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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

3703133241

BIOLOGY **9700/41**

Paper 4 Structured Questions A2 Core **October/November 2009**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

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.
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.

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1	
2	
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5	
6	
7	
8	
Section B	
9 or 10	
Total	

This document consists of **19** printed pages, **4** lined pages and **1** blank page.

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Section A

Answer **all** the questions.

1 **(a)** The squirrel monkey, *Saimiri sciureus*, of Costa Rica has become an endangered species.

Fig. 1.1 shows a squirrel monkey.



Fig. 1.1

Explain what is meant by the term *endangered species*.

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(b) Discuss possible ways in which the squirrel monkey could be protected.

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[Total: 6]

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2 **(a)** *Asellus aquaticus* is a small freshwater crustacean.

200 *A. aquaticus* were released into a pond where there had previously been none. The pond was favourable for their growth and reproduction.

Describe **and** explain the expected changes in the population size of *A. aquaticus* over the following few months.

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(b) In order for natural selection to occur a population must show phenotypic variation.

Explain why variation is important in natural selection.

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[Total: 7]

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3 Proteases that work in alkaline conditions are made in large quantities for use in the detergent industry. The microorganism that is generally used for this is the bacterium *Bacillus subtilis*.

An investigation was carried out to compare three potential production methods:

- using free cells of *B. subtilis*
- using *B. subtilis* cells immobilised in cubes of agar
- using *B. subtilis* cells immobilised in beads of sodium alginate.

To immobilise the cells in agar, the agar was dissolved and cooled. A suspension of *B. subtilis* was then added. The agar-bacterium mixture was poured into sterile dishes and allowed to solidify. It was then cut into cubes with sides of 2 mm.

(a) (i) Explain why the agar was cooled before the suspension of *B. subtilis* was added.

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(ii) Describe how cells of *B. subtilis* could be immobilised in beads of alginate.

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(b) A liquid medium containing glucose, a nitrogen source and various mineral ions was made up, and 50 cm^3 placed into each of three flasks.

Samples of a culture of free cells of *B. subtilis*, agar cubes containing immobilised *B. subtilis* and alginate beads containing *B. subtilis* were placed in the three flasks. Each flask contained the same number of bacteria. All the flasks were incubated at 37 °C for 48 hours.

Samples of the liquid medium in each flask were taken at six hourly intervals and the concentration of protease measured.

The results are shown in Fig. 3.1.

