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**TOTAL  
MARKS**

INTERNATIONAL SECONDARY CERTIFICATE EXAMINATION  
MAY 2024

**BIOLOGY: PAPER I**

**EXAMINATION NUMBER**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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Time: 3 hours

200 marks

**PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY**

1. This question paper consists of 37 pages. Please check that your question paper is complete.
2. This question paper consists of four questions.
3. Read the questions carefully and make sure that you answer all parts of all the questions.
4. Write the answers on the question paper in the spaces provided. Please make sure that you write your examination number in the blocks above.
5. Use the total marks that can be awarded for each question and the space provided 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 36–37) are included at the end of the question paper. If you run out of space for an answer, use these pages. Should you use this extra space, number the answers exactly as the questions are numbered.

**FOR MARKER'S USE ONLY**

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

**QUESTION 1**

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

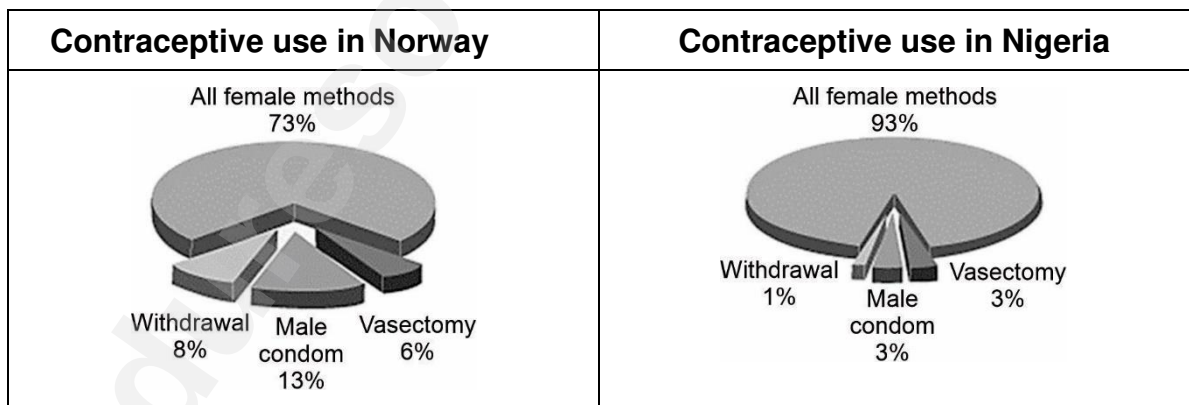
| <b>COLUMN A</b> |                                                                                                  | <b>COLUMN B</b> |                 |
|-----------------|--------------------------------------------------------------------------------------------------|-----------------|-----------------|
| [ ]             | Position of a gene on a chromosome.                                                              | A               | Mutation        |
| [ ]             | The phase of meiosis when crossing over occurs between homologous pairs of chromosomes.          | B               | Polyploidy      |
| [ ]             | The heritable condition of possessing more than two complete sets of chromosomes in plants.      | C               | Anther          |
| [ ]             | The disorder caused by nondisjunction of chromosome pair 21.                                     | D               | Metaphase I     |
| [ ]             | Random, unexpected change in the genetic make-up of an organism.                                 | E               | Prophase I      |
| [ ]             | The phase of meiosis when homologous pairs of chromosomes line up along the equator of the cell. | F               | Aneuploidy      |
| [ ]             | The male part of a plant where meiosis occurs to produce pollen grains.                          | G               | Locus           |
| [ ]             | The term for a trait that is determined by multiple genes.                                       | H               | Alleles         |
| [ ]             | The alternative forms of a gene.                                                                 | I               | Telophase II    |
| [ ]             | The phase of meiosis when four haploid gametes are produced.                                     | J               | Polygenic       |
|                 |                                                                                                  | K               | Down's syndrome |
|                 |                                                                                                  | L               | Anaphase        |

(10)

- 1.2 **SIX** multiple-choice questions are given below. Choose the most correct option for each question and write the letter of your choice in the space provided in the table below.

| Question | 1.2.1 | 1.2.2 | 1.2.3 | 1.2.4 | 1.2.5 | 1.2.6 |
|----------|-------|-------|-------|-------|-------|-------|
| Answer   |       |       |       |       |       |       |

- 1.2.1 What is the function of progesterone in the oral contraceptive pill?
- A Slows down the movement of sperm in the Fallopian tubes.  
 B Signals the pituitary gland to inhibit FSH and LH therefore preventing ovulation.  
 C Prevents thickening of the endometrium so that implantation does not occur.  
 D Inhibits the secretion of oestrogen so that ova do not start developing. (1)
- 1.2.2 Which hormone is produced by the pituitary gland?
- A Antidiuretic hormone  
 B Progesterone  
 C Thyroxin  
 D Growth hormone (1)
- 1.2.3 The following pie graphs show contraceptive use among men and women in Norway versus men and women in Nigeria.

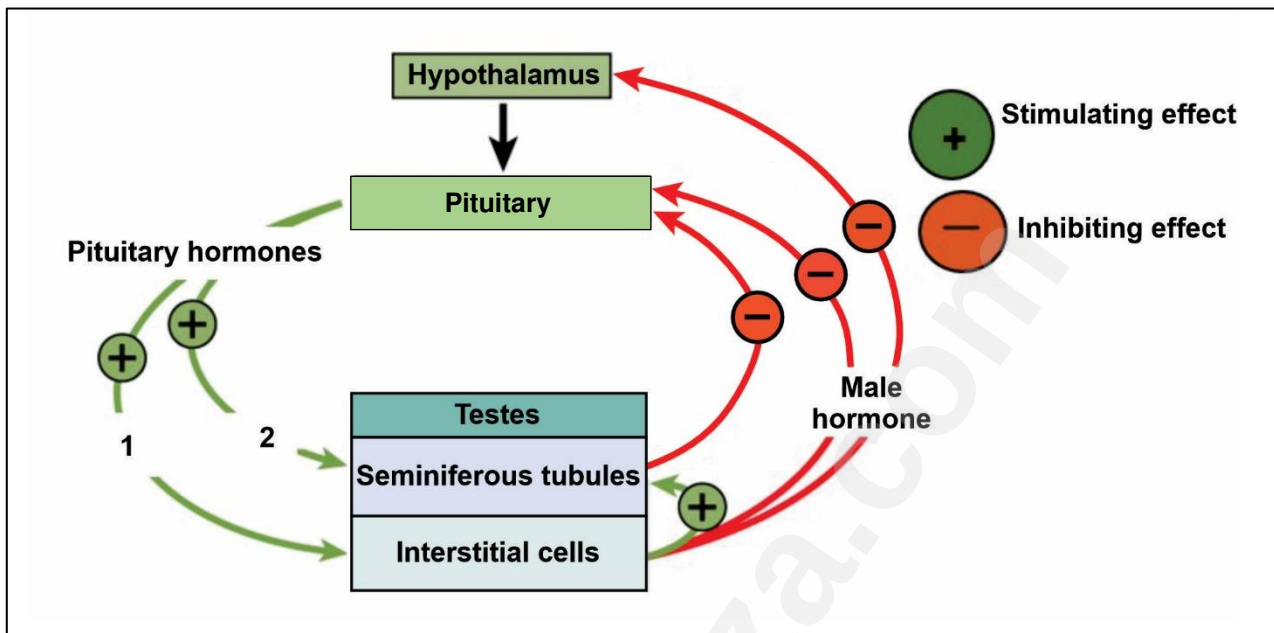


Which statement below is **INCORRECT** with respect to the data provided?

- A Men in Norway take more responsibility for contraception compared to men in Nigeria.  
 B Twice as many men in Norway use vasectomy as a method of contraception compared to men in Nigeria.  
 C More women in Norway use contraceptives when compared to women in Nigeria.  
 D The withdrawal method is more common in Norwegian men compared to Nigerian men.

