

**LIFE SCIENCES: PAPER I**

Time: 3 hours

200 marks

PLEASE READ THE FOLLOWING INSTRUCTIONS CAREFULLY

1. This question paper consists of 12 pages and an Answer Booklet of 16 pages (i–xvi). Please check that your question paper is complete. Detach the 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 Answer Booklet provided.
 4. Questions 2, 3 and 4 must be answered in your Answer Book.
 5. Start **each question** on a **new** page.
 6. Read the questions carefully.
 7. Number the answers exactly as the questions are numbered.
 8. Use the total marks that can be awarded to 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.
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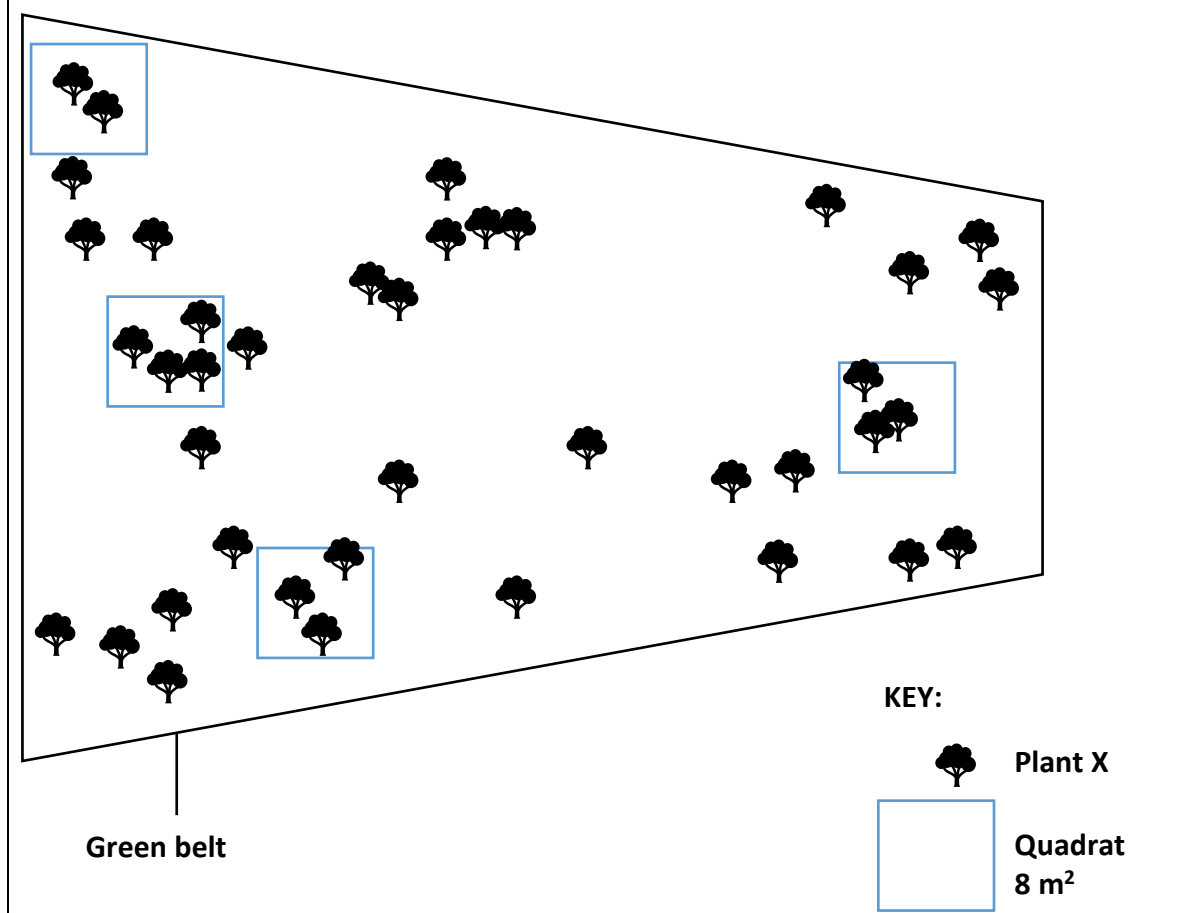
QUESTION 2

- 2.1 Read the information in the text box below. Use the information provided and your own knowledge to answer the questions that follow.

