury, heart disease ✓

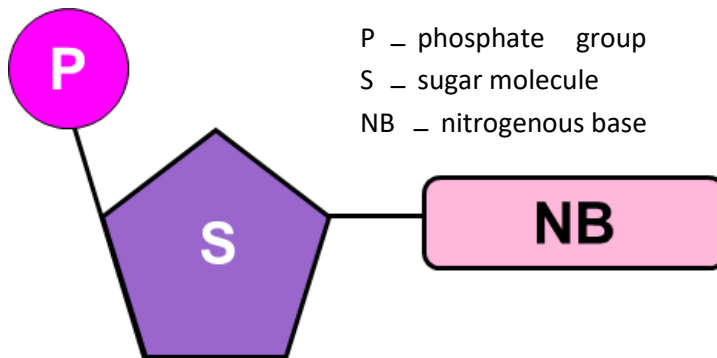
DNA – CODE OF LIFE

❖ **Name TWO types of nucleic acids**

- DNA ✓
- RNA ✓

❖ **State the monomers of nucleic acids**

- Nucleotides ✓
- The basic structure of a nucleotide is made up of a phosphate (P), a sugar molecule (S) and a nitrogenous base (NB).



DNA MOLECULE

❖ **State the natural shape of DNA molecule**

- Double helix ✓

❖ **Describe the location DNA**

- The DNA is located in the nucleus✓, mitochondria✓ and chloroplast✓

❖ **Describe the structure of DNA**

- DNA is a nucleic acid ✓
- It has a double stranded ✓
- consisting of building blocks called nucleotides ✓

The three components of a nucleotide are as follows:

- Nitrogenous bases ✓
- Phosphate portion ✓
- Deoxyribose sugar portion ✓
- 4 nitrogenous bases are A,T,C,G ✓ of DNA:
- adenine (A) bonds with thymine (T) ✓
- cytosine (C) bonds with guanine (G) ✓
- by weak hydrogen bonds ✓

❖ **Describe the functions of DNA**

- Sections of DNA carry/pass hereditary ✓ information (eye colour, Height etc)
- DNA contains coded information for protein synthesis ✓

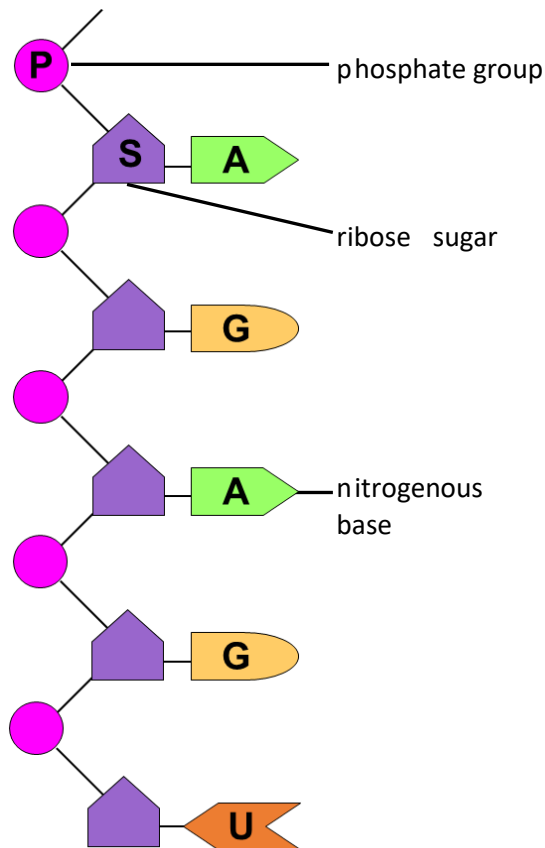
RNA MOLECULE

❖ **State two types of RNA**

- messenger RNA (mRNA) ✓
- transfer RNA (tRNA) ✓

❖ **Describe the location RNA**

- mRNA is formed in the **nucleus** ✓ but then enters the cytoplasm where it attaches to ribosomes.
- tRNA is found freely in the **cytoplasm** ✓ of the cell.



