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NAME: _____



**KINGSMEAD
COLLEGE**

**GRADE 12
LIFE SCIENCES
PAPER I
PRELIMINARY EXAMINATION 2023**

Time: 3 Hours

200 marks

**Examiner: Miss Minnie
Moderator: Miss Pillay**

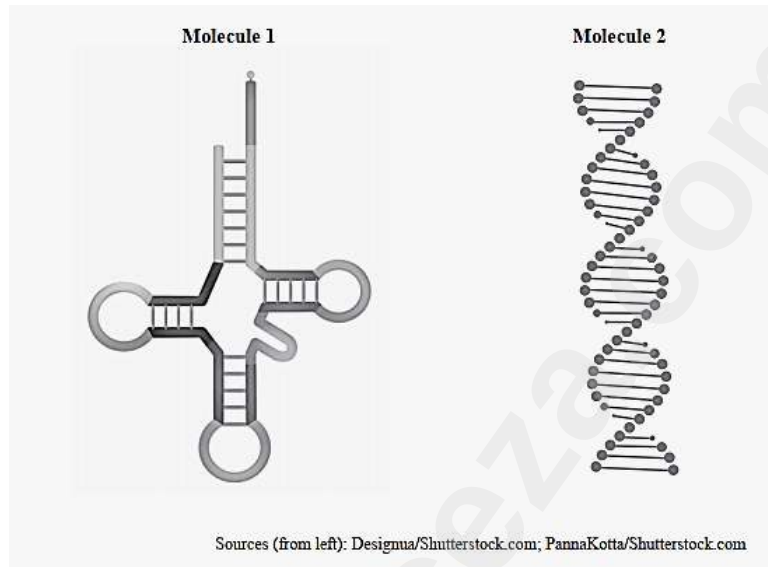
PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 27 pages and a separate Answer Booklet for Question 1 (i - xviii). Please ensure your copy is complete.
2. Answer Question 1 in the yellow answer booklet and Question 2-4 in the spaces provided in the white booklet. Hand in both the white and yellow booklet at the end of the examination.
3. Ensure your name is on both the yellow Answer booklet and the white question booklet.
4. ONE blank page is provided at the end of the Answer booklet (xviii) and TWO blank pages at the end of this question booklet (pg 26-27). If you run out of space, use these pages and clearly indicate the question number should you be using this extra space.
5. Read the questions and source extracts carefully.
6. Plan your time wisely.
7. It is in your interest to write legibly and to present your work neatly.

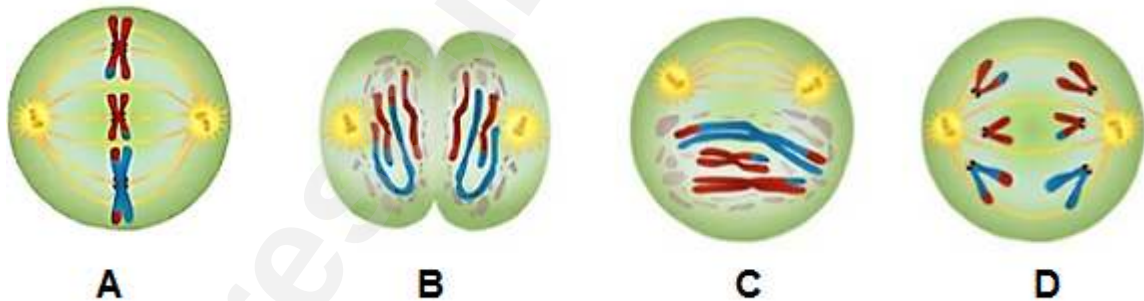
QUESTION 2

2.1 Study the various diagrams and answer the questions that follow:

Biological molecules



Meiosis



[Adapted from <https://biologydictionary.net/meiosis/#foobox-1/0/Meiosis-Stages.jpg>]

2.1.1 Complete the table below. Provide TWO structural differences between the **monomers** making up biological Molecule 1 and Molecule 2.

	Molecule 1	Molecule 2
Difference 1		
Difference 2		

(4)

- 2.1.2 a) Which phase of meiosis, Meiosis I or Meiosis II, is illustrated in the diagram on page 2? Give **TWO** visible reasons for your answer. (3)

- b) Using the letters of each diagram, place these phases in the correct sequence. (1)

[8]

- 2.2 Read the article below. Use the information in the source and your own knowledge to answer the questions that follow.

Squids' Gene-Editing Superpowers May Unlock Human Cures



Scientists reported that cephalopods (cuttlefish, squid and octopuses) are the first known animals that can edit mRNA outside the cell nucleus. This may help scientists who are working on gene therapy treatments.

Joshua Rosenthal at the Marine Biological Laboratory in Woods Hole, Massachusetts;

Eli Eisenberg at Tel Aviv University in Israel and their

colleagues, have found that mRNA editing is particularly common in behaviourally complex cephalopods, like squid, where editing of the mRNA sequence occurs most frequently in cells associated with the nervous system.

mRNA editing may be the way to go in gene therapy as changing the genetic code in DNA is irreversible and would result in permanent changes to the structure of a protein. While editing the mRNA code is temporary, as mRNA that is not being used to make protein degrades quickly so that any errors caused by mRNA editing would fade away, rather than staying with a person forever.

