GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GAUTENG DEPARTMENT OF EDUCATION

PREPARATORY EXAMINATION

2020

10832

LIFE SCIENCES

PAPER 2

TIME: 2½ hours

MARKS: 150

17 pages

INSTRUCTIONS AND INFORMATION

Read the following instructions carefully before answering the questions.

1. Answer ALL the questions.
2. Write ALL the answers in the ANSWER BOOK.
3. Start the answers to EACH question at the top of a NEW page.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Present your answers according to the instructions of each question.
6. Do ALL drawings in pencil and label them in blue or black ink.
7. Draw diagrams, tables or flow charts only when asked to do so.
8. The diagrams in this question paper are NOT necessarily drawn to scale.
9. Do NOT use graph paper.
10. You may use a non-programmable calculator, protractor and a compass, where necessary.
11. Write neatly and legibly.

SECTION A

QUESTION 1

1.1 Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A – D) next to the question number (1.1.1 to 1.1.9) in your ANSWER BOOK, for example 1.1.10 D.

1.1.1 Which of the following statements supports the theory of evolution?

A All life on earth originated on land.
B Rocks can be dated by radiometric dating.
C Genotypes and phenotypes of individuals of the same species are all identical.
D Fossils show that life has a long history.

1.1.2 Which of the following is the CORRECT definition of a species?

A A group of similar organisms that live in the same habitat at the same time
B A group of similar organisms that have the same chromosome number
C A group of organisms that are similar in size, shape and colour
D A group of similar organisms that are able to interbreed to produce fertile offspring

1.1.3 In rabbits, grey fur colour is dominant to white fur colour.
A heterozygous grey rabbit is mated with a white rabbit.
What is the percentage chance of the offspring being grey?

A 50
B 100
C 0
D 25

1.1.4 The following is the DNA base sequence coding for a portion of a particular protein:

GTT TAC TAC TCT TCT TCT TTA

How many types of amino acids are coded for by this sequence?

A 3
B 7
C 4
D 5

1.1.5 A phylogenetic tree represents …

A the number of species on earth.
B possible evolutionary relationships.
C only organisms that are now extinct.
D only species that belong to the same genus.

1.1.6 In multiple alleles …

A more than one gene controls a characteristic.
B more than two alleles occur for the same gene.
C many genes code for the same allele.
D there are only two alleles for a particular gene.

1.1.7 Scientists wanted to investigate the effect of insecticides on mosquitoes.

They carried out some of the following steps, though not necessarily in this order:

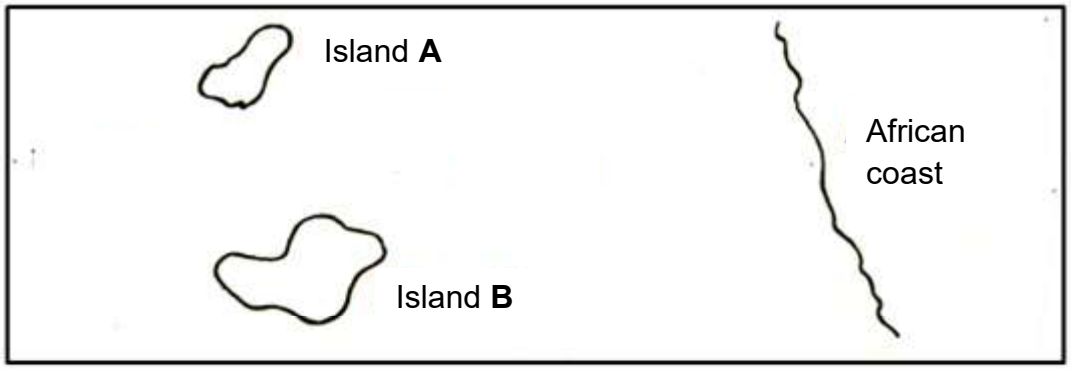
(i) The first sample of mosquitoes was collected.
(ii) The data was recorded in the table.
(iii) A decision was made where to collect the mosquitoes.
(iv) A method of how to capture the mosquitoes was selected.
(v) The concentration of the insecticide dose was decided.

Which of the following combinations represents the *planning* steps of this investigation?

