JENN
Training and Consultancy
The path to enlightened education

Province of the
EASTERN CAPE
EDUCATION

LIFE SCIENCES

GRADE 12

WINTER CLASSES

Topics: Genetics
Theories of Evolution
Human Evolution

TEACHER AND LEARNER CONTENT MANUAL

Suggested modified programme due to repetition of genetics which was covered during Autumn Vacation Classes.

Genetics Pre- Test Marks decreased to 50 marks, questions testing the same skill were removed.

Genetics and inheritance **P2**	**48 marks**	**Day 1**	1. **Pre – Test on genetics** 2. **Blood grouping, interpretation of pedigree diagram,**
		Day 2	3. **Interpretation of pedigree diagram** 4. **Dihybrid cross**
		Day 3	5. **Biotechnology and genetic lineage, mutations** 6. **Post- test on genetics**
EVOLUTION **P2**	**54 marks**	**Day 4**	1. **Evidence for evolution** 2. **variation**
		Day 5	3. **Origins of ideas** (Darwin, Lamarck, **punctuated equilibrium**), 4. **Artificial selection**, **differences between artificial selection and natural selection**
		Day 6	5. **Speciation** 6. **Reproductive isolation- mechanism**
		Day 7	7. **evolution in present times** 8. **Differences and similarities between human and other primates**
		Day 8	9. **Evidence of common ancestors** (Bipedalism, brain size, teeth, prognathism, palate, cranial ridges, brow ridges) Main **fossil sites in SA**
		Day 9	10. **Out of Africa hypothesis** (Ardipithecus, Australopithecus & sites where they were found) 11. **ASSESSMENT (FORMAL)**
		Day 10	12. **Feedback on formal assessment in evolution**

CONTENT   PAGE

GENETICS AND INHERITANCE Paper 2: 48 marks	Term 1 & 2	3½ weeks

Blood grouping	❑ Different blood groups are a result of multiple alleles
	❑ The alleles I^A, I^B and i in different combinations result in four blood groups
	❑ Genetics problems involving the inheritance of blood type
Dihybrid crosses	❑ 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.
	❑ Dihybrid genetics problems
	❑ Determination of the proportion/ratio of genotypes and phenotypes
Genetic lineages/pedigrees	❑ A genetic lineage/pedigree traces the inheritance of characteristics over many generations
	❑ Interpretation of pedigree diagrams

A. BLOOD GROUPINGS AS THE RESULTS OF MULTIPLE ALLELES

In an exam you may be asked to do other sex-linked disorders other than haemophilia and colour-blindness. DO NOT make a disease sex-linked unless they TELL YOU it is sex-linked.

Both gene alleles are equally dominant so the heterozygous individual expresses both traits, example: blood groups. Protein **A** and protein **B** are coded by alleles **A** and **B**. If no protein **A** or **B** is present, then these cells will be coded by the allele **O**. This means that there are **three** possible alleles for this **one** gene **locus** in humans. When there are **mor**e than **two** possible alleles, it is termed **multiple alleles**. Any two of these alleles will occur in combination in an individual. The alleles **A** and **B** are **co-dominant** and **A** and **B** completely dominate allele **O**. When two individuals with **AB** blood type have children, the children can be type **A**, type **B** or type **AB**.

Phenotype/Blood type	Genotype	Can receive blood from:
A	$I^A I^A$	A or O
A	$I^A i$	
B	$I^B I^B$	B or O
B	$I^B i$	
AB	$I^A I^B$	A, B, AB or O (also known as the **universal acceptor** because blood group AB can <u>accept</u> blood from any other group)
O	$i \, i$	O (also known as the **universal donor** because any blood group can <u>receive</u> O blood)

B. CO-DOMINANCE IN HUMANS:

Homozygous dominant = $I^A I^A$ (blood group **A**)

Homozygous recessive = $I^B I^B$ (blood group **B**)

Heterozygous = $I^A I^B$ (blood group **AB**)

C. USE OF BLOOD TESTS IN PATERNITY TESTS

• The blood groups of the mother, possible father and child must be compared.

• If the blood groups of the adults do not correspond to or match the child's blood group then this man is not the father.

• If the blood groups of the adults correspond to or match the child's blood group, Then there is a possibility that the man is the father, and other tests need to be done as other men may have the same blood group.

• Only DNA profiling can be conclusive as it looks at the similarities between the nucleotides in the DNA of the father and the child.

• Each DNA profile is unique to an individual.

• 50 % of the DNA fragments / bands / bars are derived from the mother and 50 %. from the father.

• If 50 % of the DNA fragments / bands / bars correspond with the father, then it can be claimed that he is the father of the child.

• DNA is viewed as more reliable evidence of paternity than the use of blood groups.

D. EXAMPLE OF A MONOHYBRID CROSS USING BLOOD TYPES

*A man and a woman both have blood group **B**. Use a genetic cross to show how itis possible for them to have a child with blood group **O**.*

P₁	Phenotype	Blood group B	x	Blood group B
	Genotype	$I^B i$	x	$I^B i$

Meiosis — Gametes: I^B i x I^B i

Fertilisation

F₁	Genotype	$I^B I^B$	$I^B i$	$I^B i$	ii
	Phenotype	3 Blood group B : 1 Blood group O			

OR

P₁	Phenotype	Blood group B	x	Blood group B
	Genotype	$I^B i$	x	$I^B i$

Meiosis — Gametes: I^B i x I^B i

Fertilisation

Gametes	I^B	i
I^B	$I^B I^B$	$I^B i$
i	$I^B i$	ii

F₁	Phenotype	3 Blood group B : 1 Blood group O
	Genotype	$I^B I^B$ $I^B i$ $I^B i$ ii
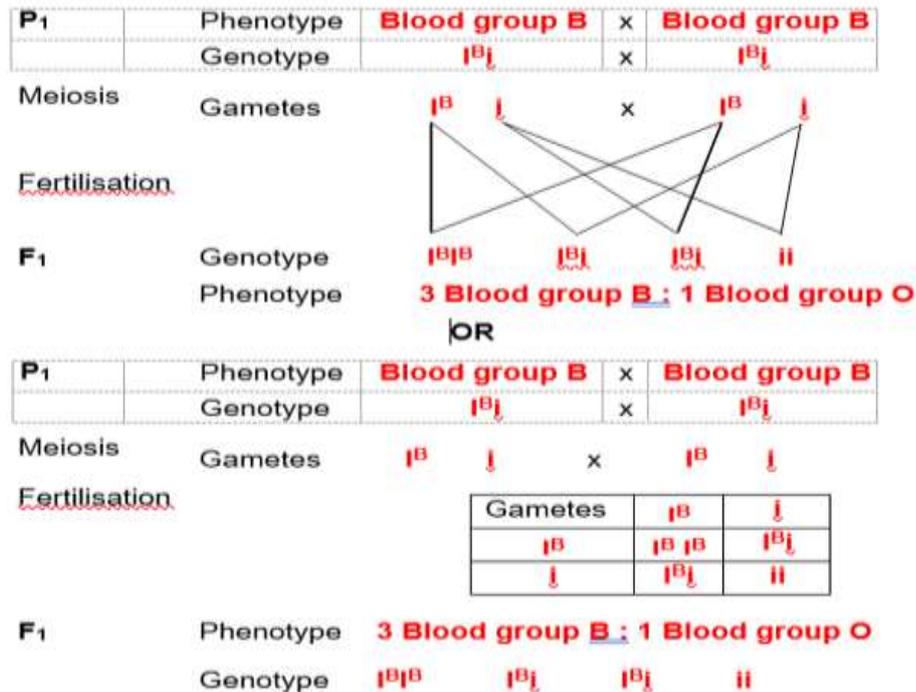
ACTIVITY A

1. Two newborn babies were accidentally mixed up at the hospital. In an effort to determine the correct parents of each baby, the blood types of the babies and the parents were determined as follows:

Baby 1 – type O	Baby 2 – type A
Mr Smith – type AB	Mrs Smith – type B
Mr Jones – type B	Mrs Jones – type B

1.1.1. Who are the parents of Baby 2? (2)

1.1.2. Provide evidence for your answer in 1.1.1 by showing your working in a Punnett square. (6)

[Remember: Blood group is a result of multiple alleles and is an example of co-dominance. A and B are equally dominant and will dominate over O. Blood type O can only occur if both alleles are recessive = 'OO']

(8)

2. Where is DNA found? (2)

2.1.1. What are the constituent groups of molecules that form the nucleotides? (3)

2.1.2. Name the pyrimidines and purines of DNA and RNA. (6)

2.1.3. Name the mRNA produced by each of the following strands of DNA:

a) **A A C G G C T A T** (1)

b) **C C G T A A C G A A T T** (1)

c) **G C G A A T T C A** (1)

(14)

3. A child is born out of wedlock and the mother wants to find out who is the father of the child. Using the DNA fingerprints below determine who the father of the child is. Explain your answer. (3)

[Hint: Remember to **ALWAYS** use a ruler horizontally across the strands so that you do not make a mistake when comparing the **VNTR** markers. Place a mark next to each **VNTR** marker that corresponds]

Mother   Child   Male 1   Male 2
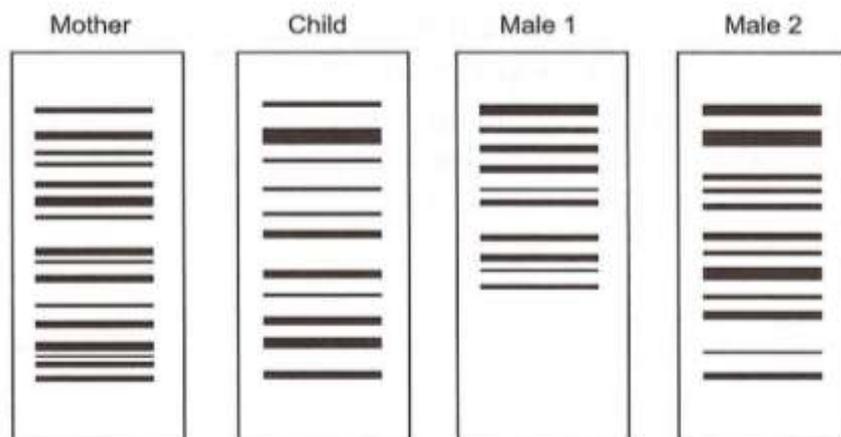
E. HOW TO TACKLE ANSWERING PEDIGREE DIAGRAM QUESTION

Generation

Female with blonde hair

Male with blonde

Female with brown

Male with brown
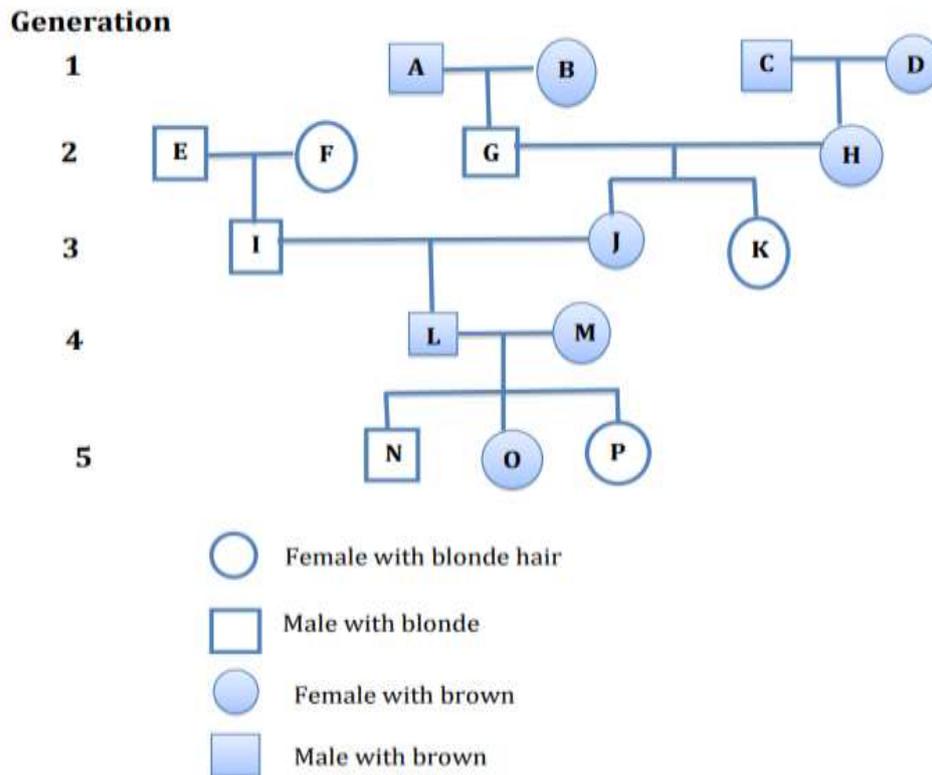
Analysing the genetic lineage in a pedigree diagram:

Step 1: Mark all the homozygous recessive individuals with blonde hair.

This will be all the white shapes: E, F, G, I, K, N and P as bb on the pedigree

chart.

Step 2: Work from the generation line 5 up towards the generation line 1 so that you

start with the last offspring on the pedigree diagram.

To produce an offspring with bb, BOTH parents must have at least one

homozygous recessive gene (b).

If the parent is a white shape – then the parent is bb and already marked.

If the parent is a shaded shape and produced a bb offspring, then the parent

Must be heterozygous Bb. Mark the Bb parents on the pedigree diagram.

Step 3: Parents that are shaded shapes and produce only shaded shape offspring,

can be homozygous BB or heterozygous Bb. Look to the next generation and

then work backwards. Mark the parents on the pedigree diagram.

Step 4: Answer the questions that relate to the pedigree diagram.

Try to work out the genotype of **A, B, C, D, H, J, L, M** and **O** on your own first.

Let us see if you were right:

- **A** and **B** are **Bb** because they produce **G (bb)**
- If **C** is **BB** then **D** must be **Bb** or **C** is **Bb** then **D** is **BB** because **H** must be **Bb** to
- produce **K (bb)**
- **J** is **Bb** because **G** is bb and **H** is **Bb** (produced sister **K - bb**)
- **L** and **M** are both **Bb** because parent **J** is **Bb** and **I** is **bb** so they cannot be
- homozygous **BB** AND **L** and **M**
- produce a son **(N)** and daughter **(P)** that are both homozygous **bb**
- Offspring **O** can be either **BB** or **Bb** because both parents are heterozygous **Bb**

ACTIVITY B

4. Haemophilia is a sex-linked hereditary disease that occurs as a result of a recessive allele on the **X-**chromosome. Study the family tree below and answer the questions that follow:

(Use the symbols **H** for normal and **h** for haemophilia above the sex chromosomes, for example.: $X^H X^h$)

Peter (haemophilia) — Susan (normal carrier)

Danelle (haemophilia)   Stefan (haemophilia)   Sue (normal carrier)
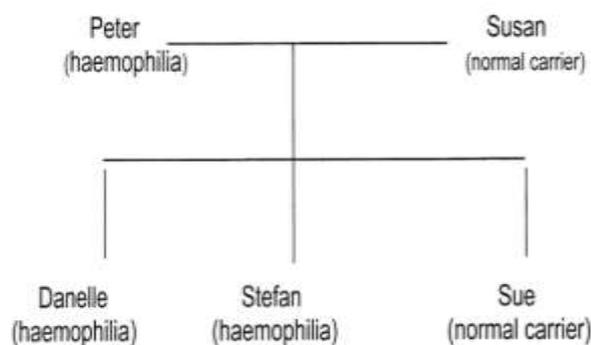
4.1. Write down the genotype of Stefan.   (2)

4.1. Peter and Susan would like to have a fourth child. Calculate the percentage probability of this child having haemophilia.   (6)

5. Study the diagram below, which shows three generations of snapdragon plants and answer the questions which follow. Use the following symbols for the contrasting alleles: **W** – for white flowers **R** – for red flowers [HINT: you have been told to use **W** for white flowers.

So a homozygous white flower will be **WW**. A homozygous red flower will be **RR.**

This means that a heterozygous flower will be **WR**.

Do NOT use any lower-case letter for the recessive gene because you have been provided with the symbols for the alleles. ONLY use the **W** and the **R**]

Diagram showing inheritance of colour of snapdragon flowers

KEY:

	Snapdragon with pink flowers
	Snapdragon with red flowers
	Snapdragon with white flowers
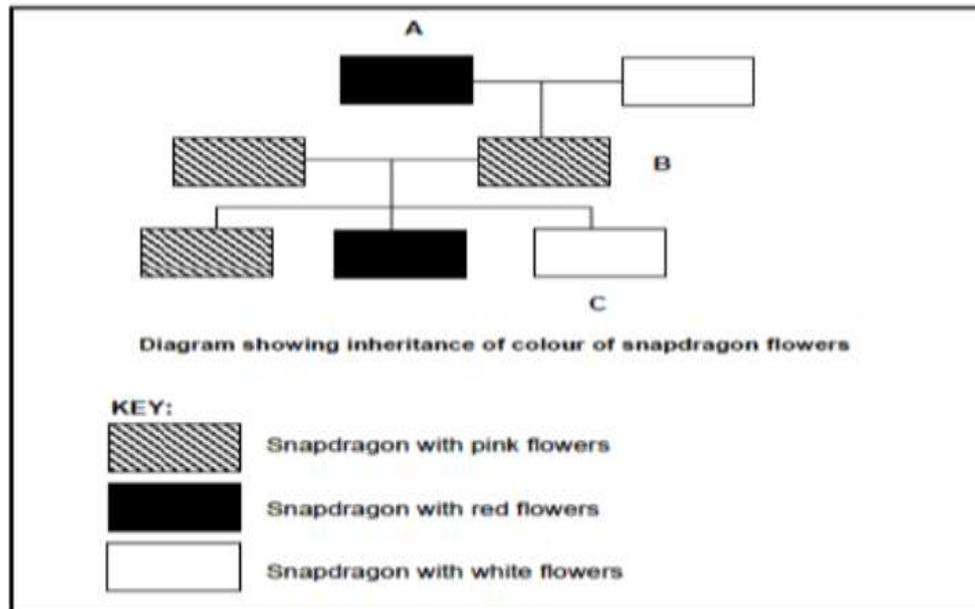
5.1 State the kind of dominance shown in the diagram above. (1)

5.2. Use the symbols **R** and **W** and write down the genotypes of each of the following snapdragon plants:

   a) A   (2)

   b) B   (2)

   c) C   (2)

           (7)

F. Dihybrid Cross

Dihybrid crosses involve **two pairs** of alleles representing **two different** characteristics,e.g.: the height of a plant and the colour of its seeds.

According to the Law 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.**

Work through the following example of a dihybrid cross and remember that the alleles for each characteristic could be either homozygous or heterozygous.

Example of a Dihybrid cross

- In pea plants, the allele for tallness (**T**) is dominant and the allele for shortness (**t**) is recessive. The allele for purple flowers is dominant (**P**) and the allele for white flowers is recessive (**p**). Two plants, heterozygous for both tallness and purple flowers were crossed.

- **Step 1**: Decide whether this concerns a monohybrid or a dihybrid cross.

  Since two characteristics of each plant are mentioned

  *(phenotypes: **height** of plant + **colour** of flower), it must be a dihybrid cross.*

- **Step 2:** Choose/ use letters to represent the alleles for the gene responsible for each characteristic.

  Let T = the allele for tall plants

  Let t = the allele for short plants

  Let P = the allele for purple flowers

  Let p = the allele for white flowers

- **Step 3**: Write down the phenotype of the two parents that would be producinggametes.
- *tall purple* X *tall purple* (as per question)
- **Step 4**: Write down the genotype of the parents.

<div align="center">

TtPp X TtPp

</div>

- **Step 5:** Show the gametes that each parent produces after meiosis. Eachgamete must have two letters (dihybrid) – one from each characteristic.

  N.B. Remember Mendel's Law of Independent Assortment.

