OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE **2806/01**

BIOLOGY

Unifying Concepts in Biology

WEDNESDAY 24 JANUARY 2007 Morning

Time: 1 hour 15 minutes

Additional materials: Electronic calculator
Ruler (cm/mm)

Candidate Name

Centre Number | | | | | |

Candidate Number | | | | |

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre Number and Candidate Number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED. ANSWERS WRITTEN ELSEWHERE WILL NOT BE MARKED.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	**11**	
2	**16**	
3	**13**	
4	**8**	
5	**12**	
TOTAL	**60**	

This document consists of **15** printed pages, **1** blank page and an insert.

[Turn over

Answer **all** the questions.

1 **(a)** Fig. 1.1 shows the percentage of deaths from cancer in the UK attributed to some environmental and behavioural factors.

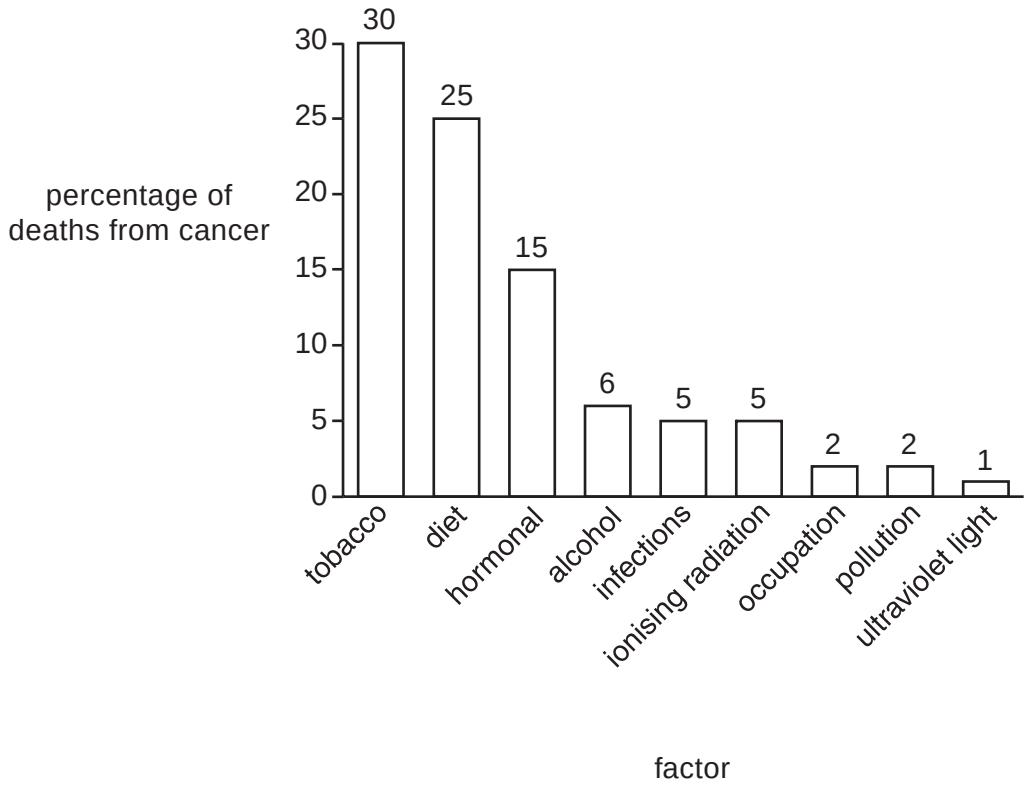

Fig. 1.1

(i) Calculate the percentage of deaths from cancer that are attributed to environmental and behavioural factors.

Answer = ... % [1]

(ii) Suggest **and** comment on another risk factor that may account for the remaining percentage of deaths from cancer.

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..... [2]

The effect of diet on cancer mortality is partly due to its effect on obesity. Obesity is defined as having a Body Mass Index (BMI) over 24.9. BMI is calculated by the following formula.

$$\text{BMI} = \frac{\text{body mass (kg)}}{\text{height (m)}^2}$$

Fig. 1.2 shows the effect of BMI on the relative risk of dying from cancer. Non-obese people with a BMI of 18.5–24.9 are assigned a baseline risk of 1.

