Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

BIOLOGY **9700/43**

Paper 4 A Level Structured Questions **October/November 2016**

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 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.

Section B
Answer **one** question.

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.

This document consists of **21** printed pages and **3** lined pages.

CAMBRIDGE International Examinations

Section A

Answer **all** the questions.

1 The Labrador retriever is a modern breed of dog that can have yellow, black or brown fur and pale, black or brown noses. The inheritance of fur and nose colour is the result of the interaction between genes at two different loci, the B locus and the E locus.

Fig. 1.1 shows a Labrador retriever.

Fig. 1.1

Table 1.1 shows how gene interaction results in different phenotypes.

Table 1.1

alleles at B locus	alleles at E locus	phenotype
B_	ee	yellow fur black nose
bb	ee	yellow fur pale nose
B_	E_	black fur black nose
bb	E_	brown fur brown nose

A male Labrador retriever, heterozygous at the B locus and homozygous recessive at the E locus, was mated with a female Labrador retriever heterozygous at both loci.

(a) Explain the terms *locus* and *homozygous*.

locus .....

.....

homozygous .....

..... [2]

(b) Use a genetic diagram to show the possible genotypes and phenotypes of the offspring from the mating between the two Labrador retrievers.

parental phenotypes

parental genotypes

gametes

offspring genotypes and phenotypes

[6]

[Total: 8]

[Turn over

2 Most plants are C3 plants and are so-called because their first photosynthetic product is a three carbon compound.

The enzyme ribulose bisphosphate carboxylase/oxygenase (rubisco) catalyses the fixation of carbon dioxide in the Calvin cycle and is used by both C3 and C4 plants.

Each molecule is made up of eight large polypeptides and eight small polypeptides. Fig. 2.1 shows a side view of the molecule.

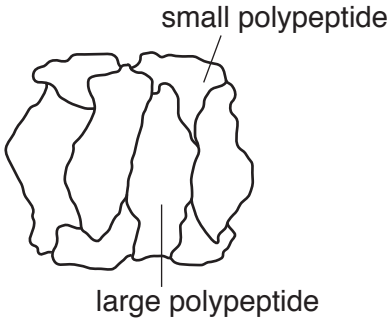

Fig. 2.1

(a) (i) Outline how the biochemistry of C4 plants differs from that of C3 plants.

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.....[2]

(ii) State why rubisco is said to have quaternary structure.

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.....[1]

(iii) Explain what makes a molecule such as rubisco soluble.

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.....[2]

(b) The active sites of rubisco accept ribulose bisphosphate (RuBP) and **either** carbon dioxide **or** oxygen and can catalyse the two reactions shown below.

either

$RuBP + CO_2 \longrightarrow$ unstable intermediate compound $\longrightarrow$ 2GP (PGA)

or

$RuBP + 2O_2 \longrightarrow$ unstable intermediate compound $\longrightarrow$ GP (PGA) + $2CO_2$

Explain the consequences to the plant of the reaction involving oxygen.

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.....[2]

(c) In the absence of light, rubisco changes shape from an active form to an inactive form.

Explain why rubisco does **not** need to be in an active form in the absence of light.

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.....[3]

[Total: 10]

[Turn over

3 Vitamin A deficiency is a major health problem in parts of the world where children have a limited diet. Rice enhanced with pro-vitamin A has been produced through genetic engineering. This new rice, called Golden Rice, contains large amounts of β-carotene, which is used in the human body to synthesise vitamin A. From this Golden Rice, newer varieties of Golden Rice have been developed by selective breeding.

Fig. 3.1 shows how Golden Rice was originally produced by genetic engineering.

