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assessment matters

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TOTAL MARKS

NATIONAL SENIOR CERTIFICATE EXAMINATION
MAY 2024

LIFE SCIENCES: PAPER I

EXAMINATION NUMBER

Time: 3 hours

200 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 42 pages. Please check that your question paper is complete.
2. This question paper consists of four questions.
3. **Answer ALL the questions on the question paper and hand it in at the end of the examination. Remember to write your examination number in the space provided.**
4. Read the questions carefully.
5. Use the total marks that can be awarded for each question as an indication of the detail required.
6. It is in your own interest to write legibly and to present your work neatly.
7. TWO blank pages (pages 41 to 42) are included at the end of the question paper. If you run out of space for a question, use these pages. Clearly indicate the number of your answer should you use this extra space.

FOR MARKER'S USE ONLY

Question	1	2	3	4	**Total**
Marks	80	40	40	40	**200**
Marked					
Moderated					

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QUESTION 1

1.1 Select the term in Column B that best matches the description in Column A. Write the letter of the term in the space provided between the brackets. Each letter may be used only once.

COLUMN A		COLUMN B	
[ ]	The position of a gene on a chromosome	A	Polypeptide
[ ]	A single unit/monomer of a nucleic acid	B	PCR
[ ]	A random change in the DNA sequence	C	James Watson
[ ]	A molecule produced from protein synthesis	D	Adenine
[ ]	The biologist who conducted experiments to investigate the inheritance of traits	E	Locus
[ ]	A scientist who discovered the structure of DNA	F	DNA Ligase
[ ]	A nitrogenous base found only in RNA	G	Nucleotide
[ ]	A single unit of a protein	H	Amino acid
[ ]	An enzyme that joins two DNA molecules	I	Mutation
[ ]	A technique that increases the amount of DNA in a sample	J	Uracil
		K	Gregor Mendel

(10)

1.2 FIVE multiple-choice questions are asked on the following pages. Choose the most correct answer to each question and write the letter of your choice in the table below.

Question	1.2.1	1.2.2	1.2.3	1.2.4	1.2.5
Answer					

1.2.1 Which of the following correctly shows complementary pairing of nitrogenous bases in DNA?

A Guanine pairs with cytosine
B Guanine pairs with thymine
C Adenine pairs with cytosine
D Adenine pairs with guanine (1)

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1.2.2 A healthy individual is a carrier of a lethal allele but is unaffected by it. What is the most likely genotype of this individual?

A Genotype containing two recessive lethal alleles
B Genotype containing one dominant lethal allele and one recessive normal allele
C Genotype containing one recessive lethal allele and one dominant normal allele
D Genotype containing one recessive lethal allele and one dominant lethal allele (1)

1.2.3 Human proteins are synthesised from only 20 different amino acids. There are thousands of different proteins found in human cells. What is a possible reason for the great variety of proteins in human cells?

A The number and size of an amino acid can vary within a protein.
B The order and number of amino acids are different in each protein.
C The same amino acid can have many different properties.
D The structure of each amino acid will differ in each protein. (1)

1.2.4 Some of the steps in DNA replication are listed in a random and incorrect order below.

(i) DNA polymerase reads the template DNA strand.
(ii) Hydrogen bonds break between DNA strands.
(iii) Complementary bases pair together.
(iv) DNA helix reforms.

Which of the following shows the correct sequence of steps in DNA replication?

A (ii), (i), (iii), (iv)
B (ii), (iii), (i), (iv)
C (i), (ii), (iii), (iv)
D (i), (iii), (ii), (iv) (2)

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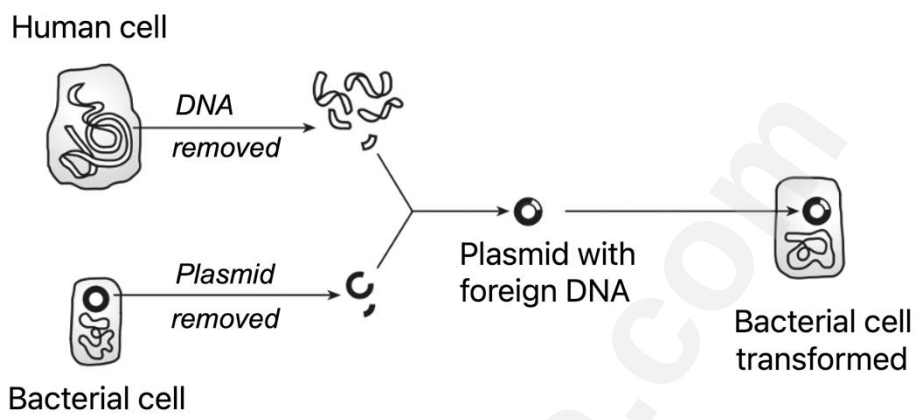
1.2.5 Study Figure 1 below and use it to answer the following question.

Figure 1



Which row in the table below correctly identifies the procedure and an example of a substance that is produced by the procedure shown in Figure 1 to treat pituitary dwarfism?

	Procedure	**Substance**
A	Gene therapy	Thyroxin
B	Gene therapy	Growth hormone
C	Recombinant DNA technology	Thyroxin
D	Recombinant DNA technology	Growth hormone

(2)

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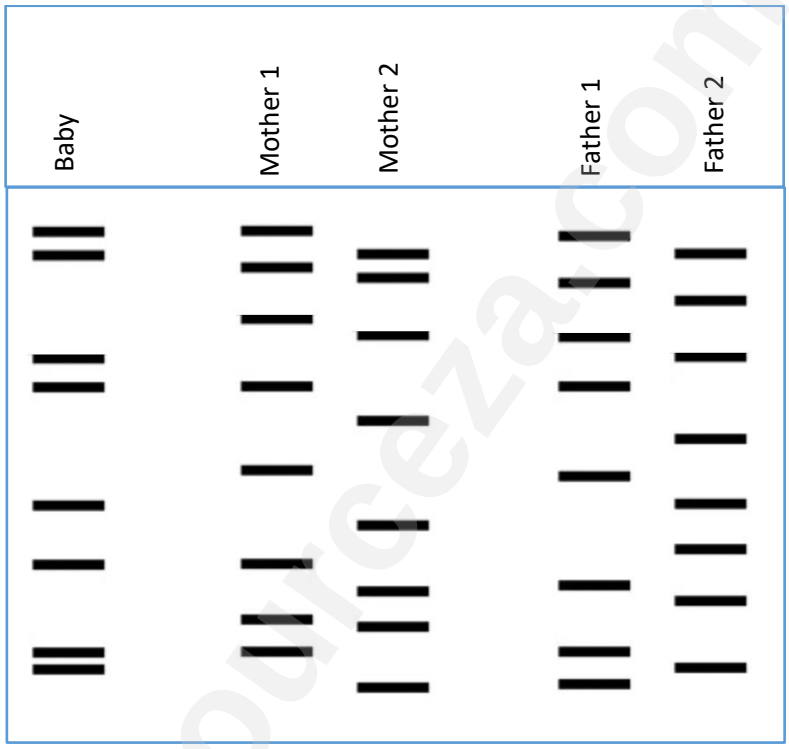
1.3 Read the information in the text box below and study Figure 2 to answer the questions that follow.