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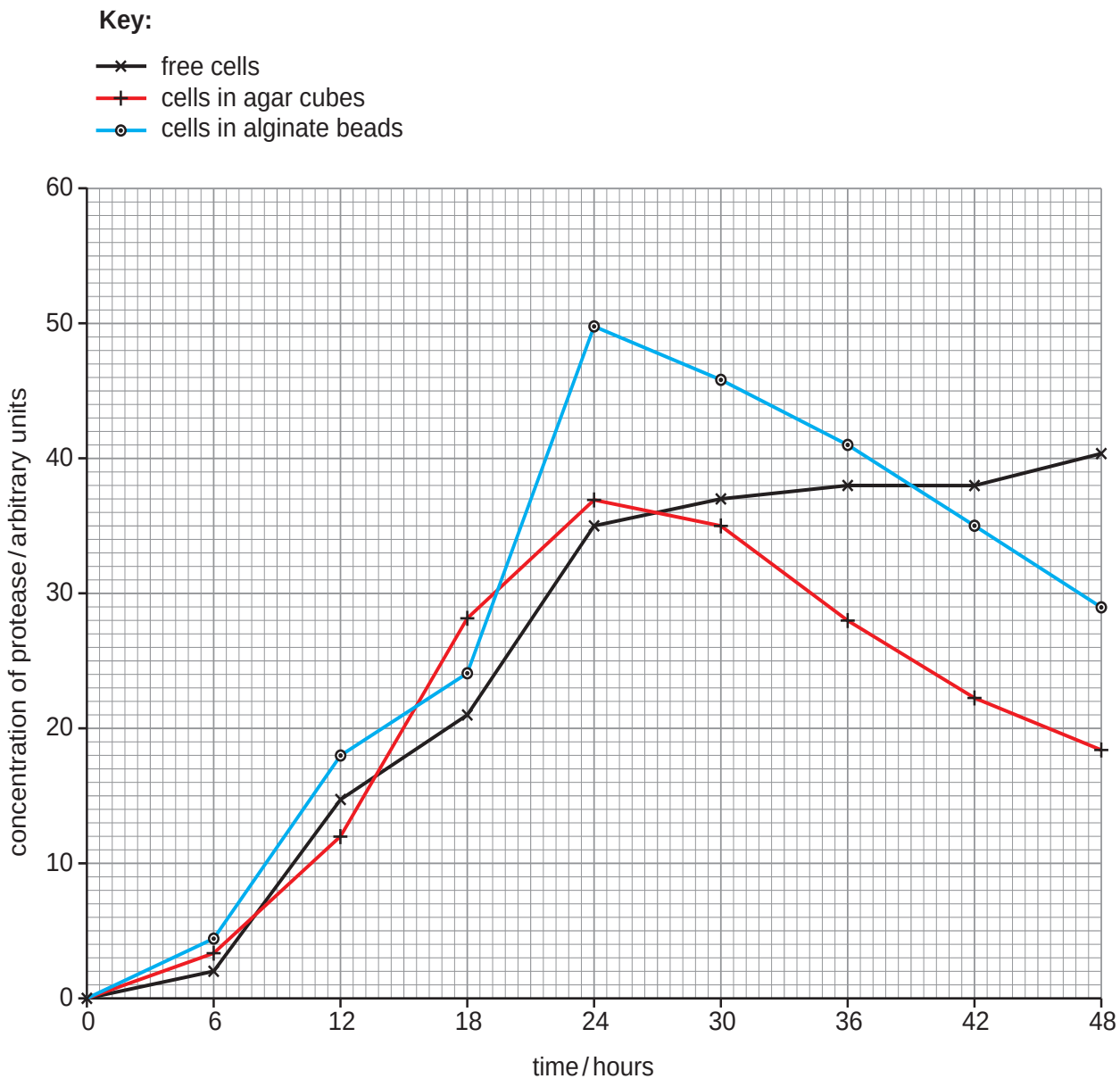


Fig. 3.1

(i) With reference to Fig. 3.1, compare the results for the free cells of *B. subtilis* and cells immobilised in alginate beads.

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(ii) Suggest why lower concentrations of protease were produced by *B. subtilis* immobilised in agar cubes than *B. subtilis* immobilised in alginate beads.

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(c) Two new cultures of immobilised *B. subtilis* were set up as described in **(b)**.
However, this time a repeat batch fermentation method was used, in which the liquid medium was replaced every 24 hours. This was continued until the cubes or beads had begun to disintegrate.

The results are shown in Table 3.1.

Table 3.1

	number of batches before cubes or beads disintegrated	total fermentation time / hours	total protease produced / arbitrary units	mean productivity of protease / arbitrary units per hour
agar cubes	6	144	1792	12.44
alginate beads	9	216	3264	15.11

With reference to Table 3.1

(i) calculate the percentage increase in the total protease produced when the bacteria were immobilised in alginate rather than agar.

Show your working.

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(ii) explain why using bacteria immobilised in alginate rather than agar would be a more cost-effective production of protease.

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[Total: 15]

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4 Modern varieties of wheat have developed from numerous hybridisation events between different species of wild grasses. Fig. 4.1 shows some of the possible steps that are believed to have been involved in the development of bread wheat, *Triticum aestivum*.

The letters **A**, **B** and **C** represent three different sets of seven chromosomes.

