OCR
Oxford Cambridge and RSA

Tuesday 20 October 2020 – Afternoon

A Level Biology A

H420/03 Unified biology

Time allowed: 1 hour 30 minutes

You can use:
- a scientific or graphical calculator
- a ruler (cm/mm)

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **28** pages.

ADVICE
- Read each question carefully before you start your answer.

Answer **all** the questions.

1 **(a)** A student dissected a kidney. Fig. 1.1 shows one half of the dissected kidney.

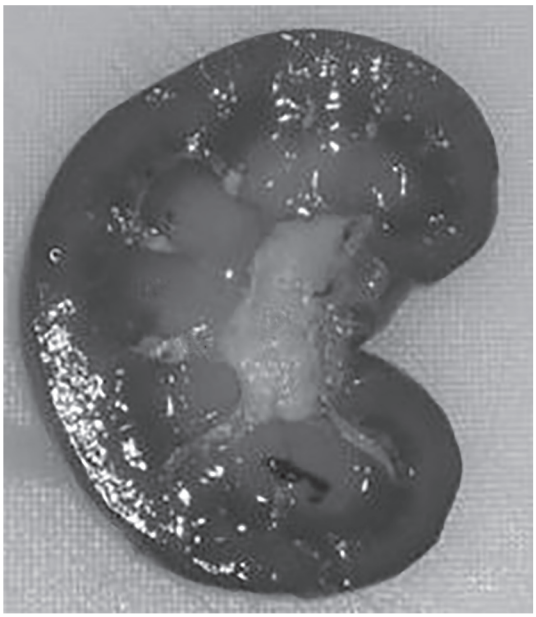

Fig. 1.1

Draw a simple diagram of the kidney in Fig. 1.1 in the space below.

On your diagram, label the pelvis, medulla and cortex.

[2]

(b) A photomicrograph of a stained section of kidney tissue is shown in Fig. 1.2.

