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Other names

**Pearson
Edexcel GCE**

Centre Number

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Candidate Number

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Biology

Advanced Subsidiary

Unit 2: Development, Plants and the Environment

Monday 1 June 2015 – Afternoon

Time: 1 hour 30 minutes

Paper Reference

6BI02/01

You do not need any other materials.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
– *there may be more space than you need.*

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
– *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
– *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- Candidates may use a calculator.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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PEARSON

Answer ALL questions.

Some questions must be answered with a cross ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

1 The details of the ultrastructure of a cell can be seen using an electron microscope.

(a) Complete the table below. If the organelle can be present, place a tick (✓) in the box and if the organelle could not be present, place a cross (✗) in the box.

(4)

Organelles	Prokaryotic cell	Eukaryotic cell
centrioles		
flagella		
Golgi apparatus		
ribosomes		

(b) Place a cross ☐ in the box next to the correct word or words to complete each of the following statements.

(i) Plant and animal cells may both contain

(1)

- ☐ **A** amyloplasts, centrioles and mitochondria
- ☐ **B** centrioles, mitochondria and rough endoplasmic reticulum
- ☐ **C** chloroplasts, mitochondria and rough endoplasmic reticulum
- ☐ **D** mitochondria, rough endoplasmic reticulum and smooth endoplasmic reticulum

(ii) The cytoplasmic connections between one plant cell and another are known as

(1)

- ☐ **A** middle lamellae
- ☐ **B** plasmodesmata
- ☐ **C** pits
- ☐ **D** tonoplasts



(iii) Prokaryotic cells and plant cells both contain

(1)

- ☐ **A** a cell membrane and chloroplasts
- ☐ **B** a cell membrane and mesosomes
- ☐ **C** a cell wall and chloroplasts
- ☐ **D** a cell wall and ribosomes

(iv) Woese suggested that there are three domains based on evidence from

(1)

- ☐ **A** molecular pharmacology
- ☐ **B** molecular phylogeny
- ☐ **C** molecular physiology
- ☐ **D** phenetic taxonomy

(v) The two domains that contain prokaryotic cells are

(1)

- ☐ **A** Animalia and Bacteria
- ☐ **B** Archaea and Bacteria
- ☐ **C** Bacteria and Eukarya
- ☐ **D** Bacteria and Plantae

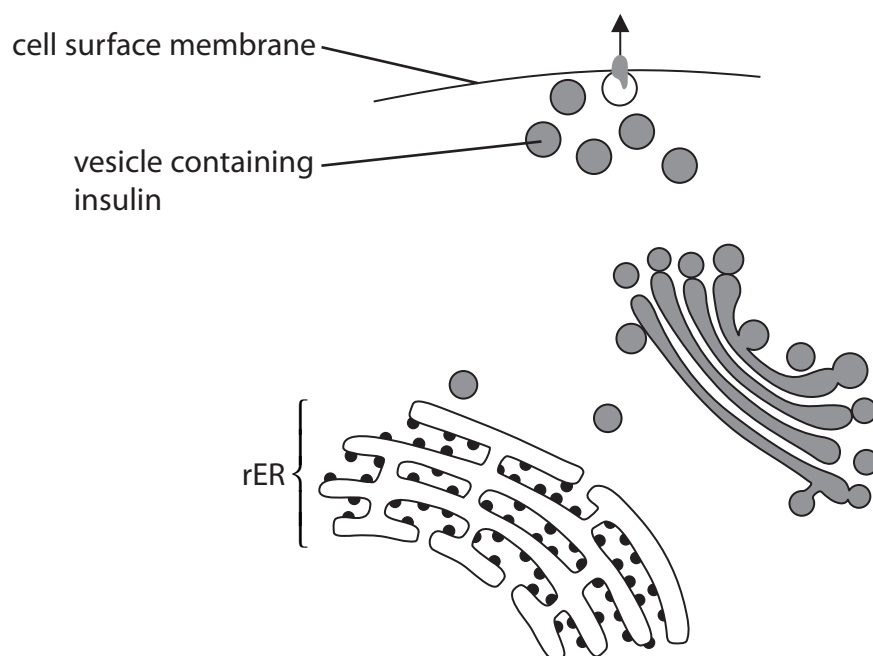
(Total for Question 1 = 9 marks)



P 4 5 0 6 8 A 0 3 2 8

- 2 Insulin is a protein produced by beta cells in the pancreas. Insulin is synthesised on ribosomes, then modified and packaged in vesicles. It is stored in these vesicles until it is secreted.