A (i), (ii), (iii), (iv) and (iv)
B (ii), (iii), (iv) and (v) only
C (ii), (iii) and (iv) only
D (iii), (iv) and (v) only

QUESTION 1.1.8 is based on the information, diagram and table below.

Three related species of insect have been studied in three separate locations. The insects may be grey or black in colour and may have wings or may be wingless. Scientists used their phenotypes, locations and fossil ages as evidence for speciation.



Location	Characteristics	Age of Fossil evidence
Island **A**	Grey body, wingless	100 000 years ago
Island **B**	Black body, wingless	100 000 years ago
African coast	Grey body, with wings	1 000 000 years ago

1.1.8 Below is a list of possible explanations regarding their speciation:

(i) The African coast is less windy than the two islands.
(ii) The common ancestor migrated from island **A** to the African coast.
(iii) Island **B** has darker soil.
(iv) The insects on the two islands evolved due to identical environmental conditions.
(v) Speciation occurred due to geographic isolation.

Which of the following is the correct combination as an explanation for this speciation?

A (i), (ii), (iii), (iv) and (v)
B (i), (iii) and (v) only
C (iii) and (iv) only
D (ii), (iii) and (iv) only

1.1.9 A boy is colour-blind. What could the possible genotype of his mother be?

A bb
B X^bY
C X^BX^b
D X^BX^B

(9 x 2) **(18)**

1.2 Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (1.2.1 to 1.2.9) in the ANSWER BOOK.

1.2.1 The type of inheritance that results in an intermediate phenotype in the heterozygous condition

1.2.2 The failure of a pair of homologous chromosomes to separate normally during meiosis

1.2.3 The type of digit on the hand in humans that allows for better grasping and manipulation of tools

1.2.4 A genetic disorder that is characterised by the absence of a clotting factor

1.2.5 The site of meiosis in human males

1.2.6 The phase of meiosis during which homologous chromosomes pair up

1.2.7 The genus to which humans belong

1.2.8 Undifferentiated cells that can give rise to any type of body cells

1.2.9 An explanation of an observation that is supported by facts, models, and laws

(9 x 1) **(9)**

1.3 Indicate whether each of the descriptions in COLUMN I applies to **A ONLY**, **B ONLY**, **BOTH A AND B** or **NONE** of the corresponding items in COLUMN II. Write **A** only, **B** only, both **A** and **B** or **none** next to the question number (1.3.1 to 1.3.3) in the ANSWER BOOK.

COLUMN I	COLUMN II
1.3.1 Evidence for evolution	A: Modification by descent B: Biogeography
1.3.2 The formation of haploid cells	A: Meiosis B: Mitosis
1.3.3 Example of discontinuous variation	A: Height B: Hair colour

(3 x 2) **(6)**

1.4 The table below shows the age and discovery sites of some hominin fossils.

Fossil Species	Age of fossil (mya)	Fossil site
Ardipithecus ramidus	5 – 4	North-East Ethiopia
Australopithecus afarensis	4 – 2,7	Ethiopia, Kenya, Tanzania
Australopithecus africanus	3 – 2	Taung: Sterkfontein
Homo habilis	2,2 – 1,6	Tanzania

1.4.1 Name the major world heritage sites where the following fossils were found.

(a) *Australopithecus africanus* (1)

(b) *Ardipithecus ramidus* (1)

1.4.2 Name the genus of the fossil that was discovered in Ethiopia and is regarded as the most recent ancestor of all *Australopithecines.* (1)

1.4.3 Which OTHER species existed at the same time as:

(a) *Ardipithecus ramidus?* (1)

(b) *Homo habilis*? (1)