A Grade 12 student conducted an investigation on the population of an invasive plant species, **plant X**, in the green belt outside her school. A green belt is an area of open land in or around a city, on which building is restricted. The following details relate to her investigation:

- She used the quadrat sampling method
- Total area of green belt: 600 m²
- Size of each quadrat: 8 m²

Figure 2.1: A diagrammatic representation of the student's investigation



[Source: <Examiner's own>]

2.1.1 What is meant by the term *population*? (2)

2.1.2 (a) How many quadrat samples did the student use in her investigation? (1)

(b) What is the average number of plant X in the quadrats that were sampled? Choose the correct letter from the options listed below. (1)

- A 12
- B 4
- C 3

- (c) Use the method for quadrat sampling to calculate the population of plant X in the green belt. Show all working. (3)

2.1.3 The student states that she placed the quadrats randomly in the green belt.

- (a) Suggest a method that the student could have used to ensure simple random sampling took place. (2)
- (b) Why is random sampling important? (1)
- (c) By looking at the actual distribution of plant X in Figure 2.1, evaluate the accuracy of the quadrat method in estimating population size in this student's investigation. (3)

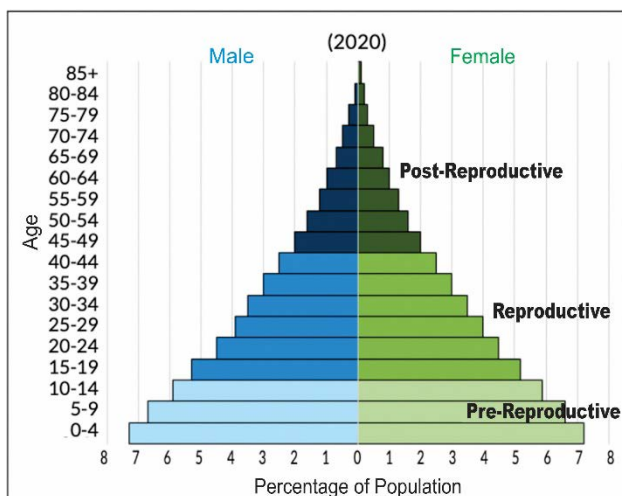
2.1.4 Why is the mark-recapture method not suitable to estimate the population of plant X? (2)

2.1.5 Suggest how the population of plant species X will impact the indigenous plants in the green belt. (2)

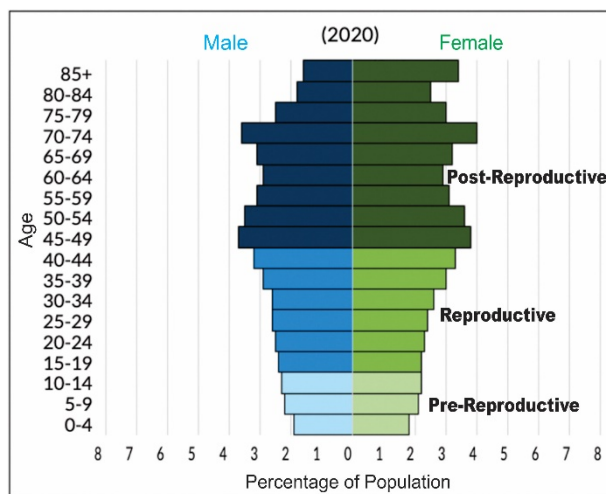
2.2 Study the population pyramids below.

