NOTICE TO CUSTOMER:

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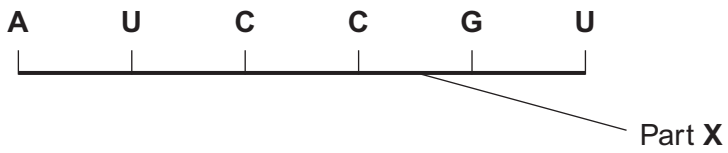
Answer **all** questions in the spaces provided.

1 The diagram shows part of a pre-mRNA molecule.



1 (a) (i) Name the **two** substances that make up part **X**.

..... and .....

(1 mark)

1 (a) (ii) Give the sequence of bases on the DNA strand from which this pre-mRNA has been transcribed.

.....

(1 mark)

1 (b) (i) Give **one** way in which the structure of an mRNA molecule is different from the structure of a tRNA molecule.

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(1 mark)

1 (b) (ii) Explain the difference between pre-mRNA and mRNA.

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(1 mark)

1 (c) The table shows the percentage of different bases in two pre-mRNA molecules. The molecules were transcribed from the DNA in different parts of a chromosome.

Part of chromosome	Percentage of base			
	A	**G**	**C**	**U**
Middle	38	20	24	
End	31	22	26	

1 (c) (i) Complete the table by writing the percentage of uracil (U) in the appropriate boxes.

(1 mark)

1 (c) (ii) Explain why the percentages of bases from the middle part of the chromosome and the end part are different.

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(2 marks)

7

Turn over for the next question

2 Different substances are involved in coordinating responses in animals.

2 (a) Hormones are different from local chemical mediators such as histamine in the cells they affect.

2 (a) (i) Describe how hormones are different in the cells they affect.

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(1 mark)

2 (a) (ii) Describe how hormones and local chemical mediators reach the cells they affect.

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(2 marks)

2 (b) Synapses are unidirectional. Explain how acetylcholine contributes to a synapse being unidirectional.

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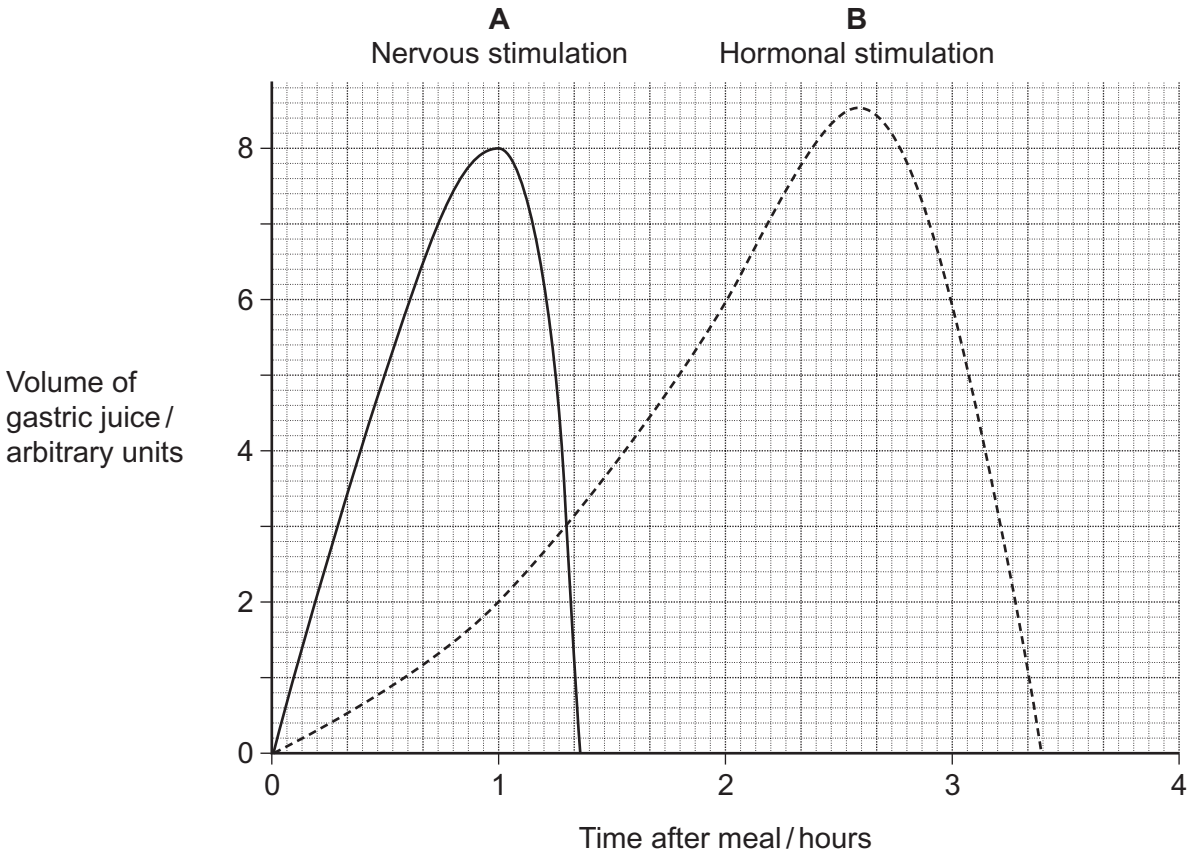
(2 marks)

2 (c) Cells in the stomach wall release gastric juice after a meal. The graph shows how the volumes of gastric juice produced by nervous stimulation and by hormonal stimulation change after a meal.



2 (c) (i) Describe the evidence from the graph that curve **A** represents the volume of gastric juice produced by nervous stimulation.

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(2 marks)

2 (c) (ii) Complete the table to show the percentage of gastric juice produced by nervous stimulation at the times shown.

	Time after meal / hours		
	1	**2**	**3**
Percentage of gastric juice produced by nervous stimulation			

(1 mark)

8

3 IAA is a specific growth factor.

3 (a) Name the process by which IAA moves from the growing regions of a plant shoot to other tissues.

.....

(1 mark)

3 (b) When a young shoot is illuminated from one side, IAA stimulates growth on the shaded side. Explain why growth on the shaded side helps to maintain the leaves in a favourable environment.

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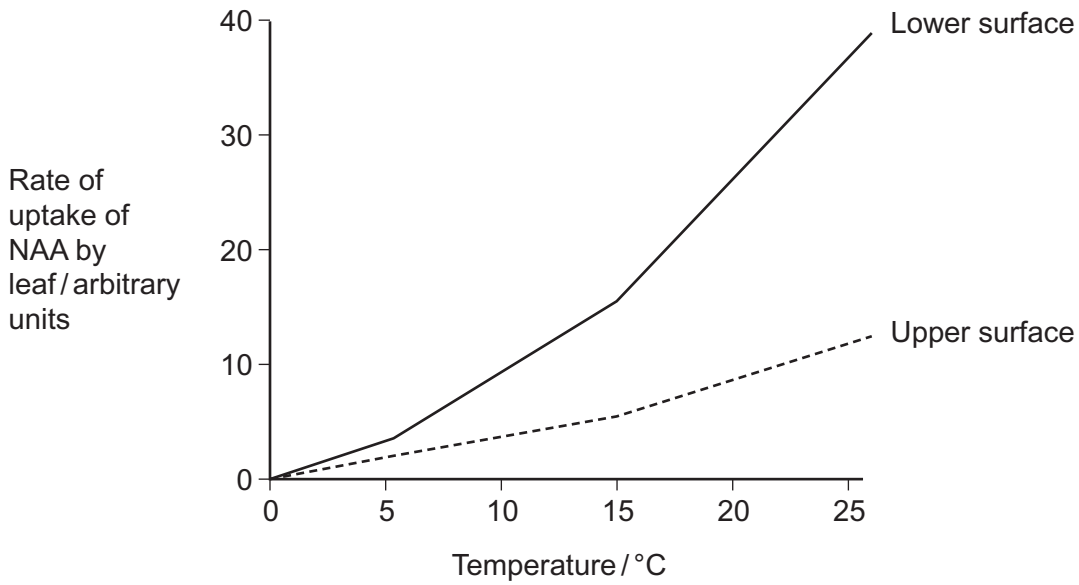
(2 marks)

NAA is a similar substance to IAA. It is used to control the growth of cultivated plants. Plant physiologists investigated the effect of temperature on the uptake of NAA by leaves. They sprayed a solution containing NAA on the upper and lower surfaces of a leaf. The graph shows their results.



3 (c) Explain the effect of temperature on the rate at which NAA is taken up by the lower surface of the leaf.

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(2 marks)

3 (d) There are differences in the properties of the cuticle on the upper and lower surfaces of leaves.

3 (d) (i) Suggest how these differences in the cuticle might explain the differences in rates of uptake of NAA by the two surfaces.

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(2 marks)

3 (d) (ii) In this investigation, the physiologists investigated the leaves of pear trees. Explain why the results might be different for other species.

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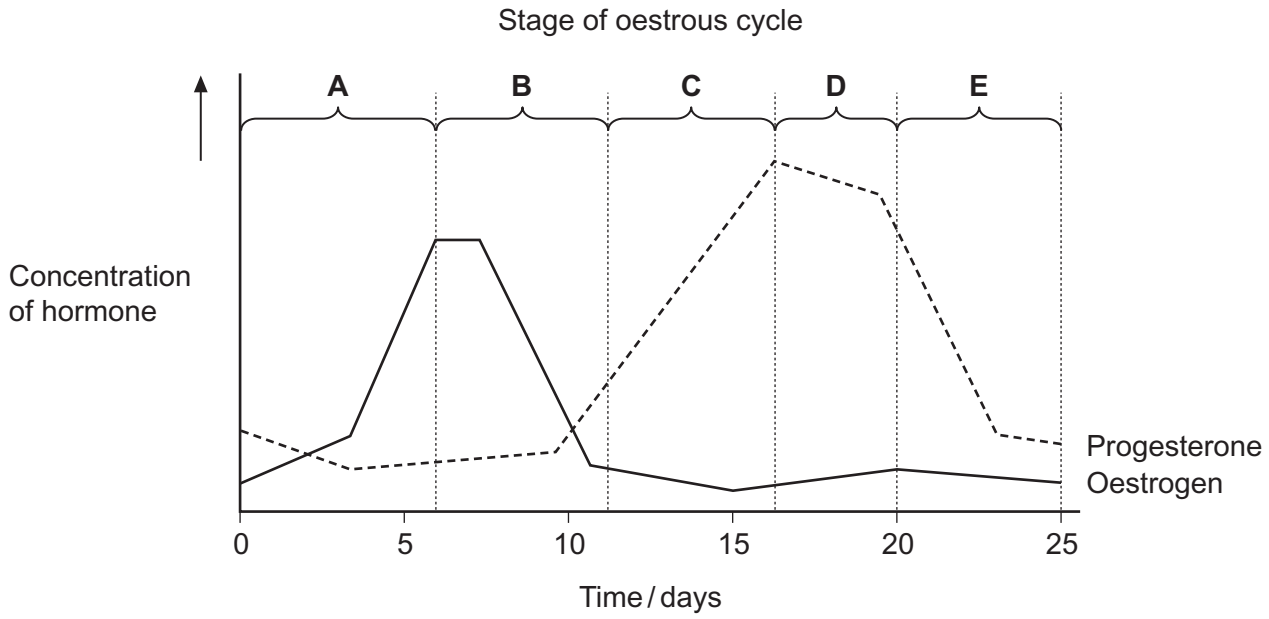
(1 mark)

8

4 The graph shows the concentrations of two hormones in the blood of an adult female pig over 25 days.



4 (a) (i) Use the graph to give the letter of the stage where ovulation occurred.