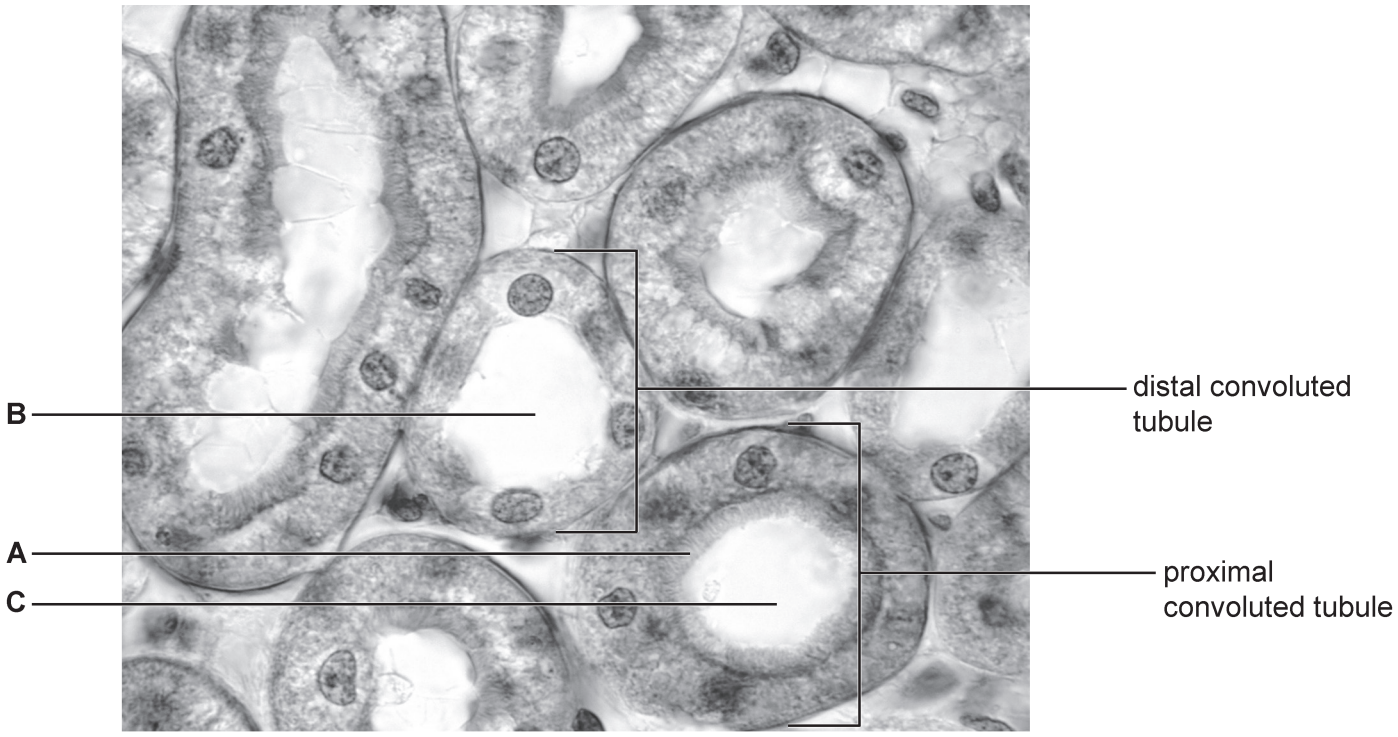

Fig. 1.2

(i) State one function of the distal convoluted tubule.

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..... **[1]**

(ii) Describe the function of the structures labelled **A** in Fig. 1.2.

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..... **[1]**

(iii) Suggest which lumen, **B** or **C**, has the highest concentration of urea. Explain your answer.

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..... **[1]**

(c)* Water reabsorption in the kidney is controlled by the endocrine and nervous systems.

Aldosterone and ADH are hormones that act on the kidney.

Aldosterone causes sodium ions to be pumped from the collecting duct cells into tissue fluid.

Describe how the endocrine **and** nervous systems work together to increase water reabsorption from the collecting duct.

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Additional answer space if required.

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(d) Diuretics are drugs that decrease the reabsorption of water into the blood from the kidney.

Diuretics can change the concentration of ions and other molecules in the blood.

Some diuretics are used to treat high blood pressure.

The table below lists three different diuretics, **X**, **Y** and **Z**, and some of their effects in the body.

	Without a diuretic	**With a diuretic**		
		X	**Y**	**Z**
Rate of urine production ($ml\,min^{-1}$)	1	3	13	8
Blood chloride ion concentration ($mmol\,dm^{-3}$)	60	15	150	150
Blood potassium ion concentration ($mmol\,dm^{-3}$)	15	60	12	25
Blood glucose concentration ($mmol\,dm^{-3}$)	6	6	9	8

(i) Suggest which of the diuretics, **X**, **Y** or **Z**, would be the most effective at reducing a person's blood pressure. Explain your choice.

diuretic.....

explanation.....

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[1]

(ii) Suggest which of the diuretics, **X**, **Y** or **Z**, would be the most appropriate for use by a person with type II diabetes. Explain your choice.

diuretic.....

explanation.....

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[1]

2 **(a)** Valves control the flow of blood through the heart.

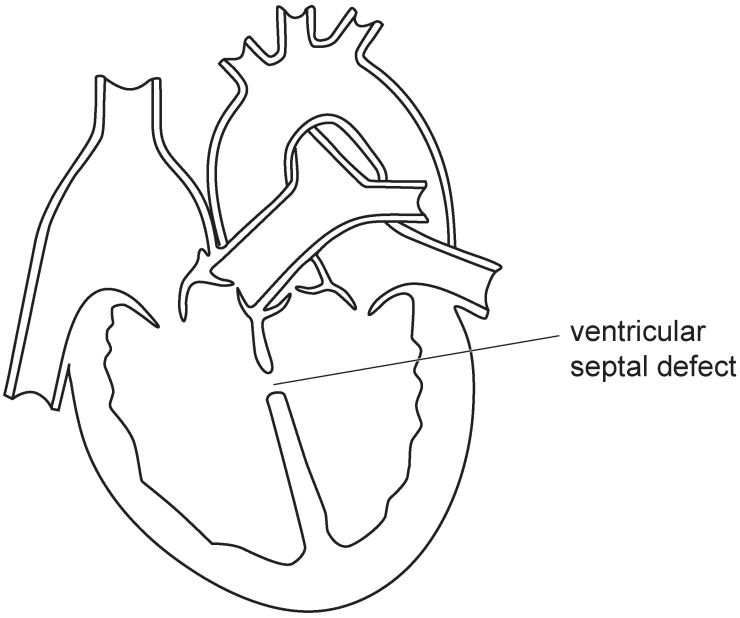
Complete the table below to show the roles of two valves in the heart.