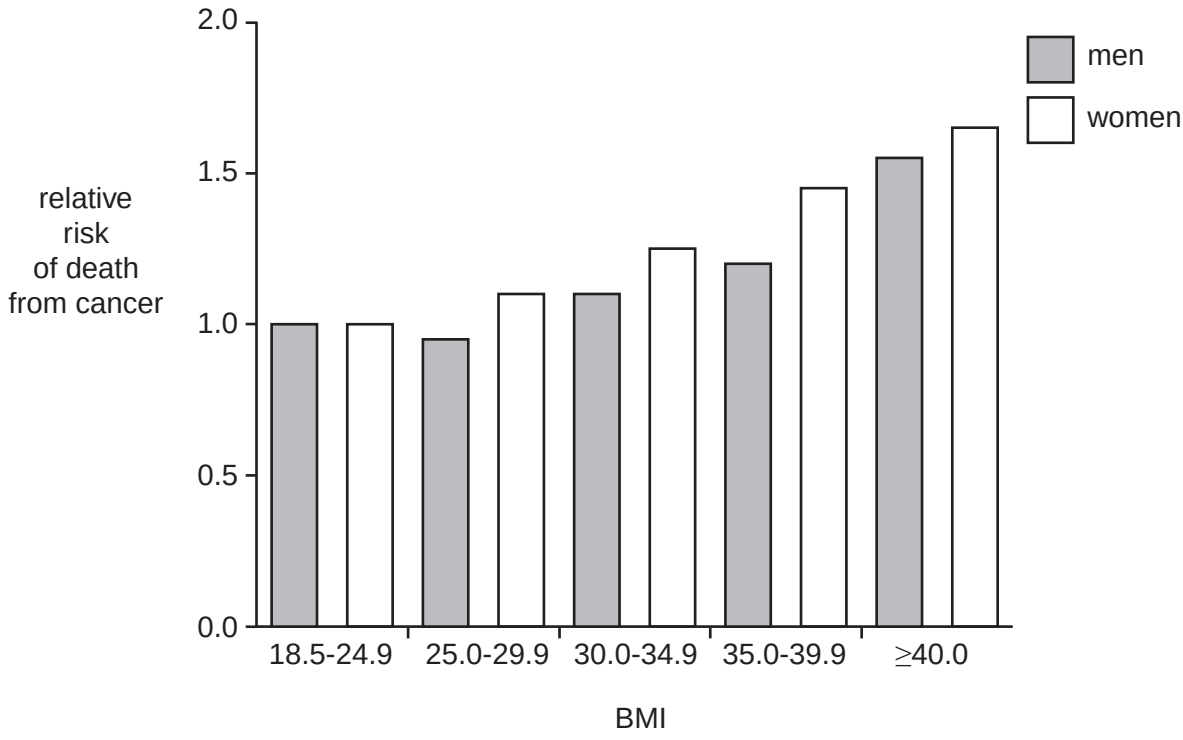

Fig. 1.2

(b) (i) Calculate the BMI of a woman 1.7 m tall with a mass of 105 kg.

Answer = ... [2]

(ii) Use Fig. 1.2 to explain the likelihood of this woman dying from cancer.

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(c) One type of cancer that has a link to obesity is breast cancer. Increased concentration of the hormone oestrogen increases the likelihood of developing breast cancer. Oestrogen is secreted by the ovaries and by cells that store fat. Oestrogen concentration drops at the time of the menopause.

(i) Predict the relationship between age at onset of menopause and the incidence of breast cancer.

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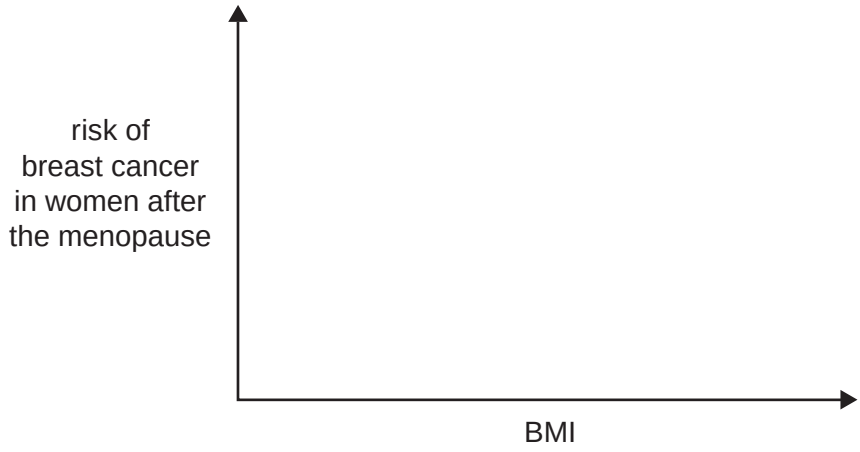
..... [1]

(ii) After the menopause, the ovaries of women stop producing oestrogen. However, cells that store fat continue to produce low quantities of oestrogen.