(1 mark)

4 (a) (ii) Give **one** piece of evidence from the graph that this pig was **not** pregnant at 25 days.

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(1 mark)

4 (b) The relationship between oestrogen and LH is an example of positive feedback. Explain how.

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(2 marks)

4 (c) Farmers sometimes give progesterone to sheep to prevent ovulation. Explain how progesterone prevents ovulation.

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(2 marks)

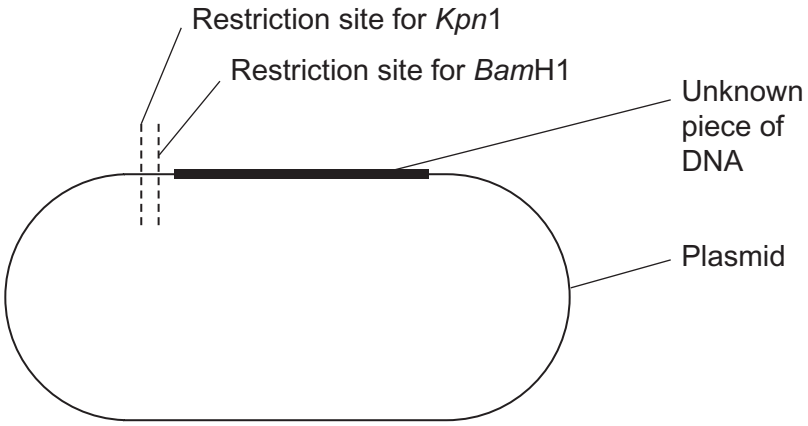
6

Turn over for the next question

5 Scientists used restriction mapping to investigate some aspects of the base sequence of an unknown piece of DNA. This piece of DNA was 3 000 base pairs (bp) long.

The scientists took plasmids that had one restriction site for the enzyme *Kpn*1 and one restriction site for the enzyme *Bam*H1. They inserted copies of the unknown piece of DNA into the plasmids. This produced recombinant plasmids.

The diagram shows a recombinant plasmid.



5 (a) When the scientists digested one of the recombinant plasmids with *Kpn*1, they obtained two fragments. One fragment was measured as 1 000 bp.
The other fragment was described as "very large".

5 (a) (i) What does this show about the base sequence of the unknown piece of DNA?

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(2 marks)

5 (a) (ii) One of the fragments that the scientists obtained was described as "very large".
What is represented by this very large fragment?

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(1 mark)

5 (b) When the scientists digested another of the recombinant plasmids with *Bam*H1, they obtained three fragments.

How many *Bam*H1 restriction sites are there in the unknown piece of DNA?

(1 mark)

5 (c) (i) Scientists can separate fragments of DNA using electrophoresis. Suggest how they can use electrophoresis to estimate the number of base pairs in the separated fragments.

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(2 marks)

5 (c) (ii) Scientists need to take precautions when they carry out restriction mapping. They need to make sure that the enzyme they have used has completely digested the DNA. One check they may carry out is to add the sizes of the fragments together. How could scientists use this information to show that the DNA has **not** been completely digested? Explain your answer.

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(2 marks)

8

6 Plant physiologists attempted to produce papaya plants using tissue culture.
They investigated the effects of different concentrations of two plant growth factors on small pieces of the stem tip from a papaya plant. Their results are shown in the table.

Concentration of auxin / μmol dm^{-3}	Concentration of cytokinin / μmol dm^{-3}		
	5	25	50
0	No effect	No effect	Leaves produced
1	No effect	Leaves produced	Leaves produced
5	No effect	Leaves produced	Leaves and some plantlets produced
10	Callus produced	Leaves and some plantlets produced	Plantlets produced
15	Callus produced	Callus and some leaves produced	Callus and some leaves produced

Callus is a mass of undifferentiated plant cells.
Plantlets are small plants.

6 (a) Explain the evidence from the table that cells from the stem tip are totipotent.

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(2 marks)

6 (b) Calculate the ratio of cytokinin : auxin that you would recommend to grow papaya plants by this method.

Answer .....

(2 marks)

6 (c) (i) Papaya plants reproduce sexually by means of seeds. Papaya plants grown from seeds are very variable in their yield. Explain why.

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(2 marks)

6 (c) (ii) Explain the advantage of growing papaya plants from tissue culture rather than from seeds.

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(1 mark)

7

Turn over for the next question

7 (a) Desert iguanas are lizards that live in hot, dry conditions. Scientists measured the rate of oxygen consumption of desert iguanas at different body temperatures. Some of their results are shown in the table.

Body temperature / °C	Mean rate of oxygen consumption at rest / $cm^3\ g^{-1}\ h^{-1}$
25	0.4
30	0.7
35	1.2
40	1.5

7 (a) (i) Explain how an increase in the iguana's body temperature affects its oxygen consumption when it is at rest.

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(3 marks)

(Extra space) .....

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7 (a) (ii) The units in the table allowed the scientists to compare the oxygen consumptions of different iguanas. Explain how.

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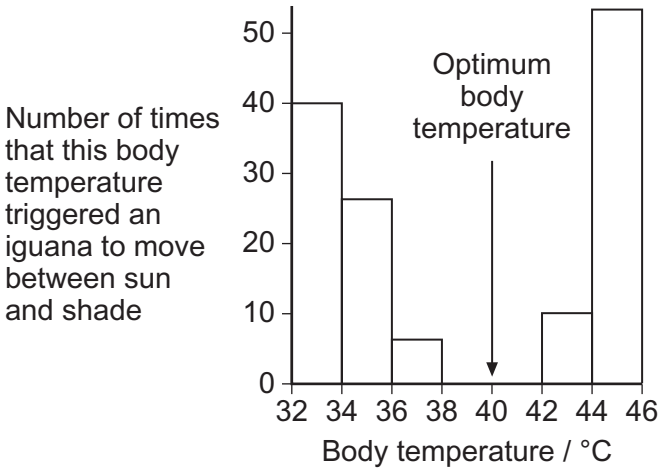
(1 mark)

7 (b) The scientists then investigated how body temperature affected the behaviour of desert iguanas. They kept the iguanas in cages. Half of each cage was in the sun and half was covered to provide shade. The scientists continuously measured the body temperature of each iguana. They also recorded the body temperature when the iguana moved between sun and shade. Their results are shown in the graph.



7 (b) (i) Describe how the movements of the iguanas between sun and shade are related to body temperature.

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(1 mark)

7 (b) (ii) The behaviour of the desert iguanas keeps their body temperatures within a narrow range. Explain how.

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(2 marks)

7 (c) At high temperatures, a desert iguana keeps its mouth wide open and breathes in and out rapidly. This is called panting. Explain how panting helps to reduce the body temperature of an iguana.

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(2 marks)

9

8 (a) Transcriptional factors are important in the synthesis of particular proteins. Describe how.

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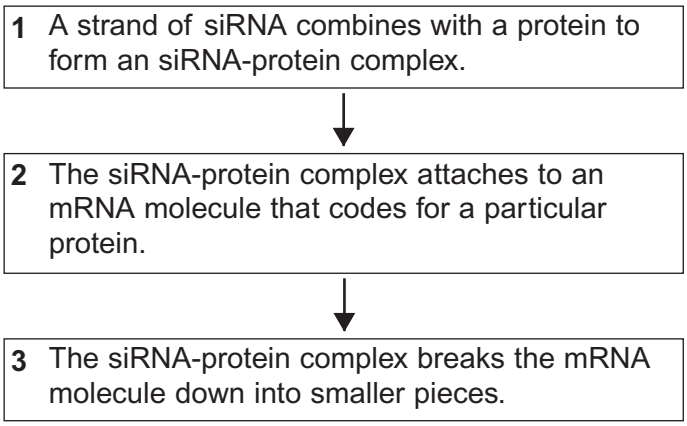
(2 marks)

8 (b) The flowchart shows how small interfering RNA (siRNA) affects the expression of a particular target gene.



8 (b) (i) The siRNA-protein complex attaches to an mRNA molecule coding for a particular protein (step **2**). Explain what causes the siRNA to attach only to one sort of mRNA molecule.

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(1 mark)

8 (b) (ii) Describe and explain how expression of the target gene is affected by siRNA.

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(2 marks)

8 (b) (iii) Scientists have suggested that siRNA may be useful in treating some diseases. Suggest why siRNA may be useful in treating disease.

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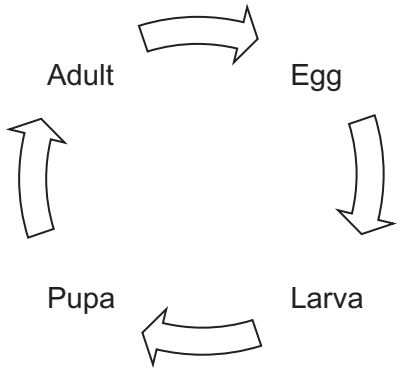
(2 marks)

7

Turn over for the next question

9 The diagram shows the life cycle of a fly.



When the larva is fully grown, it changes into a pupa. The pupa does not feed. In the pupa, the tissues that made up the body of the larva are broken down. New adult tissues are formed from substances obtained from these broken-down tissues and from substances that were stored in the body of the larva.

9 (a) Hydrolysis and condensation are important in the formation of new adult proteins. Explain how.

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(2 marks)

9 (b) Most of the protein stored in the body of a fly larva is a protein called calliphorin. Explain why different adult proteins can be made using calliphorin.

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(1 mark)

The table shows the mean concentration of RNA in fly pupae at different ages.

Age of pupa as percentage of total time spent as a pupa	**Mean concentration of RNA / µg per pupa**
0	20
20	15
40	12
60	17
80	33
100	20

9 (c) Describe how the concentration of RNA changes during the time spent as a pupa.

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(2 marks)

9 (d) (i) Describe how you would expect the number of lysosomes in a pupa to change with the age of the pupa. Give a reason for your answer.