<div align="center">

(**TP**) (**Tp**) (**tP**) (**tp**)   **X**   (**TP**) (**Tp**) (**tP**) (**tp**)

</div>

- **Step 6:** Draw and complete a punnet square by writing in the combination ofalleles in each block.

P1 Phenotype	**Tall, purple**	x	**Tall, purple**
Genotype	**TtPp**	x	**TtPp**
Meiosis			
Gametes	(TP)(Tp) (tP)(tp)	x	(TP)(Tp)(tP)(tp)

Fertilisation

Gametes	TP	Tp	tP	tp
TP	TTPP	TTPp	TtPP	TtPp
Tp	TTPp	TTpp	TtPp	Ttpp
tP	TtPP	TtPp	ttPP	ttPp
tp	TtPp	Ttpp	ttPp	ttpp

F1   Genotype   **9 different genotypes, as in the table above**

Phenotype   **9 tall, purple flowered plants**

3 short, purple flowered plants

3 tall, white flowered plants

1 short, white flowered plant

- **Step 7**: Determine the phenotypic ratios from the genotypes in the punnet square

   Phenotypic ratio: 9:3:3:1

If there is one capital letter for the allele in the **F1** generation, then that trait (characteristic) shows in the phenotype; if there are small letters then the recessive trait shows.

ACTIVITY C

1. Two characteristics of an animal (length of the ears and shape of the lip) were studied. Each of these characteristics has two variations: Ears may belong or short, and the lip may be a wide or pointed.

   A male animal homozygous for wide lips (**LL**) and heterozygous for short ears (**Ee**) is crossed with a female animal that is heterozygous for wide lips(**Ll**) and homozygous for long ears (**ee**).

1.1. What term describes a genetic cross involving two characteristics?   (1)

1.2. Give the

   a) dominant phenotype for the length of ears   (1)

   b) recessive phenotype for the shape of the lip   (1)

   c) possible genotype/s for an animal with short ears and a pointed lip   (1)

1.3. A male animal with genotype EELl is crossed with a female animal with genotype Eell.

a) List all the possible gametes that could be produced by the male animal.   (2)

b) Explain how Mendel's Law of Independent Assortment applies to parents with LIEe genotypes during gamete formation.   (4)

2. In humans the allele for short fingers (brachydactyly – a shortening of the fingers and toes), represented by **B**, is dominant over the allele for normal fingers (**b**). The allele for curly hair (**H**) is dominant over the allele for straighthair (**h**).Andrew, with genotype **Bbhh**, married Susan, with genotype **bbHh**.

2.1.How do Andrew and Susan's phenotypes differ from each other?   (2)

2.2.List all possible genotypes of the gametes produced by Andrew.   (2)

G. GENETIC ENGINEERING:

The process where scientists alter, swap or manipulate the genes on the DNA, to produce a different organism. Genetic engineering involves the transfer of genes from one organism to an unrelated species.

Diabetics are people who cannot produce their own insulin. Insulin is a hormone needed to regulate blood sugar. Biochemists have devised a way in which to produce artificial insulin. A similar process is used to genetically modify many different organisms. Make sure you know the basic process:

Bacteria produce restriction enzymes that 'cut' DNA molecules. These restriction enzymes are extracted from the bacteria.

- DNA is removed from a healthy person's pancreas cells.
- Restriction enzymes are used to 'cut' out a piece of DNA, which contains the genes that produce insulin.
- When the genes are transferred from one organism's cells to another, the DNA in the recipient cell is called recombinant DNA. Insulin is produced by using recombinant DNA in the bacterium called Escherischia coli (E. coli), which lives in the human gut.
- Plasmids are taken out of a bacterium and cut open with the restriction enzyme.

- The human genes are inserted into the plasmid.
- The healthy bacterium absorbs the plasmids.
- The piece of human DNA continues to produce proteins, which make insulin, inside the bacterium.
- The insulin is then extracted from the bacterium cell.
- Diabetics inject themselves with this insulin every day, so that they can regulate their blood sugar.

Advantages of GM crops	Disadvantages of GM crops
• Better nutritional value • Greater crop yield resulting in higher food production and long term reduction in costs • Crops are better adapted to less favourable environments and climates • Disease and pest resistant means less insecticides and pesticides are released into the environment • Increased biodiversity as new varieties are developed • Efficient use of scarce agricultural land as well as land that may	• Possible increase in allergen and carcinogen levels • Nutritional changes and possible toxicity • Traits can be transferred to other species like weeds • Cause un-natural selection pressure • Expensive start-up costs • DNA alteration of the new varieties are owned and controlled by biotechnology company which may lead to issues with ethics and ownership
previously not have been fit	• Lack of transparency regarding what is in our food

H. CLONING

- With cloning, the nucleus of a somatic cell **(2n)** of one organism is removed.
- An egg cell **(n)** is taken from an ovary.
- The nucleus of the egg cell is destroyed.
- The somatic cell's nucleus **(2n)** is then placed inside the egg cell.
- The egg cell is put back into a uterus where it is allowed to grow and differentiate into an embryo.
- When the baby is born, it is identical to the original organism.
- A sheep called Dolly was cloned successfully in 1997.

Advantages of Cloning	Disadvantages of Cloning
Produce individuals with desired traits	Objections to interfering with God's creation
Better yields	Reducing the gene pool by reducing variation
Resistant to diseases	Cloned organisms may have developmental problems
Organisms produced in a shorted time	Costly process
Saving endangered species	Generate experimental waste
Produce body parts/organs for transplant	May lead to killing clones for organs/body parts
Produce offspring when organisms are infertile	Cruelty to animals and inhumane behaviour

I.STEM CELL RESEARCH:

A stem cell is a cell that has the potential to regenerate multiple cell type tissue and self-renew so a stem cell is able to produce new cells over a long term by the process of mitosis.

Once mitosis occurs, the cells are able to differentiate into many different types of specialized cells and tissue.

Stem cells can be harvested from umbilical cord blood (once a baby has been born), a foetal blastocyst and bone marrow.

Stem cell therapy can be used to treat a variety of different human diseases:

- cancers like Leukemia

- degenerative diseases like Multiple Sclerosis

- diabetes mellitus where the pancreas no longer produces insulin

- muscle damage

- organ damage and

- certain genetic diseases in conjunction with gene therapy

Teaching Tool 1: Evidence of Evolution

EVOLUTION Paper 2: 54 marks	Terms 3	4weeks

CONTENT	ELABORATION
Introduction	❑ Definition of biological evolution change in the characteristics of species over time ❑ Difference between a hypothesis and a theory ❑ The Theory of Evolution is regarded as a scientific theory since various hypotheses relating to evolution have been tested and verified over time
Evidence for evolution	❑ Role of the following as evidence for evolution: • Fossil record – Link to Grade 10 • Biogeography – Link to Grade 10 • Modification by descent (homologous structures) • Genetics

Variation	❑ Definition of a biological species and a population
	
	❑ A review of the contribution of each of the following to variation that exists amongst individuals of the same species:
	• Meiosis
	   o Crossing over
	   o Random arrangement of chromosomes
	• Mutations
	• Random fertilisation
	• Random mating
	
	❑ Types of variation:
	• Continuous variation – those characteristics where there is a range of inter-mediate phenotypes, e.g. height
	• Discontinuous variation – those characteristics that fall into distinct catego-ries e.g., blood groups

Mind map
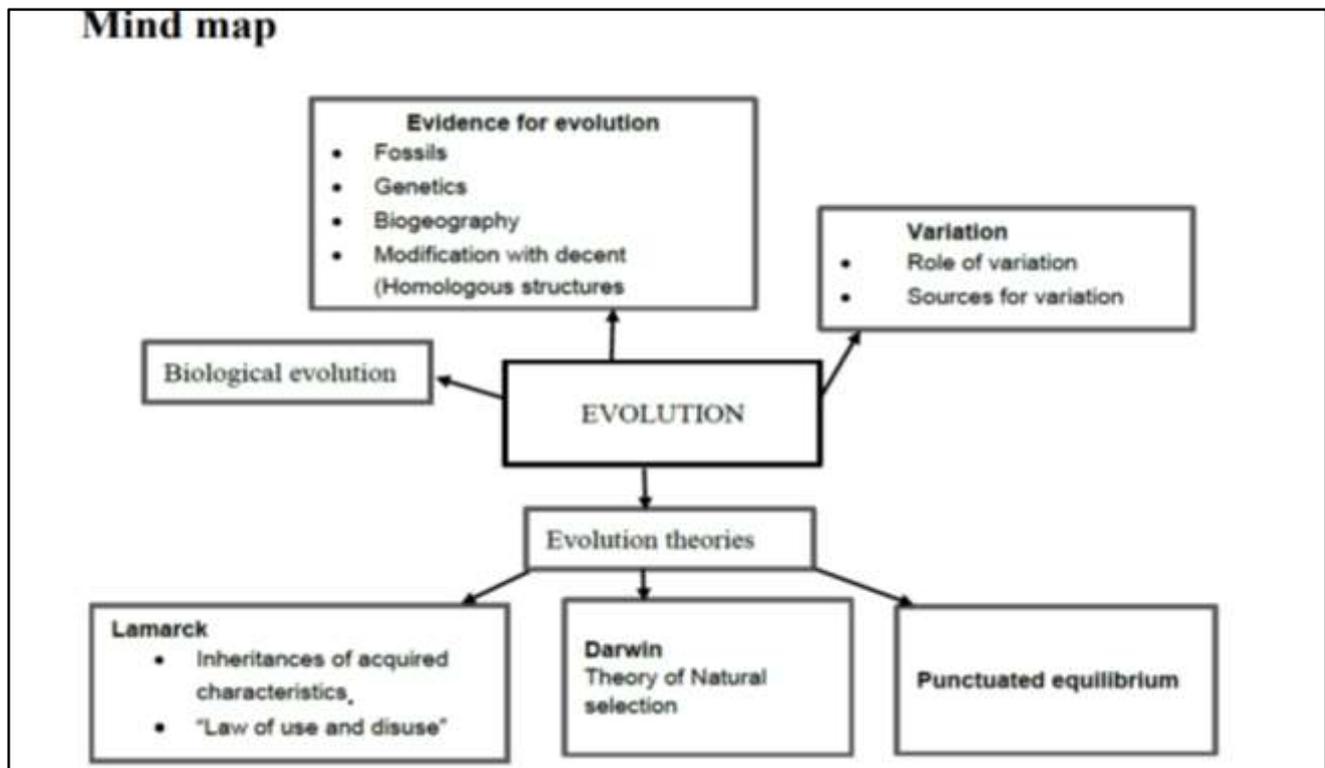
1. Focus on the following definitions.

1.1. Definition of ==biological evolution:==
➢ ==Biological evolution refers to any genetic change in a population that is inherited and becomes a characteristic of that population over several generations.==

Difference between a ==hypothesis and a theory==

➢ **A theory** is an explanation of something that has been observed in nature which can be supported by facts, generalisations, tested hypotheses, models, and laws.

➢ **A hypothesis** is a possible solution to a problem.

1.2. Definition of a biological species and a population

➢ **Population**

==A group of organisms of the **same species** that lives together in a **defined area**== at a ==**given time**== and ==**interbreeding**== can take place.

➢ **Species**

==A group of organisms that have **similar characteristics** and can **interbreed**== to produce ==**fertile offspring**== *(why 2 species are not of the same species or are of the same species)*

2. Evidence of Evolution: Emphasize the ==Role== of the following as evidence for evolution:

2.1 Fossil record – Link to Grade 10

==Palaeontology== refers to the study of fossils. Fossils are the remains of ancient life forms preserved usually in rock. Radiometric dating is used to determine the age of the rock in which the fossil is preserved. Scientists used the age of fossils to establish when organisms excised and to determine the characteristics of the organism by studying the fossil. Knowledge of these characteristics allows us to see relationship amongst different organisms, this is represented in a phylogenetic tree, Fossils provide evidence of the history of extinct organism on earth and give an indication of the climate and environment millions of years ago.
(Fossils record is not good evidence of evolution – not all organisms can be fossilised and there are lots of gabs in fossil record)

2.2 Biogeography – Link to Grade 10

Biogeography refers to the study of past and present distribution of individual species. Such studies show that closely related species tend to be found in the same geographic regions of the different continents because of very similar habitats. For example:

Baobab trees in Africa   and   Madagascar

The distribution of the flightless birds of the world we get ostriches in Africa, Rhea's in southern America, Kiwi's and Emu's in Australia.
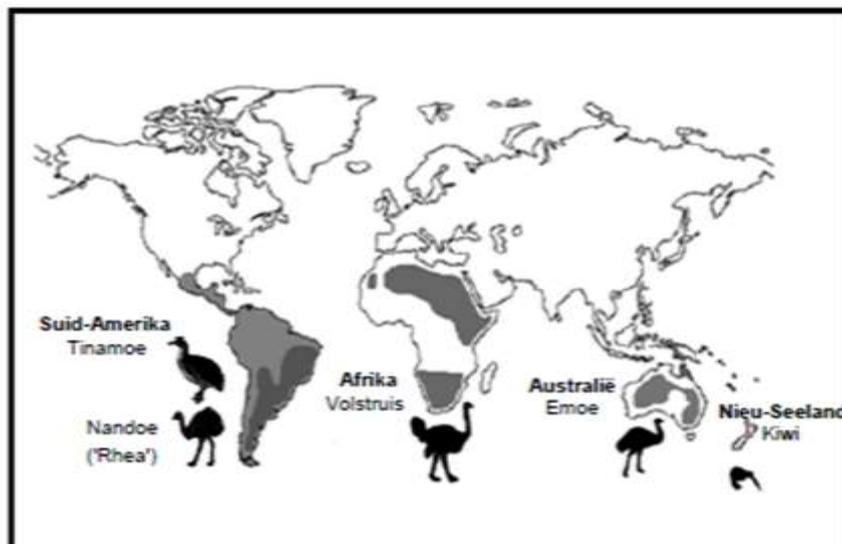
2.3 Modification by descent (homologous structures)

Modification by descent

Is the phenomenon where the basic body plans of different plants and animals were modified over time to better adapted to their different environments.

Because the similarities may be track back to a common ancestor

Important to note

Homologous structures *(act as evidence for modification by descent)*

Homologous structures have the same basic plan even though they may look different or perform different functions. Comparison of homologous structures among organisms to show similarities and differences e.g. Homologous bone structures in the front limbs of different vertebrates, Scientist interpret homologous structures in the way that it indicates common ancestor.*(why is homologous structure important evidence in evolution – because they indicated common ancestors)*
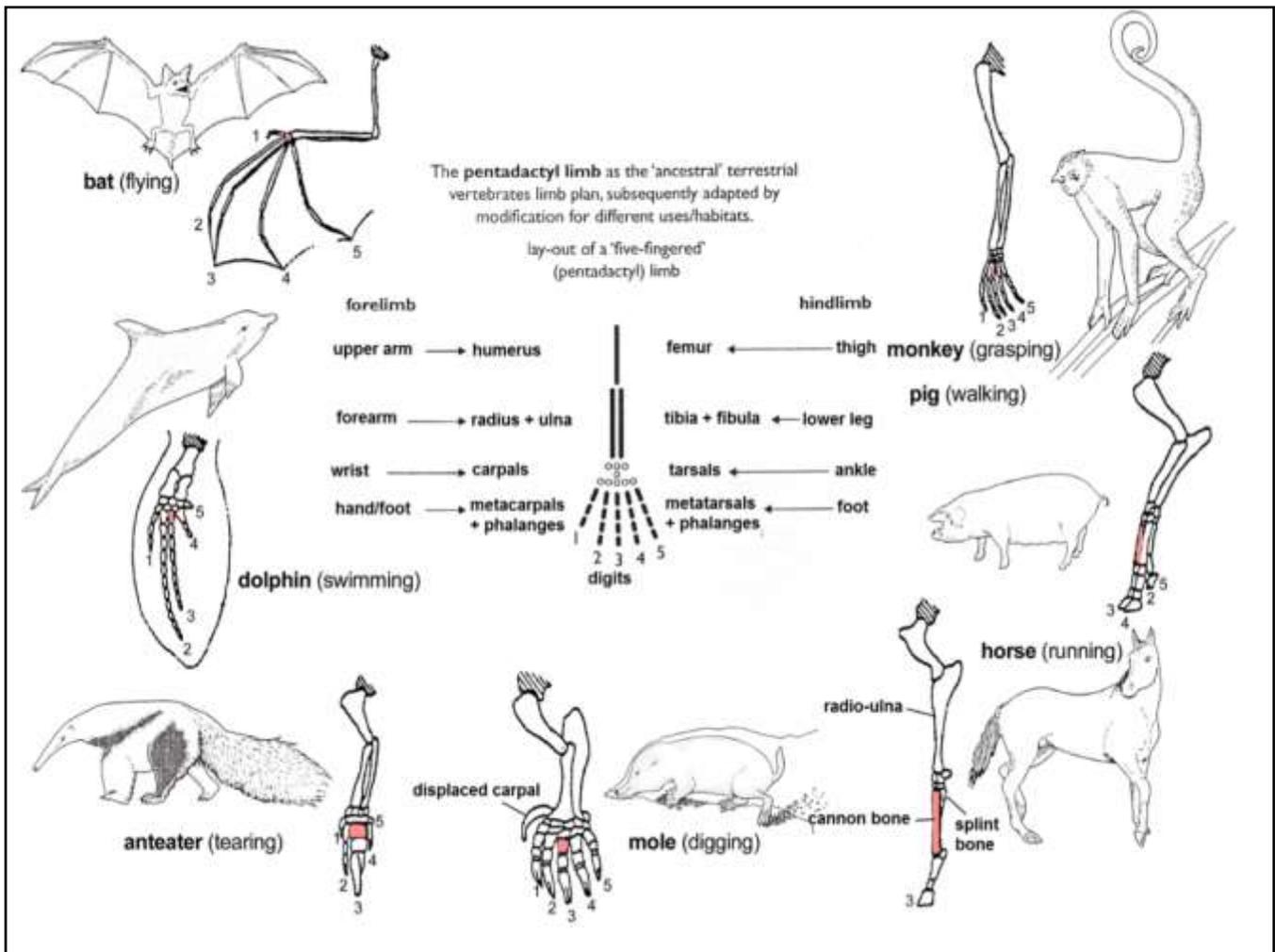
All living organisms share a universal code of three DNA bases (codons) that are used to specify each amino acid.

Comparison of the human genetic code with that of other organisms show that chimpanzees are nearly genetically identical (differ by less than 1.2%) whereas the mouse differs by ≈15%.