(2)

1.2.4 The diagram below shows the regulation of testosterone levels in males.



[Source: <<https://opentextbc.ca/biology/chapter/24-4-hormonal-control-of-human-reproduction/>>]

Which of the following statements represent numbers 1 and 2?

|   | 1                          | 2                          |
|---|----------------------------|----------------------------|
| A | Decreased secretion of FSH | Decreased secretion of LH  |
| B | Decreased secretion of LH  | Increased secretion of FSH |
| C | Increased secretion of LH  | Increased secretion of FSH |
| D | Increased secretion of FSH | Increased secretion of LH  |

(2)

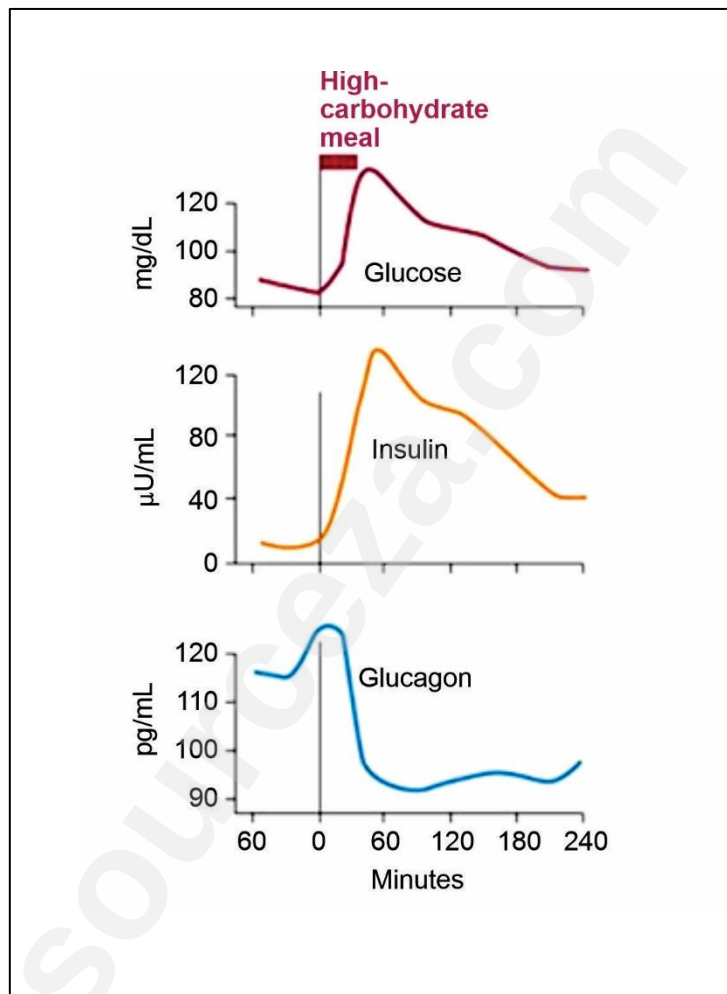
1.2.5 Select the most correct statement describing a feature of testosterone.

- A Testosterone is secreted by the interstitial cells found in the pituitary gland.
- B Testosterone is secreted by the interstitial cells found in the testes.
- C Testosterone is secreted by the cells of Sertoli in the testes.
- D Testosterone inhibits the secretion of prolactin.

(2)

1.2.6 Study the graphs below to answer the question that follows.

**Figure 1.2 – Graphs showing the relationship between glucose, insulin and glucagon over a four-hour time period, since a meal was consumed**



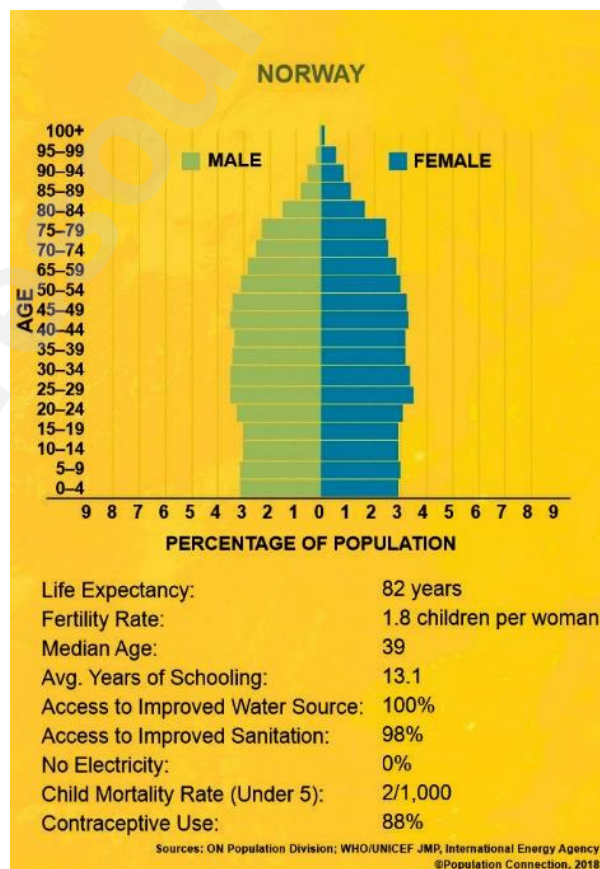
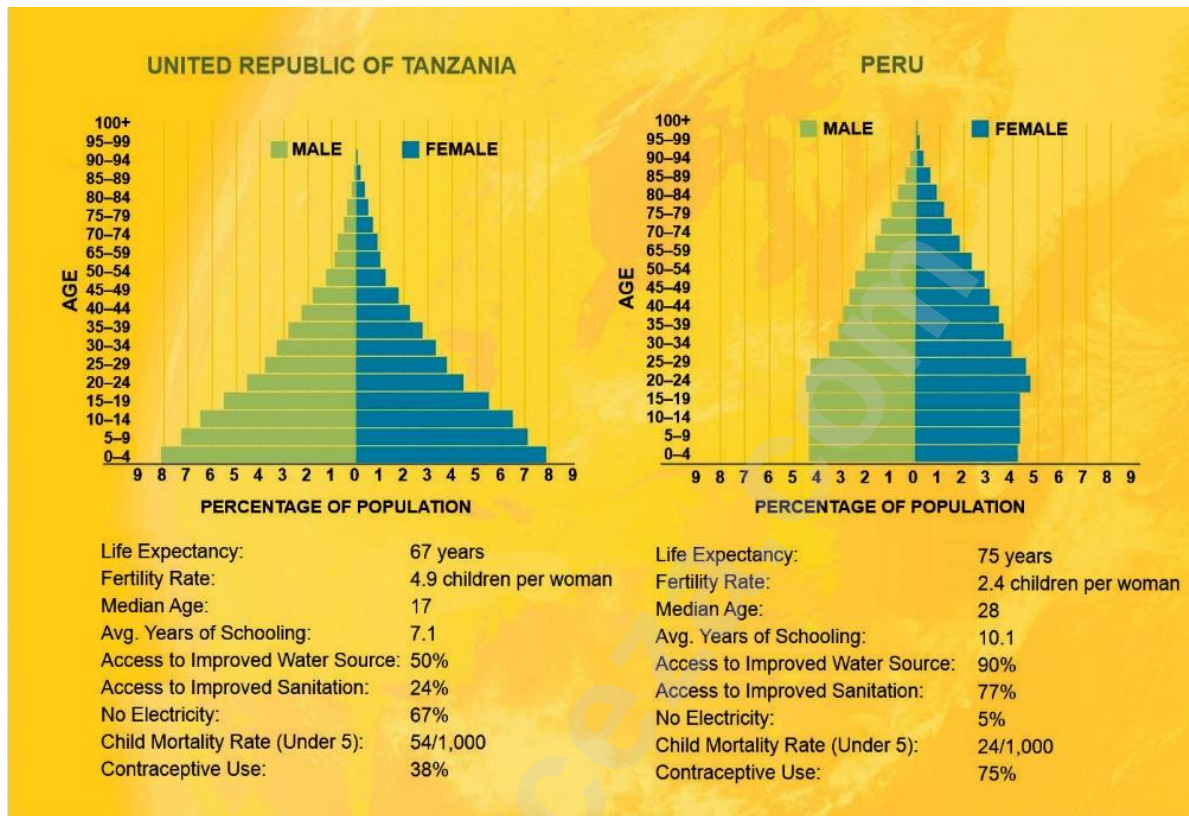
[Source: <<https://study.com/academy/lesson/homeostasis-glucose-levels-and-osmolarity-hormonal-control.html>>]

Which of the following is a correct conclusion that can be drawn from these graphs?