Figure 2.2: Age–sex population pyramids of Country A and Country B

Country A



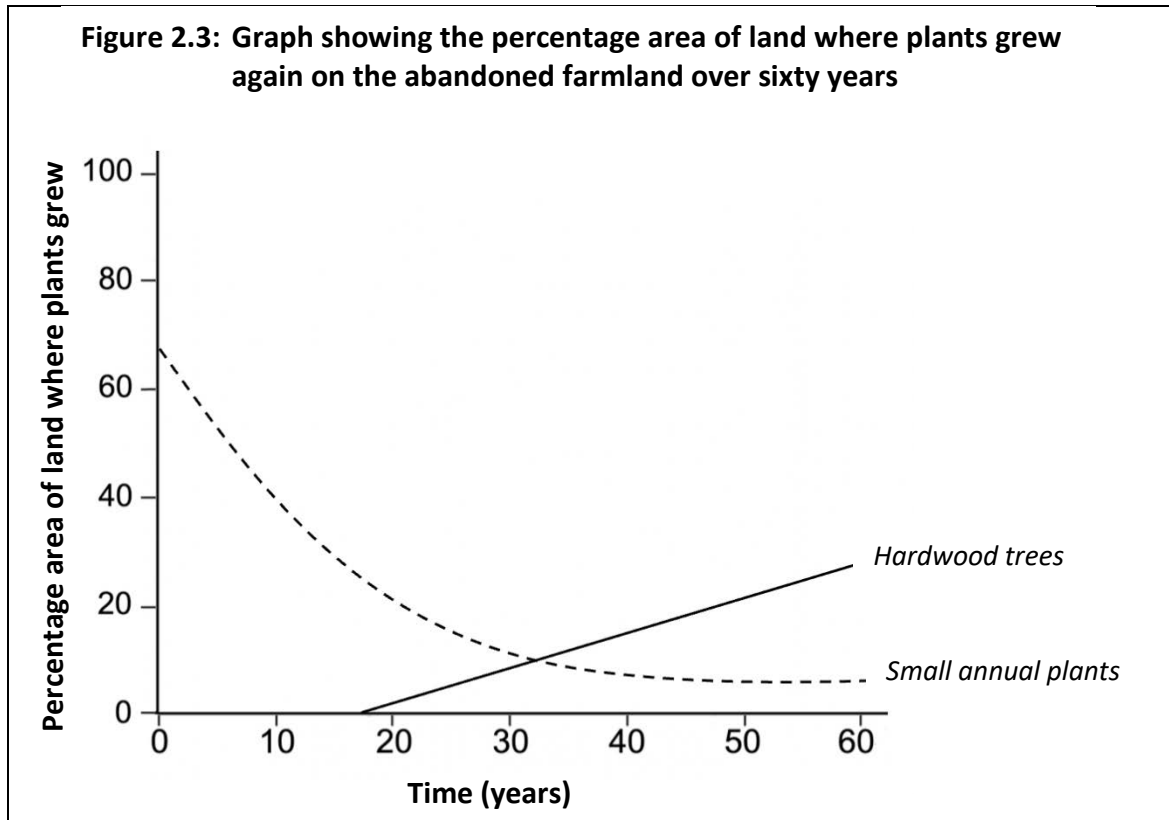
Country B



[Adapted: <www.populationeducation.org>]

- 2.2.1 Suggest ONE reason why it is important that the government of a country obtains the information represented in age–sex population pyramids? (1)
- 2.2.2 By analysing these graphs, can it be determined which country has the greatest number of people? Explain your answer. (2)
- 2.2.3 Which country, A or B, has the fastest growth rate? Explain your answer using information from the images. (4)
- 2.2.4 Describe ONE population parameter and how it could change the shape of the graph of country A to a stable population. (2)

- 2.3 Biologists conducted a study on ecological succession on abandoned farmlands over a period of 60 years. The biologists collected data on hardwood trees and small annual plants. Hardwood trees are large, well-established trees, and small annual plants are plants that produce seeds and then die within one growing season. The data they collected is shown in the graph below. Use the graph and your own knowledge to answer the questions that follow.