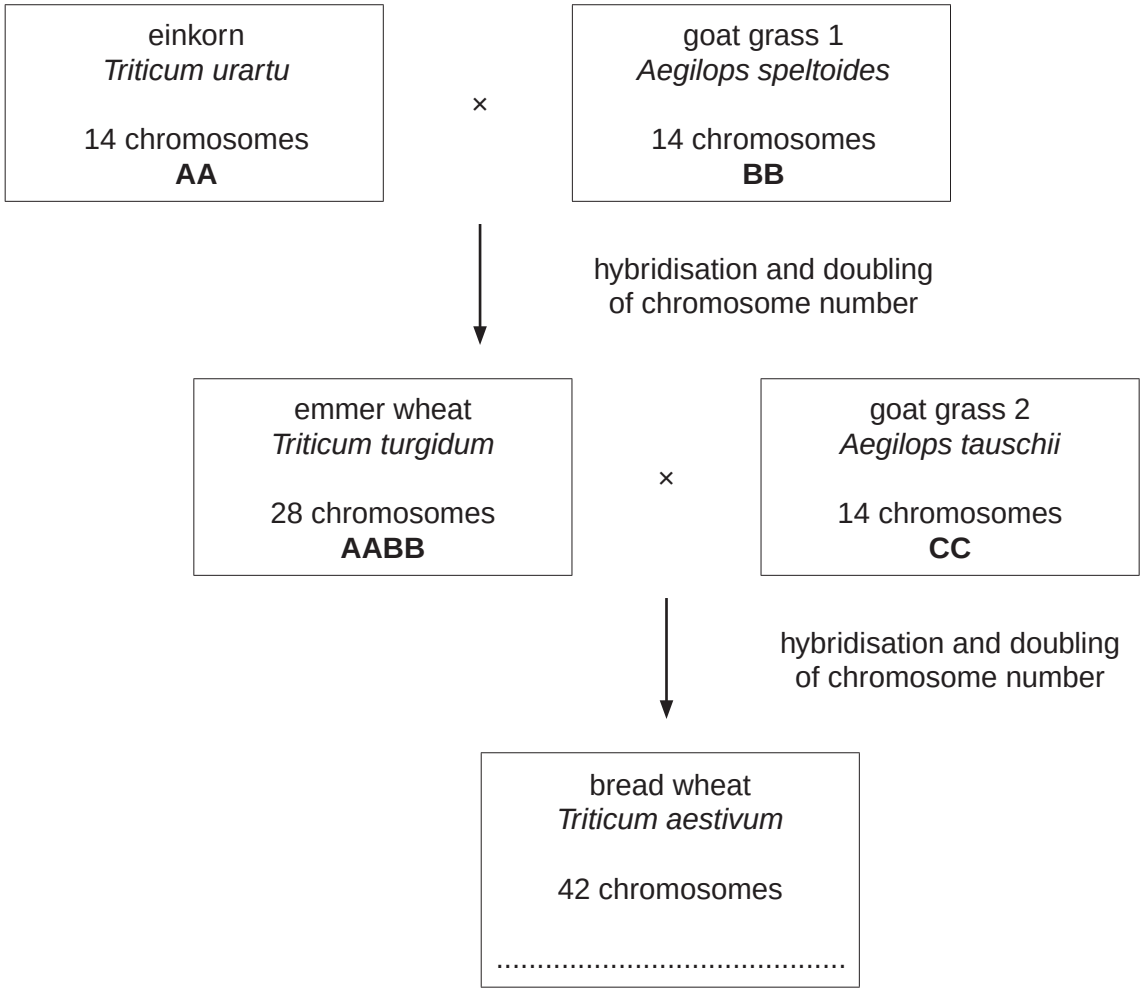


Fig. 4.1

(a) Complete Fig. 4.1 by writing letters to represent the sets of chromosomes in bread wheat.

Write your answer on Fig. 4.1. [1]

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(b) Explain why hybridisation between emmer wheat and goat grass 2 would have produced a sterile hybrid, if doubling of chromosome number had **not** occurred.

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(c) With reference to Fig. 4.1, suggest why *Triticum urartu* and *Triticum turgidum* are classified as different species.

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(d) *Triticum turgidum* emerged as a new species without being geographically isolated from *Triticum urartu*.

Outline how geographical isolation may result in speciation.