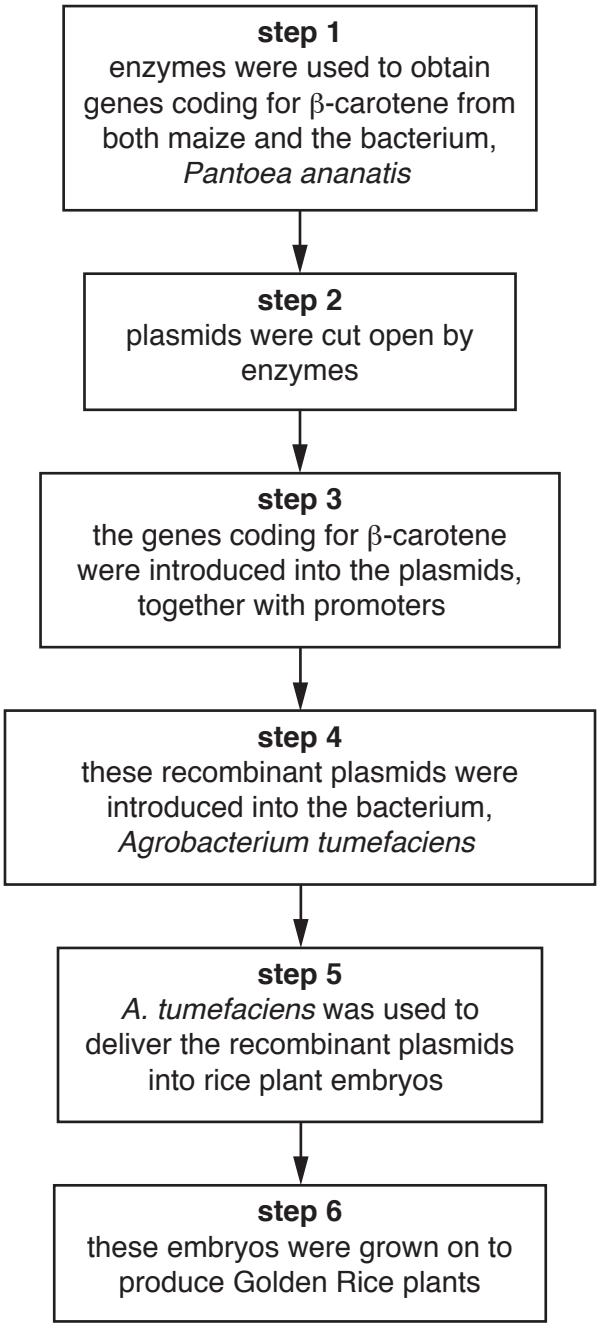

Fig. 3.1

(a) (i) Name the types of enzyme used in **step 1** and **step 2**.

.....[1]

(ii) Name the enzyme used in **step 3**.

.....[1]

(iii) Explain why promoters were introduced along with the genes for β-carotene in **step 3**.

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.....[2]

(iv) Describe the properties of plasmids that make them suitable for their roles in the production of Golden Rice.

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(b) Rice is an important food crop in many different countries. Farmers in different parts of the world have developed rice varieties that grow well in the local climate and soil conditions.

Selective breeding programmes have been carried out in which Golden Rice was interbred with local rice varieties to produce varieties of Golden Rice that grow well in different localities.

Explain why the original Golden Rice had to be developed by genetic engineering, but locally-adapted varieties of Golden Rice could be developed by selective breeding.

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.....[3]

(c) An investigation was carried out to check that β-carotene from Golden Rice can be converted to vitamin A in the body.

Golden Rice plants were grown using water whose molecules contained deuterium instead of ordinary hydrogen. Deuterium is an isotope of hydrogen that contains a neutron as well as a proton in its nucleus. The β-carotene synthesised in these rice plants contained deuterium.

Volunteers ate a measured dose of rice taken from these Golden Rice plants. The concentrations in the blood of vitamin A containing deuterium were measured on the day before they ate the rice, and then over the next 6 days.

Fig. 3.2 shows the results.