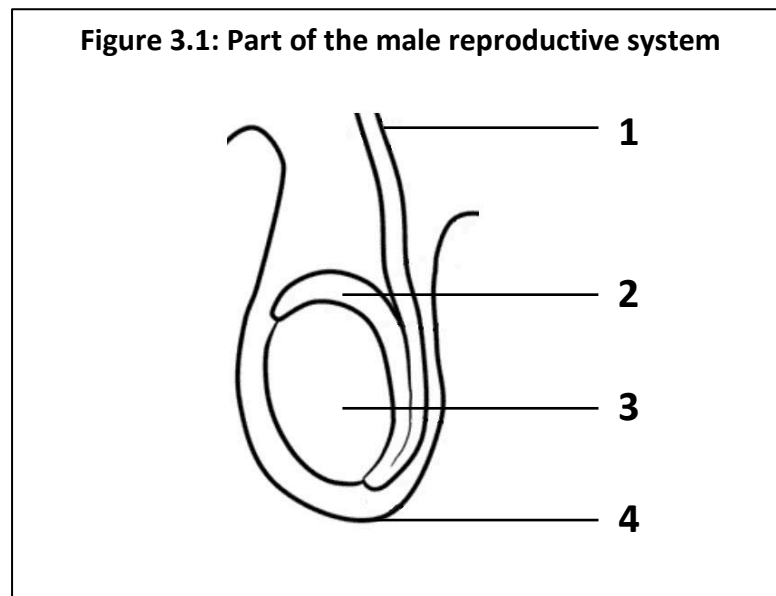
[Adapted: <<https://www.mdpi.com>>]

- 2.3.1 Explain what is meant by ecological succession. (3)
- 2.3.2 Which plants, hardwood trees or small annual plants, are the climax species? Give evidence from the graph to support your answer. (2)
- 2.3.3 List any three characteristics that are typical of pioneer plants that allow them to colonise an area. (3)
- 2.3.4 How long in the process of succession on the abandoned farmlands did it take for hardwood trees and small annual plants to have an equal percentage of cover? (2)
- 2.4 Using an example that you have studied, name and explain how two different species of animals that live in the same habitat are able to co-exist. (4)

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QUESTION 3

3.1 Use Figure 3.1 below to answer the questions that follow.



[Adapted: <www.exploringnature.org>]

3.1.1 For each statement below, give the correct **number** shown in Figure 3.1.

- (a) The part where sperm is stored and matured. (1)
- (b) The part that regulates the temperature to ensure healthy sperm is produced. (1)
- (c) The part that has a similar function to an ovary in a female. (1)

3.1.2 Name the organ in the male reproductive system that transfers sperm to the female body (not shown in the Figure 3.1.). (1)

3.1.3 During a vasectomy, the part numbered 1 is surgically cut.

- (a) Name the part numbered 1. (1)
- (b) Explain why a vasectomy is a successful method of contraception. (2)

3.1.4 Using your knowledge of negative feedback, explain how sperm production is controlled when testosterone levels are high. (4)

- 3.2 Read the information in the text box below and answer the questions that follow.

Scientists studied the effect of smoking on male fertility. The study was performed on a group of men of various ages for one month: 344 men who smoked and 187 non-smoking men took part in the investigation. The semen of all the men was examined to determine sperm viability (this is the percentage of live sperm in the semen sample). The results of the study are shown in Table 3.1 below.