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[Total: 9]

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5 **(a)** Hormones are secreted by endocrine glands.

Explain what is meant by the term *endocrine gland*.

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(b) Fig. 5.1 shows the changes in concentration in the blood of follicle stimulating hormone (FSH) and luteinising hormone (LH) during the first half of the menstrual cycle.

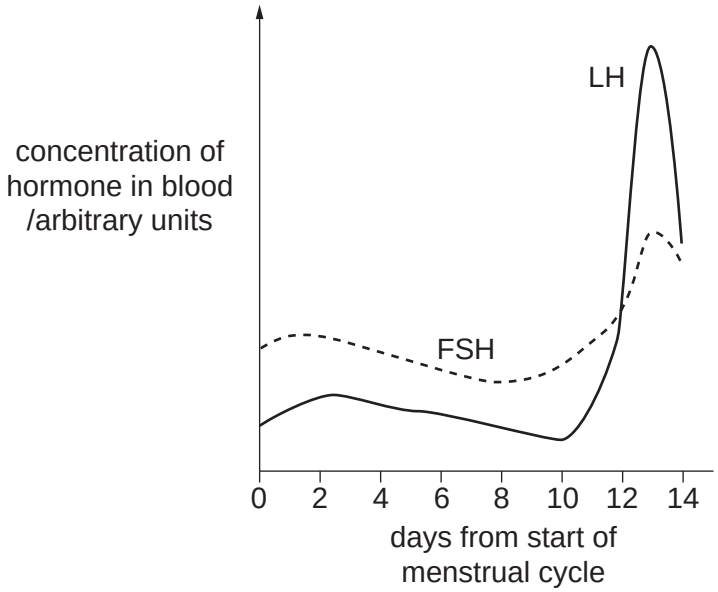


Fig. 5.1

With reference to Fig. 5.1, describe,

(i) the changes that take place in the ovary during this time, as a result of the action of FSH

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(ii) the role of LH.

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(c) In preparation for in-vitro fertilisation (IVF), women are injected with FSH. Explain why treatment with FSH is a necessary preparation for IVF.

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(d) The standard treatment with FSH and clomiphene (clomifene) causes significant side-effects. Clomiphene occupies oestrogen receptors, blocking a negative feedback mechanism.

(i) Explain briefly what is meant by *negative feedback*.

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(ii) Outline the feedback mechanism that is blocked by clomiphene.

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(e) Recently a so-called 'mild' treatment has been introduced in the hope of avoiding the side-effects of the standard treatment. This treatment does not use clomiphene. Instead, an antagonist to LH secretion is used.

The days in the first half of the menstrual cycle on which injections of FSH and clomiphene are given in the two treatments are shown by asterisks (*) in Fig. 5.2.

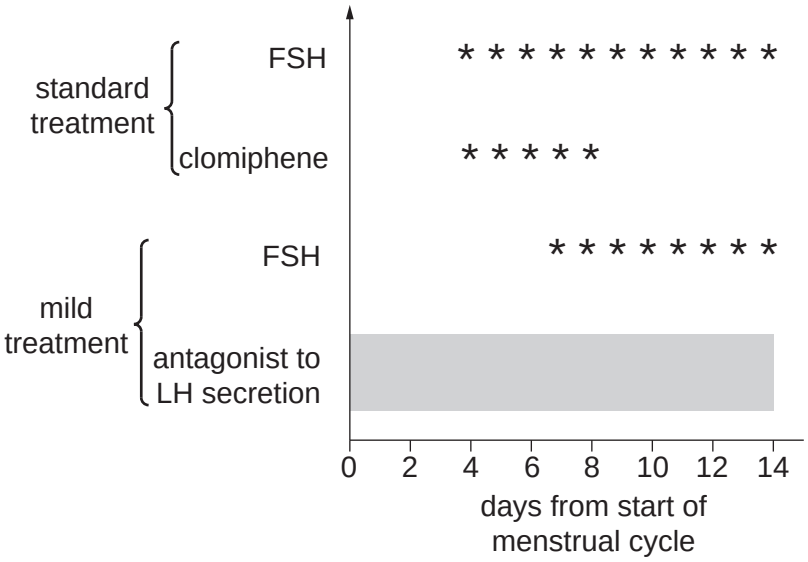


Fig. 5.2

(i) With reference to the concentrations of LH shown in Fig. 5.1, show, using an asterisk on Fig. 5.2 when the antagonist to LH secretion should first be given.