The diagram below shows the organelles involved in this process of modifying and packaging the insulin in vesicles.



- *(a) Using the information in the diagram, describe how insulin is modified, packaged and secreted by the cell.

(4)

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(b) Type 1 diabetes occurs when beta cells in the pancreas do not produce insulin.

Stem cells produced from skin cells can be used to replace these beta cells in mice. The skin cells can be stimulated to become pluripotent stem cells.

(i) Place a cross ☒ in the box next to the correct definition to complete the following statement.

Pluripotent stem cells are

(1)

- ☒ **A** specialised cells that can differentiate to give rise to almost any type of cell in the body, including totipotent cells
- ☒ **B** specialised cells that can differentiate to give rise to any type of cell in the body, excluding totipotent cells
- ☒ **C** unspecialised cells that can differentiate to give rise to almost any type of cell in the body, excluding totipotent cells
- ☒ **D** unspecialised cells that can differentiate to give rise to any type of cell in the body, including totipotent cells

(ii) The pluripotent stem cells were injected into the mice. After eight weeks, these cells had developed into insulin-secreting beta cells.

Describe how these pluripotent stem cells became specialised beta cells.

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(Total for Question 2 = 9 marks)



- 3 Infertility reduces the chance of successful fertilisation of the egg by a sperm cell. There are many causes of infertility in humans.

One cause of infertility is cigarette smoking. Men who smoke cigarettes have a 30% higher risk of infertility.

Cigarette smoke contains nicotine. The effects of nicotine on the quality of sperm cells have been studied in rats.

Male rats were given nicotine at levels of either 0.5 mg per kg of body mass or 1.0 mg per kg of body mass.

The sperm cells produced by these rats were compared with sperm cells produced by a control group of rats. The rats in the control group were not exposed to nicotine. The defects in the sperm cells produced were recorded and the results are shown in the table below.

Type of sperm cell	Percentage of each type of sperm cell (%)		
	Control	0.5 mg of nicotine per kg	1.0 mg of nicotine per kg
normal sperm cells	93.6	83.2	75.2
sperm cells with flagella defects	3.9		19.9
sperm cells with mid-piece defects	2.0	2.7	3.7
other defects, including missing heads	0.5	1.0	1.2

- (a) (i) Complete the table to give the percentage of sperm cells with flagella defects when the rats were given 0.5 mg of nicotine per kg of body mass.

(1)



(ii) Using the information in the table, calculate the difference in the percentage of sperm cells with defective flagella in rats given 1.0 mg of nicotine per kg of body mass compared with the control group.

(1)

.....%

(iii) Name the organelle that may be missing from the sperm cells with mid-piece defects.

(1)

(iv) Using the information in the table, suggest why nicotine reduces the movement of the sperm cells.

(4)

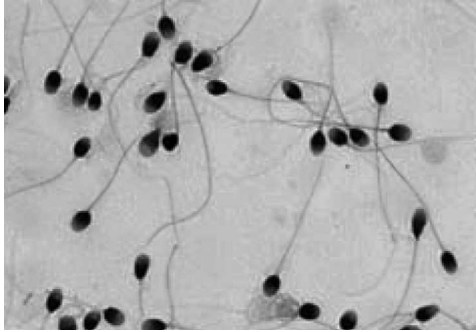


P 4 5 0 6 8 A 0 7 2 8

(b) A genetic cause of infertility is globozoospermia.

This condition results in round-headed sperm cells being produced. These sperm cells do not possess an acrosome.

Photograph **A** shows normal sperm cells and photograph **B** shows sperm cells from a man with globozoospermia.



A



B

Magnification $\times 500$

Suggest why the sperm cells in photograph **B** would not be able to fertilise an egg.

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(c) Suggest why a valid study on the effects of globozoospermia on fertility would have to be carried out on non-smokers.

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(Total for Question 3 = 13 marks)





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4 Almond trees can be grown from shoot tips using a tissue culture technique.

This involves removing explants (small pieces of plant tissue) from the shoot tips of adult plants. The explants are placed on a growth medium, such as agar. The explants develop roots and shoots as they grow into new plants.

Tissue culture techniques have to be carried out under conditions that prevent contamination of the explants.

(a) (i) Describe how contamination of a tissue culture is avoided.

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(ii) Explain why contamination of tissue cultures has to be avoided.

