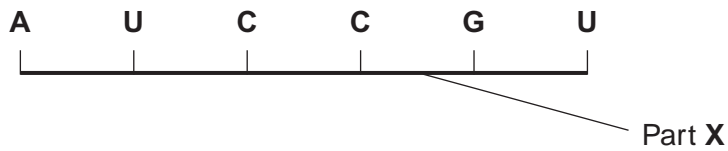


Answer **all** questions in the spaces provided.

- 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.

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(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)

Turn over for the next question

2 (a) Explain what is meant by the term population.

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(1 mark)

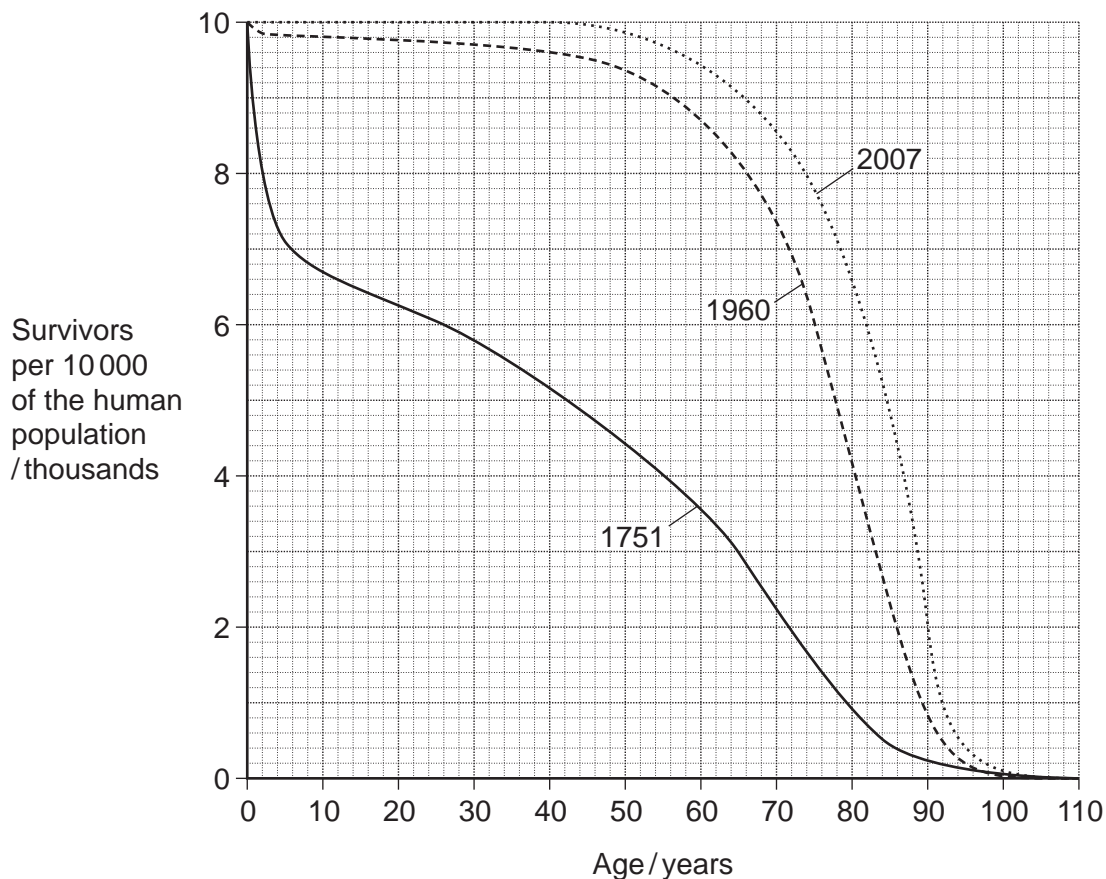
2 (b) Give **two** factors which could lead to a decrease in the death rate in a human population.

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(1 mark)

The graph shows survival curves for human populations of the same country in different years.



- 2 (c)** Calculate the percentage increase from 1751 to 2007 in the number of people who survived to 70 years of age. Show your working.

Answer = %
(2 marks)

- 2 (d)** The changes in the survival curves between 1751 and 1960 show that a demographic transition has taken place in this country. Explain how the changes show this.

