



NATIONAL SENIOR CERTIFICATE EXAMINATION
SUPPLEMENTARY EXAMINATION MARCH 2016

LIFE SCIENCES: PAPER I

Time: 3 hours

200 marks

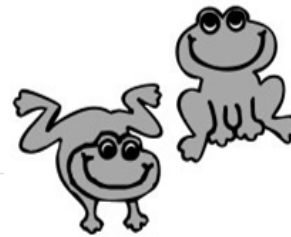
PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 12 pages and a yellow Answer Booklet of 9 pages (i – ix). Please check that your question paper is complete. Detach the yellow Answer Booklet from the middle of the question paper.
 2. This question paper consists of four questions.
 3. Question 1 must be answered in the yellow Answer Booklet provided. Questions 2, 3 and 4 must be answered in your Answer Book.
 4. Read the questions carefully.
 5. Number the answers exactly as the questions are numbered.
 6. Use the total marks that can be awarded for each of Questions 1, 2, 3 and 4 as an indication of the detail required.
 7. It is in your own interest to write legibly and to present your work neatly.
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QUESTION 2

2.1 Study the information provided below and answer the questions that follow:

South Africa is home to 110 of southern Africa's 130 frog species. They lay their eggs in ponds, dams and rivers where they hatch into tadpoles, providing a food source for predators in the area.



Ecologists investigated the effect of predation on three species of tadpole in various ponds.

They set up four artificial pond communities, each with an abundance of space and resources for the tadpoles.

Each community contained:

- 200 tadpoles from Species I
- 200 tadpoles from Species II
- 200 tadpoles from Species III

The ecologists then added different species of common fish predators to each pond. After a week, the fish were removed and the surviving tadpoles were counted. The graph below shows the effect of the species of fish predator on the percentage survival of the tadpoles of each species.



[Source: Examiner's own hypothetical data]

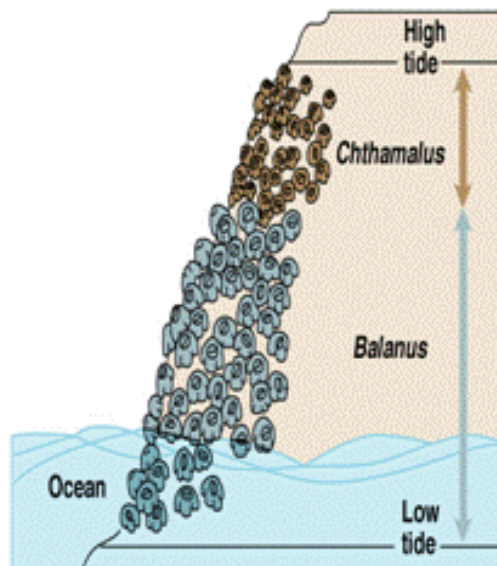
- 2.1.1 In natural rivers and dams, what relationship exists between the different species of fish predators? (1)
- 2.1.2 What was the preferred tadpole species eaten by the Tiger-fish? (1)
- 2.1.3 Which species of predatory fish ate the most tadpoles? (1)
- 2.1.4 Which species of predatory fish had the least impact on tadpoles from Species I? (1)
- 2.1.5 How many Species III tadpoles (actual number – not %) were left in the Trout pond? Show your working. (3)
- 2.1.6 In order to make this a valid experiment, the ecologist needed to control a number of variables. Suggest THREE fixed variables that would apply to this investigation. (3)

2.1.7 Draw a simple graph to show the relationship between predator and prey numbers over time. Your axes need to be labelled but no number values need to be provided. (6)

2.2 Gause's law states that when two species compete for the same resource within an environment, one of them will eventually outcompete and displace the other. Study the text and diagram below and answer the questions that follow:

Barnacles are marine crustaceans that attach themselves to rocks. Two species of barnacle, *Chthamalus* and *Balanus*, both live on rocks at the edge of the sea. During low tide, the sea retreats from the rocks, exposing the barnacles. During high tide, the sea covers the rocks, submerging the barnacles. While each species can survive being exposed to the air for a time, *Chthamalus* can last longer in the air than *Balanus*. Both barnacles can survive being completely submerged.

