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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8302500130

BIOLOGY **9700/43**

Paper 4 A2 Structured Questions **October/November 2012**

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

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.

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

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UNIVERSITY of CAMBRIDGE International Examinations

Section A

Answer **all** the questions.

For Examiner's Use

1 **(a)** Fig. 1.1 shows a neurone forming three synapses with adjacent neurones.

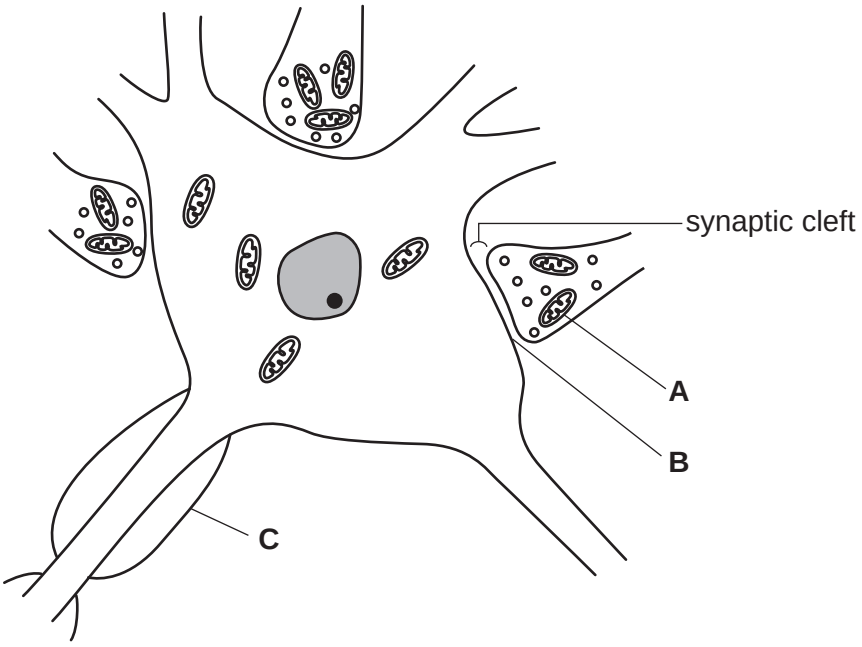

Fig. 1.1

Name **A**, **B** and **C**.

A.....

B.....

C.....[3]

(b) Outline the role of structure **A** in synaptic transmission.

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.....[3]

(c) The drug nicotine has a similar structure to acetylcholine.

Suggest the effects on brain neurones of inhaling nicotine from a cigarette.

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[Total: 8]

For Examiner's Use

2 The artificial plasmid, pBR322, was constructed to act as a vector. It has often been used to insert human genes, such as the human insulin gene, into the bacterium, *Escherichia coli*.

For Examiner's Use

The plasmid was constructed to include two genes, each giving resistance to a different antibiotic: an ampicillin resistance gene and a tetracycline resistance gene. The plasmid also has a target site for the restriction enzyme, *Bam*HI, in the middle of the tetracycline resistance gene.

A pBR322 plasmid was cut using *Bam*HI and the cDNA gene for human insulin inserted into it.

Fig. 2.1 shows pBR322 and the recombinant plasmid.

