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TOTAL
MARKS

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INTERNATIONAL SECONDARY CERTIFICATE EXAMINATION
MAY 2025

BIOLOGY: PAPER I

EXAMINATION NUMBER

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Time: 3 hours

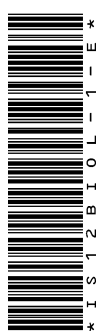
200 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 36 pages. Please check that your question paper is complete.
2. Read the questions carefully and make sure that you answer all parts of all the 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 blocks above.**
4. Use the total marks that can be awarded for each question and the space provided as an indication of the detail required.
5. It is in your own interest to write legibly and to present your work neatly.
6. Two blank pages (pages 35 and 36) are included at the end of the question paper. Use these pages if you run out of space for a question. Clearly indicate the number of the question you are answering should you use this additional space.

FOR MARKERS' 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.

COLUMN A	COLUMN B
[] All the plants and animals in an environment that interact with each other and with the non-living environment.	A Immigration
[] The one-way movement of organisms out of an area.	B Carrying capacity
[] A group of organisms of the same species that live in a particular area at the same time and can breed with each other.	C Ecosystem
[] The sum of all the limiting factors that affect the growth of a population.	D Population
[] The one-way movement of organisms into an area.	E Species
[] The number of individuals that can be sustained by the environment.	F Census
[] The ecological process by which the mix of species and habitat in an area change over time.	G Environmental resistance
[] An indirect method used to estimate the size of a population.	H Density dependent factor
[] A factor that alters the population size regardless of the size of the population.	I Mark-recapture
[] A direct method used to estimate the size of a population.	J Emigration
	K Density independent factor
	L Succession

(10)

- 1.2 Nine multiple-choice questions are given below. Choose the most correct option for each question and write the letter of your choice in the grid below.

Question	1.2.1	1.2.2	1.2.3	1.2.4	1.2.5	1.2.6	1.2.7	1.2.8	1.2.9
Answer									

1.2.1 Which of the following scientists developed the theory of natural selection?

- A James Watson
 - B Jean-Baptiste Lamarck
 - C Erasmus Darwin
 - D Charles Darwin
- (1)

1.2.2 Which of the following provides a reason for why bacteria that cause tuberculosis have become resistant to the antibiotics used to treat the disease?

- A Bacterial populations are rapidly evolving.
 - B Human populations are rapidly evolving.
 - C The bacteria that cause tuberculosis are genetically very similar to humans.
 - D There is currently no treatment for tuberculosis.
- (1)

1.2.3 Which one of the following hominids was an early tool maker known as 'handy man'?

- A *Homo habilis*
 - B *Homo erectus*
 - C *Australopithecus africanus*
 - D *Homo naledi*
- (1)

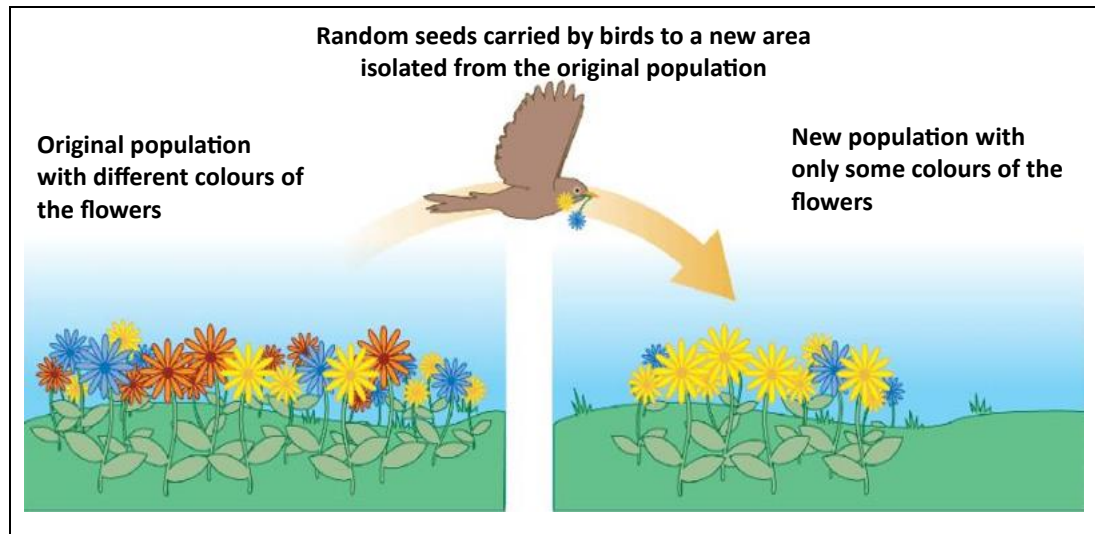
1.2.4 In evolutionary terms, the San are described as an extant population because:

- A they have become extinct.
 - B they are hunter-gatherers.
 - C they are one of the oldest living human populations.
 - D they are found in the Kalahari.
- (1)

1.2.5 Which one of the following statements best describes the Out of Africa hypothesis?

- A *Homo erectus* migrated out of Africa and evolved into *Homo sapiens* in different regions.
 - B Modern humans evolved in Africa from *Homo erectus* and then migrated to other continents.
 - C Modern humans evolved in Europe from early humans and then dispersed to other regions including Africa.
 - D *Homo sapiens* interbred with *Homo neanderthalensis* in Europe.
- (1)

- 1.2.6 Study the diagram below showing an evolutionary mechanism in a species of flower.



[Source: <<https://www.bioexplorer.net/>>]

Which of the following is the most likely explanation for the new population having only 'some colours' of the flowers?