Diagram showing position of barnacles on rock



[Adapted from: <<http://www.sleepingdogstudios.com>>]

- 2.2.1 What ecological concept is illustrated in the example of the two species of barnacles that are able to co-exist? (1)
- 2.2.2 Explain the advantage of this relationship to the barnacles concerned. (3)
- 2.2.3 Discuss how this ecological concept applies in a forest ecosystem. (3)

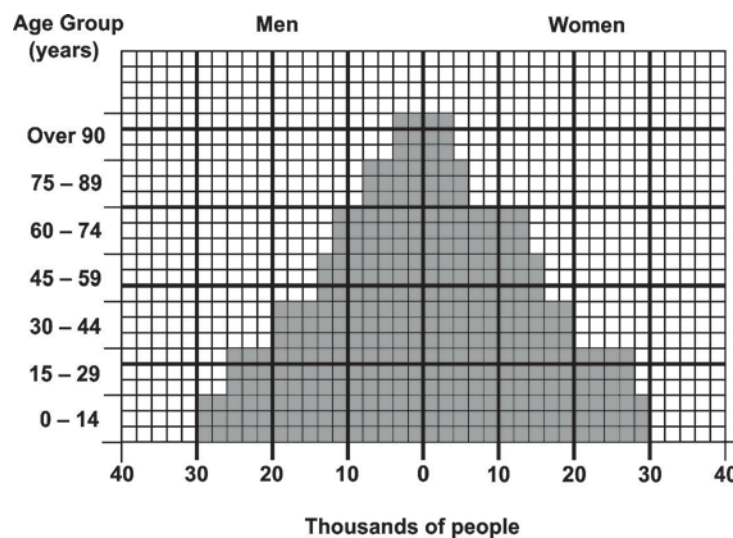
2.3 In South Africa, the Burchell's zebra (*Equus burchelli*) is a common inhabitant in game reserves, where it can frequently be seen grazing in large herds on the open savannah plains.

2.3.1 Explain three advantages of living in a zebra herd as a predator-avoidance strategy. (3)

2.3.2 How do the stripes of a zebra help to protect it from predators? (3)

2.3.3 Wild dogs are one of the predator species that prey on zebra. They need to compete for food with many other, often larger predators. Explain TWO reasons why the wild dogs' method of co-operative hunting ensures success. (4)

2.4 The diagram below shows a population pyramid for a small country.



[Givens, P. & Reiss, M. (2002). *Human biology and health studies*]

2.4.1 How many of the population are aged 75 years or older? (1)

2.4.2 Predict what will happen to the population of the small country over the next 20 years. Use information from the population pyramid to explain the reason for your answer. (2)

2.4.3 Explain TWO ways in which the population pyramid of a developed first-world country might differ from the pyramid shown above. (4)

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QUESTION 3

3.1 Read the following text and answer the questions that follow:

When Arizona's Grand Canyon formed, squirrels and other small mammals that had once been part of a single population were now split geographically. Today, two separate squirrel species inhabit the north and south rims of the canyon. Birds in the same region never underwent speciation.

Kaibab Squirrel



[<http://www.natureartists.com>]