List the following features that show possible common origin of different organisms

- Identical DNA compounds
- Similar sequence of genes
- Similar portions of DNA with no function
- Identical protein synthesis
- Similar metabolic pathways such as glycolysis, Kreb's cycle and
- electron transport system

ACTIVITY 1
1.   Match the definition in **Colum B** to fit the term in **Colom A**

	COLUM A		COLUM B
1.1	Biological evolution	A	Species that are closely related have a greater genetic similarity to each other than distant species and therefore shares more recent common ancestor.
1.2	Specie	B	a group of organisms with similar characteristics that interbreed with one another to produce fertile offspring
1.3	Population	C	The study of the distribution of existing(extant) plant and animal species in specific geographical regions
1.4	Theory	D	Similar structure with the same body plan that perform different functions
1.5	Hypothesis	E	a group of individuals of the same species occupying a specific habitat in a specific time
1.6	Fossil records	F	The study of fossilises

1.7	Homologous structures	G	any genetic change in a population that is inherited over several generations
1.8	Biogeography	H	a possible solution to a problem or explanation of a specific phenomenon
1.9	Genetics evidence	I	The basic body plan of different plant and animals 'groups change through time and is then better adapted to their different environments
1.10	Decent with modification	J	an explanation of something that has been observed in nature which can be supported by facts, generalisations, tested hypotheses, models and laws
1.11	Palaeontology	K	Different fossils are found in different rock layers with the oldest fossils in the oldest rock layers with transitional fossils present

Teaching Tool 2:

2.1. Variation (Causes) *(how variation can play a role in natural selection – variation causes genetic different individuals and that individual may have an extra characteristics)*

A review of the contribution of each of the following to variation that exists amongst individuals of the same species: *(here the question can combine genetics and evolution)*

2.1.1. Meiosis *(what is the role of meiosis in variation)*

1.1. **Crossing over** (what is the difference in variation on crossing over and random arrangement - genetic different chromosomes)

- occurs during prophase I ✓
- Homologous chromosomes ✓
- non-sister – chromatids/adjacent chromatids overlap ✓
- at points called chiasma ✓/chiasmata
- Genetic material is exchanged ✓
- resulting in new combinations of genetic material from both parents ✓

homologous chromosomes

crossover between non-sister chromatids

non-sister chromatids
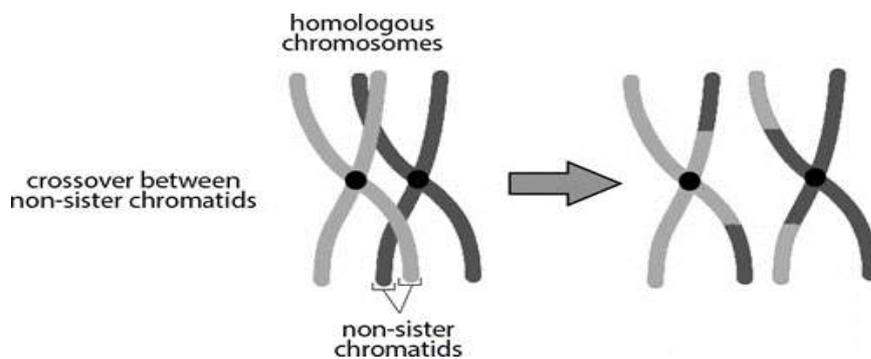
1.2. **Random arrangement of chromosomes** (what is the difference in variation on crossing over and random arrangement – causes different genetic gametes)

- Homologues chromosomes arrange randomly on the equator during Metaphase 1 and single chromosome arrange randomly on the equator during Metaphase 2

- This result into genetic different gametes

P1 M1

P2 M2
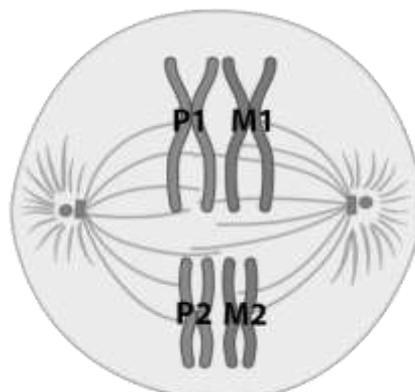
1.3 Mutations

- **Gene Mutation** – a change in the sequence of nitrogenous bases or nucleotides of DNA (learners should know the definition)

- **Chromosomal mutation** – a change in the normal structure or number of chromosomes *(use the correct wording as it comes from the Exam Guidelines)*

1.4 Random fertilisation - between different egg cells and different sperm cells formed by meiosis result in offspring that are different from each other. *(any sperm cell can fertilise the ovum)*
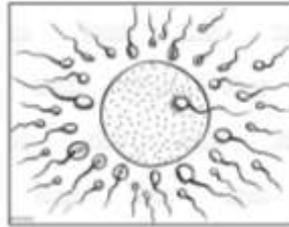

1.5 Random mating - between organisms within a species leads to a different set of offspring from each mating pair. *(any male can mate with any female)*
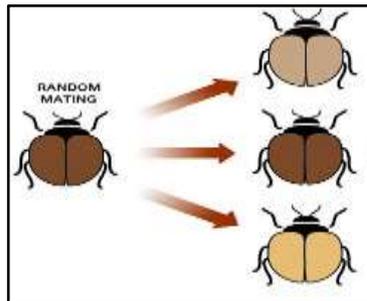
4. TYPES OF VARIATION

Continuous variation - *(the word range must be emphasized and taught – light yellow red or dark red)*

- When traits do not fall into clear cut classes.
- For example, there is every shade of hair colour between black and blond. People do not belong to one or other of a small number of distinct categories i.e. there is continuous variation from one extreme to the other.
- Variations such as these are under genetic control but there are several pairs of genes involved.
- The genome **AA BB CC DD** might give black hair while the genome aa bb cc dd might give blond hair.*
- Genomes **Aa Bb Cc Dd** or **AA Bb CC dd** or **aa BB cc Dd** and all the other possible combinations would give intermediate colours
- The condition of having more than one gene controlling a characteristic is called polygenic inheritance
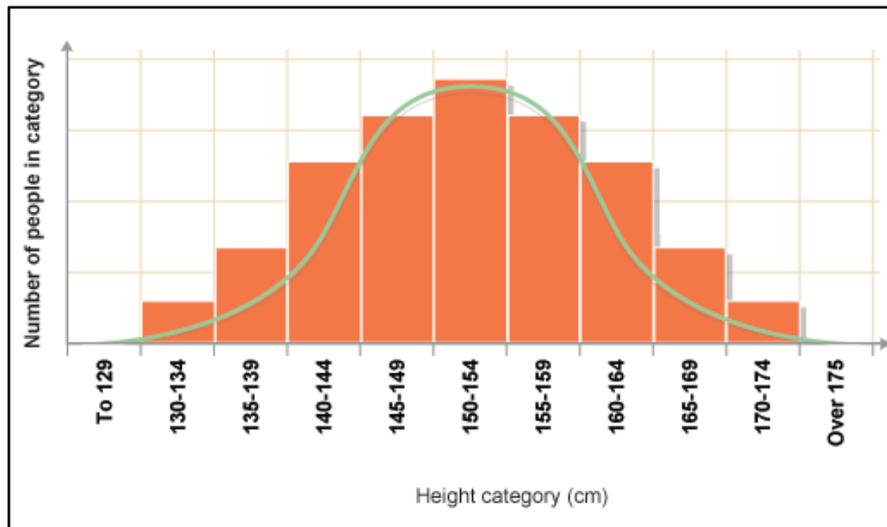
Discontinuous variations e.g. Mendel's pea plants either tall or short and had no intermediate forms between these traits

- You are either male or female, there are no intermediates
- your abo blood group is either a, b, ab or O
- Easily distinguishable and not affected by environmental conditions
- Brought about by one or two genes
- Genetic defects such as colour blindness, albinism, sickle cell anaemia are

  all genetically controlled in a discontinuous way

- You either have these conditions or you do not.

- There are no intermediate state
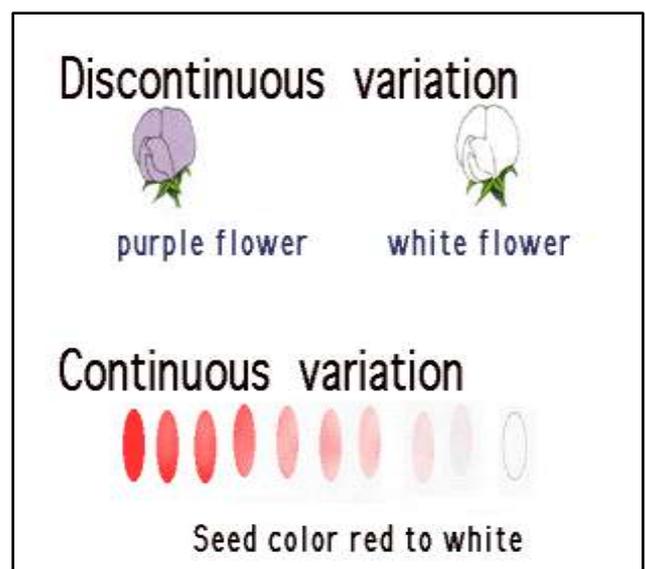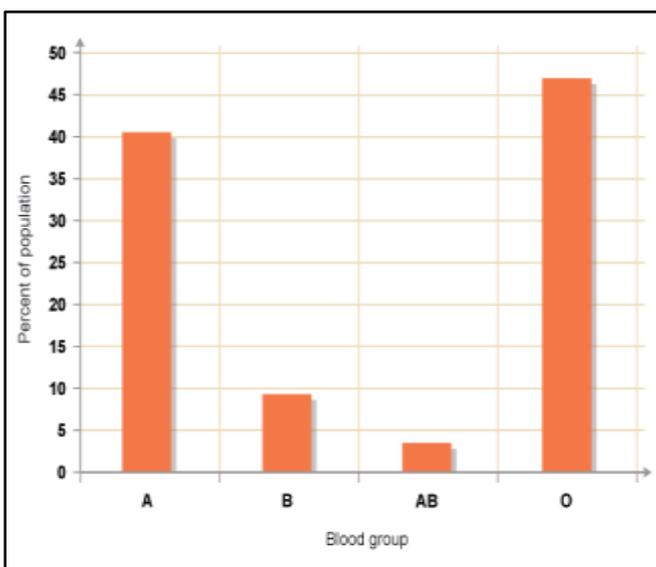
Discontinuous variation in blood group. The figures cannot be made to fit a smooth curve because there are no intermediates

ACTIVITY 2

2.1.1. Name the sources of variation in a population (4)

2.1.2. Describe how meiosis contributes to variation among individuals of the same species (8)

2.1.3. Distinguish between Random fertilisation and Random mating (4)

2.3.1. Complete the table below on the differences between continues and discontinues variation

	Continuous variation	Discontinues variation
Definition	Those characteristics where there is a range of intermediate phenotypes	
Gene locus		Usually only one but may be a very small number
Number f alleles	Many pairs of alleles as many genes contribute to the inheritance	
Effect on phenotype	Many intermediate phenotype	
Environment influence		Environment has little to no influence
Example		

(5)

3 The graph below illustrated different hights in humans.
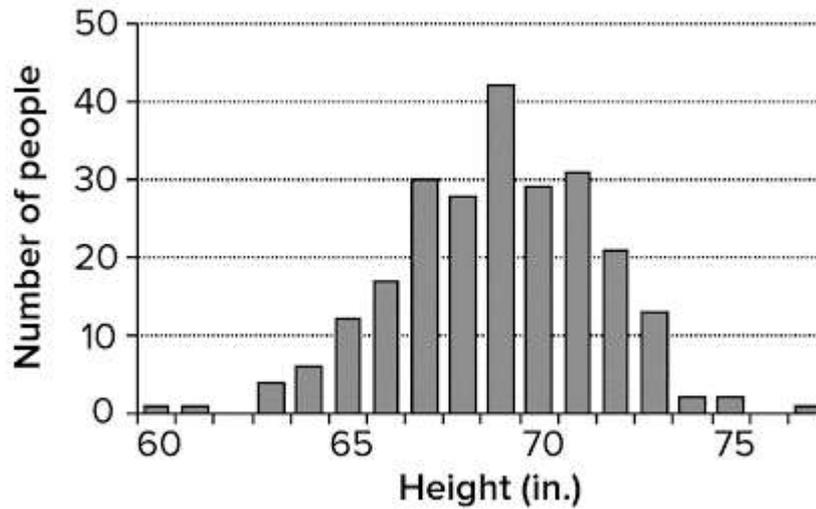
(5)

3.1.1   What type of variations is illustrated in this graph   (1)

3.1.2   Explain your answer in 3.1.1   (2)

4 The diagram below is a phase during meiosis
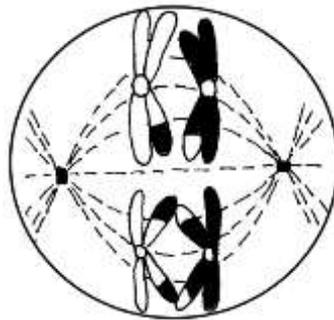
4.1.1.   Name the **proses** that is illustrated in the diagram   (1)

4.1.2   Explain the significance of this proses in 4.1.1.   (2)

5   Explain how gene mutations can play a role in genetic variation in species.

6   Explain random fertilisation and the role it plays in genetic variation

Teaching Tool 3:

2. ORIGIN OF AN IDEA (Evolution theories)

CONTENT	ELABORATION
Origin of an idea about origins (a historical development)	❏ Ideas on evolution in the order of their origin are as follows: • Lamarckism • Darwinism • Punctuated Equilibrium
Lamarckism (Jean Baptiste de Lamarck – 1744–1829)	❏ Lamarck used two 'laws' to explain evolution: • 'Law' of use and disuse • 'Law' of the inheritance of acquired characteristics ❏ Reasons for Lamarck's theory being rejected
Darwinism (Charles Darwin – 1809–1882)	❏ Darwin's theory of evolution by natural selection: • There is a great deal of variation amongst the offspring. • Some have favourable characteristics and some do not. • When there is a change in the environmental conditions or if there is competition, • then organisms with characteristics, which make them more suited, survive • whilst organisms with unfavourable characteristics, which make them less suited, die. • The organisms that survive, reproduce • and thus, 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.

History of Evolutionary Thought

Hebert Spencer
1820 – 1903
Proposed concept of the *'survival of the fittest'*

Erasmus Darwin
1731 - 1802
Charles Darwin's grandfather and probably an important influence in developing his thoughts on evolution.

John Baptiste de Lamarck
1744 - 1829
First to publish a reasoned theory of evolution. Proposed idea of use and disuse and inheritance of acquired characteristics.

Rev. Thomas Malthus
1766 - 1834
Wrote: *'An Essay on the Principles of Population'*, attempting to justify the squalid conditions of the poor.

Alfred Russel Wallace
1823 – 1913
Theory of Natural Selection

Charles Darwin
1809 - 1882
'Theory of Evolution by Natural Selection'

Charles Lyell
1797 - 1875
Major influence on Darwin. Lyell's work *'Principles of Geology'* proposed that the earth is very old.

Gregor Mendel
1822 - 1884
Developed the fundamentals of the genetic basis of inheritance.

August Weismann
1834 - 1914
Proposed chromosomes as the basis of heredity, demolishing the theory that acquired characteristics could be inherited.

R.A. Fisher	1890-1962
J.B.S. Haldane	1898-1964
Sewall Wright	1889-1988

Founding of population genetics and mathematical aspects of evolution and genetics.

Julian Huxley	1887-1975
Ernst Mayr	1904-2005
T. Dobzhansky	1900-1975

Collaborated to formulate the modern theory of evolution, incorporating developments in genetics, paleontology and other branches of biology.

The New Synthesis
Neo-Darwinism: The version of Darwin's theory refined and developed in the light of modern biological knowledge (especially genetics) in the mid-20th century

2.1. Jean Baptiste de Lamarck – 1744-1829 (Lamarckism) *(learners have to know how to spell it)*

1. Law of use and disuse (explain the theory – firstly they must state the law and explain the law)

- Changes in the environment create new needs that cause organisms to modify their existing organs to meet the need.
- Repeated use of the organ would cause it to enlarge and become more efficient. Disuse of a organ would cause it to degenerate

2. **Law of inheritance** *(explain the theory – firstly they must state the law and explain the law)*

- The modification an organism acquired during its lifetime could be pass on to its offspring.

How to describe Lamarckism

Example:

The law of use and disuse
Time
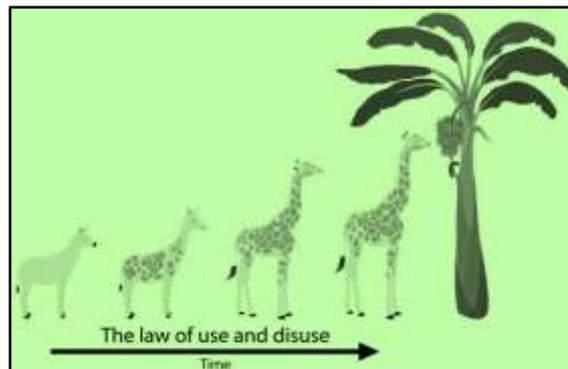
Guiding Questions	Lamarck's explanation
What was the original characteristic at the start?	All giraffes had **short necks** originally
What did the organism do?	Giraffes frequently stretched
Why did the organism do this?	used their necks to reach -for leaves of tall trees/to feed
What was the result?	necks become longer
What happened to this new characteristic?	The **long necks acquired** in this way could be passed on to the next generation /were inherited
What was the result of this?	All the giraffes have **long necks**

(no longer a general statement - learners must state the favorable characteristics)

Example:

Refer to the characteristic (Long necks) – do not only state - "*the favorable characteristic was pass on to the next generation***"**

2.2. Darwinism (Charles Darwin – 1809–1882)

Darwin's theory of evolution by natural selection:

- There is a great deal of variation amongst the offspring.
- Some have favorable characteristics, and some do not.
- When there is a change in the environmental conditions or if there is competition,
- then organisms with favorable characteristics, which make them more suited, survive.
- whilst organisms with unfavorable characteristics, which make them less suited, die.
- The organisms that survive, reproduce
- and thus, pass on the allele for the favorable characteristic to their offspring.
- The next generation will therefore have a higher proportion of individuals with the favorable characteristic. *(If they ask learners to explain Darwinism – the answer is straight forward – no example – just as it come from examination guidelines)*

Note the difference how to answer this from previous years on how to describe Darwinism

How to describe Darwinism

Example:

Natural Selection in action
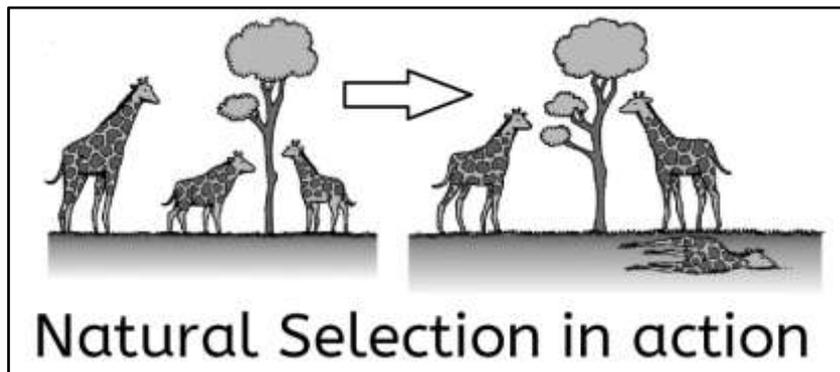
(Natural section keeps on changing and learners must be able to answer it – it is not a straight forward question – refer to 2018 question paper – new way to answer natural selection)

Guiding Question	Darwin's explanation
1-State the characteristic that varies	There is a variation in the 1- **length** of giraffe's necks.
Describe the 2- variations	There were giraffes with 2- **long** neck and **short** necks
3- Explain the environmental change/ selection pressure for natural selection (what is causing natural selection)	Leave/ food was only available on the top of the tree/higher trees and natural selection took place between giraffes with long necks and short necks for food
4- State the unfavorable characteristic and why it is unfavorable	Giraffes with 4- short necks (unfavorable characteristic) could not get food from the top of a tree/higher trees, 4- 4- their neck was to short
Explain 5- what happen to this individual with the unfavorable characteristics	The 5- die of hunger
State the favorable characteristic and why it is favorable	Giraffes with long necks (favorable characteristic) could get food from the top of a tree/higher trees, their neck was long enough
Explain what happen to this individual with the favorable characteristics	They could eat more leave/food and survive
What happen to the favorable characteristic	The giraffes with the long necks reproduce
	The allele for long necks will be passed on to the offspring
	The next generation of giraffes will have higher proportion with long necks

Guiding Question	Darwin's explanation
1-State the characteristic that varies	There is a variation in the **1- length** of giraffe's necks.
Describe the **2- variations**	There were giraffes with **2- long** neck and **short** necks
3- Explain the environmental change/ selection pressure for natural selection (what is causing natural selection)	**Leave/ food** was only available on the top of the **tree/higher trees** and natural selection took place between giraffes with **long necks** and **short necks** for **food**
4- State the unfavorable characteristic and why it is unfavorable	Giraffes with **4- short necks** (unfavorable characteristic) could not get food from the top of a tree/higher trees, 4- **4- their neck was to short**
Explain **5- what happen** to this individual with the unfavorable characteristics	The **5- die of hunger**
State the favorable characteristic and why it is favorable	Giraffes with **long necks** (favorable characteristic) could get food from the top of a tree/higher trees**, their neck was long enough**
Explain what happen to this individual with the favorable characteristics	They could **eat more leave/food** and **survive**
What happen to the **favorable characteristic**	The giraffes with the **long necks reproduce**
	The **allele for long necks** will be passed on to the offspring
	The next generation of giraffes will have higher proportion with long necks

2.3. Difference between Lamarck and Darwin

Lamarck's	Darwin's
Variation of offspring brought about individuals in the population changing	**Offspring inherit variation**
Individuals want to change	**Environmental factors working randomly**
Change because of adaptation to environment	**Natural selection – best suited to the environment to survive**
Individuals in the population change	**The population as a whole changes**
Changes brought about by adaptation to the environment are inherited from parent to offspring	**Characteristics are passed on from generation to generation to enable individuals to survive in the environment**

ACTIVITY 3

Brine shrimp are small arthropods found in saltwater lakes. During favourable conditions female shrimps produce eggs that hatch into live young. However, when conditions are unfavourable, the shrimp produce cysts. Each cyst contains the embryo covered with a hard, protective covering. In this state the embryo stops growing and is said to be dormant. The embryo can remain in this dormant state for many years and the cyst will only hatch at the optimum salt concentration.