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(2 marks)

9 (d) (ii) Suggest an explanation for the change in RNA concentration in the first 40 % of the time spent as a pupa.

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(2 marks)

9 (e) Suggest an explanation for the change in RNA concentration between 60 and 80 % of the time spent as a pupa.

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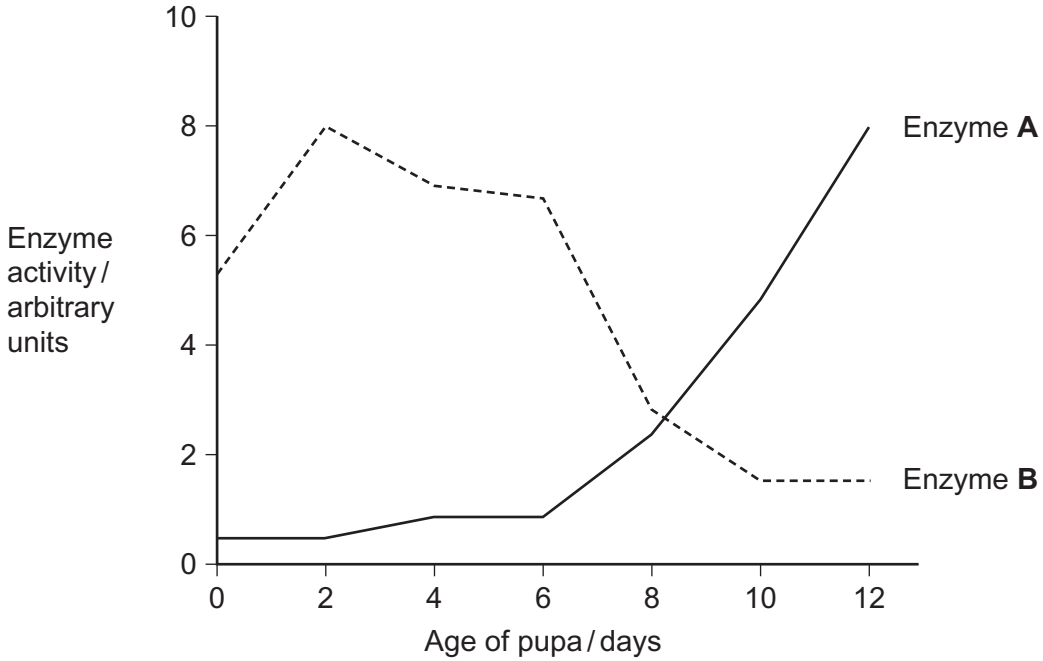
(2 marks)

Question 9 continues on the next page

9 (f) The graph shows changes in the activity of two respiratory enzymes in a fly pupa.

- Enzyme **A** catalyses a reaction in the Krebs cycle
- Enzyme **B** catalyses the formation of lactate from pyruvate



During the first 6 days as a pupa, the tracheae break down. New tracheae are formed after 6 days. Use this information to explain the change in activity of the two enzymes.

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(4 marks)

(Extra space) .....

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15

Essay

You should write your essay in continuous prose.

Your essay will be marked for its scientific accuracy. It will also be marked for your selection of relevant material from different parts of the specification and for the quality of your written communication.

The maximum number of marks that can be awarded is

Scientific content	16
Breadth of knowledge	3
Relevance	3
Quality of written communication	3

10 Write an essay on **one** of the following topics.

EITHER

10 (a) Using DNA in science and technology

(25 marks)

OR

10 (b) A cycle is a biological pathway or process in which the end product of one cycle becomes the starting point for the next cycle. Write an essay about cycles in biology.

(25 marks)

If you want to make a plan write it here.

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1 Fig. 1.1 is a flow diagram showing the main stages involved in making cheese. The starting material is milk, which contains the protein, casein.

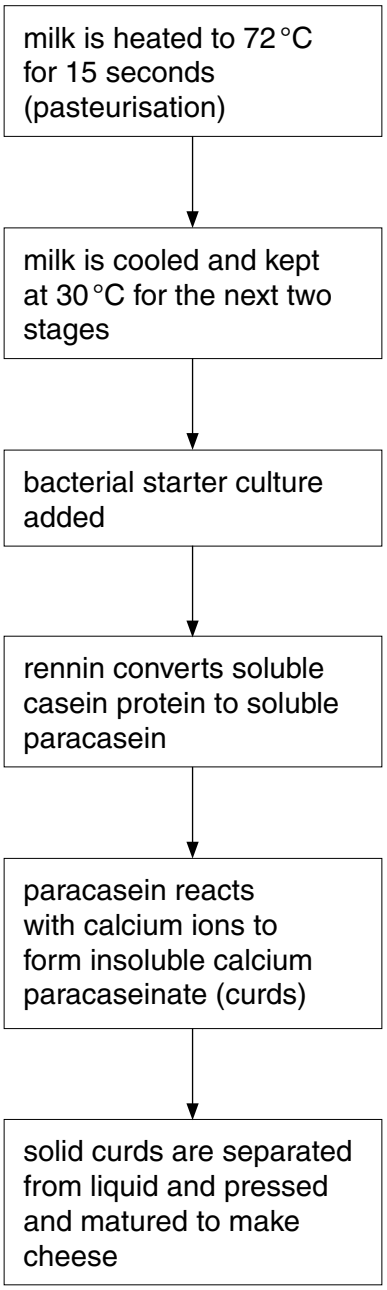

Fig. 1.1

(a) (i) Explain why making cheese can be described as a biotechnological process.

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

(ii) Suggest **two** benefits of the pasteurisation stage.

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

(b) (i) Rennin is a protein that can be obtained from the stomach lining of calves. It is used in the cheese-making process in the ratio one part rennin to 10 000 parts milk.

Suggest what type of protein rennin is **and** explain how a very small quantity of rennin is able to convert a large quantity of milk.

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

(ii) Rennin could, in theory, be immobilised for use in cheese-making.

List **two** potential advantages of this.

1 .....

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

(c) Rennin can now be made by genetically modified microorganisms.

Outline the process by which bacteria can be genetically modified to produce rennin.

In your answer, you should make clear how the steps in the process are sequenced.

.... **[8]**

[Total: 17]

2 Four different eye pigments in the fruit fly, *Drosophila melanogaster,* are made from the amino acid tryptophan. A simplified metabolic pathway of pigment production is shown in Fig. 2.1.

Three different gene loci control the pathway. Each locus has two alleles. These alleles are **V** or **v**, **C** or **c** and **B** or **b**, as shown in Fig. 2.1.

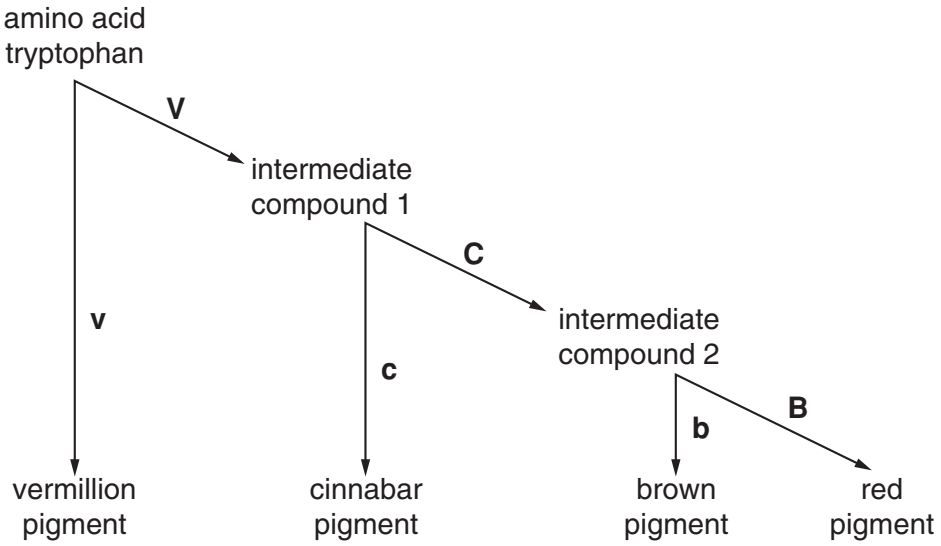

Fig. 2.1

(a) (i) Using the information in Fig. 2.1, deduce the phenotypes of flies with the following genotypes:

genotype	*phenotype*
VvCcBb	.....
vvCCBB	.....
VvccBB	..... **[3]**

(ii) State the term that is applied to this type of gene interaction.

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

(iii) Explain how the products **coded for** by the genes interact to give the different pigments.

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

(b) A mutation in another gene at another locus in *Drosophila* gives rise to white-eyed flies. The red eye allele of this gene (**R**) is known to be dominant to the white eye allele (**r**).

A student crossed a red-eyed fly with a white-eyed fly, expecting to get an F1 generation of red-eyed flies. In fact, the results were as shown in Table 2.1.

Table 2.1

phenotype of fly	number of offspring
red-eyed female	27
red-eyed male	0
white-eyed female	0
white-eyed male	23

(i) The student first suggested that the reason for there being red-eyed and white-eyed flies in the offspring was that the red-eyed parent was heterozygous.

Explain why this **cannot** be the correct explanation for the results shown in Table 2.1.

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

(ii) In *Drosophila*, the males are the heterogametic sex, possessing two different sex chromosomes, X and Y.

Draw a genetic diagram to show how the results shown in Table 2.1 could have been produced.

Parental genotypes …… ……

Gametes …… ……

F_1 genotypes …… ……

[3]

(iii) The chi-squared (χ^2) test can be used to analyse the results in Table 2.1.

The expected ratio of red-eyed females to white-eyed males is 1:1.

Use Table 2.2 to calculate a value for chi-squared (χ^2).

$$\chi^2 = \Sigma \frac{(O - E)^2}{E} \qquad df = n - 1$$

Key to symbols:

Σ = 'sum of …'
df = degrees of freedom
n = number of classes
O = observed value
E = expected value

Table 2.2

phenotype of fly	O	E	O – E	$(O - E)^2$	$\frac{(O - E)^2}{E}$
red-eyed female					
white-eyed male					

χ^2 = ...

Use your calculated value of χ^2 and the table of probabilities shown in Table 2.3 to test the significance of the difference between the observed and expected results.

State your conclusion in the space below.

Table 2.3

degrees of freedom	probability, p			
	0.90	0.50	0.10	0.05
1	0.02	0.45	2.71	3.84
2	0.21	1.39	4.61	5.99

Conclusion .....

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

[Total: 16]

3 **(a)** The fruit fly, *Drosophila melanogaster*, the zebra fish, *Danio rerio*, and the mouse, *Mus musculus*, have all been used by scientists to find out more about how genes control development in all animals, including humans. They are described as 'model organisms'.