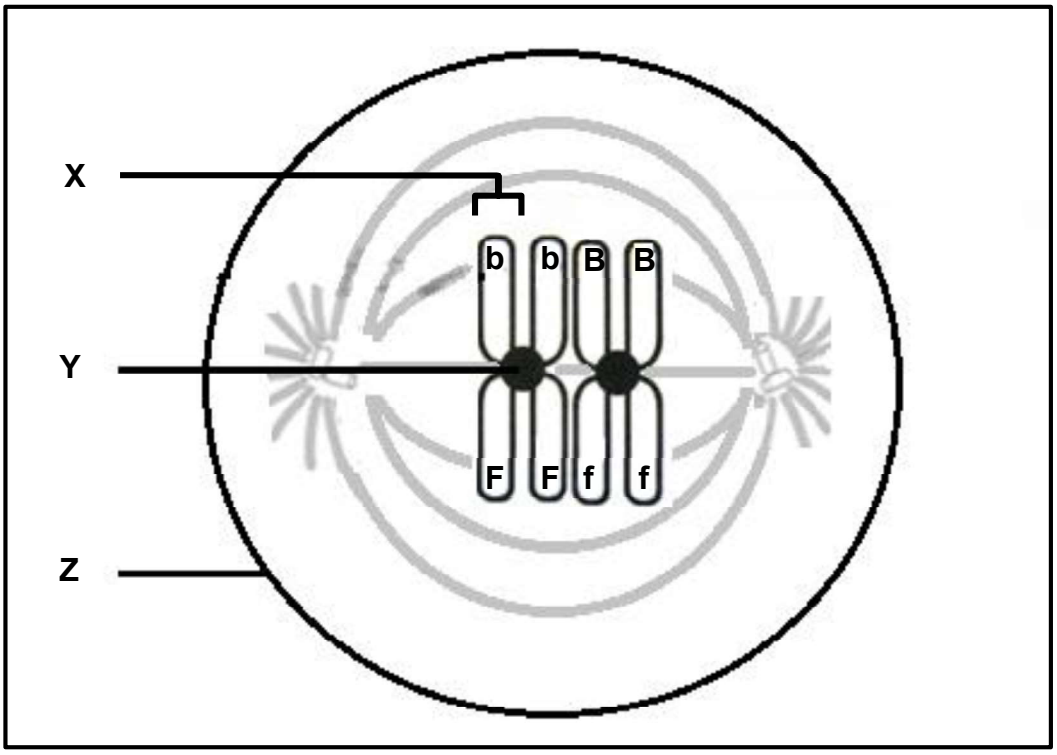
1.4.4 Name ONE characteristic of the spine of *Australopithecus* that allowed for bipedal movement. (1)

1.4.5 Name TWO fossils of *Australopithecus africanus*, that were found in or near the Sterkfontein caves. (2)

1.4.6 Which other species of *Australopithecus* was recently discovered that is believed to be a transitional fossil? (1)
(9)

1.5 The diagram below shows two chromosomes in a human cell, undergoing meiosis.

The letters on the chromosomes indicate the alleles for hair colour and freckles as follows: black hair (**B**); blonde hair (**b**); freckles (**F**) and no freckles (**f**).



1.5.1 Identify the stage of meiosis shown in the diagram. (1)

1.5.2 Provide labels for **X**, **Y** and **Z**. (3)

1.5.3 Name TWO processes in meiosis that ensure genetic variation in the gametes produced. (2)

1.5.4 Give the:

(a) Recessive phenotype for hair colour (1)
(b) Genotype of this individual (1)
(8)

TOTAL SECTION A: 50

SECTION B

QUESTION 2

2.1 A genetic condition called muscular hypertrophy or double-muscle phenotype in cattle results in an increase in the number of muscle fibres. The condition is caused by a recessive allele and causes difficulty in calving (giving birth), reduced stress tolerance, reduced fertility, and reduced calf survival.

When beef cattle were artificially selected for their meat-producing qualities, it was noticed that the condition became more frequent.

2.1.1 What is *artificial selection*? (2)

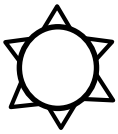
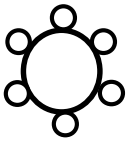
2.1.2 Give TWO negative effects of muscular hypertrophy. (2)

2.1.3 Why would scientists continue with artificial selection, even though it increased the chances of the disorder occurring? (3)

2.1.4 Use a genetic cross to show that a normal cow and a normal bull can produce offspring with the condition. Use the letter (**N**) to indicate normal muscle production and (**n**) for the double-muscle condition. (6)

2.1.5 Use the genotypic ratio of the F1 generation in QUESTION 2.1.4 to explain why cross-breeding the individuals of the F1 generation will increase the frequency of the disorder. (3)
(16)

2.2 Blood groups in humans are determined by three alleles of a single gene. Each allele codes for an antigen on a red blood cell that has a specific shape. The alleles, antigens and blood groups are shown in the table below.

