Rewarding Learning

ADVANCED
General Certificate of Education
2017

Centre Number

Candidate Number

Biology

Assessment Unit A2 2
assessing
Biochemistry, Genetics and Evolutionary Trends

[AB221]

MV18

TUESDAY 20 JUNE, MORNING

Time

2 hours, plus your additional time allowance.

Instructions to Candidates

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided. Do not write outside the boxed area on each page or on blank pages.
Complete in black ink only.
Answer **all eight** questions.

Information for Candidates

The total mark for this paper is 90. Section A carries 72 marks. Section B carries 18 marks.
Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.
You are reminded of the need for good English and clear presentation in your answers.
Use accurate scientific terminology in all answers.
You should spend approximately **25 minutes** on Section B.
You are expected to answer Section B in continuous prose.
Quality of written communication will be assessed in Section B, and awarded a maximum of 2 marks.
Statistics sheets are provided for use with this paper.

Section A

1 Genetically engineered microorganisms contain a gene or genes from another organism.

(a) State the role of bacteriophages in genetic engineering. [1 mark]

_____

_____

_____

(b) Safety precautions are necessary to prevent genetically engineered microorganisms escaping and causing harm in the environment.

State **two** safety precautions that can be employed for this purpose. [2 marks]

1. _____

_____

2. _____

_____

(c) A range of useful substances can be produced by genetically engineered microorganisms.

Suggest **one** advantage of using microorganisms for this purpose, rather than plants or animals. [1 mark]

2 **(a)** The table below shows some features found in phyla of the kingdom Animalia.

Complete the table by placing a tick (✓) in the appropriate box(es) if the feature is present in that phylum. [3 marks]

Feature / **Phylum**	Bilaterally symmetrical	Triploblastic	Coelomate	Gut has both a mouth and an anus	Support by internal skeleton of bones
Platyhelminthes					
Chordata					
Annelida					

(b) Digestion in animals can be intracellular and/or extracellular.

(i) Describe precisely the process of extracellular digestion in animals. [1 mark]

(ii) Describe the main evolutionary trend in digestion across the three animal phyla listed above. [2 marks]

BLANK PAGE

DO NOT WRITE ON THIS PAGE

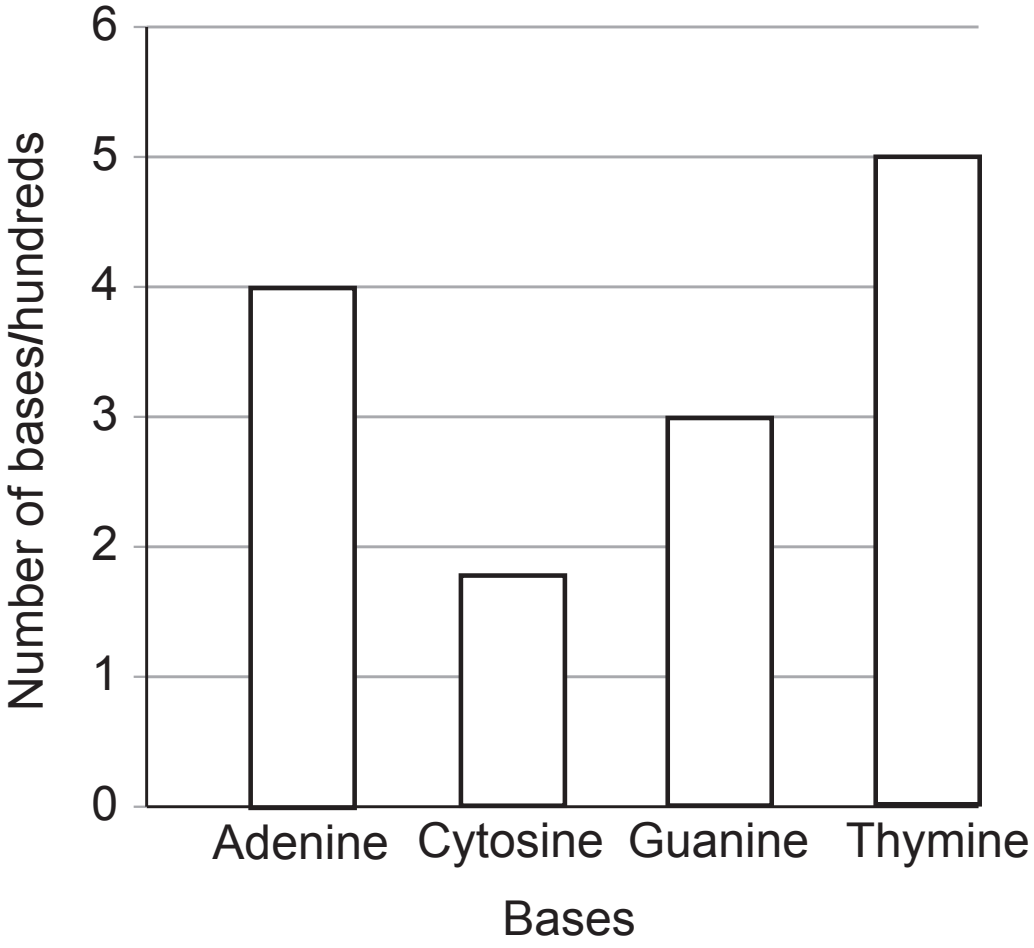
(Questions continue overleaf)