[Adapted from: <https://www.wired.com/story/squids-gene-editing-superpowers-may-unlock-human-cures/>]

2.2.1 (a) Name the process in the cell that makes mRNA.

_____ (1)

(b) Briefly explain the process mentioned in 2.2.1(a).

_____ (5)

2.2.2 What are the benefits to editing mRNA when treating genetic disorders in humans?

_____ (3)

2.2.3 Why does DNA editing result in permanent changes to the structure of a protein.

(2)

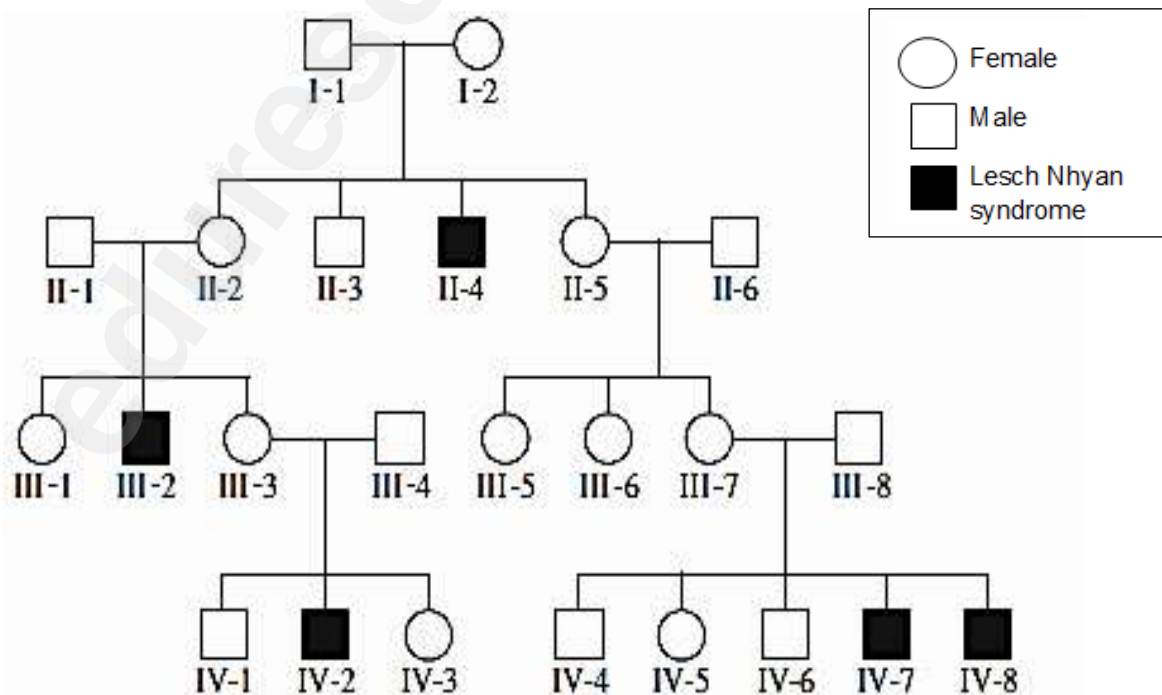
[11]

2.3 Read the following information on Lesch Nyhan syndrome and answer the questions that follow.

Lesch Nyhan syndrome is characterized by neurological and behavioural abnormalities and the overproduction of uric acid in the body. Lesch Nyhan syndrome is caused by different mutations in the *HPRT1* gene. One of these mutations results in fewer nitrogenous bases that make up the gene. Affected people often do not survive past 20 years of age.

[Source: <https://rarediseases.info.nih.gov/diseases/7226/lesch-nyhan-syndrome>]

Family pedigree of Lesch Nyhan syndrome.



[Source: <https://www.chegg.com/homework-help/lesch-nyhan-syndrome-due-mutation-gene-encodes-protein-calle-chapter-24-problem-13cq-solution-9780073525341-exc>]

 (2)