Sketch on the axes provided a straight line to predict the relationship between BMI and the risk of developing breast cancer after the menopause. [1]



(d) The low concentration of oestrogen after the menopause causes some problems however, including an increased risk of osteoporosis. Hormone Replacement Therapy (HRT) is one way of preventing this. A patch fixed to the skin releases oestrogen into the blood. Oestrogen is a steroid hormone that is classified as a lipid.

Explain how oestrogen is able to travel from the skin patch into the blood.

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..... [2]

[Total: 11]

2 All organisms can be classified according to where they get their energy and the element carbon. Table 2.1 shows the four forms of nutrition (photoautotrophic, photoheterotrophic, chemoautotrophic, chemoheterotrophic) that are possible. A number of different bacteria (kingdom Prokaryotes) are shown in the table to identify their forms of nutrition.

Table 2.1

		CARBON SOURCE	
		carbon dioxide (autotrophic)	organic carbon (heterotrophic)
ENERGY SOURCE	light (phototrophic)	**photoautotrophic** ..... cyanobacteria	**photoheterotrophic** purple non-sulphur bacteria
	chemical reactions (chemotrophic)	**chemoautotrophic** nitrifying bacteria	**chemoheterotrophic** ..... saprophytic bacteria

(a) Complete Table 2.1 with the names of two **other** kingdoms. **Write your answers on the dotted lines in the shaded boxes.** [2]

(b) Explain why organisms need to obtain energy and carbon.

energy .....

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carbon .....

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..... [4]

(c) Nitrifying bacteria are chemoautotrophs. Some nitrifying bacteria gain energy from converting nitrite ions (NO_2^-) to nitrate ions (NO_3^-).

Explain how the activity of these bacteria affects the growth of plants in an ecosystem.

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Bacteria are metabolically very diverse and show all four forms of nutrition identified in Table 2.1. This diversity can be shown in a simple piece of apparatus called a Winogradsky column.

A glass tube, 30 cm tall and 5 cm in diameter, is set up with the lower third containing river mud, some shredded newspaper as a source of cellulose, and the minerals sodium sulphate and calcium carbonate. The top two-thirds of the column is filled with river water and the tube is sealed and placed under a bright light source. After three months different types of bacteria establish themselves in zones.

Fig. 2.1, on an insert, shows some chemical changes occurring in a Winogradsky column containing six types of bacteria.

Fig. 2.2, also on the insert, gives more details of the metabolic activities of the six types of bacteria.

(d) Use the information given in Figs. 2.1 and 2.2, and in Table 2.1 (on page 5) to identify the forms of nutrition of

(i) *Clostridium* and *Desulfovibrio* ..... [1]

(ii) green sulphur bacteria ..... [1]

(e) **(i)** Name the element that is being recycled in **Fig. 2.2**.

..... [1]

(ii) Use Fig. 2.1 to describe how **two** named types of bacteria recycle sulphur in the Winogradsky column.

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..... [2]

(f) Unusual communities of animals are found deep in the ocean in warm, sulphur-rich water.

Use the information given in Figs. 2.1 and 2.2 to suggest which type of bacteria is the **producer** at the base of food chains in these communities.

..... [1]

(g) Gas gangrene is a condition caused by the bacterium *Clostridium perfringens*.

Suggest why gas gangrene only occurs in severely damaged tissue where blood supply is restricted.

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[Total: 16]

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3 Hummingbirds are very small. Typically their mass is between 3 and 5 g. They are able to hover at a fixed point in the air by beating their wings very rapidly. The rufous hummingbird, *Selasphorus rufus*, is a migratory species. It breeds in Canada and Alaska in the summer, migrates south to Mexico in the autumn and returns to high latitudes in spring after completing its annual moult (loss of feathers, which are then re-grown).