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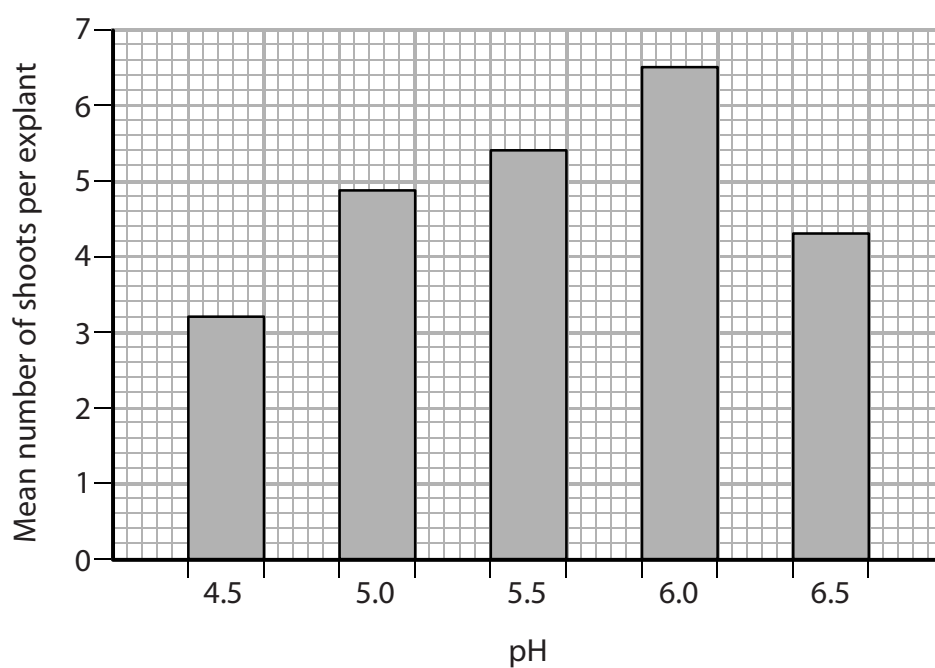
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(b) Explants of almond plant shoot tips were grown using tissue culture techniques.

The effect of pH on the development of shoots from the explants was investigated.

The graph below shows the effects of pH on the number of shoots that developed from each explant.



- (i) Give **two** environmental factors that would have to be controlled when investigating the effect of pH on the development of shoots from the explants.

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(ii) Using the information in the graph, explain the effect of pH on the development of shoots from explants of almond trees.

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(Total for Question 4 = 9 marks)



5 The biodiversity of species in Costa Rica is one of the highest in the world.

Costa Rica represents 0.3% of the Earth's total land area. It has 4% of all identified species of living organisms. Many of these species live in the rainforests of this country.

(a) (i) Explain what is meant by the term **biodiversity**.

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(ii) Describe how the species richness of the rainforests in Costa Rica could be measured.

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(b) A study was carried out to investigate the antimicrobial properties of plants found in Costa Rica. The species tested are all used in traditional medicine.

Nine of the species tested showed antimicrobial properties and six of these species are found only in the rainforest.

(i) Suggest why the results of this investigation support the need to maintain biodiversity.

(2)

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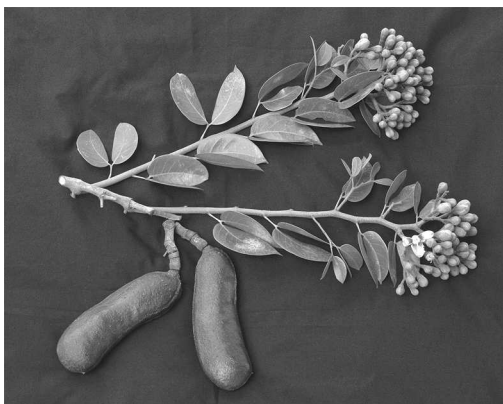
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*(ii) The species tested included the Jatobá plant, *Hymenaea courbaril*.

The photograph shows leaves, flowers and seed pods of the Jatobá plant.



©Smithsonian Tropical Research Institute

Magnification $\times 0.3$

Describe how the antimicrobial properties of the seeds of the Jatobá plant could be tested.

(5)

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(iii) Some of the plants tested could be used to develop new drugs to treat diseases caused by bacteria.

Before these drugs could be approved for use, they would have to be tested on animals and healthy volunteers.

Suggest why these drugs would have to be tested on animals and healthy volunteers.

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(Total for Question 5 = 12 marks)



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- 6 The photograph below shows part of a cellulose cell wall, as seen using an electron microscope.