(i) Suggest why information gained from studying such model organisms can be applied to humans.

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

(ii) Suggest **two** characteristics that researchers should look for when choosing an organism for research into how genes control development.

1 .....

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

(b) Fig. 3.1 and Fig. 3.2, **on the insert**, show the heads of two *Drosophila* fruit flies.

Fig. 3.1 shows a normal wild type fly.
Fig. 3.2 shows a mutant fly.

(i) Name the type of microscope used to take the two pictures.

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

(ii) State one significant difference between the two heads.

.....

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

(iii) Name the type of gene which, if mutated, gives rise to dramatic changes in body plan.

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

(c) Describe how the information coded on genes is used to synthesise polypeptides **and** how these polypeptides control the physical development of an organism.

In your answer, you should consider both the synthesis of polypeptides and their roles.

[8]

[Total: 16]

Turn over

4 Fig. 4.1 shows a junction between two neurones where the neurotransmitter is dopamine. Fig. 4.2 shows a neuromuscular junction.

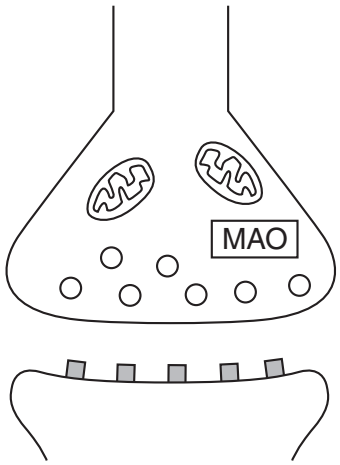

Fig. 4.1

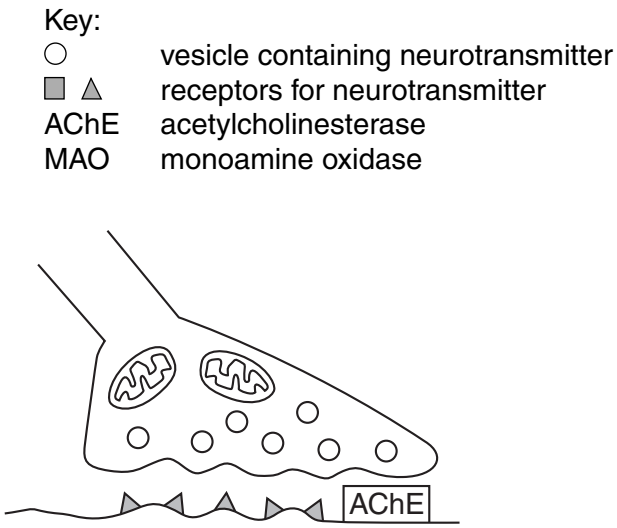

Fig. 4.2

(a) Complete Table 4.1 below to compare the structure and function of the dopamine synapse and the neuromuscular junction.

Table 4.1

	similarity	difference
structure		
function		

[4]

(b) The sequence of events at a dopamine synapse is given below:

- dopamine molecules bind to the protein receptors on the postsynaptic membrane and trigger a response
- dopamine leaves the receptors and moves back into the presynaptic neurone
- some dopamine is repackaged into vesicles
- some dopamine is broken down by the enzyme monoamine oxidase (MAO).

Table 4.2 summarises the action of some drugs that affect dopamine synapses.

Table 4.2

drug	action at synapse
phenothiazine	binds to and blocks dopamine receptors
phenelzine	acts as an inhibitor of MAO
amphetamine	binds to and activates the dopamine receptor and causes release of stored dopamine from vesicles

(i) Use the information in Table 4.2 to suggest which drug molecule could have a shape that **differs** from that of the dopamine molecule. Give a reason for your answer.

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

(ii) Schizophrenia is a condition in which there is a higher than usual level of dopamine in certain areas of the brain.

Suggest why phenothiazine is used to treat schizophrenia.

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

(c) DRD4 is a dopamine receptor in humans. The DRD4 receptor gene has a large number of alleles, of which a single individual can only have two.

(i) Explain why one individual can only have two of the different alleles of the DRD4 gene.

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

(ii) Name a technique that would reveal differences in the lengths of the different forms of the DRD4 receptor gene.

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

(d) Three alleles of DRD4 have the following alterations:

- a single base-pair substitution
- a 21 base-pair deletion
- a 13 base-pair deletion.

Suggest which of the three mutations will have the most serious consequences for the structure of the protein receptor. Give a reason for your choice.

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

(e) One allele of DRD4 has been found more frequently amongst individuals whose personality is described as 'novelty-seeking' and whose behaviour tends to be exploratory and impulsive.

Suggest how this particular allele of the DRD4 receptor could have become common in the human population.

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

[Total: 18]

5 Sarawak is an area of tropical rainforest in south-east Asia. Logging has been allowed in 60% of the forest.

A study was carried out into the effects of logging on the diversity of mammal species living in the forest. An area of rainforest was sampled before logging, immediately after logging and then again two years and four years after logging.

Before logging began, there were 29 mammal species and four years after logging there were 26 mammal species.

Table 5.1 shows the population densities of six groups of mammals before and after logging. Where numbers were too small to measure the density, the species was recorded as "present".

Table 5.1

mammal	mean number of animals per km^2			
	before logging	immediately after logging	two years after logging	four years after logging
marbled cat	present	0	0	0
oriental small-clawed otter	present	0	0	0
giant squirrel	5	1	4	1
small squirrel	16	24	104	19
tree shrew	10	5	10	38
barking deer	3	1	10	present

(a) Marbled cats and otters are carnivores, while squirrels, shrews and deer are herbivores.

Use the information provided to choose the best word(s) or terms to complete the following passage.

The rainforest …… is a dynamic set of interactions between populations of organisms and the abiotic environment. Energy flows from …… , such as trees, to …… consumers, such as squirrels, and on to consumers such as cats and otters at higher …… . The activities of decomposers contribute to the energy lost from the …… component of the rainforest but decomposers allow …… to be recycled. **[6]**

(b) (i) Table 5.1 shows that the number of small squirrels increases initially, but then decreases.

Explain, using your knowledge of factors affecting population growth, why the small squirrel population in this rainforest does **not** increase in size indefinitely.

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

(ii) Describe, using the information provided, how species richness **and** species evenness change in the rainforest by comparing the situation before logging and four years after logging.

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

(c) (i) Suggest why marbled cats and oriental small-clawed otters became extinct in this area but other mammals did not.

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

(ii) Outline **three** reasons for conserving biological resources, such as the rainforest in Sarawak.

1 .....

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2 .....

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3 .....

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

(d) Timber is produced sustainably in the United Kingdom.

Describe **and** explain the benefits of **two** management practices used in sustainable timber production in a temperate country.

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

[Total: 20]

6 **(a)** Plant responses to environmental changes are co-ordinated by plant growth substances (plant hormones).

Explain why plants need to be able to respond to their environment.

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

(b) The following investigation was carried out into the effects of plant growth substances on germination:

- a large number of lettuce seeds was divided into eight equal batches
- each batch of seeds was placed on moist filter paper in a Petri dish and given a different treatment.

The different treatments are shown in Table 6.1. Each tick represents one of the eight batches of seeds.

Table 6.1

	treatment	concentration of gibberellin (mol dm^{-3})			
		0.00	0.05	0.50	5.00
A	water	✓	✓	✓	✓
B	abscisic acid	✓	✓	✓	✓

The batches of seeds were left to germinate at 25 °C in identical conditions and the percentage germination was calculated.

Fig. 6.1 shows the results of this investigation.

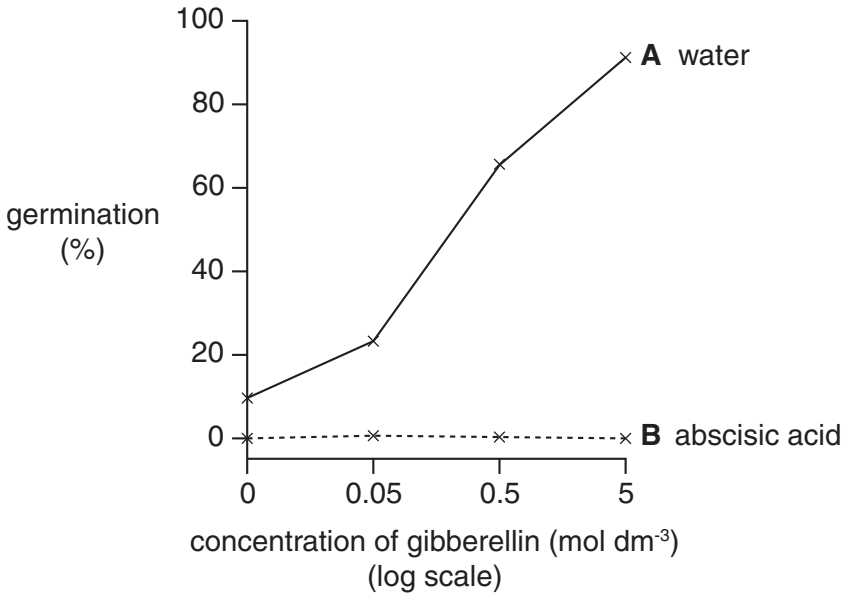

Fig. 6.1

(i) Describe, with reference to Fig. 6.1, the effects of the plant growth substances on the germination of lettuce seeds.

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

(ii) Explain why all the lettuce seeds were kept at 25 °C.

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

(iii) State **three** variables, **other than temperature**, that needed to be controlled in the investigation.

1 .....

2 .....

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

(c) State **two** commercial uses of plant growth substances.

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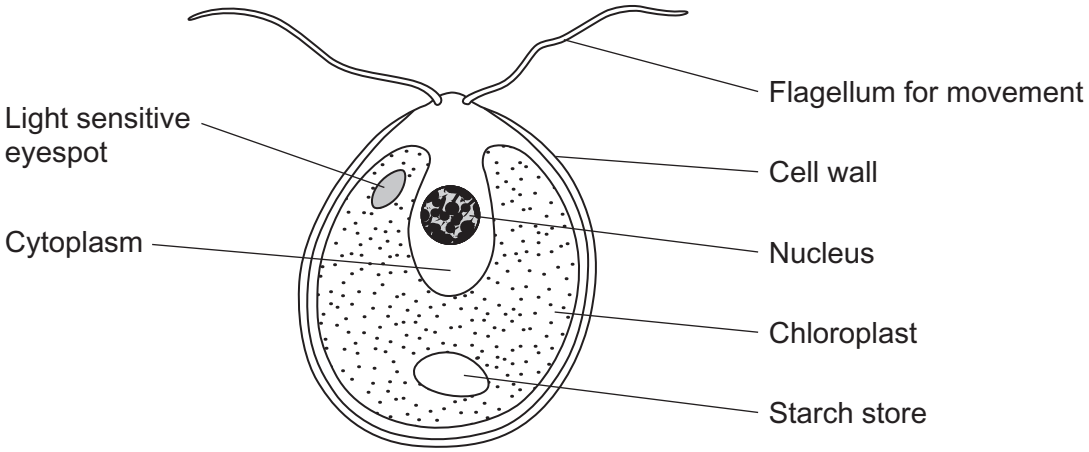
..... **[2]**

[Total: 13]

END OF QUESTION PAPER

Answer **all** questions in the spaces provided.