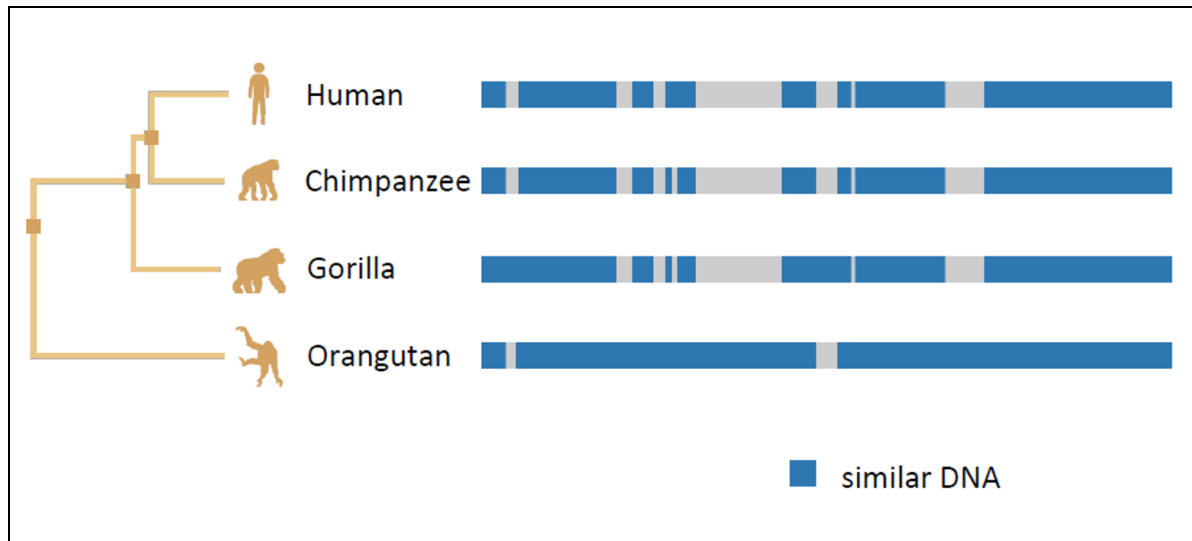
- A Convergent evolution
 - B Sexual selection
 - C The founder effect
 - D Artificial selection
- (1)

- 1.2.7 Which of the following factors contributed to the development of early human societies?

- (i) The use of stone tools
- (ii) Controlling and using fire
- (iii) The development of language
- (iv) The ability to climb trees

- A (i) only
 - B (iii) and (iv)
 - C (ii) and (iii)
 - D (i), (ii) and (iii)
- (1)

1.2.8 The diagram below shows a comparison of the DNA of four primates and their evolutionary relatedness.



[Source: <<https://www.yourgenome.org>>]

Which of the following statements describes the most correct evolutionary relationship?

- A Chimpanzees have a closer evolutionary relationship to gorillas than to humans.
- B The similarity in the DNA of the human and chimpanzee indicates their close evolutionary relatedness.
- C Humans are not closely related to the other primates.
- D The DNA of the orangutan is most similar to that of human DNA.

(2)

1.2.9 Which of the following combinations of characteristics, (i) to (iv) are true of a small population lacking genetic diversity?

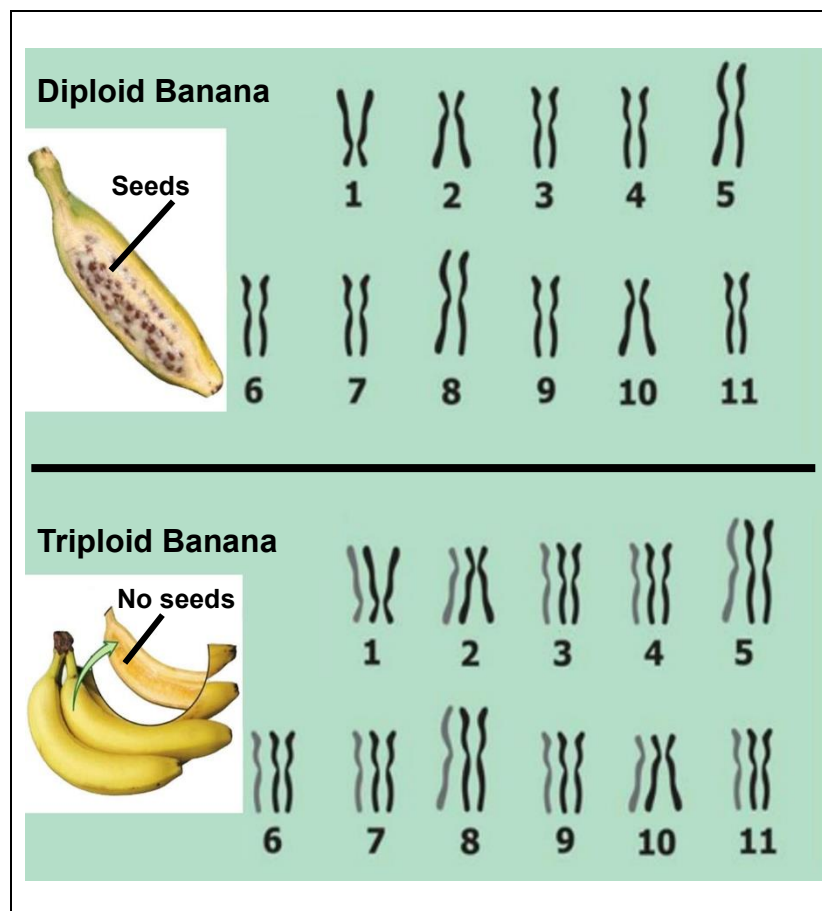
- (i) High risk of extinction
- (ii) Low levels of homozygosity
- (iii) Loss of hybrid vigour
- (iv) Increased risk of inbreeding

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

(2)

- 1.3 Bananas are selectively bred polyploid fruit that are commonly eaten throughout Africa and the world. Study the image below to answer the questions that follow.