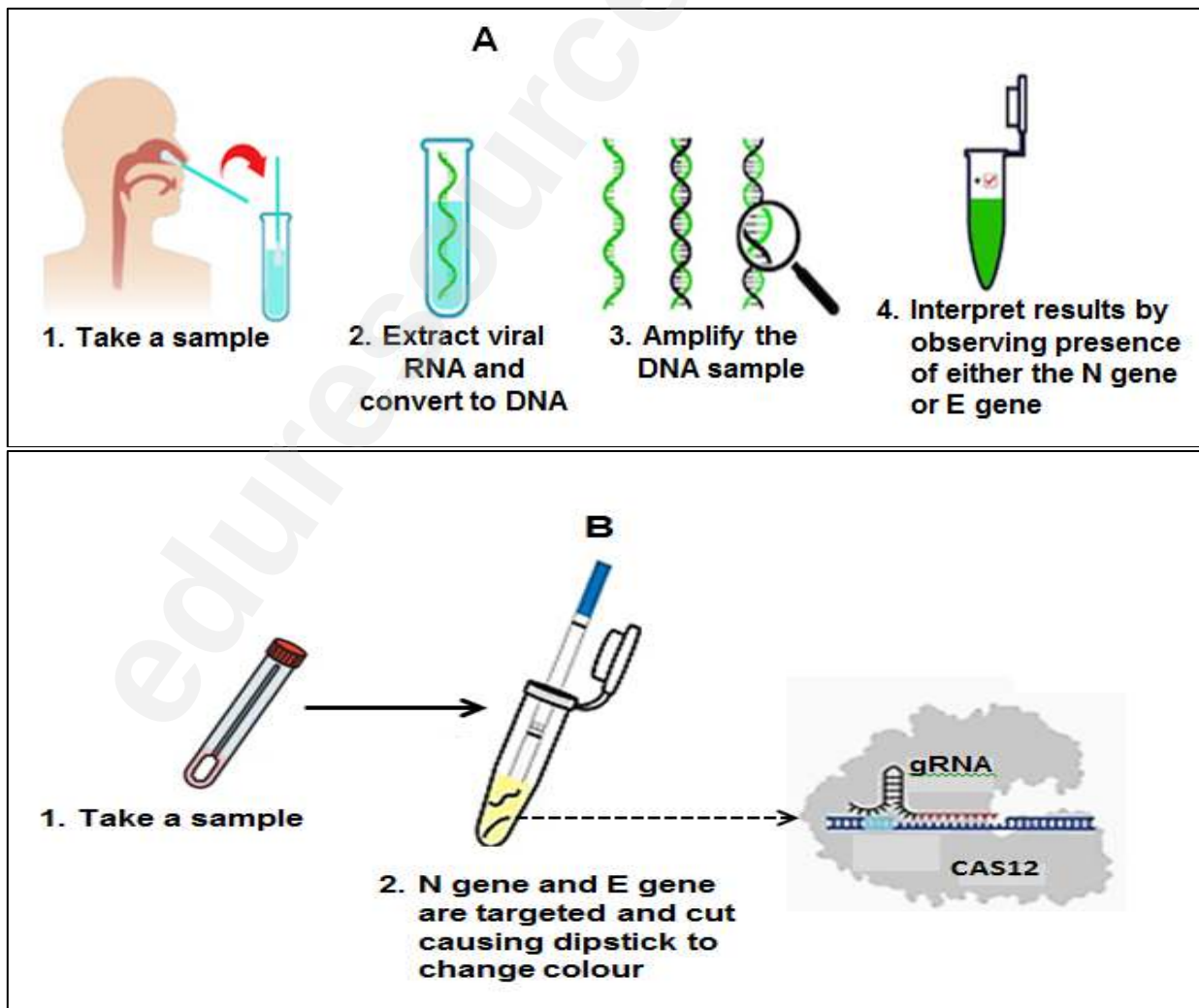
 (1)

Use the letters **N= normal** and **n = Lesch Nhyan syndrome**.

2.3.4 It was suggested that parents III-3 and III-4 undergo genetic counselling before having children, but they chose to ignore this advice. Do you think this was a wise decision? Give TWO reasons to support your answer.

[12]

2.4 Using the diagrams below illustrating two different processes involved in genetic engineering, answer the questions that follow.



2.4.1 Which diagram, A or B, illustrates the PCR test for Covid-19? Give a visible reason for your answer.

2.4.2 Name ONE of the genes identified using CRISPR in the Covid-19 test.

(1)

2.4.3 Name the enzyme that is used in recombinant DNA technology to perform the same function as the CAS12 enzyme shown in the CRISPR technique.

_____ (1)

2.4.4 Briefly explain why using the CRISPR technique should be used in South Africa to test people for Covid-19?

2.4.5 What ethical considerations should be taken into account if the CRISPR test is used to test a person for Covid-19.

(2)

[9]

[40 marks]

Question 3

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

Concern over Declining Vulture Populations



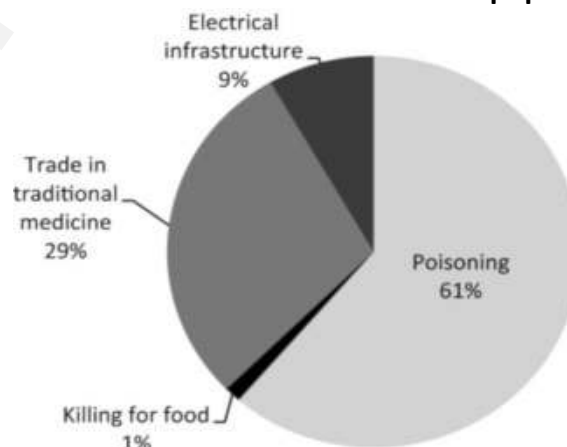
Vultures are one of the most important scavengers that exist; they can strip a carcass in a matter of minutes. The vulture population is fast declining and could possibly become extinct in the near future. Across Africa, there are many factors that have led to the decline in vulture populations.