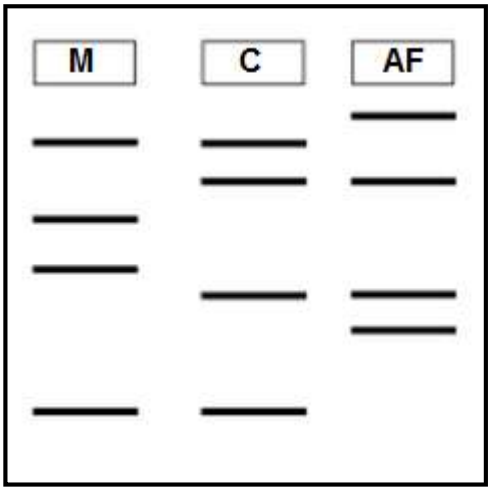
Allele	I^A	I^B	i	I^AI^B
Antigen	A	B	None	Both
Antigen shape	△	○	N/A	△ and ○
Phenotype (blood group)	A	B	**1**	**2**
Red blood cell appearance			**X**	**Y**

2.2.1 Identify the missing blood groups **1** and **2** respectively. (2)

2.2.2 Draw a schematic diagram of two red blood cells **X** and **Y**, which would represent blood groups **1** and **2** respectively**.** (5)
(7)

2.3 A man claims to be the father of a child. The mother denies that he is the biological father and requested a DNA paternity test.

The DNA profiles of the mother, child and alleged father are shown below.



Key:
M: Mother
C: Child
AF: Alleged Father

2.3.1 Is the man the biological father? (1)

2.3.2 Explain your answer to QUESTION 2.3.1. (3)

2.3.3 State TWO other uses for DNA profiling. (2)
(6)

2.4 In squirrel monkeys, there are two alleles for colour vision found on the X chromosomes.
X^R codes for red colour vision and X^G codes for green colour vision.
Male monkeys can have the genotype $X^R Y$ or $X^G Y$ only.

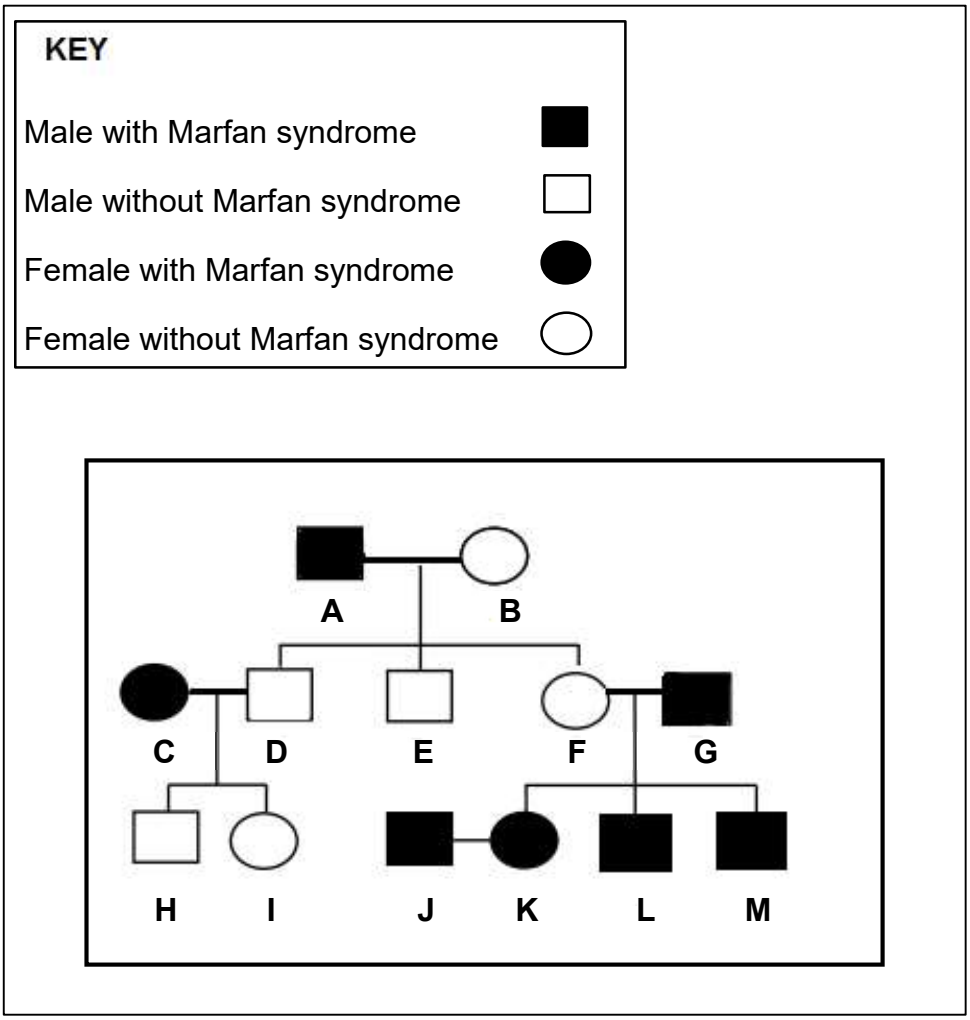
2.4.1 What conclusion about MALE squirrel monkeys can be made from the above information regarding their colour vision? (2)