Figure 1.3 Image showing the number of chromosomes in a diploid and triploid banana plant



[Source: <<https://academic.oup.com/aob/article/127/1/iv/6026662>>]

Study the table that follows (on page 7) which consists of a statement in the first column and two terms (numbered 1 and 2) in the second column. **Decide which term(s) relate(s) to the statement.**

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

- | | |
|-------|--|
| 1 | Only term 1 relates to the statement. |
| 2 | Only term 2 relates to the statement. |
| 1 & 2 | Both terms 1 and 2 relate to the statement. |
| None | Neither term 1 nor 2 relates to the statement. |

Statement		Terms	Answer
1.3.1	The number of chromosomes in a diploid banana.	1. 22 2. 11	
1.3.2	The ploidy of the triploid banana.	1. 3n 2. 33	
1.3.3	A photograph showing all the chromosomes in a somatic cell.	1. Cladogram 2. Karyotype	
1.3.4	A banana plant that has an extra set of chromosomes.	1. Polyploid 2. Polygenic	
1.3.5	The number of chromosomes in the gamete of a diploid banana plant.	1. 22 2. 33	
1.3.6	The trait that was selected for in the production of triploid banana plants.	1. More nutrition 2. No seeds	
1.3.7	The arrangement of chromosomes as seen in the image next to the diploid banana.	1. Homologous pairs 2. Chromatids	
1.3.8	The banana plant that has a larger genome.	1. Haploid 2. Triploid	
1.3.9	The process that occurs in meiosis when homologous pairs of chromosomes do not separate, leading to polyploidy in plants.	1. Non-disjunction 2. Crossing over	
1.3.10	The number of chromosomes in a new polyploid plant developed from the cross between two diploid banana plants.	1. 44 chromosomes 2. 4 sets of each chromosome	

(10)

1.4 Read the information below on the discovery of a fossil in the Cradle of Humankind.

In 1924, Raymond Dart discovered the fossil of a skull of a child in the Cradle of Humankind, a World Heritage Site, in South Africa. The teeth from the skull revealed that the child was three to four years old. Dart was convinced he had discovered the fossil of a human ancestor. He classified it as *Australopithecus*. The hole through which the spinal cord exits the bottom of the skull suggested that the child had an erect posture and walked upright on two legs. As more fossils were discovered, Dart noticed that there were always animal bones, teeth and hooves in the vicinity of the fossils.

Figure 1.4.1 – The fossilised skull discovered by Raymond Dart

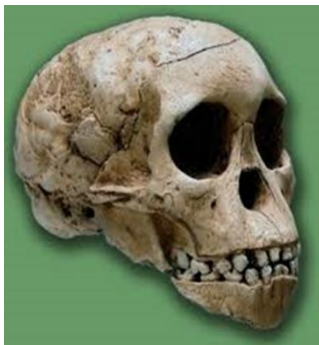
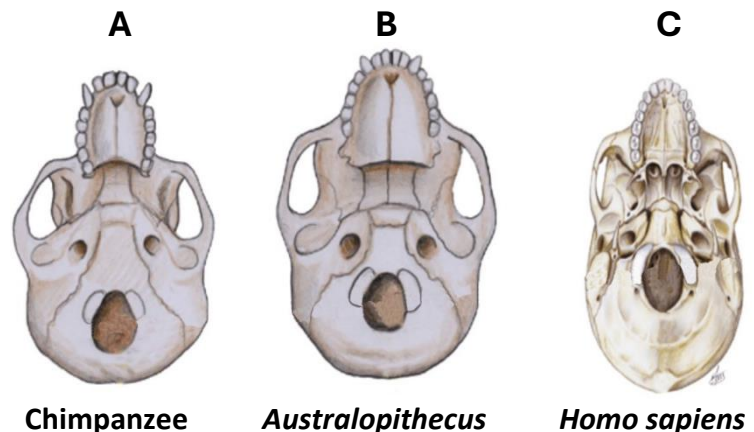


Figure 1.4.2 – The bottom view (underneath) of three different skulls



[Source: <<https://www.smithsonianmag.com/science-nature/how-africa-became-the-cradle-of-humankind-108875040/>> and <<https://musculoskeletalkey.com/cranial-vertebra/>>]

1.4.1 Provide the correct biological term for the following phrases found within the text:

- (a) *'hole through which the spinal cord exits the bottom of the skull'*

(1)

- (b) *'had an erect posture and walked upright on two legs'*

(1)

1.4.2 (a) Label the structure you identified in Question 1.4.1 (a) on any one of the skulls in Figure 1.4.2.

(1)

- (b) Discuss the evidence shown on Figure 1.4.2 that suggests the child had an erect posture and walked upright on two legs, unlike the chimpanzee.

(2)

- 1.4.3 (a) To which *Australopithecus* species did the child fossil belong?

(1)

- (b) Provide the common name given to the child fossil discovered by Dart.

(1)

- (c) Name ONE other fossil, from the same species, that has also been discovered in the Cradle of Humankind.

(1)

- 1.4.4 What evidence on the skull discovered by Dart suggested that it belonged to a three- to four-year-old child?

(1)

- 1.4.5 Provide ONE well-explained reason for finding the other animal remains near the human ancestor fossils.

(2)

- 1.4.6 List ONE difference in the teeth found in skull A compared to the teeth found in skull C.

(1)

- 1.4.7 Do you think it is justifiable to refer to Africa as the cradle of humankind? Explain your answer.

(2)

- 1.5 Read the information below on haemophilia in dogs in order to answer the questions that follow.

A German Shepherd



A dog has 39 pairs of chromosomes in its somatic cells. In dogs, the X and Y chromosomes determine gender, just like in humans. Haemophilia is an X-linked recessive bleeding disorder that affects humans and dogs, particularly the German Shepherd. A mutation occurs in the clotting factor viii gene, resulting in a lack of a protein which is vital for normal blood clot formation.

The affected dog presents with easy and excessive bruising and frequent nosebleeds. Bleeding in joints results in lameness or stiffness. Excessive bleeding can result in death. Breeding of affected male dogs and carrier female dogs is not recommended.

Currently the most common treatment option for haemophilia in humans is to inject the factor viii concentrate directly into a vein. This is not a cure for haemophilia so it must be repeated weekly or daily which means it can be expensive. This treatment is not available for use on dogs.

[Source: <<https://www.pawprintgenetics.com/blog/2014/02/09/beyond-dominant-and-recessive-x-linked-canine-inheritance/>>]

- 1.5.1 From the text above, provide the correct biological term for the following statements:

- (a) A body cell in a dog.

(1)

- (b) The sequence of nucleotides that codes for the clotting factor protein.

(1)

- (c) A spontaneous change within the clotting factor viii gene.

