2.2 A farmer decided to have his best meat-producing bull cloned.

The following steps were used in the process:

- A muscle cell was taken from the bull and the nucleus was removed.
- An ovum was taken from a cow and the nucleus was removed and discarded.
- The nucleus from the muscle cell was placed in the empty ovum.
- The ovum was given an electric shock to stimulate normal cell division to produce an embryo.
- The embryo was placed in the uterus of a surrogate cow where it developed into the clone.

2.2.1 What is *cloning*? (1)

2.2.2 Explain why the nucleus of a muscle cell was used and not the nucleus of a sperm cell. (2)

2.2.3 Explain why the nucleus of the ovum was removed. (2)

2.2.4 State ONE benefit of cloning. (1)
(6)

2.3 A man with blood group **AB** and a woman who is heterozygous for blood group **B** plan to have children.

2.3.1 How many alleles control the inheritance of blood groups? (1)

2.3.2 Describe the type of dominance that occurs in the inheritance of blood group **B** in the woman. (3)

2.3.3 Use a genetic cross to show all the possible genotypes and phenotypes of their children. (6)

(10)

2.4 Sickle cell disease is caused by a recessive allele and first appeared in humans as a result of a gene mutation.

The table below shows the number of children born with sickle cell disease in some regions in a particular year.

REGION	NUMBER OF CHILDREN BORN WITH SICKLE CELL DISEASE
Democratic Republic of Congo	39 746
United States of America	90 128
Nigeria	91 011
United Kingdom	13 221
Tanzania	11 877
Other	59 750
Worldwide total	**305 733**

2.4.1 What is a *gene mutation*? (2)

2.4.2 Which region had the highest number of children born with sickle cell disease in that year? (1)

2.4.3 What percentage of the worldwide total of children born with sickle cell disease came from the Democratic Republic of Congo? Show ALL calculations. (3)

2.4.4 Use the letters **D** and **d** to give the genotype of a person who:

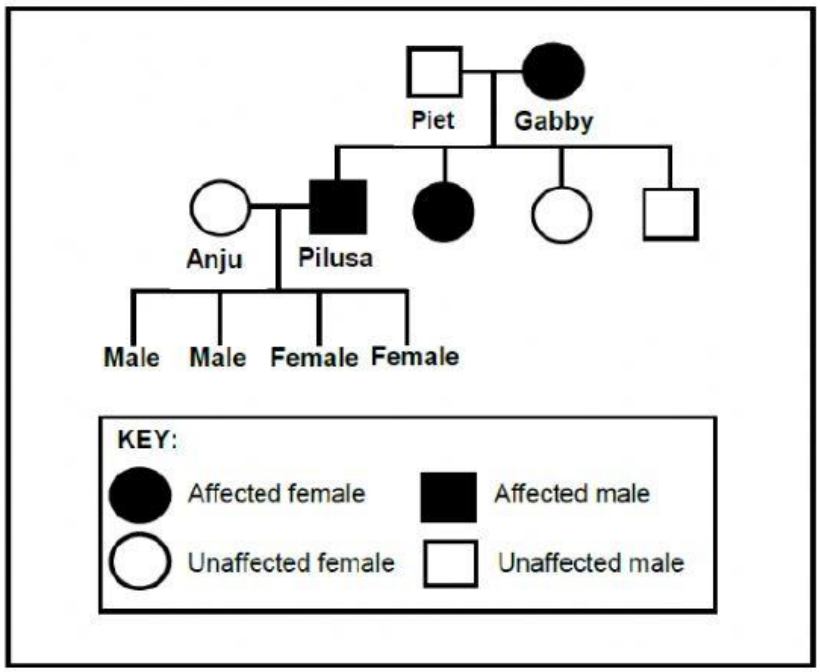
(a) Suffers from sickle cell disease (1)

(b) Carries the allele but does not suffer from the disease (1)

(8)

2.5 Goltz syndrome is a sex-linked genetic disorder. It is caused by a dominant allele X^G.

The diagram below shows the inheritance of Goltz syndrome in a family.