Scientists wanted to investigate which salt concentration resulted in the highest percentage of hatched cysts

They did the following:

• Prepared salt solutions of different concentrations: 0%, 0,5%, 1%, 1,5% and 2%

 • Placed 30 mℓ of each solution into one of five beakers

• Took samples of brine shrimp cysts using a dropper

 • Counted the number of cysts in each sample

 • Recorded this as the initial number of cysts

 • Placed the samples into each of the five beakers

• Left the beakers at room temperature for 48 hours

• Recorded the number of cysts that hatched in each beaker

• Calculated the percentage of cysts that hatched.

• The results are shown in the table below.

SALT CONCENTRATION (%)	NUMBER OF CYSTS USED AT THE START	NUMBER OF CYSTS THAT HATCHED	PERCENTAGE OF CYSTS THAT HATCHED
0	54	0	0
0,5	34	2	6
1	40	6	15
1,5	40	1	2,5
2	53	1	X

3.1.   State TWO planning steps to consider before collecting the samples.   (2)

3.2   State the:

   a) Independent variable   (1)

   b) Dependent variable.   (1)

3.3   Calculate the value of X in the table. Show ALL working.   (3)

3.4   State THREE factors that were kept constant in order to ensure the validity of this investigation.   (3)

3.5   Which salt concentration resulted in the highest percentage of hatched cysts?   (1)

ACTIVITY 4

4.1. There are two variations in the colour of kingsnakes. Some have a bright colourful pattern and others have a dull pattern. Kingsnakes are non-poisonous to their predators. Coral snakes also have a bright colour pattern but are poisonous to their predators. This is a defence mechanism as predators avoid them. Scientists observed that where kingsnakes shared the same habitat with coral snakes, there were more kingsnakes that had bright colourful patterns. The diagram below represents the distribution of the snakes.

KEY:
● Coral snakes
▲ Bright kingsnakes
△ Dull kingsnakes
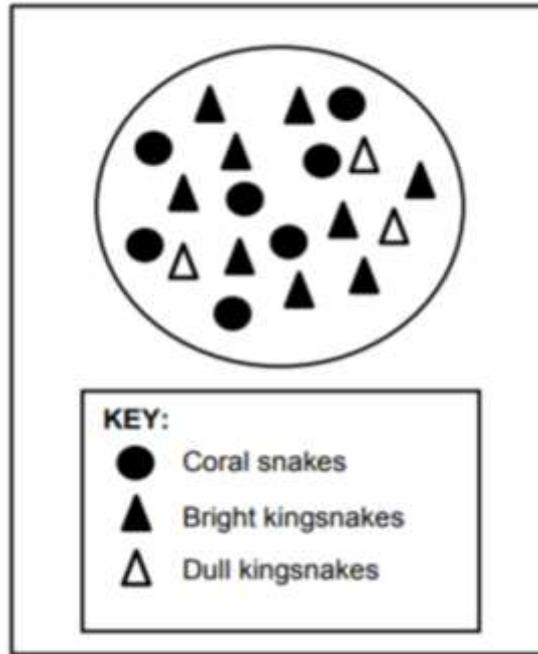
4.1.1. Explain how the bright colour pattern of coral snakes influences their survival. (3)

4.1.2. Use Darwin's theory of evolution through natural selection to explain why there are more brightly coloured kingsnakes in this habitat. (6)

ACTIVITY 5

5.1. *Flightless bird species that are currently distributed across different continents are shown in the picture below.*

South America
Tinamou

Rhea

Africa
Ostrich

Australia
Emu

New Zealand
Kiwi
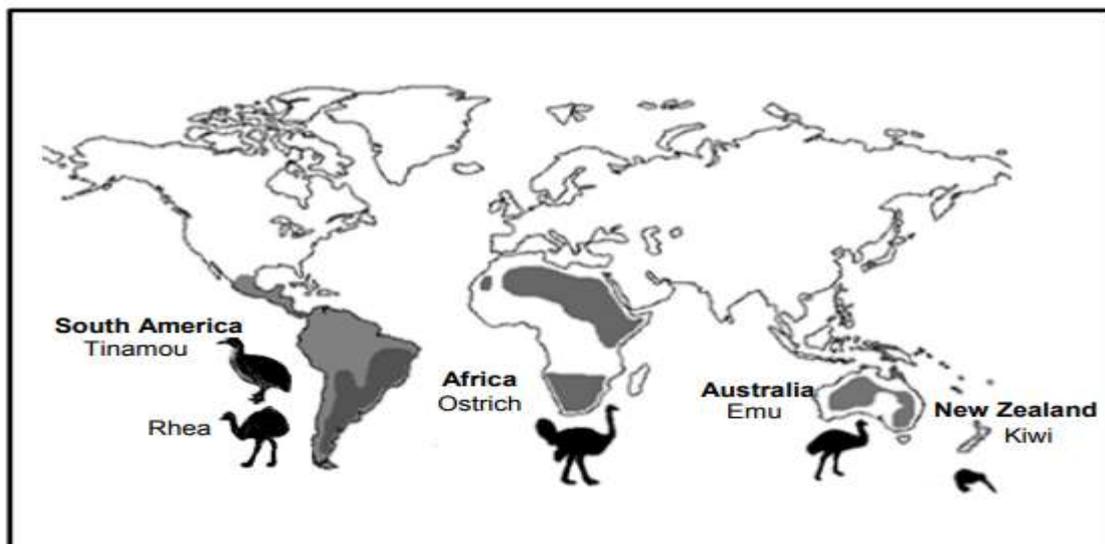
Scientists hypothesise that these species of flightless birds arose from a single common ancestor that was able to fly.

5.1.1 Describe how Lamarck would have explained the evolution of

flightless birds (6)

ACTIVITY 6

Darwin and Lamarck were both scientists who tried to understand evolution.

Lamarck's theory of evolution was based around how organisms (e.g. animals, plants) change during their lifetime, and then pass these changes onto their offspring. For example, Lamarck believes that the giraffe had a long neck because its neck grew longer during its lifetime, as it stretched to reach leaves in high-up trees, meaning that each generation of giraffe had a longer neck than previous generations.

Darwin's theory, known as **natural selection,** believed that organisms possessed **variation** and these variations led to some being more likely to **survive** and **reproduce** than others. In terms of the giraffe, Darwin's theory would state that longer necked giraffes were more likely to survive, because they could eat leaves from taller trees, and therefore more long-necked giraffes will be born, which eventually caused all giraffes to have longer necks.

6.1. Give:

   a) The term that describes Lamarck's ideas. (1)
   b) The term that describes Darwin's idea of Naturale selection.(1)
   c) The name of the Scientist that is associated with the theory of punctuated equilibrium. (1)

6.2. Tabulate the difference between Lamarck's theory of evolutions and Darwin's

   theory of evolution (2)

6.3. Explain whose idea evolution is more acceptable today. (2)

Punctuated Equilibrium (Eldredge and Gould – 1972)	❏ Punctuated Equilibrium explains the speed at which evolution takes place:
	  • Evolution involves long periods of time where species do not change or change gradually through natural selection (known as equilibrium).
	  • This alternates with (is punctuated by) short periods of time where rapid changes occur through natural selection
	  • during which new species may form in a short period of time.

Artificial selection	❏ Artificial selection involving:
	  • A domesticated animal species
	  • A crop species

Formation of new species	❏ Biological species concept: similar organisms that are capable of interbreeding to produce fertile offspring
	
	❏ Speciation and extinction and the effect of each on biodiversity
	
	❏ Speciation through geographic isolation:
	  • 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.
	
	❏ Speciation through geographic isolation in ONE of the following:
	  • Galapagos finches
	  • Galapagos tortoises
	  • Plants on different land masses (linked to continental drift)
	    ○ Baobabs in Africa and Madagascar
	    ○ Proteas in South Africa and Australia
	  • Any example of mammals on different land masses

3. Punctuated Equilibrium (Eldredge and Gould – 1972) *(Learners must know who came up with this theory)*

- Stephan J Gould and Niles Eldredge formulated this model (1972).

- They observed that the fossil record gives a different picture of evolution.

- They claim that there were long periods of **stasis** (4-10 million years) involving little evolutionary change.

- Then occasional rapid formation of new species (5,000 - 50,000 years).

- Punctuated Equilibrium explains the speed at which evolution takes place:

- Evolution involves long periods of time where species do not change or change gradually through natural selection *(known as equilibrium).*

  ➢ This alternates with (is punctuated by) short periods of time where rapid changes occur through natural selection.

  ➢ during which new species may form in a short period of time.

(Punctuated equilibrium is supported by the absences of transitional fossils indication the period of rapid change)

Stasis

Rapid change
(Punctuated
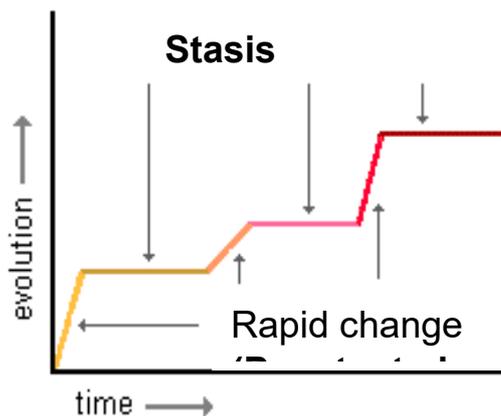
Graphs showing time frame of Evolution:
• **Gradualism:**   • **Punctuated Equilibrium**
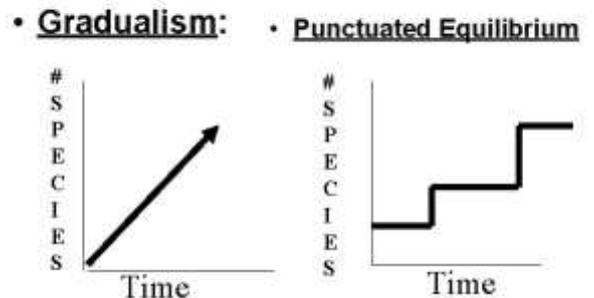
3.1. Differences between Gradualism and Punctuated equilibrium

Natural selection		Punctuated equilibrium
Change is continuous and slow for many years	Time period	Change occurs during brief period of time
New species evolve through the accumulation of many small changes over a long time	Change of Species	Species exist unchanged for many years and then a short period of time there is a sudden change
Constant and consistent	Change in a population	Irregular and inconsistent
Supported by transitional form	Fossil record	Supported by lack of intermediate forms

(Similarities between Natural selection and Punctuated equilibrium – natural section occurs in both of them the other one takes long and the other one the change is slow)

3.2. How the giraffe got a long neck! – according to punctuated equilibrium

- All giraffes had short necks for a long period of time.
- A mutation occurred and some giraffes were born with long necks.
- These giraffes were able to get more food and survive and therefore reproduced more.
- Therefore, more longneck giraffe survived from generation to generation.
- Over a few generations the whole population had long necks.

3.3. Artificial selection

➢ **Natural selection** refers to the changes in the population brought about by environmental factors working **randomly on the population** i.e **nature selects those individuals with the most suitable characteristics to survive.**

- **Artificial selection** (is also known as **selective breeding)** occurs when **humans determine** which genes will be passed on to future generations.
- They chose characteristics that will **desirable/beneficial to human needs** and not necessarily beneficial to the organism.
- Farmers, scientists and pet breeders choose their best individuals to interbreed so that they may produce the best characteristics such as:
  - high butterfat milk in jersey cattle
  - high quality meat in Hereford cattle
  - resistance to disease and a hot climate in indigenous Nguni cattle

Teaching Tool 4

Natural selection VS Artificial selection

Natural selection	Artificial selection
Environment is the selective force	Human is selective force
Response is adaptation to nature	Response to satisfy human need
Happens in a species	Can include more than one species

Example Natural Selection
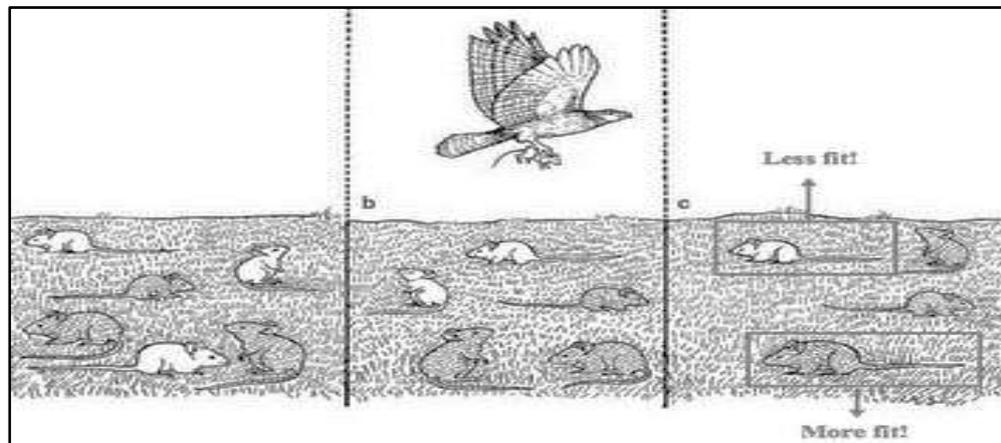
Example Artificial Selection
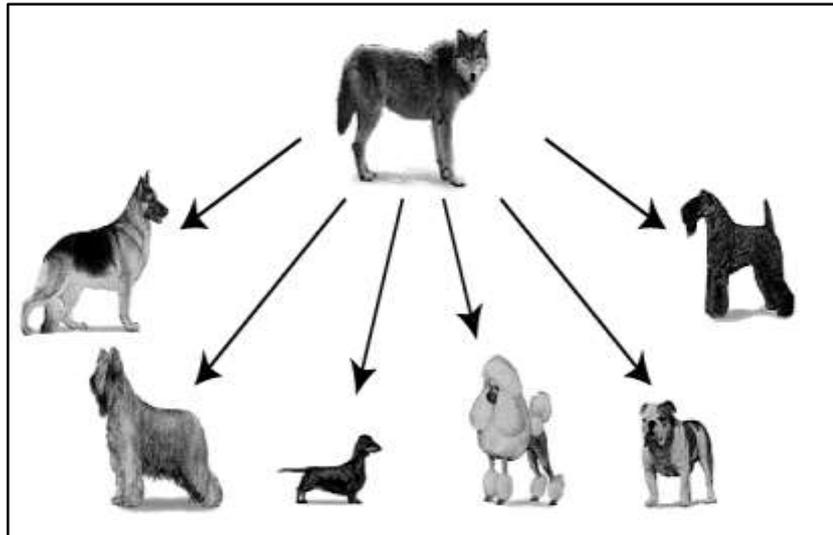
4.1. **Describe**

artificial selection using an example of each of the following:

• A domesticated animal species e.g. different breeds of dogs

• A crop species e.g. maize with full kernels is selected by farmers

4.2. **List similarities between natural selection and artificial selection.**

- both create a trend towards organisms better suited for their environment 'purpose'

- natural selection and artificial both involve an organism's traits being determined by how much they are favoured

- then, the organisms with favourable traits pass those traits on to future generations. both processes eventually form a new species.

ACTIVITY 7

7.1. Distinguish between punctuated equilibrium and gradualism. (2)

7.2. What is the similarity between punctuated equilibrium and gradualism (4)

7.3. The first dog evolved from a population of wolves. Although wolves look very similar to some breeds of domestic dogs, wolves and domestic cannot interbreed.
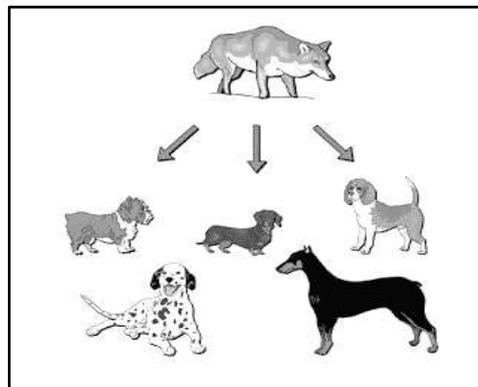
All type of domestic dogs is capable of interbreeding to produce puppies which will eventually be capable of interbreeding with any other domestic dog

7.3.1. Explain why all breeds of domestic dogs belong to the same species (2)

6.3.2. Domestic dogs are bred to show specific characteristics with respect to their health, personality, and appearance. Explain why this is consider as artificial selections. (2)

7.3.3. Describe how artificial selection led to different breeds of domestic dogs (3)

7.3.4. What effect does the type of selection mentioned in 1.3 have on the survival change of the dog species. (2)

Teaching Tool 5: Speciation

8. **Formation of new species (Speciation)**

Geographic speciation occurs when part of a **population becomes isolated** from the **parent** population due to **physical barriers**. Such barriers could be continental drift, oceans, rivers, mountains, or other natural disturbances such as volcanos or earthquakes.

Speciation through geographic isolation *(according to the exam guidelines)*

- 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.

NOTE HOW WE ANSWER IT BY APPLYING AN EXAMPLE

- **The BOLD is the fact that you state** according to the exam guidelines

- **The highlight is what you must get out of the example** in the e

If a population of a single species/original population
(Mention the original specie in the extract that they give you and refer to where the specie lived)

becomes separated by a geographical barrier
(Mention the specific barriers sea, river, mountain, lake)

then the population splits into
(Mention in how many **populations** does the original species /original population splits into according to the extract)

There is now no gene flow between the
(Mention how many populations are there now)

Since each population may be exposed to different environmental conditions/the selection pressure may be different
(Mention the selection pressure if there is one mention in the example)

natural selection occurs independently in each of the two/three etc. populations

such that the individuals of the two populations become very different from each other

genotypically and phenotypically.
(Mention the differences if the extract indicates differences)

Even if the two populations were to mix again
they will not be able to interbreed.

The two populations are now different species, name the new species. *(mention the new species that form)*

Example 1

Pottos and lemurs are small mammals. Scientists believe that pottos and lemurs share a common ancestor that existed in Africa. Presently pottos only occur in Africa while lemurs are only found in Madagascar. Madagascar is an island off the East coast of Africa as shown in the diagram below.
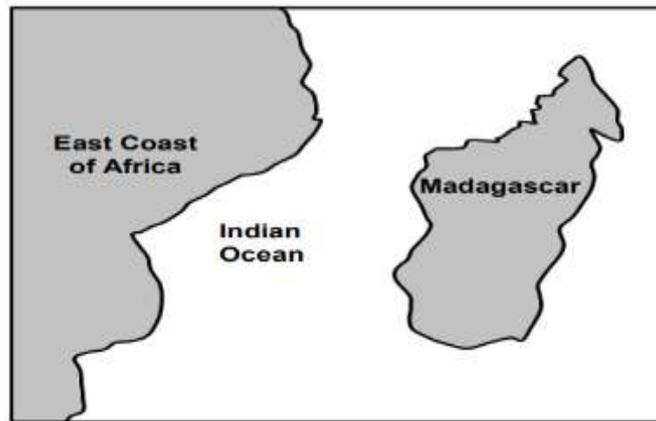
Describe the speciation of the pottos and lemurs.