One of the greatest threats to their population is the impact of poaching. Vultures die after eating carcasses left behind by poachers. Poachers poison the corpse to throw off law enforcement, who use circling vultures as a beacon for illegal activity. In July 2013, researchers came across a horrific scene: 500 dead vultures surrounded an elephant carcass that was laced with poison. In May 2021, an article published in the Journal of Global Ecology and Conservation, noted a sudden spike in intentional vulture poisoning and poaching.

Conservationists in KwaZulu Natal noticed a significant decline in nesting sites of the lappet-faced vulture in that specific area. The lappet-faced vulture is the largest vulture on the African continent and is listed as endangered on the IUCN red list. After intensive aerial surveys in September 2021, it was noticed that nest counts for the lappet-faced vulture dropped from 15 active nests in 2020 to only six active nests in 2021, in KZN.

Adapted from: <https://www.nationalgeographic.com/animals/article/150731>

Figure 3.1: Some factors that have led to the decline in vulture populations



Adapted from: https://www.researchgate.net/figure/Major-threats-to-vulture-populations-Four-quantitative-factors-constituted-a-serious_fig1_278675705

3.1.3 Calculate the percentage decrease in the number of active nests between 2020 and 2021. Show all working out.

A All the vultures that live in the conservation area in KZN and can breed with one another.

B All the lappet-faced vultures that share similar traits, can exchange genes and produce fertile offspring.

C All the birds that live in KZN, their interactions with each other and with their non-living environment. (2)

(2)

(2)

3.1.4 Draw a sketch graph that can be included into the article published in the Journal of Global Ecology and Conservation in May 2021.

The sketch graph must indicate how **poaching** has impacted the **vulture population** over **time**.

(6)



3.1.5 What method was used to estimate the number of active vulture nests in 2021, a direct method or an indirect method? Explain your answer.

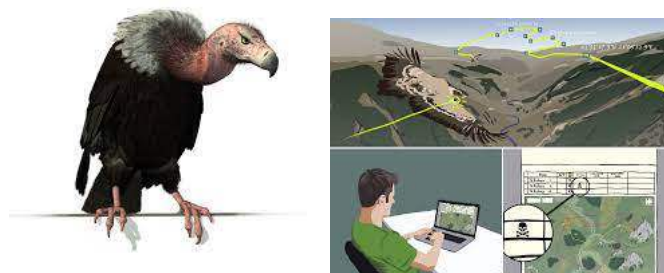
(2)

- 3.1.6 Evaluate the effectiveness of the method mentioned in question 3.1.5 when using it to determine the number of vulture nests.

(2x2)

- 3.1.7 Conservationists have now started installing solar-powered GPS tracking units on each of the lappet-faced vulture chicks so that they can monitor the chicks' movements.
Do you agree with this monitoring system? Fully justify your answer.

(2)



[20]

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

Reintroduction of Apex Predators

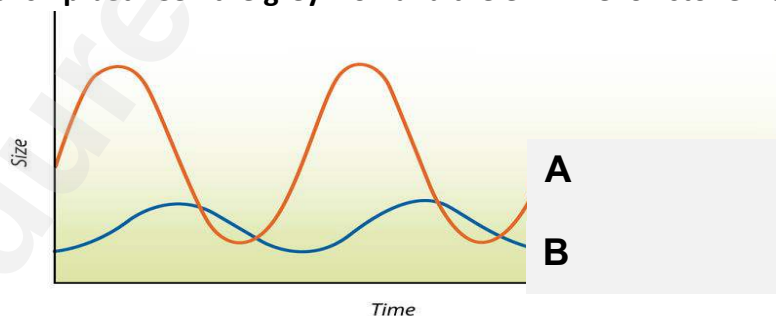
The reintroduction of apex predators into ecosystems can affect food webs and have varied success rates.

In the United States in the 1900s, humans competed with grey wolves (*Canis lupis*) for large prey, such as bison, deer and moose, as a source of food. The hungry wolves then began to prey on livestock and were therefore hunted and killed by ranchers protecting their flocks. This led to a drastic decline in the grey wolf population. The loss of grey wolves led to an explosion of the elk population and subsequent overgrazing of plants, including immature trees. Without enough plants to hold the soil together, the overgrazing also led to riverbank erosion. This complex relationship within a food web, in which the feeding habits of a predator trickle down and influence lower levels of the food web beyond the predator's immediate prey, is called a **trophic cascade**. The United States National Park Service reintroduced the grey wolf into Yellowstone National Park in the mid-1990s, quickly stabilizing some parts of the food web and ecosystem in the park.

In the case of the Yellowstone grey wolves, reintroduction has been largely successful and has reversed some of the ecological imbalance and restoring the grey wolf population; however, the balance within the food web may never return to its original stable state.

In other cases, reintroduction of apex predators has been less successful. For example, African wild dogs (*Lycaon pictus*) reintroduced to various parts of the African continent, where they were once apex predators, failed to reduce trophic cascades or improve ecosystem stability and the wild dog still remains endangered.