2.5.1 Name the type of diagram shown. (1)

2.5.2 How many:

(a) Females are in this family (1)

(b) Males in the F_1-generation have Goltz syndrome (1)

2.5.3 Give Gabby's genotype. (2)

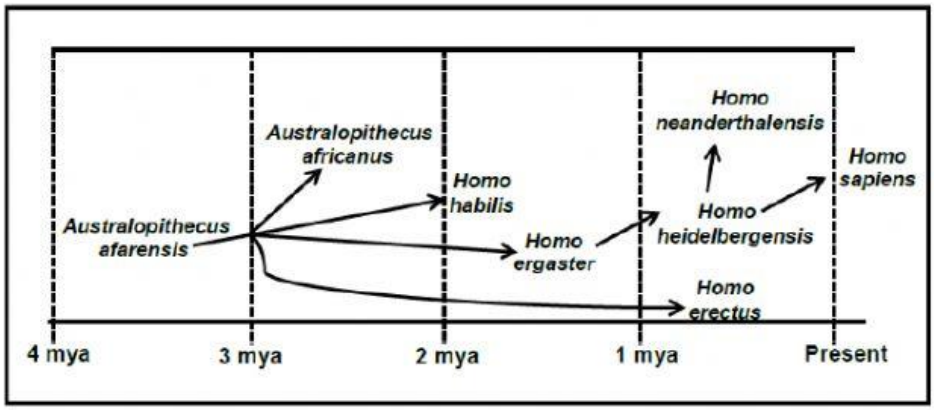
2.5.4 Anju and Pilusa have four children. Give the phenotype of their sons. (2)

2.5.5 Explain your answer to QUESTION 2.5.4. (4)
(11)
[40]

QUESTION 3

3.1 Describe the process of natural selection. **(7)**

3.2 Fossil evidence for humans may be interpreted in different ways. One possible model of human evolution is shown below.



3.2.1 Name the family to which all of the represented organisms belong. (1)

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

3.2.3 How long ago did the most recent common ancestor of *H. erectus* and *H. heidelbergensis* exist on earth? (1)

3.2.4 Explain a possible reason why *H. ergaster* was placed between *A. afarensis* and *H. heidelbergensis* on the model. (2)

3.2.5 Explain how the fossils of organisms that existed from **4** mya to present time are used to support the 'Out of Africa' hypothesis. (3)
(9)

3.3 Male long-tailed widowbirds have extremely long tail feathers that they use in mating displays to attract females.

Scientists conducted an investigation to determine the relationship between the length of the male long-tailed widowbird's tail and its mating success.

The procedure was as follows:

- A total of 27 male long-tailed widowbirds was sampled and divided into 3 equal groups.
- The tail feathers of the birds in each group were treated in the following way:
  - Group **1** – Cut short
  - Group **2** – Made longer by adding artificial feathers
  - Group 3 – Left unchanged
- The 3 groups of male long-tailed widowbirds, along with female long-tailed widowbirds, were released into an environment suitable for mating.
- Each time a pair mated successfully they produced a nest and all the nests were counted.
- The average number of nests produced by each group was calculated and used as an indication of mating success.

The results are shown in the table below.

GROUP	AVERAGE NUMBER OF NESTS PRODUCED
1	0,5
2	2,5
3	1

3.3.1 Name the:

(a) Reproductive isolating mechanism that occurs in long-tailed widowbirds (1)

(b) Independent variable in this investigation (1)

3.3.2 Explain why 27 long-tailed widowbirds were used in the investigation instead of only 3. (2)

3.3.3 Explain why Group **3** was included in the investigation. (2)

3.3.4 Draw a bar graph to represent the results of this investigation. (6)

3.3.5 State a conclusion for this investigation. (2)
(14)