Source of blood	Valve that controls blood flow	Destination of blood
....	right semilunar valve	....
left atrium	....	left ventricle

[2]

(b) A ventricular septal defect (VSD) is a hole in the septum of the heart.

The diagram below shows a heart with VSD.



Describe and explain why people with VSD can easily become tired.

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..... **[4]**

(c) Creatine kinase (CK) is an enzyme that catalyses reactions in heart muscle. High levels of CK in the blood indicate that a person may have had a heart attack.

Suggest why high levels of CK in the blood indicate that a person may have had a heart attack.

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..... **[1]**

(d) Mice are often used in laboratory studies to research treatments for heart conditions.

These mice are often clones.

Suggest one reason why clones are used in these studies.

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..... **[1]**

3 Students investigated the effect of light on the growth of garden cress seedlings.

- A total of 120 seedlings were divided into 2 groups of 60.
- Group A was grown in darkness for 2 days.
- Group B was grown for 1 day in darkness and then for 1 day in white light using the set-up shown in Fig. 3.1.

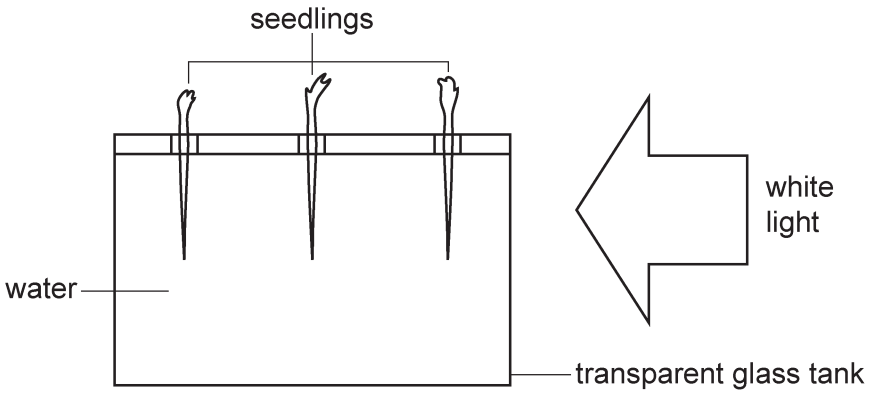

Fig. 3.1

The results of the students' experiment are shown in Tables 3.1 and 3.2.

Group	Mean length (mm)		Mean mass (μg)	
	stem	root	stem	root
A	13	18	102	60
B	25	23	160	120

Table 3.1

	Number of seedlings	
Direction of growth in Group B	**stem**	**root**
Away from light	2	29
Neither away from nor towards light	3	20
Towards light	55	11

Table 3.2

(a) (i)* Describe and explain the results shown in Tables 3.1 and 3.2.

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Additional answer space if required.

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(ii) The students wanted to test whether there was a significant difference between the stem lengths of the seedlings in Group A and the seedlings in Group B.

State the name of the most appropriate statistical test for the students to use.

..... **[1]**

(iii) Justify your choice of statistical test given in part **(ii)**.

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..... **[1]**

(iv) Table 3.2 records the direction of growth as:

- away from light
- neither away from nor towards light
- towards light.

The students used the chi-squared test to determine whether the direction of root growth was significantly different from their expectations.

Their null hypothesis was:

There is no difference between the expected direction of root growth and the observed direction of root growth.

The calculated chi-squared value was 8.10.

The students compared their chi-squared value of 8.10 to the values in Table 3.3.

Degrees of freedom	**Probability (*p*)**		
	0.10	**0.05**	**0.01**
1	2.71	3.84	6.64
2	4.60	5.99	9.21
3	6.25	7.82	11.34
4	7.78	9.49	13.28
5	9.24	11.07	15.09

Table 3.3

What can the students conclude about their results based on a chi-squared value of 8.10?

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..... **[3]**

(b) The solution in which the seedlings were grown contained various dissolved ions.

The table below lists two of the functions of these ions in the seedlings.

