NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2022

LIFE SCIENCES: PAPER I

Time: 3 hours 200 marks

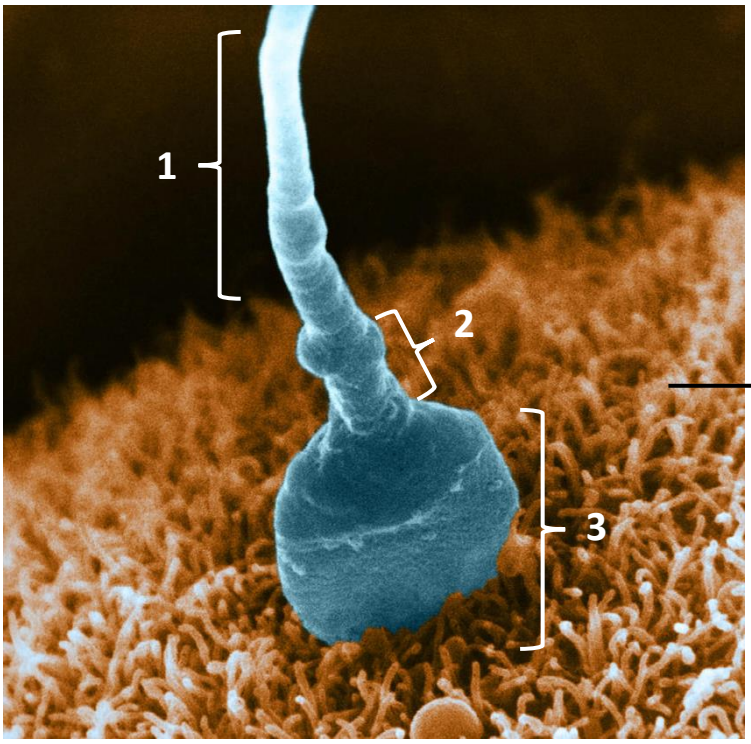
PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 14 pages and a yellow Answer Booklet of 17 pages (i–xvii). Please check that your question paper is complete. Detach the yellow Answer Booklet from the middle of the question paper. Remember to write your examination number in the blocks provided.
2. This question paper consists of four questions.
3. Question 1 must be answered in the yellow Answer Booklet provided.
4. Questions 2, 3 and 4 must be answered in your Answer Book.
5. Read the questions carefully.
6. Start **each question** on a **new** page.
7. Number the answers exactly as the questions are numbered.
8. Use the total marks that can be awarded for each of the questions as an indication of the detail required.
9. It is in your own interest to write legibly and to present your work neatly.

QUESTION 2

2.1 Study the micrograph below that shows a sperm cell entering the ovum.

Figure 2.1 – Micrograph showing a single sperm cell entering an ovum



[Adapted: <https://pixels.com>]

2.1.1 Give the biological term that describes the process of a sperm cell entering an ovum. (1)

2.1.2 State where in the female's reproductive system this process would most likely occur. (1)

2.1.3 Provide labels for the parts of the sperm numbered:

(a) 2 (1)

(b) 3 (1)

2.1.4 What is the purpose of the many mitochondria found in the part numbered 2? (1)

2.1.5 Explain how the sperm enters the ovum. (3)

2.2 Study the information in the text box below and then answer the questions that follow.

Polycystic Ovary Syndrome **(PCOS)** is a condition in which the ovaries produce an increased amount of male sex hormones that are usually present in females in small amounts. This imbalance in reproductive hormones causes numerous small cysts (membranous sacs that are filled with fluid) to form in the ovaries and interrupts the menstrual cycle.

Symptoms of PCOS can be:

- Missed or irregular menstrual periods that may be painful
- Infertility
- Acne and increased body and facial hair
- Weight gain
- Depression and mood swings

PCOS affects 1 in 10 women of child-bearing age. The most common treatment for PCOS symptoms is the oral contraceptive pill or the contraceptive hormonal patch. With PCOS, LH levels are higher than in regular menstrual cycles; so the pill or the hormonal patch decreases LH and FSH secretion to normalise the LH and FSH levels.