2.4.2 Squirrel monkeys live in trees and feed largely on fruit and insects. Suggest ONE reason why the ability to distinguish between red and green may be relevant to their survival. (1)

2.4.3 A female squirrel monkey can also be red or green colour blind. Explain how this is possible. (2)
(5)

2.5 An autosomal genetic disorder known as Marfan syndrome affects the connective tissue of the body and is caused by a dominant allele (**T**),

The pedigree diagram below illustrates the inheritance of this disorder in a family.



2.5.1 Give the genotypes of individuals **A** and **B** respectively. (2)

2.5.2 Give the letter/s of ALL the possible heterozygous individual/s in the second generation. (1)

2.5.3 Give a reason for your answer to QUESTION 2.5.2. (2)

2.5.4 Individual **M** married a woman that is heterozygous for the condition. What percentage of their offspring would be without Marfan syndrome? (1)
(6)
[40]

QUESTION 3

3.1 Read the following extract.

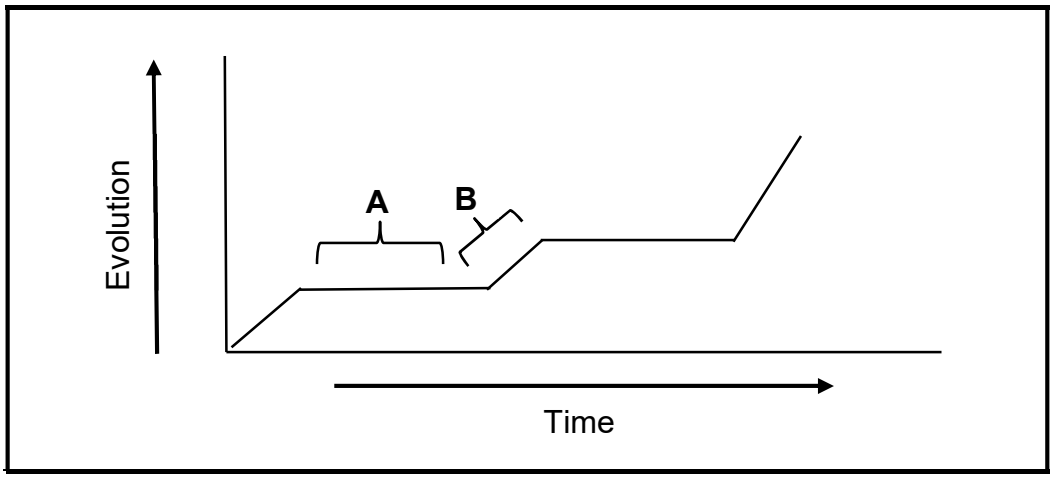
> Penguins are birds that cannot fly. This does not seem to make them good candidates for survival. In Antarctica, and other places where penguins live, there are few natural predators on land. There is also more prey available in the water than on land. Losing the ability to fly is therefore not really a disadvantage to the penguins.
>
> However, instead of flying, penguins are adapted to be master swimmers. This benefits them greatly in finding food and escaping predators in the water. The wings are short with heavy bones which make them better suited to swimming than to flight. The fossils of the penguin ancestor show that their wings were larger, and the bones were much lighter.