3 DNA provides the code for protein synthesis in living organisms. Transcription and translation of the DNA code results in the production of polypeptides.

(a) The bar charts below and opposite on page 9 show the numbers of different bases present in a short section of DNA and mRNA.

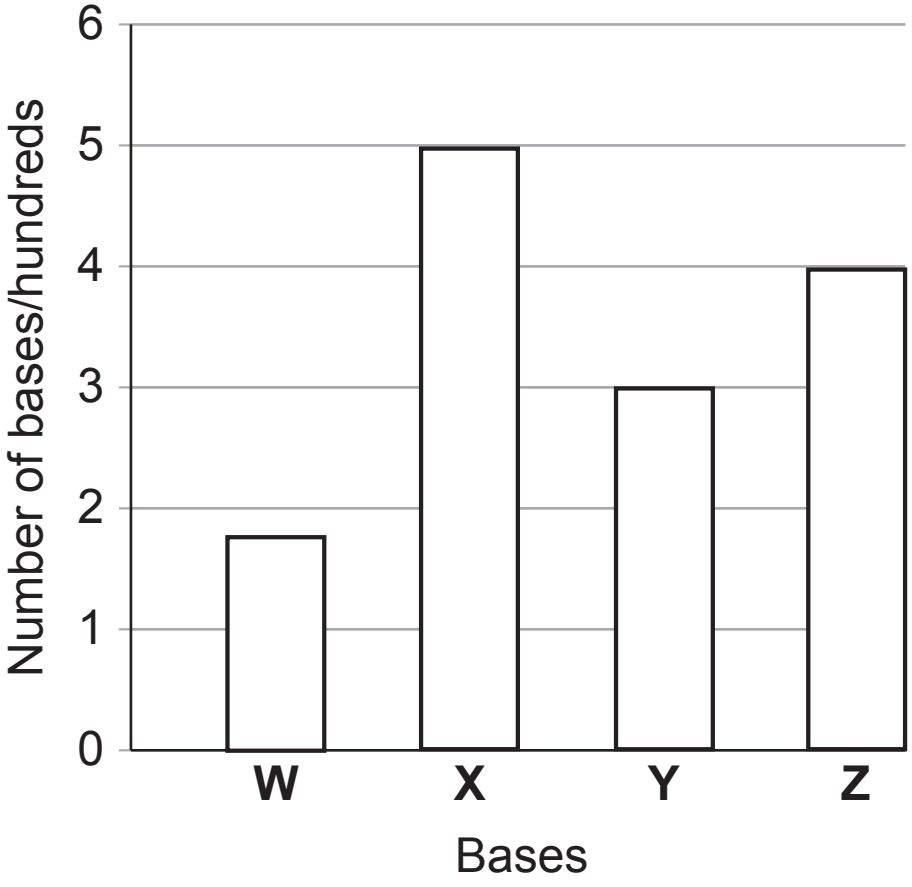
Graph 1

Bases present in a short section of a DNA coding (template) strand



Graph 2