Figure 3.2: The relationship between the grey wolf and the elk in Yellowstone National Park



https://www.nationalgeographic.org/article/reintroduction-top-predator/?utm_source=BiblioRCM_Row

3.2.1 Use **Figure 3.2** to answer the following questions:

a) Name the relationship shown by the graph.

_____ (1)

b) Which organism, **A or B**, represents the wolf? Give a reason for your answer.

_____ (2)

3.2.2 Why are predators described as apex organisms?

_____ (1)

3.2.3 **In your own words**, explain what is meant by a trophic cascade.

_____ (1)

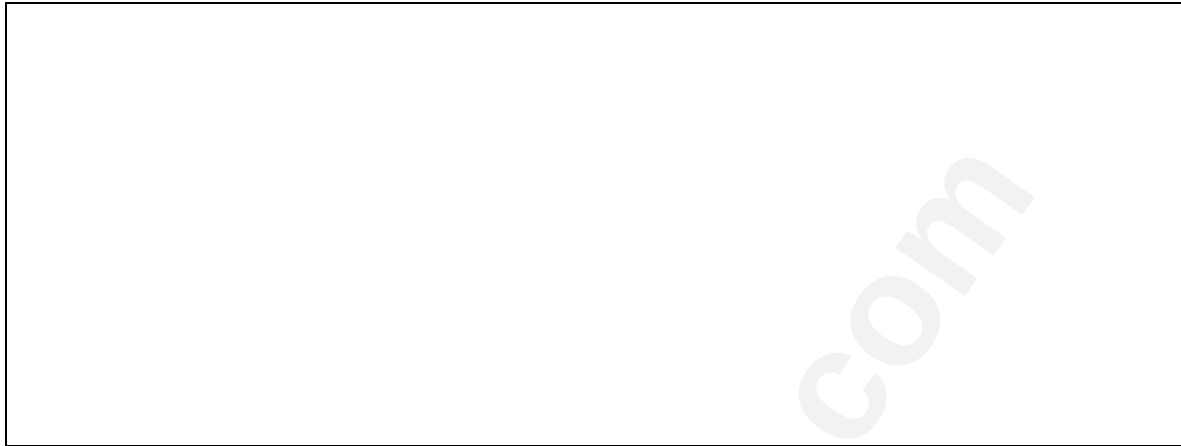
3.2.4 Describe ONE example of a trophic cascade in Yellowstone National Park.

_____ (2)

3.2.5 Identify the type of competition that existed between the humans and the grey wolves, when they competed for the bison.

_____ (1)

- 3.2.6 Draw a simple food chain, consisting of three organisms, that existed in Yellowstone National Park.



(4)

- 3.2.7 Identify the population parameter that affected the decline of the wolf population.

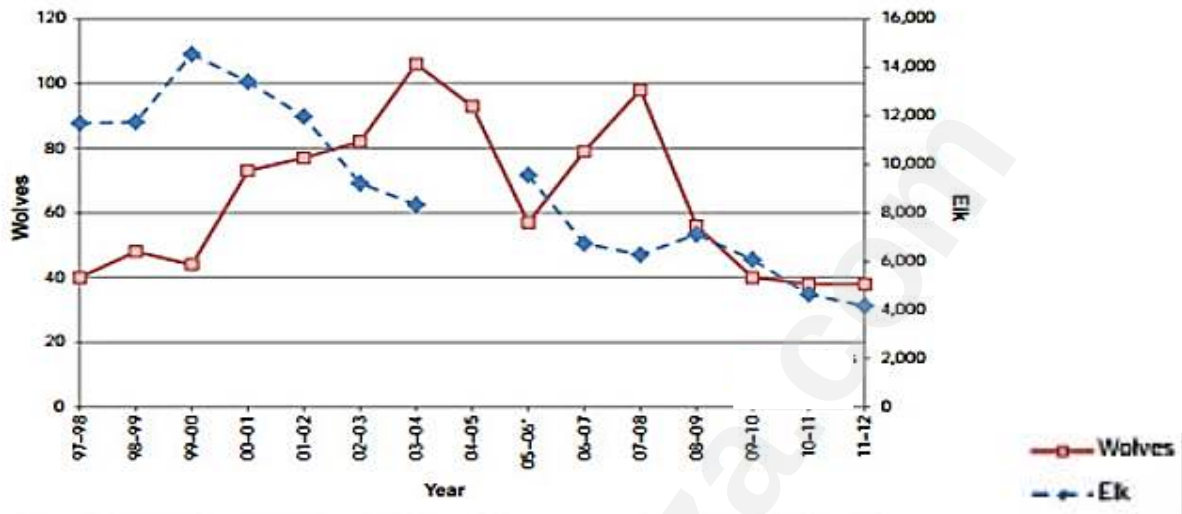
_____ (1)

- 3.2.8 The grey wolf shares the same complex social organisation strategy as wild dogs; this makes the grey wolf a very successful predator. Describe TWO strategies used by the grey wolf that makes it a successful predator.

_____ (2x2)

3.2.9 Study the graph below to answer the questions that follow.

Figure 3.2.9: The wolf and the elk population at Yellowstone Nation Park between 1997 and 2012



- a) What was the elk population number when the grey wolves were introduced into the park in 1997?