3.1.1 State ONE reason why losing the ability to fly is not a disadvantage to penguins. (1)

3.1.2 List TWO ways in which penguins benefit from improved aquatic locomotion. (2)

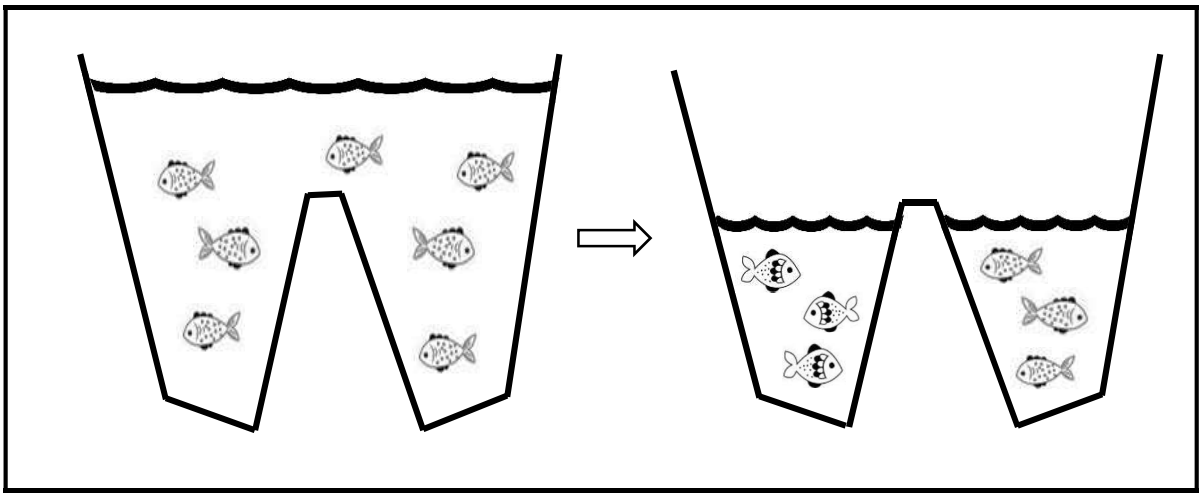
3.1.3 Use Darwin's theory of natural selection to explain how the penguins have all evolved to have short wings with heavy bones. (6)
(9)

3.2 The graph below shows evolution over a period of time and is characteristic of punctuated equilibrium.



Use the labels **A** and **B** on the graph to explain *punctuated equilibrium*. **(5)**

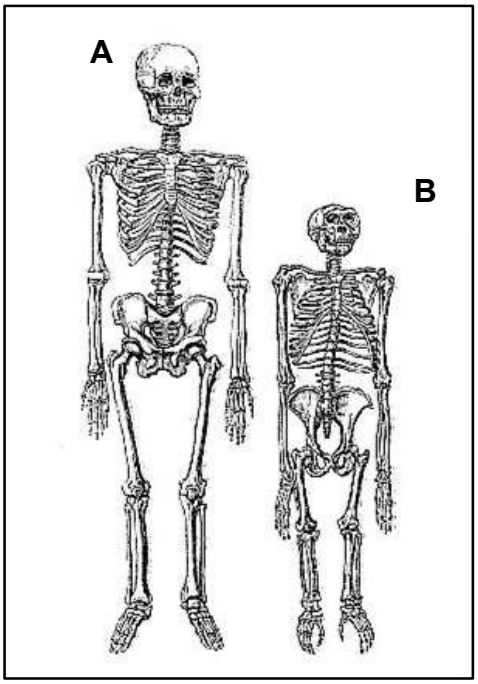
3.3 A lake was once full of water and a population of fish was able to move freely throughout the lake. A severe drought caused the level of water in the lake to drop such that the fish population was separated, as shown in the diagram below. Many years later it was discovered that speciation had occurred.