Bases present in mRNA transcribed from the section of DNA in Graph 1



(i) Using the information provided and your understanding, identify the bases **W**, **X**, **Y** and **Z**. [2 marks]

W _____

X _____

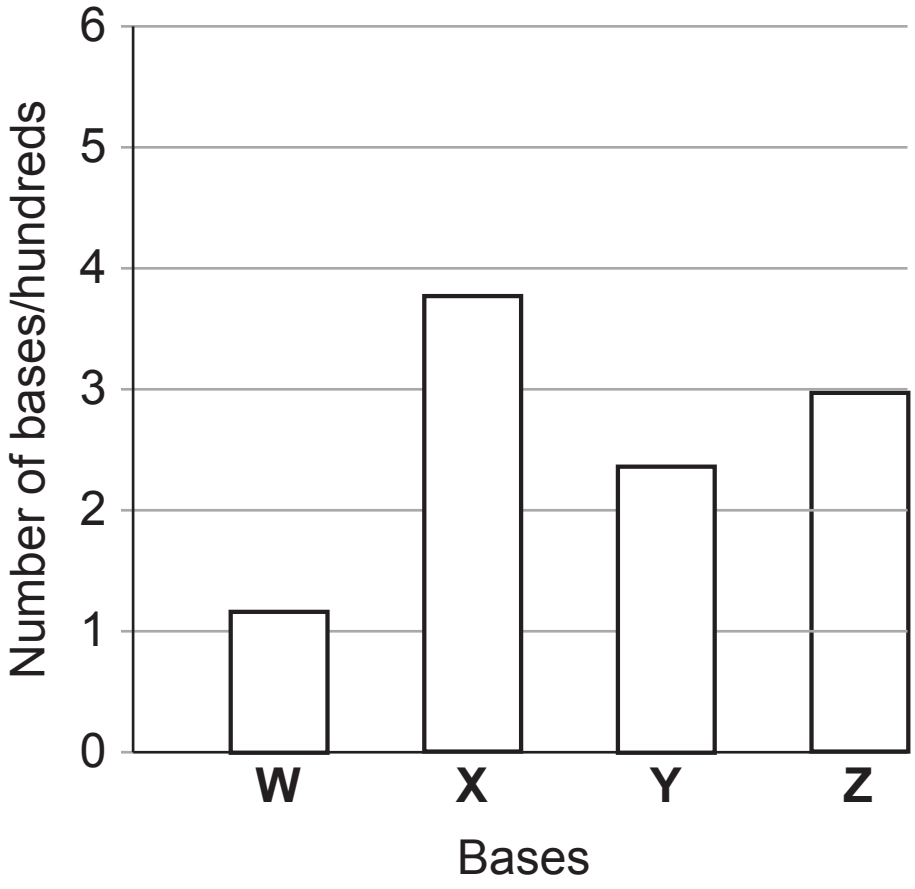
Y _____

Z _____

After transcription, but before translation, the mRNA in **Graph 2** is modified by the cell. The graph below shows the numbers of different bases present in the mRNA **after** this modification.