(1)

- b) Even though the reintroduction of the grey wolves into the park was successful, many conservationists claim that the restoration of the wolf population was at the detriment of other organisms in the park. **Use evidence from the graph to discuss this claim.**

(2)

[20]

[40 marks]

Question 4

Read the source below and answer the questions that follow.

The Blue Crane is a bird that represents South Africa's biodiversity, where the natural environment abounds with creatures found nowhere else on Earth and with more than 840 species of birds.

Blue Cranes are monogamous for life and despite being very social animals are extremely territorial while breeding, driving any other Blue Cranes from the breeding territory. They usually nest in summer in open grasslands and agricultural areas. The mating and egg-laying date can be anytime between August and April. The birds often return to the same area and nest close to the previous year's nest.



Blue Cranes display a wonderful courtship dance during which the two birds jump up and down with their wings extended, often picking up and tossing a leaf or small stick at the same time. The birds are mature at about three to five years of age. They usually lay two eggs with an incubation period of 30 to 33 days and both the male and female incubate the eggs. Chicks are fed on an initial diet of insect larvae and worms. The chicks are able to fly at about three to five months. The parents are very protective of their young and will guard them against predators. They puff up their heads like a cobra, hissing and moving aggressively toward the predator. Sometimes one of the parent's fakes a broken wing to cause distraction while the other parent moves to shelter with the chicks.

Blue cranes live for about 30 years in the wild and on average pairs raise one or two chicks a year. Their survival strategy is opposite to that of animals such as rabbits or mice, which have short lives and high reproductive rates. This means crane populations don't recover easily after declines. Blue Crane chicks often die during the first year, because they are simply so vulnerable to so many threats. The following breeding season, the young juveniles will join the large flocks of non-breeding birds.

Adapted from: www.bluecrane.org.za and www.getaway.co.za

4.1.1 State whether the following statements are True or False. Write your answer in full next to the statement given.

- (i) Blue Cranes are viviparous animals. _____
- (ii) Blue Cranes show little to no parental care. _____
- (iii) Blue Cranes reproduce by means of internal fertilisation. _____
- (iv) Blue Cranes display auditory courtship. _____ (4)

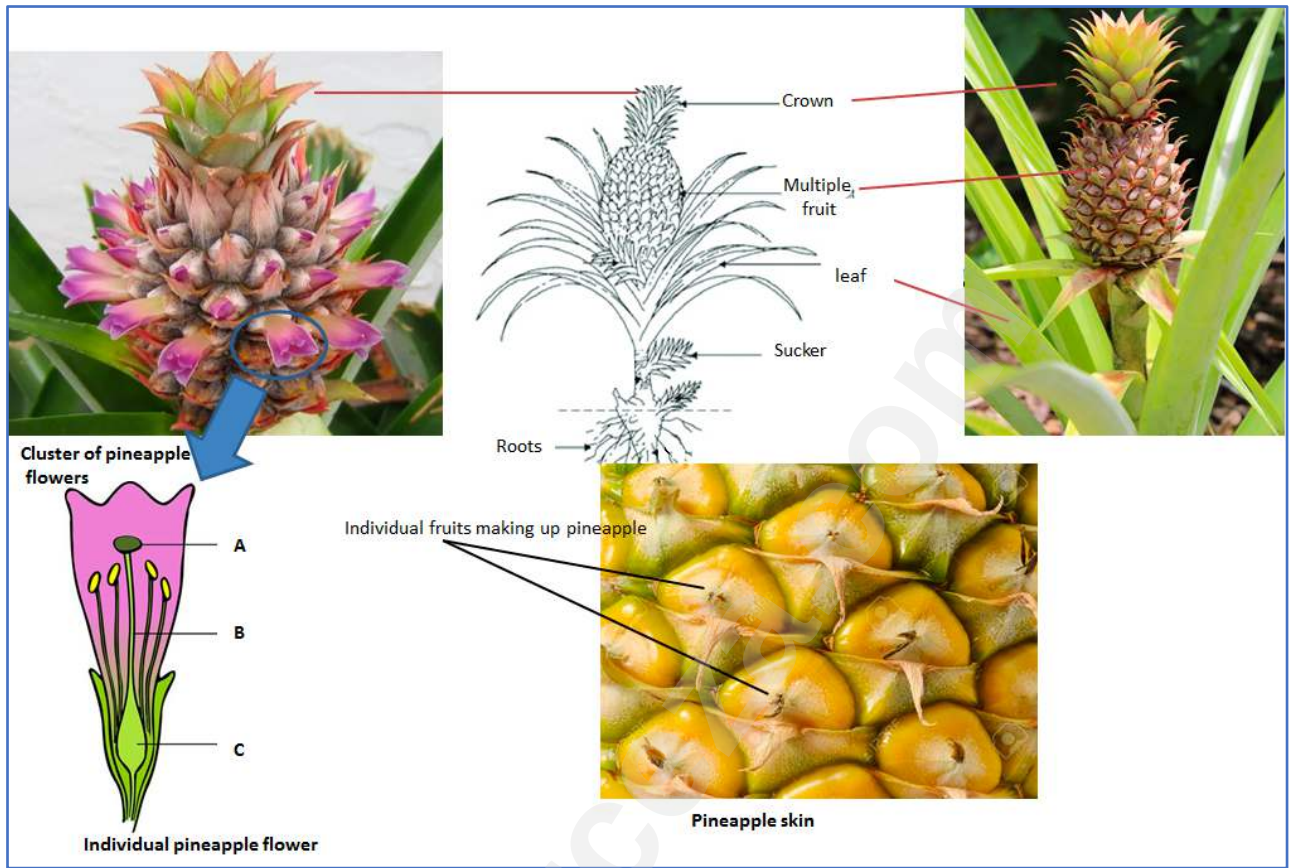
4.2. Read the information below and use it, and your own knowledge, to answer the questions that follow.