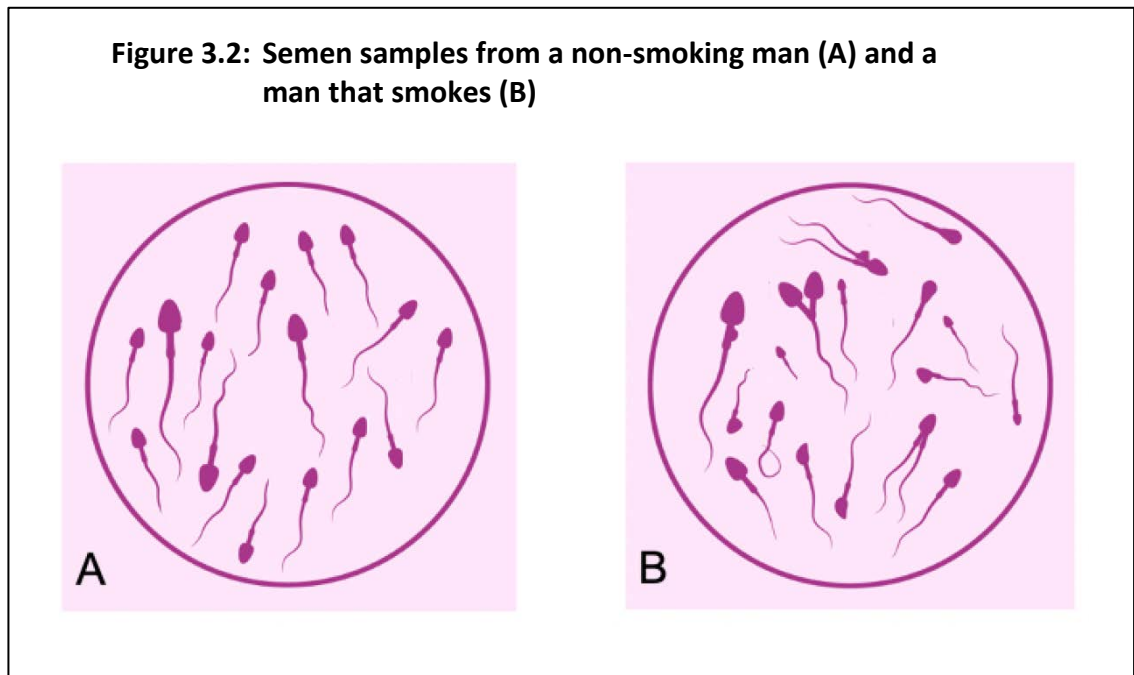
Table 3.1: Results showing the effect of smoking on sperm viability

Smoking status of men	Sperm viability (%)
Smoking	47
Non-smoking	72

[Adapted: <www.spandidos-publications.com>]

- 3.2.1 Describe the difference between sperm and semen. (2)
- 3.2.2 Identify the following in the investigation:
- (a) independent variable (1)
 - (b) dependent variable (1)
- 3.2.3 What would the scientists observe under a microscope if the sperm in the semen sample were alive? (1)
- 3.2.4 What will the scientists conclude from the results of the study shown in Table 3.1? (2)
- 3.2.5 Other scientists may regard these results as unreliable. Why might other scientists have this opinion? (2)
- 3.2.6 What is the most suitable type of graph to draw (line or bar graph), to represent the data in Table 3.1? (1)

3.2.7 Figure 3.2 below illustrates the results of what the scientists observed under a microscope when analysing the semen samples of one non-smoking man and one man that smokes.



[Adapted: <www.invitra.com>]

Tabulate TWO visible differences between the sperm in the semen samples, A and B, in Figure 3.2.

(5)

- 3.3 Read the text on the development of an artificial placenta below and use the information and your own knowledge to answer the questions that follow.

Artificial Uterus Technology

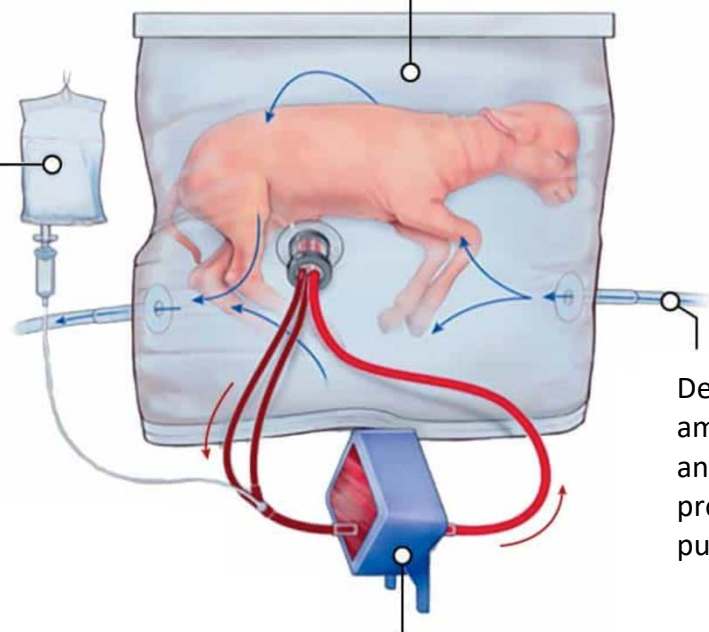
It is estimated that every year more than 15 million babies are born too early. The lungs of these premature infants are often immature and easily damaged. Premature births happen for a variety of reasons. Scientists are researching what causes premature births, in an attempt to develop solutions to prevent them.