- A The high-carbohydrate meal triggers an increase in blood glucose levels which then causes glucagon levels to rise.
- B The high-carbohydrate meal triggers an increase in insulin which will then increase blood glucose levels
- C The high-carbohydrate meal triggers an increase in glucagon and insulin levels.
- D The high-carbohydrate meal triggers the secretion of insulin which will then lower blood glucose levels.

(2)

## 1.3 Study the population pyramids of three different countries shown below.



[Source: <<https://populationeducation.org/resource/population-pyramids-for-tanzania-peru-and-norway-infographic/>>]

The five statements in the table below relate to the population pyramids on page 6.

Consider the statements in the table below and for each statement decide whether:

**A** the statement is supported by the information

**B** the statement is contradicted by the information

**C** the statement is neither supported nor contradicted by the information

|       | STATEMENT                                                                         | A, B OR C |
|-------|-----------------------------------------------------------------------------------|-----------|
| 1.3.1 | The percentage of males and females in the 0–4 age group in Tanzania is the same. |           |
| 1.3.2 | Norway is a highly developed country since it has a low life expectancy.          |           |
| 1.3.3 | In Peru, most children do not finish school due to lack of resources.             |           |
| 1.3.4 | Sixty-two percent (62%) of people in Tanzania do not use contraceptives.          |           |
| 1.3.5 | Tanzania has poor access to water and sanitation.                                 |           |

(5)

- 1.4 Read the information about cheetahs given below and then answer the questions that follow.

**'Project Cheetah' – Translocation of cheetahs from South Africa and Namibia to India**

After 70 years of being extinct in India, cheetahs are being reintroduced into the country. Twelve cheetahs from a cheetah conservation centre in KwaZulu-Natal, South Africa, and eight cheetahs from Otjiwarongo, Namibia, made the long journey to be introduced into Kuno National Park in India. The translocation took place between September 2022 and February 2023. The cheetahs will initially be kept in an enclosed area and once they have adjusted, they will be released into the wild.

One of the Namibian cheetahs, three-year-old Siyaya, has just given birth to a litter of four cubs.



**Reproductive behaviour in cheetahs**

**Females**

A female will urinate on bushes, trees and rocks when she is ready to mate. A male that picks up this scent will call out to a female with a series of yelps. She will respond with yelps as the male approaches her. She then rolls on the ground and self-grooms when the male is present. She will then growl and strike the male with her paws.

**Males**

When the male encounters the female, he is very aggressive. He strikes her with his paws and knocks her down. He sometimes bites her hind legs.

**Mating and birth**

When they mate, the male inserts his penis into the female's vagina; and copulation lasts for less than a minute. This is repeated about 14 times over the next three days. After a gestation period of about 98 days, the female gives birth to live young and three to four cubs are born. The mother provides the young with milk for the first two months. After that, the mother hunts and tears open the prey so that the cubs can feed on meat. The mother moves the cubs to a new den every few days to protect them from predators.

[Source:<<https://www.downtoearth.org.in/news/wildlife-biodiversity/three-year-old-cheetah-siyaya-gives-birth-to-litter-of-four-cubs-at-kuno-88533>>]

[Source:<<https://ielc.libguides.com/sdzg/factsheets/cheetah/reproduction>>]

1.4.1 Do cheetahs display external or internal fertilisation?

(1)

1.4.2 How do cheetahs maximise the chances of fertilisation occurring?

(1)

1.4.3 Identify a feature of the courtship behaviour of males and females that is similar.

(1)

1.4.4 Describe the courtship behaviour of the female cheetah to attract the male.

(3)

1.4.5 Provide TWO pieces of evidence from the text that indicate that cheetahs are viviparous animals.

(2)

1.4.6 Provide evidence from the text to illustrate the following statement:

*'The female cheetah displays a high degree of parental care'*

(2)

1.4.7 Provide a meaning for the term *gestation*.

(1)

- 1.4.8 Discuss ONE reason why cheetahs from two different locations on the African continent were chosen for translocation to India.

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(2)

- 1.4.9 Do you support the decision to translocate the cheetahs from Africa to India? Give a well explained reason for your answer.

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(2)

1.5 Read the information below and answer the questions that follow.

### DNA from elephant dung and tusks reveal poaching hotspots in Africa

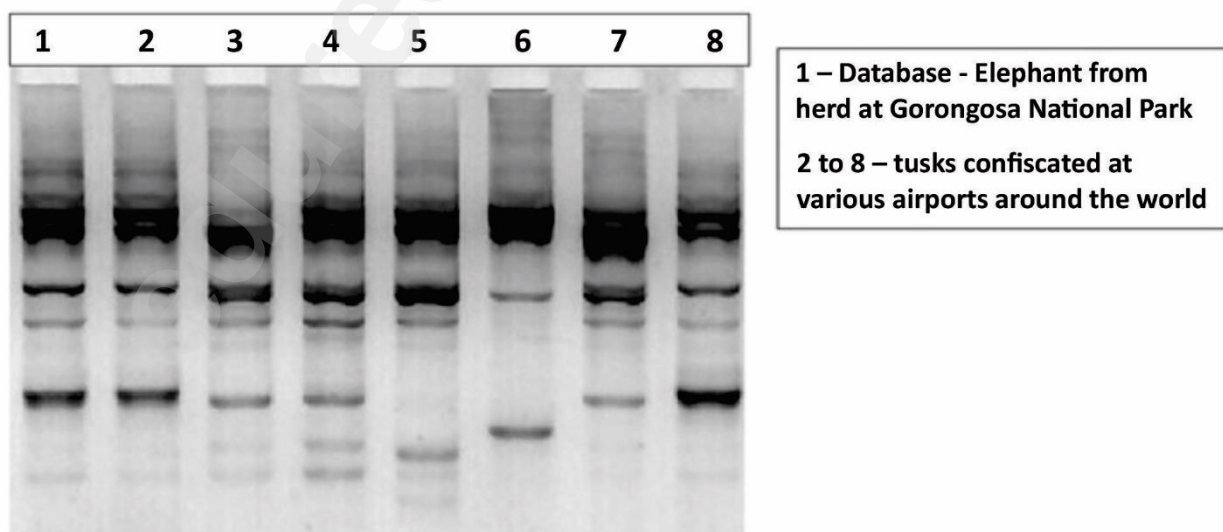
Elephant poaching currently occurs at an alarming rate and elephant populations are severely threatened. Scientists are trying to stop poachers by using improved DNA technology. This technology analyses the DNA from elephant dung collected across the African continent and the DNA from elephant tusks that are confiscated at airports.