Pineapples (*Ananas comosus*) are tropical plants with an edible fruit. The pineapple is indigenous to South America where it has been cultivated for many centuries. The plant grows to about 1,5m tall. It has a short stem surrounded by tough, spiky leaves. It usually produces up to 200 flowers surrounding an upright stalk. Pineapple flowers are usually pollinated by bees. However, sexual reproduction is avoided by farmers. Seed germination is also slow. Seeds are therefore only desired in the production of new varieties. After pollination and fertilisation, the ovaries of each flower join to create a single multiple fruit. The pineapple that is eaten therefore consists of the stalk surrounded by the fused swollen ovaries from each flower. Pineapple ovaries can also swell to produce fruit even if no pollination and fertilisation occurs. Therefore, the ovules do not grow and develop in the fruit. There are two parts of the pineapple that can be used for vegetative reproduction: the crowns and suckers. The crown is the very top of the pineapple. Suckers (young plantlets) grow from the bottom of the stem.

Two common varieties of pineapple grown in South Africa include:

'Charlotte Rothschild' – these pineapples are very juicy. The plant grows quickly and produces ripe pineapples early in the season.

'Queen' - the plant is small and compact, and cold and disease-resistant. It matures its fruit early, but the yield is low. The fruit is juicy and keeps well. It is not suitable for canning as the fruit is cone shaped.



[Adapted: <<https://cdn.pixabay.com>>]; [Adapted: <<https://previews.123rf.com>>]
 [Adapted: <<https://www.hort.purdue.edu>>]

4.2.1 Provide labels for structures A to C shown in the diagram above.

A. _____

B. _____

C. _____

(3)

4.2.2 Describe the process of pollination.

(3)

4.2.3 Explain why farmers would not want to grow pineapples from seeds they have collected.

(3)

4.2.4 Describe the steps that are involved in the development of a new variety of pineapple.

(4)

4.2.5 Pineapple fruit can develop even without pollination and fertilisation occurring. What is the advantage of this process for both farmers and consumers?

(2)

4.2.6 Provide ONE advantage and ONE disadvantage to farmers in growing the 'Queen' variety of pineapple.

(2)

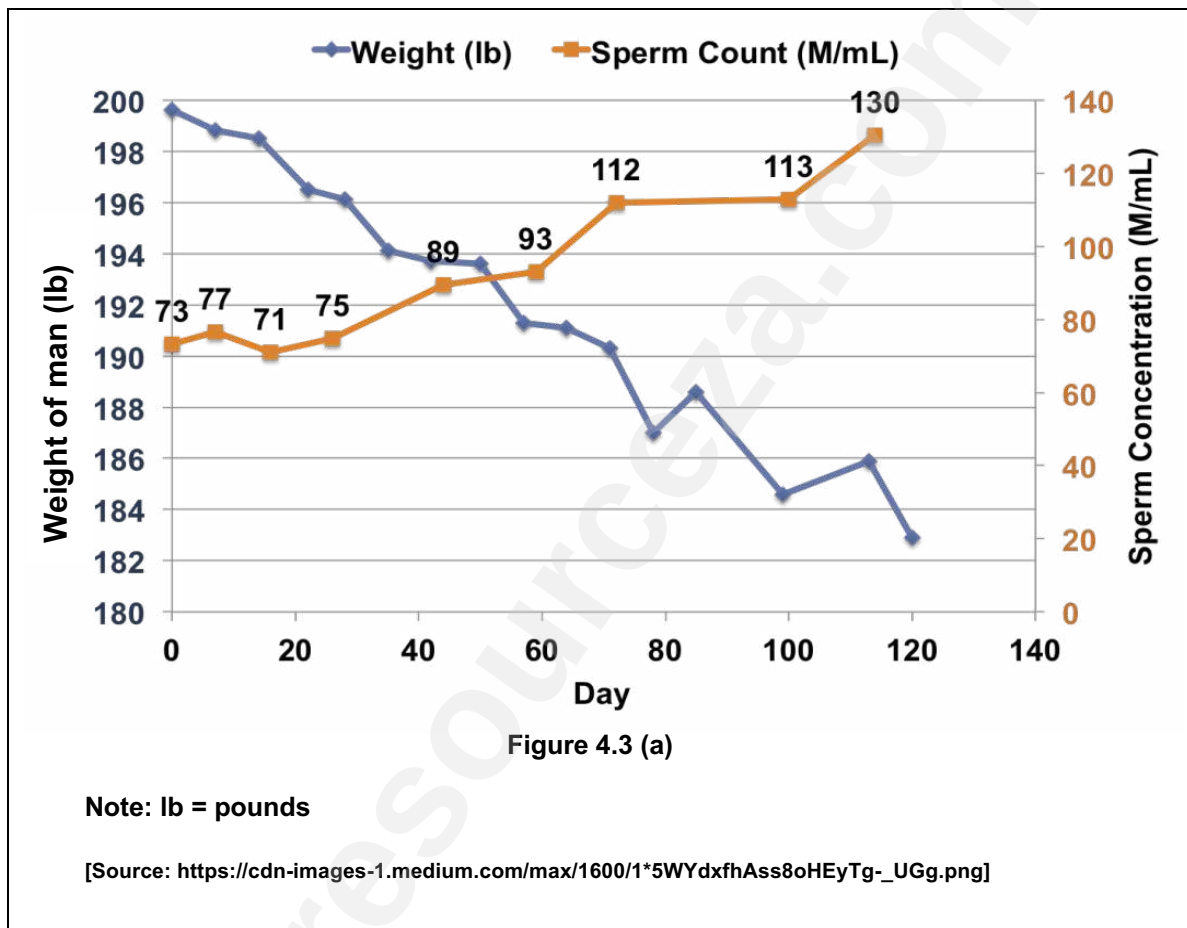
4.2.7 Reproduction can also be conducted using tissue culture. Draw a flow diagram to explain how this process occurs.