Put your asterisk into the grey area on Fig. 5.2. [1]

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(ii) Suggest why an antagonist to LH secretion forms part of the mild treatment.

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(f) The average dose of FSH given in the mild treatment is 1300 international units (IU), compared with an average dose of 1800 IU in the standard treatment. This could lead to the mild treatment being less effective.

The outcomes of an investigation into the two treatments are shown in Table 5.1.

Table 5.1

	mild treatment	standard treatment
mean number of oocytes harvested per treatment cycle	6.7	8.5
mean number of embryos produced per treatment cycle	2.8	3.8
percentage of pregnancies resulting in live birth	43.4	44.7

With reference to Table 5.1, compare the effectiveness of the two treatments.

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(g) FSH consists of two polypeptide chains which are encoded by genes on different chromosomes. The two genes, together with their promoters, have been inserted into bacteria to produce the hormone used in fertility treatments.

Explain briefly why promoters need to be transferred into the recipient bacteria together with the two genes for the FSH polypeptides.

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[Total: 16]

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6 **(a)** A husband and wife who already have a child with cystic fibrosis (CF) elected to have their second child tested for the condition while still a fetus in very early pregnancy. The results of the test, a DNA banding pattern, were discussed with a genetic counsellor.

The relevant DNA banding pattern produced by electrophoresis is shown in Fig. 6.1.

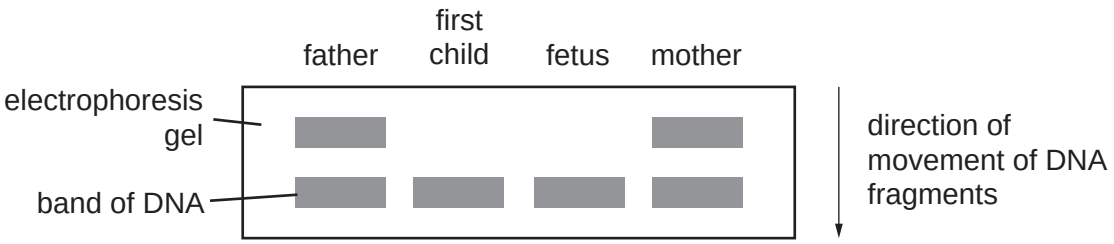


Fig. 6.1

With reference to Fig. 6.1, explain why,

(i) the fetus will develop CF,

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.....[1]

(ii) the positions of the bands of DNA of the first child and of the fetus indicate that the mutant allele for CF has a deletion in comparison with the normal allele.

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(b) Explain briefly the need to discuss the result of the test with a genetic counsellor.

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[Total: 7]

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7 **(a)** The fruit fly, *Drosophila melanogaster*, feeds on sugars found in damaged fruits. A fly with normal features is called a wild type. It has a striped body and its wings are longer than its abdomen. There are mutant variations such as an ebony coloured body or vestigial wings. These three types of fly are shown in Fig. 7.1.



wild type **ebony body** **vestigial wing**

Fig. 7.1

Wild type features are coded for by dominant alleles, **A** for wild type body and **B** for wild type wings.

Explain what is meant by the terms *allele* and *dominant*.

allele .....

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dominant .....

..... [2]

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(b) Two wild type fruit flies were crossed. Each had alleles **A** and **B** and carried alleles for ebony body and vestigial wings.

Draw a genetic diagram to show the possible offspring of this cross.

[6]

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(c) When the two heterozygous fruit flies in **(b)** were crossed, 384 eggs hatched and developed into adult flies.