Elephant dung contains the elephant's body cells with the animal's DNA intact. Scientists collected over 2 000 dung samples from 29 African countries, including two poaching hotspots, Mozambique and Gabon. Once the DNA is extracted from the dung and tusks, it is analysed and then added to an elephant DNA database. With the help of the database, authorities can quickly identify the region where confiscated tusks were originally poached. The elephant dung and the ivory contain small amounts of DNA, so the sample of DNA must be amplified (more copies made) before scientists can analyse the DNA.

The database matches genetic sequences from poached ivory to those stored in the database. The database relies on genetic information from a small segment of mitochondrial DNA (mtDNA). mtDNA provides a record of recent genetic changes between herds. This makes it an ideal tool for distinguishing between elephant herds. Herds tend to stay in certain geographical regions and because elephants live in close-knit family units, matching DNA from their tusks allows investigators to track and map a far greater number of animals than previous methods.

The database contains sequences of mtDNA from more than 7 000 African elephants. Even though this tool is effective and leads to arrest of poachers, more DNA samples from more locations are needed.

**Figure 1.5 – DNA collected from elephant tusks confiscated at various airports**



[Source: <<https://www.awf.org/blog/abc%E2%80%99s-elephant-dna#:~:text=We%20obtain%20DNA%20from%20dung,it%20scrapes%20along%20the%20walls>>]  
[Source: <<https://www.technologynetworks.com/genomics/news/geographic-and-genetic-information-helps-track-elephant-poachers-326737>>]  
[Source: <DNA analysis of elephant ivory reveals trafficking networks | The Seattle Times>]

1.5.1 From your own knowledge, provide the correct biological terms for the following phrases found in the text.

(a) The elephant's '*body cells*'. \_\_\_\_\_

(b) The process when the scientists amplify DNA.

\_\_\_\_\_  
(2)

1.5.2 Name TWO cell organelles from which DNA can be extracted.

\_\_\_\_\_  
(2)

1.5.3 Do you support the idea of the creation of a DNA database for elephants? Discuss TWO reasons to justify your answer.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
(4)

1.5.4 Suggest and explain ONE disadvantage of only using mtDNA to match a poached elephant with its original herd.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
(2)

1.5.5 (a) Provide the correct term used to describe the image of DNA shown in **Figure 1.5**.

\_\_\_\_\_  
(1)

(b) Using **Figure 1.5**, identify which TWO tusks belong to the elephant that was poached from Gorongosa National Park in Mozambique.

\_\_\_\_\_  
(2)

1.5.6 Tracking elephants using their DNA can now be used to estimate herd sizes.

- (a) What direct sampling method would usually be used for estimating the size of an elephant population?

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(1)

- (b) Discuss ONE reason why it may be more advantageous to estimate elephant populations using their dung rather than the method you identified in **1.5.6 (a) above**.

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(2)

1.6 Read the information and study the diagrams to answer the questions that follow.

### Flooding across the African continent has decimated many hectares of farms

Recent flooding across West and Central Africa has affected five million people in 19 countries. Over a million hectares of farmlands were destroyed in regions that already face a hunger crisis. Animal and bird life were also victims of the flooding.

The United Nation's World Food Program (WFP) has been providing small-scale farmers with financial assistance to help restore degraded ecosystems and replant their crops, mostly maize and tomatoes, which are staples to the African people. The WFP is also focusing on building the resilience of local farmers by teaching them farming techniques that will help them improve their yields and their income. Some of the techniques the farmers were exposed to included selective breeding of maize and creating more tomatoes by tissue culture.

**Figure 1.6.1 – Selective breeding of maize with more kernels on a larger cob**

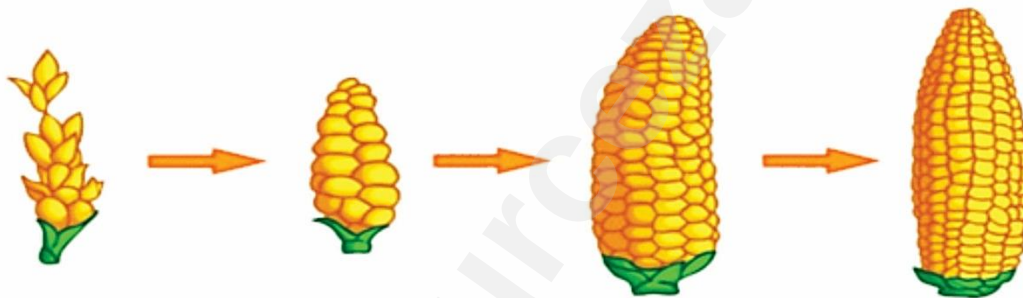
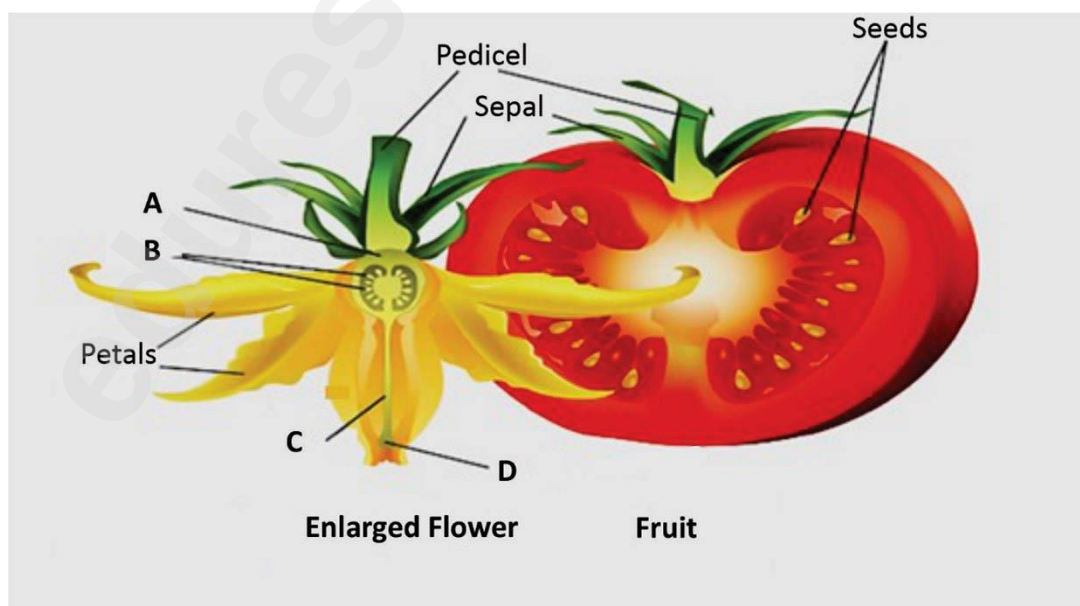


**Figure 1.6.2 – Tomato produced by tissue culture**



[Source: <<https://reliefweb.int/report/central-african-republic/west-africa-hard-hit-climate-crisis-deadly-floods-decimate-lives-and-livelihoods>>]

[Source: <<https://www.twinkl.fr/teaching-wiki/selective-breeding>>]

[Source: <<https://letstalkscience.ca/educational-resources/backgrounders/life-cycle-a-tomato-plant>>]

- 1.6.1 (a) Identify the type of ecological succession that would occur on land after a flood.

---

(1)

- (b) Give a reason for your answer.

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(1)

- 1.6.2 Name a pioneer plant species that first appears after the type of succession you mentioned **1.6.1 (a) above**.

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(1)

- 1.6.3 Provide another term for:

(a) selective breeding \_\_\_\_\_

(b) tissue culture \_\_\_\_\_

(2)

- 1.6.4 (a) Refer to **Figure 1.6.1** and describe the process of selective breeding an African farmer would use to achieve a more desirable maize cob.

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(5)

- (b) Discuss TWO ways that farmers will benefit from the selectively bred maize.

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(4)

1.6.5 Refer to **Figure 1.6.2** to answer the following questions.

- (a) Provide labels for structures C and D of the flower.