Figure 2.2 (a) – Hormone concentrations and the ovarian cycle in women with PCOS

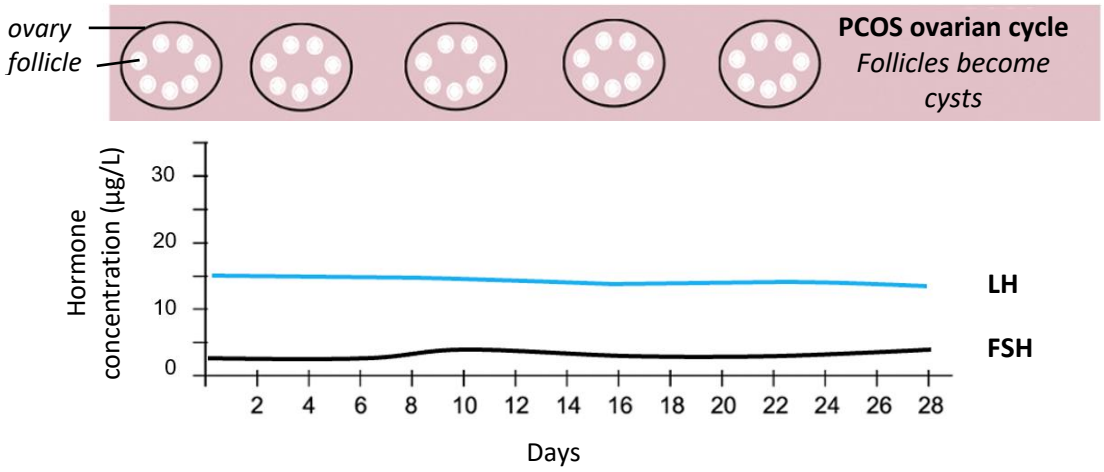
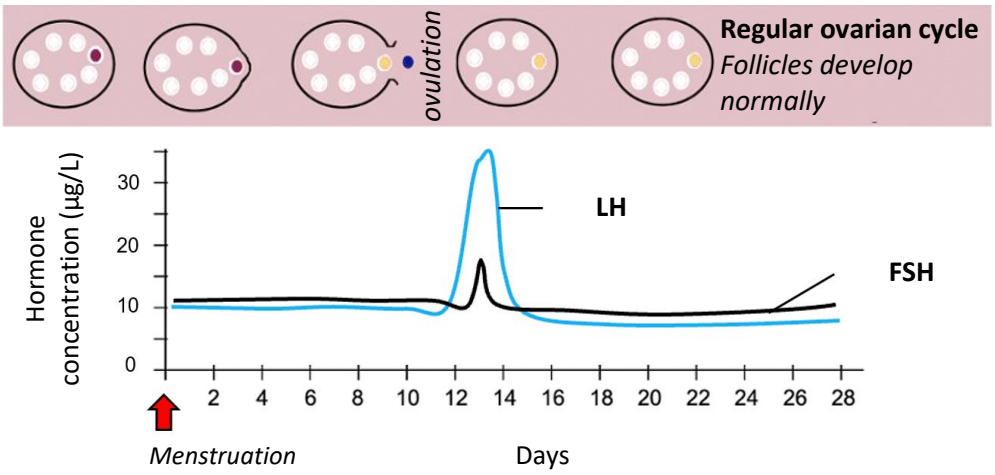


Figure 2.2 (b) – Hormone concentrations and the ovarian cycle in women with regular menstrual cycles



[Adapted: <https://youngwomenshealth.org>; <https://www.womenshealth.gov>]

2.2.1 List any TWO symptoms of a woman with PCOS. (2)

2.2.2 (a) Name the gland that secrets FSH and LH. (1)

(b) Where in the body is this gland situated? (1)

2.2.3 Calculate the percentage of women of child-bearing age who suffer from PCOS. Show all working. (2)

2.2.4 Refer to Figures 2.2 (a) and (b) to answer this question.

Tabulate any THREE differences in the menstrual cycles of women with regular menstrual cycles compared to women with PCOS. (6)

2.2.5 Most oral contraceptive pills contain both progesterone and oestrogen. What effect do these hormones have on the LH levels in the PCOS menstrual cycle? (1)

2.2.6 By referring to FSH and LH levels, explain why women with PCOS may be infertile. (3)

2.2.7 Suggest how living with PCOS may have a social and/or cultural impact on women. (2)

2.3 Read the source below and use the information and your own knowledge to answer the questions that follow.

Carp (*Cyprinus carpio*) are a freshwater fish species that are a valuable food source. Wild populations of carp have decreased in numbers in their natural habitat due to human interference in the environment.