Complete the table below with the **formula** of each ion.

Function	Formula of ion
Supplies elements that form part of the structure of amino acids and nucleotides	
Forms part of the structure of DNA and phospholipids	

[2]

(c) The students also investigated the effect of plant hormone concentration on root growth.

(i) State the name of a plant hormone that would be expected to affect root growth.

..... **[1]**

(ii) In the investigation, the students controlled light, temperature and mineral concentration.

State one **other** factor that the students should have controlled in this investigation.

..... **[1]**

(d) The growth of plant roots is thought to be controlled by specialised cells called statocytes.

One hypothesis for how a statocyte controls root growth involves small organelles called amyloplasts and is shown in Fig. 3.2.

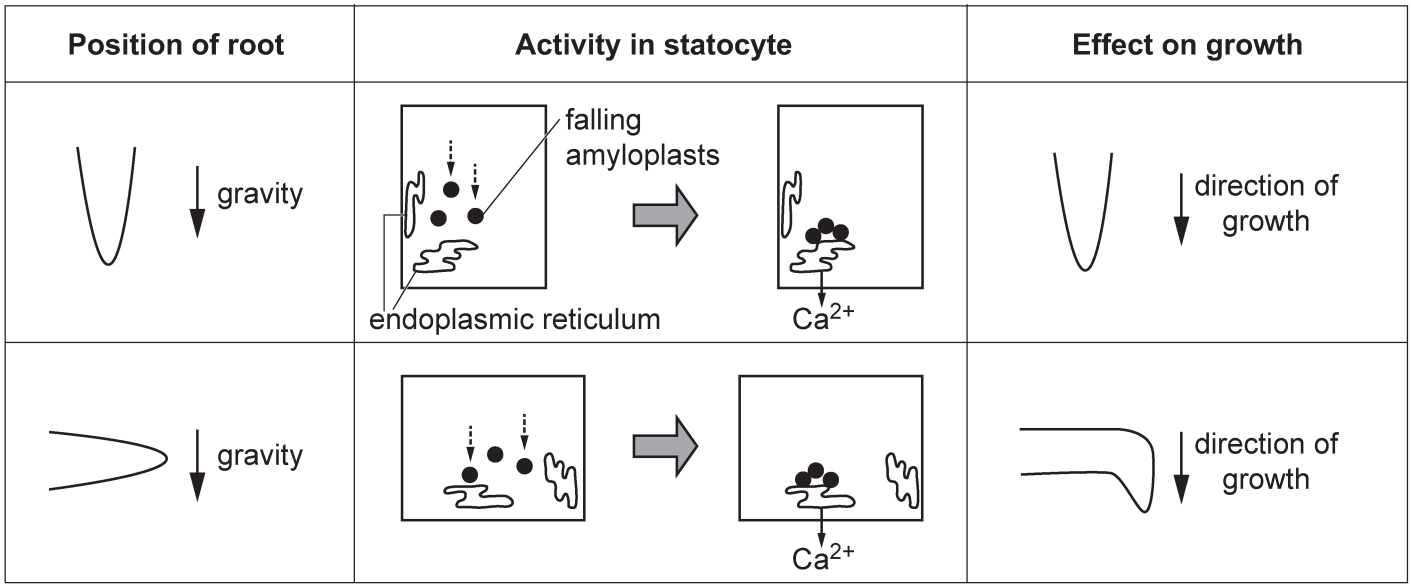

Fig. 3.2

What can you conclude from the information in Fig. 3.2 about how a statocyte controls root growth?

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4 **(a)** Prokaryotic cells have cytoskeletons. The molecules in prokaryotic cytoskeletons are different from the molecules in eukaryotic cytoskeletons.

Table 4.1 lists three molecules present in a prokaryotic cytoskeleton.

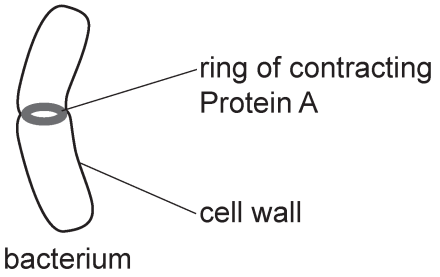
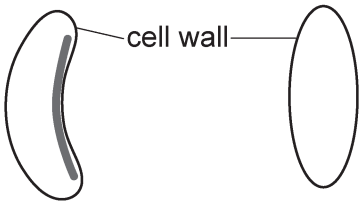
Prokaryotic cytoskeleton molecule	Information
Protein A	
Protein B	Similar structure to actin.
Protein C	

Table 4.1

(i) Suggest the function of Protein A.