A chi-squared (χ^2) test was carried out to test the significance of the differences between observed and expected results.

$$\chi^2 = \Sigma \frac{(O - E)^2}{E}$$

where Σ = sum of
O = observed value
E = expected value

(i) Complete the missing values in Table 7.1.

Table 7.1

	phenotypes of *Drosophila melanogaster*			
	grey body long wing	grey body vestigial wing	ebony body long wing	ebony body vestigial wing
observed number (O)	207	79	68	30
expected ratio	9	3	3	1
expected number (E)	216	72	72	24
O – E	-9	.....	-4	6
$(O - E)^2$	81	.....	16	36
$\frac{(O - E)^2}{E}$	0.38	.....	0.22	1.50

[3]

(ii) Calculate the value for χ^2.

χ^2 = ... [1]

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Table 7.2 relates χ^2 values to probability values.

As four classes of data were counted the number of degrees of freedom was $4 - 1 = 3$. Table 7.2 gives values of χ^2 where there are three degrees of freedom.

Table 7.2

probability greater than	*0.50*	*0.20*	*0.10*	*0.05*	*0.01*	*0.001*
values for χ^2	2.37	4.64	6.25	7.82	11.34	16.27

(iii) Using your value for χ^2, and Table 7.2, explain whether or not the observed results were significantly different from the expected results.

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[Total: 14]

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8 **(a)** Fig. 8.1 shows the results from two experiments carried out to investigate the effect of light intensity and carbon dioxide concentration on the rate of photosynthesis.

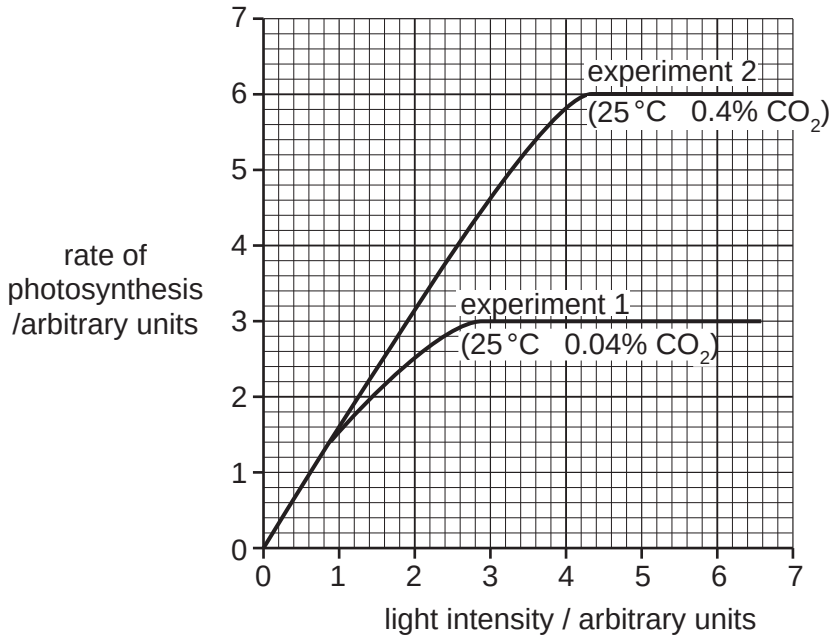


Fig. 8.1

(i) Describe **and** explain the results shown in Fig. 8.1 for **experiment 1**.

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(ii) Describe **and** explain the difference between the results for experiment 1 **and** experiment 2.

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(b) The optimum temperature for many plants living in temperate regions is approximately 25 °C.

Explain why the rate of photosynthesis in these plants decreases at temperatures above 25 °C.

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[Total: 11]

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Section B

Answer **one** question.

9 **(a)** Describe the process of glycolysis. [7]

(b) Describe the structure and synthesis of ATP **and** its universal role as the energy currency in all living organisms. [8]

[Total: 15]

10 **(a)** Describe a reflex arc **and** explain why such reflex arcs are important. [7]

(b) Describe the structure of a myelin sheath **and** explain its role in the speed of transmission of a nerve impulse. [8]

[Total: 15]

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