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(2 marks)

6

Turn over for the next question

Turn over ►

- 3** The fruit fly is a useful organism for studying genetic crosses. Female fruit flies are approximately 2.5 mm long. Males are smaller and possess a distinct black patch on their bodies. Females lay up to 400 eggs which develop into adults in 7 to 14 days. Fruit flies will survive and breed in small flasks containing a simple nutrient medium consisting mainly of sugars.

- 3 (a)** Use this information to explain **two** reasons why the fruit fly is a useful organism for studying genetic crosses.

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(2 marks)

- 3 (b)** Male fruit flies have the sex chromosomes XY and the females have XX. In the fruit fly, a gene for eye colour is carried on the X chromosome. The allele for red eyes, **R**, is dominant to the allele for white eyes, **r**. The genetic diagram shows a cross between two fruit flies.

- 3 (b) (i)** Complete the genetic diagram for this cross.

Phenotypes of parents red-eyed female × white-eyed male

Genotype of parents

Gametes and and

Phenotypes of offspring red-eyed females and red-eyed males

Genotype of offspring

(3 marks)

- 3 (b) (ii)** The number of red-eyed females and red-eyed males in the offspring was counted. The observed ratio of red-eyed females to red-eyed males was similar to, but not the same as, the expected ratio. Suggest **one** reason why observed ratios are often **not** the same as expected ratios.

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(1 mark)

- 3 (c)** Male fruit flies are more likely than female fruit flies to show a phenotype produced by a recessive allele carried on the X chromosome. Explain why.

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(2 marks)

8

Turn over for the next question

Turn over ►

- 4** A student investigated an area of moorland where succession was occurring. She used quadrats to measure the percentage cover of plant species, bare ground and surface water every 10 metres along a transect. She also recorded the depth of soil at each quadrat. Her results are shown in the table.

	Percentage cover in each quadrat A to E				
	A	B	C	D	E
Bog moss	55	40	10	–	–
Bell heather	–	–	–	15	10
Sundew	10	5	–	–	–
Ling	–	–	–	15	20
Bilberry	–	–	–	15	25
Heath grass	–	–	30	10	5
Soft rush	–	30	20	5	5
Sheep's fescue	–	–	25	35	30
Bare ground	20	15	10	5	5
Surface water	15	10	5	–	–
Soil depth/cm	3.2	4.7	8.2	11.5	14.8

– Indicates zero percentage cover.

- 4 (a)** Explain how these data suggest that succession has occurred from points **A** to **E** along the transect.

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(3 marks)

(Extra space)

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- 4 (b)** The diversity of animal species is higher at **E** than **A**. Explain why.

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(2 marks)

- 4 (c)** The student used the mark-release-recapture technique to estimate the size of the population of sand lizards on an area of moorland. She collected 17 lizards and marked them before releasing them back into the same area. Later, she collected 20 lizards, 10 of which were marked.

- 4 (c) (i)** Give **two** conditions for results from mark-release-recapture investigations to be valid.

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(2 marks)

- 4 (c) (ii)** Calculate the number of sand lizards on this area of moorland. Show your working.

Answer =

(2 marks)

Question 5 & 6: N/A

7 Scientists investigated the effect of a pesticide called malathion on the survival of tadpoles of species of toads found in the USA. The scientists determined the LC50 for the tadpoles of each species over a 16-day period in an aquarium. The LC50 is the concentration of malathion that killed 50 percent of a population of tadpoles. The scientists also investigated whether the presence of a predator of tadpoles changed the effect of malathion.

7 (a) Suggest **two** advantages of using the LC50 to determine the effect of a pesticide.

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(2 marks)

The scientists looked at previous studies on the effects of various pesticides on tadpoles.

They found that most of these studies:

- were carried out on tadpoles of the African clawed toad
- measured the LC50 of each pesticide over 1 to 4 days in the absence of any biotic factor.

7 (b) The scientists concluded that these previous studies were of limited use when trying to assess the effects of malathion on the tadpoles of toads found in the USA. Suggest why the scientists reached this conclusion.