❖ **Describe the structure of RNA in a cell**

- RNA is single stranded✓
- and is made up of nucleotides✓which comprise:
- ribose sugar ✓
- Phosphate group ✓
- nitrogenous bases✓which are
- adenine, uracil, guanine and cytosine✓/ (A, U, G and C)
- The phosphate group is attached to the ribose sugar✓
- and the nitrogenous base is attached to the ribose sugar✓
- Bases on RNA are arranged in triplets✓
- as codons on mRNA✓
- and anticodons on tRNA ✓

❖ **State the significance of RNA**

- Play a role in the process of protein synthesis (mRNA and tRNA✓)
- mRNA carries codons✓
- tRNA carries anticodons✓

❖ **Give the similarities between DNA and RNA**

- contain sugar molecules✓
- contain the nitrogenous bases adenine, guanine and cytosine✓
- play a role in protein synthesis✓

❖ **Tabulate FOUR main differences between DNA and RNA**

DNA	RNA
Double stranded molecule✓	Single stranded molecule✓
contains deoxyribose sugar ✓	contains ribose sugar ✓
contains the nitrogenous base thymine ✓	contains the nitrogenous base uracil ✓
has weak hydrogen bond✓	no weak hydrogen bonds✓

❖ **State TWO differences between a DNA nucleotide and an RNA nucleotide**

DNA	RNA
Has deoxyribose sugar ✓	Has ribose sugar✓
Has nitrogen base thymine (T)✓/ A, C, G and T	Has nitrogen base uracil(U)✓/ A, C, G and U

❖ **Describe the discovery of DNA molecule**

- DNA was first identified in 1869 by Swiss chemist Friedrich Miescher.
- In 1953 **James Watson and Francis Crick** discovered the structure of DNA
- **Rosalind Franklin's** X-ray produced a double-helix structure of DNA

DNA REPLICATION eg unreplicated chromosome to have enough DNA to pass from parents to offspring

❖ **Name the process by which DNA molecule makes the copies of itself**

- DNA replication ✓

❖ **When in the cell cycle it takes place? (phase)**

- Interphase ✓

❖ **Where in the cell it takes place?**

- Nucleus ✓

❖ **Describe the process of DNA replication**

- The double helix DNA unwinds ✓
- Double stranded DNA unzips as the weak hydrogen bonds break to form two separate strands ✓
- Each original DNA strand serves as a template ✓
- Using free DNA nucleotides from the nucleoplasm ✓
- a new DNA strand onto each of the original DNA strands ✓
- by attaching to their complementary ✓ nitrogenous bases/(A to T, and C to G)
- this results in two identical DNA molecule ✓

❖ **Significance of DNA replication**

- Doubles genetic information so it can be shared between the resulting daughter cells during cell division ✓
- Ensures that each daughter cell has identical DNA composition to the mother cell ✓
- Ensures that each daughter cell contains the same number chromosomes as the mother cell ✓

❖ **Describe how an error in DNA replication may lead to a gene mutation**

- If the incorrect nitrogen base ✓ attaches to the original strand/if a nitrogen base is added or deleted
- the sequence ✓/order of the bases change on the new DNA molecule
- resulting in a change in the gene structure ✓

DNA PROFILING

❖ Define DNA replication

- A method of identifying an individual by comparing his or her DNA profiles with the other known DNA profiles✓
- DNA can be extracted from body tissue✓, hair✓, body fluids such as blood, semen✓ or saliva✓

❖ DNA profiles for three different individuals



❖ State TWO other uses of this technique.

