Province of the
EASTERN CAPE
EDUCATION

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Porafensie Ya Kapa Botjahabela: Lefapha la Thuto

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2024

LIFE SCIENCES P2

MARKS: **150**

TIME: **2½ hours**

This question paper consists of 16 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 answer 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. ALL drawings MUST be done in pencil and labelled 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 must use a nonprogrammable calculator, protractor and a compass, where necessary.
11. All calculations to be rounded off to TWO decimal spaces.
12. Write neatly and legibly.

SECTION A

QUESTION 1

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

1.1.1 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.

This refers to …

A Mendel's principle of segregation.
B Mendel's principle of independent assortment.
C Lamarck's 'law' of the inheritance of acquired characteristics.
D Chance fertilisation.

1.1.2 Multiple alleles exists when …

A one allele controls the inheritance of a gene.
B two alleles control the inheritance of a gene.
C alleles are inherited from two parents.
D more than two alleles control the inheritance of a gene.

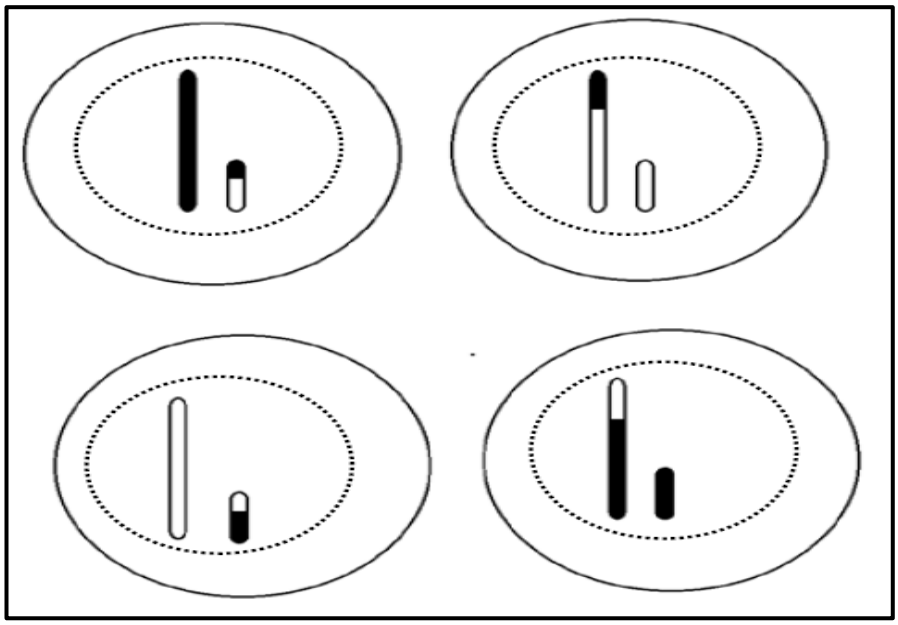
1.1.3 How many nitrogenous bases are found in a protein made up of 66 amino acids?

A 198
B 22
C 132
D 66

1.1.4 A structural difference between nucleic acids is.

	DNA	RNA
A	Double-stranded molecule	Single-stranded
B	Contains the nitrogenous base, uracil	Contains the nitrogenous base, thymine
C	Straight-stranded structure	Helical structure
D	Shorter molecule	Longer molecule