C \_\_\_\_\_ D \_\_\_\_\_  
(2)

- (b) Provide the letters of the parts of the flower that form the following after fertilisation:

(i) fruit \_\_\_\_\_ (ii) seed \_\_\_\_\_  
(2)

1.6.6 Provide TWO reasons why farmers would be opposed to the process of tissue culture of crop plants.

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(2)

1.6.7 One of the bird species that was seriously affected by the heavy rains in Nigeria is the Anambra waxbill.

**Figure 1.6.3 – The Anambra waxbill**



[Source:<<https://steemit.com/nature/@the-explorer/meet-the-anambra-waxbill-the-bird-that-exists-in-only-one-place-in-the-world>>]

After the floods, conservationists wanted to estimate the population of the Anambra waxbill using the mark-recapture method to see if the flooding had any detrimental effect on the population size of the birds. They captured 500 birds and marked them, using a suitable method. They then released the birds and after two weeks, they captured 150 birds. Of the 150 birds, 30 of them were originally marked.

Estimate the size of the Anambra waxbill population in Nigeria after the floods. Show all working.

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(4)  
[80]

**QUESTION 2**

Read the information below on wild dogs and answer the questions that follow.

**Reintroduction of an apex predator in Gorongosa National Park (GNP) in Mozambique**

The African wild dog (*Lycaon pictus*) is currently listed as endangered on the IUCN Red List. The main reason for their decline is habitat loss due to human interference. Wild dogs require large areas to hunt and with their habitats shrinking, they are struggling to survive. About 25 years ago, the ecological impact of the loss of this apex predator was quite noticeable in GNP. Once the number of apex predators decline in any ecosystem, that ecosystem becomes unstable and food webs are negatively affected. Due to the decline in the number of wild dogs in the park, one of the wild dog's prey, the bushbuck, increased in number. The bushbuck grazed openly in the plains, and this had a detrimental impact on the plant populations.

In 2018, conservationists started the process of translocation and reintroduction of wild dogs into GNP. This was carried out and monitored over a 28-month period. Conservationists removed solitary wild dogs from various nature reserves across South Africa to form the new artificial pack that would be reintroduced into GNP. The conservationists had to ensure that the wild dogs did not previously belong to packs, and that the males and females were not related.

This was the first successful reintroduction of wild dogs in Mozambique. Reasons for the successful reintroduction include the following:

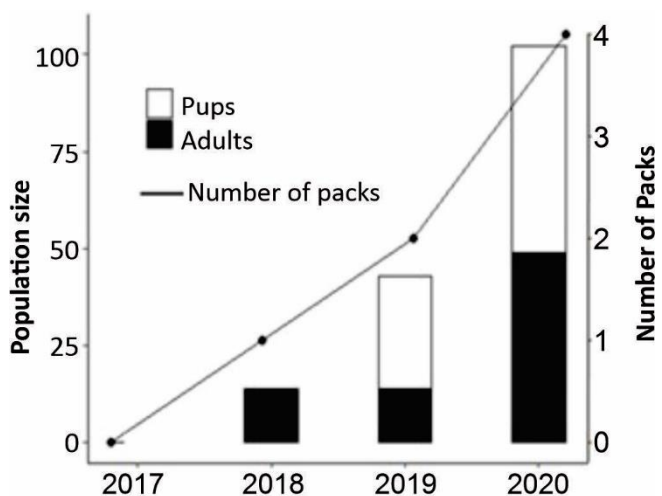
1. An abundance of prey, bushbuck in particular, was available.
2. The wild dogs were reintroduced into areas not widely used by lions, so they did not have to share food resources with lions.
3. There were no human settlements close by that had farm animals.

Of the 111 pups born in the 28 months (between 2018 and 2020), 62 survived to three months of age, 23 survived to six months of age, and 23 survived to one year old.

**Figure 2.1 – Pack of wild dogs in GNP**



**Figure 2.2 – Wild dog population in GNP before and after the reintroduction of the wild dogs**



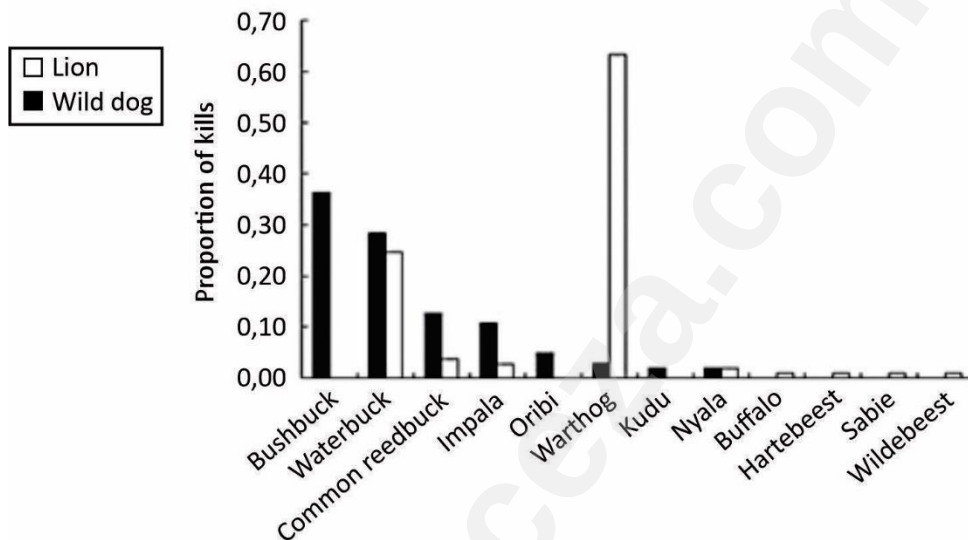
[Source: <<https://www.discoverwildlife.com/photo-galleries/remembering-african-wild-dogs/>>]

[Source: <<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0249860>>]

Lions are the main natural threat to wild dogs due to competition for similar food resources.

Conservationists predicted that wild dogs and lions could coexist in GNP by sharing food resources.

**Figure 2.3 – Comparison between wild dogs and lions in Gorongosa National Park between 2018 and 2022 in relation to the proportion of each prey in their diet**



[Source: <<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0249860>>]

[Source: <<https://www.sciencedaily.com/releases/2019/03/190307141018.htm>>]

2.1 Provide a word from the text that defines the following statements:

2.1.1 The wild dog is a predator found at the top of the food chain and rarely has any natural predators of its own.

(1)

2.1.2 The organised movement of wild dogs from all over South Africa to GNP.

(1)

2.1.3 The species name of the wild dog.

(1)

2.1.4 An animal that is caught and killed by another animal for food.

(1)

2.2 Conservationists predicted that wild dogs and lions in GNP would share food resources and therefore coexist.

2.2.1 Provide the correct biological term for this phenomenon.

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(1)

2.2.2 Identify the type of competition that exists between the wild dog and the lions.

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(1)

2.2.3 The prediction made by conservationists proved to be accurate because wild dog and lion shared resources effectively. Use evidence from **Figure 2.3** AND your own knowledge to justify this statement.

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(2)

2.3 Draw a simple food chain that includes any THREE organisms mentioned in the sources.

(4)

2.4 Use evidence from the text to discuss the negative impact of the loss of wild dogs on the food chain.

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(2)

- 2.5 Why was the newly formed pack that was reintroduced into GNP, known as an 'artificial' pack?

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(1)

- 2.6 Provide TWO pieces of evidence from **Figure 2.2** that suggests that reintroduction of wild dogs into GNP was successful.

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(2)

- 2.7 Suggest how the reintroduction of wild dogs near human settlements with farm animals would not have been successful.