- To investigate crimes✓/resolve disputes
- To identify organisms from their remains✓
- To identify family relationships other than paternity✓ e.g. siblings or cousins
- To test for the presence of specific alleles✓/genes that cause a genetic disorder
- To establish matching tissues for organ transplants✓
- for paternity testing✓

❖ **Give ONE reason why this evidence may be considered reliable.**

- Everybody, except for identical siblings, has a unique DNA profile✓

❖ **Give TWO views against the use of DNA profiling**

- Samples containing DNA can be planted/person was framed✓
- Human error✓during DNA profiling process
- Costly procedure✓
- Can reveal privacy (such as presence of a particular disease)✓

❖ **Describe how DNA profiling are used in paternity testing**

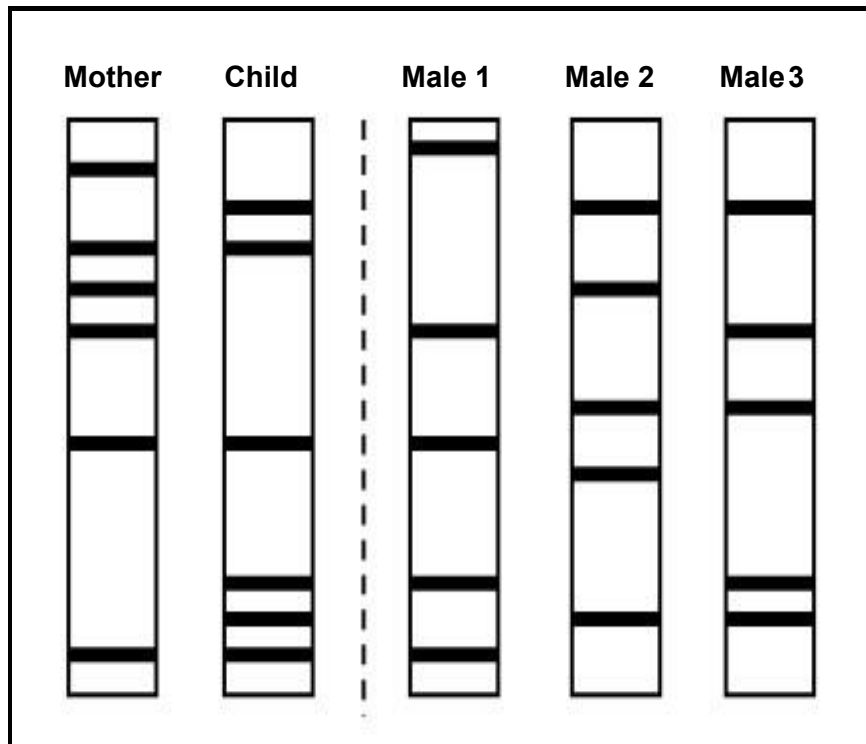
- A child received DNA from both parents✓
- The DNA profiles of the mother, child and the possible father are determined✓
- A comparison of the DNA bands of the mother and the child is made ✓
- The remaining DNA bands are compared to the possible father's DNA bands✓

If all/most of the remaining DNA bands in the child's profile match the possible father's DNA bands✓

- then the possible father is the biological father✓
- If all the remaining DNA bands in the child's profile does not match the possible father's DNA bands✓
- then the possible father is not the biological father ✓

❖ Paternity testing

The diagram below shows a technique used in paternity testing.