- **The BOLD is the fact that you state** according to the exam guidelines.

- The highlight is what you must get out of the example.

- Applying the answer

- **If a population of a single species/original population**
- *(Mention the original specie in the extract that they give you and refer to where the specie lived)*

- ***If the original population of the common ancestor/small mammals of the pottos and lemurs that existed in AFRICA***

- **becomes separated by a geographical barrier**
- *(Mention the specific barriers sea, river, mountain, lake)*

- **becomes separated by a geographical barrier the Indian Ocean**

- **then the population splits into**
- (Mention in how many **population** does the original species /original population splits into according to the extract)

- **then the population splits into 2 - Africa and Madagascar**

- **There is now no gene flow between the**
- (Mention how many populations are there now)

- **There is now gene flow between the two population in Africa and Madagascar**

- **Since each population may be exposed to different environmental conditions/the selection pressure may be different**
- (Mention the selection pressure if there is one mention in the example)

- **Each population may be exposed to different environmental conditions on the eats cost of Africa and Madagascar**

- **natural selection occurs independently in each of the two/three etc. populations**

- **natural selection occurs independently in each of the eilands**

- **such that the individuals of the two populations become very different from each other**

- **genotypically and phenotypically.**

- **Even if the two populations of Africa and Madagascar were to mix again**
- **they will not be able to interbreed.**

- **The two populations are now different species, Pottos and Lemurs**

Example 2:

The present-day distribution of three closely related species of the dog family, the coyote, jackal and dingo, is shown on the world map below.
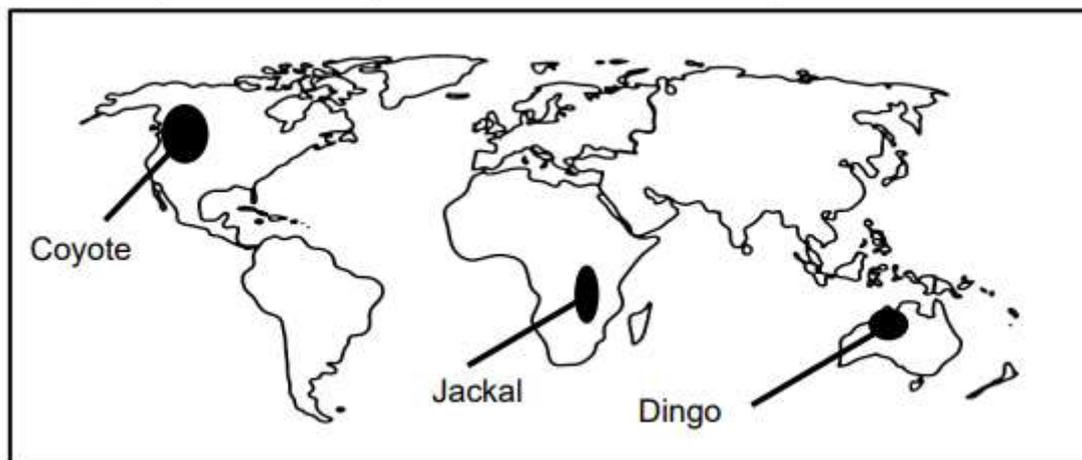
- If a population of a single species Dog family/ original population of the dog's ancestor lived on a large continent

- They become separated by a geographical by continental drift/ ocean

- The population splits into three
- There is now no gene flow between the three populations, Jackal, Coyote and Dingo

- Since each population may be exposed to different environmental conditions on the three continents/ islands

- natural selection occurs independently in each of the Three populations

- such that the individuals of the three populations become very different from each other

- genotypically and phenotypically

- Even if the three populations were to mix again

- they will not be able to interbreed

- The three populations are now different species, Coyote, Jackal and Dingo

ACTIVITY 8
8.1.

When the Grand Canyon was formed, the population of the ancestral species of squirrels living in the area were split into two sub-populations. Over a period two species developed.
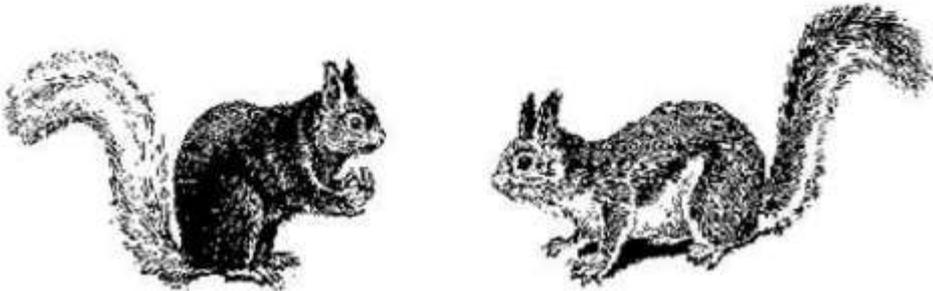
Kaibab squirrel   **Abert's squirrel**

One species is the Kaibab squirrel which has black fur and fluffy tail. The other is the Abert's squirrel which has grey fur and a bushy tail.

Members of these two species have a similar size, shape, and diet, but they are no longer in contact with each other and have become so different during their separation that they are now separate species.

[Adapted for http://biologydictionary.net/allopatric-speciation]

8.1.1.   Define population   (2)

8.1.2.   Describe how speciation of the **GRAND CANYON** squirrels took place.   (5)

ACTIVITY 9

9.1.   Darwin discovered two different species of tortoises on two different island in the Galapagos. One had a domed shell and short neck, the other had an elongated shell and a longer neck. The two islands had very different vegetation. One of the islands (island X) was rather barren, dry and arid. It had no grass but rather short tree-like cactus plants. On the other island (island Y), there were no cactus plants but it had a good supply of water and grass grew freely. The diagram below shows the two main

Tortoise 1   Tortoise 2
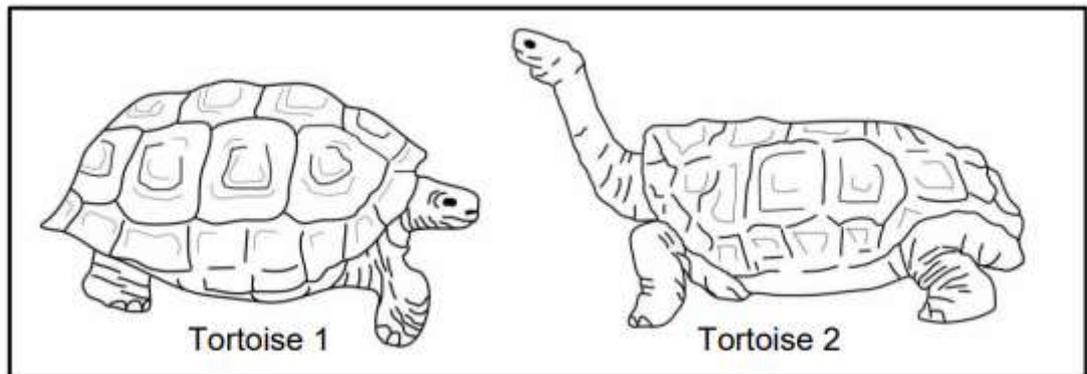
9.1.1. Which tortoise would be found on island **Y**   (2)

9.2.2. Describe how the two tortoise species become different   (6)

9.2.3. List FOUR sources of variation that could led to the variation in the tortoise population   (4)

9.2.4. Explain the role of natural selection on **island X** where more of tortoise 2 are found.   (6)

Teaching Tool 6: Reproductive isolation mechanisms

CONTENT	ELABORATION
Mechanisms of reproductive isolation (Keeping species separate)	❑ A brief outline of reproductive isolation mechanisms that help to keep species separate: • Breeding at different times of the year • Species-specific courtship behaviour • Plant adaptation to different pollinators • Infertile offspring • Prevention of fertilisation

Reproductive isolation mechanisms that help to keep <u>TWO DIFFERENT</u> species separate:

● Breeding at different times of the year

Different species will have different breeding seasons or, in the case of plants, will flower at different times of the year, in order to prevent cross-pollination.
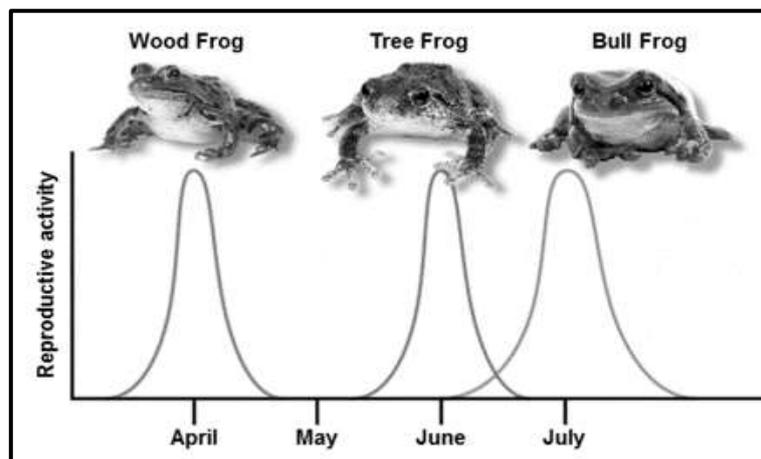
● Species-specific courtship behaviour

Some animals have very specific courtship behaviours that do not attract

individuals of other species, even if they are closely related species.

Courtship behaviour is a physical or chemical signal that an organism is ready to

mate.

This can include anything from being brightly coloured, to singing elaborate mating

songs or mating dances, to the secretion of pheromones in order to attract a mate.

The blue-footed booby (*Sula nebouxii*) performs an elaborate courtship dance.

The masked booby (*Sula dactylatra*) performs a different courtship ritual.

• **Plant adaptation to different pollinators**

Many plants and their flowers are specifically adapted for specific pollinators. Some closely related species of plants have different characteristics such as flower shape, size, colour, reward type (nectar or pollen), scent and timing of flowering all play a role in attracted certain pollinators to them.

Also, cross-pollination between the different species is prevented.

(a) Honeybee drinking nectar from a foxglove flower
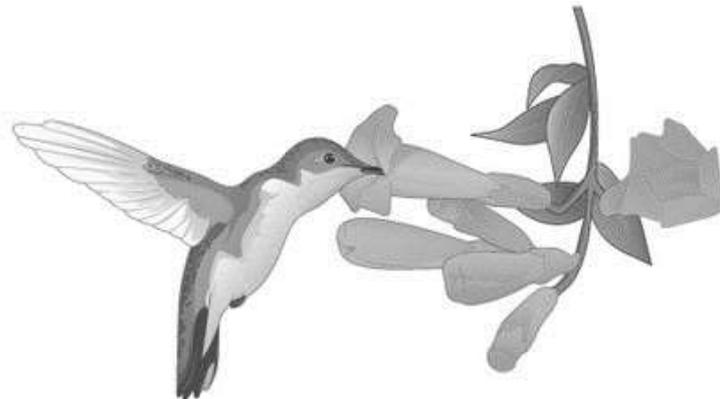
(b) Ruby-throated hummingbird drinking nectar from a trumpet creeper flower

● **Infertile offspring**

Even if two species are able to physically mate and produce offspring, they will still be reproductively isolated due to the fact the most hybrid offspring are infertile.
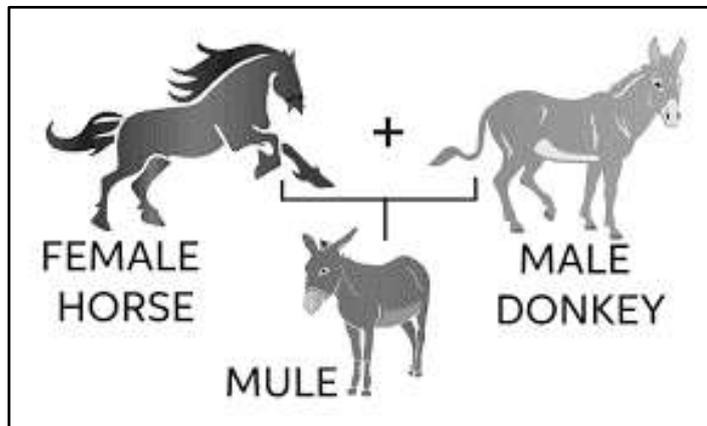
● **Prevention of fertilisation**

Incompatible sex- organs- the shape, size and location of genitals do not match those of another's species.
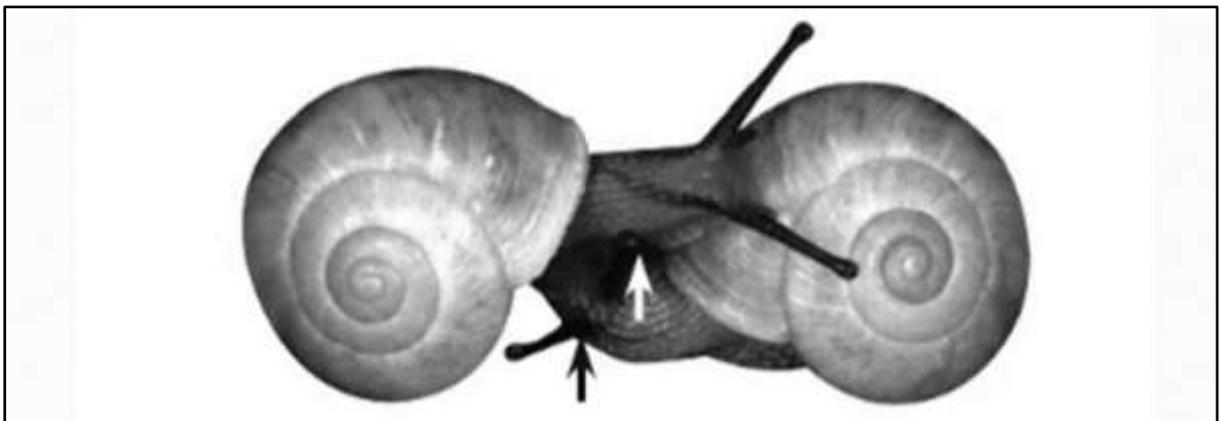
(The genital opening of these snails are not aligned, and mating cannot be completed)

ACTIVITY 10

10.1. Identify the reproductive isolation mechanisms hat is illustrated in the diagrams below. (5)

Insects have very specific copulatory organs.	
May Specie 1 Specie 2	
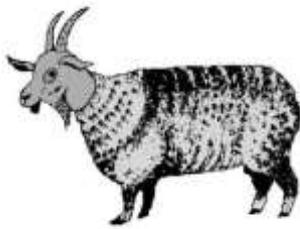
Sheep and goat hybrid dies before birth	

ACTIVITY 11

11.1.1. What is meant by the term reproductive isolation? (1)

11.1.2. Describe species- specific courtship (2)

11.1.3. Give THREE examples of species- specific courtship (3)

(1)
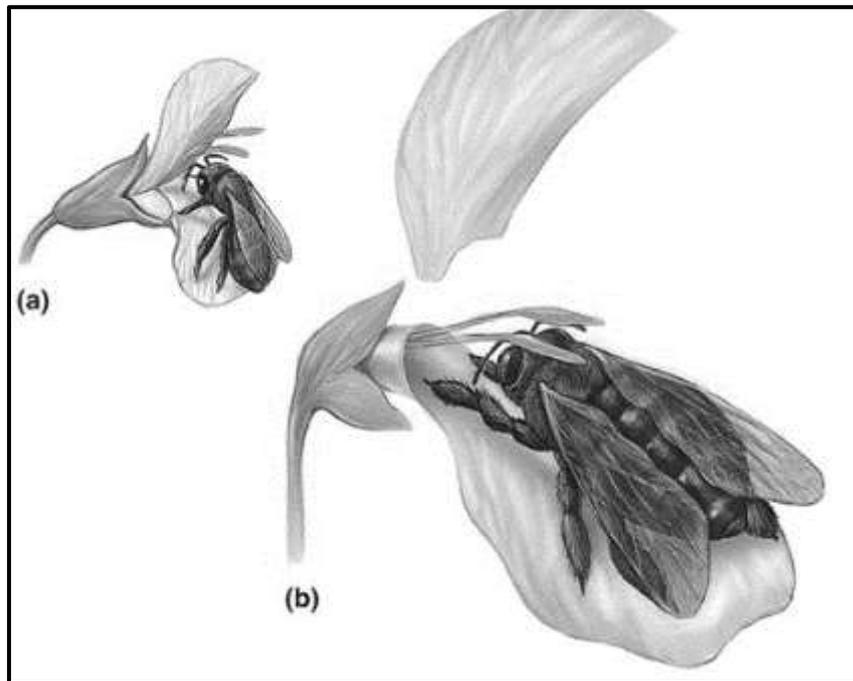
Differences in flowers structure in black and white sage select for different pollinating bees. Big bees do not fit on black sage petals.

11.2.1   Identify the reproductive isolation mechanism that is illustrated in the diagram above   (1)

11.2.2.   Explain what the significance of this isolation mechanism is   (2)

11.2.3.   Explain the development of infertile offspring between two species.   (3)

11.2.4   Give a example of infertile offspring's between two species.   (2)

Evolution in present times	❑ Any ONE example of natural selection and evolution in present times: • Use of insecticides and consequent resistance to insecticides in insects • Development of resistant strains of tuberculosis-causing bacteria (MDR and XDR) to antibiotics, due to mutations (variations) in bacteria and failure to complete antibiotic courses • HIV resistance to antiretroviral medication • Bill (beak) and body size of Galapagos finches
Evidence of common ancestors for living hominids, including humans	❑ Interpretation of a phylogenetic tree to show the place of the family Hominidae in the animal kingdom ❑ Characteristics that humans share with African apes ❑ Anatomical differences between African apes and humans, with the aid of diagrams, as it applies to the following characteristics: • Bipedalism (foramen magnum, spine and pelvic girdle) • Brain size • Teeth (dentition) • Prognathism • Palate shape • Cranial ridges • Brow ridges ❑ Lines of evidence that support the idea of common ancestors for living hominids including humans: • Fossil evidence: Evidence from fossils of different ages show that the anatomical characteristics of organisms changed gradually over time. • Emphasis on evolutionary trends provided by the anatomical features of fossils of the following three genera: ○ *Ardipithecus* ○ *Australopithecus* ○ *Homo* as well as: ○ The age of each fossil found/time-line for the existence of the three genera ○ The fossil sites where they were found: emphasis on the fossil sites that form a part of the Cradle of Humankind ○ The scientists who discovered them • Genetic evidence: mitochondrial DNA • Cultural evidence: tool-making
Out-of-Africa hypothesis	❑ The Out-of-Africa hypothesis: Modern humans originated in Africa and then migrated to other continents ❑ Evidence for the 'Out-of-Africa' hypothesis: • Fossil evidence: information on each of the following fossils that serve as evidence for the 'Out-of-Africa' hypothesis: ○ *Ardipithecus* (fossils found in Africa only) ○ *Australopithecus* (fossils found in Africa only, including Karabo, Little Foot, Taung Child, Mrs Ples) ○ *Homo* (fossils of *Homo habilis* found in Africa only; oldest fossils of *Homo erectus* and *Homo sapiens* found in Africa, while the younger fossils were found in other parts of the world) • Genetic evidence: mitochondrial DNA ❑ Timeline for the existence of different species of the genus *Homo* and significant features of each of fossil type to show the differences amongst them ❑ Interpretation of phylogenetic trees proposed by different scientists showing possible evolutionary relationships as it applies to hominid evolution

Teaching Tool 7 Evolution in present times (based on the theory of natural selection – teach it based on COVID 19 which mutated many times EXAMPLE PFESER and JONSON & JONSON)

Evolution is always happening. Most of the time it is impossible to observe changes in populations and species because evolution happens very slowly – thus the theory of gradualism. However, there are some cases (e.g.: rapidly producing organisms such as viruses and bacteria) that allow scientists to study how species change in response to environmental factors. Pathogens (viruses and bacteria) evolve quickly because there is lots of natural variation amongst them and the fact that mutations occur most often in rapidly reproducing organisms.