(1)

1.5.2 List TWO symptoms experienced by haemophiliac German Shepherds.

(2)

1.5.3 Explain why it is more likely for male dogs to be affected with haemophilia than female dogs.

(2)

1.5.4 Describe the process of translation of the clotting factor protein at the ribosome in a cell.

(5)

1.5.5 The breeding of a haemophiliac male dog and a carrier female dog is not recommended.

- (a) Draw a Punnet square or genetic cross to show the expected offspring between a haemophiliac male dog and a carrier female dog. Provide all genotypic and phenotypic percentages for the offspring of the cross.

Use the letters:

X^H – normal blood clotting gene, not affected with haemophilia

X^h – mutated blood clotting gene, affected with haemophilia

Parental genotypes: _____ x _____

Gametes: _____ and _____

Punnett square/genetic cross:

Genotypes of offspring: _____

Phenotypes of offspring: _____

(6)

- (b) Refer to your cross to explain why it is not recommended that a haemophiliac male dog and a carrier female dog mate and produce offspring.

(1)

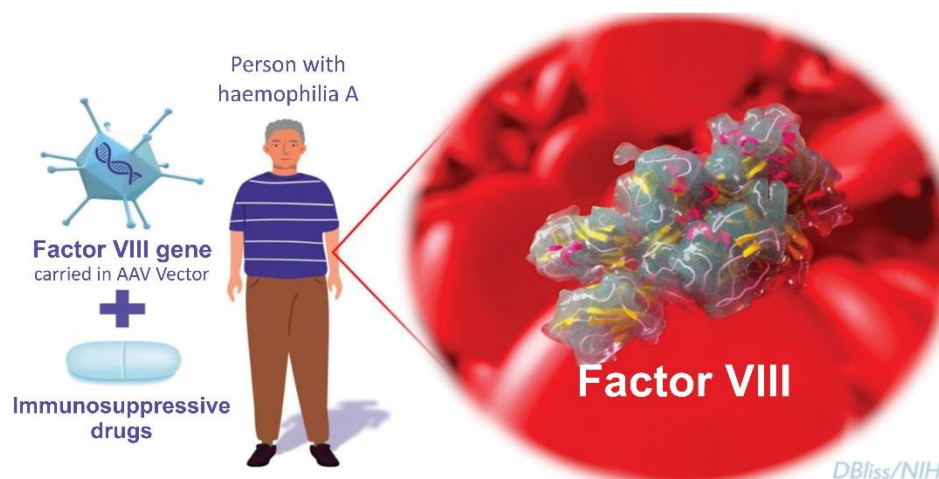
1.5.6 The current treatment for haemophilia, mentioned in the text, is not being used to treat haemophilia in dogs. Do you regard this as ethical? Justify your answer.

(2)

- 1.6 Read the information below related to gene therapy and haemophilia and answer the questions that follow.

Recent studies, published in the *New England Journal of Medicine*, show that there could be a possible cure for haemophilia. Haemophilia is a disorder which prevents blood from clotting after an injury. Haemophilia is caused by a mutation in the gene that codes for the clotting factor viii protein. With the advance in gene therapy research, this technology can be used to produce the essential clotting factor in people with haemophilia. Recombinant technology was used to insert the normal factor viii gene into the liver cells of haemophiliac patients using the adeno-associated virus (AAV) as a vector. This treatment is in very early-stage clinical trials. The results showed that in 14 out of the 18 patients gene therapy resulted in the production of factor viii, but after a year the same patients had a drastic decline in factor viii production. Follow up studies indicated that the decline was possibly linked to an immune response to the AAV vector.

Figure 1.6 The process of recombinant technology used to insert the factor viii gene into the haemophiliac patient's DNA



[Source: <<https://directorsblog.nih.gov/2021/11/30/encouraging-news-on-gene-therapy-for-haemophilia-a/>>]

- 1.6.1 (a) Name the vector used in the process shown in Figure 1.6.

(1)

- (b) Describe the process of recombinant DNA technology used to insert the factor viii gene into the patient's DNA.

(5)

- (c) According to the study, why is recombinant DNA technology not yet ready to be used in the treatment of haemophilia in humans? Provide TWO reasons.

(2)

- (d) Besides the treatment of disorders, provide ONE other use of recombinant DNA technology.

(1)

- 1.6.2 Calculate the percentage of patients where gene therapy resulted in the production of factor viii. Show all working out and round off your answer to the nearest whole number.

(2)

1.6.3 The study on **recombinant technology for factor viii** shows great promise in finding a cure for haemophilia.

- (a) Discuss ONE reason why the potential cure outlined, may not be easily accessible to patients in Africa.

(1)

- (b) Discuss ONE reason why the findings of this study can be seen as reliable.

(2)
[80]

QUESTION 2

Read the information below on the evolution of lion subspecies in Africa and then answer the questions that follow.

Fossil evidence indicates that lions roamed the planet about 1,8 million years ago and their habitat range was extensive throughout Europe, Asia, Africa and both the American continents. Now wild populations of lions (*Panthera leo*) can only be found as two subspecies – one in Africa (*Panthera leo leo*) and one in Asia (*Panthera leo persica*). The term 'subspecies' refers to different types/breeds of the same species of lions. Lion populations are currently listed as endangered. Their decline in habitat range is due to expanding human populations and climate change.

The African and Asian lion are genetically and physically very different. Asian lions have reduced genetic variation compared to African lions because Asian lions went through an event where their population size was drastically reduced. DNA analysis provided evidence to show the genetic differences in certain structures between the African and the Asian lion. Some of the structural differences included:

- the abdominal skin fold which was found in 98% of Asian lions but only in 4% of African lions.
- Asian lions have two small holes in the skull to serve as a passageway for nerves and blood vessels to reach the eye, but African lions only have one hole.

Figure 2 Differences between the African and the Asian lion



[Source: <<https://www.pmfias.com/asiatic-lions/>>]

Researchers originally believed that African lions belonged to a single population of breeding lions that migrated to different areas. However, new studies indicate that there may now be more than one subspecies of lion in Africa because as they migrated to different areas, they underwent genetic variation.

The study of the distribution of the African lions indicates that the population of lions split into west, east, central and southern Africa about 300 000 years ago. Genetic differences between them are evident from random mutations found within their genotypes. Natural geographic structures like the Rift Valley and expansion of the African rain forests are acting as barriers to keep the lions apart in Africa. Lion populations are becoming isolated, and this limits their gene flow.