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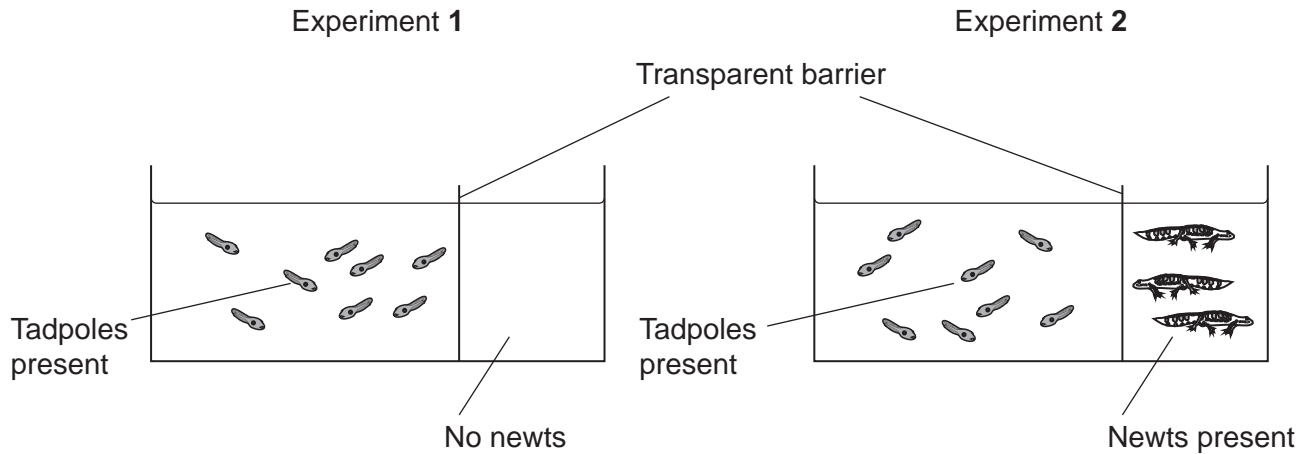
(3 marks)

(Extra space)

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- 7 (c)** Malathion affects the nervous system of tadpoles. The scientists investigated whether the stress caused by the presence of a predator changed the effect of malathion on the tadpoles. The scientists used newts which are predators of tadpoles. They carried out two experiments, as shown in the diagram.



- 7 (c) (i)** Explain why the scientists carried out experiment 1.

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(2 marks)

- 7 (c) (ii)** Explain why the scientists used a transparent barrier in experiment 2.

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(2 marks)

Question 7 continues on the next page

Turn over ►

- 7 (d) Adult toads spend most of their time on land but lay their eggs in water. These eggs hatch into tadpoles, which live in water and develop into adults. The tadpoles are much smaller than adult toads. Use this information to explain why the tadpoles are affected more rapidly by pesticides in water than adult toads.

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(2 marks)

- 7 (e) When malathion is used as a pesticide, it is often sprayed onto aquatic habitats at concentrations of 0.1 to 1.6 mg dm^{-3} . The scientists tested the effect of malathion at concentrations of 0.001 to 10 mg dm^{-3} . Suggest why.

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(2 marks)

- 7 (f) As a result of this investigation, the scientists concluded that more studies on pesticides should be carried out in natural habitats rather than under laboratory conditions. Suggest **two** advantages of carrying out such investigations in natural habitats.

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(2 marks)

- 8 (a)** Energy enters most ecosystems through the light-dependent reaction of photosynthesis. Describe what happens during the light-dependent reaction.

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(5 marks)

(Extra space)

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Turn over ►

8 (b) Describe the reasons for the low efficiency of energy transfer through ecosystems.

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(5 marks)

(Extra space)

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It has been suggested that a new species of grass may evolve on soil that has been polluted with copper. Explain how this new species might evolve.

[illegible]

(5 marks)

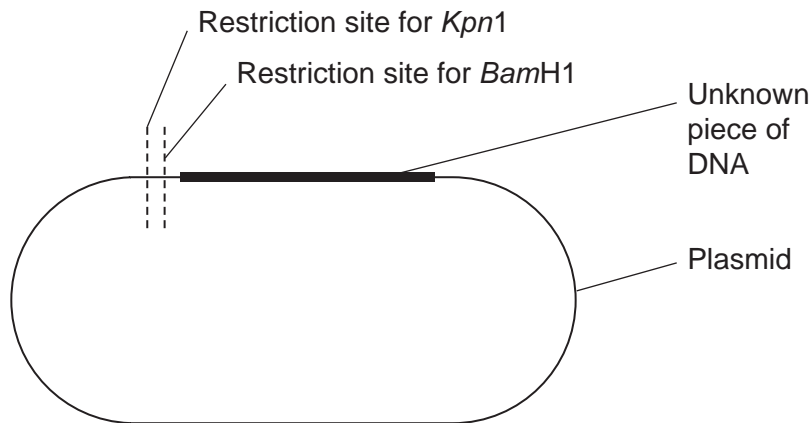
[illegible]

9

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*I and one restriction site for the enzyme *Bam*HI. They inserted copies of the unknown piece of DNA into the plasmids. This produced recombinant plasmids.