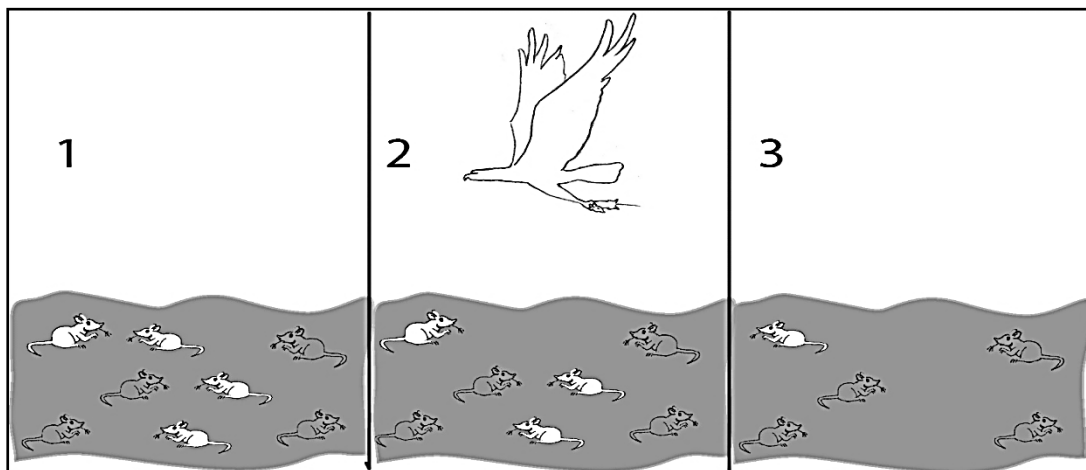
Albert's Squirrel



[<http://s3.amazonaws.com>]

- 3.1.1 What type of speciation (allopatric or sympatric) caused the formation of the two species of squirrels referred to above? (1)
- 3.1.2 Explain **why** and **how** this speciation took place. (6)
- 3.1.3 Why do you think the birds in this area did not undergo speciation? (2)

3.2 Study the sequence of diagrams below (sequenced in time order) and answer the questions that follow:



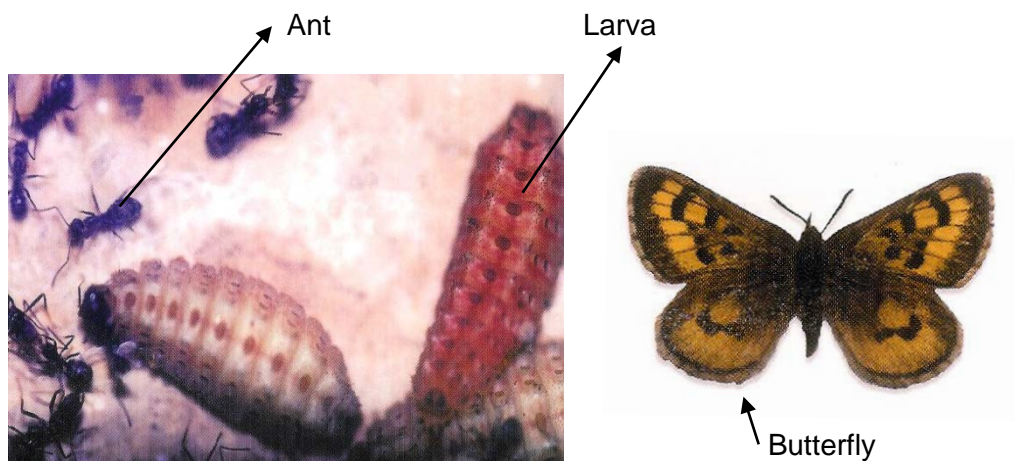
[Adapted from the University of California, Los Angeles, *Life Sciences 1: Demonstration Manual*]

- 3.2.1 What was the selection pressure that directed the evolution of the mice? (1)
- 3.2.2 Explain the term 'survival of the fittest' in relation to the example given above. (4)

- 3.3 The following information and photographs were obtained from an article in the *Veld & Flora* Magazine, September 2013 by André Claassens:

Pugnacious Ants and Black Skolly Butterflies in South Africa seem to have developed a mutualistic relationship. Larvae of the Skolly Butterfly are frequently found in nests of Pugnacious Ants where they are part of a feeding ritual that has developed over many years.

An ant returning to the nest with food will link up with either another ant or the 'guest' Skolly larvae. The Skolly larva will place its unusually delicate mouthparts into the ant's mouth, and the Skolly larva will regurgitate its stomach contents onto the new food. This will provide additional digested nutrients as well as help to digest the food, which both the ant and the larva will eat. To ensure that the ants do not attack them, the larvae emit a sweet honeydew secretion from glands in their skin, which the ants feed on. Without this secretion, the ants would kill the larvae.