It is clear that conservation efforts would benefit from a better understanding of the lion subspecies. Having a better understanding of genetic diversity in lions is important in the fight against their extinction. If genetic diversity is lost, then lions lose their adaptability to the changes in the environment, and they are more likely to become extinct. A delegation of conservationists from South Africa met with local communities in Botswana to discuss ways to conserve the lion population. The knowledge and values of the local communities are now being acknowledged as being very valuable for biodiversity and conservation.

[Source: <<https://lionalert.org/lion-genetics/>> and <<https://theconversation.com/genetic-studies-may-hold-the-key-to-saving-west-and-central-africas-lions-64254>>]

- 2.1 Identify the evolutionary line of evidence being referred to by the following phrase from the text above.

'The study of the geographic distribution of the African lions'

(1)

- 2.2 2.2.1 Identify TWO other types of evolutionary evidence that were used to classify the lion into the African and Asian subspecies.

1. _____

2. _____

(2)

- 2.2.2 Discuss how each of these two lines of evidence you mentioned in Question 2.2.1 above can be used to support the theory of evolution.

1. _____

2. _____

(2)

2.3 2.3.1 Provide the meaning of the term *species*.

(3)

2.3.2 The lions in Africa can be regarded as having undergone microevolution. Using the text and your own knowledge explain TWO pieces of evidence that support this.

(4)

2.4 Provide ONE reason for the decrease in the size of the habitat available to the African lions.

(1)

2.5 Tabulate TWO differences between the African and Asian lion.

(6)

2.6 The African lions are currently undergoing allopatric speciation.

(a) Provide evidence from the text that supports this observation.

(1)

- (b) Describe how the process of allopatric speciation of the African lions will result in two different species.

(5)

- 2.7 2.7.1 Explain why Asian lions have less genetic variation when compared to African lions.

(2)

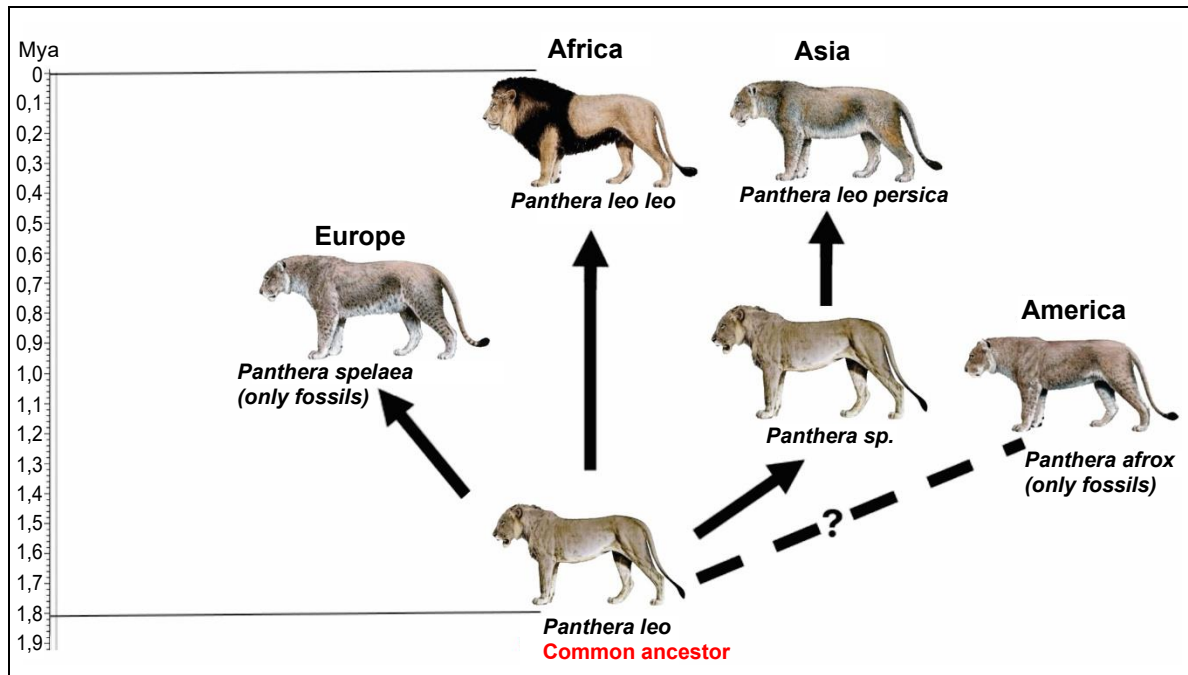
- 2.7.2 Discuss why is it important for conservationists to understand the genetic diversity of the African lion.

(2)

- 2.8 Explain the importance of South African scientists meeting with local communities from Botswana, rather than conservationists, to work on strategies aimed at protecting the African lion population.

(3)

- 2.9 Study the image shown below showing the evolution of lions. Use this image to answer the questions that follow.



[Source: <https://www.researchgate.net/figure/Hypothetical-look-at-the-temporal-and-spatial-distribution-of-single-phylogenetic_fig1_287422796>]

- 2.9.1 Fossil evidence suggests that lions roamed the planet approximately 1,8 million years ago. Use evidence from the diagram to justify that the timeline is correct.

(2)

- 2.9.2 What information on the diagram indicates that the lions in Europe and America are extinct?

(1)

- 2.9.3 Explain why the evolution of lions can be described as divergent evolution.

(2)

2.9.4 Suggest what is indicated by the question mark and dotted line on the diagram.

(2)

2.9.5 Name the scientist that you studied who would have made the following statement:

'The African lion acquired its mane because it used it for camouflage and then passed on this acquired trait to its offspring.'

(1)

[40]

QUESTION 3

3.1 Read the information provided below to answer the questions that follow.

In 2021, 1,5 million people in Africa contracted HIV and 650 000 people died from AIDS-related illnesses, despite antiretroviral therapy reducing HIV cases. African populations have the highest rate of HIV infection and the highest human genome diversity, yet they are still drastically underrepresented in human DNA studies.