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..... **[1]**

(ii) Suggest the function of Protein C.

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..... **[1]**

(iii) An antibiotic called A22 binds irreversibly to Protein B. Despite its antibiotic properties, A22 is not used in humans.

Suggest why scientists have advised that A22 should not be used in humans.

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..... **[1]**

(b) Vancomycin is an antibiotic that has been used to treat bacterial infections for many decades. Several strains of bacteria have evolved resistance to vancomycin.

Oritavancin is an antibiotic with a similar structure to vancomycin.

Table 4.2 shows data obtained from treatments with the two antibiotics.

		oritavancin	**vancomycin**
Years of use as an antibiotic		4	60
Percentage of patients developing side effects	nausea	9.9	10.5
	headache	7.1	6.7
	diarrhoea	3.7	3.2
	vomiting	4.6	4.7
	constipation	3.4	3.9
	dizziness	2.7	2.6
Percentage of bacterial infections cured	*Staphylococcus aureus*	82.5	83.5
	MRSA	81.4	80.6
	Streptococcus sp.	77.2	85.3

Table 4.2

Use the data in Table 4.2 to evaluate the advantages **and** disadvantages of using oritavancin rather than vancomycin as an antibiotic.

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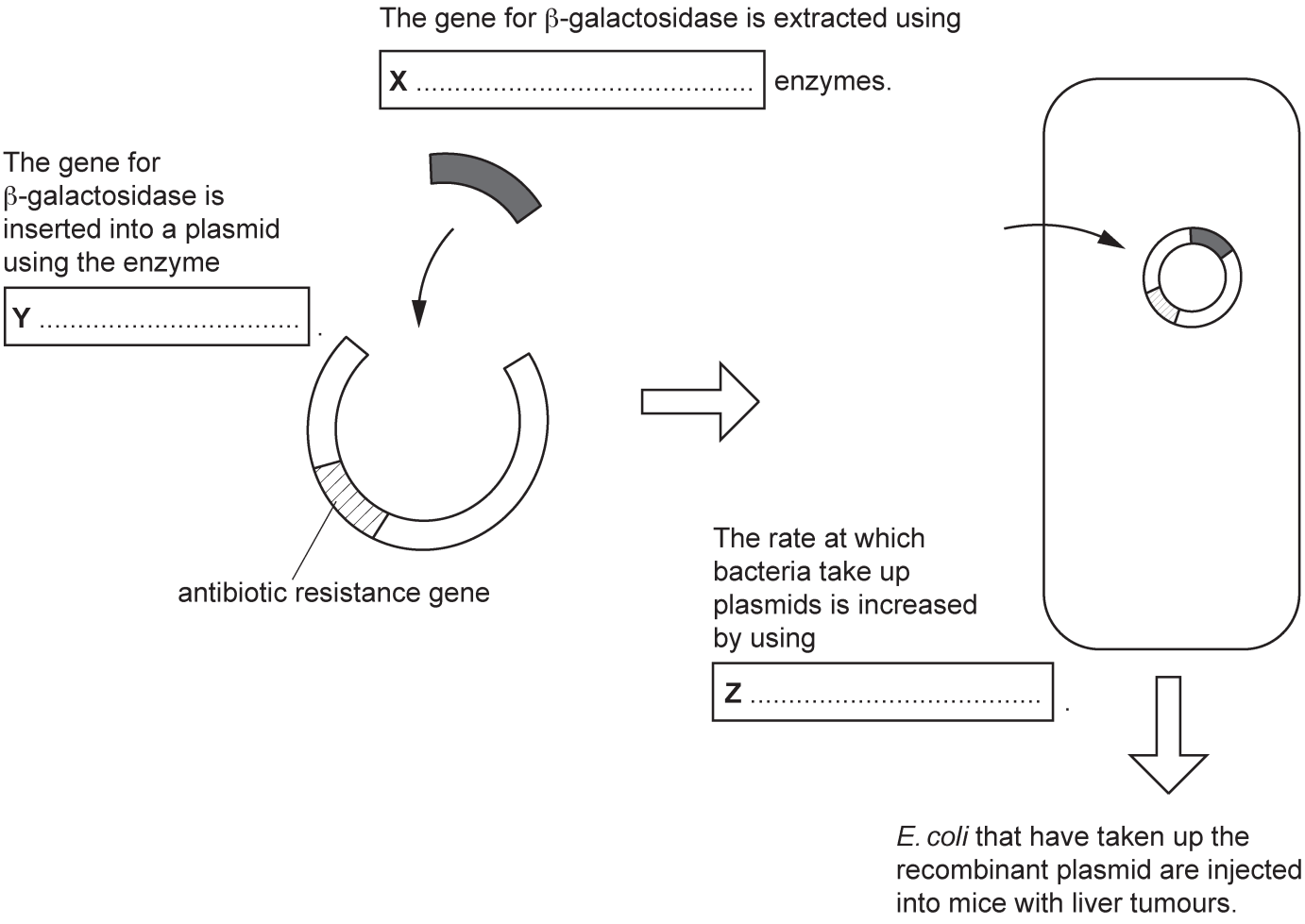
(c) Bacteria such as *E. coli* can be genetically engineered for use in medical science.