Figure 2.3 (a) – Carp fish

[Image: <media.istockphoto.com>]

An artificial breeding programme was established in an effort to conserve this species. To assist the breeding programme, biologists conducted one study to test the effectiveness of two synthetic hormones for increasing ovulation in the female carp. A total of 36 mature females were used in this breeding programme. Treatments involved injections of synthetic hormones (X or Y), or a saline (salt solution).

The results of the study are shown in Figure 2.3 (b).

Figure 2.3 (b) – Table of results of synthetic hormone treatments on female brook carp fish

	Treatment		
	Hormone X	**Hormone Y**	**Saline**
Number of females in sample	12	12	12
Number of ovulating fish	5	9	1
Total number of eggs produced	1519	2457	400
Number of offspring reaching maturity	927	1941	20

[Adapted: <https://scialert.net>]

2.3.1 (a) State TWO reasons why the setting up of an artificial breeding programme for carp is important. (2)

(b) Suggest a human activity that would impact the wild populations of carp. (1)

2.3.2 Carp are considered an *r*-strategy species. Provide any THREE features of a typical *r*-strategy species. (3)

2.3.3 What is the purpose of the saline treatment being given to one group of female carp? (2)

2.3.4 State TWO ways in which this investigation can be improved so that the results can be published in a scientific journal. (2)

2.3.5 Refer to the table in Figure 2.3 (b) and suggest which treatment is most suitable for increasing carp numbers. Provide data to support your answer. (4)

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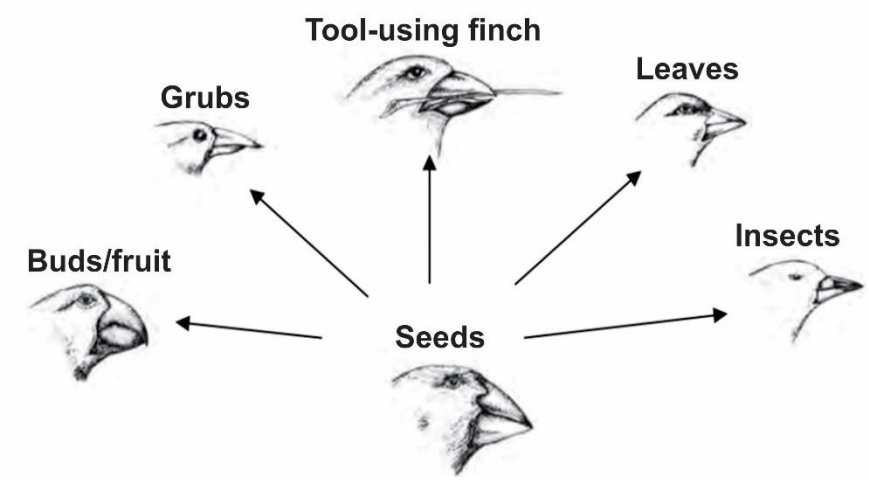
QUESTION 3

3.1 Read the following source and use the information and your own knowledge to answer the questions that follow.

The Galápagos finches are all dark coloured with similar body proportions. The various species differ from one another by body size, beak size and beak shape. Each species lives in a specific niche. All species of Galápagos finches have evolved and diversified from one ancestral species that colonised the Galápagos Islands. Each species of finch occupies a specific niche in the Galápagos Islands, which reduces competition amongst them.

Figure 3.1 – Some of these different finches and their food sources



[Image: <https://www.biologyonline.com>]

3.1.1 Name the biologist who studied the Galápagos finches and proposed natural selection as a mechanism for evolution. (1)

3.1.2 How would a biologist determine if two finch birds belonged to the same species? (2)

3.1.3 (a) Explain the meaning of an ecological 'niche'. (2)

(b) Refer to Figure 3.1 and describe how occupying different niches enables each finch species to survive. (3)

3.1.4 Are the different finches on the islands an example of convergent or divergent evolution? Give a reason for your answer. (2)

3.1.5 Why are islands like the Galápagos Islands suitable places for speciation to occur? (2)

3.2 Name and describe TWO lines of evidence for the theory of evolution. (4)

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

Grade 12 students conducted an investigation to simulate natural selection. Various instruments (numbered 1 to 3) were used to represent the beaks of bird species. Objects (a, b, c and d) represent different food types. The instruments and objects used in the simulation are shown in Figure 3.2. *[Note: not shown to scale.]*

Figure 3.2 – Instruments and objects used in natural selection simulation

Instrument (Beak type)	Object (Food type)
(1) forceps 	(a) rubber bands 
(2) tongs 	(b) jelly beans 
(3) peg 	(c) tooth picks 
	(d) rice grains 

[Source: <google.images>]

Many of the food objects were randomly scattered across a table. The following instructions for the simulation were given to the students:

1. Each student was given an instrument to use to pick up the food objects that were on the table.
2. Each student was given 5 minutes to pick up as many different food objects as possible.
3. After each food object was picked up, it was placed in the student's free hand to represent the food as having been eaten.
4. The total number of food objects captured by each instrument was counted and recorded.