During a natural disaster, a newborn baby was rescued. Two sets of parents claimed that they were the parents of the baby. DNA testing was done to confirm who the baby's actual parents were. The DNA profiles are shown below.

Figure 2 – DNA Profiles



[Adapted: <https://biology.kenyon.edu/slonc/bio3/DNA_Practice.htm>]

1.3.1 Fill in the table below by writing the correct number of the actual mother and father of the rescued baby.

	Number
Mother of baby	
Father of baby	

(2)

1.3.2 Other than determining familial relatedness, give ONE other use of DNA profiling.

_____

_____

(1)

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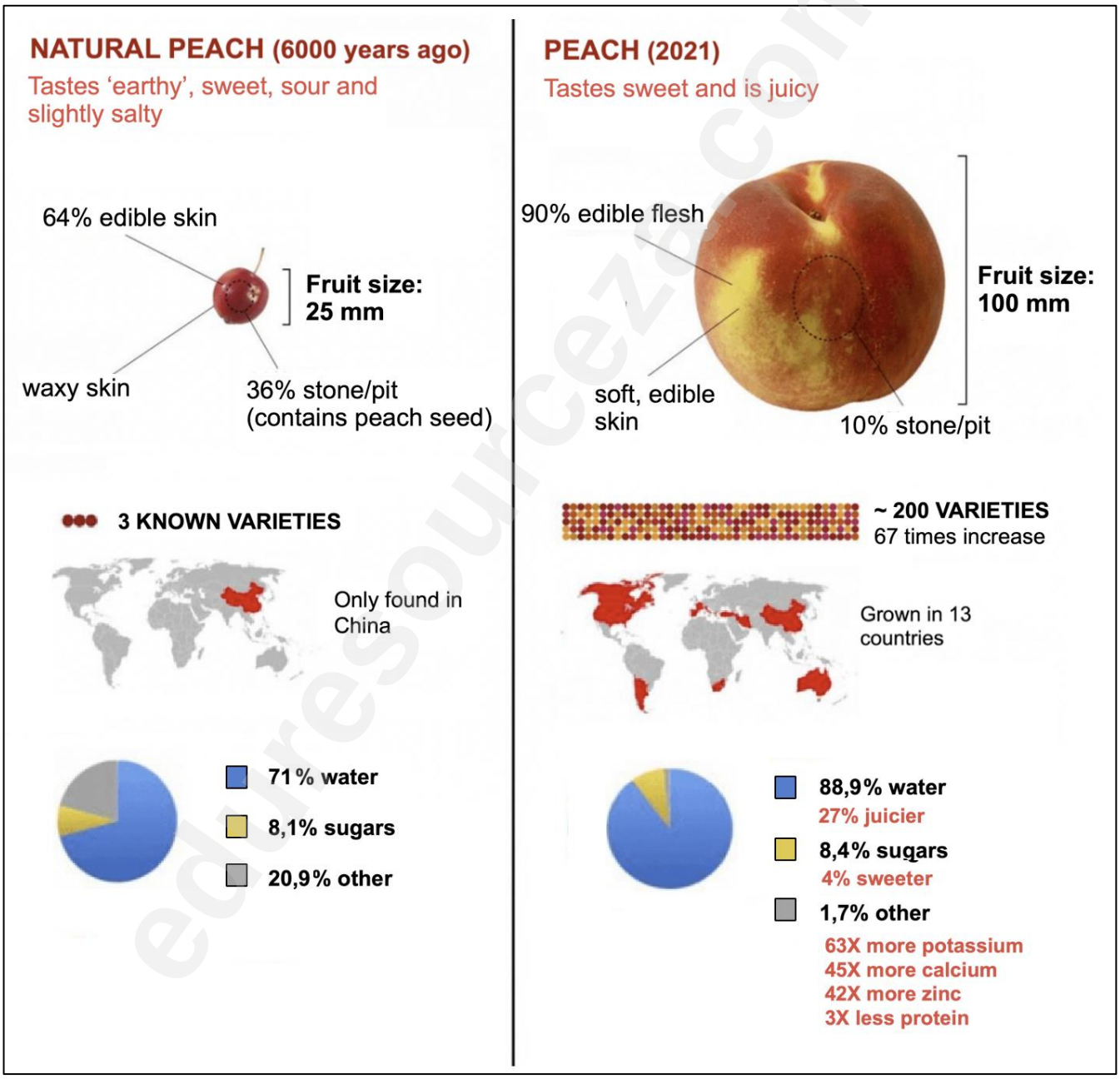
1.3.3 Explain why using DNA profiles is a reliable method of accurately identifying an individual.

_____

_____

(2)

1.4 Study the infographic below on the artificial selection or domestication of peaches.



[Adapted: <https://foodinsight.org/wp-content/uploads/2016/02/peach.png>]

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1.4.1 The four statements in the table below refer to the infographic on page 6. For each statement decide whether:

A: The statement is supported by the information in the infographic.

B: The statement is contradicted by the information in the infographic.

C: The statement is neither supported nor contradicted by the information in the infographic.

	Statement	**A, B or C**
(a)	The size of peaches has increased by only 50 mm.	
(b)	The peaches grown in 2021 have a shorter growing season.	
(c)	Peaches today contain a greater percentage of water than natural peaches of 6 000 years ago.	
(d)	The sugar content in peaches has remained near 8% since being domesticated.	

(4)

1.4.2 Compare and describe ONE change in phenotype that occurred in the peach fruit after 6 000 years of the artificial selection process.

_____

_____

(2)

1.4.3 Why is sexual reproduction in plants important for improvement in food crops?

_____

_____

_____

_____

_____

(2)

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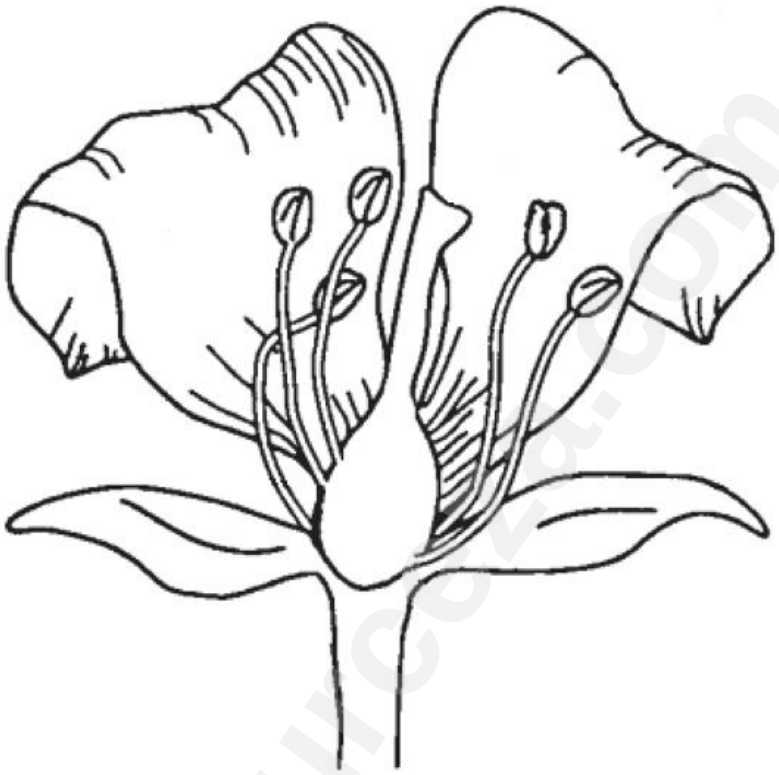
Figure 3 below shows a longitudinal section of a peach blossom.