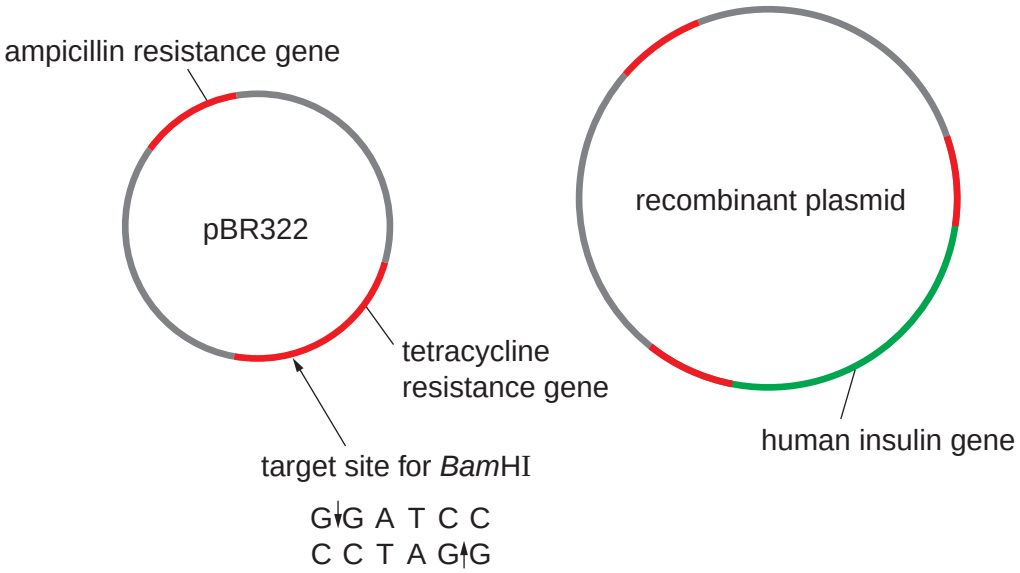

Fig. 2.1

(a) With reference to Fig. 2.1, describe how a cDNA human insulin gene can be inserted into pBR322 that has been cut by *Bam*HI.

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..... [4]

For Examiner's Use

(b) Bacteria were then mixed with the recombinant plasmids. Those bacteria which had successfully taken up recombinant plasmids were identified using the following steps:

step 1 – the bacteria were spread onto culture plates containing nutrient agar and ampicillin and incubated to allow colonies to form

step 2 – some bacteria from each of the colonies growing on these plates were transferred to plates containing nutrient agar and tetracycline, as shown in Fig. 2.2.

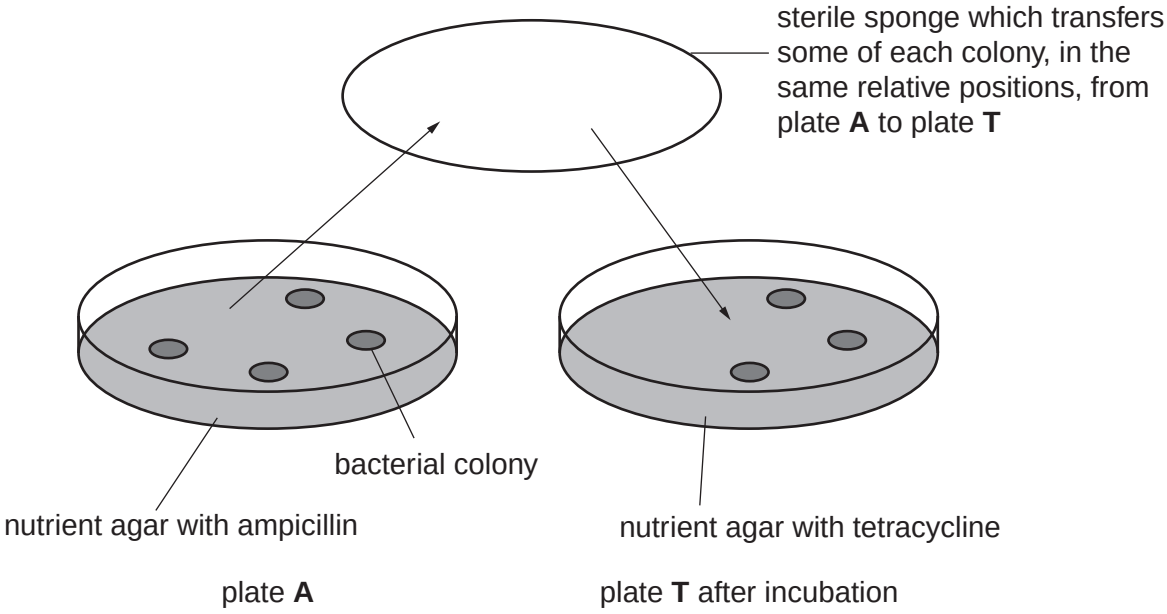

Fig. 2.2

(i) Explain why the bacteria were first spread onto plates containing ampicillin.

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..... [3]

(ii) Explain why it is important, for identifying bacteria that have successfully taken up the recombinant plasmid, that on pBR322 the target site for *Bam*HI is in the middle of the tetracycline resistance gene.

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.....[3]

(iii) Use a label line and the letter **C** to identify, on Fig. 2.2, a colony of bacteria that contain the recombinant plasmid.