[Source: <google images>]

3.3.1 What principle of evolution is this investigation simulating? (1)

3.3.2 Give the dependent variable in this investigation. (1)

3.3.3 During the simulation, some students stole the objects from other students. Choose which option listed below represents this concept in nature. Write only the correct letter.

A predation
B competition
C adaptation (1)

3.3.4 A student hypothesizes that the peg instrument will pick up the least number of rice grains in 5 minutes compared to the other instruments. Suggest why the peg would be **less effective** at picking up the rice grains compared to the forceps. (3)

3.3.5 In your opinion, does the simulation represent the principles of natural selection correctly? Give a well-explained reason for your answer. (2)

3.4 3.4.1 Explain what is meant by Lamarck's theory of acquired characteristics. (2)

3.4.2 Lamarck's theory was rejected by the scientific community, yet it is still taught in the study of evolution. What value is there in learning about Lamarck? (3)

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

Proteaceae (proteas) form a large family of flowering plants that are distributed in the Southern hemisphere. *Leucospermum tottum* and *Leucospermum arenarium* are two species of 'pincushion' proteas. These species are part of the Cape Floral Kingdom. They grow in the same areas in the South-Western Cape of South Africa but are reproductively isolated. The two species of protea arose by sympatric speciation.

Figure 3.3 (a) and (b) – Comparison of two pincushion protea species

(a) Leucospermum tottum

- Pink to orange flowers
- Stems grow upright with flowers at the end of the branch
- Flowering season is late spring to early summer
- Pollinated by birds

(b) Leucospermum arenarium

- Pale yellow flowers
- Stems grow downward with flowers found near ground level
- Flowering season is late winter to early summer
- Pollinated by mice

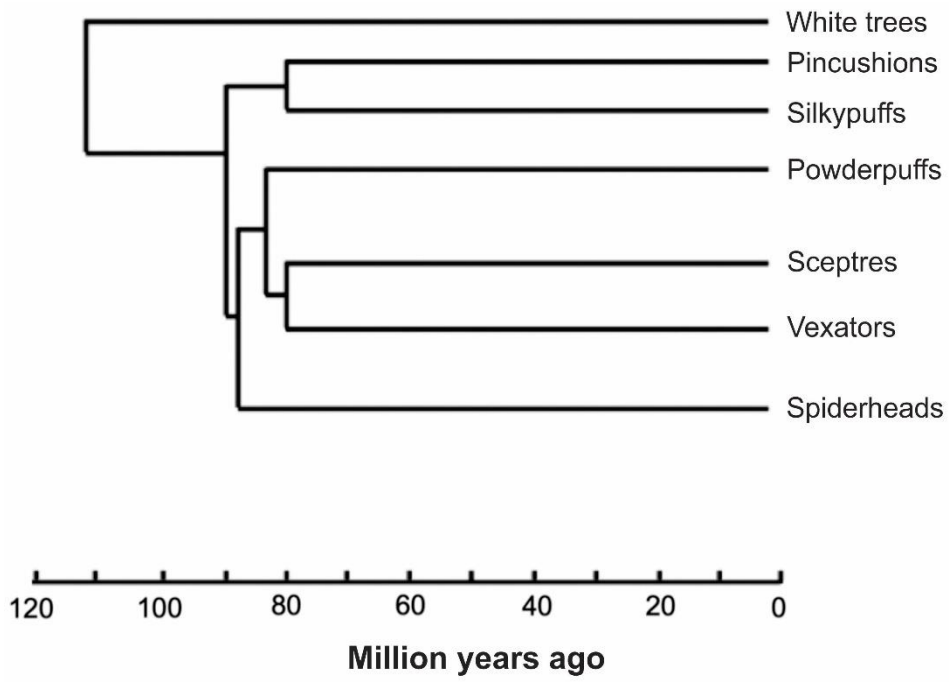
[Adapted:<http://pza.sanbi.org>; <https://scholar.sun.ac.za>]

3.5.1 Explain the difference between allopatric and sympatric speciation. (2)

3.5.2 Describe TWO ways in which reproductive isolation is brought about in the two pincushion protea species. (4)

3.5.3 Study the phylogenetic tree below that shows the evolutionary relationship between some members of the Proteaceae family and answer the questions that follow.