1 The diagram shows an organism called *Chlamydomonas*.



1 (a) Name **two** structures shown in the diagram that are present in plant cells but are **not** present in animal cells.

1 .....

2 .....

(2 marks)

1 (b) *Chlamydomonas* lives in fresh water ponds. Use your knowledge of osmosis to suggest an advantage of using starch as a carbohydrate store.

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(2 marks)

1 (c) *Chlamydomonas* has adaptations that help it to maintain a high rate of photosynthesis. Use information in the diagram to explain what these adaptations are.

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(3 marks)

(Extra space) .....

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7

2 (a) Explain what is meant by genetic diversity.

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(1 mark)

2 (b) Apart from genetic factors what other type of factor causes variation within a species?

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(1 mark)

2 (c) The spotted owl is a bird. Numbers of spotted owls have decreased over the past 50 years. Explain how this decrease may affect genetic diversity.

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(2 marks)

4

3 The diagram shows a short sequence of DNA bases.

T T T G T A T A C T A G T C T A C T T C G T T A A T A

3 (a) (i) What is the maximum number of amino acids for which this sequence of DNA bases could code?

(1 mark)

3 (a) (ii) The number of amino acids coded for could be fewer than your answer to part **(a)(i)**. Give **one** reason why.

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(1 mark)

3 (b) Explain how a change in the DNA base sequence for a protein may result in a change in the structure of the protein.

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(3 marks)

(Extra space) .....

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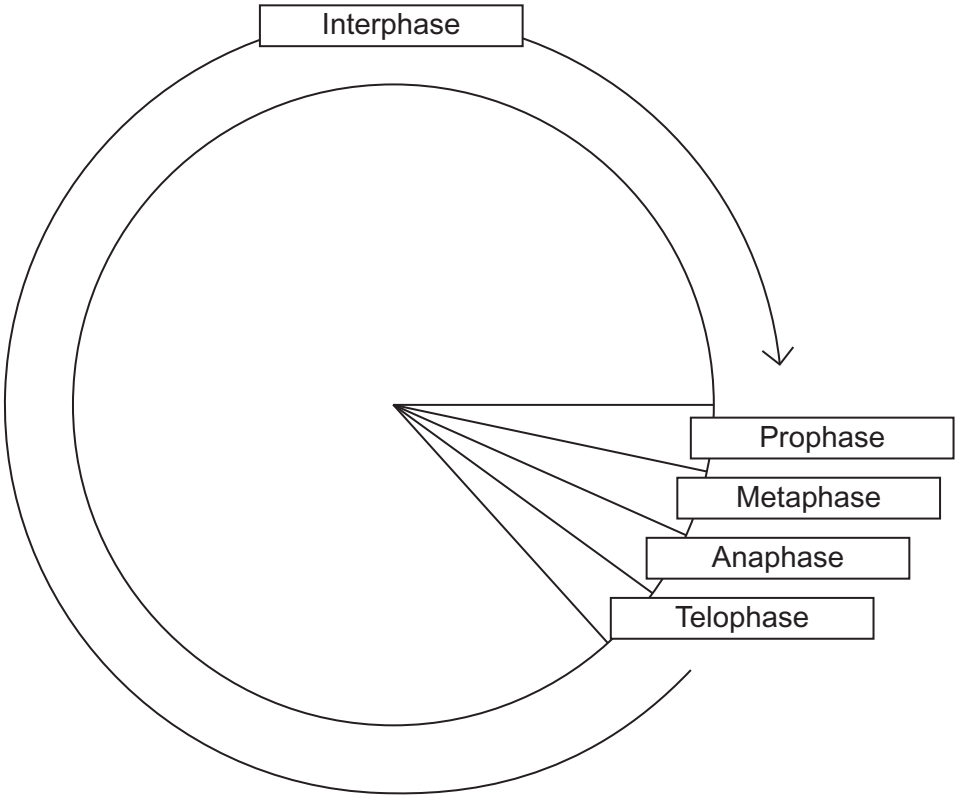
3 (c) A piece of DNA consisted of 74 base pairs. The two strands of the DNA, strands **A** and **B**, were analysed to find the **number** of bases of each type that were present. Some of the results are shown in the table.

	Number of bases			
	C	G	A	T
Strand **A**	26			
Strand **B**	19		9	

Complete the table by writing in the missing values. *(2 marks)*

7

4 The diagram shows a cell cycle.



4 (a) In prophase of mitosis, the chromosomes become visible. Describe what happens in

4 (a) (i) metaphase

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(2 marks)

4 (a) (ii) anaphase.

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(2 marks)

4 (b) (i) Cells lining the human intestine complete the cell cycle in a short time. Explain the advantage of these cells completing the cell cycle in a short time.

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(1 mark)

4 (b) (ii) The time required for a cell to complete the cell cycle was 4 hours 18 minutes. Calculate the time required in minutes for this cell to multiply to produce eight cells. Show your working.

Answer .....

(2 marks)

4 (c) Mikanolide is a drug that inhibits the enzyme DNA polymerase. Explain why this drug may be effective against some types of cancer.

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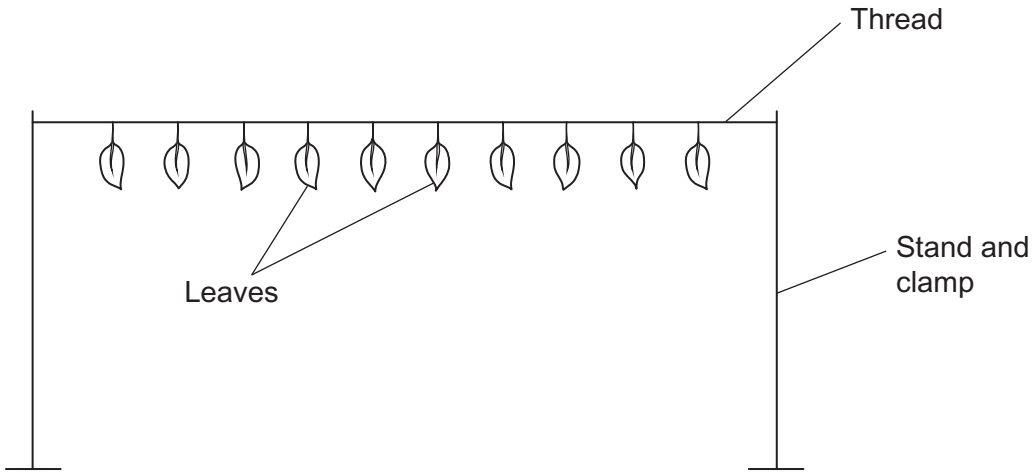
(2 marks)

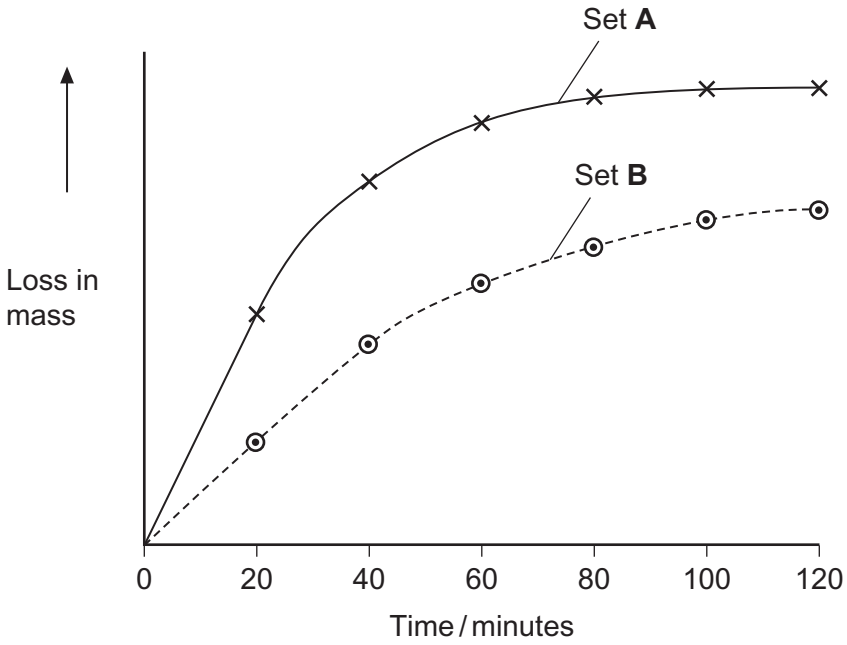
9

5 A student investigated the rate of transpiration from privet leaves.

- She obtained two sets of ten privet leaves.
- She left the ten leaves in set **A** untreated. She covered the upper surfaces of the ten leaves in set **B** with grease.
- She weighed each set of leaves and then tied all the leaves in each set to a separate length of thread. This is shown in the diagram.



- She then weighed each set of leaves every 20 minutes over a period of 2 hours and plotted a graph of her results.



5 (a) Give **two** environmental conditions that the student should have kept constant during this investigation.

1 .....

2 .....

(2 marks)

5 (b) The student measured the water loss in milligrams. Explain the advantage of using ten leaves when taking measurements in milligrams.

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(1 mark)

5 (c) Explain the change in mass of untreated leaves in set **A** shown in the graph.

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(3 marks)

(Extra space) .....

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5 (d) The results that the student obtained for the leaves in set **B** were different from those for set **A**. Suggest an explanation for this difference.

