

CANDIDATE  
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**BIOLOGY**

**9700/41**

Paper 4 A2 Structured Questions

**May/June 2014**

**2 hours**

Candidates answer on the Question Paper.

Additional Materials: Answer Paper available on request.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name in the spaces provided at the top of this page.

Write in dark blue or black pen.

You may use a pencil for any diagrams, graphs or rough working.

Do not use staples, paper clips, highlighters, glue or correction fluid.

**DO NOT WRITE IN ANY BARCODES.**

**Section A**

Answer **all** questions.

**Section B**

Answer **one** question.

Circle the number of the Section B question you have answered in the grid below.

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.

Electronic calculators may be used.

For Examiner's Use	
<b>Section A</b>	
<b>1</b>	
<b>2</b>	
<b>3</b>	
<b>4</b>	
<b>5</b>	
<b>6</b>	
<b>7</b>	
<b>8</b>	
<b>Section B</b>	
<b>9 or 10</b>	
<b>Total</b>	

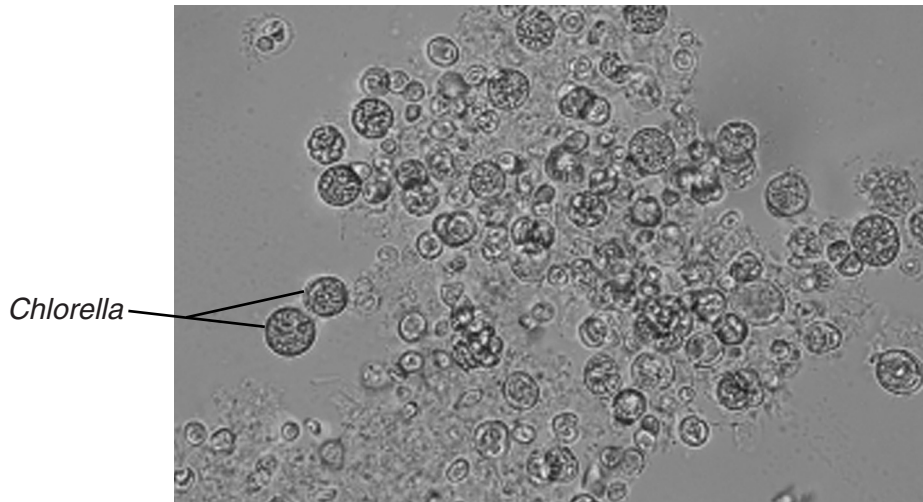
This document consists of **22** printed pages and **2** lined pages.

## Section A

Answer **all** the questions.

- 1 (a) The unicellular green alga, *Chlorella*, a photosynthetic protocist, was originally studied for its potential as a food source. Although large-scale production proved to be uneconomic, the many health benefits provided by *Chlorella* mean that it is now mass produced and harvested for use as a health food supplement.

Fig. 1.1 shows cells of *Chlorella*.

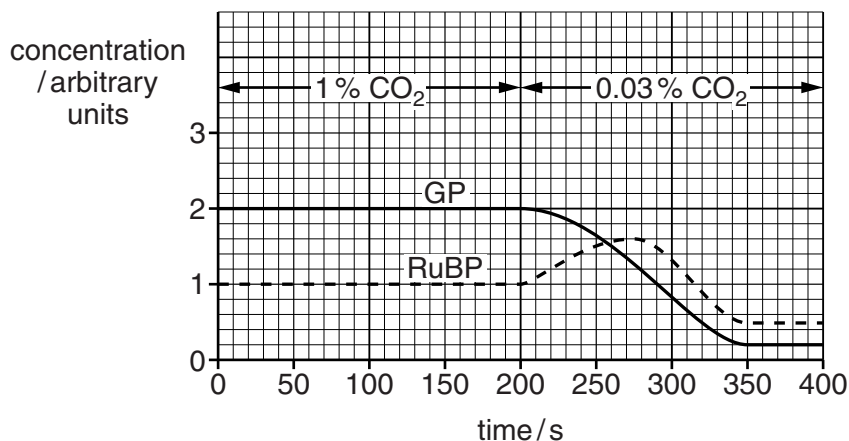


**Fig. 1.1**

In one study into the productivity of *Chlorella*, carbon dioxide concentration was altered to investigate its effects on the light-independent stage of photosynthesis.