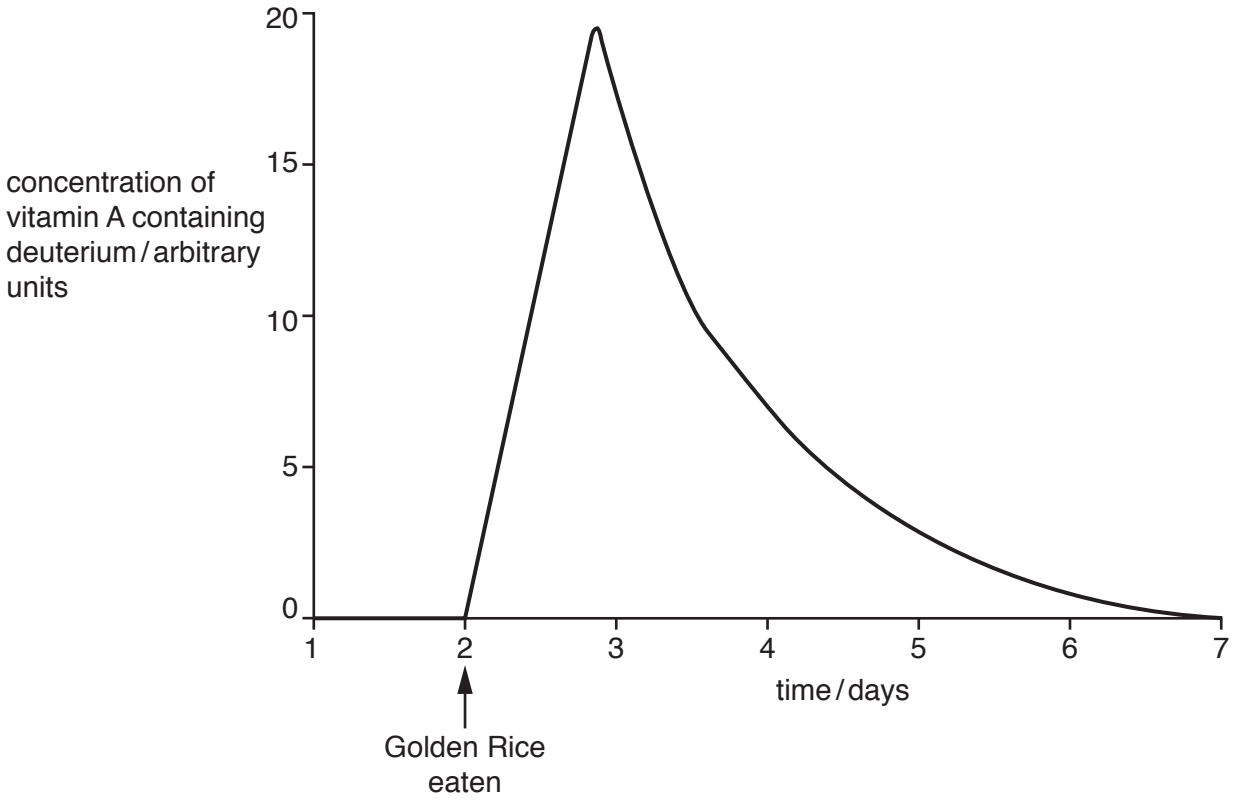

Fig. 3.2

(i) Explain why the Golden Rice was grown using water containing deuterium.

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.....[2]

(ii) Suggest why it took several hours after the Golden Rice had been eaten for the maximum concentration of vitamin A containing deuterium to be reached.

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.....[1]

[Total: 13]

4 Drug therapy is the main method of treating cases of malaria. A number of different drugs have been used to kill a species of the *Plasmodium* parasite that causes malaria.

Chloroquine was the main drug used in Africa for many years. In 1996 the newer drug, sulfadoxine-pyrimethamine (Fansidar®), was used instead and the use of chloroquine was discontinued.

A study was carried out to estimate the percentage of parasites that were killed by the two different drugs in two countries in Africa.

The results of the study are shown in Table 4.1.