(a) Suggest why the rufous hummingbird has a very high requirement for energy.

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In order to save energy, rufous hummingbirds can enter a state called torpor during the night. This is when their metabolic rate and body temperature both drop to a very low level. An investigation into how rufous hummingbirds use, save and store energy at different times of year was carried out. Key findings of the study are given in Figs. 3.1, 3.2 and 3.3 on page 10.

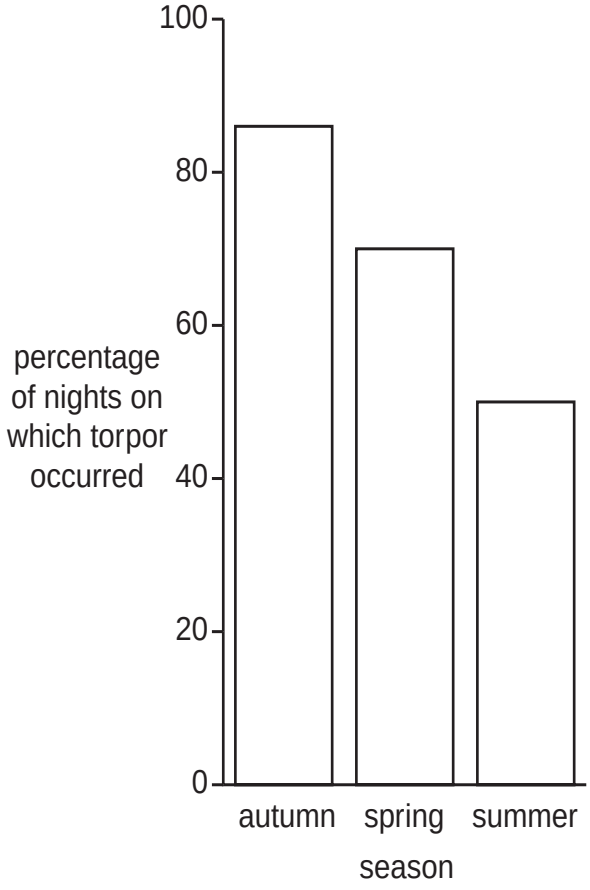

Fig. 3.1

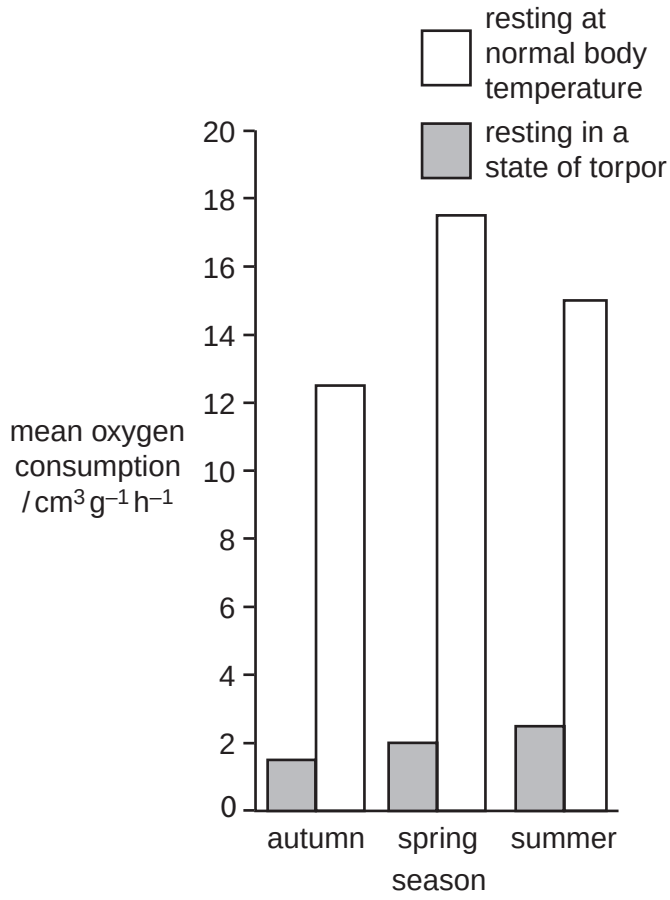

Fig. 3.2

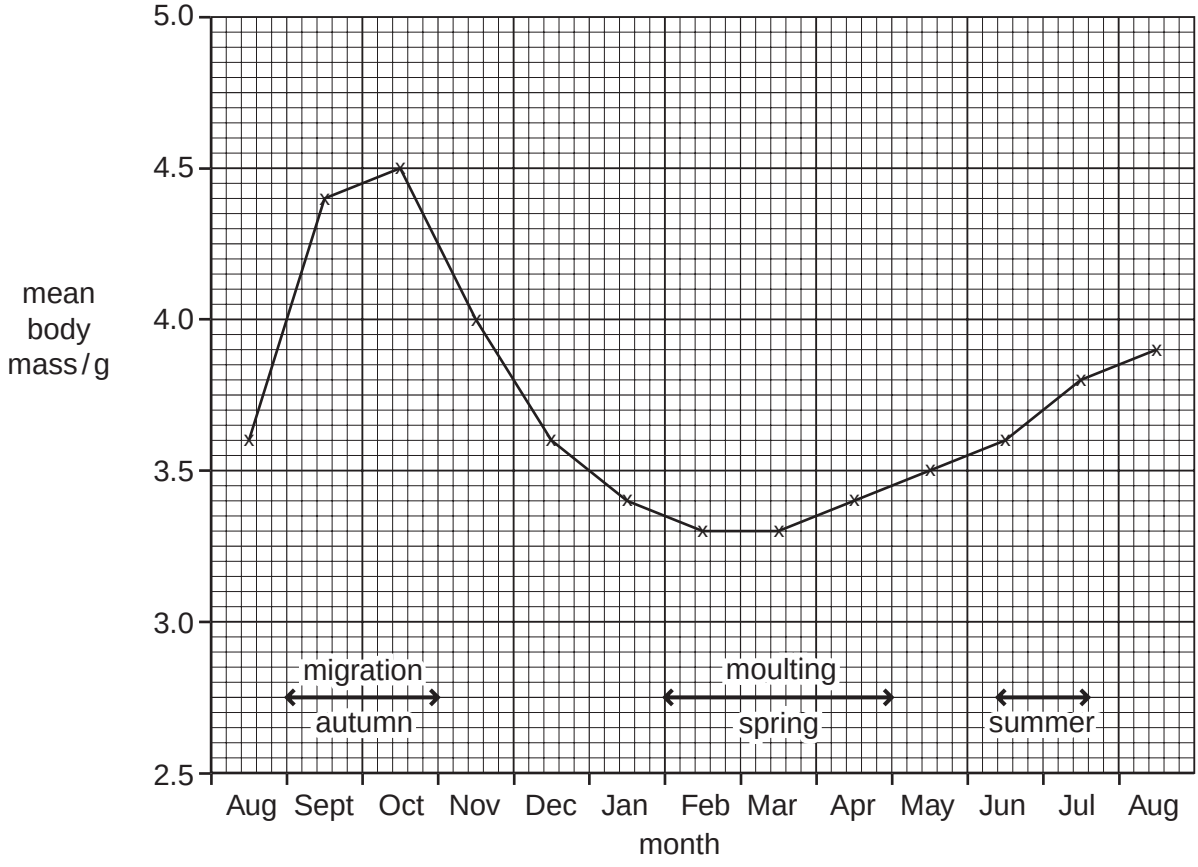

Fig. 3.3

- Fig. 3.1 shows how use of torpor by the birds varies according to season.
- Fig. 3.2 compares the oxygen consumption of birds resting at normal body temperature with that of birds resting in a state of torpor.
- Fig. 3.3 shows how body mass of the birds changes over the course of a year.

(b) Use Figs. 3.1, 3.2 and 3.3 to describe **and** explain the results for the birds in the September-October (autumn) period.

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(c) Suggest how the low body mass of the birds in spring may be related to enhancing the birds' survival during the moulting period, when the feathers are lost and regrown.

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(d) It is suggested that **smaller** birds, which have a larger surface area to volume ratio when compared to larger birds, require **more** oxygen per gram of their body mass.

Discuss whether the data given in Figs. 3.1, 3.2 and 3.3 support this hypothesis.

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..... [3]

[Total: 13]

4 In this question, one mark is available for the quality of spelling, punctuation and grammar.

Some of the key physiological areas of a mammal are the:

- blood
- alveoli
- gut
- kidney.

