Cambridge Pre-U

Cambridge International Examinations
Cambridge Pre-U Certificate

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1483570127

BIOLOGY **9790/02**

Paper 2 Long Answer **May/June 2014**

2 hours 45 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section B
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section C
Answer **one** question.
Write your answer on the Question Paper. Separate answer paper will be available if required.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
Section B	
7	
8	
9	
Total	

This document consists of **26** printed pages and **2** blank pages.

CAMBRIDGE International Examinations

Section A

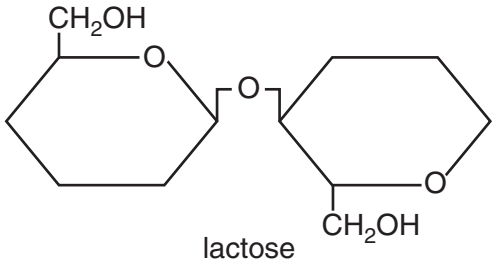
Answer **all** the questions.

You are advised to spend no more than 65 minutes on this section.

Data Analysis

1 Lactose is a disaccharide found in cow's milk. Some people become lactose intolerant because they cease to produce enough of the enzyme lactase. Lactase digests lactose to glucose and galactose.

(a) Complete Fig. 1.1 to show how lactose is broken down into glucose and galactose by the enzyme lactase.



lactose

lactase

Fig. 1.1

[3]

(b) Lactose-intolerant people suffer from severe discomfort, including diarrhoea, when they drink cow's milk or eat dairy products.

Fig. 1.2 shows the results of an investigation comparing:

- the effects on 50 lactose-intolerant volunteers of drinking normal cow's milk
- the effects on the same 50 lactose-intolerant volunteers of drinking low lactose cow's milk
- the effects on a control group of 15 volunteers, who were not lactose intolerant, of drinking normal cow's milk.

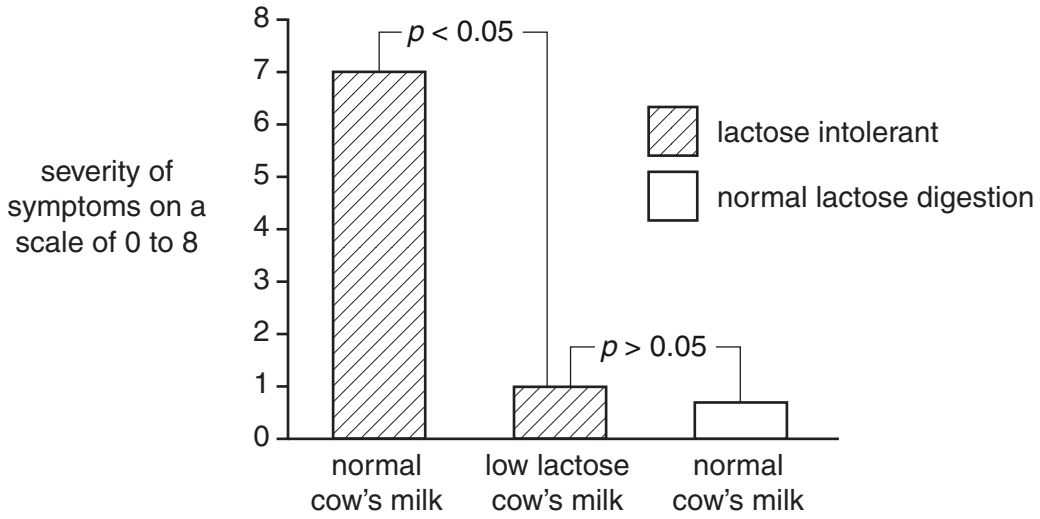


Fig. 1.2

(i) With reference to the probability values shown in Fig. 1.2, comment on the results of this investigation.

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(ii) Discuss the limitations of this investigation.

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(c) Immobilised lactase can be used commercially to produce low lactose cow's milk from normal cow's milk for people who are lactose intolerant.

Discuss the advantages of using immobilised lactase rather than lactase that is not immobilised.