Figure 3.4 – Phylogenetic tree of family members in Proteaceae



[Adapted: <https://www.researchgate.net>]

(a) Which species, powderpuffs or spiderheads, are more closely related to the vexators? Give a reason for your answer. (2)

(b) Approximately how long ago did the pincushions and silkypuffs diverge? (2)

(c) Which species is the oldest amongst all the Proteaceae? (1)

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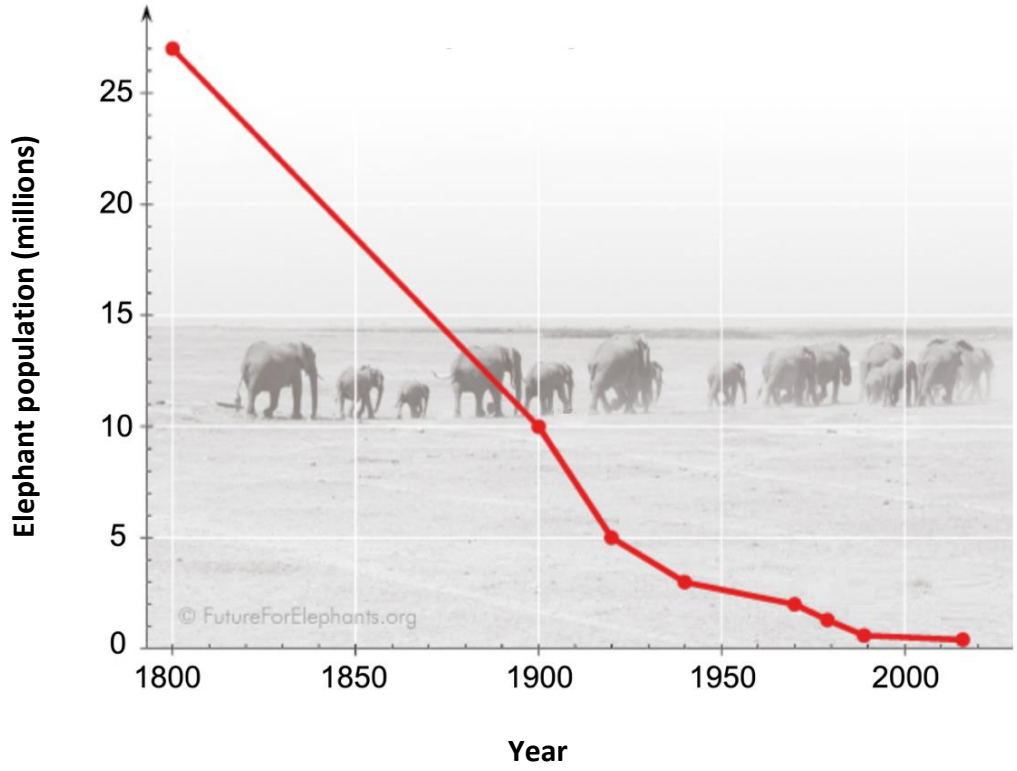
QUESTION 4

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

African elephant population change over the decades

In 1900, 10 million wild African elephants (*Loxodonta africana)* roamed the forests and savannah of the African continent. In 2016, the population size of elephants on the African continent was estimated at just 415 000 elephants throughout Africa. Biologists determined this estimate using a combination of aerial surveys and transect sampling (which is similar to quadrat sampling).