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(3)

- 2.8 Suggest a reason why the conservationists had to ensure that the 'wild dogs were solitary animals and did not previously belong to other packs'.

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(2)

- 2.9 The relationship between wild dog and bushbuck is described as a predator-prey relationship.

- 2.9.1 Is predation a density-independent or density-dependent factor? Explain your answer.

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(2)

2.9.2 Sketch a graph to illustrate a typical predator-prey relationship as seen between the wild dog and the bushbuck.

(5)

2.10 Study **Figure 2.3** to answer the following questions.

2.10.1 What is the preferred prey for lions?

(1)

2.10.2 What proportion of the wild dog's diet is made up of impala?

(1)

2.10.3 Which prey is most commonly preferred by both lions and wild dogs?

(1)

2.11 Discuss ONE reason why the social organisation in wild dogs is advantageous to their survival.

(2)

2.12 Refer to the data provided in the text on page 18 to answer the following questions.

2.12.1 What percentage of pups born between 2018 and 2020 survived up to three months of age? Show all working.

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(2)

2.12.2 Draw a table to summarise the data on the number of wild dog pups that survived in the 28-month period.

(4)  
[40]

**QUESTION 3**

3.1 Read the information below and answer the questions that follow.

**First ever giraffe genome sequencing in Africa**

In 2012, two geneticists, Morris Agaba, the first African geneticist from the Nelson Mandela African Institute of Science and Technology in Tanzania, and Doug Cavener of Pennsylvania State University, started a major project of sequencing the giraffe genome. The Nelson Mandela Institute was newly established and Morris wanted to promote Africa in science by sequencing this iconic African animal.

The giraffe genome on its own would not provide much information, so the geneticists had to find something to compare it to. This is when they decided to sequence an okapi. An okapi (otherwise known as the forest giraffe) is the giraffe's closest relative; however, the okapi lacks the giraffe's impressive phenotype of a long neck and a powerful heart. The genomes of two Masai giraffes from the Masai Mara National Reserve in Kenya and one okapi were sequenced. Both the giraffe and the okapi contain 17 000 genes.

Further genetic analysis found that one gene, *FGFRL1*, which provides instructions for the synthesis of a protein required for cell growth, contained seven mutations in the giraffe but not in the okapi. *FGFRL1* mutations cause abnormalities in the skeletal system and the cardiovascular system of humans and mice, but not in that of the giraffe. In fact, in the giraffe, mutations in this gene resulted in longer neck vertebrae with increased bone density and increased blood pressure within the heart to ensure blood could reach the brain.

**Figure 3.1.1 – Adult male giraffes in Ndarakwai, West Kilimanjaro, Tanzania**



**Figure 3.1.2 – An okapi, the giraffe's closest living relative**



Researchers hypothesised that mutations within the *FGFRL1* gene were responsible for the giraffe's adaptation to the environment. To test this hypothesis, researchers used CRISPR to insert the giraffe gene into a group of mice. Two groups of mice, the experimental group (containing the *FGFRL1* gene) and control group, were given steroids to increase their blood pressure over a 28-day period. **The results of this study are shown in Figure 3.1.3 on the next page.**

This research may be helpful to the future of gene therapy for humans suffering from hypertension and other disorders such as brittle bone disease.

[Source: <<https://www.pbs.org/newshour/science/first-giraffe-genome-reveals-the-oddity-behind-an-african-icon/>>]

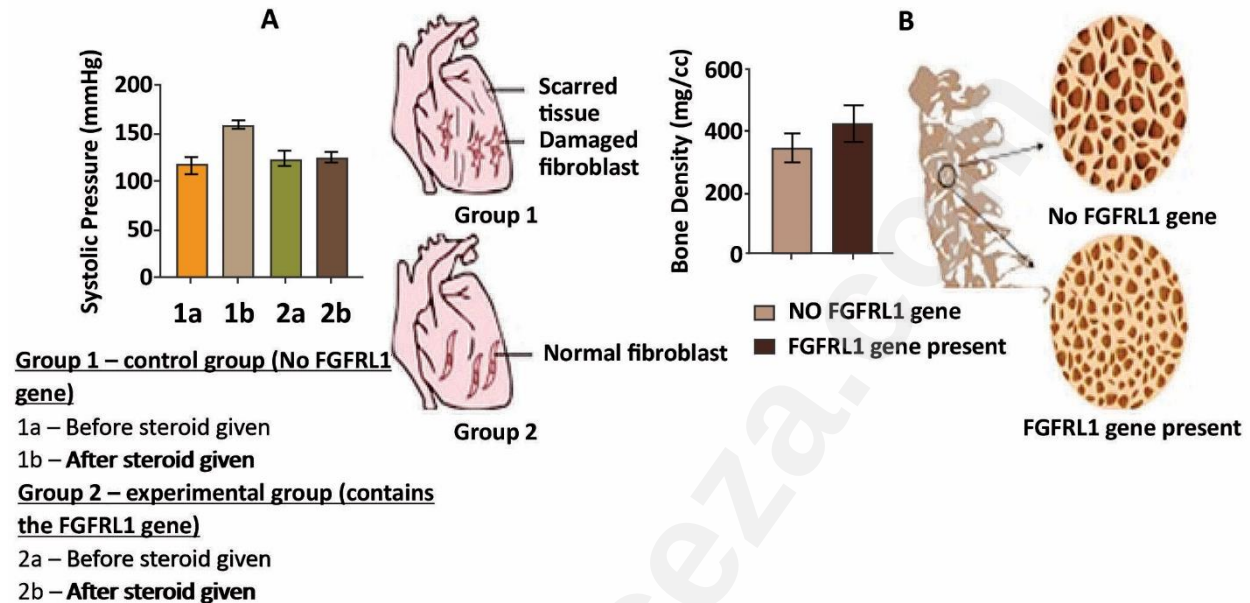
[Source: <<https://www.newscientist.com/article/2088571-giraffes-got-their-long-necks-thanks-to-a-few-dozen-gene-changes/>>]

[Source: <<https://africageographic.com/stories/giraffe-evolution-pieces-of-the-puzzle/>>]

**Figure 3.1.3 – The results shown after the FGFR1 gene was isolated from the giraffe and inserted into mice, using CRISPR – experimental group vs control group**

**A: The impact of the FGFR1 gene on blood pressure and heart structure in mice**

**B: The impact of the FGFR1 gene on bone density in mice**



Fibroblast – a type of cell that makes connective tissue such as bone and muscle

[Source: <<https://www.cell.com/trends/genetics/fulltext/S0168-9525%2821%2900132-3>>]

- 3.1.1 (a) Provide a term from the text that describes the observable traits of the giraffe, such as its long neck and long legs.

(1)

- (b) Provide the meaning for the term '*giraffe genome*'.

(1)

- (c) Name the building blocks of any protein such as the fibroblast growth receptor 1 protein.

(1)

3.1.2 Discuss ONE importance of sequencing the genome of any organism.

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(2)

3.1.3 Highlight the importance for the African continent of Morris Agaba, an African scientist, working on the sequencing of the giraffe genome.

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(2)

3.1.4 Copies of the chromosome with the FGFR1 gene are made in the nuclei of giraffe cells by DNA replication. Describe the process of DNA replication.

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(4)

3.1.5 (a) State the function of the FGFR1 gene.

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(2)

(b) Was the mutation in the FGFR1 gene lethal, neutral or beneficial to the giraffe? Provide a reason for your answer.

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(2)

3.1.6 Refer to the study on CRISPR discussed in the text, and graphs on page 25 to answer the questions that follow.

(a) What is the purpose of CRISPR?

\_\_\_\_\_  
(1)

(b) Refer to the results provided in **Figure 3.1.3**, on the study done on mice.