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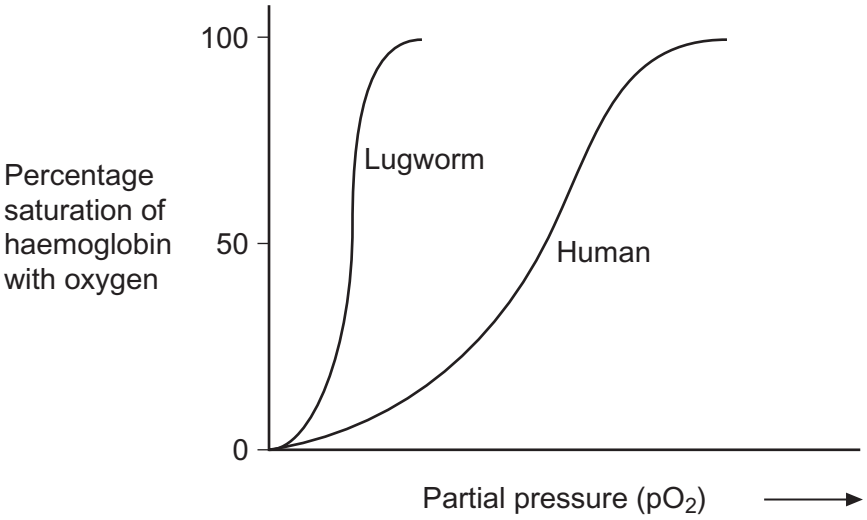
(2 marks)

8

6 Lugworms live in mud where the partial pressure of oxygen is low. The graph shows oxygen dissociation curves for a lugworm and for a human.



6 (a) Explain the advantage to the lugworm of having haemoglobin with a dissociation curve in the position shown.

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(2 marks)

6 (b) In humans, substances move out of the capillaries to form tissue fluid. Describe how this tissue fluid is returned to the circulatory system.

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(3 marks)

(Extra space) .....

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5

7 Cranes are large birds. One of the earliest methods of classifying cranes was based on the calls they make during the breeding season.

7 (a) Explain why biologists could use calls to investigate relationships between different species of crane.

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(2 marks)

7 (b) More recently, biologists have used DNA hybridisation to confirm the relationships between different species of crane. They made samples of hybrid DNA from the same and from different species. They measured the percentage of hybridisation of each sample. The results are shown in the table.

Species of crane from which hybrid DNA was made			**Percentage DNA hybridisation**
Grus americana	and	*Grus monachus*	97.4
Grus monachus	and	*Grus rubicunda*	95.7
Grus americana	and	*Grus rubicunda*	95.5
Grus rubicunda	and	*Grus rubicunda*	99.9
Grus americana	and	*Grus americana*	99.9
Grus monachus	and	*Grus monachus*	99.8

7 (b) (i) Which **two** species seem to be the most closely related? Explain your answer.

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(2 marks)

7 (b) (ii) The biologists measured the temperatures at which the samples of hybrid DNA separated into single strands. Explain why these temperatures could be used to find the percentage of DNA hybridisation.

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(2 marks)

7 (c) Biologists can also use protein structure to investigate the relationship between different species of crane. Explain why.

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(2 marks)

8

Turn over for the next question

8 Costa Rica is a Central American country. It has a high level of species diversity.

8 (a) There are over 12 000 species of plants in Costa Rica. Explain how this has resulted in a high species diversity of animals.

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(2 marks)

8 (b) The number of species present is one way to measure biodiversity. Explain why an index of diversity may be a more useful measure of biodiversity.

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(2 marks)

8 (c) Crops grown in Costa Rica are sprayed with pesticides. Pesticides are substances that kill pests. Scientists think that pollution of water by pesticides has reduced the number of species of frog.

8 (c) (i) Frogs lay their eggs in pools of water. These eggs are small. Use this information to explain why frogs' eggs are very likely to be affected by pesticides in the water.

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(2 marks)

8 (c) (ii) An increase in temperature leads to evaporation of water. Suggest how evaporation may increase the effect of pesticides on frogs' eggs.

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(1 mark)

7

Turn over for the next question

9 Erythropoietin (EPO) is a substance produced in the body. It increases the production of red blood cells. Synthetic EPO is made artificially. It is used to treat patients who have a form of anaemia in which there is a reduced number of red blood cells. Scientists investigated the effect of synthetic EPO on volunteers with this form of anaemia.

- The scientists injected synthetic EPO in a salt solution into patients in the experimental groups. They also set up control groups.
- They gave the different experimental groups different doses of synthetic EPO and different lengths of treatment.
- At the beginning and end of the treatment, the scientists measured each patient's haemoglobin concentration. From these measurements, they calculated the mean increase in haemoglobin concentration.

Some of the results are shown in the table.

Number of volunteers	Length of treatment / weeks	Dose of synthetic EPO / units per kilogram per week	Mean increase in haemoglobin concentration / arbitrary units
58	8	85	19.0
18	8	170	26.0
40	12	150	12.5
82	12	450	34.2
46	24	120	23.0
53	24	240	31.0

9 (a) Explain why treatment with synthetic EPO affects the haemoglobin concentration in these volunteers.

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(2 marks)

9 (b) Suggest how the control groups should have been treated in this investigation.

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(2 marks)

9 (c) The scientists measured the dose of synthetic EPO per kilogram per week. Explain why they measured the dose per unit mass and per unit time.

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(2 marks)

9 (d) Explain how the information that the scientists collected might be useful in treating patients with anaemia.

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(2 marks)

9 (e) Some athletes have used synthetic EPO as a performance enhancer. Explain how synthetic EPO may improve performance in long-distance events.

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(4 marks)

(Extra space) .....

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9 (f) Athletes may be tested to see if the concentration of EPO in their blood is above normal. Suggest how scientists determine the normal concentration of EPO in blood.

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(2 marks)

9 (g) Synthetic EPO can increase blood pressure. Suggest why.

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(1 mark)

15

10 (a) *Clostridium difficile* is a bacterium that is present in the gut of up to 3% of healthy adults and 66% of healthy infants.

10 (a) (i) *C. difficile* rarely causes problems, either in healthy adults or in infants. This is because its numbers are kept low by competition with harmless bacteria that normally live in the intestine.

Use this information to explain why some patients treated with antibiotics can be affected by *C. difficile*.

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(2 marks)

10 (a) (ii) Suggest why older people are more likely to be affected by *C. difficile*.

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(1 mark)

10 (b) The antibiotic methicillin inhibits the enzyme transpeptidase. This enzyme is used by some bacteria to join monomers together during cell wall formation. Methicillin has a similar structure to these monomers. Use this information to explain how methicillin inhibits the enzyme transpeptidase.

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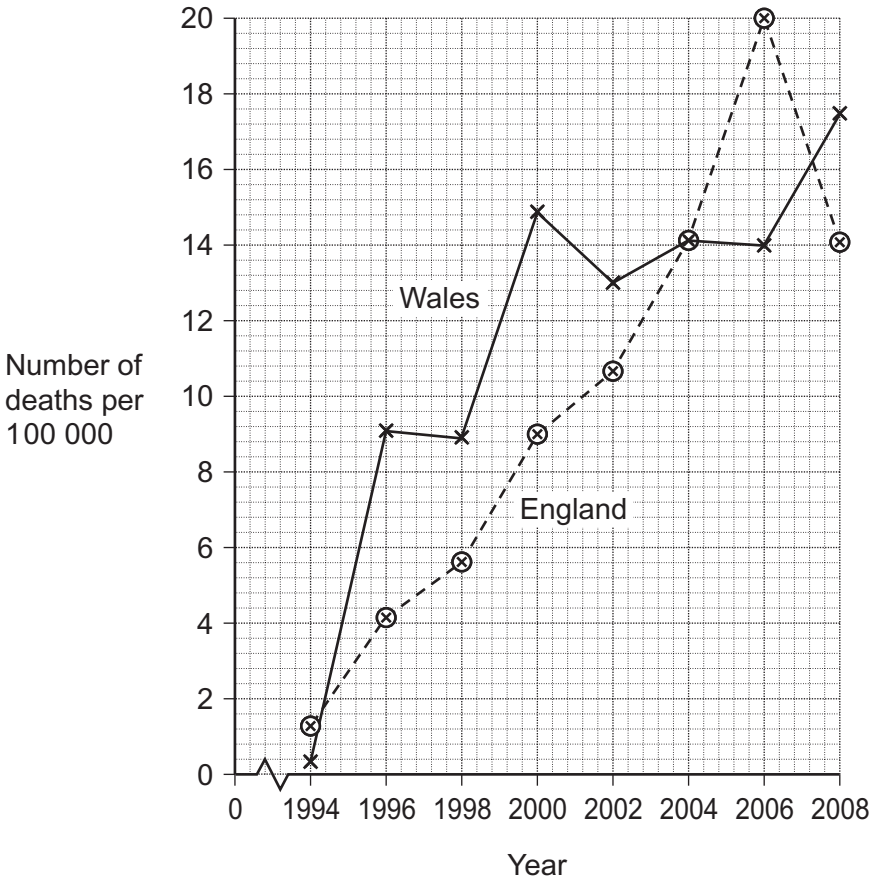
(2 marks)

10 (c) MRSA is a variety of *Staphylococcus aureus*. It is difficult to treat infections caused by this bacterium because it is resistant to methicillin and to some other antibiotics. As a result, some patients who are already very ill may die if they become infected with MRSA. The graph shows the number of deaths in England and Wales between 1994 and 2008 caused by MRSA.



10 (c) (i) It may be difficult to identify MRSA as the actual cause of death. Explain why.

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(1 mark)

10 (c) (ii) Describe the change in the number of deaths caused by MRSA in England in the period shown in the graph.

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(1 mark)

10 (c) (iii) Calculate the percentage increase in the number of deaths caused by MRSA in Wales from 1996 to 2006. Show your working.

Answer ..... *(2 marks)*

10 (d) Describe how gene transmission and selection have increased the difficulty of treating bacterial infections with antibiotics.

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(6 marks)

(Extra space) .....

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END OF QUESTIONS

15

1 **(a)** Complete the following passage by using the most appropriate terms from the list to fill the gaps. Each term should not be used more than once.

anti-parallel	**β-pleated sheet**	**covalent**
double helix	**hydrogen**	**parallel**
polypeptide	**ribose**	**sugar-phosphate**

DNA is found in the nucleus. The molecule is twisted into a .... in which each of the strands are ..... . It has two ..... backbones attached to one another by complementary bases. These bases pair in the centre of the molecule by means of ..... bonds. **[4]**

(b) Table 1.1 shows the relative proportions of different DNA bases in four different organisms.

Table 1.1

	relative proportions of bases in DNA as a percentage			
organism	A	C	G	T
human	30.9	19.8	19.9	29.4
grasshopper	29.3	20.7	20.5	29.3
wheat	27.3	22.8	22.7	27.1
E. coli	24.7	25.7	26.0	23.6

(i) Describe the patterns shown by the data given in Table 1.1.

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

(ii) Suggest how the data given in Table 1.1 might have been helpful to scientists in working out the structure of DNA.

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

(c) DNA in the nucleus acts as a template for the production of RNA.

Complete the table below to show **three** ways in which the structure of DNA differs from that of RNA.

feature	DNA	RNA
number of strands		
bases present		
sugar present		

[3]

(d) DNA codes for the structure of polypeptides.

State the role of messenger RNA (mRNA).