Figure 3 – Diagram of a peach blossom



1.4.4 On Figure 3 above, complete the following:

(a) Draw in and label the structure that will form the seed of the peach fruit. (2)

(b) Shade in ONE whole stamen in pencil. (1)

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1.5 Study the following table which consists of two items (numbered 1 and 2) in the first column and a term in the second column. Decide which item(s) relate to the term.

Write down your choice in the space provided in the 'Answer' column, making use of the following codes:

1 only item 1 relates to the term
2 only item 2 relates to the term
Both both items 1 and 2 relate to the term
Neither neither item 1 nor item 2 relates to the term

Item	**Term**	**Answer**
1. Site of sperm storage 2. Deposits semen into the vagina	Penis	
1. Secreted by the pituitary gland 2. Secreted by the seminal vesicle	Testosterone	
1. Sterilisation procedure in males 2. Removal of the foreskin	Circumcision	
1. Expulsion of semen from the body 2. Enlarged and rigid state of the penis	Ejaculation	
1. Controls the temperature of the testes 2. Muscular bag surrounding the testes	Scrotum	

(5)

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1.6 Study Figure 4 below that shows a cell at two different phases in meiosis.

Figure 4 – A cell seen in two different phases of meiosis (Image X and image Y)

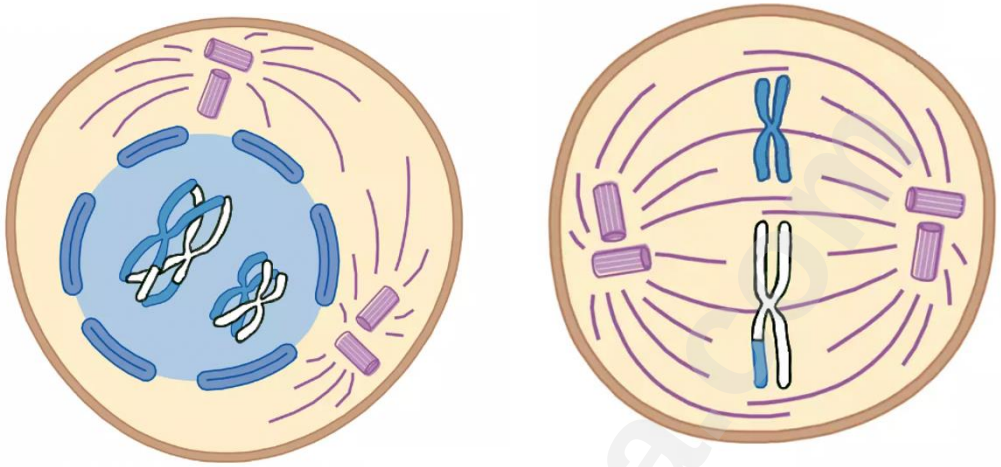

Image X **Image Y**

[Adapted: <www.slideshare.net/nirmalajosephine1/biology-form-4-chapter-5-cell-dvision-part-2-meiosis>]

1.6.1 Draw a circle around the option in the brackets provided in the table below to correctly identify the phases shown in Figure 4.

	Phase in Meiosis Division
Image X	(Prophase I/Telophase I)
Image Y	(Metaphase I/Metaphase II)

(2)

1.6.2 Explain why it is important in animals that meiosis halves the chromosome number in cells produced by gonads.

_____

_____

_____

(2)

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1.6.3 Refer to Image Y. Draw any ONE cell that will be produced at the end of meiosis in Telophase II.

Your diagram must include the following:
- The correct number of chromosomes
- The correct relative sizes of chromosomes

(4)

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1.7 Refer to Figure 5 below of a karyotype of a person with a chromosomal mutation resulting from abnormal meiosis to answer the following questions.

Figure 5 – Karyotype with chromosomal mutation

[Source: <https://iiif.wellcomecollection.org/image/B0000249/full/full/0/default.jpg>]

1.7.1 What is the name of the chromosome disorder/condition shown by this karyotype?

_____ (1)

1.7.2 Describe the appearance of the chromosomal mutation as it is seen in the karyotype above.

_____

_____

_____ (2)

1.7.3 On the karyotype in Figure 5 above, circle any one gonosome. (1)

1.7.4 Would a biologist who studies this karyotype conclude that the person is a male or a female? Give a reason for your answer.

_____

_____ (2)

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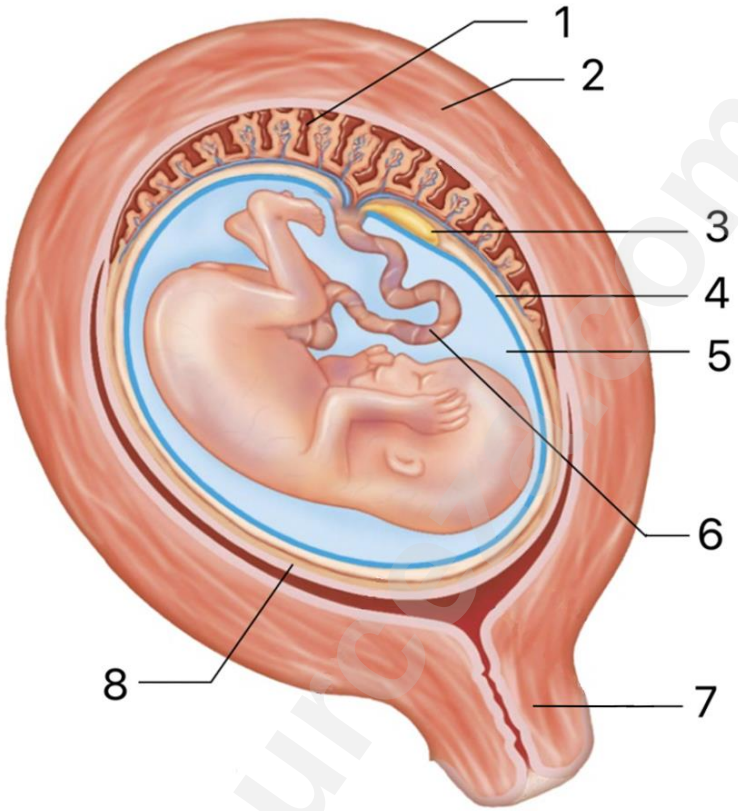
1.8 Study Figure 6 below, which shows a developing foetus in the uterus, and answer the questions that follow.

Figure 6 – A developing foetus in the uterus



[Adapted: <https://o.quizlet.com/6yVIISeRtEnEY.AmqnQc2w_b.png>]

1.8.1 Select the number on Figure 6 that best matches the description in the table below. Numbers may be used more than once.