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[Total: 13]

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2 Many individuals of a large number of different mammal species living in northern North America were weighed and the mean mass of each mammal species was calculated.

Fig. 2.1 shows the relationship between the mean mass of different mammal species and the mean annual temperature of the habitat in which they normally live.

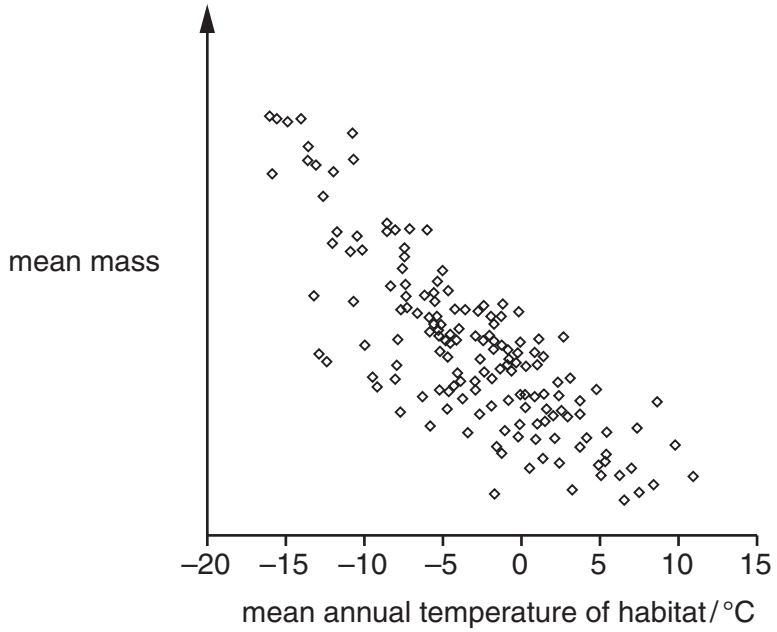

Fig. 2.1

(a) Discuss the relationship between the mean mass of mammal species and the mean annual temperature of their habitat shown in Fig. 2.1.

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(b) Dragonflies today rarely have a wingspan greater than 120 mm. However, 300 million years ago there were dragonflies with wingspans of more than 850 mm. The reason that dragonflies were much larger 300 million years ago is thought to be related to evidence that the oxygen concentration of the atmosphere was 50% higher than it is today.

(i) Describe briefly the ventilation mechanism of insects such as dragonflies.

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(ii) Suggest why the difference in oxygen concentration of the atmosphere might account for the difference in size of the dragonflies, from 300 million years ago to the present day.

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[Total: 11]

3 Fig. 3.1 shows the nucleotide base sequence of a length of DNA from the gene coding for a cytochrome from a modern human, *Homo sapiens*, and the corresponding base sequences from a Neanderthal and four other primate species.

Neanderthals were human or human-like animals that became extinct about 30 000 years ago and are known only from fossil remains. Chimpanzee, orangutan and gorilla are species of ape, whilst the macaque is a type of monkey.

modern human	ATGACCCCAATACGCAAAATTAACCCCCTAATAAAATTAATTAACCACTCA
Neanderthal	ATGACCCCAATACGCAAAATTAACCCCCTAATAAAATTAATTAACCACTCA
chimpanzee	ATGACCCCAACACGCAAAATTAACCCCCTAATAAAATTAATTAATCACTCA
orangutan	ATGACCTCAACACGTAAAATCAACCCCCTAATAAAATTAATCAACCACTCA
gorilla	ATGACCCCTATACGCAAAACTAACCCCCTAACAAAACTAATTAACCACTCA
macaque	ATGACTCCAATACGCAAATCCAACCCACTAACAAAAATAATTAATCGCTCC

Fig. 3.1

(a) Name the bases represented by the letters A, G, C and T in Fig. 3.1.

A ..... G .....

C ..... T .....

[1]

(b) Sometimes it is possible to obtain small quantities of DNA from fossils.

Name the technique that is used to provide multiple copies of such DNA molecules for analysis.