Put your answer onto Fig. 2.2 on page 5. [1]

(c) Plasmid vectors carrying antibiotic resistance genes are now rarely used in gene technology.

(i) Explain why antibiotic resistance genes are now rarely used.

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.....[2]

(ii) State one type of gene that has replaced antibiotic resistance genes in plasmid vectors and indicate how its presence can be detected.

type of gene .....

.....

detection.....

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.....[2]

[Total: 15]

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For Examiner's Use

3 Penicillin-binding proteins (PBPs) are proteins found in the cell surface membranes of bacteria. PBPs catalyse the final steps in the production of a peptidoglycan cell wall.

(a) From the information given above, describe the likely molecular structure of a PBP.

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.....[2]

(b) Penicillin-resistant mutants of the bacterium, *Staphylococcus aureus*, produce a PBP, PBP2a, that does not bind well with penicillin.

Suggest how the presence of PBP2a in the cell surface membrane provides *S. aureus* with resistance to the effects of penicillin.

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(c) Explain why penicillin does not affect viruses.

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[Total: 7]

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[Turn over

For Examiner's Use

4 **(a)** Fig. 4.1 shows a light micrograph of a section through a wheat grain.

The structure of a wheat grain is very similar to that of a maize fruit.

Fig. 4.1

On Fig. 4.1, use label lines and letters to label each of the following parts.

A endosperm

B fused testa and pericarp (fruit coat)

C embryo [3]

(b) Wheat grains are ground to make flour, which can be used for making bread.

Whole grain flour is made from the complete wheat grain.

Refined (white) flour is produced from wheat grains from which the embryo, aleurone layer and the fused testa and pericarp have been removed.

Table 4.1 shows the carbohydrate, protein and dietary fibre content of bread made from whole grain flour and white flour.

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Table 4.1

For Examiner's Use

	bread made from whole grain flour	bread made from white flour
protein / g per 100 g	9.4	7.9
dietary fibre / g per 100 g	7.0	2.5
carbohydrate / g per 100 g	42	46

With reference to the structure of a wheat grain, explain the differences between the composition of the two types of bread shown in Table 4.1.

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(c) The glycaemic index, GI, of a carbohydrate-containing food is a measure of the effect of its consumption on blood glucose concentration. If two foods containing the same mass of carbohydrate, but different GIs, are consumed, the food with the higher GI will increase blood glucose concentration more rapidly than the food with the lower GI.

Suggest an explanation for each of the following.

(i) Foods containing starch have lower GIs than foods containing glucose.

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.....[1]

(ii) Foods containing starch made up mostly of amylose have lower GIs than foods containing starch made up mostly of amylopectin.

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.....[2]

For Examiner's Use

(d) A diet containing large amounts of foods with a high GI can increase the risk of developing type II diabetes. A study was carried out into the effect of consuming whole cereal grains, refined cereal grains and fruit on the risk of developing type II diabetes.

- In 1986, questionnaires about diet were completed by 41 836 women, all between the ages of 55–69 years old, in Iowa, USA.
- The women were then divided into five groups according to their range of intake of each food type.
- In 1992 the same women were asked whether or not they had developed type II diabetes.
- Their answers were used to calculate the relative risk of developing type II diabetes for each of the five groups.

For each food type, the group with the lowest intake of that food type was allocated a risk of 1.00.

Table 4.2 shows the results of this study.

Table 4.2

food type	range of intake / servings per week	relative risk of developing type II diabetes
whole cereal grains	< 13.0	1.00
	13.0 – 18.5	0.89
	19.0 – 24.5	0.94
	25.0 – 33.0	0.81
	> 33.0	0.68
refined cereal grains	< 6.0	1.00
	6.0 – 9.5	0.96
	10.0 – 13.5	1.00
	14.0 – 22.0	0.98
	> 22.0	0.87
fruit	< 6.25	1.00
	6.5 – 10.0	1.05
	10.1– 13.5	1.00
	13.6 – 19.0	1.08
	> 19.0	1.14

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For Examiner's Use

(i) Describe the effect of increased intake of whole cereal grains on the risk of developing type II diabetes.