The evolution of drug resistance in bacteria

Low ---------------------->High

Antibiotic restance level

Original population
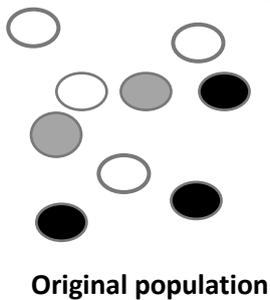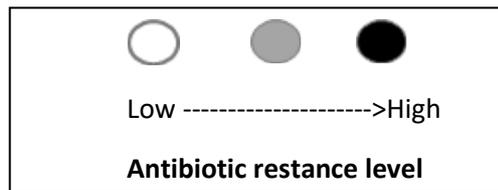
- With any population there is genetic variation
- Some bacteria are more resistant to antibiotics than others
- If the amount of antibiotics taken is too low, or the full course of antibiotics is not completed
- Those who are less resistant to antibiotics will die
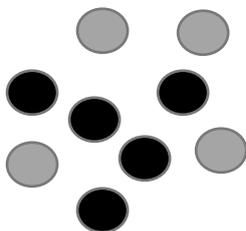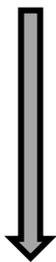
- The population of resistant bacteria increase
- Continued use of antibiotics had little effect on the resistant bacteria
- The resistant bacteria reproduce and pass the resistant gene on to the next generation and increased
- Non- resistant bacteria decrease
- The antibiotics will now be ineffective
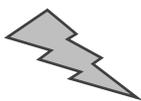
- The antibiotics acts as the selective mechanism.
- Natural selection plays a role in the evolution of antibiotic resistant bacteria.

ACTIVITY 12

12   The introduction of DDT represents a change in the environment of the   (1)
          mosquito. Study the diagram and answer the questions
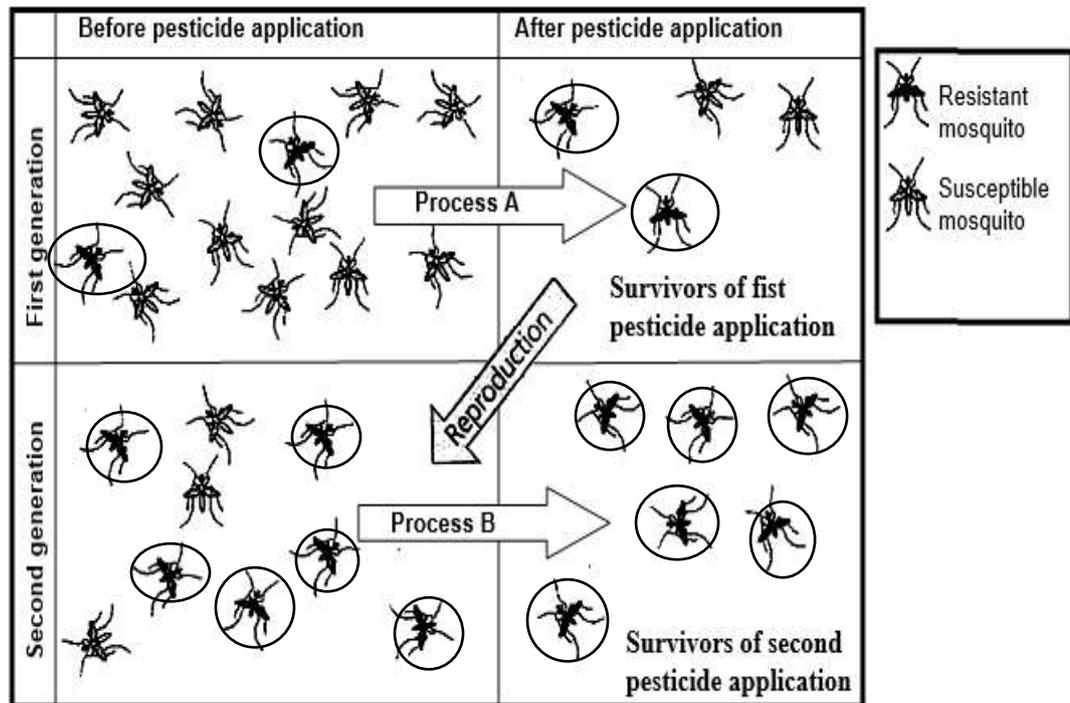

12.1.1. Give a suitable heading for the above diagram   (2)
12.1.2. What process is represented by

    a) A   (1)
    b) B   (1)

12.1.3   Describe the composition of the first generation   (2)

12.1.4   Explain how these two dark mosquitoes evolved in the first generation   (3)

12.1.5   Describe the composition of the survivors of the second pesticide application (2)

Teaching Tool 8 - The place of humans in the phylogenetic tree

Human Evolution

1. The place of the family Hominidae in the animal kingdom

Hominidae is the family name for all primates including all African Apes
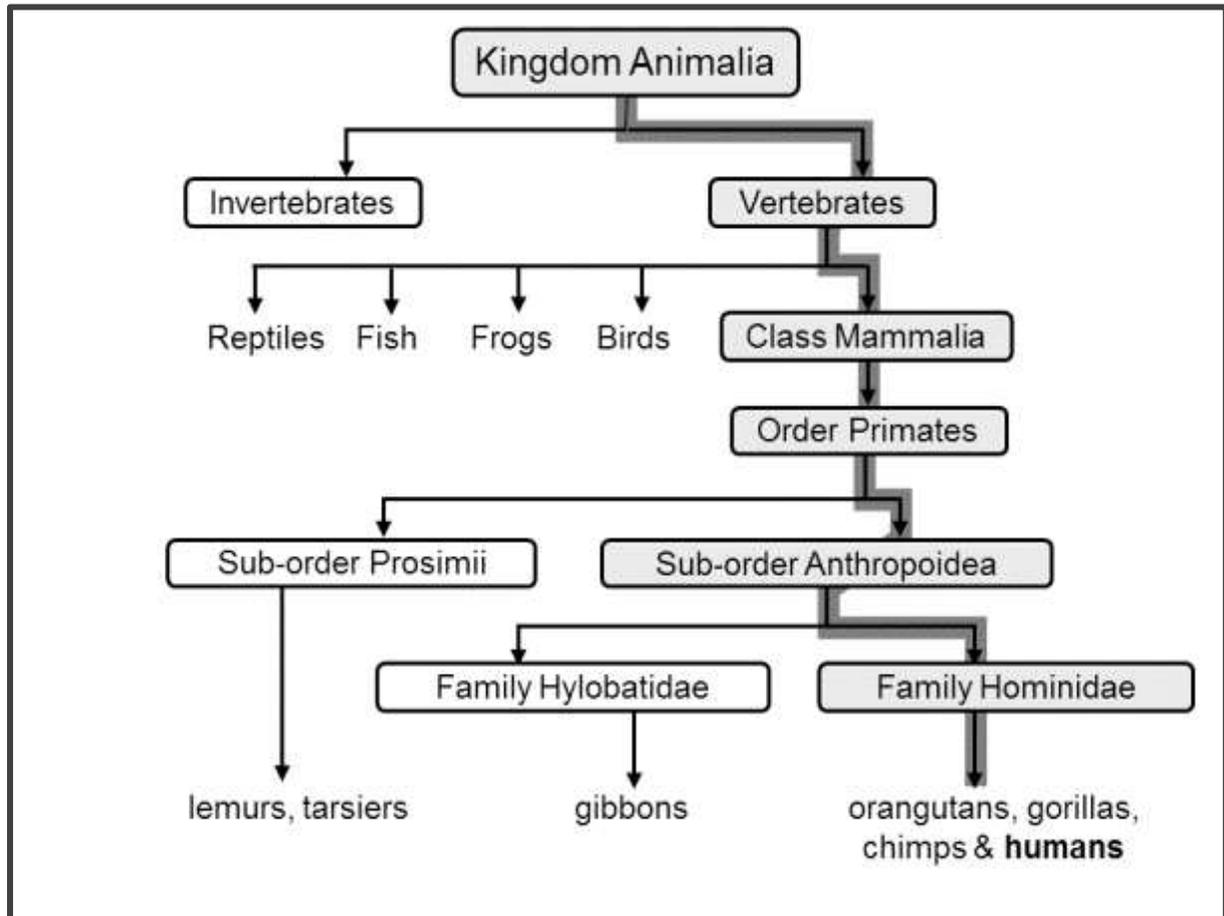
- Humas are mammals and belong to the class **MAMMALIA,** because their bodies is covered with hair and they suckle their young
  - The order they belong to is **PRIMATES**. - Primates includes human, apes, orangutangs, gorillas an chimpanzees
  - The Family **HOMINIDAE** includes **HOMINIDS**

HOMINIDS

Great Apes

Orangutan

Gorilla

Chimpanzee

HOMININS

(refers to bipedalism)

(bipedal)

Ardipithecus

Australopithecus
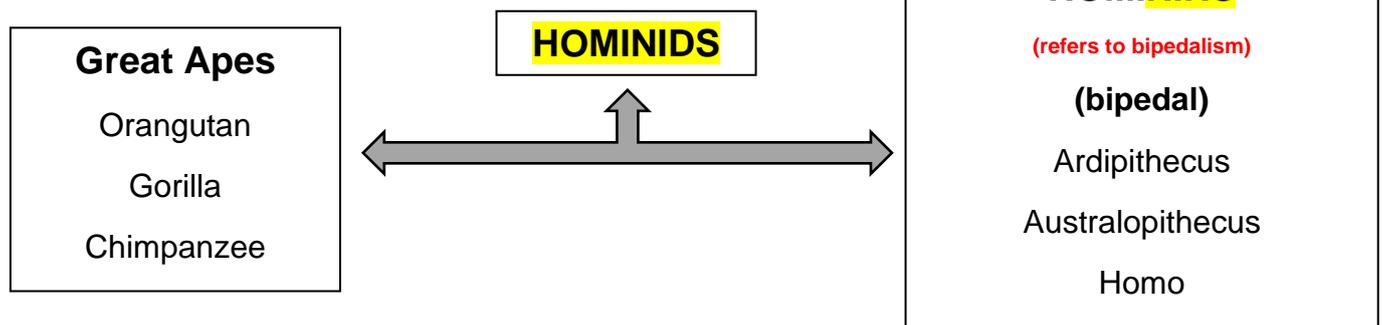
Homo

Hominids refer to the great apes and humans and their fossil ancestors

Great Apes is also referring to as African Apes

Hominin – refers to bipedal organism

Ardipithecus, Australopithecus and early ***Homo***- species are considered fossil ancestors of modern humans **(learners must know this line of development)**

Modern Humans are classified in the genus and species – ***Homo sapiens***

Homo – sapiens

Genus – *Homo*

Specie- *sapiens*

The genus name and specie name must be underline / cursive

Read what the question asks – Give the Genus, specie, family, class or order name

2. Interpretation of a Phylogenetic tree to show humans place in the Animal Kingdom (in grade 12 it is not necessary to emphasis the clinogram)

The evolutionary relationships of ancestral species and their descendants can be illustrated using a branching phylogenetic tree. A phylogenetic tree indicates which ancestors gave rise to which descendants.

How to interpretate a Phylogenetic tree:

- The root of the phylogenetic diagram represents the ancestor, and the tips of the branches, the descendants of that ancestor. To move upwards is to move forward in time.
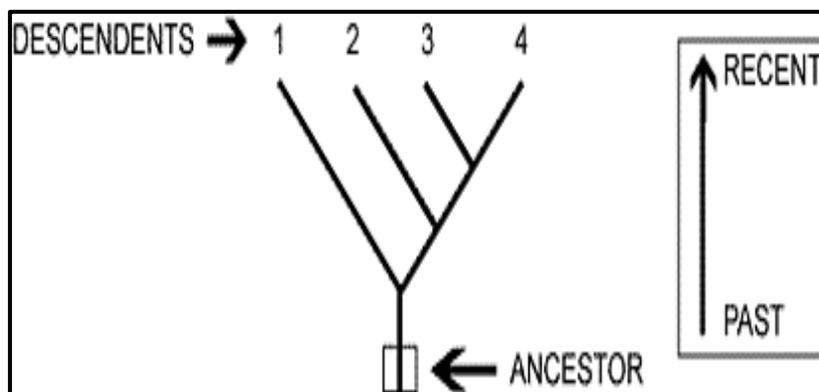
(3 and 4 are more related to each other because there we have a more recent common ancestor)

- Speciation is represented as a branching of the tree, as a single ancestral lineage gives rise to two or more daughter lines
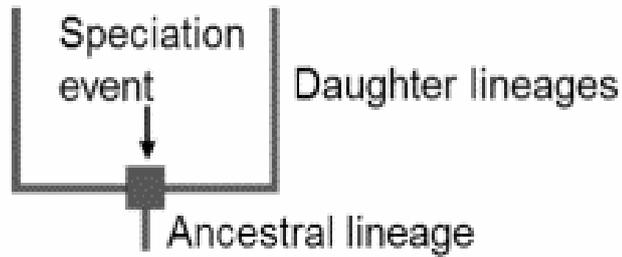
- Each lineage has a part of its history that is unique and parts that are shared with other lineages, as illustrated below …
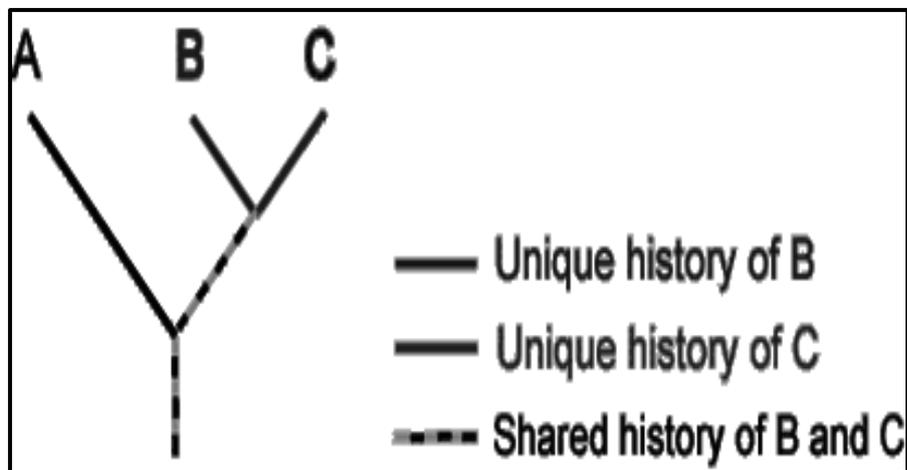

- And each lineage has ancestors that are unique to that lineage and common ancestors that are shared with other lineages
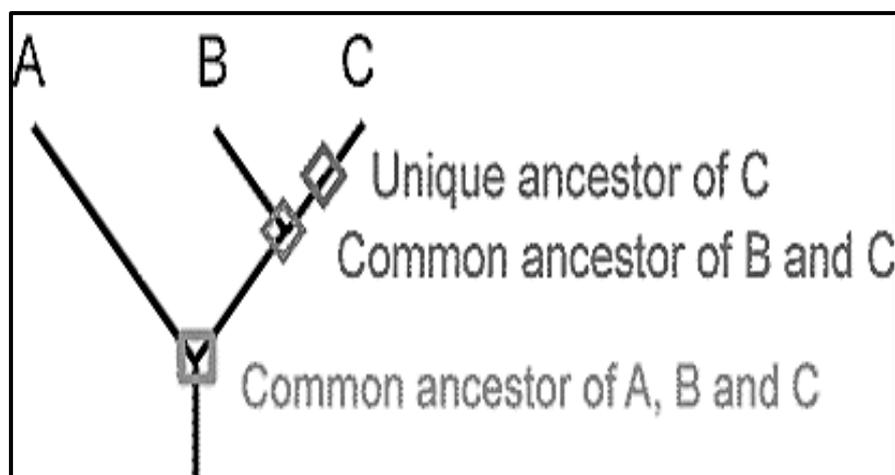
ACTIVITY 13

13   The diagram below shows possible relationships between members of Hominids

POSSIBLE RELATIONSHIPS BETWEEN HOMINIDS
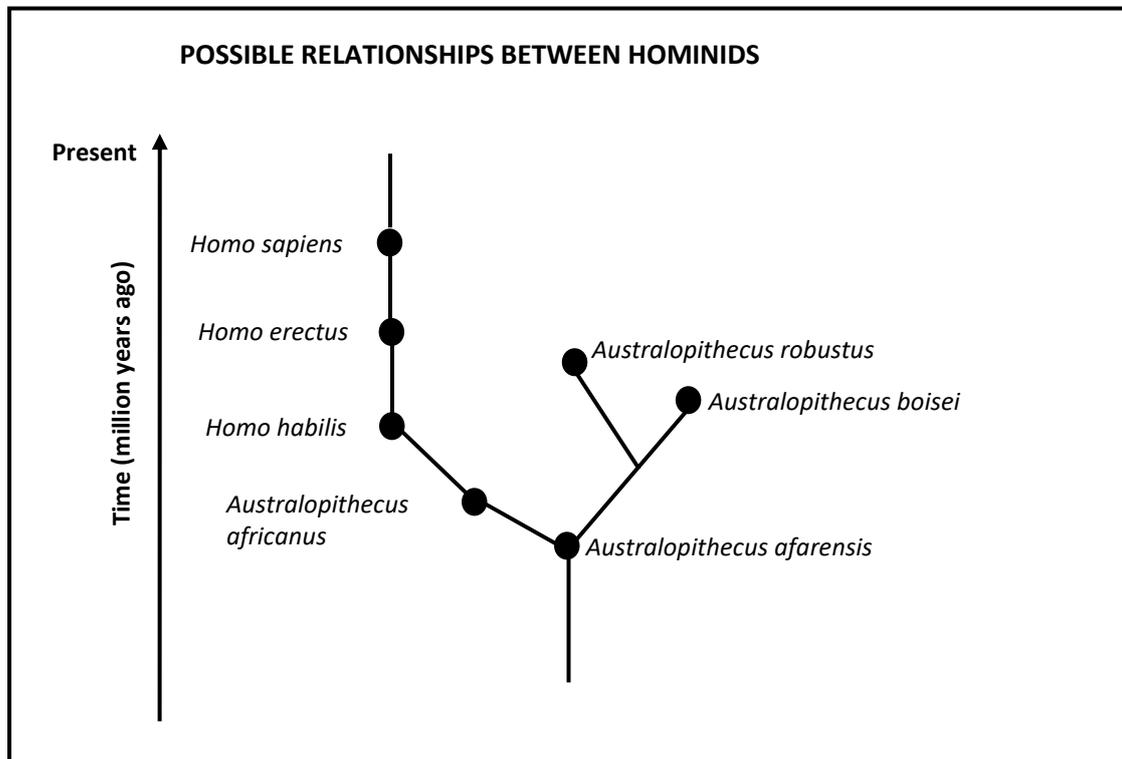
13.1.1. What is the name given to this diagram? (1)

13.1.2. How many of each of the following are represented in the diagram (2)

   a) Genera
   b) Species

13.1.4. Explain why A. robustus and A. boisei are more closely related than A. boisei and A. afarensis. (2)

13.1.5. Which hominid is the common ancestral of all the hominids in this diagram? (1)

13.1.6. Give the (1)
   a) Family to which all humans belong to
   b) Genera to which all humans belong to
   c) Name of the ancestral of homo sapience

(5)