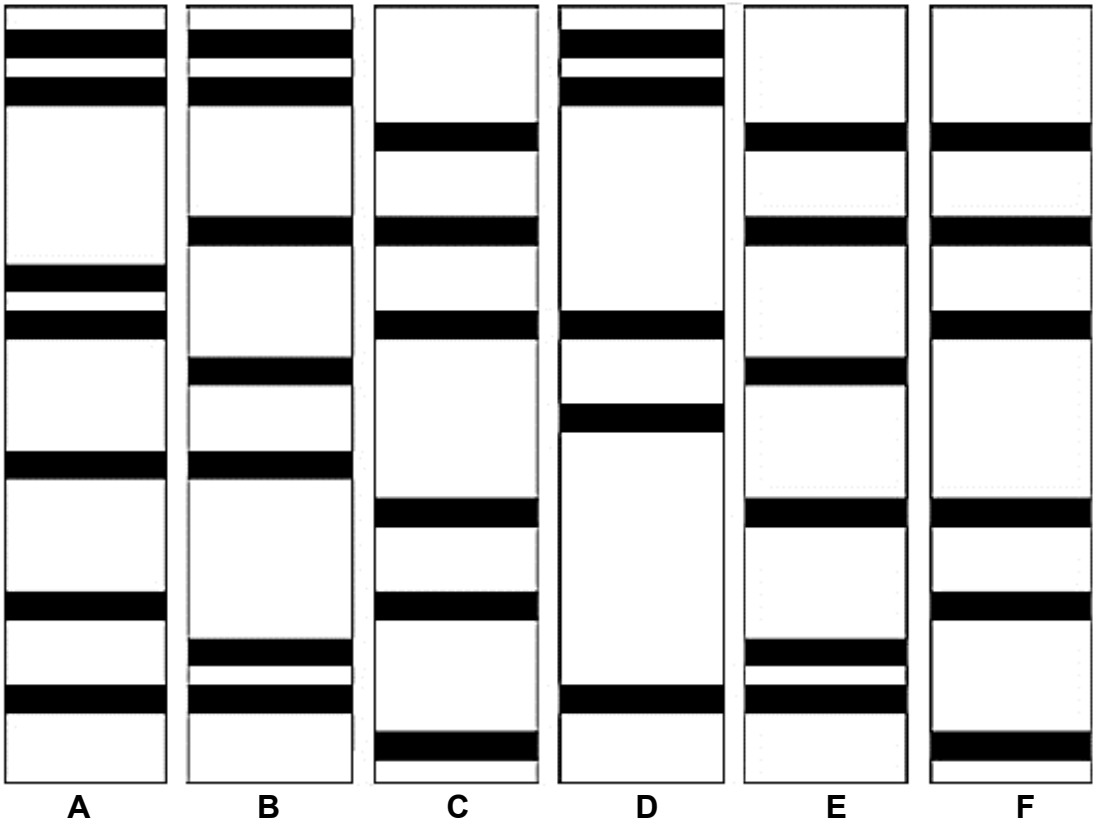
1.1.5 The diagram below shows a phase in cell division.



The phase in the diagram above is …

A prophase II.
B telophase II.
C telophase I.
D telophase.

QUESTIONS 1.1.6 AND 1.1.7 ARE BASED ON DNA PROFILING BELOW.



1.1.6 The parents of individual **B** are …

A A and F.
B C and E.
C A and E.
D D and F.

1.1.7 Which ONE of the following options is NOT used for DNA profiling?

A Matching tissues for organ transplants.
B Diagnosis of inherited disorders.
C Developing cures for inherited disorders.
D Biological evidence in criminal cases.

1.1.8 The diploid chromosomes composition in normal human males is …

A 44 autosomes + XX gonosomes.
B 22 autosomes + Y gonosomes.
C 22 autosomes + XY gonosomes.
D 44 autosomes + XY gonosomes.

1.1.9 A mutation can have the following effects:

(i) Code for the same amino acid
(ii) Change the protein formed
(iii) Cause diseases in an organism
(iv) Not be expressed in the organism's phenotype
(v) Increases chances of survival

Which ONE of the above combinations is ONLY due to harmful mutations?

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

(9 x 2) (18)

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

1.2.1 Representation of the number, shape and arrangement of chromosomes in the nucleus of a somatic cell

1.2.2 Location of extra-nuclear DNA in plant cells only

1.2.3 The point of contact as non-sister chromatids overlaps each other in crossing over

1.2.4 A blood type that has two recessive alleles

1.2.5 Position of a gene in a chromosome

1.2.6 A strand of DNA where nucleotides attach to build a new DNA strand

1.2.7 A condition characterised by an extra chromosome at position 21

1.2.8 The type of bonds that hold nitrogenous bases in a DNA molecule

1.2.9 A condition of the cell where there is only one set of chromosomes

(9 x 1) (9)