- 3.3.1 The Skolly Butterfly and the Pugnacious Ant have both evolved over time to allow for this mutualistic association. What is this phenomenon known as? (1)
- 3.3.2 Discuss certain physical characteristics of the Skolly larva which have evolved to facilitate this relationship. (4)
- 3.3.3 What benefits do the ants derive from this relationship? (2)

3.4 Read the following passage and answer the questions that follow:

It doesn't get much more peaceful than the simple life among the Amish in rural Ohio.

They have no cars, no electricity and no televisions.

The nearly 150 000 Amish in the United States of America can trace their roots back to a few hundred German-Swiss settlers who brought the Amish lifestyle to the United States in the 18th century.

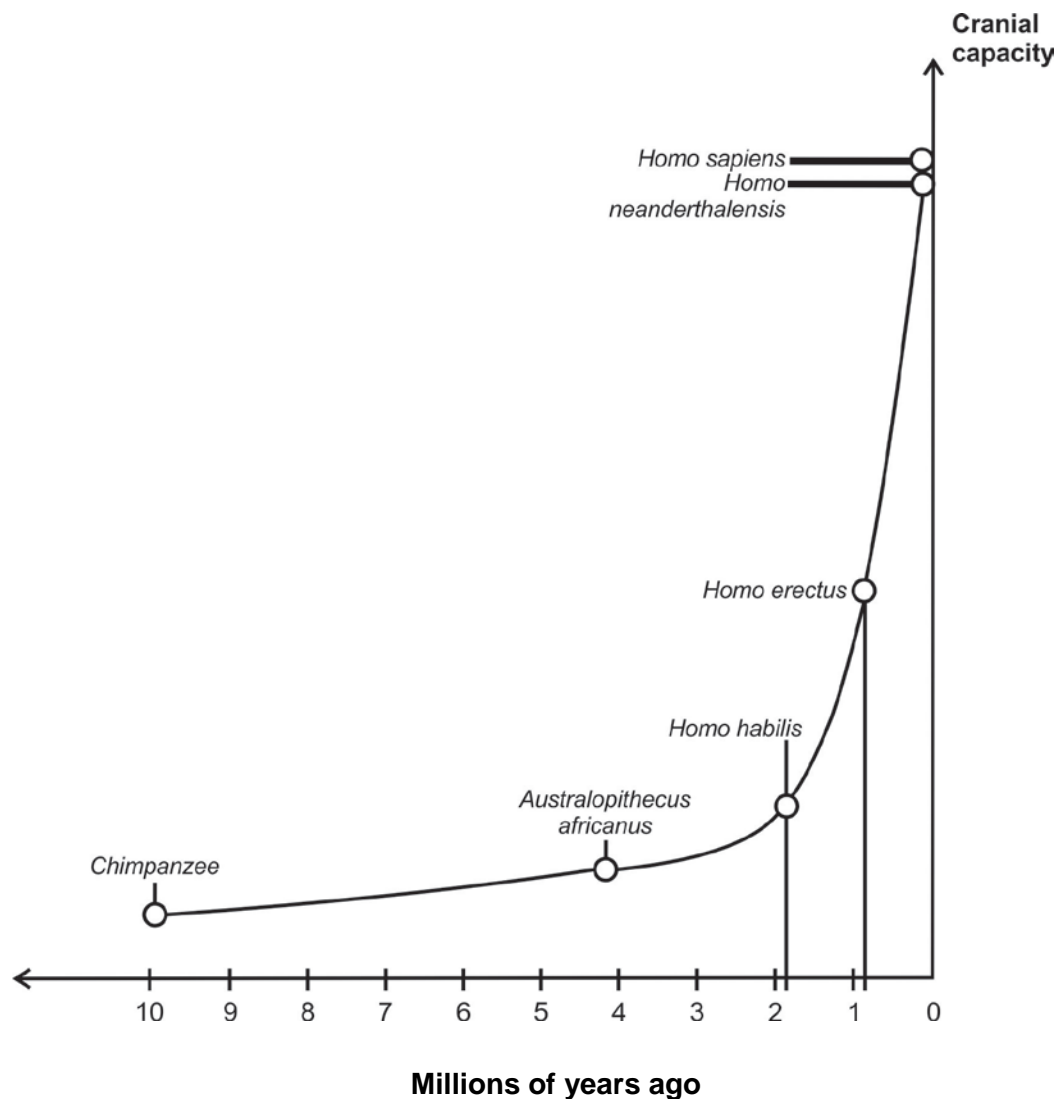


Their children have medical conditions so rare that doctors don't have names for them as yet. Recessive mutations have led to an ever-increasing number of victims of life-threatening conditions. The best prevention for many of these conditions is to prevent intermarriage, which is hard to do. Marrying outside the faith could create a healthier gene pool, but it would also ultimately destroy the very essence of what it means to be Amish.

[Adapted from: <<http://www.cbsnews.com>>]

- 3.4.1 Explain how the founder effect results in these recessive genetic conditions being more common among populations such as the Amish. (3)
- 3.4.2 (a) Why will intermarriage with outsiders be beneficial to the health of the Amish community? (2)