	Description	Number
(a)	The fluid that supports the developing foetus and allows the freedom of movement.	
(b)	The umbilical cord.	
(c)	The structure that secretes the hormones progesterone and oestrogen during pregnancy.	
(d)	The membrane that secretes a fluid that protects the foetus against changes in temperature and dehydration.	
(e)	The structure that widens during labour to allow passage of the foetus into the vagina.	
(f)	The uterine layer that is responsible for powerful contractions during labour and birth.	

(6)

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1.8.2 How is a zygote different from an embryo?

_____

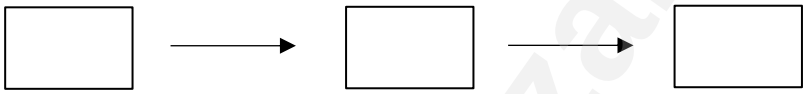
_____

(2)

1.8.3 The list below shows some events of a normal vaginal childbirth in a random order.

1 Baby's head comes out of the vagina
2 Placenta expelled from the uterus
3 Contractions of the uterine wall

Write the numbers in the correct order in the boxes below to show the sequence of events during a normal vaginal childbirth.



(2)

1.9 Read the information in the text box below and answer the questions that follow.

Scientists studied the effects of alcohol consumption and drinking patterns of pregnant women on the brain development of the foetus. To do this, the scientists monitored the 10-year records of research that had been done on women who drank alcohol during pregnancy. The scientists classified the mothers into three groups according to alcohol exposure during pregnancy.

Group A did not drink any alcohol during pregnancy. Groups B and C drank alcohol but at different frequencies during the pregnancy. See below:

- Group A: No exposure (zero alcohol consumed)
- Group B: One alcoholic drink 7 to 9 times a week (frequent drinker)
- Group C: One alcoholic drink once a week (infrequent drinker)

The average brain mass of the newborn babies was determined for each group and is shown in Table 1 below:

Table 1 – Average brain mass of newborn babies when the mothers have different exposures to alcohol during pregnancy

Groups of mothers	Average brain mass (g)
A	400
B	310
C	350

[Adapted: <https://pubs.niaaa.nih.gov/publications/arh25-3/168-174.htm>]

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1.9.1 Identify the following in the scientists' investigation:

(a) independent variable

_____

_____

(1)

(b) dependent variable

_____

_____

(1)

1.9.2 Which group of women in the study is the control group? Give a reason for your answer.

_____

_____

(2)

1.9.3 Study the results in Table 1.

What conclusion can the scientists make about foetal brain development and alcohol consumed during pregnancy?

_____

_____

_____

_____

(2)

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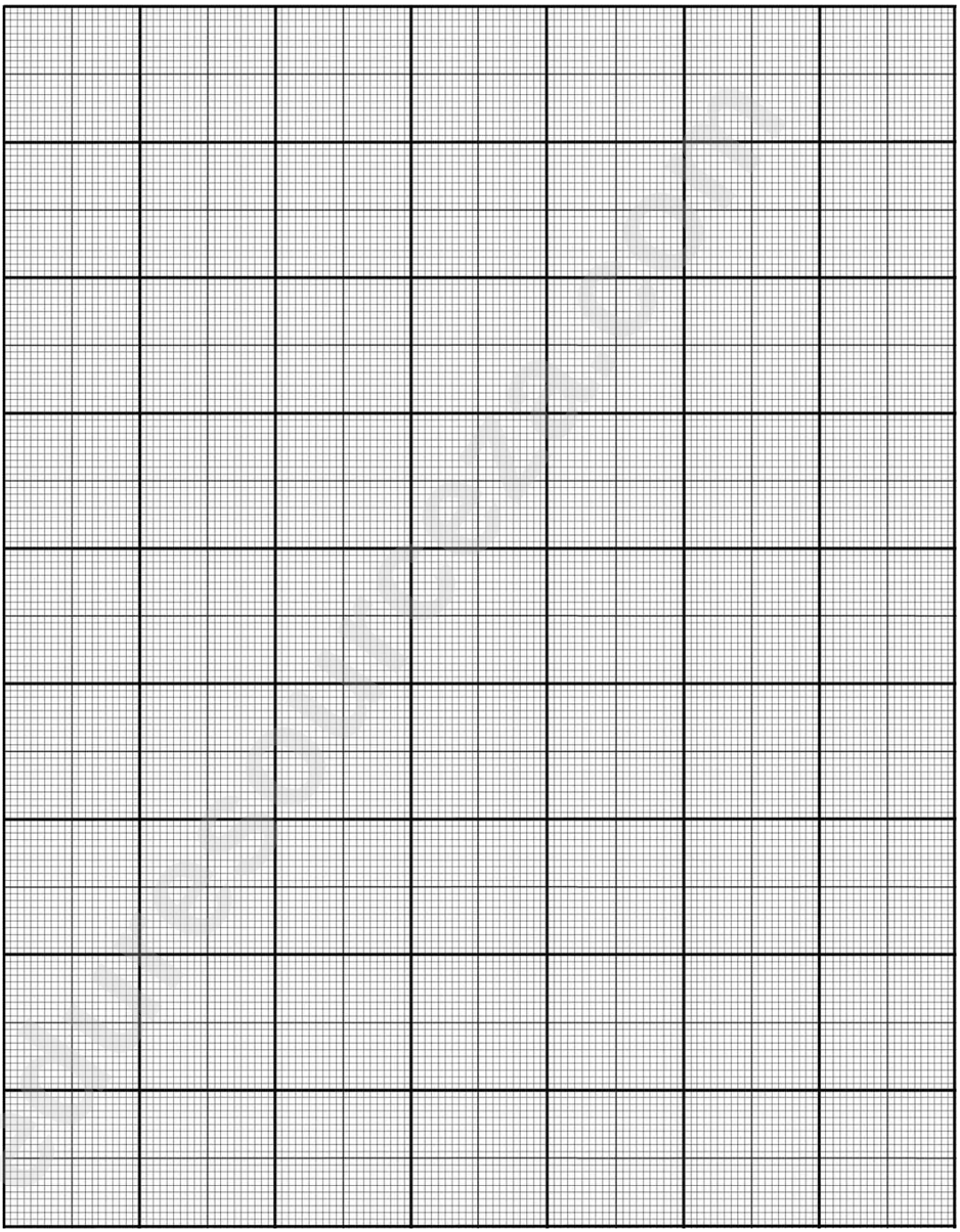
1.9.4 Plot a bar graph of the results of Table 1 on the graph grid provided below.



(8)

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1.9.5 Consider the information in the text box below:

In South Africa, a person convicted of child abuse is imprisoned for a minimum of 10 years. Foetal alcohol syndrome (FAS) is a condition in a child that can result from any exposure to alcohol while the mother is pregnant. FAS results in permanent damage. Its effect varies from child to child and may be moderate to severe. Effects include brain damage, growth and developmental problems, poor co-ordination and behaviour problems. The symptoms of FAS tend to get worse as the child gets older.

[Adapted: <https://www.westerncape.gov.za/general-publication/what-child-abuse>]

Should a woman in South Africa who gives birth to a child who has FAS be charged with child abuse? Justify your decision with well-explained reasons.