Fig. 4.1 shows some of the pathways where biochemicals are exchanged between these areas, the tissue fluid (extracellular fluid) and a liver cell.

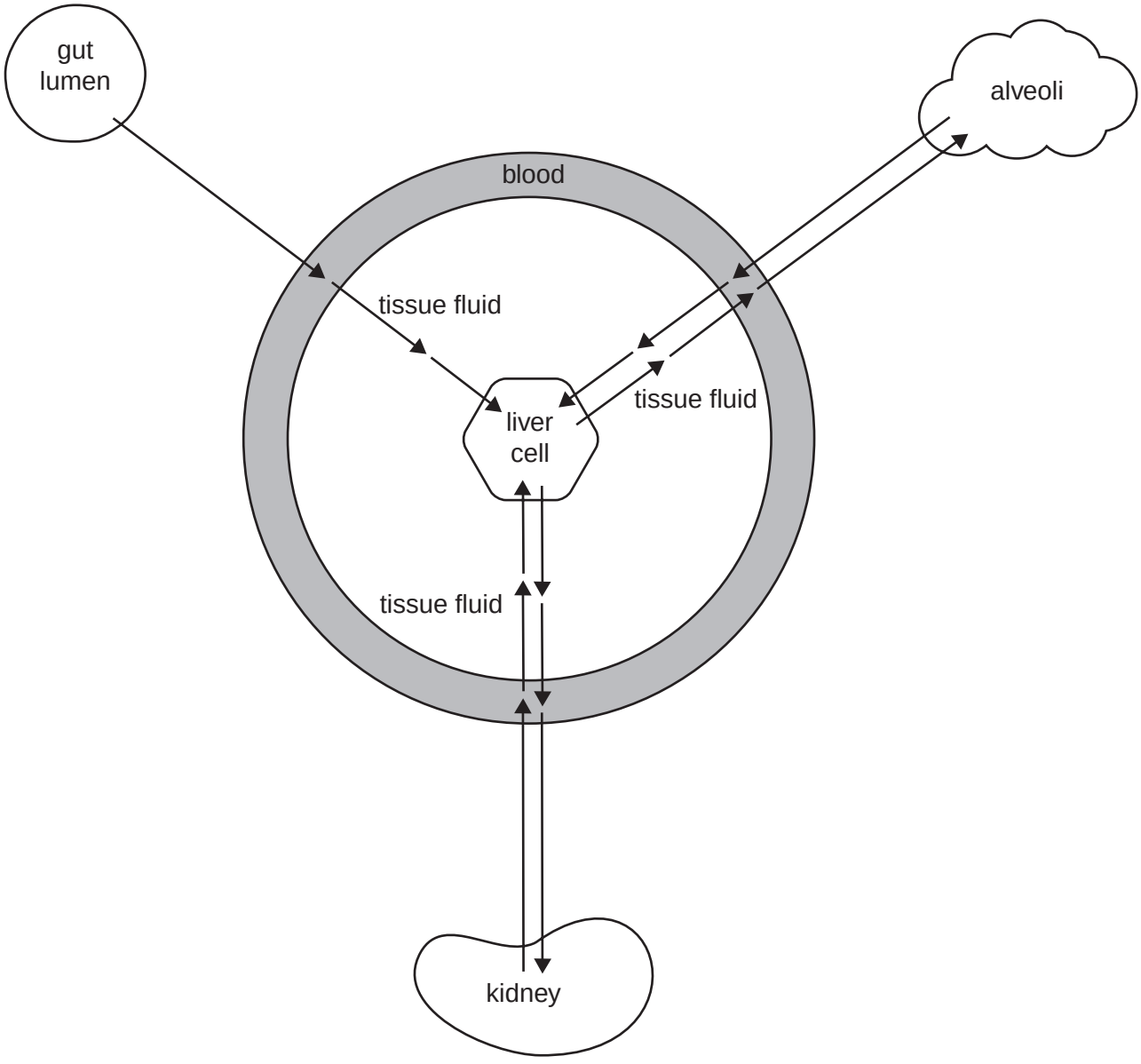

Fig. 4.1

Use the diagram to describe how these exchange pathways function to maintain relatively constant concentrations of biochemicals **in the liver cell**.