Teaching Tool 9: Humans vs African apes

1. Characteristics we share with other primates
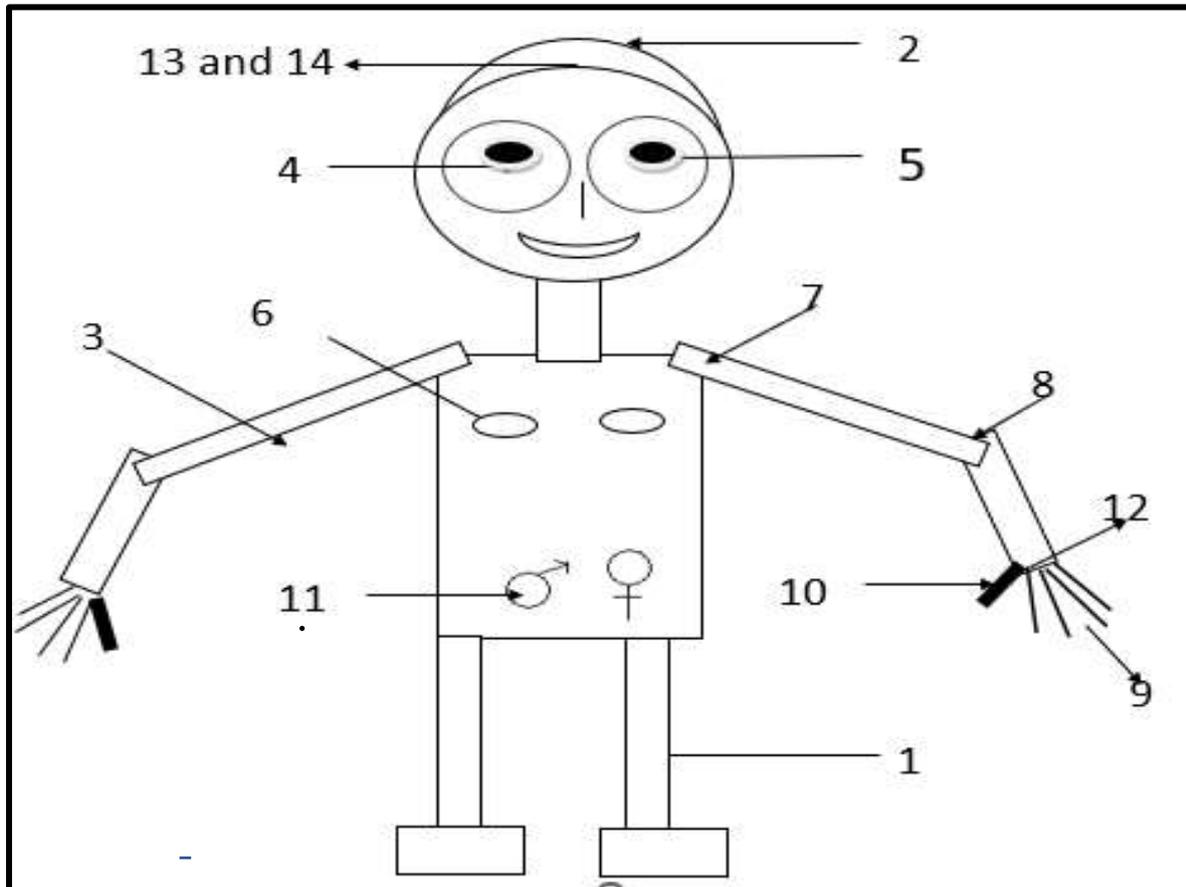
1. **Upright posture:** the back limbs of hominids are generally stronger than their front limbs, enabling them to stand erect (upright) and use their hands for grasping; standing erect also gives a better view of surroundings and exposure of genitals to attract the opposite sex

2. **Large brains:** relative to their body size, hominids have larger brains than other species in the Animal Kingdom. This allows them to process and store information.

3. **Long upper** arms / front limbs: apes are normally **quadrupeds**, and this requires longer front limbs. Longer front limbs also make it easier to grasp and swing from branches.

4. **Two eyes in the front** of the head, this provides good binocular vision as both eyes work together.

5. The **eyes have cones** for colour vision that gives greater clarity.

6. **Two teats**/nipples only

7. **Freely rotating arms**: arms can be lifted above the head to swing from branch to branch, or to pick fruit hanging relatively high above the ground. **(learners must also know the significance of this characteristic)**

8. **Elbow joints allowing rotation of forearm** this allows the limb to extend or flex to grasp and reach for objects. It also enables the flexing and rotation of the wrists

9. **Bare fingertips or nails instead of claws**: Digits (finger and toes) have soft, broad, and very sensitive pads. The flat fingernails or toenails protect these pads.

10. **Opposable thumb**: the thumbs of hominids are positioned so that it can oppose other digits, enabling the hand to grip an object

11. **Sexual dimorphism** – this refers to differences between males and females of the same species. Humans and apes are sexually dimorphic. This is linked to competition.

12. **Rotate hands at least 180º**

13. **Olfactory brain centres** reduced/reduced sense of smell

14. **Parts of the brain that process information from the hands and eyes are enlarged**

#Note *(correct way of stating them)*

Correct way to state	Incorrect way
Large brain relative to body size	Not just large brain- elephants have large brain to
Two eyes in front of the head	Two eyes
Long upper arms	Long arms
Upright posture	Can stand up straight
Two teats/nipples	Two mammal glands

| Freely rotating arms	Rotating arms
Elbow joints allowing rotation of forearm	Elbow rotate

## ACTIVITY 13

13   Skeletons of an African ape and a human
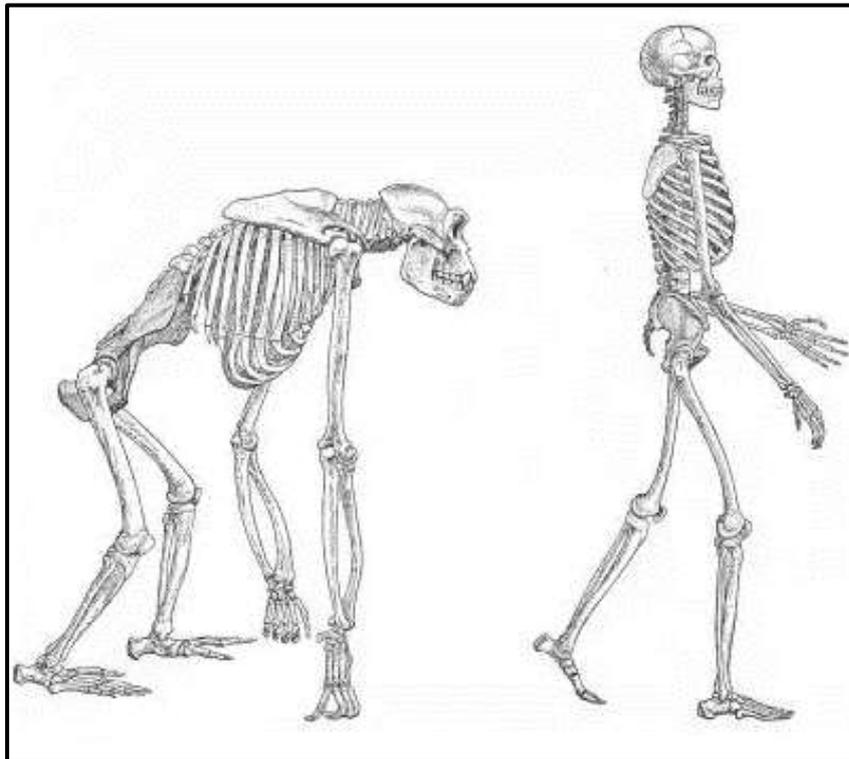
13.1.1. Organism **A** and **B** belong to the same order and family. Give   (1)
the name of the order and family

13.1.2. Give FOUR similarities they share regarding their **upper**   (4)
limps

13.1.4. Which organism   (1)
a) belong to the hominin group
b) Is quadrupedal
c) Is Mammalia

13.1.5. What is the different function of the opposable thumbs of   (2)
organism **A** and **B**

13.1.6. Give any other similarities that you did not mention in 1.2

2. Anatomical differences between Africa apes and humans (also emphasis the significance)


Diagram labels:
- Shape and slope of forehead
- Brow ridge development?
- Brain case: size and shape
- Facial angle
- Position of the foramen magnum (hole at the base of the skull that joins on to the spine)
- Size of canines
- Degree of prognathism (snout or muzzle)
- gap between incisors and canines
- Chin
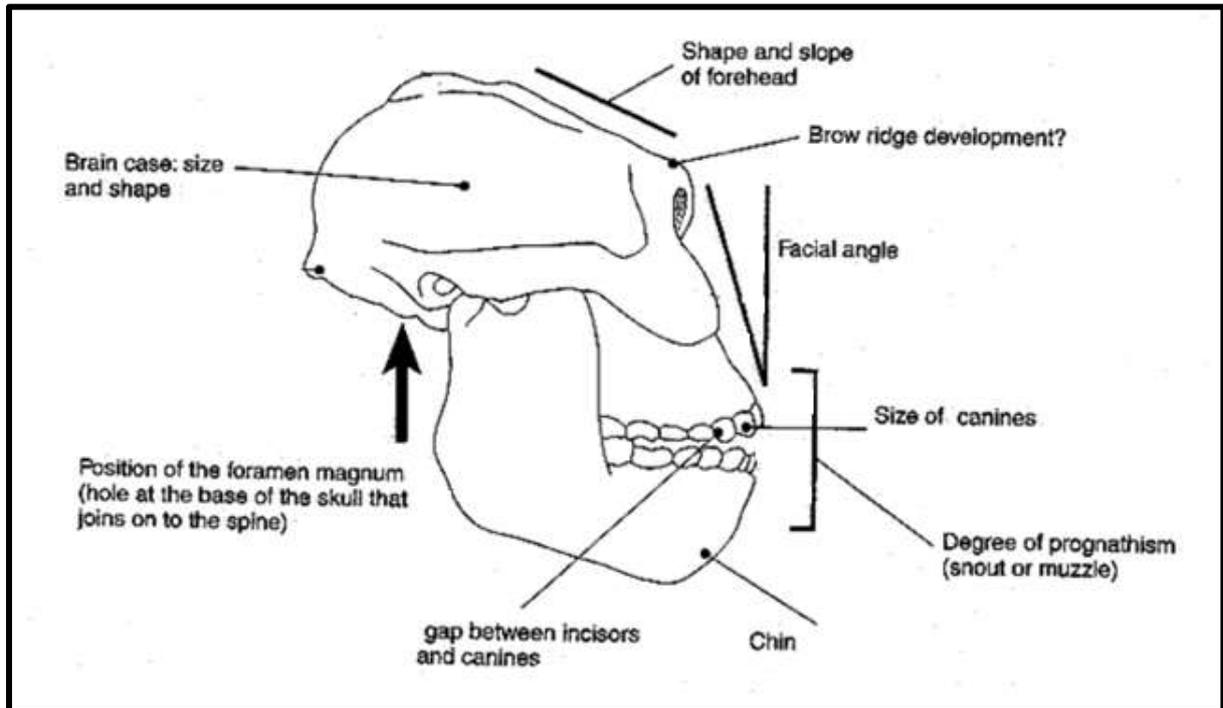
| Homo sapiens	Other primates
1. Larger cranium	1. Smaller cranium
2. Flat face/ Forehead slope less backwards	2. Face sloping/ Foreheads slope more backwards
3. Foramen magnum **more** forward at the bottom of the skull	3. Foramen magnum **more** backwards Position at the bottom of the skull
4. Brow ridges are not **well developed**	4. Brow ridges are **well developed**
5. **Smaller** canines	5. **Larger** canines
6. **Smaller spaces**/diastema between the teeth	6. **Larger spaces**/diastema between the teeth
7. Jaws with teeth on a gentle/round curve/**C** - shape	7. Jaws with teeth in a rectangular/**U** shape
8. Jaws None – prognathous/ Less protruding jaw	8. Jaws prognathous/ More protruding jaw
9. Lower jaw has a well-developed chin	9. Lower jaw has poorly developed chin
10. No cranial ridge	10. Cranial ridges at the top of the cranium
11. Spine more curve/ S- shape	11. Less curve/ C- Shape
12. Pelvic gridle short and wide	12. Pelvic gridle long and narrow
13. Palate small and round	13. Palate long and rectangular
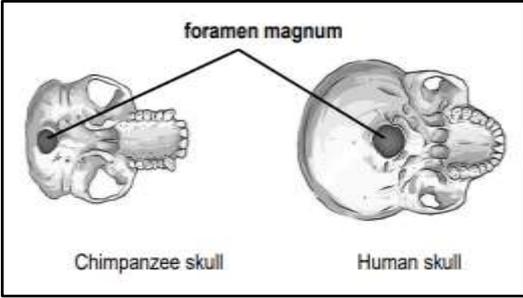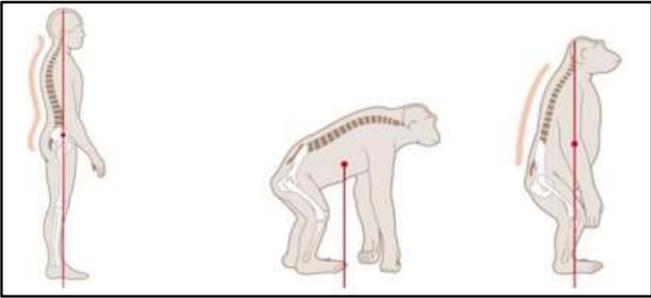
(visible features)

Mistakes made when answering anatomical differences/ visible differences

|	
Brain size- if the brain is not indicated in a diagram, you cannot state large brain and small brain when the question refers to visible differences.	**Skull with brain** **Skull without a brain**
Foramen magnum **Human-** *more forward position* **African apes**-*more backwords position* *In both cases you must refer to more forward/backwards position at the bottom of the skull*	
Brow ridges are well or not well develop. (number 4) No marks will be allocated for: • Big and small brow ridges • Visible and not visible • Prominent and not prominent	
Lower jaw has a well-developed chin or poorly develop chin (number 6) No marks will be allocated for: • Prominent and not prominent • Big and small chin	
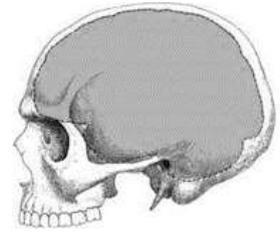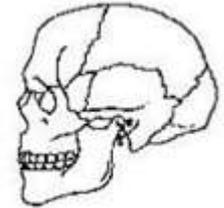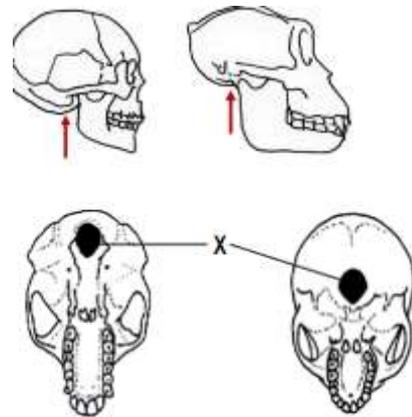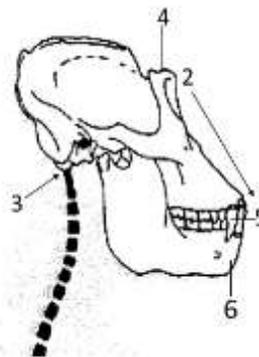
JAWS	In African Apes
In Humans **None – prognathous** **OR** **Less protruding**	**Prognathous** **OR** **More protruding**
Teeth Canines is larger or smaller **It is <u>canines</u> and not <u>teeth</u>** **Not:** Big and small Larger and shorter Larger and smaller teeth	 canines Chimpanzee Human
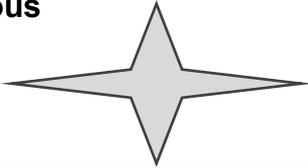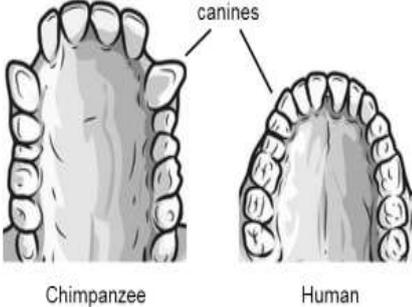
3.   **Th significance of the structural changes that characterise the evolution of modern humans**

| Structure	Significance
Foramen magnum The foramen magnum was in a backward position at the bottom of the skull in the ape-like beings✓ but in a forward position at the bottom of the skull in modern humans✓	This represents a change from quadrupedal in ape-like beings To bipedalism in modern humans, leading to the following in modern humans: • Increased awareness of the environment in sensing danger/food • Freeing of the hands to use implements/carry objects/weapons/ offspring • Exposure of a large surface area for thermoregulation S /lose body heat to surroundings in hot conditions/reduce overheating • Display of sex organs /breasts as part of courtship behaviour
Cranium Modern humans have a larger cranium than the ape-like beings	This allowed space for a larger brain in humans than in ape-like beings, making the following possible:

Modern humans have a less sloping forehead than the ape-like beings Modern humans have a cranium that is more rounded than the ape-like beings	• Better co-ordination of movement • Processing of a large amount of information • Processing information faster • Development of spoken and written languages to communicate

| Structure	Significance
Jaws Humans have jaws that are <mark>non-prognathous</mark> compared to the jaws of ape-like beings which are prognathous	• This corresponds with a change in diet from hard, raw food$\checkmark^S$ in the ape-like beings • To softer, cooked food$\checkmark^S$ in humans
Dentition/Teeth In ape-like beings there are gaps/diastema between incisors and canines but no gaps between the teeth in humans Humans have smaller canines than the ape-like beings Humans have flatter molars and pre-molars than the ape-like beings	• This corresponds with the decreased need to bite and tear • and an increased need to grind and chew in humans • in view of the change in diet to soft, cooked food
Chin In humans the chin is more developed compared to the ape-like beings	• Developed chin assists with speech in humans
Zygomatic arch In humans the zygomatic arch is less developed than in the ape-like beings	• This corresponds with the decreased need for attachment of strong muscles • due to the decreased jaw size in humans
Pelvis Humans have a (Wide and short) pelvis, apes have a (Long and Narrow pelvis)	• Support greater wight due to the upright position
Spine Humans' spine is more curve/ S- shape and ape-like beings is less curve/ C- Shape	• For flexibility • Shock absorption

ACTIVITY 14

14   Parts of an African ape an a human skeletons

DIAGRAM A   **DIAGRAM B**

DIAGRAM C   **DIAGRAM D**

<u>SKELETON PARTS OF AFRICAN APE AND</u>
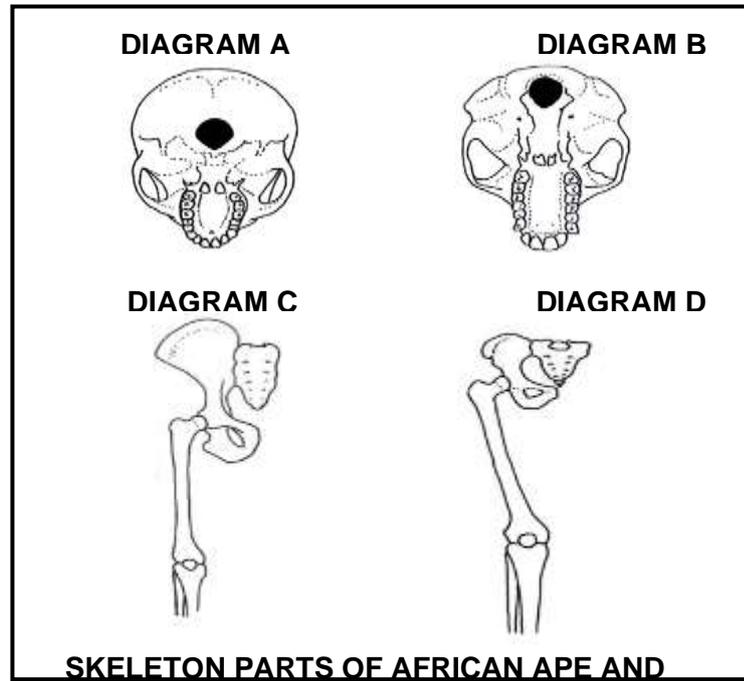
14.1.1.   Organism **A** and **B** belong to the same order and family. Give the name of the order and family   (1)