(4)
[80]

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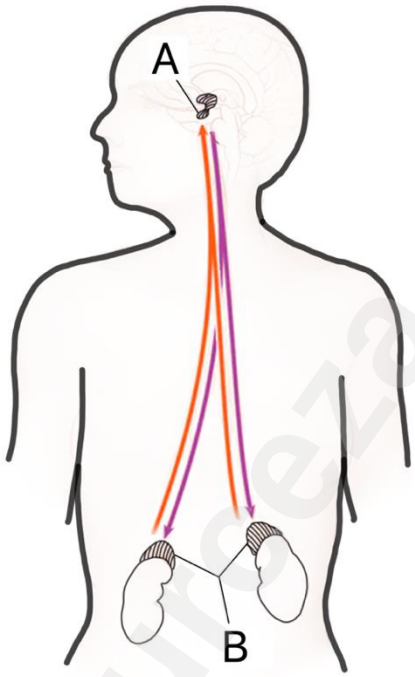
QUESTION 2

2.1 Figure 7 below shows two endocrine glands, A and B, involved in preparing the body to respond to a stressful situation. Use the diagram and your own knowledge to answer the questions that follow.

Figure 7 – Endocrine glands involved in a stressful situation



[Adapted: <https://www.mayoclinic.org>]

2.1.1 Endocrine glands secrete hormones. What is meant by the term *hormone*?

_____

_____ (2)

2.1.2 Identify the following glands:

(a) A: _____ (1)

(b) B: _____ (1)

2.1.3 Name the hormone that is secreted by gland B that prepares the body for action in a stressful situation.

_____ (1)

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2.1.4 Explain THREE effects of the hormone secreted by gland B to prepare the body to respond to a stressful situation.

(6)

2.2 Read the information in the text box below and use your own knowledge to answer the questions that follow.

It is normal for blood glucose levels to vary throughout the day. It typically varies within a certain range (between 80 – 100 mg/dL). A person probably will not be able to tell when their blood glucose levels rise and fall. But if blood glucose levels go below the healthy range and this is not treated, it can become dangerous.

Hypoglycaemia is the condition that results from problems associated with homeostasis of glucose in the body. The blood glucose levels are lower than the standard range. Blood glucose levels fall low enough (about 70 mg/dL) that the body needs to take action to bring the levels back to the target range (about 100mg/dL).

Some symptoms of hypoglycaemia include:
- Feeling weak, shaky, lightheaded and sleepy
- Headaches, co-ordination problems, seizures

[Adapted: <https://www.frontiersin.org>; <https://www.mayoclinic.org>]

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2.2.1 What is meant by the term *homeostasis*?

(3)

2.2.2 Suggest and explain why hypoglycaemia can become dangerous if untreated in a person.

(3)

2.2.3 Suggest why drinking a fruit juice would be an immediate and suitable treatment for someone who is in a hypoglycaemic state.

(2)

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2.2.4 Complete the flow diagram to outline the negative feedback mechanism involved in returning the blood glucose levels back to the target range/normal. The first step in the flow diagram has been completed. No heading required.

Blood glucose levels are low.

(6)

2.2.5 Hyperglycaemia is when blood glucose levels are too high.

(a) Name ONE other condition characterised by high or uncontrolled blood glucose levels.

_____

(1)

(b) State the hormone that is released to lower blood glucose levels.

_____

(1)

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2.3 Different reproductive strategies are shown in Images A, B and C below. Use the images and your own knowledge to answer the questions that follow.

Image A – Blue cranes dancing

Image B – Baboon and it's infant

Image C – Male and female tortoise mating

[Image A: <https://i.pinimg.com/736x/3e/8a/13/3e8a13cacc1c5d79234cc52ef04d3af2--dancing-south-africa.jpg>]
[Image B: <https://www.flickr.com/photos/berniedup/46917330622>]
[Image C: <https://st.depositphotos.com/1007385/57300/i/600/depositphotos_573009142-stock-photo-mating-turtles-radiated-tortoises-astrochelys.jpg>]

2.3.1 What is meant by the term *reproductive strategy*?

_____

_____

_____

(2)

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2.3.2 Construct a table naming each reproductive strategy shown in Images A, B and C and include ONE way in which each strategy maximises success in reproduction for the organisms in the illustrations.
No heading required.

(7)

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2.3.3 The female tortoises of the species in Image C lay 8 to 12 hard-shelled eggs. After laying, the females cover the eggs with soil and then leave them, showing no further interest in the nest. Four months later the eggs will hatch. There is low mortality in the newly hatched tortoises and the offspring have a high survivorship rate and many reach their maximum life span.

(a) Is the tortoise oviparous, ovoviviparous or viviparous? Give a reason for your answer.

(2)

(b) Give TWO pieces of evidence from the information given that supports the conclusion that the tortoise is a *K*-strategist species.

(2)
[40]

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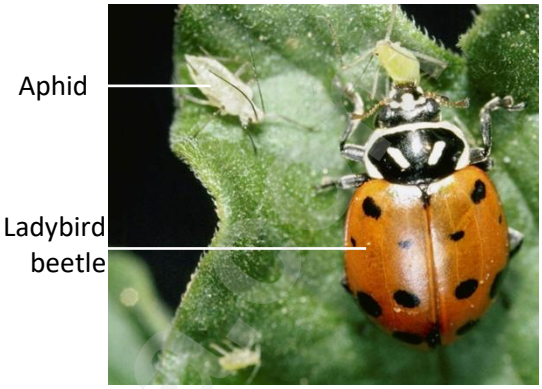
QUESTION 3

3.1 Read the information in the text box below to answer the questions that follow.

A gardener grows rosebushes in a greenhouse and notices that aphids are living on the undersides of the leaves of the plants.

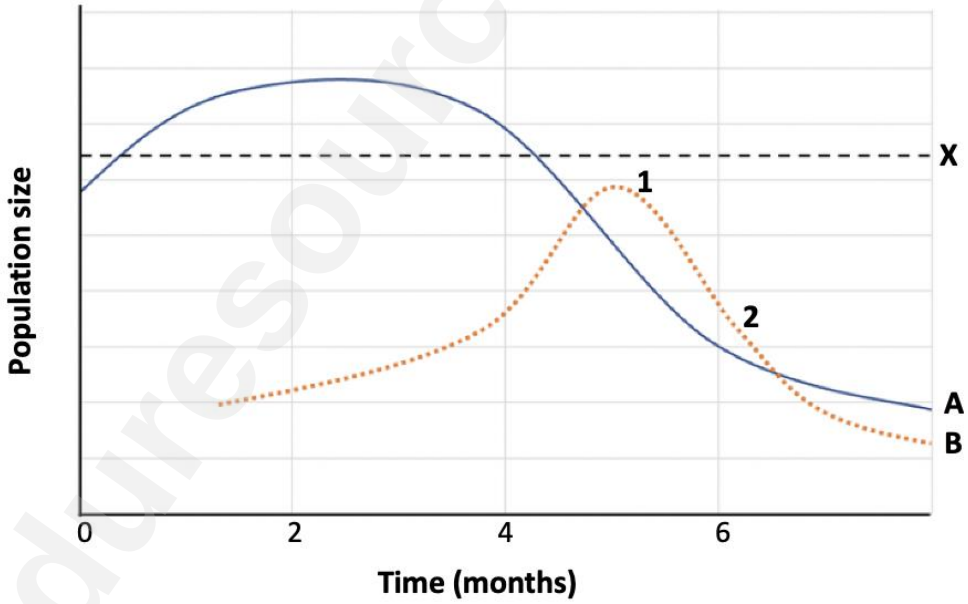
The gardener introduces ladybird beetles into the greenhouse as a means of biological control of the aphids. The gardener plotted a graph of the general growth of the aphid and ladybird beetle populations over one season – see Figure 9.