1.1 Identify the technique shown above. (1)

DNA profiling✓

1.2 Which male is the biological father of the child? (1)

Male 3✓

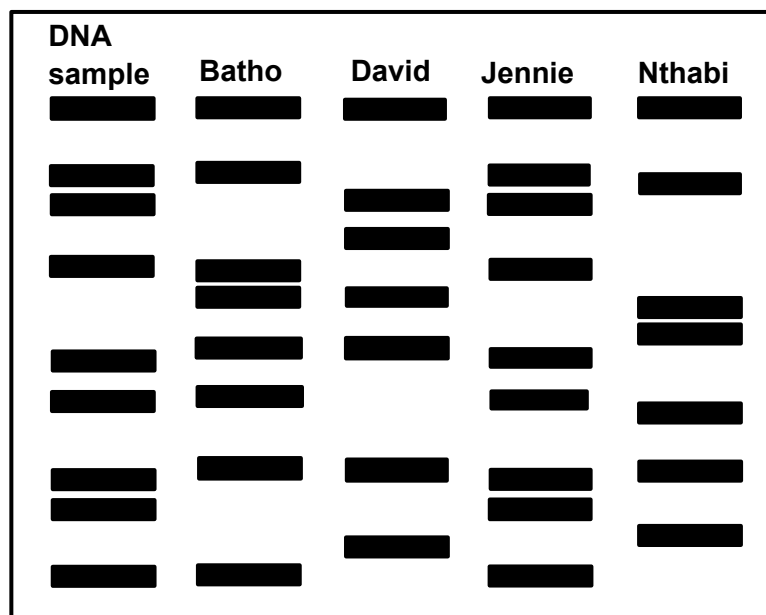
1.3 Explain your answer to QUESTION 1.2. (3)

- The bands of the child's DNA is a combination of the DNA from each parent ✓
- Three bands are identical to that of the mother✓
- The remaining three bands correspond with that of male 3✓

❖ **Investigating a crime scene**

Detectives were investigating a crime scene and found blood on a broken window. They suspected that the blood was that of the criminal. To identify the criminal, they analysed a DNA sample from the blood and compared it to that of four suspects.

The diagram below was produced:



2.1 Name the technique that was used to identify the criminal. (1)

DNA profiling✓

2.2 Who is the possible criminal? (1)

Jennie✓

2.3 Explain your answer to QUESTION 2.2. (2)

- Most Jennie's DNA profiles✓/ bands
- match the DNA profiles/ bands of the sample✓from the crime scene

PROTEIN SYNTHESIS

- Proteins are organ compounds required by living organisms to grow and repair damaged tissues.
- **Enzymes** and **hormones** are proteins
- A protein consists of **50 or more** amino acids
- The building blocks of proteins are **amino acids**.

❖ **State TWO stages/processes/phases of protein synthesis**

- **Transcription**✓ takes place in nucleus to form mRNA
- **Translation**✓ takes place in the ribosome and cytoplasm

❖ **Describe the process of transcription.**

(6)

- The double helix DNA unwinds✓
- Double stranded DNA unzips as the weak hydrogen bonds break to form two separate strands✓
- to form two separate strands✓
- One strand is used as a template✓
- to form mRNA✓
- using free RNA nucleotides from the nucleoplasm✓
- The mRNA is complementary to the DNA✓
- The coded message for protein synthesis is thus copied onto mRNA✓

❖ **Tabulate FOUR differences between the process of DNA replication and transcription**

DNA Replication	Transcription
Two DNA strands are used as template✓	One DNA strand is used as template ✓
Free DNA nucleotides join ✓ to DNA template	Free RNA nucleotides join ✓ to DNA template
Whole DNA unwinds ✓	A part of DNA unwinds ✓
A pairs with T ✓	A pairs with U ✓

❖ **Describe the process of translation in protein synthesis. (5)**

- The anticodon on the tRNA matches the codon on the mRNA✓
- tRNA brings the required amino acid✓
- to the ribosome✓
- amino acids are joined by peptide bonds ✓
- to form the required protein✓

❖ **Describe the role of tRNA in translation**

- Each tRNA carries a specific amino acid✓
- to the codon on the mRNA / ✓ribosome

Describe the involvement of the different types of RNA in protein synthesis (8)

- mRNA✓ forms
- during transcription✓/by copying the coded message from DNA
- and moves out of the nucleus✓
- and attaches to the ribosome✓
- During translation✓
- the anticodon matches the codon✓
- tRNA✓
- brings the required amino acid✓ to the ribosome
- Amino acids become attached by peptide bonds✓
- to form the required protein✓