Table 4.1

country	year	percentage of parasites killed by	
		chloroquine	sulfadoxine-pyrimethamine
Kenya	1996	5	85
	2006	38	5
Uganda	1996	0	88
	2006	0	5

(a) With reference to Table 4.1, describe the difference in effectiveness of the two drugs.

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.....[3]

(b) Explain how the data in Table 4.1 show evidence that the use of chloroquine was discontinued after 1996.

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(c) The researchers concluded that in both Kenya and Uganda the parasite had evolved resistance to sulfadoxine-pyrimethamine.

Explain how the parasites evolved resistance.

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.....[4]

(d) The resistance of *Plasmodium* parasites to chloroquine was found to be due to a difference in the shape of one specific type of cell surface membrane protein.

Name the type of variation controlling chloroquine resistance in the *Plasmodium* population.

.....[1]

(e) The life cycle of *Plasmodium* is very complex, with a number of stages. The stages that infect human beings are haploid.

Suggest why the Hardy-Weinberg principle **cannot** be used to calculate the frequency of the allele for chloroquine resistance.

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[Total: 12]

[Turn over

5 Researchers measured insect biodiversity on *Acacia* trees in the African savannah using the following method:

- insecticide was sprayed into each tree
- this killed the insects, which fell onto a sheet below the tree
- the dead insects were collected, identified and counted.

(a) The researchers considered each tree to be a small, distinct ecosystem.

Discuss whether or not an individual tree can be described as a small, distinct ecosystem.

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(b) Table 5.1 shows summary statistics for some of the trees sampled in this study. The leaf canopy area is a measure of the size of the tree and the extent of its leaf cover.

Table 5.2 shows the diversity and abundance of some different taxonomic groups of insects in the study.

Table 5.1

tree species	**number of trees sampled**	**total leaf canopy area sampled / m^2**	**number of insect species**		
			on the single tree with the smallest diversity	**on the single tree with the largest diversity**	**mean for all trees sampled**
Acacia mellifera	4	6.28	35	79	62
Acacia nilotica	12	23.72	65	188	98
Acacia tortilis	2	4.00	84	125	.....

Table 5.2

taxon	number of species	total number of individuals
Coleoptera (beetles)	113	2 197
Diptera (flies)	58	1 029
Formicidae (ants)	14	7 467
Hemiptera (bugs)	121	11 875

(i) Complete Table 5.1 by calculating the mean number of insect species for *Acacia tortilis*. [1]

(ii) Select, from Tables 5.1 and 5.2, a name to fit the following taxonomic groups:

a genus .....

a species .....
[2]

(iii) Comment on the effects of sample size on the quality and accuracy of the data in Table 5.1.

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.....[2]

(c) This study was carried out in Mkomazi Game Reserve in Tanzania.

Suggest how research into insect diversity on *Acacia* trees is relevant to the conservation of bigger animals in the reserve, such as elephants.

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.....[3]

[Total: 11]

[Turn over

6 **(a)** Fig. 6.1 shows the concentration of two hormones, oestrogen and progesterone, in a woman's blood during one menstrual cycle.