In one study, researchers have recently analysed the DNA of 4 000 people of African ancestry living with HIV-1 and found a gene variant CHD1L on chromosome 1 that most likely controls HIV infection. The gene is known as *Chromodomain Helicase DNA Binding Protein 1 Like (CHD1L)*. This gene contains instructions that code for the helicase enzyme which is used in DNA repair.

Different forms of this gene, specifically present in the African population, has been linked to reduced viral load (the number of viruses in a person's body) of the deadliest type of HIV, called HIV-1. This means they have a lower risk of transmitting the virus and the development of HIV to AIDS is delayed.

The team also carried out a few laboratory tests by growing cells that either had the CHD1L gene activity turned on or turned off. Next, they infected these cells with HIV. They found that the virus made copies of itself when CHD1L was turned off.

[Source: <<https://www.downtoearth.org.in/news/africa/gene-variant-in-people-of-african-origin-helps-control-hiv-says-study-90974>> and <<https://www.nature.com/articles/s41586-023-06370-4#Sec2>>]

3.1.1 Provide the correct biological term for the following phrase found in the text:

'different forms of genes'

(1)

3.1.2 (a) Name the organelle in which DNA can be found in a cell.

(1)

(b) Explain the function of the CHD1L gene.

(3)

- (c) Name the building blocks/monomers that make up the DNA of the CHD1L gene.

(1)

- (d) Is the CHD1L gene found on an autosome or gonosome?

(1)

- (e) List TWO reasons why the CHD1L gene is beneficial to people that are infected with HIV.

(2)

- 3.1.3 Calculate the percentage of people with HIV that died from AIDS-related illnesses in 2021. Show all working.

(2)

- 3.1.4 (a) Provide the meaning of the term *genome*.

(2)

- (b) What is the Human Genome Project?

(1)

- (c) Explain ONE important benefit of the Human Genome Project.

(2)

3.1.5 Refer to the statement provided below.

'African populations have the highest rate of HIV infection and the highest human genome diversity, yet they are still drastically underrepresented in human DNA studies.'

Why do you think African populations are not well represented in human DNA studies? Provide TWO well-explained reasons to support your answer.

(4)

3.2 Read the information on genetic engineering and then answer the questions that follow.

Malaria infects about 200 million people in sub-Saharan Africa every year and 400 000 of these people die. Children are the most prone to malaria infection. Efforts to control the disease in sub-Saharan Africa have slowed down, mostly because the *Anopheles* mosquitoes that spread the parasite have become increasingly resistant to insecticides. Scientists have been struggling to find new ways to kill these mosquitoes. In the hope of finding a new way to fight malaria, scientists have used a spider gene to genetically engineer a fungus to produce a toxin that can quickly kill mosquitoes.

Scientists genetically modified the fungus using a gene from the Blue Mountain funnel-web spider. The spider gene, which produces a toxin that kills mosquitoes, was inserted into the DNA of the fungus. The modified fungus appeared to be highly effective in laboratory tests, so scientists decided to test the organisms in sub-Saharan Africa, a setting that more closely resembled their natural environment. The scientists built a 'MosquitoSphere' in Burkina Faso, a country in West Africa. The structure resembled a large greenhouse. Instead of glass, the walls were made of mosquito netting. Inside, there were six compartments, including four designed to resemble typical living huts in the region.

The 'MosquitoSphere' in Burkina Faso



The scientists spread oil containing the modified fungus on black sheets inside the huts. Next, the researchers released 1 500 *Anopheles* mosquitoes into each hut. The idea was that the mosquitoes would pick up the fungus when they rested on the black sheets. Mosquitoes are attracted to black objects.

The researchers then compared what happened to the mosquitoes inside the huts with the modified fungus compared with the mosquitoes inside huts with unmodified fungus or no fungus. The population of mosquitoes in the huts with the modified fungus decreased within 45 days. More research is still needed to further evaluate the fungus before it is released into the wild.

[Source: <<https://www.npr.org/sections/goatsandsoda/2019/05/30/727884309/scientists-genetically-modify-fungus-to-kill-mosquitoes-that-spread-malaria>> and <<https://www.science.org/doi/10.1126/science.aaw8737>>]

3.2.1 (a) Why is the fungus referred to as a *transgenic organism*?

(2)

(b) From which organism did scientists extract the gene that produced the toxin?

(1)

3.2.2 How many people per year in sub-Saharan Africa are likely to survive a malaria infection?

(1)

3.2.3 Refer to the theory of natural selection to explain how mosquitoes became resistant to insecticides.

(6)

3.2.4 Discuss ONE reason why more research must be carried out on the genetically modified fungus before releasing it into the wild.

(2)

3.2.5 (a) Identify the control that was set up in the study.

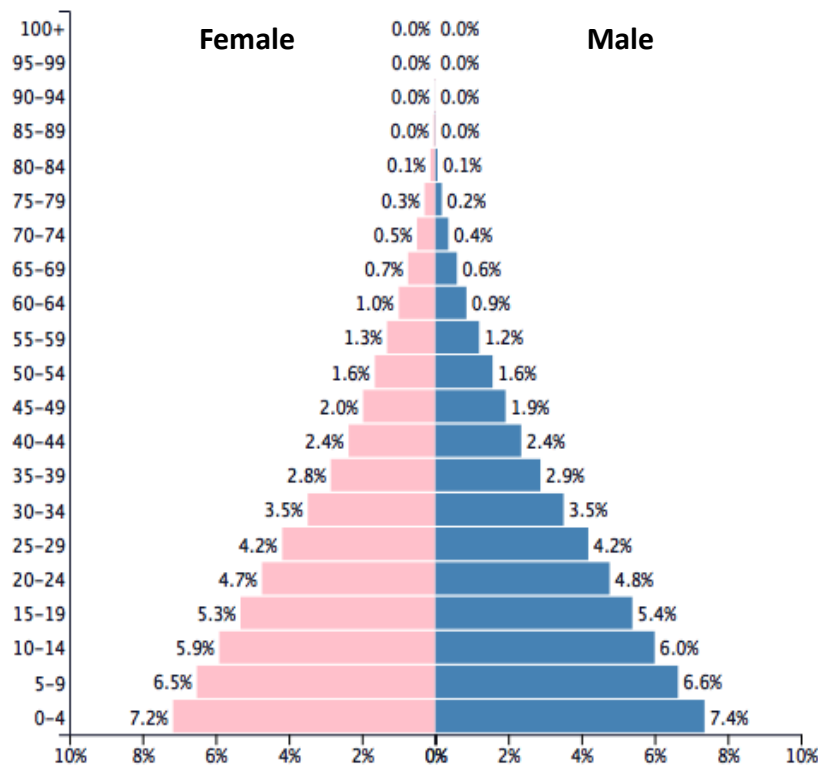
(1)

(b) Draw a simple sketch graph to illustrate the effect that the genetically modified fungus had on the mosquito population over the 45 days.