One possible solution that scientists are working on is the development of an artificial placenta and uterus. At a research centre, five premature lambs were placed in 'biobags' with an artificial placenta and kept alive for weeks. During this time, each lamb's blood was circulated through its artificial placenta, as shown in Figure 3.3 below. The 'biobag', if as successful as early animal testing suggests, will change how premature babies are cared for in intensive care in hospitals. At present, premature babies born earlier than 22 weeks have no hope of survival.

Figure 3.3: How an artificial placenta works

The premature lamb is placed into a sterile, fluid-filled 'biobag' that is temperature controlled.

Artificial amniotic fluid flows into the bag.



The lamb's heart pumps blood through the artificial placenta.

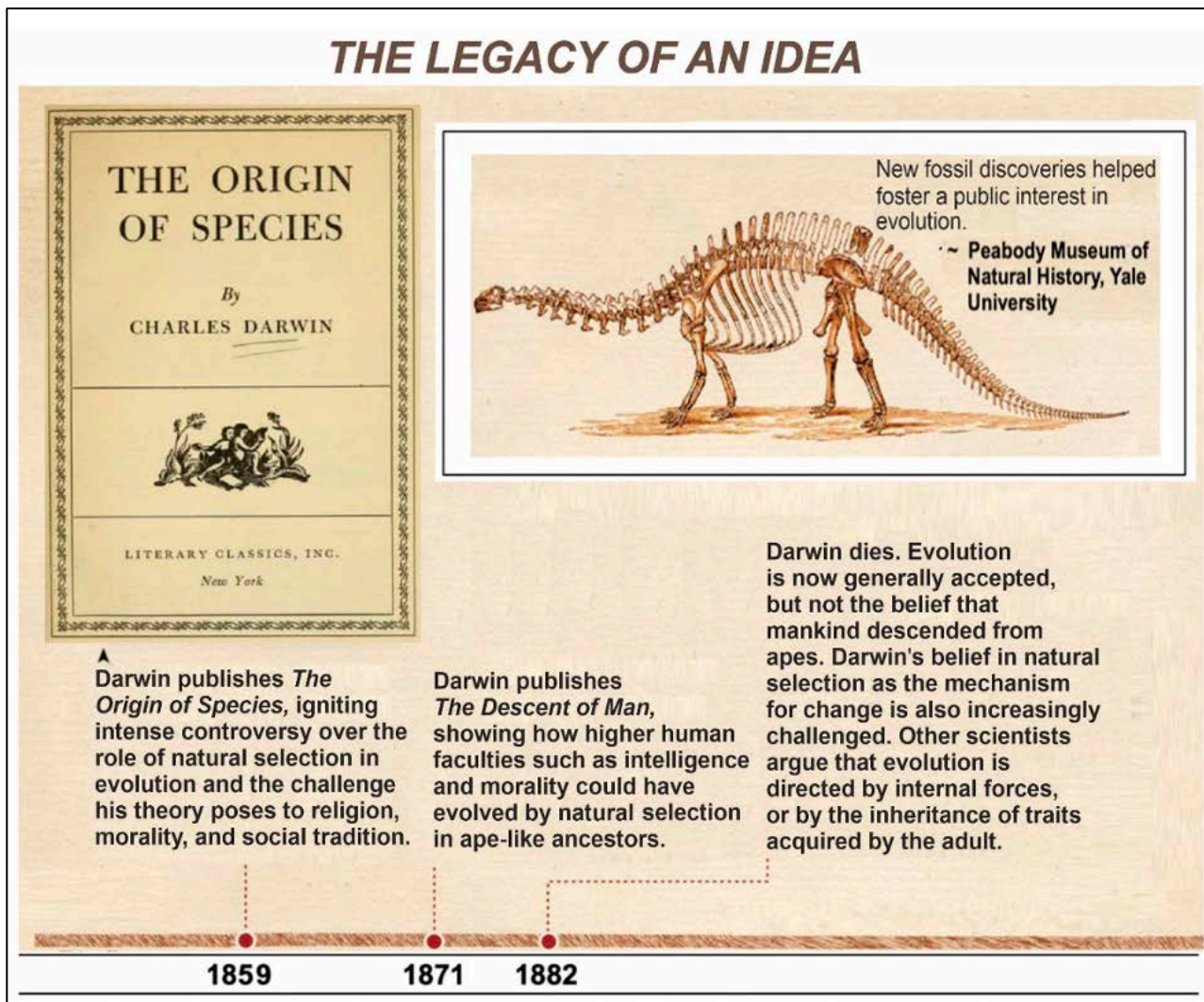
[Adapted: <www.prodigitalweb.com> and <me.bmj.com>]