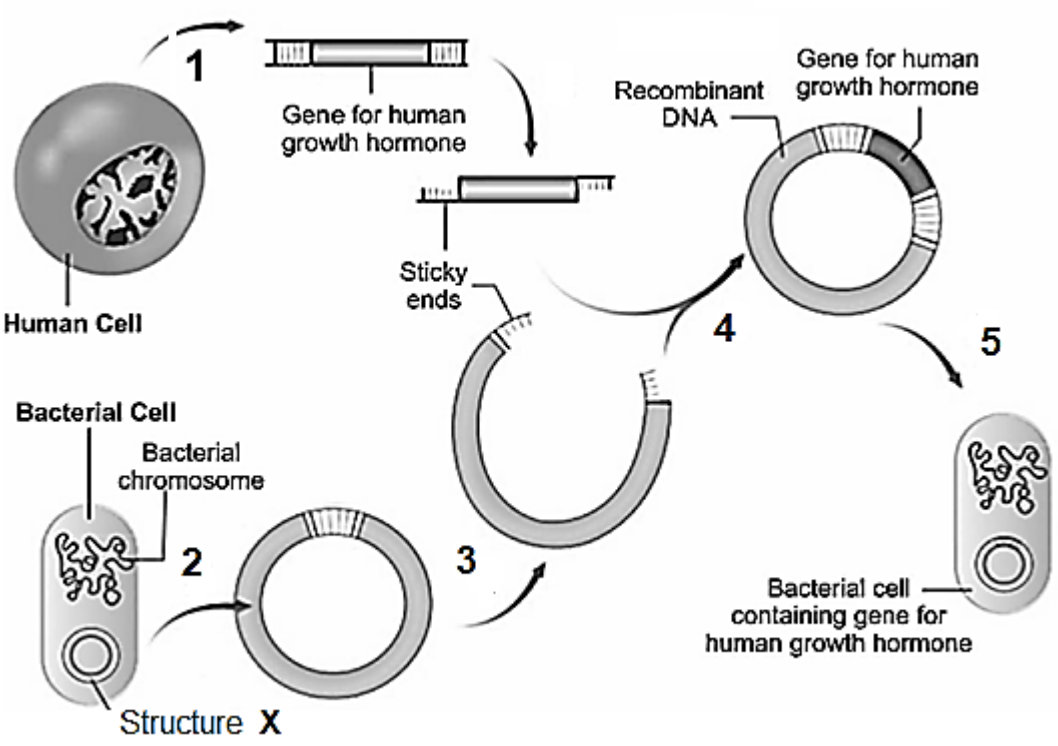
1.3 Indicate whether each of the descriptions in COLUMN I, applies to **A ONLY**, **B ONLY**, **BOTH A and B**, or **NONE** of the items in COLUMN II. Write **A only**, **B only**, **both A and B**, or **none** next to the question numbers (1.3.1 to 1.3.3) in the ANSWER BOOK.

COLUMN I		COLUMN II	
1.3.1	Type of variation that exists in blood groups	A:	Co-dominance
		B:	Discontinuous variation
1.3.2	Cytokinesis occurs twice	A:	Meiosis
		B:	Mitosis
1.3.3	Absence of blood-clotting factors	A:	Haemophilia
		B:	Colour-blindness

(3 x 2) (6)

1.4 Growth hormone is important in promoting skeletal and muscular growth. It can be produced for people who do not secrete, or under secrete this hormone using recombinant DNA technology.

HUMAN GROWTH HORMONE PRODUCTION USING RECOMBINANT DNA TECHNOLOGY



1.4.1 Name the biotechnological process that is shown above. (1)

1.4.2 Identify structure **X** found in a bacterial cell which is used in the above process. (1)

1.4.3 Name the organic catalysts used to cut structure **X**. (1)

1.4.4 Give ONE benefit of:

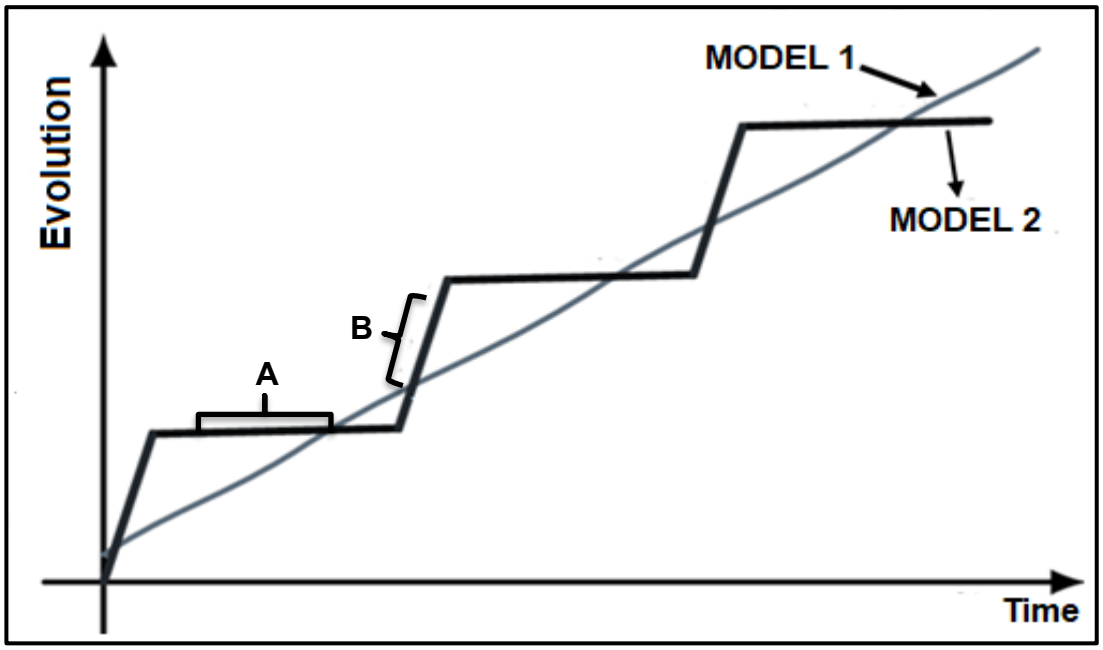
(a) Using growth hormone by sports athletes (1)