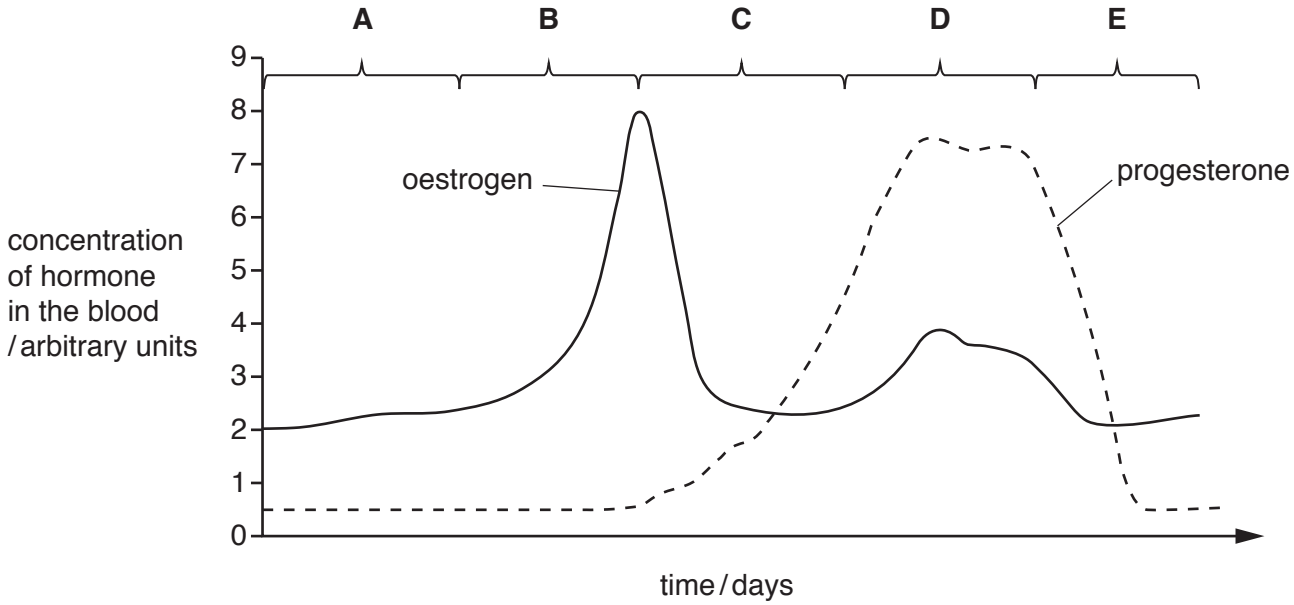

Fig. 6.1

(i) With reference to Fig. 6.1, state the letter of the stage of the cycle during which ovulation occurs.

.....[1]

(ii) State how Fig. 6.1 shows that the woman did not become pregnant during this cycle.

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.....[1]

(iii) Name the ovarian structure that secretes progesterone after ovulation.

.....[1]

(iv) State the role of progesterone during stage **D**.

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.....[1]

(b) The combined contraceptive pill contains oestrogen and progesterone.

Explain how this combined contraceptive pill works to prevent pregnancy.

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.....[4]

[Total: 8]

7 **(a)** Fig. 7.1 is an electron micrograph of a section of striated muscle.

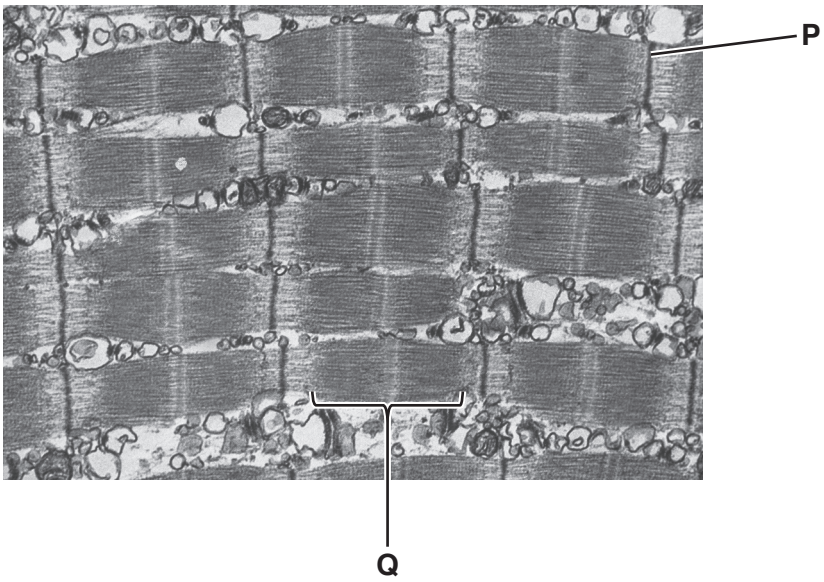

Fig. 7.1

Name structure **P** and the region represented by **Q**.

P .....

Q .....