Figure 8 – Aphids and ladybird beetle on a leaf



[Image: <https://ucanr.edu>]

Figure 9 – Predator–prey relationship of population A and B



Key:

Population A

Population B

[Adapted: <https://ipm.ucanr.edu>]
[Graph: Examiner's own]

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3.1.1 Which population, A or B, in Figure 9 represents the aphids? Give TWO reasons to support your answer.

(3)

3.1.2 The dashed line labelled X in Figure 9 does not represent the carrying capacity for population A. Give TWO pieces of evidence from the graph that support this statement.

(2)

3.1.3 (a) Describe the trend for population B between points 1 and 2.

(1)

(b) Suggest and explain a reason for what is happening to the size of population B between points 1 and 2.

(2)

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3.1.4 Explain ONE advantage of using ladybird beetles to control the aphid population.

(2)

3.1.5 (a) What is meant by the term *population density*?

(3)

(b) State TWO density-dependent factors that could decrease the aphid population.

(2)

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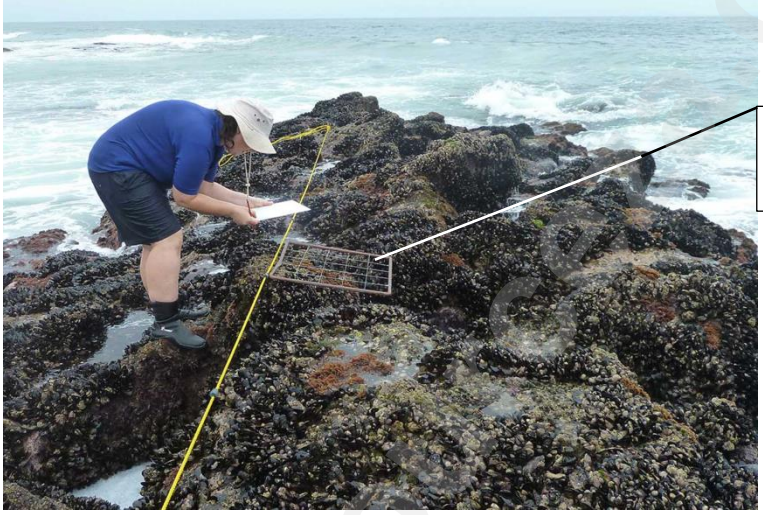
3.2 Read the information below and then answer the questions that follow.

A mussel is a small invertebrate animal that has two shells that close tightly together. Mussels are sessile (fixed in one place) and attach themselves to rocks.

A marine biologist wants to determine the mussel population size in rock pools at her local beach using the sampling method shown in Figure 11 below. The total area of the rock pools at the beach is 180 m^2.

Figure 10 – Mussels

Figure 11 – A biologist sampling mussels



[Source: Examiner's own>]
[Figure 10: <https://www.chemistryworld.com>]
[Figure 11: <https://www.saambr.org.za/wp-content/uploads/2020/05/ORI-musselsampling-research-web.jpg>]

3.2.1 Name the sampling method that the biologist is using (as seen in Figure 11).

_____ (1)

3.2.2 Why is the method used by the biologist in Figure 11 the most suitable to estimate the population size of the mussels?

_____

_____

_____

_____ (2)

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3.2.3 The biologist takes six samples at rock pool locations that were selected randomly in the area of 180 m^2.

The results are recorded in the table below.

Sample	Number of mussels in sample
1	37
2	84
3	51
4	75
5	67
6	70

(a) Use the results from the table to calculate the estimated population size of the mussels. Show all working.

(4)

(b) How can the biologist ensure reliability of her results?

(2)

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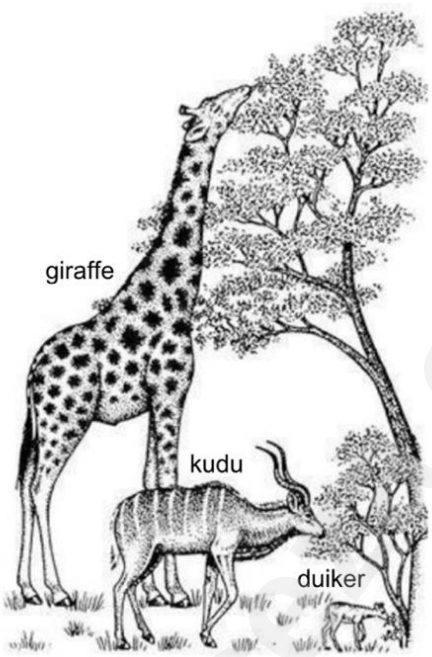
3.3 Study Figure 12 below which shows herbivores grazing in the same area in the savannah.

Figure 12 – Herbivores in the savannah



[Source: <https://www.studocu.com>]

3.3.1 Are all the herbivores that graze in the same area in the savannah considered a population or a community? Give a reason for your answer.

_____

_____ (2)

3.3.2 Which type of competition, interspecific or intraspecific, exists between the animals shown in Figure 12?

_____ (1)

3.3.3 (a) Identify the biological concept that reduces competition that is illustrated by the feeding animals in Figure 12.

_____ (1)

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(b) Describe how competition is reduced between all the feeding animals shown in Figure 12.

(4)

3.3.4 Giraffes live in herds of 10 to 20 individuals. How is this social organisation advantageous to each giraffe in the herd?

(2)