(b) The process named in QUESTION 1.4.1 for diabetics (1)

1.4.5 State TWO characteristics of bacteria that make them suitable to be used in the above process. (2)

1.4.6 Describe ONE observable function of the sticky ends as illustrated in the process above. (1)

1.5 The diagram below shows two models used to explain the theory of evolution.



1.5.1 Identify the evolutionary theory in MODEL **2**. (1)

1.5.2 Name the TWO scientists who proposed the theory of evolution in MODEL **2**. (2)

1.5.3 Which evolutionary MODEL **1** or **2** is:

(a) Showing small gradual changes in organisms from one generation to another? (1)

(b) Supported by the absence of transitional fossils? (1)

(c) Supported by a scientist who proposed the theory of evolution by natural selection? (1)

1.5.4 State what happens respectively to species at points **A** and **B** in MODEL **2**. (2)

1.5.5 Name the type of evolution where there is a change in characteristic of a species over time. (1)

TOTAL SECTION A: 50

SECTION B

QUESTION 2

2.1 The diagrams below show a DNA molecule and a phase in meiosis.

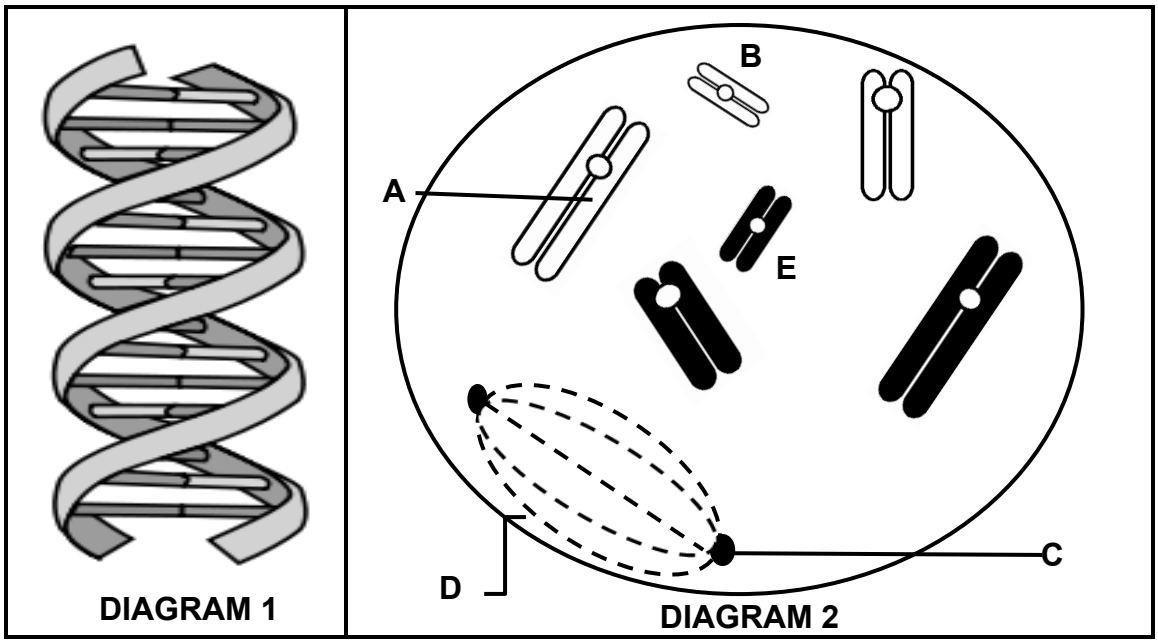


DIAGRAM 1 DIAGRAM 2

2.1.1 Which phase of meiosis is represented in DIAGRAM **2**? (1)

2.1.2 Identify:

(a) Part **C** (1)