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.....[3]

(ii) Explain why the results in Table 4.2 **cannot** be used to make a direct comparison of the effects of consuming whole cereal grains and refined cereal grains on the risk of developing type II diabetes.

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.....[2]

(iii) The results in Table 4.2 suggest that eating large quantities of fruit may slightly increase the risk of developing type II diabetes.

Suggest a reason for this.

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.....[2]

[Total: 16]

5 Many couples who are not able to have children naturally are treated using in-vitro fertilisation (IVF).

For Examiner's Use

(a) Describe how and where fertilisation occurs during IVF.

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.....[2]

(b) The embryos resulting from IVF are transferred into the mother's uterus. This is sometimes done after 3 days, and sometimes after 5 days.

Suggest **one** advantage and **one** disadvantage of transferring the embryos after 5 days rather than 3 days.

advantage .....

.....

disadvantage .....

.....[2]

(c) Many IVF clinics usually transfer two or more embryos to the mother's uterus, to increase the chances of a successful pregnancy occurring. However, this increases the risk of more than one embryo developing in the uterus, which in turn increases the risk of problems with the pregnancy or birth.

A study was carried out to compare the success rates of transferring:

- a single embryo that had been carefully chosen as being of 'top quality'
- a non-selected single embryo
- two or more embryos.

Fig. 5.1 shows the results of this study.

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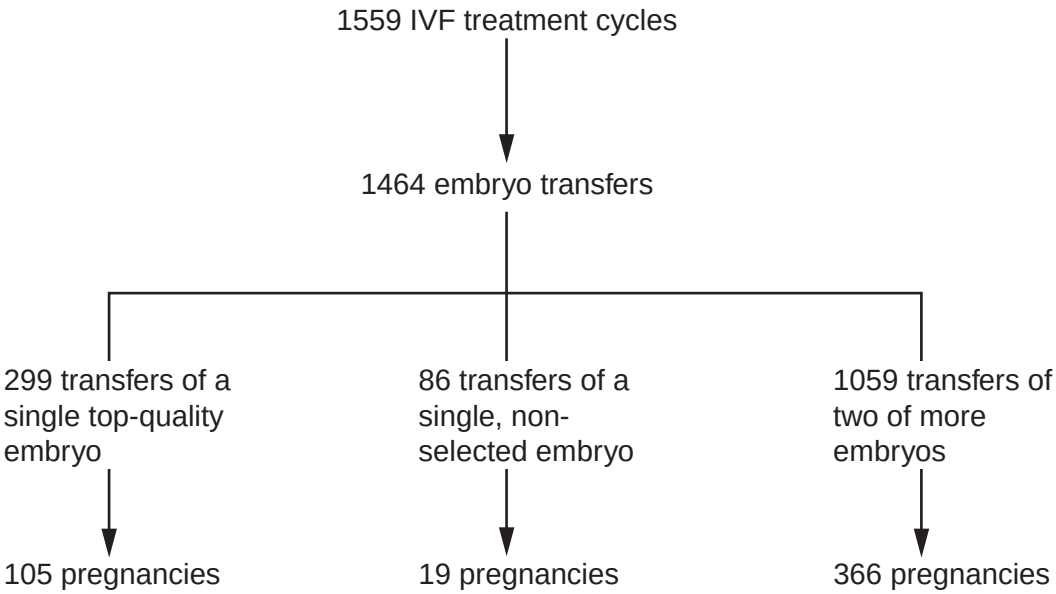

Fig. 5.1

For Examiner's Use

(i) With reference to Fig. 5.1, explain why transferring a single top-quality embryo is now considered to be the best method to maximise the chance of a successful pregnancy.

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.....[3]

(ii) State **one** ethical implication of transferring single top-quality embryos in IVF.

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.....[1]

[Total: 8]

For Examiner's Use

6 In mice, fur colour is controlled by a gene with multiple alleles. These alleles are listed below in no particular order.

black and tan = C^{bt}	yellow = C^{y}
agouti = C^{a}	black = C^{b}

(a) Suggest explanations for the results of the following crosses between mice.

(i) Mice with agouti fur crossed with mice with black fur may produce all agouti offspring **or** some agouti and some black offspring.

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.....[2]

(ii) Crosses between heterozygous parents with the genotype $C^{y}\ C^{b}$ always produce a ratio of two yellow mice to one black mouse.