(4)

[21]

4.3. Male infertility in humans has become a serious problem. Use the information provided to answer the questions that follow.



4.3.1 Give Figure 4.3(a) above a fully descriptive heading.

(2)

4.3.2 Formulate a conclusion based on the results shown in the graph.

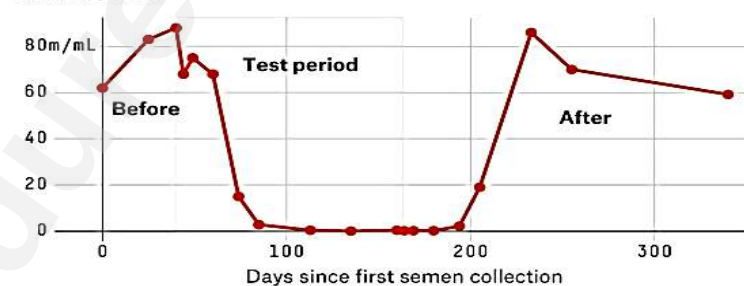
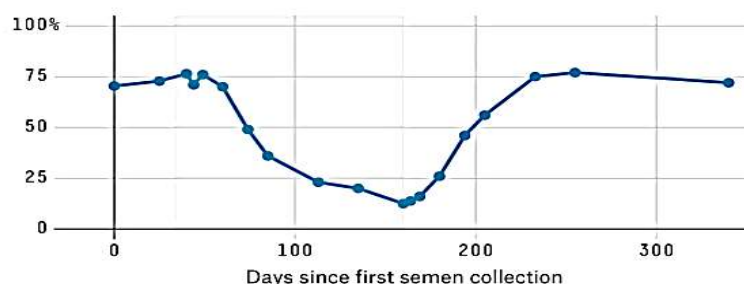
(2)

A study was conducted with five French men aged 25 to 35 years who had at least one child, to directly test the effect of heat on sperm production and sperm quality. The five men in the study were asked to wear specially designed underwear for 14 to 16 hours a day for four months. The underwear kept the scrotum and testicles very close to the body and heated the testicles by a significant amount relative to their normal state. By three to four weeks into the experiment, sperm count and quality had declined significantly. At the end of the 4 month study the sperm count for the men in this sample was at virtually zero, only three of the five men had ANY sperm in their ejaculate.

Figure 4.3 (b)

Heat Wreaks Havoc On Sperm

Average impact of testicular warming ($+2^{\circ}\text{C}$) on sperm counts and sperm viability for five 25- to 35-year-old subjects

SPERM COUNT**PERCENTAGE OF SPERM THAT ARE VIABLE**

FIVETHIRTYEIGHT

SOURCE: FERTILITY AND STERILITY

[Source: <https://espnfivethirtyeight.files.wordpress.com/2015/01/oster-feature-malefertility.png?w=575&quality=90&strip=info>]

4.3.3 Describe **TWO** variables that were controlled in this study.

(2)

4.3.4 Would you consider the study conducted as being scientifically reliable?
Provide **TWO** valid reasons for your answer.

(2)

4.3.5 Following the results of a study, a prominent newspaper published an article with this caption:

“Temporarily wearing tight underwear permanently impairs your chances of fathering children in the future.”

Do you agree with the statement above? Substantiate your answer by using the data provided.

(3)

[11]

[40 marks]

[EXTRA SPACE]

[illegible]

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