(b) The collective name for chromosomes **B** and **E** (1)

(c) The phase in meiosis where part **A** splits (1)

2.1.3 How many chromatids have identical DNA from the black-shaded chromosomes in DIAGRAM **2**? (1)

2.1.4 Describe the composition of a nucleotide in DIAGRAM **1**. (2)

2.1.5 Name and explain the significance of the process occurring in DNA during interphase that will lead to the chromosome appearance in DIAGRAM **2**. (3)

2.1.6 Explain the role of part **D** in metaphase **I** of meiosis. (3)

2.2 Name and describe the process where tRNA plays a role in the formation of a protein. (5)

2.3 Read the extract below.

Gene therapy is a medical technique that uses genetic material to prevent and targets to treat diseases such as cystic fibrosis, sickle cell disease and macular degeneration. In macular degeneration the retina cells become damaged. These genetic diseases are caused by gene mutations on DNA molecule leading to the formation of defective proteins. In gene therapy, parts of the mutant gene sequence are removed in DNA and replaced with the correct gene sequence. Stem cells are used to transfer the correct gene sequence to produce the functional protein.

2.3.1 State TWO sources where stem cells can be obtained from. (2)

2.3.2 Name ONE visual disease that gene therapy targets to treat. (1)

2.3.3 A gene mutation has occurred on a section of a DNA molecule as shown below.

Original sequence	TTT	TCA	GGT	ACG	CAC
Mutated sequence	TTT	TCA	GGT	ACC	CAC
Base triplet	**1**	**2**	**3**	**4**	**5**

Write down the base triplet number that shows the gene mutation. (1)

2.3.4 The table below shows some codons and the amino acids that they code for.

CODONS	AMINO ACIDS
AAA	Lysine
GAG	Glutamic acid
CAC	Histidine
UGC	Cysteine
ACU	Threonine
AGU	Serine
GAU	Aspartate
UGG	Tryptophan
UUU	Phenylalanine
CCA	Proline
GUG	Valine

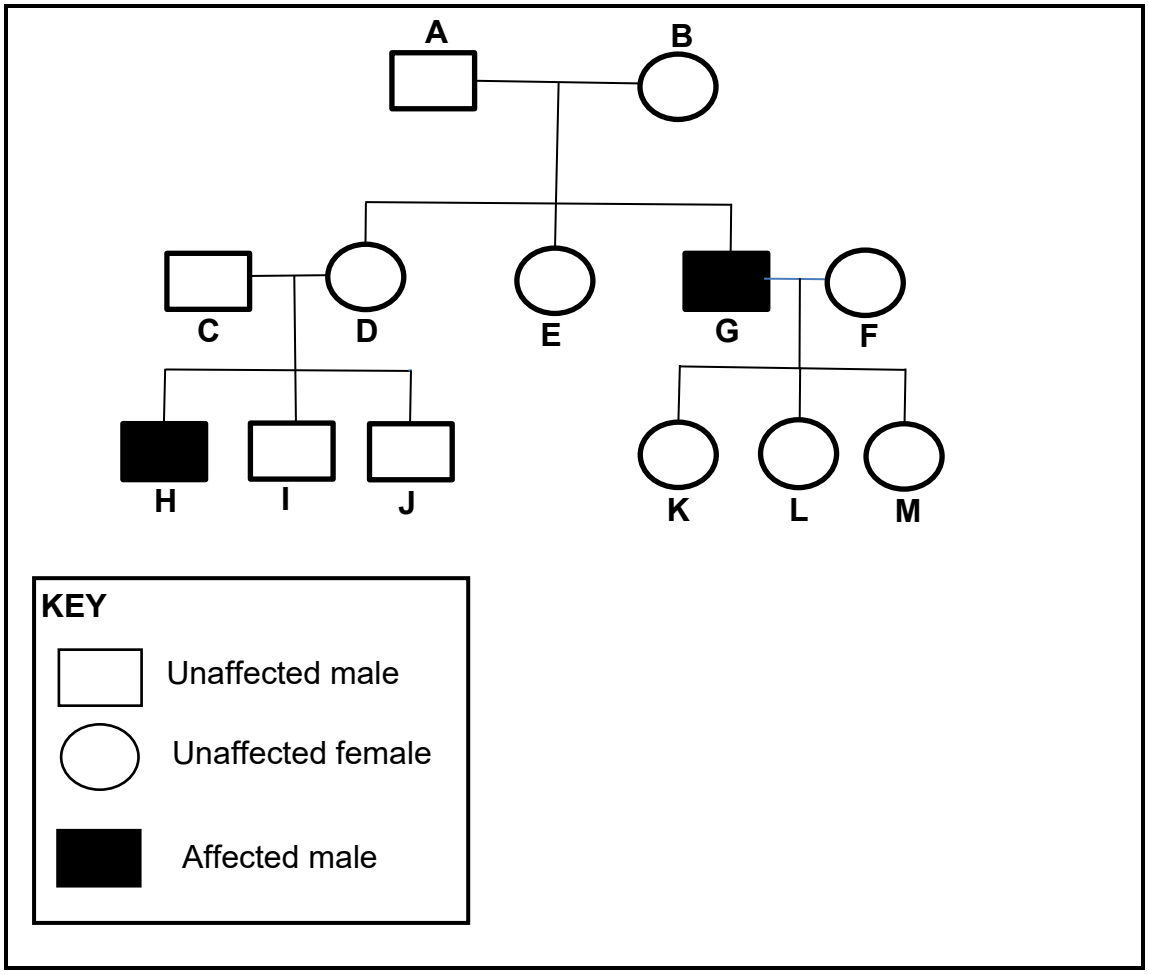
(a) Give the amino acid for base triplet **5** in QUESTION 2.3.3. (1)