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.....[2]

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(iii) Mice with yellow fur crossed with mice with black fur will produce one of the following outcomes:

- some yellow offspring and some agouti offspring
- some yellow offspring and some black and tan offspring
- some yellow offspring and some black offspring.

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.....[2]

(b) A test cross is used to determine the genotype of an organism.

Describe how you would carry out a test cross to determine the genotype of a black and tan mouse.

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.....[2]

[Total: 8]

7 **(a)** Explain the advantages to a plant species of cross-pollination compared to self-pollination.

For Examiner's Use

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..... [3]

(b) Some of the most important food plants for humans depend on insect pollinators, such as the honeybee, *Apis mellifera*.

Fig. 7.1 shows a honeybee.

Fig. 7.1

A study was carried out in 2006 to show how four food crops are pollinated.

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Fig. 7.2 shows the results of this study.

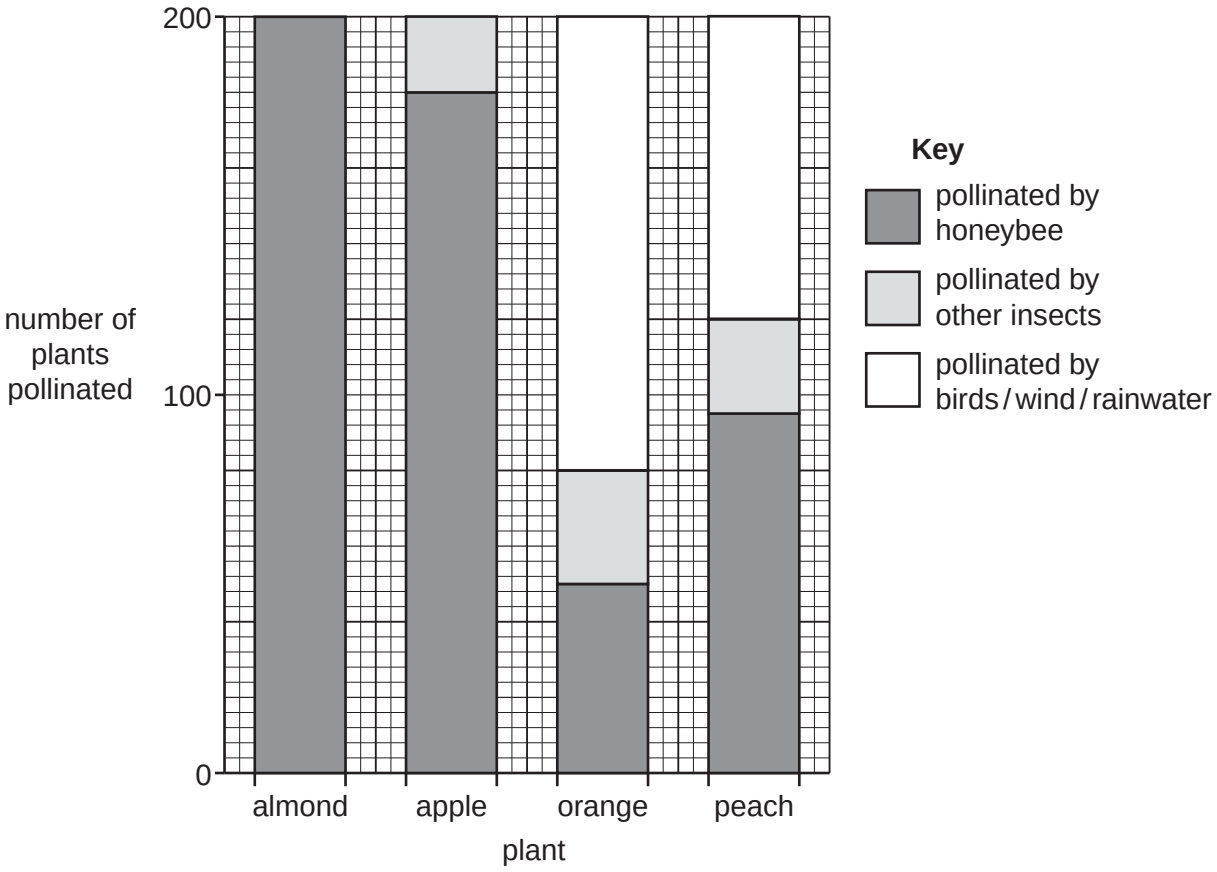

Fig. 7.2

The populations of honeybees in some parts of the world have declined in recent years.