- (b) With reference to the statements in the final paragraph, state whether you think the benefits of intermarriage is worth the risk to the Amish lifestyle. Justify your answer. (3)

3.5 Study the graph below and answer the questions that follow:



- 3.5.1 According to the graph, approximately how old are the fossils of *Australopithecus africanus*? (1)
- 3.5.2 State the common name of a fossil belonging to *Australopithecus africanus* that was discovered in South Africa. (1)
- 3.5.3 According to the 'out of Africa' hypothesis on the origin of modern man, why did *Homo neanderthalensis* become extinct? (2)
- 3.5.4 What is the significance of the enlarged cranial capacity in *Homo sapiens*? (3)
- 3.5.5 Although enlarged cranial capacity was crucial in the evolution of man, there was another development that was essential in man's evolution.
- (a) Name the other feature referred to in the statement above. (1)
- (b) Describe THREE advantages given by this feature. (3)

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QUESTION 4

4.1 Study the text below and answer the questions that follow:

Diabetes Type I is a condition caused by the human body's failure to produce the hormone insulin. For many years, scientists extracted insulin from the blood of pigs and cows in order to provide insulin injections to diabetics. In the early 1980s scientists managed to genetically engineer *E. coli* bacteria to produce human insulin.

[Adapted from: <Cambridge GCE Biology 2005>]

4.1.1 Define the following terms:

(a) plasmid (1)

(b) recombinant DNA (1)

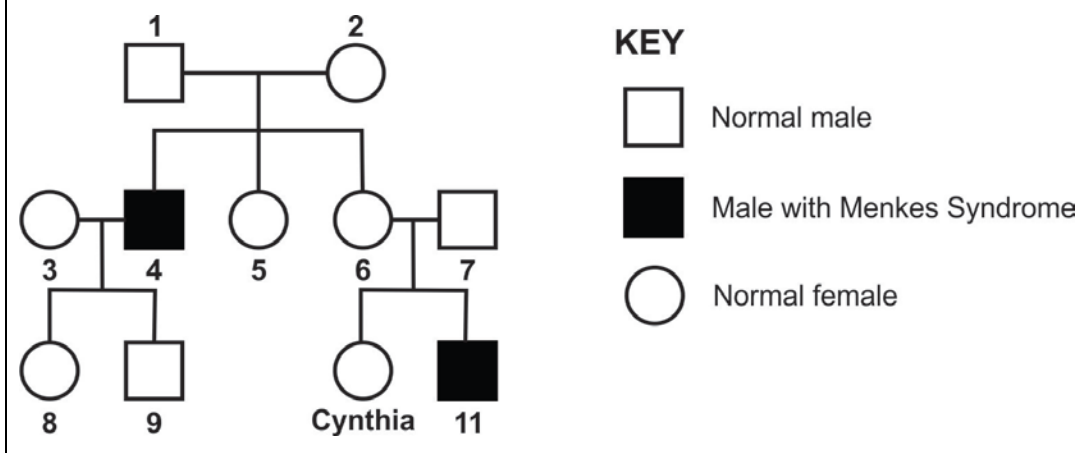
4.1.2 Name TWO enzymes that are involved in the process of forming the recombinant DNA. (2)