14.1.2.   Give FOUR similarities they share regarding their **upper limps**   (4)

14.1.4.   Which organism   (1)
       a) belong to the hominin group
       b) Is quadrupedal
       c) Is Mammalia

14.1.5.   What is the different function of the opposable thumbs of organism **A** and **B**   (2)

14.1.6.   Give any other similarities that you did not mention in 1.2

14.2   Fossilised skulls of three different species of primates
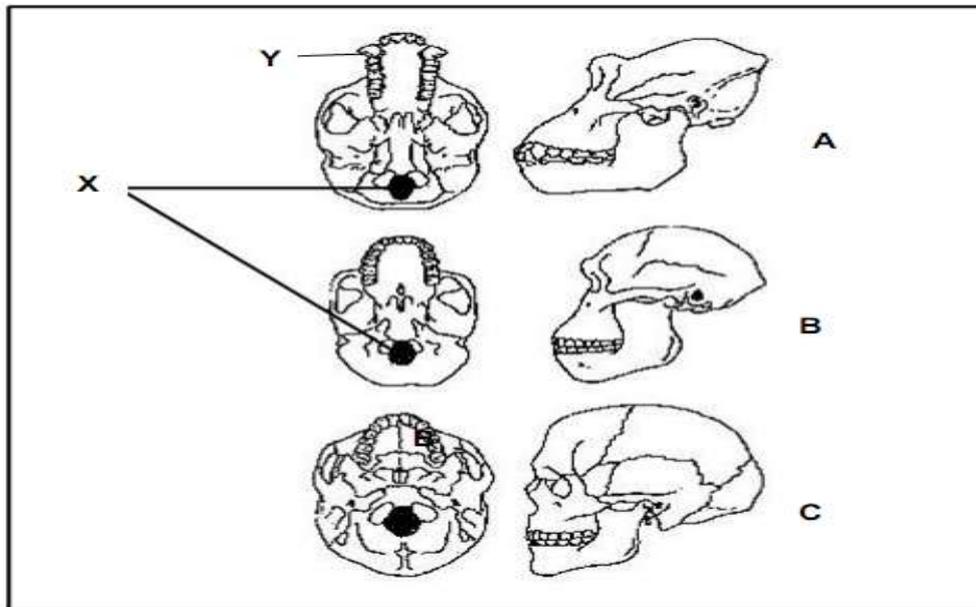
14.2.1.   Give the label for **X and Y**   (1)

14.2.2.   Which skull belongs to   (2)

          a) Hominidae
          b) Hominin
          c) Bipedal

          -
14.2.3.   Explain how the change in the skull from **B** to **C** could indicate   (4)
               change in intelligence

14.2.4   Tabulate FIVE visible differences between the skulls of **A** and **C**   (2)

Teaching tool 11: The out of Africa Hypothesis

Modern humans originated in Africa and then migrated to other continents.
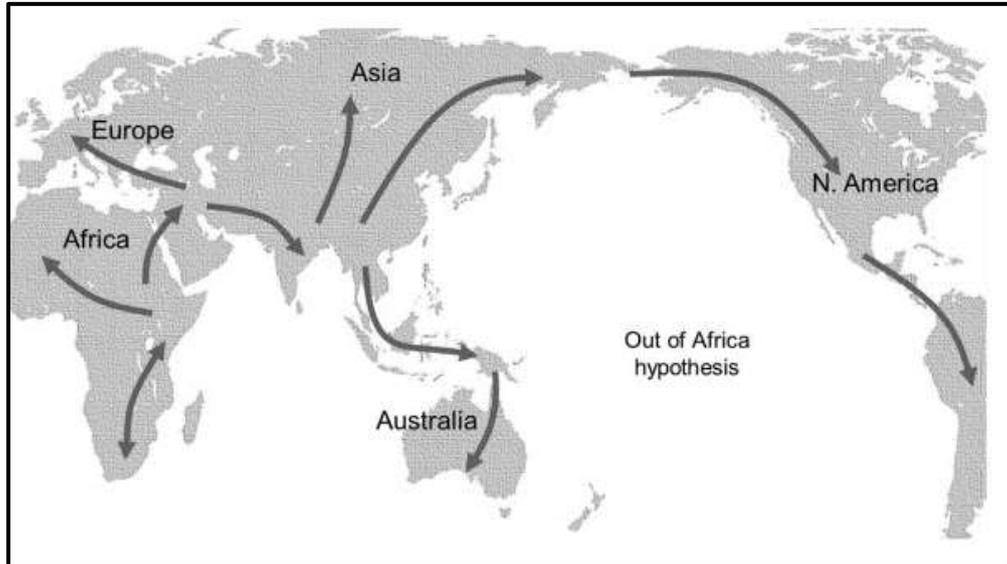
Evidence for the 'Out-of-Africa' hypothesis:

1. **Fossil evidence:**

   Information on each of the following fossils that serve as evidence for the

   'Out-of-Africa' hypothesis:

   o Ardipithecus fossils found in **Africa only**

   o Australopithecus fossils found in **Africa only** (Karabo, Little Foot, Taung

      Child, Mrs Ples)

   o Homo -fossils -

   - **Homo habilis** found in **Africa only**
   - **Oldest fossils** of **Homo erectus** and **Homo sapiens** found in Africa,
   - **Younger fossils** were found in other parts of the world)

2. **Genetic evidence: mitochondrial DNA (see teaching tool 10)**

Teaching tool 10: **Lines of evidence** that support the idea of common ancestors for living hominids including humans **(what is important to learn about fossils)**

1. Fossil evidence:

Evidence from fossils of different ages show that the anatomical characteristics of organisms changed gradually over time.
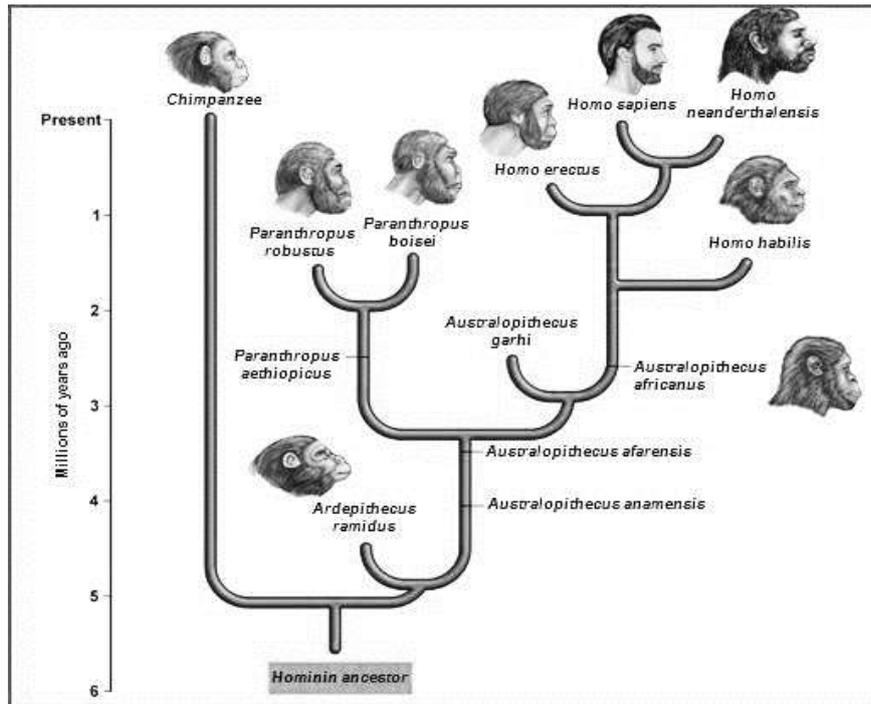
| Tree phyla are used in the fossil evidence |
| --- |
| **Ardipithecus → Australopithecus → Homo** (what learners must know in fossil evidence – lines of evidence) |
| **# It is very important to know the line of fossil evidence and the fossils that is use as reference (where they are found, who discovered them etc.)** |

Fossils that is use as reference	
Ardepithecus	*Ardepithecus ramidus*
Australopithecus	***Australopithecus afarensis*** – *Lucy*
	Australopithecus africanus Mrs. Ples Taungchild Little foot
	Australopithecus sediba *Karabo*
Homo	*Homo habilis* (the one that used tools) *Homo erectus* (the first to stand up straight) *Homo sapience* (modern humans of today)

Changes in structure that characterise human evolution (learners are expected to list the differences and the significance that these differences are bringing along**)**

> - Emphasis on evolutionary trends provided by the anatomical features of fossils of the following three genera: o Ardipithecus o Australopithecus o Homo as well as:
> - The age of each fossil found/time-line for the existence of the three genera
> - The fossil sites where they were found: emphasis on the fossil sites that form a part of the Cradle of Humankind
> - The scientists who discovered them
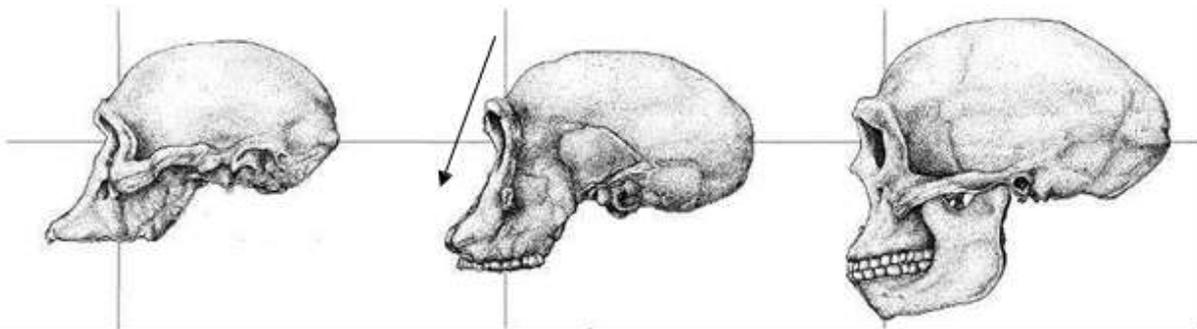
Australopithecus   **Homo habilis**   **Homo sapience's**

- Bipedalism (Shift of foramen magnum to a more forward position)
- A more rounded skull and increased cranium size
- A flatter face due to:
- less sloping forehead
- less protruding jaws (decreased prognathous)
- a more developed chin
- A more rounded jaw
- Increased size of skeleton which mean increased height
- Change in dentition

The table below shows the characteristics of different organisms (as obtained from a study of their fossils) that are thought to be in the same lineated to the evolution of modern humans.

The fossils are dealt with in the order in which they appeared on earth
(the characteristics will be given to learners but learner must know who discovered the fossil)

Organism	When organism	Fossil site	discovered by	Characteristics
Ardipithecus ramidus (Ardi)	5 – 4 mya	North-East Ethiopia	Tim White	Brain size: 300–350ml Forward position of foramen magnum Very prognathous (more protruding jaws) Heavy brow ridges Pelvis structure: bipedal and tree
Australopithecus afarensis (Lucy)	4 – 2,7 mya	Ethiopia, Kenya, Tanzania	Donald Johanson	Brain size: 375–550ml Forward position of foramen magnum Very prognathous Heavy brow ridges Canines large and pointed Long arms No cranial ridge
Australopithecus africanus (Mrs. Ples, Taungchild, Littlefoot)	3 – 2 mya	Mrs. Ples Taung; Sterkfontein Little foot	Robert Broom Raymond Dart Ron Clark	Brain size: 428–625 ml Forward position of foramen magnum Prognathous Brow ridges Teeth large, canines not long Long arms No cranial ridge
Australopithecus sediba (Karabo)	1,9 – 1,8 mya	Malapa Cave – in the cradle of humankind	Lee Burger	Brain size: 420 ml Less prognathous Brow ridges Large teeth, canines not long Long arms
Homo habilis	2,2 – 1,6 mya	Tanzania	Louis and Mary Leakey	Brain size: 650 ml Less prognathous Less pronounced brow ridges Human-like teeth – smaller
Homo erectus	2 – 0,4 mya	Java in Indonesia and then Swartkrans	Eugene Dubois	Brain size: 900 ml Prognathous Cranial ridges Short canines

| Organism	When organism	Fossil site	discovered by	Characteristics
Homo sapiens	200 000 years ago – present	Makapansgat in Limpopo; Border Cave in KZN; Blombos Cave in the Western Cape	Tim White	Brain size: 1200–1800 ml No brow ridges Small teeth Short

==Australopithecus Fossils found in the Cradle of humankind==
- Homonid species found in South Africa

- Mrs. Ples(Australopithecus africanus),
- Little foot (Australopithecus africanus),
- Taung child(Australopithecus africanus),
- Karabo(Australopithecus sediba) is also regarded as Is the missing link between Austrolopithecus Africanus and Homo erectus.

2. Genetic evidence: mitochondrial DNA

**Apart from DNA in the nucleus, DNA also occurs in the mitochondria as mitochondrial DNA**

- mtDNA of the sperm cell does not fuse with mtDNA of the egg cell
- mtDNA is therefore handed down from **mother to child**

- By following mutations in mtDNA, we can trace our female line of descent.
- Using mutant nucleotides of Y-chromosomes
- Spencer Wells and his colleagues have traced lineage of everyman alive to a common ancestor who lived in East Africa about 60 000 years ago.
- Analysis of mitochondrial DNA leads to ancestral female who lived in East Africa about 150 000 years ago.
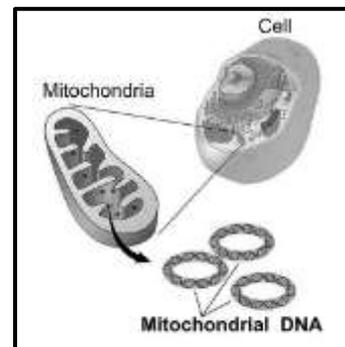
Given the amount of genetic material shared between humans and other hominids (the apes), they must have had a common ancestor who lived approximately 5 – 6 million years ago.

3. Cultural evidence: toolmaking

- A very important aspect of human evolution, separating humans from other hominids, is the development and use of tools.
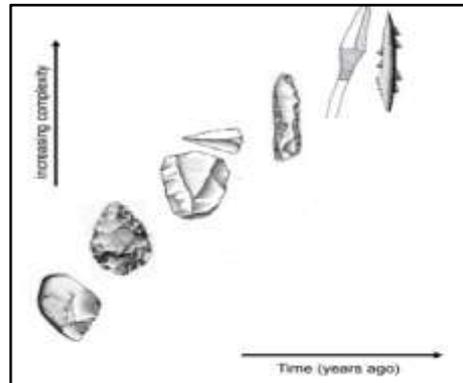
- Art also contributed. The earliest known art dates from about 100 000 years ago, and the earliest cave paintings (see Figure 26 below), of which we have an abundance in South Africa, were made some 40 000 years ago
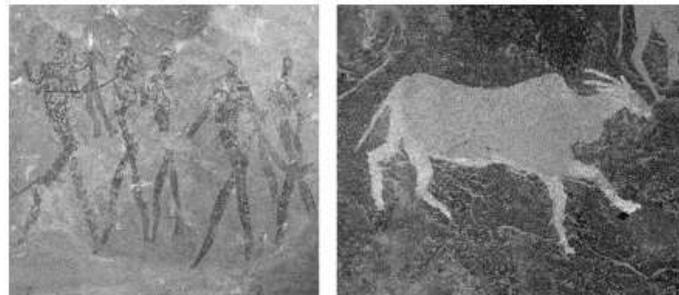
- Behaviour like burial sites

ACTIVITY 15

15   The extract below is about human evolution

> In 2004 scientists in Indonesia discovered the first fossil of the species *Homo floresiensis* along with stone tools and animal remains. The fossil was made up of a nearly complete skull and skeleton, including hand and foot bones and a pelvis.
>
> Dating of the tools suggests that *H. floresiensis* may have lived from as early as 95 000 years ago until about 12 000 years ago.
>
> Researchers closely analysed three wrist bones and found that they more closely resembled those of apes than modern humans. This finding implied that *H. floresiensis* was indeed a separate species from modern humans.
>
> They had skulls that resembled early *Homo* species. This included a flat forehead and a short, flat face; however, their teeth and jaws more closely resembled *Australopithecus*.
>
> The scans of the skull suggested that the brain volume of *H. floresiensis* was about 426 cm^3; around one-third the size of the modern human brain which has an average volume of about 1 300 cm^3. The findings suggested that *H. erectus* may be the ancestor of *H. floresiensis*, as *H. erectus* had brains about 860 cm^3 in size or, alternatively, it may have evolved from *H. habilis*, whose brains were about 600 cm^3 in size.

15.1 .1   Name the TWO lines of evidence for human evolution that is   (2)
               referred to in the extract above

15.1.2   How long did Homo floresiensis exist on Earth?   (1)

15.1.3   Name ONE Homo ancestor mentioned in the extract   (1)

15.1.4   Describe ONE feature of the skull that can be used as evidence   (2)
               for bipedalism

15.1.5   State TWO similarities between the hands of African apes and   (3)
               modern humans.

15.1.6   State THREE features of the jaw of H. floresiensis that might
               have led scientists to believe that it resembled that of
               Australopithecus, rather than of a Homo species

15.1.7   Draw a table to show the brain volumes of the different Homo   (4)
               species, using information from the extract.

15.2. Scientists use fossils as evidence for human evolution. The brain volume of some extinct primates has been estimated from their fossils and have been compared to the brain volumes of living primates

PRIMATE	PERIOD OF EXISTENCE (million years ago)	AVERAGE BRAIN VOLUME (cm^3)
Ardipithecus ramidus	5,8 to 4,4	400
Australopithecus afarensis	4 to 2,7	450
Australopithecus africanus	3 to 2	450
Homo habilis	2,2 to 1,6	750
Homo erectus	2 to 0,4	1 000
Homo neanderthalensis	0,3 to 0,23	1 500
Homo sapiens	0,2 to present	1 400
Modern apes	0,2 to present	500

15.2.1. What type of evidence of human evolution is given in the table   (1)

15.2.1. Give the

    a) Family to which all these fossils belong to   (1)
    b) First primate that become extinct   (1)
    c) Genes of erectus   (1)
    -

15.2.3 Name FOUR fossils of *Australopithecus* that is found in Africa only   (4)

15.2.4 The brain of an organism is not preserved as a fossil. How do scientists determine the brain volume of extinct primates?   (2)

15.2.5 Give evidence in the table that suggests that:

    a) Homo habilis and Homo erectus may have existed at the same time   (1)
    b) Ardipithecus was the most primitive of all the primate genera   (1)

15.2.6 Draw a bar graph to show the average brain volume of EACH of the species of the genus Homo.   (6)

15.2.7 Explain how genetic evidence as a line of evidence contribute for human evolution

ACTIVITY 16

16   The image below is of Mrs. Ples

16.1.1   Give the

     a) Genes and specie to which Mrs. Ples belong to   (1)
     b) Site where Mrs. Ples is found - The scientist that found   (1)
        Mrs. Ples –   (1)

16.1.2   Name THREE ape-like features of this skull   (3)

16.1.3   If ask to decide whether a complete skull with jaw- bones was   (8)
        that of *Ardipithecus or Australopithecus*, describe what four
        features would you examine

2 16.2.1.   Complete the table

Organism	Fossil site	Discovered by
Aridipithecus		
		Lee Berger
	Indonesia and Swartkrans	
	Makapansgat in Limpopo; Border Cave in KZN	Tim White
Lucy		Donald Johanson
	Sterkfontein	R Dart

16.2.2.   Give the name of the *Australopithecus afarensis* that was found
        in Kenya and Tanzania

16.2.3.   *Give the Australopithecus africanus that was discovered by*
        a) Robert Broom
        b) R Dart
        c) Lee Berger
        d) Ron Clark