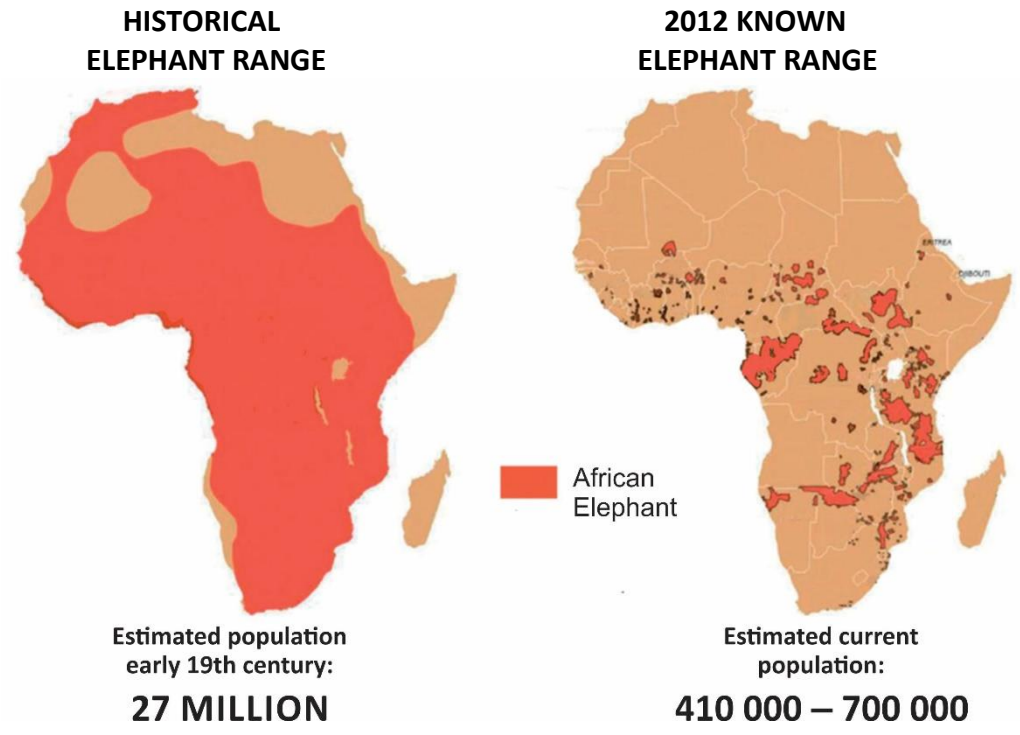
Figure 4.1 (a) – Graph showing elephant populations in Africa from 1800 until present day



Elephants need large land areas to survive and meet their ecological needs. The range (access to the land areas) for elephants has changed in Africa. Elephants do not roam the African continent freely as they once did, as shown in Figure 4.1 (b).

Most elephant populations are confined to game reserves and wildlife parks. A 'corridor' is an area that links two game reserves or conservation areas that were once divided.

Figure 4.1 (b) – Map showing change in elephant range in Africa



[Adapted: <https://www.futureforelephants.org>; <https://vividmaps.com>]

4.1.1 List THREE criteria that need to be met to consider the African elephant a 'population'. (3)

4.1.2 Refer to Figure 4.1 (a).

(a) Describe the trend in the graph. (2)

(b) Which of the following (immigration, emigration, mortality or birth rate) is most likely responsible for this trend? (1)

(c) How many elephants were living in Africa in 1920? (1)

4.1.3 Discuss THREE possible reasons for the change in elephant populations in Africa since the 1800s. (6)

4.1.4 Suggest why conservationists would want to establish corridors between smaller nearby conservation areas. (2)

4.1.5 Explain TWO possible advantages of using aerial surveys to determine elephant population sizes. (4)

4.1.6 Why is it important that the transects or quadrats are selected randomly when biologists perform the sampling method? (2)

4.1.7 Fires can occur in game reserves and then new plants will recolonise the area destroyed by fires.

(a) Is recolonisation by plants of an area destroyed by fire an example of primary or secondary succession? Give a reason for your answer. (2)

(b) What is the term used to describe the first plants and animals that appear in an area after a fire? (1)

4.2 Study Figure 4.2 below that shows a herd of elephants. Elephant herds consist of females and their young and have a very definite social structure.

Figure 4.2 – Herd of elephants

[Adapted: <www.washingtonpost.com>]

4.2.1 Describe how elephants benefit from living in a herd. (4)

4.2.2 Name the type of competition that exists within a herd of elephants and explain your answer. (2)

4.2.3 (a) Identify ONE density dependent factor that will limit the growth of elephant populations. (1)

(b) Explain how this density dependent factor identified in Question 4.2.3 (a) limits the growth of an elephant population. (1)

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

Lions are one of the very few predators that will attempt to attack an elephant, and usually only do so when other herbivores such as springboks are scarce.

Figure 4.3 – Lions and springboks

[Source: <www.catersnews.com> and <https://media.istockphoto.com>]

4.3.1 Sketch a simple graph to show the relationship between lions and springboks in a game reserve over time.

- Label the graph lines representing the lion and springbok.
- Provide a heading for the graph. (5)

4.3.2 Explain the role of lions in maintaining healthy prey populations. (3)
[40]

Total: 200 marks