4.1.3 List TWO advantages of treating diabetics with human insulin produced by genetic engineering rather than insulin from animals. (2)

4.2 Read the text below and answer the questions that follow:

Menkes Syndrome is an X-linked recessive disorder that affects copper levels in the body by preventing absorption of copper. It is characterized by sparse, brittle hair, weak muscle tone, sagging facial features, seizures, developmental delay, and intellectual disability. Children with Menkes Syndrome begin to develop symptoms during infancy and often do not live past age three. Early treatment with injections of copper supplements may improve the prognosis in some affected individuals.

Cynthia and Harold want to start a family but, although Cynthia is healthy, she is concerned because her brother died at the age of two from Menkes Syndrome. They decide to visit a genetic counsellor before they make the decision to have a family. The genetic counsellor drew up a family pedigree for Cynthia's family. She did not draw a family pedigree for Harold as he had no history of the disease in his family.



[Adapted from: <<http://ghr.nlm.nih.gov>>]

4.2.1 What evidence is there, based on the diagram above, that Menkes Syndrome:

- (a) is a recessive disorder? (1)
- (b) is a sex-linked disorder? (1)

4.2.2 Using the symbols X^N for normal and X^n for Menkes Syndrome, draw a genetic diagram of the cross between Cynthia's parents (individuals 6 and 7 in the pedigree).

Your genetic diagram must include:

- parental phenotypes and genotypes
- a genetic cross/Punnett square
- the ratio of the possible genotypes and phenotypes of the offspring. (7)

4.2.3 If Cynthia is a carrier of the disease, what is the probability that Cynthia and Harold will have a child with Menkes Syndrome? (1)

4.2.4 Cynthia and Harold decided to start their family, despite the risks involved. During her pregnancy they had the baby genetically tested and discovered that it was a boy with Menkes Syndrome. Cynthia decided to have an abortion. Do you agree with her decision? Discuss TWO reasons to support your answer. (2)

4.3 The following article is adapted from one that appeared on News24 on 2 March 2015.

Cape Town fire possibly to last a week

Paul Herman, News 24

Cape Town – the blaze spreading around Cape Town's south peninsula is likely to continue for much of the week, depending on the weather conditions, Table Mountain National Park Integrated Fire Manager Phillip Prins said on Monday. "It's a big fire. It's been aided by 70 – 80 km/h winds. In some places it was 100 km/h."

According to Prins, the fire started early on Sunday morning in the mountains above Muizenberg, before spreading aggressively to the surrounding areas in one of the worst fires of recent years in the Cape Peninsula. "At least 3 000 hectares' of vegetation are at risk of being completely destroyed but actual damage and the cost of the fire will only be known once the fire is extinguished," SANParks said in a statement.

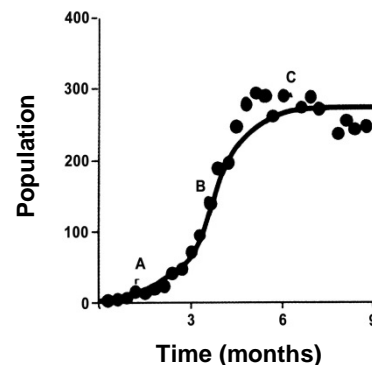
- 4.3.1 After a fire of this magnitude, it will take a long time for the ecosystem to be restored. What term is given to the process by which the plants and animals will re-establish themselves in the area? (2)
- 4.3.2 Describe step by step the process referred to in Question 4.3.1 above. (4)
- 4.3.3 After the fire, an ecologist monitored the numbers of Southern Rock *Agamas* found on the mountain to see how quickly they re-establish their population. He plotted his data on the graph below:

Photograph of a Southern Rock *Agama*



[Source: <<http://www.tablemountain.net>>]