- 3.3.1 (a) Name the organ that the 'biobag' represents. (1)
- (b) State one function of the 'biobag'. (1)
- 3.3.2 How is the blood moved through the artificial placenta? (1)
- 3.3.3 Describe the role of the placenta in a healthy pregnancy. (4)
- 3.3.4 Why is there a barrier between the foetal and the maternal blood systems? (2)
- 3.3.5 Provide one possible cause of a foetus being born prematurely. (1)
- 3.3.6 Suggest why premature lambs rather than mice are used in the research of an artificial placenta? (2)
- 3.3.7 Suggest two ethical guidelines that the scientists should follow before using this artificial uterus technology on humans. (2)

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QUESTION 4

- 4.1 Study the infographic below that shows the timeline of the early ideas of the theory of evolution and answer the questions that follow.



[Adapted: <media.nationalgeographic.org> and <https://openlibrary.org>]

- 4.1.1 Provide the names of the following biologists:

- (a) He suggested that evolution occurred by the inheritance of acquired traits. (1)
- (b) He is the co-discoverer, along with Charles Darwin, of the theory of natural selection. (1)

- 4.1.2 The ideas of evolution by Charles Darwin and other biologists were severely challenged at that time in history. Discuss reasons why people challenged their ideas. (4)

- 4.1.3 How does fossil evidence support the theory of evolution? (2)

- 4.2 Read the information below and use this information and your own knowledge to answer the questions that follow:

Honeybees are one of the largest group of pollinators of clover flowers and are important in clover seed production. Clover plants provide feed for livestock and help maintain soil fertility.

The size of the clover flower determines the type of pollination. Honeybees easily access pollen on large clover flowers, but it is difficult to do so on small clover flowers. Therefore, plants with large clover flowers are readily cross-pollinated by bees and very rarely self-pollinate.

Experiments where clover flowers were grown in a closed greenhouse (so bees could not get to the flowers) showed that only plants with small flowers produce seeds and very few seeds were formed. However, clover flowers grown in a greenhouse where bees did enter, produced many seeds.