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

[Total: 14]

2 Malaria kills over one million people every year, the vast majority being under the age often.

Adults who have survived malaria in childhood and then continue to live in an area where malaria is found, develop a limited form of immunity.

(a) (i) Name the parasite that causes malaria.

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

(ii) Name the vector for the malarial parasite.

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

(iii) Name a human cell in which the malarial parasite reproduces.

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

(b) Scientists are developing a vaccine using an attenuated (inactive) form of the malarial parasite.

The aim is to trigger an immune response without the development of the disease.

Describe the actions of the **B lymphocytes** in the immune response.

In your answer you should make clear how the steps in this part of the immune response are sequenced.

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..... **[8]**

(c) Suggest why adults who have survived malaria may lose their immunity when they **leave** a malarial area.

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

(d) State **three biological** reasons why it has not been possible to produce an effective vaccine for malaria.

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

[Total: 16]

3 In the search for new biofuels, research has been done into the digestion of wood waste by fungi.

The cellulase enzymes produced by the fungi break cellulose into sugars. These sugars can then be converted into ethanol, a biofuel.

Fig. 3.1 shows the stages in this digestion process.

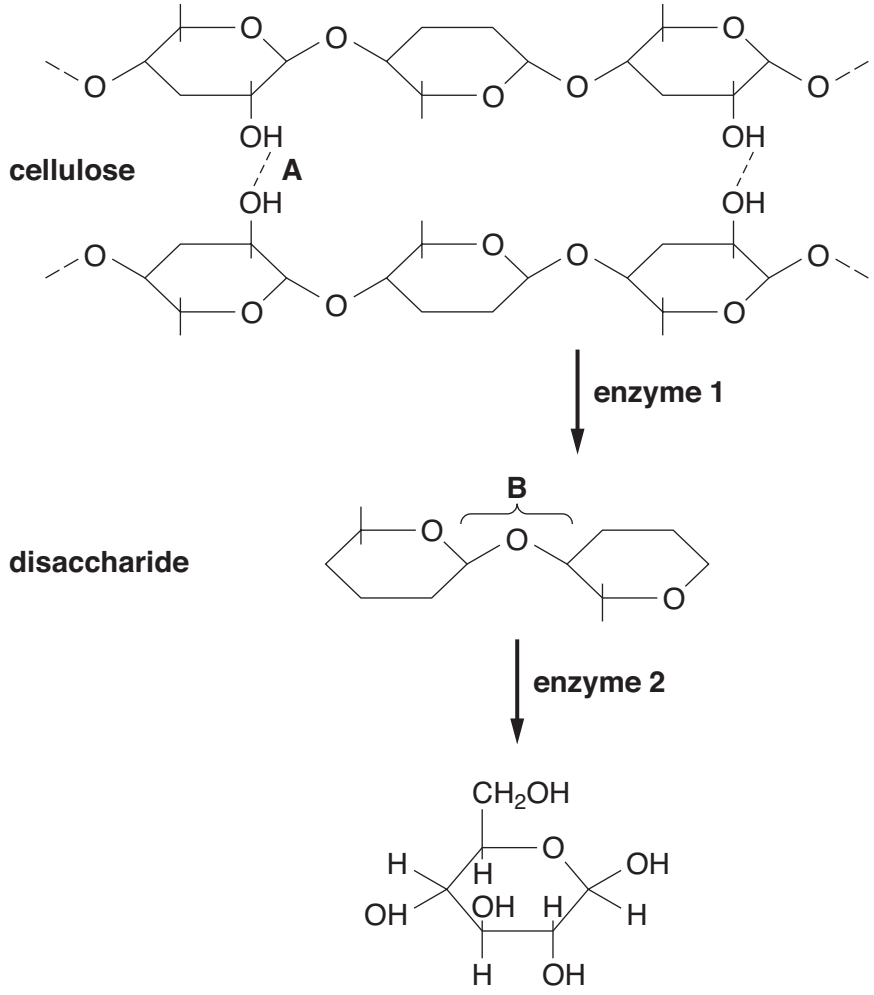

Fig. 3.1

(a) (i) Name bonds **A** and **B** shown in Fig. 3.1.

A .....

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

(ii) State how bond **B** is broken in the digestion of the disaccharide.

.....

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

(iii) Name the sugar that is the **final** product of this digestion process.

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

(b) Explain why **different** enzymes are involved in each stage of the digestion process.

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

(c) Fig. 3.2 shows the effect of changing pH on the rate of activity of **enzyme 2**.

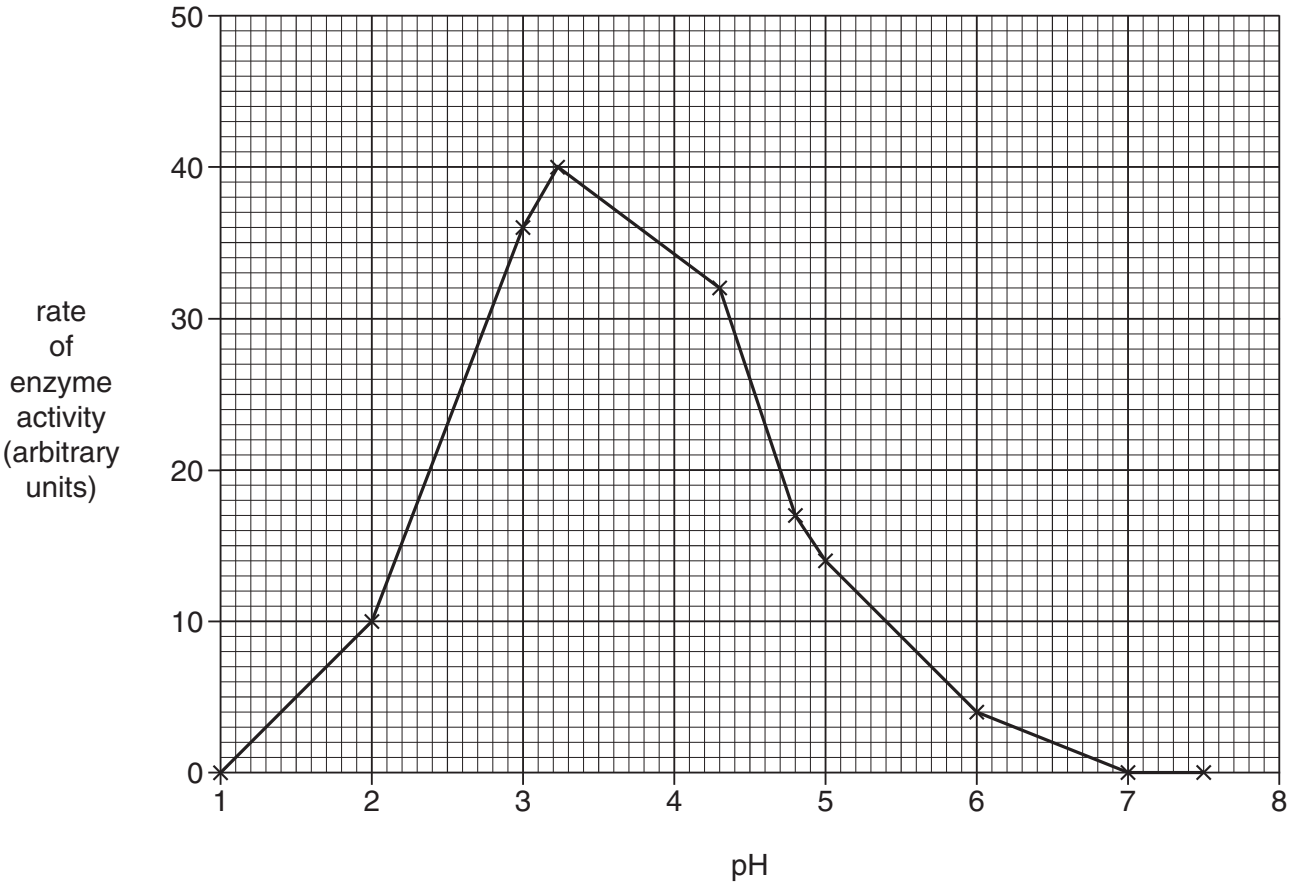

Fig. 3.2

(i) Explain why the activity of **enzyme 2** falls to zero at pH 7.

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

(ii) State **two** factors that should have been controlled when investigating the effect of pH on the activity of **enzyme 2**.

1 .....

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

(d) The activity of an enzyme can be measured by testing for the concentration of its product at regular intervals.

Describe how the concentration of a reducing sugar can be measured using a colorimeter.

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..... **[6]**

[Total: 18]

4 In India, the population of the white-backed vulture, *Gyps bengalensis*, has fallen by 97% to an estimated 4 000 vultures. This vulture is now considered to be 'critically endangered'. Reasons for the decline in numbers include:

- vultures feed on carcasses including those from farm animals.
- these farm animals may have been treated with a pain killer. This particular pain killer causes kidney failure in the vultures.
- the use of this pain killer is being phased out. However, many farmers continue to use up their stocks of the drug.
- this pain killer is not easily biodegradable and will remain in the environment for many years.

(a) (i) Suggest what is meant by *critically endangered*.

.....

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

(ii) Calculate the **original** population of the white-backed vulture.

Show your working.

Answer = ... **[2]**

(b) In an effort to save the white-backed vulture, a captive breeding programme has been set up.

Three centres in India have been built, each housing up to 40 individuals. These vultures have been collected from different areas of the Indian subcontinent.

(i) Explain why the decision was made to conserve the species in captivity (*ex situ*) rather than in the wild (*in situ*).

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

(ii) Explain why the white-backed vultures in the captive breeding programme were,

- collected from several different areas
- housed in three separate centres.

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

(c) Outline **three** reasons why the conservation of the white-backed vulture is important.

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

(d) Suggest **three** measures that could be taken **in the long term** to preserve the numbers of white-backed vultures, once the captive bred individuals have been released into the wild.

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

[Total: 16]

5 **(a)** Fig. 5.1 shows a section of a leaf from a pear tree that is infected by the mildew fungus.