An example of the genetic engineering of *E. coli* is shown in the diagram below.



(i) Complete the diagram above by writing the missing words or phrases in the boxes labelled **X**, **Y** and **Z**.

.....Answer **on** the diagram..... **[3]**

(ii) Suggest why the scientists used a plasmid that contained an antibiotic resistance gene.

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..... **[1]**

(iii) The scientists observed the following:

- 1 in 400 bacteria took up the plasmid
- 1 in 1000 of the plasmids taken up by bacteria contained the β-galactosidase gene.

Calculate the percentage of bacteria that contained the β-galactosidase gene.

percentage of bacteria = ... % **[2]**

(iv) A technique called quantitative PCR is used to check that the *E. coli* population is growing on the mice liver tumours rather than on healthy tissue.

Suggest how the scientists could use PCR to **compare** *E. coli* growth rates on cancerous liver tissue and healthy tissue.

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(v) Some people think that the genetic engineering of certain organisms is unethical.

However, there are very few ethical concerns about the genetic engineering of bacteria such as *E. coli*.

Suggest why there are very few ethical concerns about the genetic engineering of *E. coli*.

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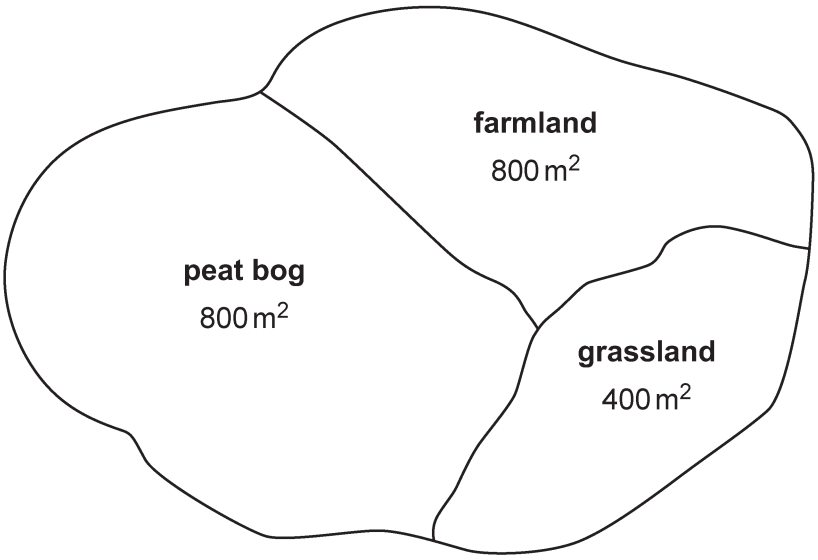
5 Ecologists were studying an area that contained three different habitats. The area is shown in the diagram below.



(a) The ecologists sampled the area to estimate insect biodiversity.

Describe how the ecologists should choose the number and locations of their samples to ensure that the sampling is representative.

Use a calculation to support your answer.