- A cell suspension of *Chlorella* was illuminated using a bench lamp.
- The suspension was supplied with carbon dioxide at a concentration of 1% for 200 seconds.
- The concentration of carbon dioxide was then reduced to 0.03% for a further 200 seconds.
- The concentrations of RuBP and GP (PGA) were measured at regular intervals.
- Throughout the investigation the temperature of the suspension was maintained at 25°C.

The results are shown in Fig. 1.2.



**Fig. 1.2**

(i) State **precisely** where in the chloroplast RuBP and GP are located.

.....[1]

(ii) Explain why the concentration of RuBP changed between 200 and 275 seconds.

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(iii) Calculate the rate of decrease per second in the concentration of GP between 200 and 350 seconds.

Show your working and give your answer to **two decimal places**.

answer ..... arbitrary units per second [2]

(b) Explain how the decrease in the concentration of GP leads to a decreased harvest for commercial suppliers of *Chlorella*.

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[Total: 7]

- 2 Russian scientists have discovered the fruits of a flowering plant, *Silene stenophylla*, in the food store in a burrow of a ground squirrel in frozen sediments in Siberia.

Dating techniques suggest that the fruits were stored by the ground squirrel about 32 000 years ago, shortly before the ground became permanently frozen.

Tissue samples were taken from the fruits and grown in a nutrient culture medium. After treatment with plant hormones to stimulate the growth of roots and shoots, 36 complete plants were produced.

These 'regenerated' plants, which looked identical to one another, flowered and after cross-pollination, produced seeds that were able to germinate.

- (a) Explain why cross-pollination produces more genetic variation among the offspring than self-pollination.

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- (b) The flowers of modern-day *S. stenophylla* look similar, but not identical, to the flowers of the 'regenerated' plants.

Outline how DNA sequencing could be used to compare the DNA of modern-day and 'regenerated' *S. stenophylla*.

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(c) Suggest a simple experiment, using plants of modern-day and 'regenerated' *S. stenophylla* to find out whether, after 32 000 years, they are still the same species.

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..... [2]

[Total: 9]



**Question 3 continues on page 8**

- (b) In 2012, permission was granted for a field trial in the UK of genetically modified *T. aestivum*. The wheat carries a gene, taken from peppermint plants, that results in the wheat leaves releasing a volatile, non-toxic chemical, (E)- $\beta$ -farnesene (E $\beta$ f), into the atmosphere.

E $\beta$ f is not only produced by various species of plants. It is also secreted by aphids when they are disturbed by a predator.

Two experiments have been performed into the effect of E $\beta$ f on the behaviour of aphids feeding on leaves in closed containers.

#### Experiment 1

Either 10 cm<sup>3</sup> of air from a syringe that contained plant leaves that secrete E $\beta$ f  
or 10 cm<sup>3</sup> of air from a syringe with no such leaves  
was added to the containers of feeding aphids.

#### Experiment 2

Either 20 cm<sup>3</sup> of air containing 50ng of E $\beta$ f  
or 20 cm<sup>3</sup> of air containing no E $\beta$ f  
was added to the containers of feeding aphids.

In both experiments, the number of aphids that stopped feeding and moved away from the food leaves was counted. The results are shown in Table 3.1.

**Table 3.1**

air added to containers of feeding aphids	Experiment 1		Experiment 2	
	10 cm <sup>3</sup> air that had been in contact with leaves secreting E $\beta$ f	10 cm <sup>3</sup> air that had not been in contact with leaves secreting E $\beta$ f	20 cm <sup>3</sup> air containing 50ng E $\beta$ f	20 cm <sup>3</sup> air containing no E $\beta$ f
number of aphids in containers	99	113	132	106
number of aphids that stopped feeding and moved away from the food leaves	54	1	111	0











- (ii) Suggest a reason for the apparent reduction in the percentage of elongated cells between 24 hours and 48 hours in some of the samples.

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- (iii) Suggest why the culture medium was maintained at a temperature of 30 °C, and not at core body temperature (37 °C).

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[Total: 16]

- 5 Deer mice, *Peromyscus maniculatus*, are small rodents that live in North America. Like all mammals, their blood contains haemoglobin which combines with oxygen in the lungs, and unloads its oxygen in respiring tissues.

Deer mice show variation in their genotypes for the genes that code for the  $\alpha$ -polypeptide chain of haemoglobin. In most populations of deer mice, the majority of individuals have the genotype  $A^1A^1$ , while a smaller number have the genotype  $A^0A^0$ .