❖ **Describe how a gene mutation may influence the structure of a protein**

- A mutation is a change in the nucleotide/nitrogenous base sequence✓
- of a DNA molecule✓/a gene
- since mRNA is copied from the DNA molecule✓
- during transcription✓
- This will result in a change in the codons✓
- As a result, different tRNA✓ molecules
- carrying different amino acids✓ will be required
- The sequence of amino acids changes✓

❖ **Describe how a gene mutation may result in the formation of a protein that is different from the one that is required.**

- A gene mutation affects the sequence of nitrogen bases✓/ change in the individual nitrogen bases in DNA ✓
- This changes transcription✓
- Resulting in a changed mRNA✓/codon
- As a result, different tRNA✓ molecules
- carrying different amino acids✓ will be required
- The sequence of amino acids changes✓
- resulting in the formation of a different protein✓
- If the same amino acid ✓is coded for there will be no change✓in the protein structure

Base pairing

Pairing bases of DNA: A with T or T with A and C with G or G with C

Pairing bases of RNA: A with U or U with A and C with G or G with C

DNA base triplet	mRNA codons	tRNA anticodons	amino acid
		AGC	serine
		GAU	aspartate
		CUA	leucine

Fill in the codons and anticodons below:

Base triplet number	1	2	3	4	5	6	7
Human DNA sequence	ATG	TGT	CCA	TTA	ACG	TGC	ACA
mRNA codons							
tRNA anticodons							

Example:

2. The table below shows a partial DNA sequence from a human, as well as a codon table that can be used to determine which amino acids are required to make a protein.

Base triplet number	1	2	3	4	5	6	7
Human DNA sequence	ATG	TGT	CCA	TTA	ACG	TGC	ACA

CODON TABLE	
Valine	GUU, GUG, GUA
Cysteine	UGU, UGC
Proline	CCA, CCU
Leucine	UUG, CUC, CUG, UUA
Threonine	ACG, ACA
Tyrosine	UAC, UAU

2.1. Name the codon that is formed from base triplet number 2 on the **DNA**

sequence.

(1)

- ACA ✓

2.2 Write down the names of the amino acids coded for by base triplets 6 and 7.

Threonine✓; Cysteine✓ (must be in correct order)

(2)

2.3 If a mutation changes base triplet 1 from ATG to ATA, why will this not change the protein formed?

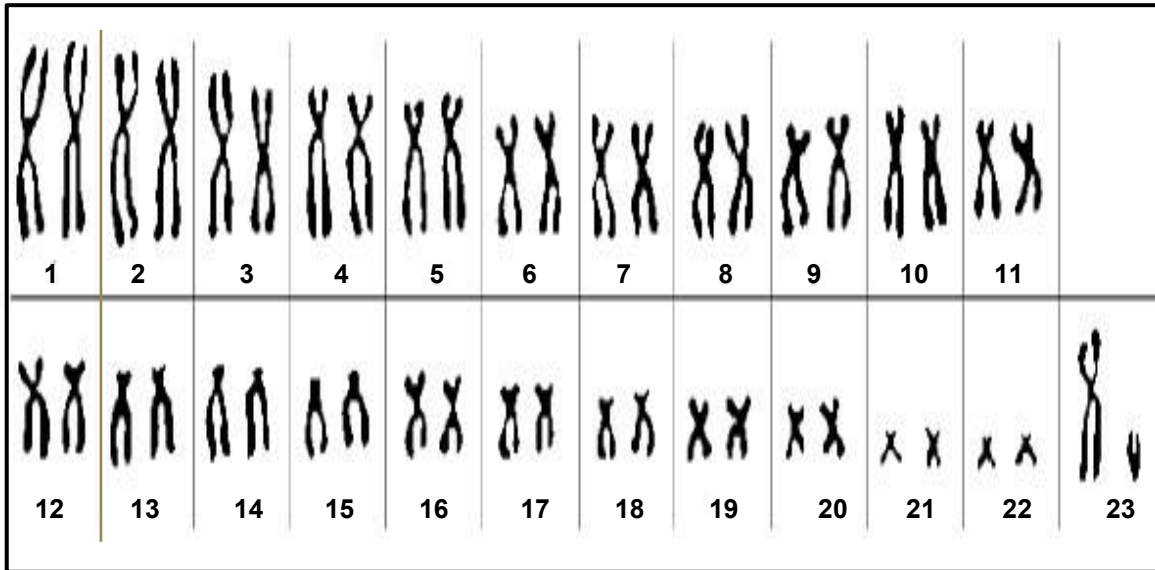
(2)