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(c) The scientific name for the Neanderthal is considered to be either *Homo sapiens* or *Homo neanderthalensis*.

A scientist considers that *Homo sapiens* is the correct name to use.

State the assumption that the scientist is making and explain why it is difficult to confirm this assumption.

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(d) Suggest what the data in Fig. 3.1 indicate about the evolutionary relationships between modern humans, Neanderthals and the other primate species, and explain why any such conclusions need to be treated with caution.

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(e) Suggest how the differences in the nucleotide sequences shown in Fig. 3.1 may have come about.

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[Total: 14]

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The Planning Task

4 Old limestone pasture is a grassland habitat noted for its high biodiversity, with many species of insects and small flowering plants, some of which are rare.

This pasture has been used for grazing cattle and sheep for several thousand years. Grazing suppresses the growth of scrub, keeping the habitat open and providing plenty of light to maintain the numerous small plant species. Sheep do not eat prickly shrubs but they do eat their seedlings. More recently, less grazing has led to increased growth of scrub consisting of brambles and hawthorn, leading to a reduction in plant and insect biodiversity.

The few old limestone pasture sites that remain are now often protected as nature reserves. Such reserves are managed either by regular mowing of the pasture or by maintaining sheep in sufficient numbers to suppress the growth of scrub without overgrazing.

Plan an investigation to find out which management procedure, mowing or controlled sheep grazing, is the more effective at maintaining plant biodiversity on old limestone pasture.

You are provided with the following equipment and resources. Choose your equipment from this list. You may **not** use any additional equipment.

- 0.25 × 0.25, 0.5 × 0.5 and 1.0 × 1.0 m quadrat frames
- point quadrats
- 50 m measuring tapes
- identification keys for plant species
- table for generating random numbers
- sheep
- unlimited supply of sheep-proof fencing
- GPS locating devices
- heavy duty mowers
- unlimited supply of marker pegs
- mallet
- appropriate protective clothing

Your plan should:

- include a clear statement of the hypothesis or prediction
- explain the rationale for your hypothesis or prediction
- identify the key variables
- give full details and explanations of the procedures that you would adopt to ensure that the results are as precise and repeatable as possible
- show how you would present and analyse your results
- include a brief risk assessment
- be written in clear scientific language.

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[Total: 22]

[Total for Section A: 60]

Section B

Read the passages carefully and answer **all** the questions.

You are advised to spend no more than 50 minutes on this section.

Stomata: enabling plants to respond to environmental change

5 The olive tree, *Olea europaea*, is a small tree native to the Mediterranean area of Europe, Africa and parts of Asia, where it has been cultivated for several thousand years. In 1993, Beerling and Chaloner carried out estimates of stomatal density on preserved olive leaves. The oldest of these were obtained from the tomb of the Egyptian King Tutankhamun who died over 3000 years ago. The results of the study are summarised in Fig. 5.1.

The error bars show the standard errors.

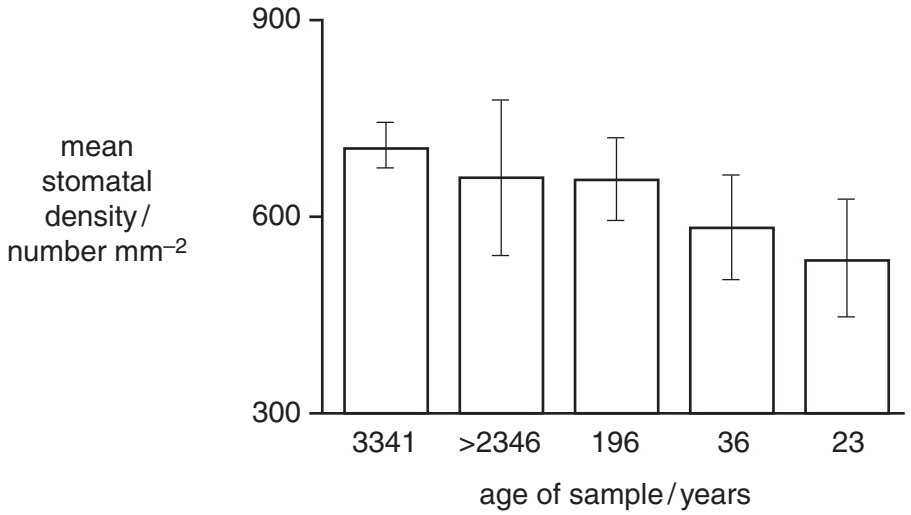

Fig. 5.1

(a) Describe the results shown by the data in Fig. 5.1 and explain why it is difficult to reach a valid conclusion about changes in stomatal density over time.