- (a) In mice with the genotype  $A^1A^1$ , the amino acid at position 64 in the  $\alpha$ -polypeptide chain is aspartic acid. In mice with the genotype  $A^0A^0$ , the amino acid at this position is glycine.

Suggest how the change from aspartic acid to glycine in the  $\alpha$ -polypeptide chain could have been brought about.

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- (b) The genotypes of deer mice from three different populations, each living at a different altitude, were analysed. Fig. 5.1 shows the relative proportions of deer mice with aspartic acid (white areas) and glycine (black areas) at position 64 in the  $\alpha$ -polypeptide of their haemoglobin.

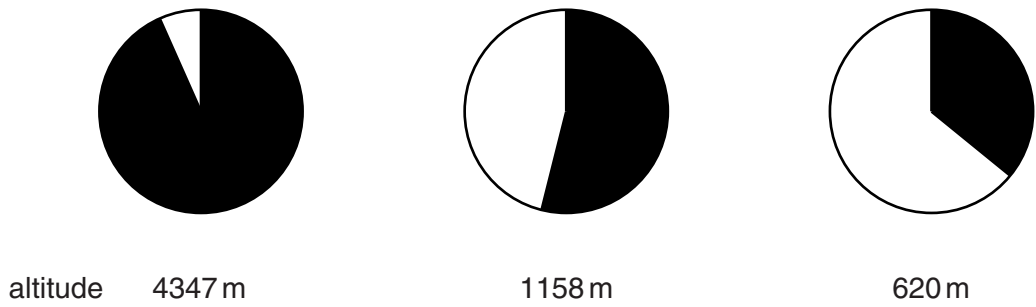


Fig. 5.1

- (i) Describe the effect of altitude on the frequency of the haemoglobin alleles in these populations of deer mice.

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- (ii) The partial pressure of oxygen is relatively low at high altitudes. Haemoglobin containing glycine at position 64 in the  $\alpha$ -polypeptide chain has a higher affinity for oxygen than haemoglobin with aspartic acid at this position.

Suggest how natural selection could account for the difference in allele frequency in deer mice living at high altitudes and low altitudes.

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[Total: 8]





**Question 7 starts on page 18**

- 7 Occasionally during meiosis, homologous chromosomes fail to separate at anaphase. This is known as non-disjunction. Turner's syndrome is the most common chromosome mutation in human females. It can occur due to non-disjunction in meiosis during gametogenesis. Some resulting gametes will be missing an X chromosome.

Some forms of Turner's syndrome occur when one of the pair of X chromosomes is not missing but has become damaged. The damaged X chromosome may have been broken and re-formed so that part of its structure is lost.

Fig. 7.1 is a diagram of a normal X chromosome and two forms of 'damaged' X chromosomes,  $X_1$  and  $X_2$ .

- In  $X_1$ , a section of the 'p' arm of the chromosome is missing. This deletion leads to reduced height of the female and abnormalities such as narrowing of the aorta.
- In  $X_2$ , a section of the 'q' arm of the chromosome is missing. This deletion leads to little or no development of the ovaries.

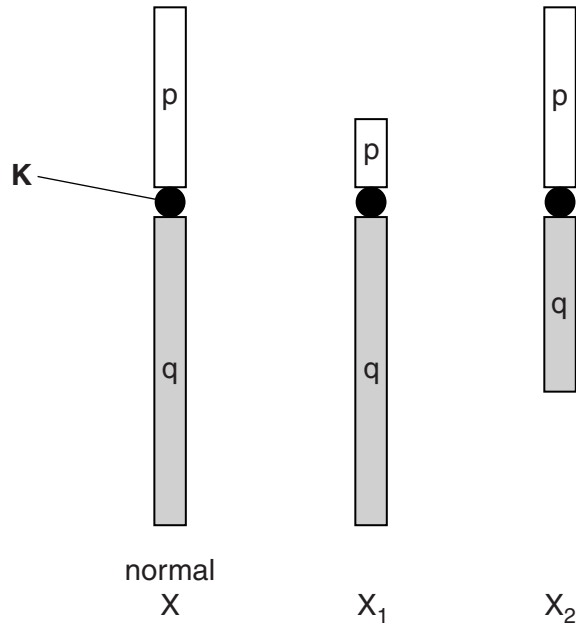


Fig. 7.1

(a) Name structure K.

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