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..... **[3]**

(b) Two of the insect species that were sampled were the large heath butterfly and the bog hoverfly.

The ecologists used the capture-mark-recapture technique and estimated population sizes using two different calculations: the Lincoln estimate and the Chapman estimate.

(i) Calculate the population sizes of the two insect species using each of the formulae below.

Write your answers in the table.

Lincoln estimate formula: population size = $\frac{n1 \times n2}{m}$

Chapman estimate formula: population size = $\left(\frac{(n1 + 1) \times (n2 + 1)}{(m + 1)}\right) - 1$

n = number of individuals in a particular sample

m = number of marked individuals in the second sample

Species	Number captured and marked in sample 1	Total number in sample 2	Number of marked individuals in sample 2	Population estimate (number of individuals)	
				Lincoln estimate	Chapman estimate
large heath butterfly	77	73	4		
bog hoverfly	5	6	1		

[2]

(ii) The Lincoln and Chapman formulae give different estimates for population size.

Give **two** further conclusions about the difference in population estimates given by the Lincoln and Chapman formulae.

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2 .....

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[2]

(c) The peat bog habitat had been damaged by peat extraction and by management of the neighbouring farmland. Ecologists decided to treat the peat bog in the following way:

- A buffer region was created between the peat bog and the neighbouring farmland.
- No visitors were allowed on the land.
- Ditches were blocked to raise water levels.
- Peat extraction, tree planting and the use of fertilisers were banned.

A student suggested that this was an example of preservation.

Evaluate the student's conclusion.

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(d) Conservation agreements can be national (within a particular country) or international.

Three conservation agreements are listed in the table below.

Place ticks (✓) in the correct boxes to indicate which features are true for each of the three conservation agreements.

Name of agreement	International agreement	Farmers are offered payments for conservation
Environmental (Countryside) Stewardship Scheme		
Convention on International Trade in Endangered Species		
Rio Convention on Biological Diversity		

[2]

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6 **(a)** The oxygen dissociation curves for adult haemoglobin and fetal haemoglobin are shown in Fig. 6.1.