- Label the x-axis.
- Label the y-axis.
- Show the correct trend of the mosquito population.

(3)

3.2.6 The graph below shows the current population of Burkina Faso.



[Source: <<https://www.populationpyramid.net/burkina-faso/2035/>>]

- (a) Describe ONE piece of evidence from the graph above that indicates Burkina Faso is a developing country.

(2)

- (b) Name the direct method that was used to collect the data shown on the graph.

(1)

- (c) What is the percentage of females in the 35–39-year age group?

(1)
[40]

QUESTION 4

Read the information provided below to answer the questions that follow.

The Serengeti is made up of the Serengeti National Park in Tanzania, the Maasai Mara in Kenya, and several other smaller protected areas. Since the 1970s scientists have been interested in the order and timing of the migration of the three main herbivores – zebra, wildebeest and the Thomson's gazelle – during the great migration. The Great Serengeti Migration is the annual movement of large numbers of herbivores across Africa over a period of time. The animals migrate due to availability of grass.

Figure 4 Zebra, wildebeest and gazelle during the Serengeti migration



Earlier research presented three different hypotheses about the migration of the herbivores:

Hypothesis 1 – grazing succession hypothesis

During the Serengeti migration, zebras migrate first, followed eight weeks later by wildebeest and then again eight weeks later the smaller gazelles follow. Since zebras and wildebeest are taller than the gazelle, they graze the tallest, low-quality grass. This exposes more nutritious grass closer to the ground and also allows the regrowth of fresh high-quality grass in time for the gazelles. Smaller herbivores which require more protein per unit body weight, can therefore obtain better nutrition per bite.

Hypothesis 2 – competition hypothesis

If the wildebeest migrated first, their huge population size reduces the height of the vegetation very quickly and this means that they can out-compete the zebra for the grass. This forces the zebras to migrate first to get enough tall grass to meet their energy requirements.

Hypothesis 3 – anti-predation hypothesis

Mixed herding behaviour (large herds made up of many different species) observed during the migration is an anti-predation strategy which reduces the risk of being killed by large predators such as lions, cheetahs and leopards.

In the past, it was impossible to test the three hypotheses mentioned, since the migration includes about two million animals. However, recent studies have been able to utilise the following technologies:

- Two hundred camera traps were put up in central Serengeti. This camera trap data provides numerous photos which clearly show the migration pattern of the herbivores.
A camera trap is a camera that is automatically triggered by motion of an animal or human being in its vicinity.
- Satellite collars were attached to migrating zebra and wildebeest to track their movements.
- Satellites operated by NASA provided data on vegetation growth and fires and how animals responded to these occurrences.
- DNA sequencing data from the dung of individual herbivores allowed scientists to study their diets.

Findings from these new forms of data now allow a new hypothesis to be proposed that it is more likely the result of human induced climate change:

New hypothesis – rain and fire hypothesis

When there is more rainfall in the Serengeti, it strengthens the relationship between the migratory herbivores, and they are more likely to migrate together. However, when more fires occur in the Serengeti, it weakens the relationship between the migratory herbivores, and they are more likely to migrate independently of each other (in isolation).

[Source: <<https://www.downtoearth.org.in/blog/africa/serengeti-migration-fire-and-rain-affect-how-zebras-wildebeest-and-gazelles-make-the-journey-94749>>]

4.1 4.1.1 Provide ONE example of an abiotic factor in the Serengeti.

(1)

4.1.2 Explain the meaning of the term *herbivore*.

(2)

4.1.3 Which option below provides the best definition of a community found in the Serengeti National Park? Circle the letter of the correct option.

- A All the wildebeest in the park that share similar characteristics, and they can breed with each other to produce fertile offspring.
- B The interactions between the wildebeest, zebra, gazelle and plants in the park.
- C The role that the gazelle plays in the park and how it interacts with, and lives in its environment.

(1)

4.1.4 List ONE density-dependent factor that forces the herbivores to migrate at a specific time.

(1)

4.1.5 Draw a simple food chain that includes any three organisms mentioned in the text on page 29 and 30.

(4)

4.2 Refer to the various grazing hypotheses in the text to answer the following questions.

4.2.1 **Hypothesis 1:**

(a) Which statement below correctly summarises the grazing succession hypothesis? Circle the letter of the correct option.

A Herbivores migrate according to body size and nutritional requirement.

B Herbivores migrate to find water.

C Herbivores migrate to protect themselves.

(1)

(b) Explain why gazelle migrate last.

(2)

4.2.2 **Hypothesis 2:**

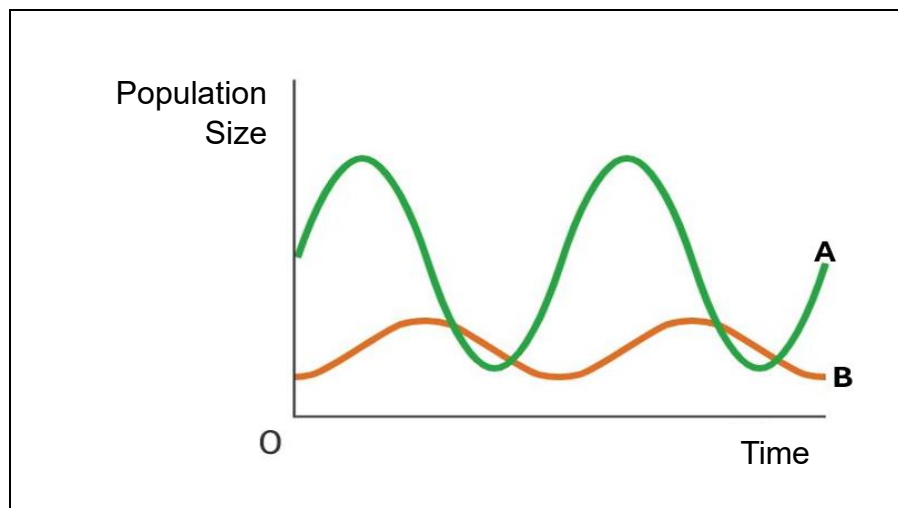
(a) Identify the type of competition that exists between wildebeest and zebras.