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(b) It has been suggested that the changes in stomatal density shown in Fig. 5.1 might be caused by global warming.

Fig. 5.2 shows the results of an investigation into the effect of temperature on the stomatal density of oak leaves.

The error bars show the standard errors.

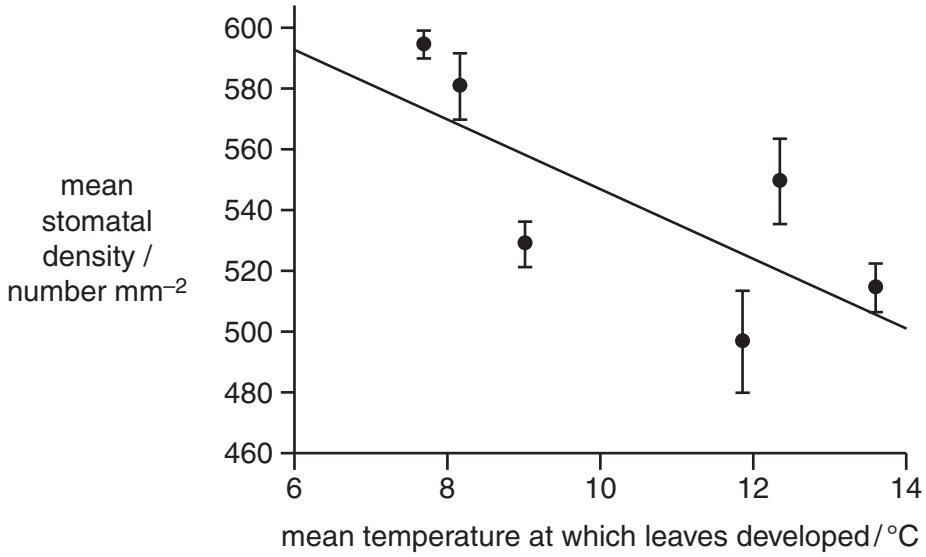

Fig. 5.2

(i) Do the data support the hypothesis that increasing the temperature at which the leaves develop results in a decrease in stomatal density?

Give reasons for your answer.

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(ii) Suggest one advantage and one disadvantage to an oak tree of responding to temperature in this way.

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(c) It has also been suggested that the changes in stomatal density shown in Fig. 5.1 might be caused by changes in carbon dioxide concentration in the atmosphere.

Some individuals from 43 different species of plant from a range of habitats were grown at normal atmospheric carbon dioxide concentration. Other individuals of the same species were grown at an increased carbon dioxide concentration.

The mean stomatal density of each species was determined at both concentrations of carbon dioxide. The percentage change in stomatal density at the increased carbon dioxide concentration compared to the stomatal density at normal atmospheric carbon dioxide concentration was calculated for each species.

Table 5.1 summarises the changes to mean stomatal density due to increased atmospheric carbon dioxide concentration for the species investigated.

Table 5.1

percentage change in stomatal density (to the nearest 10%)	number of species
+40	2
+30	2
+20	4
+10	2
0	7
–10	7
–20	9
–30	7
–40	2
–50	0
–60	1

(i) Identify the modal value of the percentage change in stomatal density for these data.

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(ii) Suggest explanations for the different responses to increased carbon dioxide concentration shown in Table 5.1.

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6 **(a)** Describe the mechanism that results in the opening of stomata at dawn.