- Both ATG and ATA✓
- Code for the same amino acid/tyrosine✓

END!

MEIOSIS

❖ Interpretation of the human karyotype



❖ Describe the composition of the human karyotype.

- There are 23 pairs✓/46 chromosomes in
- human somatic cells✓/body cells
- which are arranged into homologous pairs✓
- Each somatic cell has 22 pairs/44 autosomes ✓and
- a pair/2 gonosomes ✓/sex chromosomes/ X and Y chromosome

- Autosomes are arranged in pairs from largest to smallest ✓ in a karyotype
- Males have XY chromosomes✓
- Females have XX chromosomes✓
- The X chromosome is larger than the Y chromosome ✓

❖ **Identify the type of chromosomes numbered 1 to 22**

- Autosomes✓

❖ **State the characteristics of a male karyotype**

- There is Y-chromosome or XY chromosome✓
- At chromosome pair 23✓

❖ **State the characteristics of a female karyotype**

- There is XX-chromosomes✓
- At chromosome pair 23✓

❖ **State FIVE characteristics of homologous chromosomes**

- A pair of chromosomes that are similar in length✓
- Have the same centromere position✓
- One is obtained from each parent✓
- Carry genes for the same characteristics✓
- Have alleles at the same loci✓

❖ **State the origin of each chromosome in a homologous pair of chromosome**

- One comes from the male parent✓ and the other comes from the female parent.✓
OR one comes from the sperm cell✓ and the other comes from the ovum.✓

❖ **Revision of the process of mitosis**

- Mitosis is the cell division that occurs on the body cell that help to produce two genetically identical daughter cells
- Original parent cell divides to form two new daughter cells
- Daughter cells are identical to each other and to the original parent cell
- These daughter cells contain the same number of chromosomes as the parent cell
- Chromosomes are not in homologous pairs

THE PROCESS OF MEIOSIS

❖ Define Meiosis

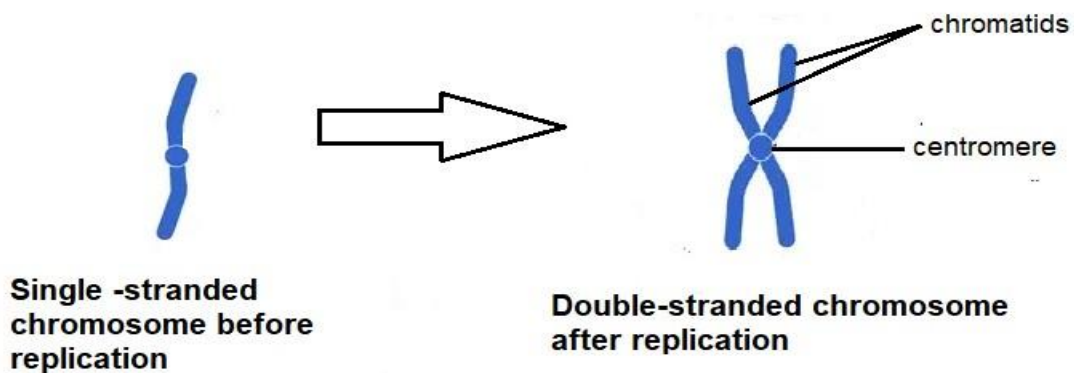
- Meiosis is a type of cell division that results in the formation of four daughter cells each with half the number of [chromosomes](#) of the parent cell.
- Meiosis leads to the production of [gametes](#) (Sperm cells and egg cells) in both animals and plants.