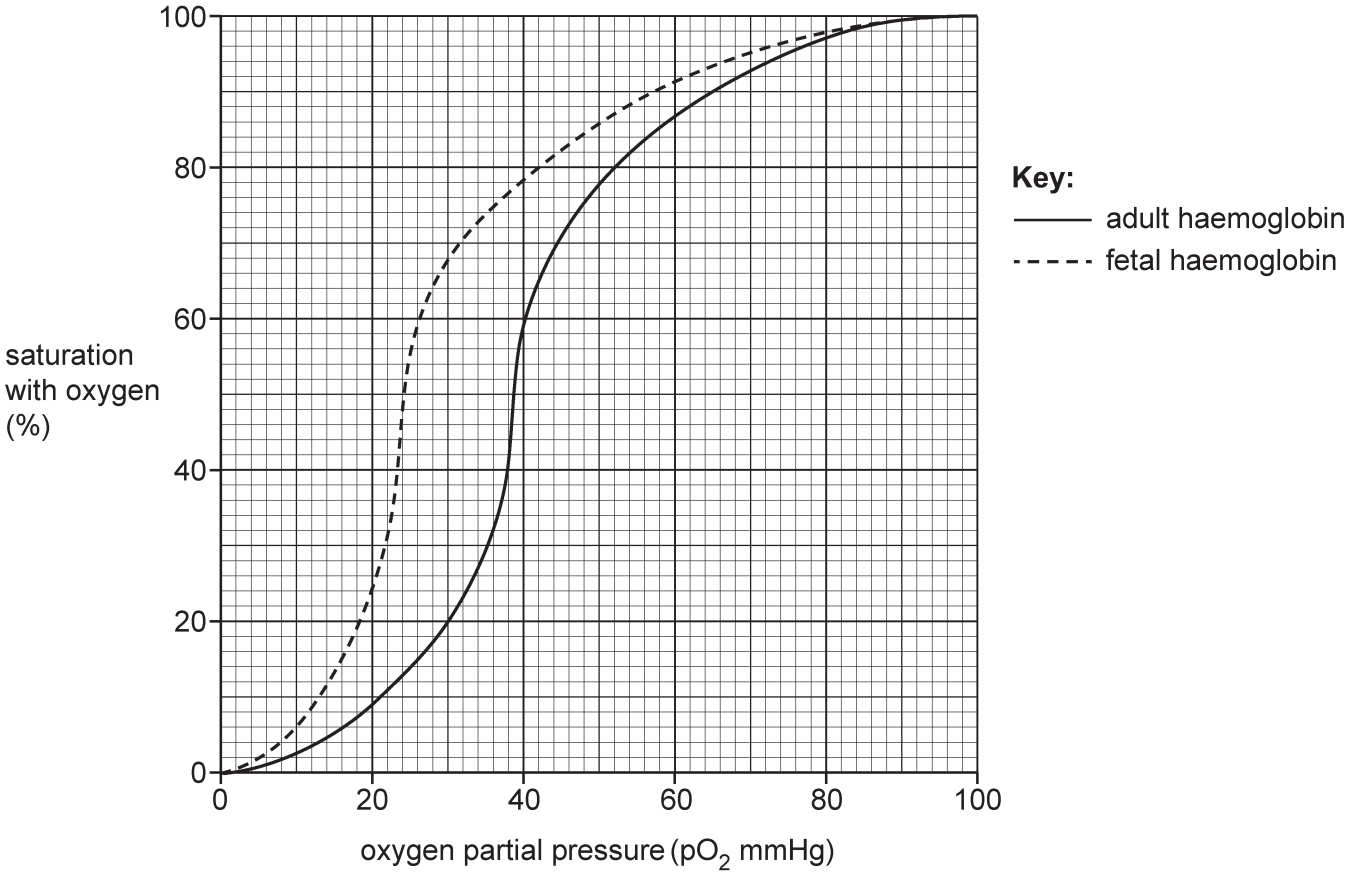

Fig. 6.1

(i) Outline why it is important that fetal haemoglobin has a higher oxygen affinity than adult haemoglobin.

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(ii) Myoglobin is a protein found in muscles. Oxygen binds to myoglobin.

A student described the oxygen dissociation curve for myoglobin as follows:

- When oxygen first becomes available, myoglobin saturation increases at a constant rate of 8% per mmHg of oxygen.
- When there is a slightly higher partial pressure of oxygen, the rate of oxygen binding slows gradually until the myoglobin is 100% saturated.
- The partial pressure at which myoglobin reaches 100% saturation is the partial pressure at which adult haemoglobin is 80% saturated.

Sketch an oxygen dissociation curve for myoglobin **on Fig. 6.1** based on the description provided above.

..... Answer **on Fig. 6.1** ..... **[2]**

(b) Haemocyanin is an oxygen-binding pigment that is found in many invertebrate animals, including lobsters.

Fig. 6.2 shows the oxygen dissociation curves for haemoglobin and haemocyanin.

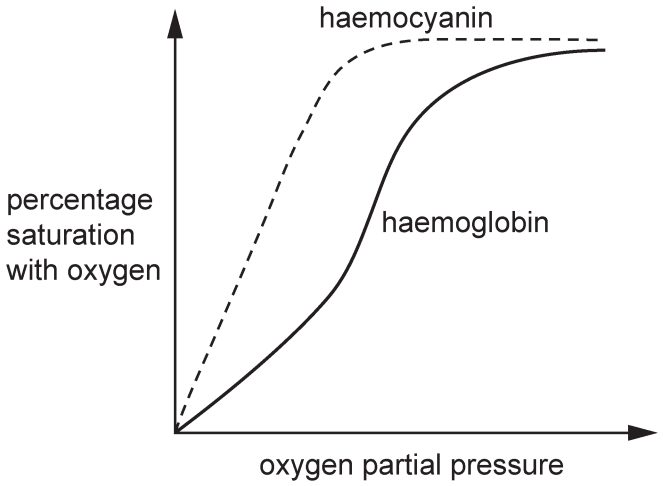

Fig. 6.2

What can you conclude about the habitat of a lobster?

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..... **[1]**

(c) When old red blood cells are broken down, each haem group is converted to a molecule called bilirubin. Bilirubin passes through the digestive system. Bilirubin gives faeces their characteristic colour.

Explain why bilirubin production and processing is an example of excretion.

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..... **[2]**

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).