What TWO pieces of evidence from the figure suggest that this treatment can be used for future gene therapy in humans?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
(4)

(c) Describe the control group in the study.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
(2)

(d) List ONE variable that would have been kept constant in the study.

\_\_\_\_\_  
(1)

(e) Is the time and money spent on this study worth the effort? Provide a valid reason to support your answer.

\_\_\_\_\_  
\_\_\_\_\_  
(2)

- 3.1.7 Once this study is approved for human clinical trials, scientists can insert the FGFR1 gene into humans that suffer from brittle bone disease. List the steps that scientists would follow if they were using recombinant DNA technology to insert the FGFR1 gene into humans, using a vector such as a bacterium.

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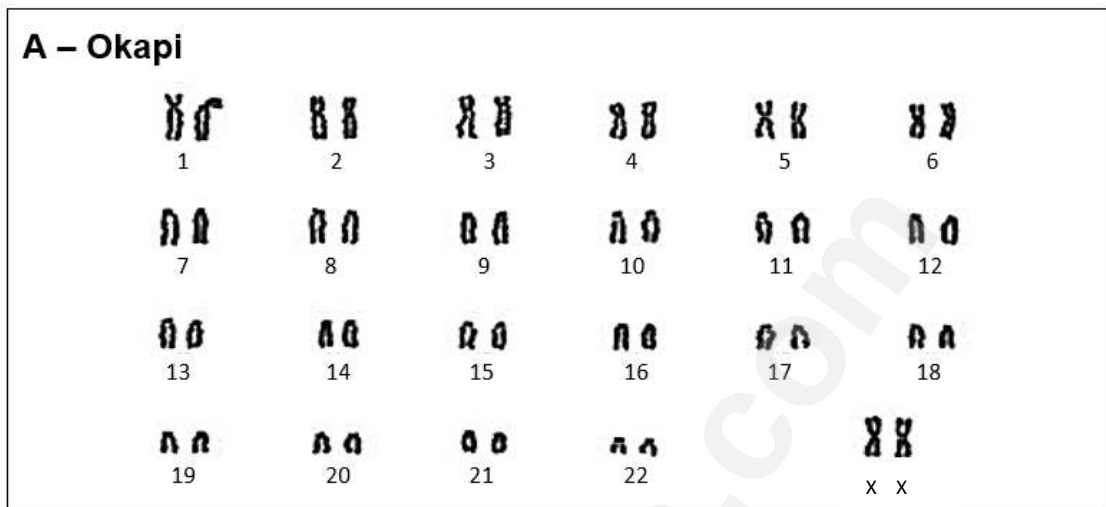
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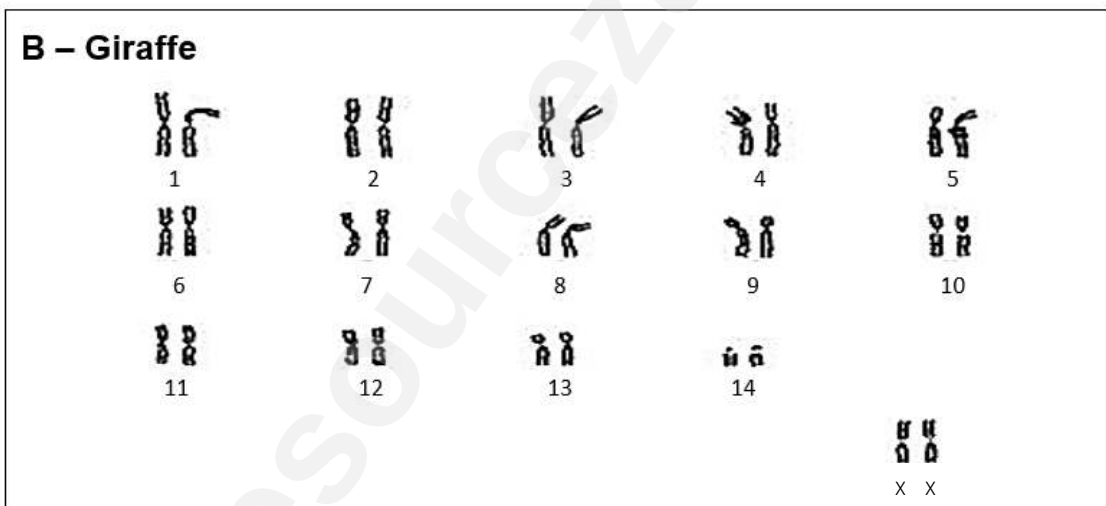
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(4)

- 3.2 Study the photographs below, showing the chromosome number in an okapi and a giraffe, then answer the questions that follow.



[Source:<<https://www.ivis.org/library/comparative-placentation/okapi-okapia-johnstoni>>]



[Source:<<https://www.ivis.org/library/comparative-placentation/giraffe-giraffa-camelopardalis>>]

- 3.2.1 Give the correct name for the photographs shown above.

(1)

- 3.2.2 Is the photograph of the giraffe taken from a skin cell or a gamete? Give a reason for your answer.

(2)

- 3.2.3 Tick the correct box below indicating the sex of the giraffe.

Male ☐ Female ☐

(1)

3.2.4 How many chromosomes are there in a body cell of an okapi?

\_\_\_\_\_ (1)

3.2.5 State the number of:

(a) autosomes in the giraffe \_\_\_\_\_

(b) gonosomes in the okapi \_\_\_\_\_

(2)

3.2.6 How can you tell from Figures A and B that the giraffe and okapi belong to two different species?

\_\_\_\_\_ (1)

3.2.7 Non-disjunction results in the mutation of chromosome 16 as shown below.



Explain how this mutation occurs in a gamete.

\_\_\_\_\_ (3)  
[40]

**QUESTION 4**

Read the information below and answer the questions that follow.

**Antibiotic-resistant gonorrhoea outbreak in Kenya – a major fertility threat**

Researchers at Kenya's Medical Research Institute (Kemri) are concerned about the recent strain of antibiotic-resistant gonorrhoea that has hit Kenya. The resistant strain was first detected in blood samples taken from sex workers in the capital city of Nairobi. This sexually transmitted infection (STI) can result in significant health challenges, such as permanent damage to the reproductive system in men and women, which can cause infertility. The resistant strain was tested against 13 different antibiotics and there was complete resistance to all of the antibiotics. The resistance of the bacterium to the antibiotics can be attributed to the overuse of antibiotics. The current prevalence of infertility in Kenya is 11,9%; and is likely to increase among people aged 15–24 with the outbreak of drug-resistant gonorrhoea. In sub-Saharan Africa, infertility is caused by STIs in more than 85% of women compared to only 33% worldwide.

In women, gonorrhoea can spread from the vagina into the cervix, uterus and Fallopian tubes and cause pelvic inflammatory disease (PID). PID damages the uterus and Fallopian tubes which then leads to infertility. In men, gonorrhoea leads to epididymitis (inflammation of the epididymis), which can cause infertility. Gonorrhoea can also lead to the formation of abscesses in the prostate gland. Newborn babies can contract the gonorrhoeal infection when they pass through the birth canal of an infected mother during the natural birth process. The bacterium infects the baby's eyes and can result in blindness.