❖ State the site of meiosis in plants and in animals

In Plants	In Animals
- Ovules - Anthers	- Ovaries - Testes

❖ Describe the events of interphase:

- DNA replication takes place
- Chromosomes which are single threads, become double
- Each chromosome will now consist of two chromatids joined by a centromere
- DNA replication helps to double the genetic material so that it can be shared by the new cells arising from cell division



❖ **State the different phases of meiosis I and II**

PMAT

- Prophase I and II
- Metaphase I and II
- Anaphase I and II
- Telophase I and II

MEIOSIS I

❖ **Describe the events that take place in Prophase I** (3)

- Each chromosome shortens and becomes visible✓
- as two chromatids ✓
- joined by a centromere ✓
- Homologous chromosomes come to lie next to each other✓

❖ **Describe the events that take place during crossing over** (3)

- The chromatid of each homologous chromosome✓
- Overlap each other✓
- At the point called chiasma✓
- To exchange genetic material✓
-

❖ **Describe the events that take place in Metaphase I** (3)

- The chromosomes line up along the equator✓
- in homologous pairs✓
- attached to the spindle fibres✓

❖ **Describe the events that take place in anaphase I** (3)

- The spindle fibres contract✓
- The chromosomes are pulled to opposite poles✓
- Attached to spindle fibres✓

❖ **Describe the events that take place in telophase I** (3)

- There are two cells formed containing half chromosome number✓
- Chromosomes have reached the opposite poles of the cell✓
- The cytoplasm and nucleus divides ✓

MEIOSIS II

❖ **Describe the events that take place in Prophase II** (2)

- Each cell formed during meiosis I now divides again.✓
- A spindle fibres form in each of the new cells.✓

❖ **Describe the events that take place in metaphase II** (3)

- Single chromosomes✓
- Are arranged at the equator of the cell✓
- With centromeres attached to the spindle fibres✓

❖ **Describe the events that take place in anaphase II** (3)

- The spindle fibres contract✓
- The centromeres split✓
- and pull the daughter chromosomes✓/chromatids
- to the opposite poles of the cells✓
- Cytokinesis begins✓

❖ **Describe the events that take place in telophase II** (2)

- Four haploid daughter cells are formed✓
- Each cell contains has half number of chromosomes✓
- Chromatids reached the poles✓
- **Cytokinesis occurs** is the division of the cytoplasm✓
- **Karyokinesis** is the process of division of the nucleus of a cell✓

POSSIBLE EXAM QUESTIONS

❖ **Tabulate TWO differences between prophase I and prophase II** (4)

Prophase I	Prophase II
The cell is diploid✓/has homologous chromosomes	The cell is haploid✓/does not have homologous chromosomes
Crossing over takes place✓	No crossing over takes place✓

❖ **State ONE difference between metaphase I and metaphase II.** (2)

- In metaphase I, the chromosomes arrange at the equator in homologous pairs✓
- whereas in metaphase II, the chromosomes arrange at the equator singly✓

❖ **State TWO differences between Anaphase I and Anaphase II.** (4)

- In anaphase I, the chromosomes are pulled to opposite poles✓
- While in anaphase II, the chromatids are pulled to opposite poles✓
- In anaphase I, the centromere does not split✓
- In anaphase II, the centromeres split✓

❖ **State ONE difference between telophase I and telophase II.** (2)

- In telophase I, two haploid daughter cells are formed✓
- While in telophase II, four haploid daughter cells are formed✓

❖ **State THREE significance of meiosis** (3)

- Production of haploid gametes ✓
- Halving effect overcomes the doubling effect of fertilization, thus, maintaining a constant chromosome number✓
- Introduces variation in living organisms✓

❖ **Name ONE place in a human male where meiosis takes place.** (1)

- Testes✓

❖ **Name ONE place in a human female where meiosis takes place.** (1)

- Ovary✓

❖ **State the importance of crossing over.** (1)

- Crossing over introduces genetic variation✓ in gametes

❖ **Explain the importance of crossing over.** (2)

- Crossing over introduces genetic variation✓ in gametes
- It may lead to new characteristics which are favourable✓
- or new characteristics which are unfavourable✓
- therefore, affecting the chances of survival of the organism✓ / natural selection.