3.3.1 Describe the type of speciation illustrated in the diagram. (6)

3.3.2 Different species of fish breed at different times of the year. Describe how this reproductive isolation mechanism helps keep species separate. (3)
(9)

3.4 The diagrams below show the skeletons of a modern human and an African ape. The diagrams are NOT drawn to scale.

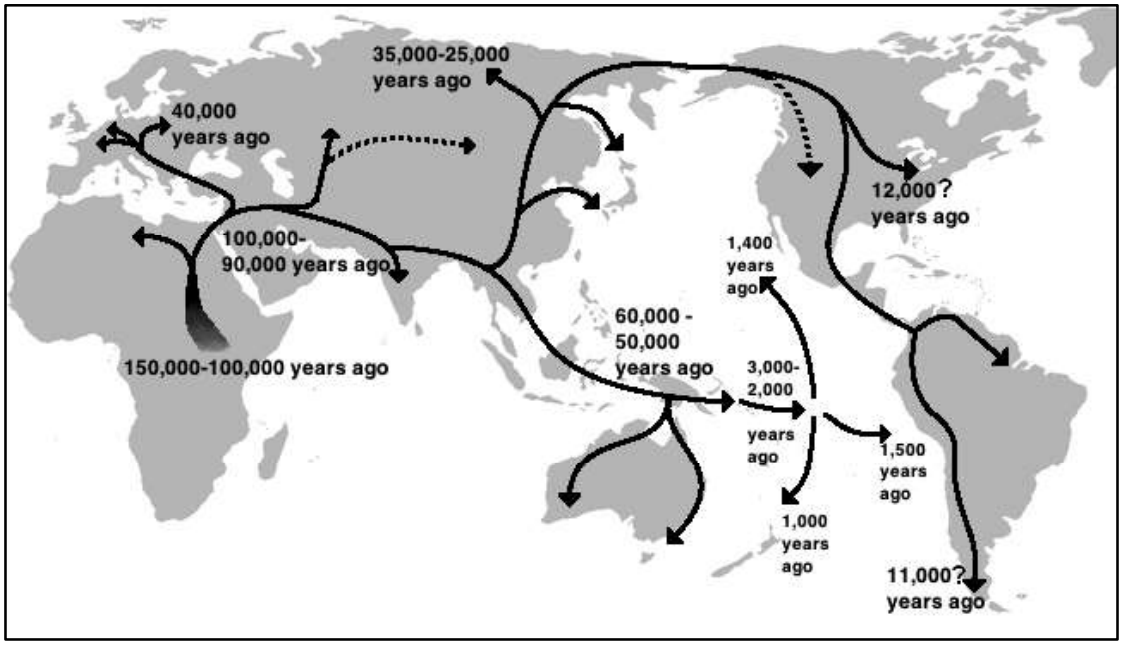


3.4.1 Which organism, **A** or **B**, has a pelvic girdle suited for bipedalism? (1)

3.4.2 Explain your answer to QUESTION 3.4.1. (2)

3.4.3 Tabulate TWO differences between the skulls of organism **A** and organism **B.** (5)
(8)

3.5 The map below illustrates a possible theory on how modern humans migrated to all parts of the world.



3.5.1 Name the hypothesis that supports this theory. (1)

3.5.2 Describe the genetic evidence that supports the hypothesis in QUESTION 3.5.1. (4)

3.5.3 Describe the fossil evidence of hominids found in Africa that supports the migration of modern humans as shown in the map. (4)
(9)
[40]

TOTAL SECTION B: 80

SECTION C

QUESTION 4

"A gene can be described as the sequence of bases on a DNA molecule that codes for the synthesis of a specific protein."

Describe the processes of transcription and translation and explain how a gene mutation can change the protein that should be formed.

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

NOTE: NO marks will be awarded for answers in the form of flow charts, tables, or diagrams.

TOTAL SECTION C: 20

TOTAL: 150

END