Graph showing size of *Agamas* population



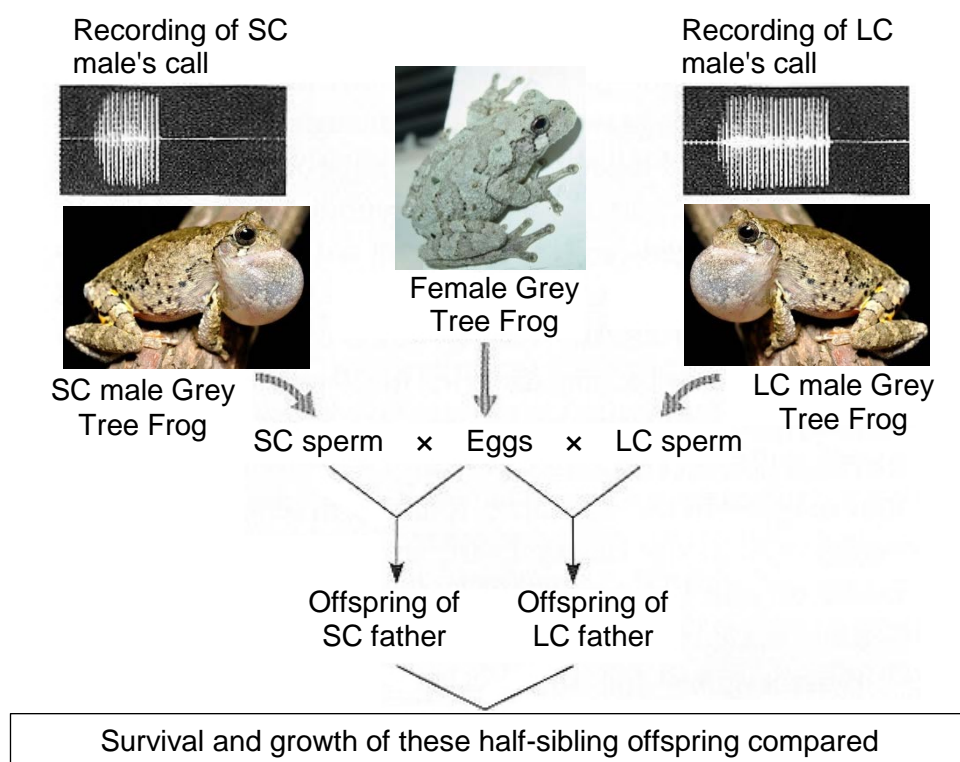
[Examiner's own hypothetical data]

- (a) How many *Agamas* were present after 4 months? (1)
- (b) Discuss the reason for the difference in the gradient of the graph at B and C. (2)
- (c) How long did it take for the *Agamas* to reach their maximum sustainable population size? (1)
- (d) Previous population estimates showed about 200 *Agamas* on the mountain. Give TWO possible reasons why the numbers recorded show a larger population. (4)

4.4 Read the text below and answer the questions that follow:

Scientists at the University of Missouri did a study on the Grey Tree Frog *Hyla versicolor*. They noted that female Grey Tree Frogs prefer to mate with males that give long mating calls. They tested whether the genetic makeup of long-calling (LC) males is superior to that of short-calling (SC) males.

The researchers gathered the eggs of female frogs and fertilized half the eggs of each female with sperm from an LC male while the other half were fertilized with sperm from a SC male. The resulting offspring were raised in a common environment and several measures of their performance were recorded. The experiment was repeated a year later.



The results collected for the two experiments were as follows:

| Offspring performance | Experiment 1 | Experiment 2 |
|-------------------------|--------------------|-------------------|
| Larval survival | LC survived better | No difference |
| Larval growth | No difference | LC grew better |
| Time to reach adulthood | LC matured sooner | LC matured sooner |

[Adapted from: *Campbell Biology 9th ed.* (Pearson)]

- 4.4.1 What was the independent variable in this study? (1)
- 4.4.2 Why was the experiment carried out twice? (2)
- 4.4.3 Which type of male Grey Tree Frog meets the requirements of 'survival of the fittest'? Explain your answer. (3)
- 4.4.4 Did the long mating call serve a purpose **for the species**? Explain. (2)

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Total: 200 marks