❖ **Describe how meiosis lead to variation.** (6)

- In **prophase 1** of meiosis✓
- Crossing over occurs✓
- Between homologous chromosomes✓
- Resulting in the exchange of genetic material✓
- Leading to chromosomes with a mixture of maternal and paternal genetic material✓
- In **metaphase 1** or 2 of meiosis✓
- Random arrangement of chromosomes occur✓
- Leading to chromosomes moving into gametes in different combinations✓

❖ **Name TWO processes that would cause genetic variation during meiosis**

- Crossing over✓
- Random arrangement of chromosomes✓ (2)

❖ **Explain why the homologous chromosomes in meiosis have a mixture of genetic material from each chromosome.**

- Crossing over has taken place✓ **what happened ?**
- and genetic material was exchanged ✓ **effect of change** (2)

❖ **State THREE similarities of mitosis and meiosis****(3)**

- Forms daughter cells from the parent cell✓
- Takes place in the nucleus✓
- Stages of cell division are prophase, metaphase, anaphase and telophase✓

❖ **Tabulate FOUR differences between mitosis and meiosis**

MITOSIS	MEIOSIS
- Takes place in somatic cells✓	- Takes place in sex cells✓
- The nucleus divides once✓	- The nucleus divides twice✓
- Two daughter cells are formed from one parent cell.✓	- Four daughter cells are formed from one parent cell✓
- Daughter cells are identical to one another and to the parent cell✓	- Daughter cells are genetically different to one another and to the parent cell✓
- Chromosome number remain constant✓	- Chromosome number is halved✓
- Chromosomes do not pair✓	- Homologous chromosomes pair✓
- Crossing over does not occur✓	- Crossing over occurs✓
- Single chromosomes lie at the equator in metaphase✓	- Homologous chromosomes lie at the equator in metaphase I✓
- Centromere splits in anaphase✓	- Centromere does split in anaphase I✓
- Chromatids move to opposite poles✓	- Whole chromosome of each homologous pair moves to opposite poles✓

❖ **Abnormal meiosis**

- Sometimes there are errors during the process of meiosis.
- These errors lead to chromosomal abnormalities
- Chromosomal abnormalities occur more often during oogenesis than during spermatogenesis.
- Also occur more often when the woman gets older

❖ **Describe how non-disjunction during meiosis occurs in human cell and consequences (general) (6)**

- Non-disjunction occurs when chromosomes do not separate ✓
- during anaphase ✓
- During anaphase I a single pair of homologous chromosomes do not separate ✓
- Or during anaphase II chromatids do not separate ✓
- One gamete will receive two ✓ copies of the same chromosome
- While the other gamete will receive none ✓
- If fertilisation ✓ occurs between the abnormal gamete and a normal gamete
- the resulting cell / zygote will have one less chromosome ✓
- Or the zygote may have an extra chromosome ✓

❖ **Describe the events that led to Down syndrome. (6)**

- Non-disjunction occurred ✓ / A homologous pair of chromosomes failed to separate
- at position 21 ✓
- during Anaphase I or II ✓
- resulting in one gamete with 24 chromosomes ✓ / an extra chromosome / 2 chromosomes at position 21
- The fertilisation of this gamete with a normal gamete ✓ / gamete with 23 chromosomes / 1 chromosome at position 21
- results in a zygote with 47 chromosomes ✓
- There are 3 chromosomes ✓ / an extra chromosome at position 21 / leading to Down syndrome

END!