© Biophoto Associates/Science Photo Library

Magnification $\times 70\,000$

- (a) Using the information in the photograph and your own knowledge, describe the structure of a cellulose cell wall.

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(b) Cellulose can be used to produce biofuel. The xylem tissue in wood is a good source of cellulose. The cell walls of this tissue are heavily lignified.

(i) Explain what is meant by the term **tissue**.

(2)

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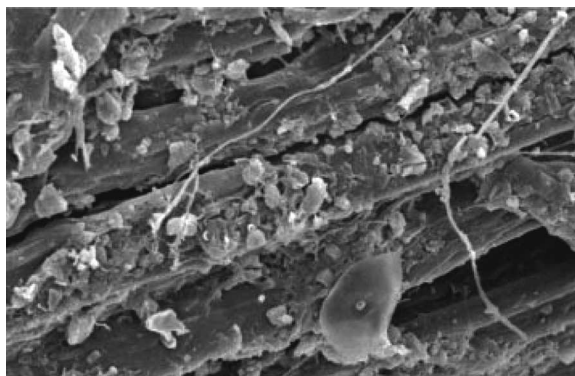
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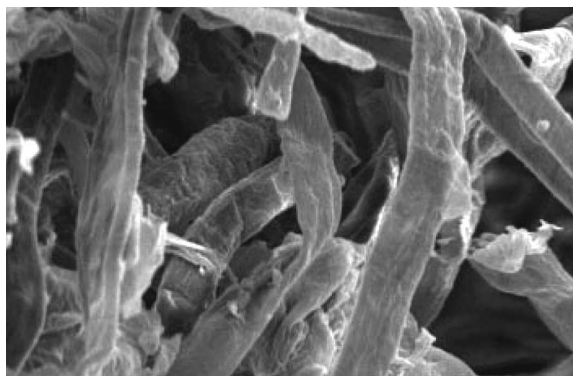
(ii) The cellulose in the xylem tissue of wood has to be broken down by enzymes before it can be used to produce biofuels.

The lignin has to be removed before the enzymes can be used to break down the cellulose.

The photographs below show fibres containing cellulose before and after the removal of lignin.



Before removal of lignin



After removal of lignin

Source: SciELO

Magnification $\times 500$

Using the information from the photographs, suggest how lignin adds strength to xylem tissue.

(2)

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(c) Mineral ions such as calcium, nitrate and magnesium are transported in the xylem vessels. These mineral ions are dissolved in water.

(i) Describe how the structure of xylem vessels allows them to transport water.

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(ii) Explain how calcium, nitrate and magnesium ions are used by plants.

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(Total for Question 6 = 12 marks)



- 7 The finches of the Galapagos Islands have different shaped beaks to feed on different food sources.

The photograph below shows one of these finches, the medium ground finch, *Geospiza fortis*. The medium ground finch has a deep beak that enables it to crush seeds.