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Quality of Written Communication [1]

[Total: 8]

5 The bulb of the onion plant, *Allium cepa*, is widely used in food preparation. It has a strong smell and flavour when raw due to sulphur-containing chemicals that are released when an onion is cut. The precursor of these flavour molecules is in the cytoplasm of the onion bulb cells. This precursor is acted on by an enzyme called alliinase, which is stored in the cell vacuole. Alliinase breaks the precursor molecule into two volatile flavour molecules, which enter the air, and into a third product, pyruvate, which remains dissolved in the onion tissue.

(a) Explain why the strong smell of an onion is only released when the onion is cut or damaged.

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..... [3]

The strength of an onion's flavour can be estimated by measuring the concentration of pyruvate in cut onions. Table 5.1 shows the pyruvate concentration of fresh onions, onions from the previous season that have overwintered, and onions of a new variety called Supasweet.

Table 5.1

type of onion	pyruvate concentration / $\mu mol\, g^{-1}$
fresh	7
overwintered	4
Supasweet	3

(b) Suggest why the concentration of pyruvate is lower in an overwintered onion.

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(c) The mild Supasweet onions were produced by a process of artificial selection. The growing environment also needs to be manipulated to decrease the concentration of flavour molecules.

(i) Explain how artificial selection was used to produce the mild Supasweet onions.

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..... [3]

(ii) Use the information given about the biochemistry of the onion smell and flavour to suggest an environmental change that would enable a milder onion to be grown.

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(d) It is claimed that strong onions, with a more pungent smell and flavour, are able to resist rotting over the winter better than milder onions.

Describe how you would test this claim.

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[Total: 12]