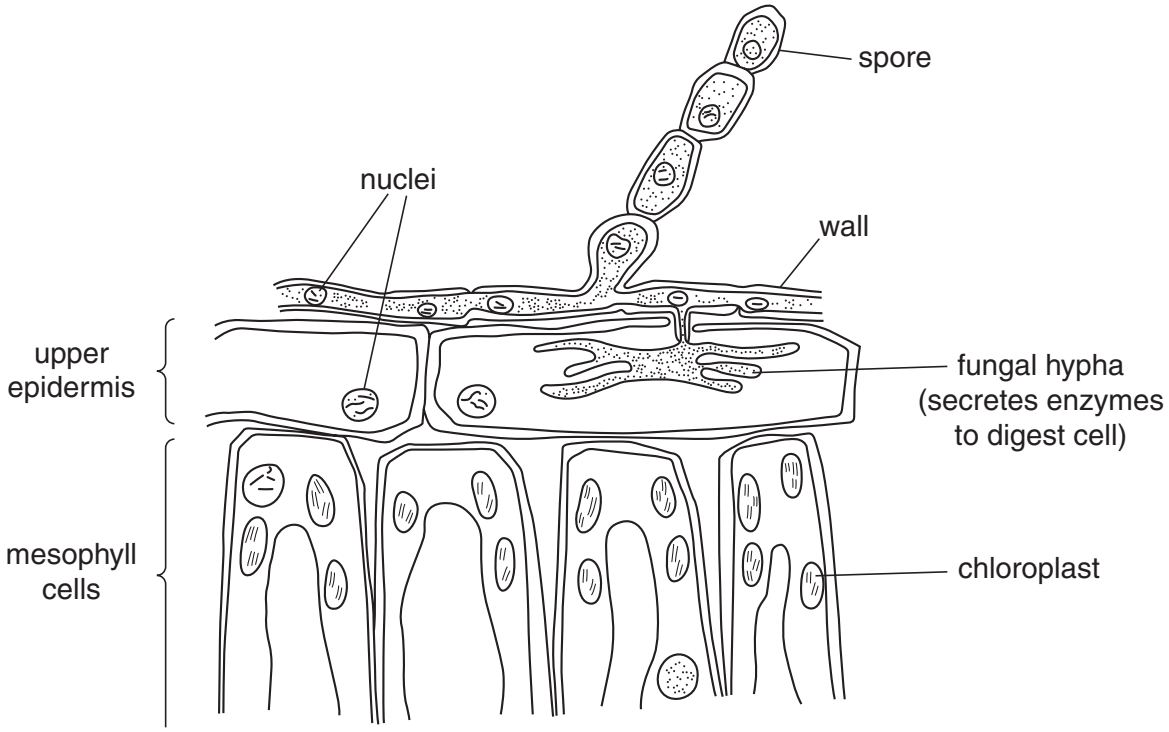

Fig. 5.1

(i) State **one** feature, **shown in Fig. 5.1**, that excludes **both** the pear tree and mildew from the kingdom Prokaryotae.

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

(ii) State **two** reasons why mildew should be placed in the kingdom Fungi.

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

(iii) State **two** reasons why the pear tree should be placed in the kingdom Plantae.

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

(iv) Name **two** kingdoms other than Prokaryotae, Fungi and Plantae.

1 .....

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

(b) The mildew fungus also infects wheat plants, causing disease.

- Most wheat plants in the UK show little resistance to this disease.
- Some Iranian wheat plants are resistant.
- The yield from these resistant wheat plants is very low.

(i) An investigation into the resistance of the Iranian wheat plants to mildew produced the results shown in Fig. 5.2.

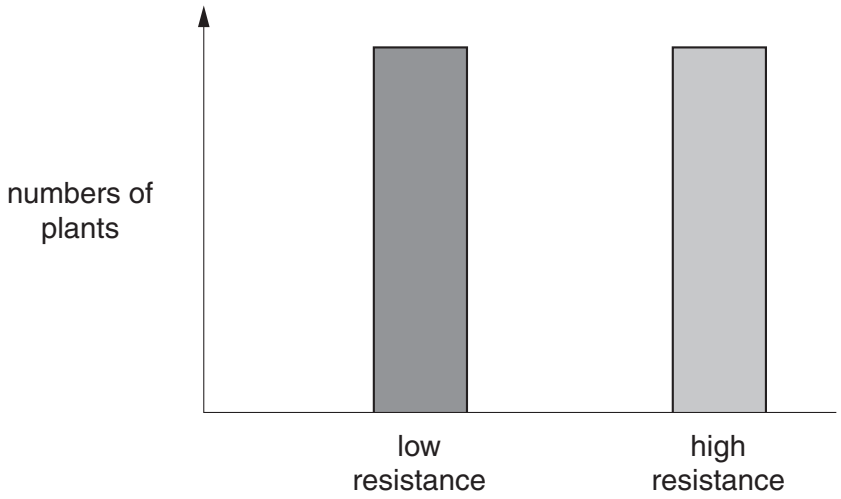

Fig. 5.2

State the type of variation that is shown in Fig. 5.2 **and** describe its characteristics.

type of variation .....

characteristic of this type of variation

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

(ii) Outline how a breeding programme could be carried out to produce wheat plants which have both high yield **and** resistance to mildew.

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

(c) Over a period of time, mildew can overcome the resistance bred into the wheat.

Use the theory of natural selection to explain how the mildew fungus adapts to overcome this resistance.

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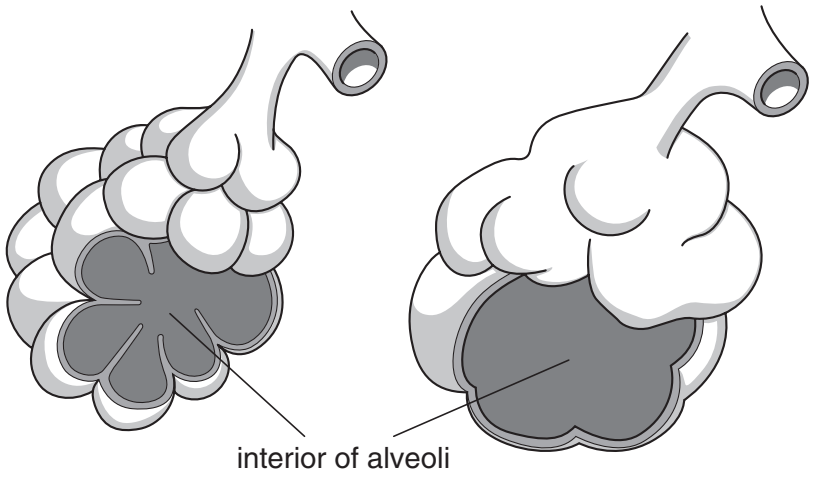
..... **[4]**

[Total: 17]

Turn over

6 **(a)** Fig. 6.1 shows a diagram of alveoli in a healthy lung and alveoli in a lung from a person with advanced emphysema.



alveoli in a healthy lung alveoli from a person with advanced emphysema

Fig. 6.1

(i) Describe how smoking could cause changes in alveoli, such as those shown in Fig. 6.1.

In your answer you should make the links between the changes and their causes clear.

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..... **[6]**

(ii) Emphysema is a form of chronic obstructive pulmonary disease (COPD).

Describe **two** signs or symptoms of emphysema.

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

(iii) Emphysema is described as a chronic disease.

Suggest the meaning of the term *chronic*.

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

(b) An investigation was conducted into the effect of smoking on lung function. One measure of lung function is peak flow rate.

The peak flow rate is the maximum volume of air expelled from the lungs in one minute ($dm^3\ min^{-1}$).

Two male volunteers, one a smoker and one a non-smoker, had their peak flow measured once a year for seven years.

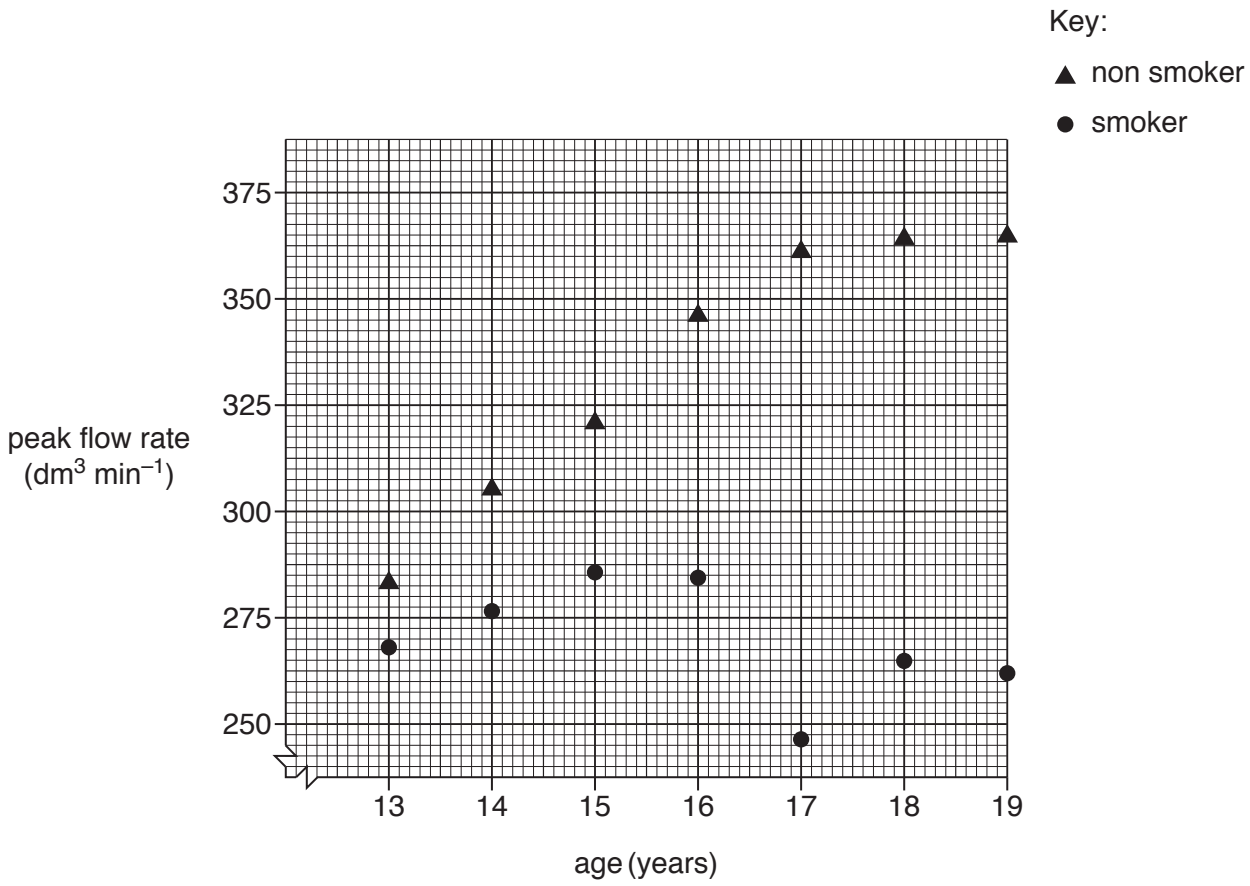

Fig. 6.2

(i) **Describe** the data shown in Fig. 6.2.

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(ii) **Explain** the results obtained for the smoker.

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(iii) Suggest **three** ways of improving the reliability of this investigation.

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

[Total: 19]

END OF QUESTION PAPER