[2]

(b) Describe the role of calcium ions (Ca^{2+} ions) in the shortening of a sarcomere.

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.....[5]

(c) A motor end plate of a neuromuscular junction is part of a modified cholinergic synapse.

Explain why mitochondria are present in the motor end plate of a neuromuscular junction.

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.....[3]

[Total: 10]

8 **(a)** A respirometer can be used to measure the respiration rate of small invertebrates such as the common woodlouse, *Oniscus asellus*.

Fig. 8.1 shows a common woodlouse.

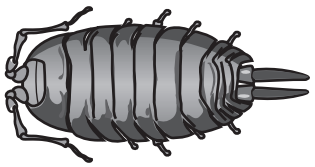

Fig. 8.1

Fig. 8.2 shows a respirometer.

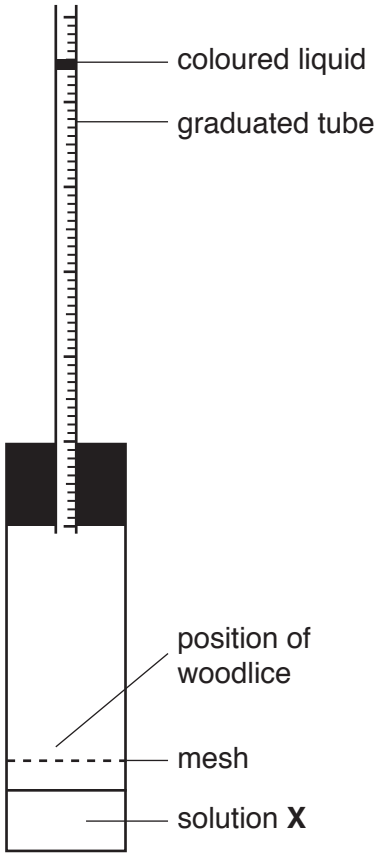

Fig. 8.2

(i) Name solution **X**.

.....[1]

(ii) The respirometer can be used to measure the effect of temperature on the rate of respiration of organisms.

Suggest **one** factor that would need to be taken into account when using woodlice rather than germinating seeds.

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.....[1]

(iii) As respiration takes place, oxygen is used by the woodlice and the coloured liquid moves down the graduated tube.

Name the stage of aerobic respiration where oxygen is used.

.....[1]

(b) A respirometer as shown in Fig. 8.2 was used to investigate the effect of temperature on the rate of respiration of woodlice.

- A student set up a respirometer containing 5 woodlice.
- The respirometer was placed in a water-bath maintained at 15 °C.
- The respirometer was left for 10 minutes to equilibrate.
- After a further 15 minutes the distance moved by the coloured liquid was measured.
- The volume of oxygen used by the woodlice was then calculated.
- The experiment was repeated, using the same woodlice and respirometer, at 25 °C.

(i) The results are shown in Table 8.1.

Table 8.1

temperature /°C	volume of oxygen used /cm^3	rate of oxygen uptake /$cm^3\,min^{-1}$
15	0.18	.....
25	0.42	.....

Complete Table 8.1 by calculating the rates of oxygen uptake at 15 °C and 25 °C.

[2]

(ii) Explain the difference in the rates of oxygen uptake at 15 °C and 25 °C.

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.....[3]

(c) In anaerobic conditions, the pyruvate formed in glycolysis is converted to ethanol in yeast cells and to lactate in mammalian tissue.

Compare the pathways by which pyruvate is converted to ethanol or to lactate.

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.....[5]

[Total: 13]

Section B

Answer **one** question.

9 **(a)** Explain how glucose is reabsorbed into the blood from a kidney nephron. [8]

(b) Describe the role of ADH when the water potential of blood decreases. [7]

[Total: 15]

10 **(a)** Describe the response of the Venus fly trap to touch. [8]

(b) Explain the control of gibberellin synthesis **and** outline how gibberellin stimulates stem elongation. [7]

[Total: 15]

[Turn over