(b) Explain how gene therapy would correct the mutated sequence to form the functional protein. (3)

(c) Draw a stick diagram of a molecule that carries the coded message for protein synthesis with the correct complementary codon for base triplet **2**. (4)

2.4 Leigh syndrome is a rare autosomal recessive genetic disorder that affects the central nervous system in young children. This condition can also affect adults and in most cases leads to death in children at an early age.

The pedigree diagram below shows the inheritance of this disorder in a family. The allele **b** is used for affected individuals.



2.4.1 What is meant by the term *autosomal recessive*? (2)

2.4.2 Write down the LETTER of the child who is likely to die in the F_2 generation. (1)

2.4.3 Describe how the child mentioned in QUESTION 2.4.2 became affected with Leigh syndrome. (2)

2.4.4 Name Mendel's Law of Dominance that exists in the phenotypes of individuals **K**, **L** and **M**. (1)

2.4.5 Explain your answer to QUESTION 2.4.4. (3)

2.5 Fragile X syndrome is a sex-linked dominant inheritance. The allele that causes this condition is dominant $\mathbf{X^R}$, while people without fragile X syndrome have the recessive allele $\mathbf{X^r}$.

2.5.1 State the phenotype of an individual with genotype $\mathbf{X^RX^r}$. (2)

2.5.2 Explain why both males and females have equal chances of suffering from fragile X syndrome. (2)

2.5.3 A man with genotype $\mathbf{X^RY}$ marries a woman with genotype $\mathbf{X^rX^r}$.

Use a genetic cross to explain the probability of this couple having a son with fragile X syndrome. (7)

[50]

QUESTION 3

3.1 In horses, baby hair coat colour **(B)** is dominant over black hair coat colour **(b)**, and smooth hair **(H)** is dominant over curly hair **(h)**.

A farmer has bred black hair coated horses with curly hair all his life and all the foals (offspring) have always looked like their parents with the same black hair coat with curly hair.

3.1.1 Give ONE reason why this is an example of a dihybrid cross. (1)

3.1.2 Name the type of selection that allowed the farmer to breed black hair coated horses with curly hair all his life. (1)

3.1.3 Suggest ONE reason the farmer bred black hair coated horses with curly hair for many generations. (1)

3.1.4 State the genotype of the:

(a) Parent with black hair coat with curly hair (2)

(b) Gametes of a horse heterozygous for both hair colour and hair type (2)

3.1.5 Determine the phenotypic ratio of the offspring that will be produced if two heterozygous horses for both characteristics were crossed. (2)

3.2 Read the extract below and answer the questions that follow.

The African penguin (*Spheniscus demersus*) population have declined in South Africa and could be non-existent by 2035. This is due to habitat loss and the overfishing of their main food, sardines (pilchards). The African penguins compete with commercial fisheries in Cape Town for sardines. The commercial fisheries are worth billions of rand and employ many people.