(1)

(b) Identify and explain the strategy used by the competing zebra and wildebeest populations that ensure the survival of both species.

(4)

4.3 Study the predator-prey graph shown below to answer the questions that follow.



4.3.1 What is a *predator*?

(2)

4.3.2 (a) Which letter on the graph indicates the predator?

(1)

(b) Provide a reason for your identification in Question 4.3.2 (a) above.

(1)

4.3.3 Discuss TWO strategies that zebra use to avoid predators.

(4)

4.4 Fire is a common occurrence in the Serengeti National Park.

4.4.1 State the type of succession that occurs after a fire. Explain your answer.

(2)

4.4.2 Provide the biological term for the first plants that grow after a fire.

(1)

4.4.3 Discuss why fire is beneficial to the gazelle population.

(2)

4.4.4 By referring to the new hypothesis on page 30, discuss how fire can alter the migration pattern of the herbivores. Use information from the other three hypotheses to support your explanation.

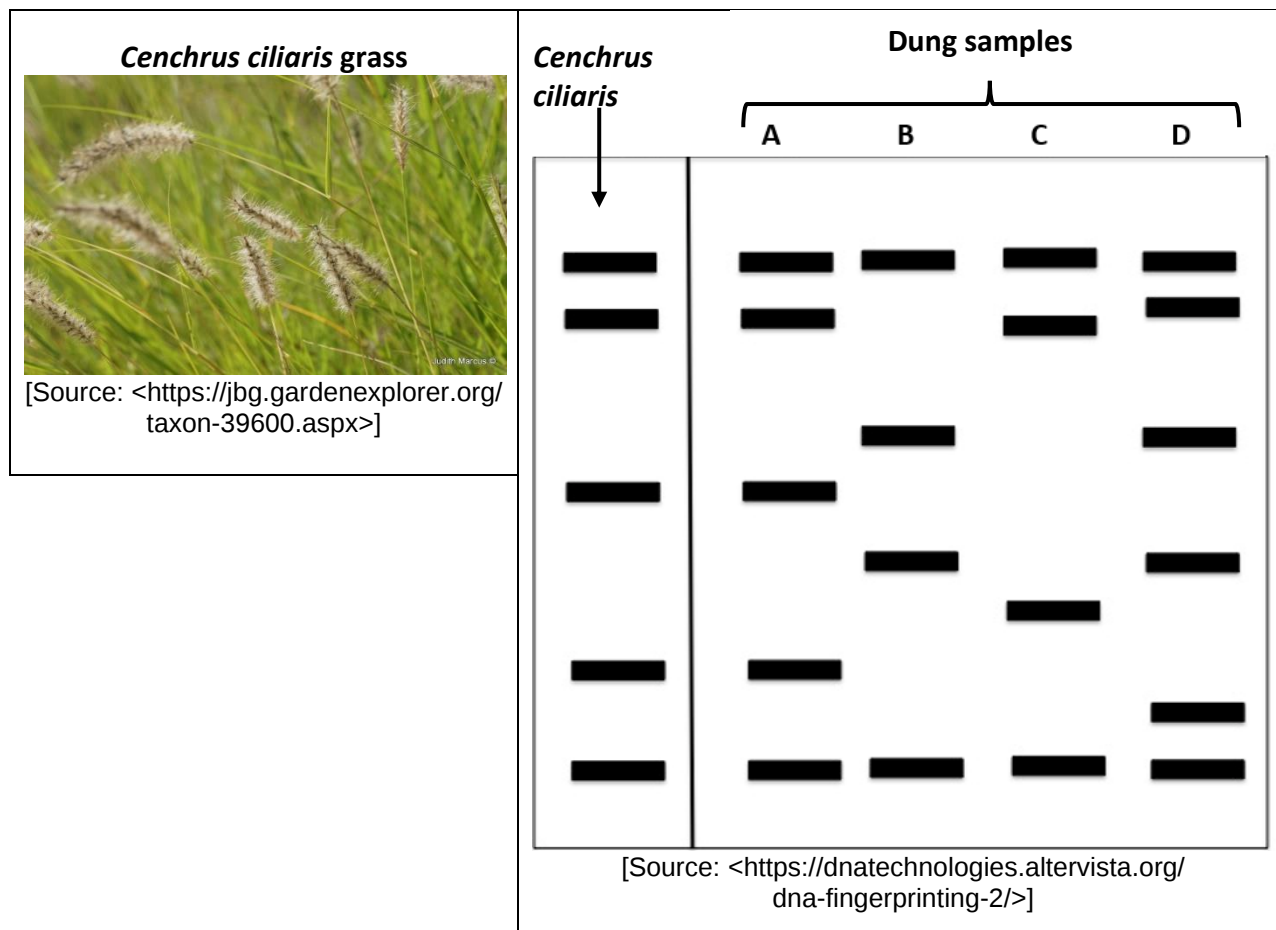
(4)

4.5 Even though the data collection process in this study is expensive, justify why studies such as these are important.

(2)

- 4.6 Zebra prefer to eat a species of grass known as *Cenchrus ciliaris* (African foxtail grass). Scientists sequenced the DNA found in the dung of different herbivores in the Serengeti National Park and the results are shown in the DNA profile below.

Figure 4.6 DNA sequence obtained from the *Cenchrus ciliaris* grass and the dung of a zebra and three other different herbivores



- 4.6.1 Which dung sample (A–D) is from the zebra? Explain your answer.

(3)

- 4.6.2 State the purpose of the polymerase chain reaction (PCR) in preparing samples for DNA analysis.

(1)
[40]

Total: 200 marks

ADDITIONAL SPACE (ALL QUESTIONS)

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

[illegible]

[illegible]