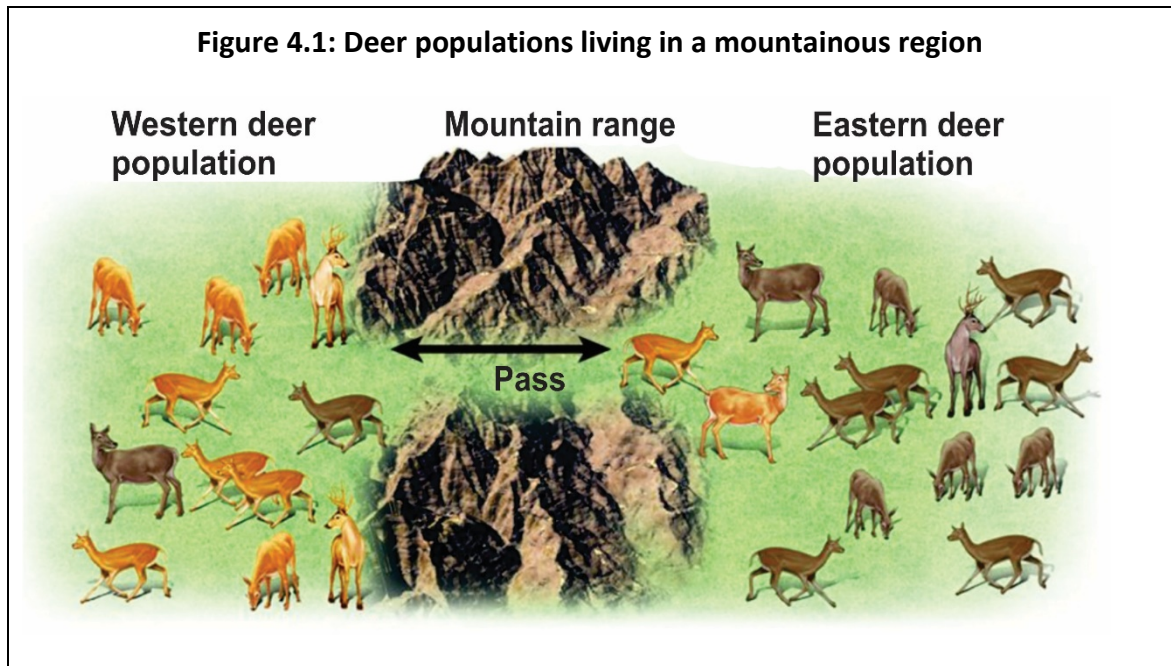
After 15 generations of growing the plants in the two greenhouses, biologists noted the following for the closed greenhouse:

- 50% of the plants were able to self-fertilise and produce seed compared to 7% at the start of the experiment.
- All the flowers were significantly smaller compared to the flowers of the plants in the open greenhouse. The smaller flower size promoted for self-pollination in the absence of bees.

[Adapted: <<https://www.far.org.nz>>]

- 4.2.1 What is meant by the term cross-pollination? (2)
- 4.2.2 Describe one characteristic of a flower that would encourage pollination by bees. (1)
- 4.2.3 Why is the pollination of plants by bees important to farmers and food production? (4)
- 4.2.4 Draw a diagram of a flower showing only the male (stamen) and female (carpel/pistil) parts.
Provide at least three labels.
You do not need to include a heading for your diagram. (4)
- 4.2.5 Name the part of the flower that forms the seed. (1)
- 4.2.6 Using the example of clover plants grown in the closed greenhouse, explain how the experiment demonstrates the mechanism of Darwin's theory of natural selection. (4)
- 4.2.7 Is this an example of microevolution or macroevolution? Give a reason for your answer. (2)

- 4.3 Figure 4.1 below shows two populations of deer that live in a mountainous location. Study the image and answer the questions that follow.



[Adapted: <<https://socratic.org>>]

- 4.3.1 Explain what is meant by the phrase, 'gene flow exists between the western deer population and the eastern deer population'. (2)
- 4.3.2 Both populations of deer belong to the same species. Describe a breeding experiment that biologists could perform to confirm this. (3)
- 4.3.3 Competition occurs amongst individuals in the western deer population.
- Name the type of competition that occurs between the members of the western deer population. (1)
 - List TWO factors for which the western deer would compete. (2)
- 4.3.4 Biologists predict that due to climate change, the pass on the mountain range will be permanently covered in snow and this will prevent movement of individuals between the two populations.
- Provide the biological term used to describe the movement of individuals between two populations? (1)
 - Describe the type of speciation that would occur as a result of the mountain range pass becoming permanently covered in snow. (5)

[40]

Total: 200 marks