(i) With reference to Fig. 7.2, **explain** which crop will be most affected **and** which crop will be least affected by the decline in honeybees.

most affected .....

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least affected .....

..... [2]

(ii) Suggest reasons why honeybee populations have declined.

For Examiner's Use

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[Total: 8]

8 **(a)** Fig. 8.1 outlines some steps in glucose metabolism in mammalian cells.

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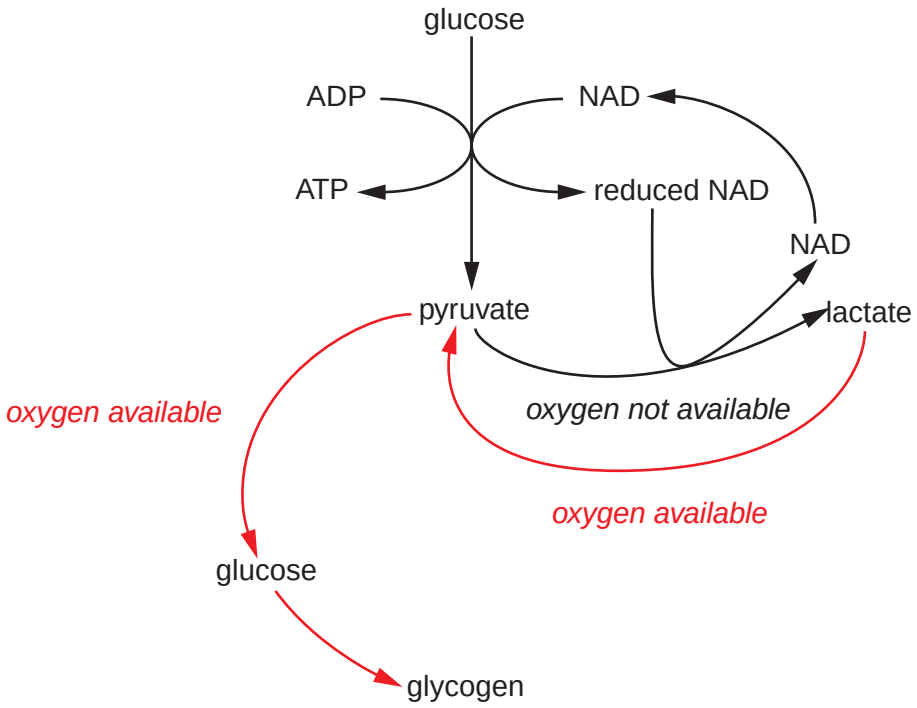

Fig. 8.1

With reference to Fig. 8.1:

(i) name the part of the cell where glucose is converted to pyruvate

.....[1]

(ii) explain why, in the absence of oxygen, pyruvate needs to be converted to lactate

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.....[2]

(iii) name the enzyme responsible for the conversion of pyruvate to lactate

.....[1]

(iv) name the type of reaction **and** the type of bonds formed when glucose molecules are used to make glycogen.

reaction .....

bonds .....[2]

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(b) Describe how anaerobic respiration in yeast cells differs from anaerobic respiration in mammalian cells.

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(c) The respiratory quotient (RQ) is used to determine the type of respiratory substrate, such as carbohydrate or lipid, which an organism uses at any one time.

(i) State how the RQ is calculated.

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.....[2]

(ii) State the typical RQ values obtained from the respiration of carbohydrates and lipids.

carbohydrate .....

lipid ..... [2]

(iii) Suggest what would happen to the RQ value when respiration becomes anaerobic.

.....[1]

[Total: 15]

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Section B

Answer **one** question.

For Examiner's Use

9 **(a)** Describe how crossing over **and** independent assortment can lead to genetic variation. [9]

(b) Outline how artificial selection differs from natural selection. [6]

[Total: 15]

10 **(a)** Outline the process of the photolysis of water **and** describe what happens to the products of photolysis. [10]

(b) Describe the roles of gibberellins in stem elongation. [5]

[Total: 15]

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