[Source: <<https://www.downtoearth.org.in/news/africa/amr-ticking-timebomb-drug-resistant-gonorrhea-outbreak-in-kenya-major-fertility-threat-researchers-warn-87143>>]

[Source: <<https://sexinfoonline.com/gonorrhea/>>]

**Figure 4A: Structure of the female reproductive system showing pelvic inflammatory disease**

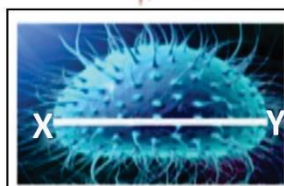
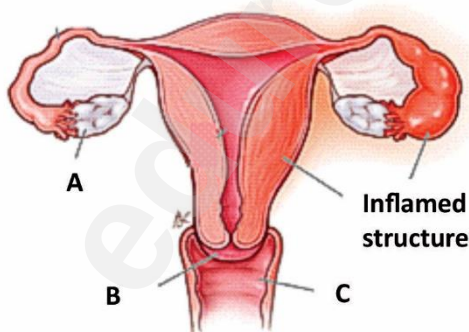
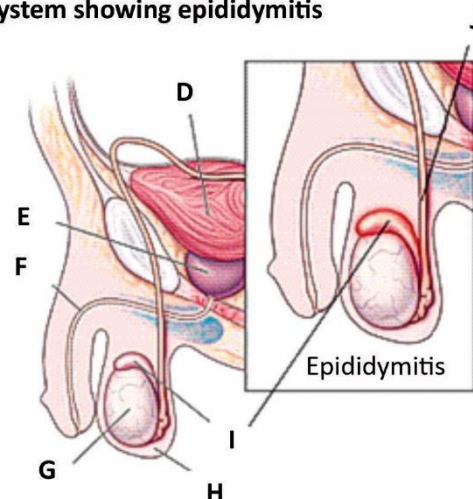


**Figure 4C: Gonorrhoea bacterium magnified 2000 X**

**Figure 4B: Structure of the male reproductive system showing epididymitis**



[Source: <<https://my.clevelandclinic.org/health/diseases/9129-pelvic-inflammatory-disease-pid>>]

[Source: <<https://my.clevelandclinic.org/health/diseases/17697-epididymitis>>]

[Source: <<https://microbenotes.com/habitat-and-morphology-of-neisseria-gonorrhoeae/>>]

4.1 Complete the table below using **Figures 4A and 4B**.

|       | Labelled part | Name of structure | Function of structure                       |
|-------|---------------|-------------------|---------------------------------------------|
| 4.1.1 | H             |                   | Ensures temperature of testes is regulated. |
| 4.1.2 |               | Testes            |                                             |
| 4.1.3 |               |                   | Release ova during ovulation.               |
| 4.1.4 | J             | Vas deferens      |                                             |

(6)

4.2 Refer to figures 4A and 4B to assist you in answering the following questions.

4.2.1 Provide ONE function of structure F in **Figure 4B**.

\_\_\_\_\_ (1)

4.2.2 Name the structures found in the ovary (A) that secrete the following reproductive hormones:

a. oestrogen \_\_\_\_\_

b. progesterone \_\_\_\_\_

(2)

4.2.3 Oestrogen has a negative feedback relationship with FSH.

a. What structure secretes FSH?

\_\_\_\_\_ (1)

b. Describe the negative feedback relationship that occurs between oestrogen and FSH in a pregnant woman.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

(5)

- 4.3 4.3.1 Name the TWO structures which become inflamed in women when infected with gonorrhoea.

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(2)

- 4.3.2 Explain how inflammation of these two structures cause infertility in women.

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(4)

- 4.4 The statements below refer to **Figures 4A and 4B**. Study the images and then draw a circle/s around the letter/s of statement/s that are correct.

- A Part labelled I, the epididymis, becomes inflamed when a man contracts gonorrhoea.  
B Abscesses form in part labelled E.  
C Natural birth occurs via the birth canal which is the cervix.

(2)

- 4.5 What is the difference in the percentage of women that are infertile in Africa, due to STIs, compared to women worldwide? Show all working.

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(2)

- 4.6 Explain why an obstetrician would recommend a Caesarean section to a pregnant mother that has gonorrhoea.

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(3)

- 4.7 Calculate the actual size of the gonorrhoea bacterium shown in **Figure 4C**. Show all working.

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(3)

- 4.8 Other than antibiotic resistance, suggest ONE other reason for the high prevalence of gonorrhoea in Kenya.

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(1)

- 4.9 Which contraceptive would be most effective in controlling the spread of gonorrhoea in the 15–24 year-old age group in Kenya? Give a reason for your answer.

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(2)

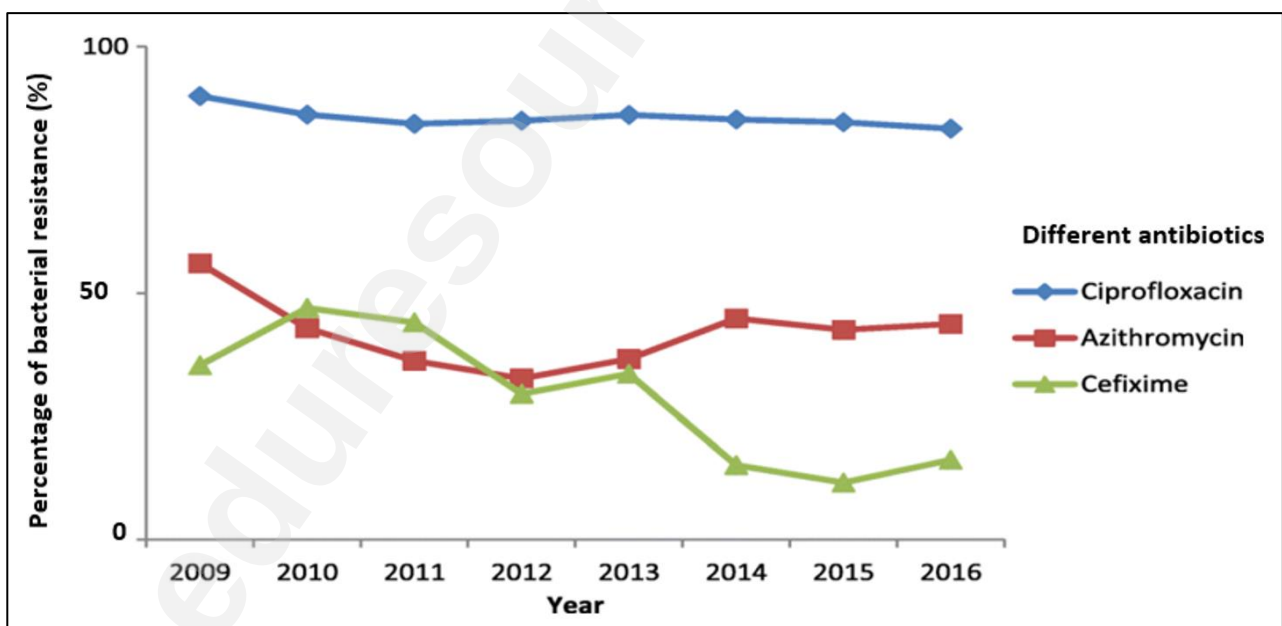
- 4.10 Provide ONE strategy the Kenyan government can implement to decrease the prevalence of gonorrhoea in Kenya in the future.

---

(1)

- 4.11 Three different antibiotics (ciprofloxacin, azithromycin, cefixime) have been used to treat gonorrhoea from 2009 to 2016. The gonorrhoea bacterium has since developed resistance against some of these antibiotics.

Refer to the following graph to answer the questions below.



[Source: <[https://www.researchgate.net/figure/Trends-in-resistant-Neisseria-gonorrhoeae-isolates-by-antimicrobial-and-year-Eyri-GASP\\_fig2\\_329366753](https://www.researchgate.net/figure/Trends-in-resistant-Neisseria-gonorrhoeae-isolates-by-antimicrobial-and-year-Eyri-GASP_fig2_329366753)>]

- 4.11.1 Provide a suitable heading for the graph.

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(2)

4.11.2 What percentage of bacteria were resistant to azithromycin in 2014?

\_\_\_\_\_ (1)

4.11.3 Which antibiotic is still effective against gonorrhoea? Give a reason for your answer from the graph.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ (2)  
[40]

**Total: 200 marks**



[illegible]