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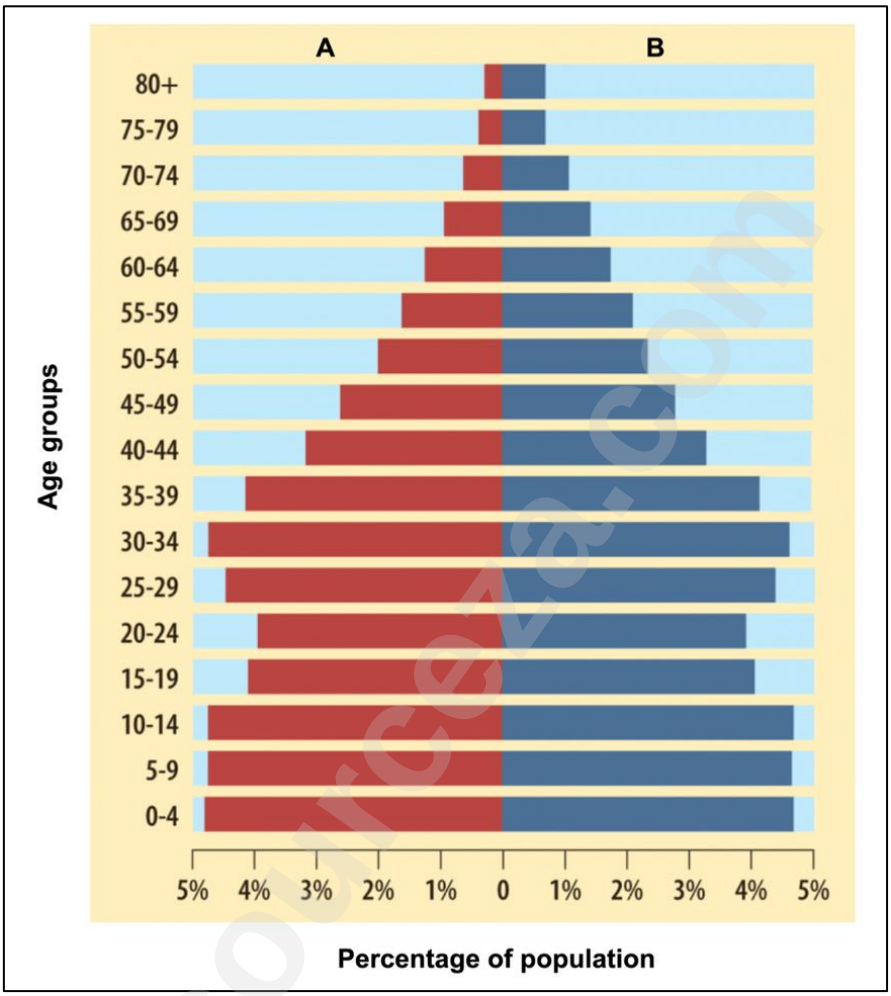
3.4 Study the population pyramid of South Africa below which was constructed from statistics obtained in 2021 and answer the questions that follow.



[Adapted: <https://mg.co.za>]

3.4.1 In South Africa, women have a higher life expectancy than men. Which side of the population pyramid, A or B, represents the female individuals in the population? Provide one piece of data to support your answer.

_____

_____

(2)

3.4.2 Discuss how the population parameters must change to result in a zero growth in the South African population over the next 10 years.

_____

_____

_____

_____

(2)

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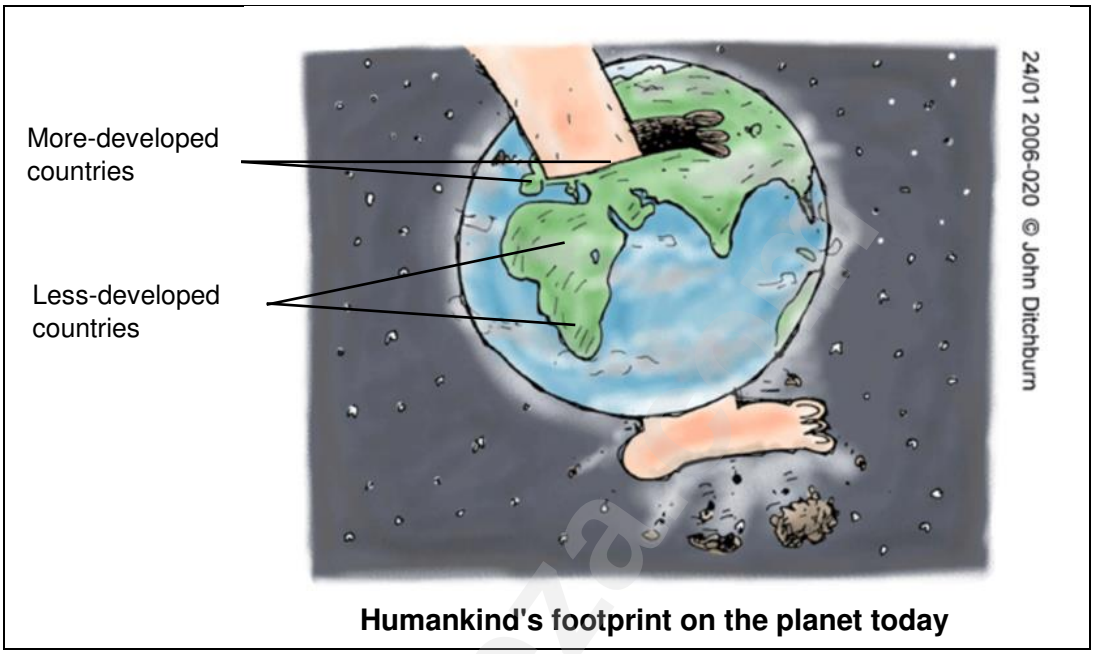
3.4.3 Describe the message of the cartoon below that is being conveyed to readers regarding the ecological footprint of countries.



Humankind's footprint on the planet today

[Adapted: <https://geiasousuperman.files.wordpress.com/2011/03/footprint.gif>]

(2)
[40]

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QUESTION 4

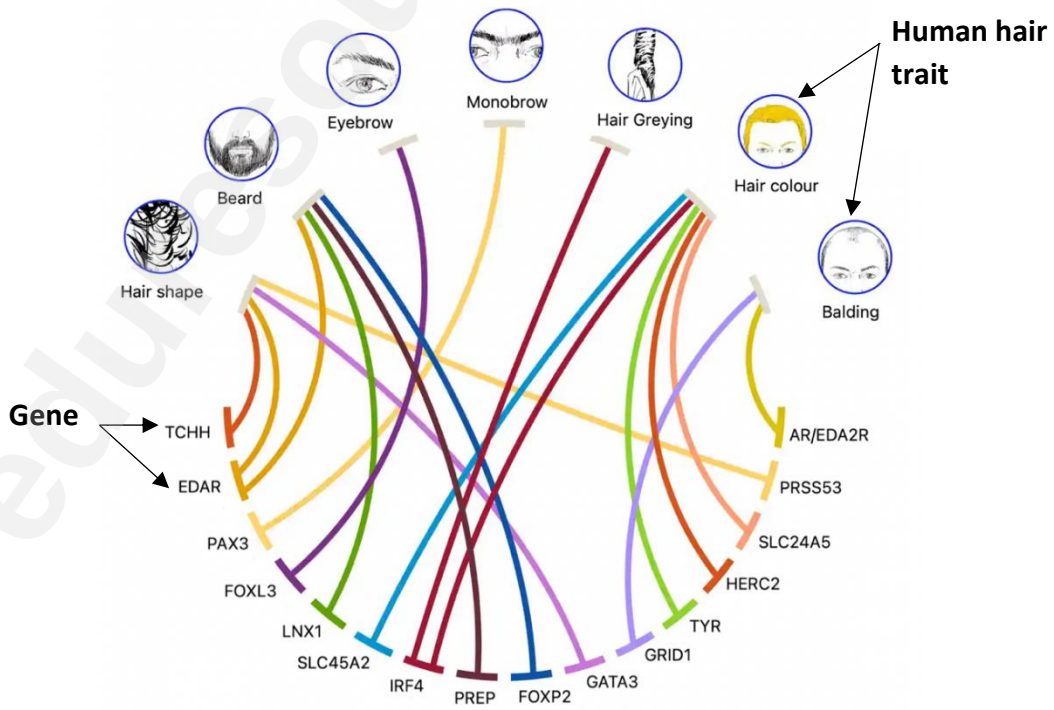
4.1 Read the information below and use it and your own knowledge to answer the questions that follow.