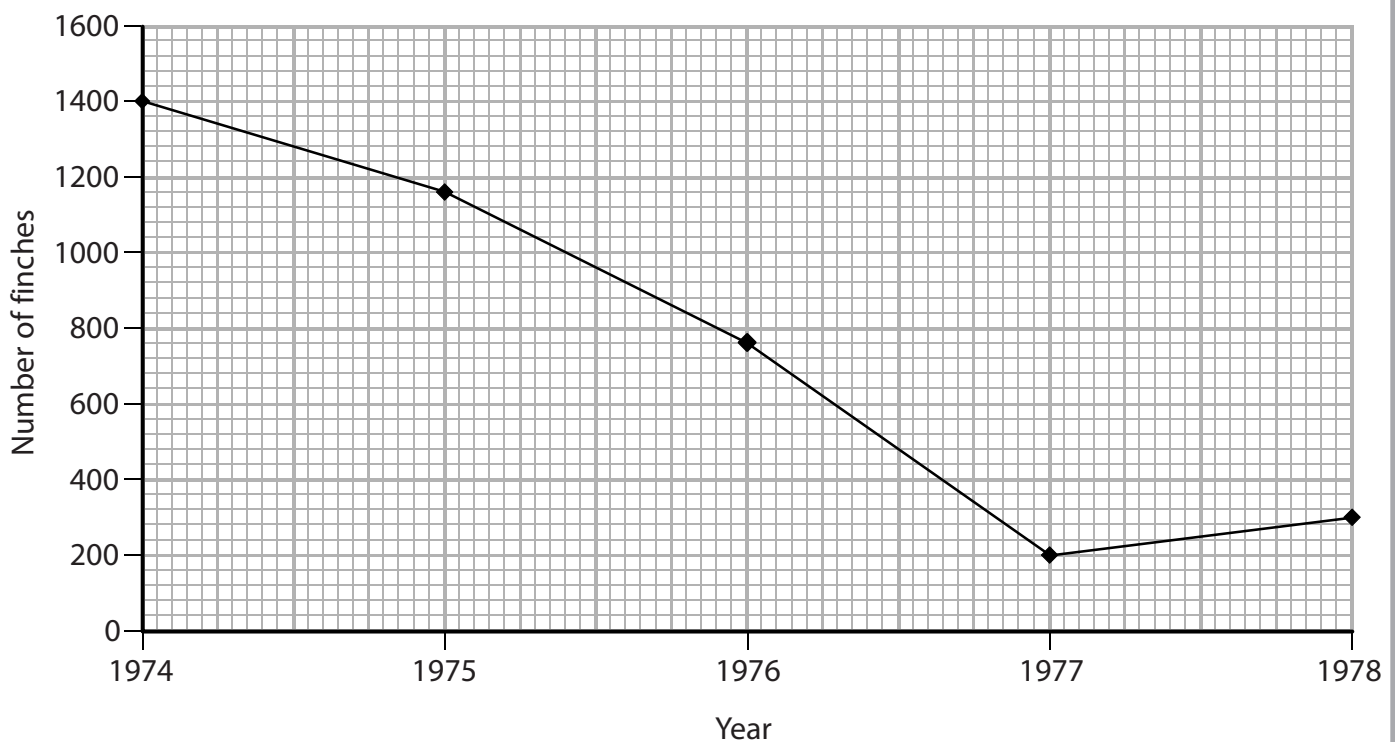


© Greg Lasley

Magnification $\times 0.5$

In the 1970s, there was a severe drought on the Galapagos Islands. This caused a decrease in the production of the seeds eaten by this finch.

The graph below shows the number of medium ground finches, on one of the Galapagos islands, from 1974 to 1978.



P 4 5 0 6 8 A 0 2 1 2 8

(a) Place a cross ☒ in the box next to the correct word or words to complete each of the following statements.

(i) The deep beak of the medium ground finch is an example of

(1)

- ☐ **A** anatomical adaptation
- ☐ **B** behavioural adaptation
- ☐ **C** physiological adaptation
- ☐ **D** selective adaptation

(ii) The number of medium ground finches fell most rapidly from

(1)

- ☐ **A** 1974 to 1975
- ☐ **B** 1975 to 1976
- ☐ **C** 1976 to 1977
- ☐ **D** 1977 to 1978

(b) Medium ground finches have a range of beak sizes.

Suggest an explanation for the variation in beak sizes in medium ground finches.

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- (c) One of the few plants that survived during the drought produces seeds in large, tough fruits. These are very difficult to eat for birds with small beaks.

Sampling the birds that survived and those that died provided the data shown in the table below.

Mean beak size / mm	Dead birds	Survivors
length	10.69	11.07
depth	9.42	9.96

As the population of the medium ground finches recovered, the mean beak size of the offspring increased.

Using the information in the table, suggest how this increase in mean beak size was brought about by natural selection.

(4)

This image shows a blank sheet of white paper with ten horizontal dashed lines spaced evenly apart, resembling notebook paper. The lines are thin and grey, extending across the full width of the page. There is no text or other markings on the paper.

(Total for Question 7 = 8 marks)



- 8** In 2014 at Longleat Safari Park, a decision was made to humanely kill a female lion and four of her cubs. These lions showed violent and aggressive behaviour to other lions.

These lions had serious genetic defects caused by inbreeding.

- (a) (i) Suggest how inbreeding could have led to genetic defects in these lions.

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(ii) Describe how breeding programmes at zoos are designed to reduce the risk of inbreeding.

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- (b) When the female lion was first brought to Longleat Safari Park, the zookeepers noted symptoms including tremors, uncoordinated movements and aggressive behaviour.

It was thought that these problems were due to a poor diet when she was younger.

Her cubs were given a better diet at Longleat but they had the same symptoms as their mother.

Suggest what could have been the main cause of the problems in these lions.
Give a reason for your answer.

(2)

(Total for Question 8 = 8 marks)

TOTAL FOR PAPER = 80 MARKS



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