Sardines are a cheap source of protein rich food and are harvested in large numbers in the months of March to May in South Africa which is also the mating season of the African penguin. During mating both sexes of the African penguin make loud sounds to call their mates. Nature conservationists want government to limit the number of sardines harvested by commercial fisheries.

African penguin

3.2.1 Give evidence from the extract that states the African penguin will be extinct in the future. (1)

3.2.2 According to the extract:

(a) Name TWO causes of the decrease in the African penguin population. (2)

(b) Identify TWO reproductive isolating mechanisms that exist in the African penguins. (2)

3.2.3 Explain how limiting the number of sardines harvested could:

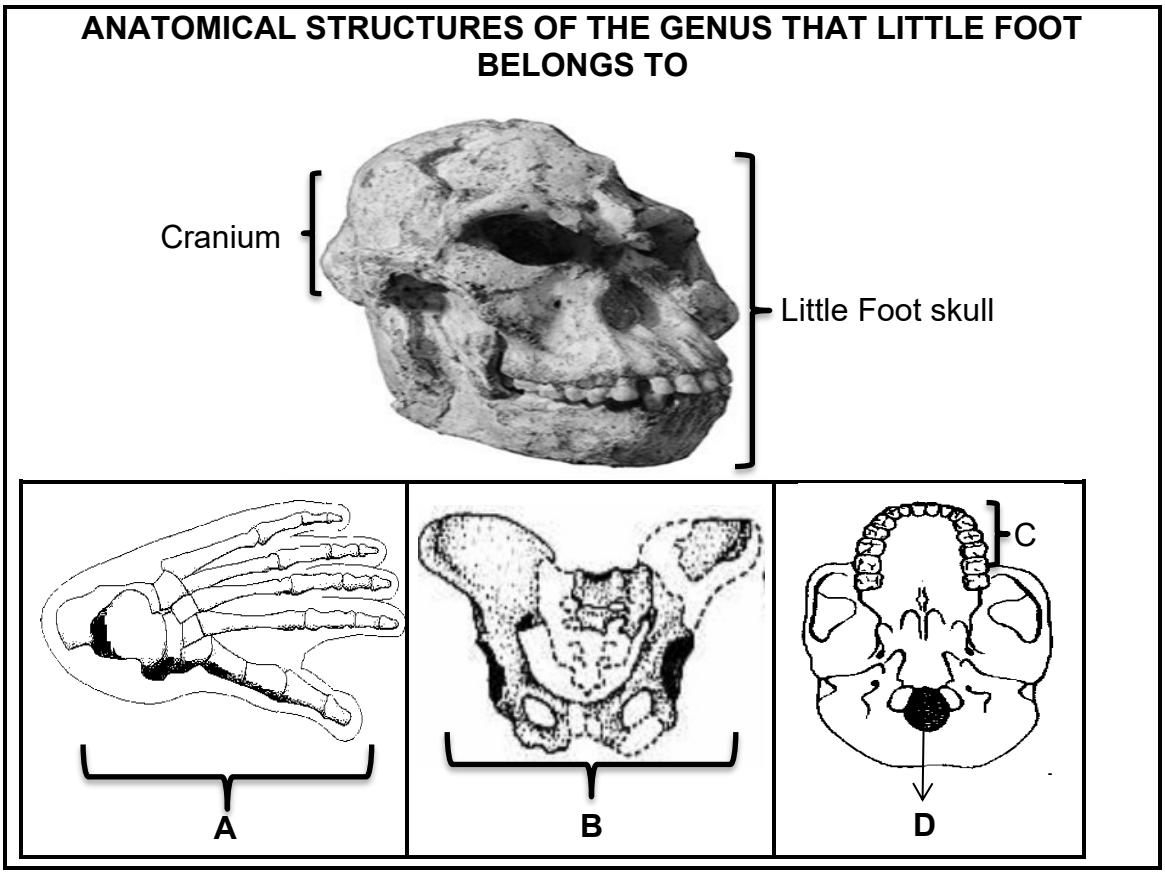
(a) Cause a decrease in the economy (2)

(b) Positively benefit the African penguins (2)

3.3 Describe how a new species forms from a geographic barrier. (7)

3.4 Little Foot is a hominid fossil that was discovered at the Sterkfontein caves by Professor Ron Clarke. The bones of Little Foot showed that this fossil had many characteristics similar to those found in humans.