END OF QUESTION PAPER

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INSERT

WEDNESDAY 24 JANUARY 2007

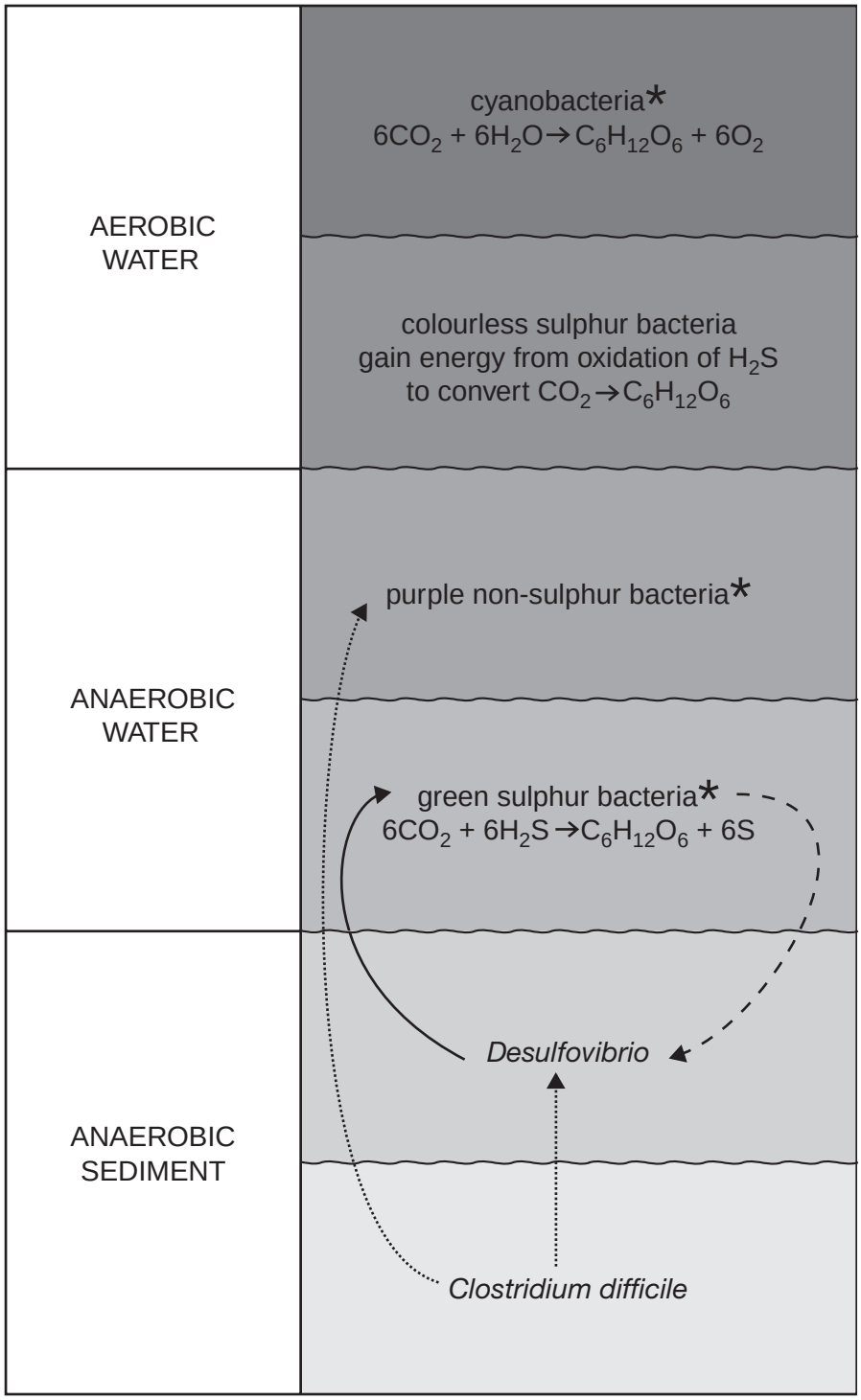
Morning

Time: 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

- This insert contains Fig. 2.1 and Fig. 2.2.

This insert consists of **4** printed pages.



Arrows show flow of:

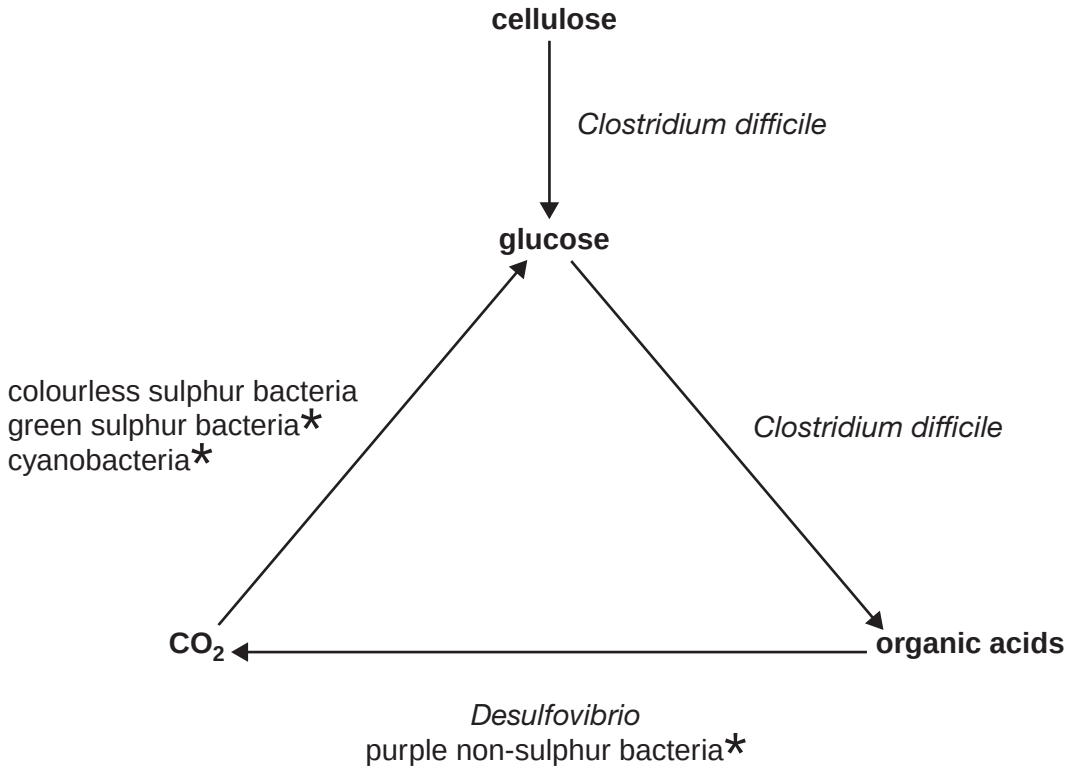
organic acids

hydrogen sulphide

sulphur

Bacteria marked * depend on light for their metabolism.

Fig. 2.1



Bacteria marked * depend on light for their metabolism.

Fig. 2.2