A major study has identified the genes that influence the trait of human hair. Scientists searched thoroughly through the genomes of more than 6 000 people to find versions of genes linked to straight hair, curly hair, grey hair, no hair, thick and thin beards, and even monobrows.

The findings provide insight into human hair types. They also pave the way for the development of drugs that slow or prevent certain changes, such as greying, before hairs even appear on the scalp. One gene identified in the study, known as IRF4, is the first gene to be linked to grey hair.

The cosmetic and hair care industry is reliant on people using their products. People spend a lot of money changing their hair colour by buying products like bleach and hair dyes. Kaustubh Adhikari, a geneticist who conducted the study at University College London, says that the identification of the IRF4 gene shows that there is a genetic component to hair greying. This raises the concern of the development of drugs and/or products by cosmetic companies. Technology, such as CRISPR, could be used to produce cosmetic products that will act on the hair internally so that the hair that grows out is the natural colour rather than grey.

Figure 13 – The genes identified in the study that influence various traits of human hair



[Adapted: <https://www.theguardian.com> and <https://www.gbhealthwatch.com/Trait-Hair-Curl.php>]

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4.1.1 Provide the term that describes the following phrase that is used in the text: 'versions of genes'.

(1)

4.1.2 Explain clearly the differences between the terms *gene* and *genome*.

(4)

4.1.3 Explain how evidence in Figure 13 shows that the trait of human hair is polygenic.

(2)

4.1.4 Explain ONE fact from the study that suggests the information is scientifically reliable.

(2)

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4.1.5 The TCHH gene controls the production of a protein, trichohyalin, which is expressed at high levels in the hair follicles of curly-haired individuals.

A mutation at position 790 in the DNA sequence in the TCHH gene causes straight hair (see table below).

	DNA sequence	**Amino acid**
Curly hair	GAC	Leucine
Straight	TAC	Methionine

(a) Name and describe the specific type of mutation that causes straight hair.

_____

_____

_____

_____

(2)

(b) Fill in the table below by stating the codon and the anticodon for the DNA sequence TAC.

DNA sequence	Codon	Anti-codon
TAC		

(2)

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(c) Describe the process of protein synthesis for a protein such as trichohyalin that is assembled from an mRNA strand.

(5)

4.1.6 Suggest ONE reason why scientists may be concerned about this research leading to the development of drugs or products that act internally on hair.

(2)

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4.2 Read the information in the text box below and use it and your own knowledge to answer the questions that follow.

> The TCHH gene controls the curliness of hair. This gene is located on chromosome 1.
>
> Curly hair **(H)** is dominant to straight hair **(h)**.
> Consider the following scenario:
> - A man with naturally curly hair has a child with a woman who has naturally straight hair.
> - Their first child has naturally straight hair.

4.2.1 Explain why curly and straight hair traits are considered autosomal traits.

_____

_____

(2)

4.2.2 Complete the parental genotypes, gamete genotypes and show by means of a Punnett diagram in the space below the probability of a child having straight hair.

Parent genotypes:

Man: _____ Woman: _____

Gametes:

Man: _____ Woman: _____

Punnett diagram:

Probability of straight hair: _____

(6)

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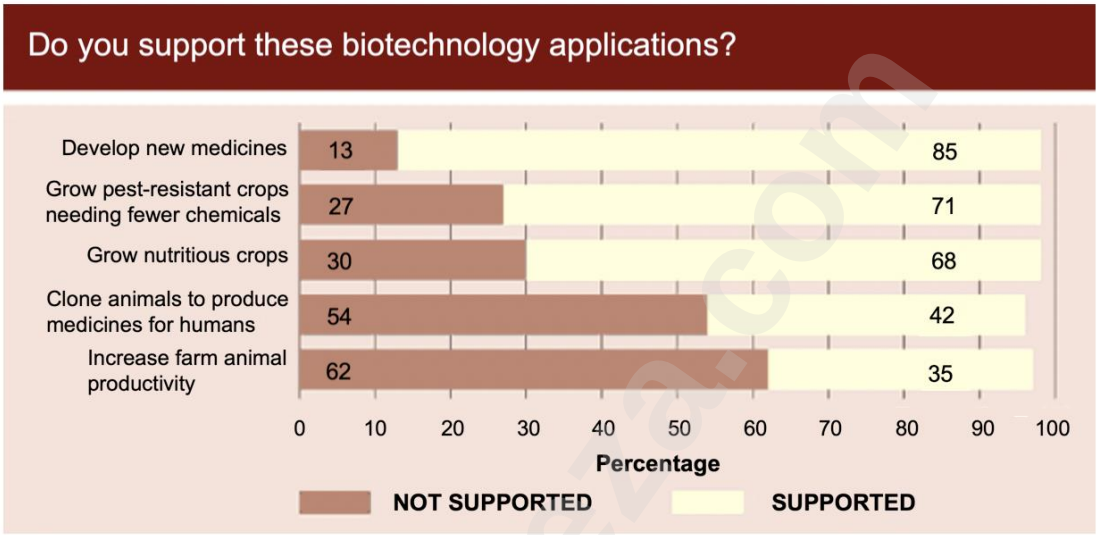
4.3 A survey was conducted to investigate the perceptions of people of biotechnology processes. The number of people surveyed was 35 000 and they came from 34 different countries. The responses to one of the questions asked are shown in Figure 14 below.

Figure 14 – Responses to a survey on biotechnology



[Adapted: <https://www.fao.org/3/y5160e/y5160e11.htm>]

4.3.1 Select TWO options from the list of statements (A to D) below that are accurate regarding biotechnology. Write only the letters of the accurate statements.

A	Biotechnology is used only to develop products and services to treat human diseases.
B	Biotechnology uses exclusively non-living substances to make parts or structures/organs of living organisms.
C	Biotechnology involves the use of organisms and their biological processes to develop products intended to benefit humans.
D	Early biotechnology processes include the making of cheeses and other fermentation products.

(2)

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4.3.2 (a) What percentage of people surveyed did not support the use of biotechnology to 'increase farm animal productivity'?

_____

(1)

(b) Suggest a well-explained reason for this response.

_____

_____

_____

_____

(2)

4.3.3 Describe ONE example of how biotechnology is applied to:

(a) treat human diseases

_____

_____

_____

_____

(3)

(b) improve crops

_____

_____

_____

_____

(3)

4.3.4 The latest biotechnology application is called CRISPR. Suggest ONE reason why many scientists warn that the use of CRISPR needs to be controlled with legislation (laws).

_____

_____

(1)

[40]

Total: 200 marks

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ADDITIONAL SPACE (ALL QUESTIONS)

ADDITIONAL SPACE TO ANSWER QUESTIONS. REMEMBER TO CLEARLY INDICATE AT THE QUESTION THAT YOU USED THE ADDITIONAL SPACE TO ENSURE THAT ALL ANSWERS ARE MARKED.

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