ANATOMICAL STRUCTURES OF THE GENUS THAT LITTLE FOOT BELONGS TO



3.4.1 What is the scientific name of Little Foot? (1)

3.4.2 Write down the LETTER of the structure suggesting this genus:

(a) Had smaller canines (1)

(b) Spinal column entered the skull vertically for bipedalism (1)

(c) Had similar forelimbs to humans (1)

3.4.3 Describe how the shape of structure **B** shows this genus is more evolved than primitive apes but less evolved than humans. (2)

3.4.4 Explain the significance of the change in the cranium size of Little Foot to modern humans. (2)

3.4.5 Little Foot is used as fossil evidence in the 'Out-of-Africa' hypothesis.

(a) Name ONE other line of evidence for the 'Out-of-Africa' hypothesis. (1)

(b) Explain how the fossils of Little Foot's genus are used in the 'Out-of-Africa'-hypothesis. (2)

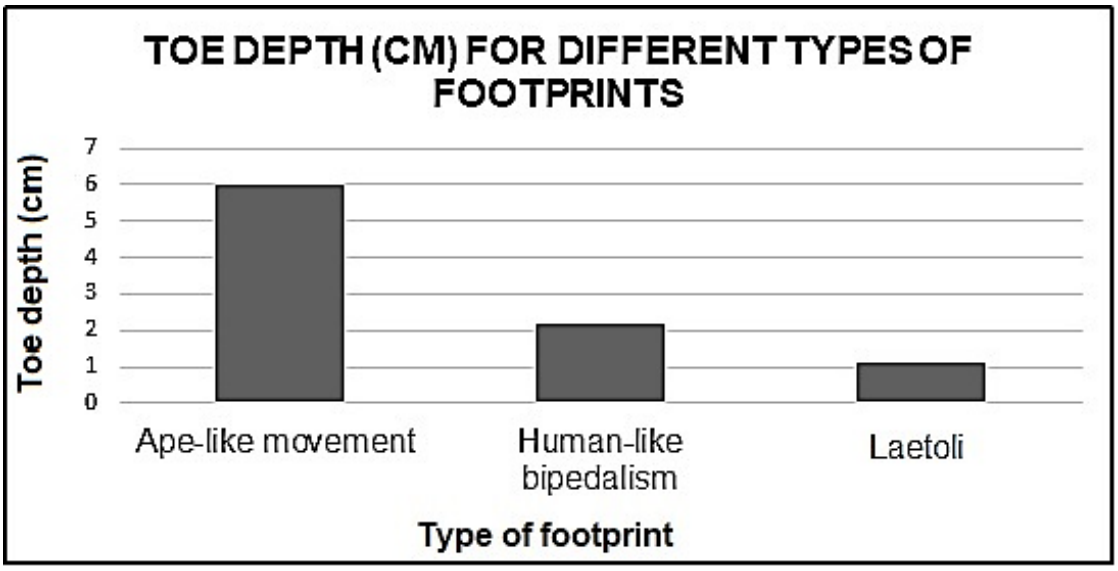
3.5 Laetoli footprints are a 3,6 million old fossil that was discovered by palaeontologist, Mary Leakey in Tanzania. The shape of the feet and toe along with feet length suggests these footprints were made by a bipedal hominid ancestor who was able to stand upright.

An investigation was conducted to determine if the individuals who made the Laetoli footprints walked using a human-like bipedalism or a more ape-like movement (bent-knee, bent-hip).

The procedure was as follows:

- The depth that the toes pressed into the ash of the preserved Laetoli footprints was measured and recorded.
- Eight human participants were asked to walk through sand and the toe depth of their footprints was measured and recorded.
- The human participants were then asked to mimic (copy) the walk of the apes by using a "bent-knee, bent-hip" ape-like movement through the sand.
- The toe depth of their footprints was measured and recorded.

The results of the investigation are recorded in the graph below.



3.5.1 State the aim for this investigation. (1)

3.5.2 Identify how the dependent variable was measured for this investigation. (1)

3.5.3 State THREE planning steps considered for this investigation. (3)

3.5.4 Give TWO reasons why this investigation may be considered unreliable. (2)

3.5.5 Name the type of footprint that has the longest toe depth. (1)

3.5.6 By how many times greater is the toe depth of human-like bipedalism compared to the Laetoli footprint? Show ALL calculations. (2)

3.5.7 Draw a table to represent the information on the graph. (4)

[50]

TOTAL SECTION B: 100
GRAND TOTAL: 150