The diagram shows a recombinant plasmid.



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

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

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(2 marks)

- (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)

- 9 (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)

- (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)

- (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)

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

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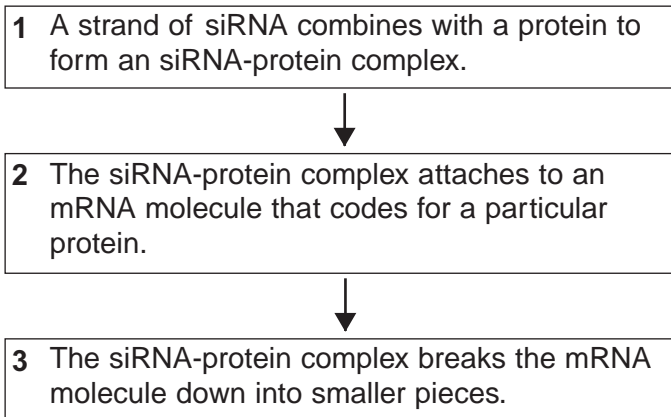
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(2 marks)

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



- (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)

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

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(2 marks)

(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)

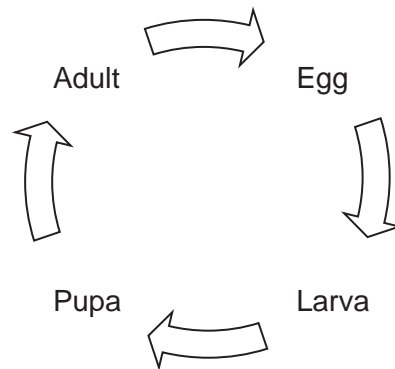
Turn over for the next question

7

Turn over ►

11

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.

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

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(2 marks)

- 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

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

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(2 marks)

- (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)

- (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)

- (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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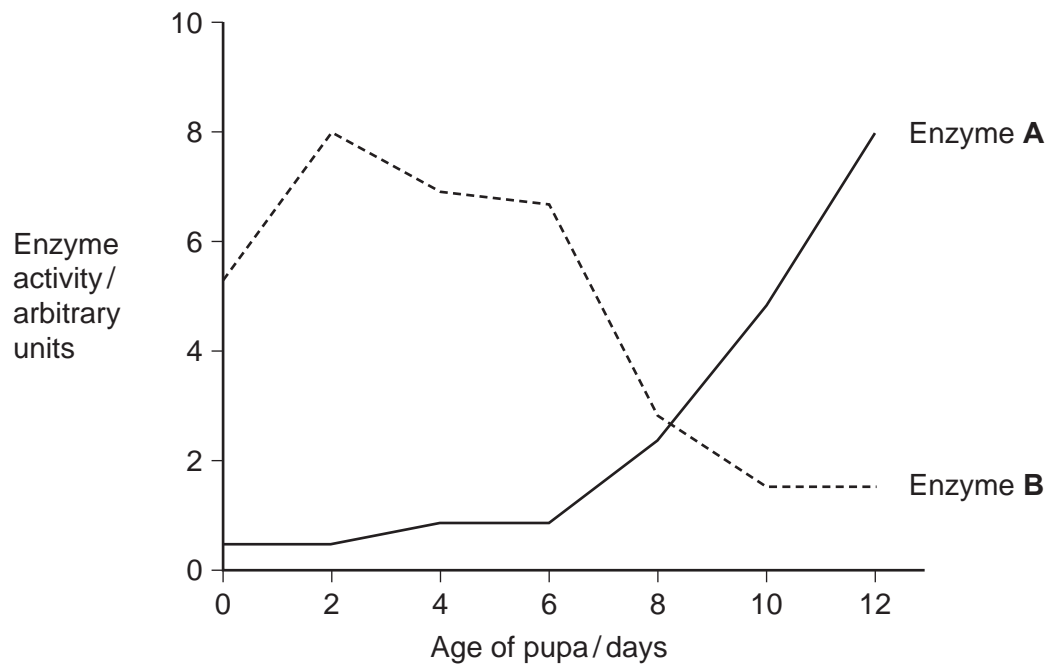
(2 marks)

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Turn over ►

(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)

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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

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

EITHER

- (a) Using DNA in science and technology (25 marks)

OR

- (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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