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(b) Guard cells, unlike most leaf cells, are not connected to other cells by plasmodesmata. A plasmodesma is a thin strand of cytoplasm that connects the cytoplasm of one plant cell to that of another through a hole in the cell walls between them.

Suggest why the lack of such intercellular connections is important to ensure the optimal working of the stomatal opening mechanism.

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(c) By the time that a plant bud opens, the new leaves already have all the stomata they will ever have.

During the formation of the bud, meristem mother cells in the outer layer divide repeatedly. Many of these divisions produce two equally sized cells, which develop into ordinary leaf epidermal cells. Sometimes, however, divisions produce two unequally sized cells, of which one becomes an ordinary epidermal cell and the other becomes a guard mother cell. The guard mother cell divides to produce two guard cells with a stoma between them. The process is illustrated in Fig. 6.1.

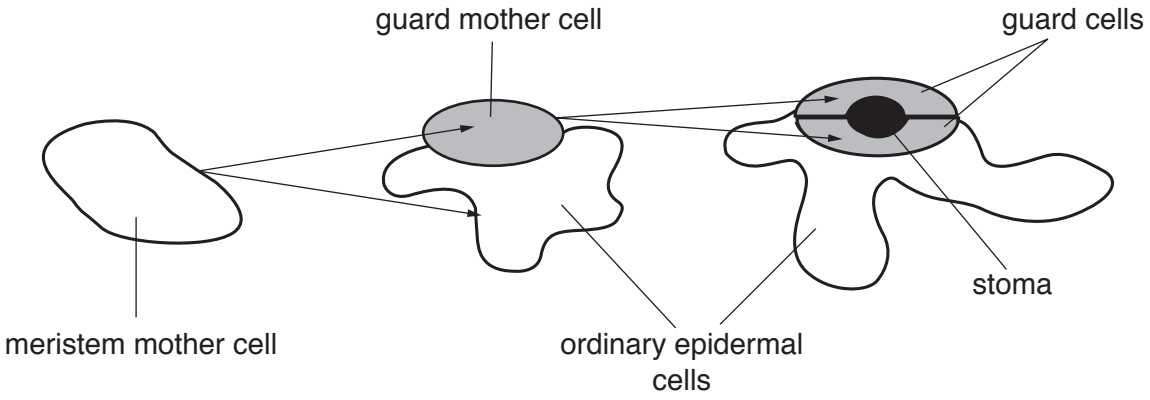

Fig. 6.1

(i) State why, as a bud opens and the new leaves expand, the stomatal density decreases.

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(ii) Brassinosteroids are signalling molecules that promote cell division and cell expansion in many species of plant.

In a research project, mutant plants of one such species that were unable to produce brassinosteroids developed few, if any, stomata when compared with normal plants of the same species. When the mutant plants were treated with brassinosteroids there was an increase in the number of stomata per leaf.

The same plant species normally produces a transcription blocking factor known as TMM. When TMM is not produced, over-production of stomata may result.

Use this information to suggest, in outline, the stages of a possible mechanism by which the carbon dioxide concentration of the atmosphere could increase stomatal density during leaf development in this plant species.

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(d) Gibberellins are another group of signalling molecules. Describe how gibberellins stimulate stem elongation in flowering plants.

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[Total: 14]

[Total for Section B: 30]

Section C

Answer **one** question on the lined paper that follows.

Credit will be given for answers that draw from a wide range of syllabus material and also for evidence of reading around the subject.

You are advised to spend no more than 50 minutes on this section.

7 Contrast the social behaviour of the dunnock, the red deer and a named primate. Discuss the selective advantages of each type of behaviour and the extent to which you consider these patterns of behaviour to be innate.

8 Describe and explain examples of directional, stabilising and disruptive selection. Suggest which types of selection might contribute to the emergence and subsequent development of a new species, and describe the circumstances under which this may take place.

9 Describe the general features of a homeostatic system, illustrating your answer by the control of blood sugar concentration and osmoregulation in the human body. Explain how a malfunction of the mechanism controlling blood sugar concentration can affect osmoregulation.

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[Total for Section C: 30]