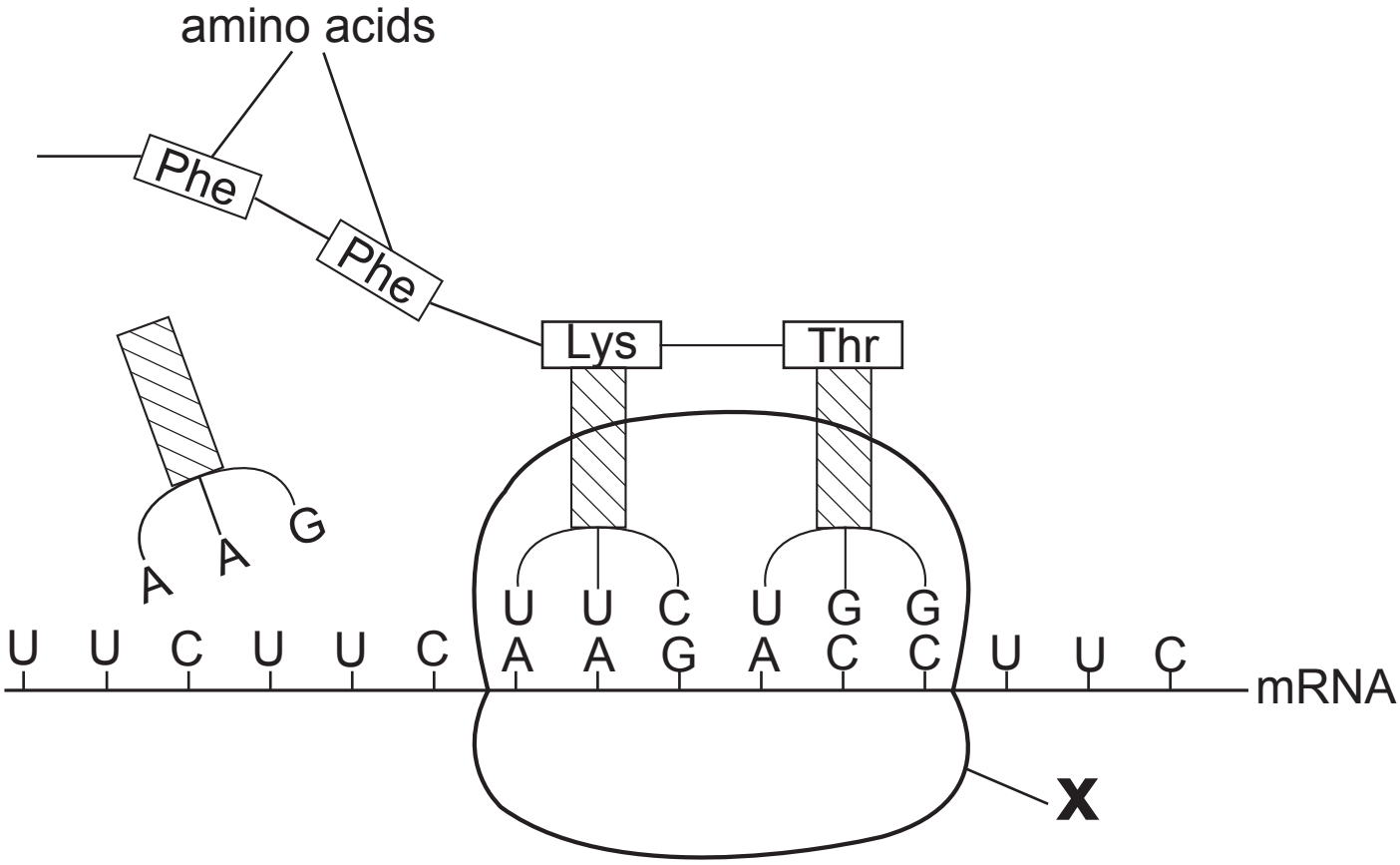
Graph 3

Bases present in mRNA after modification



(ii) Using the graph, suggest what happens during this modification. [1 mark]

(b) The diagram below shows a step in the synthesis of a polypeptide during translation.

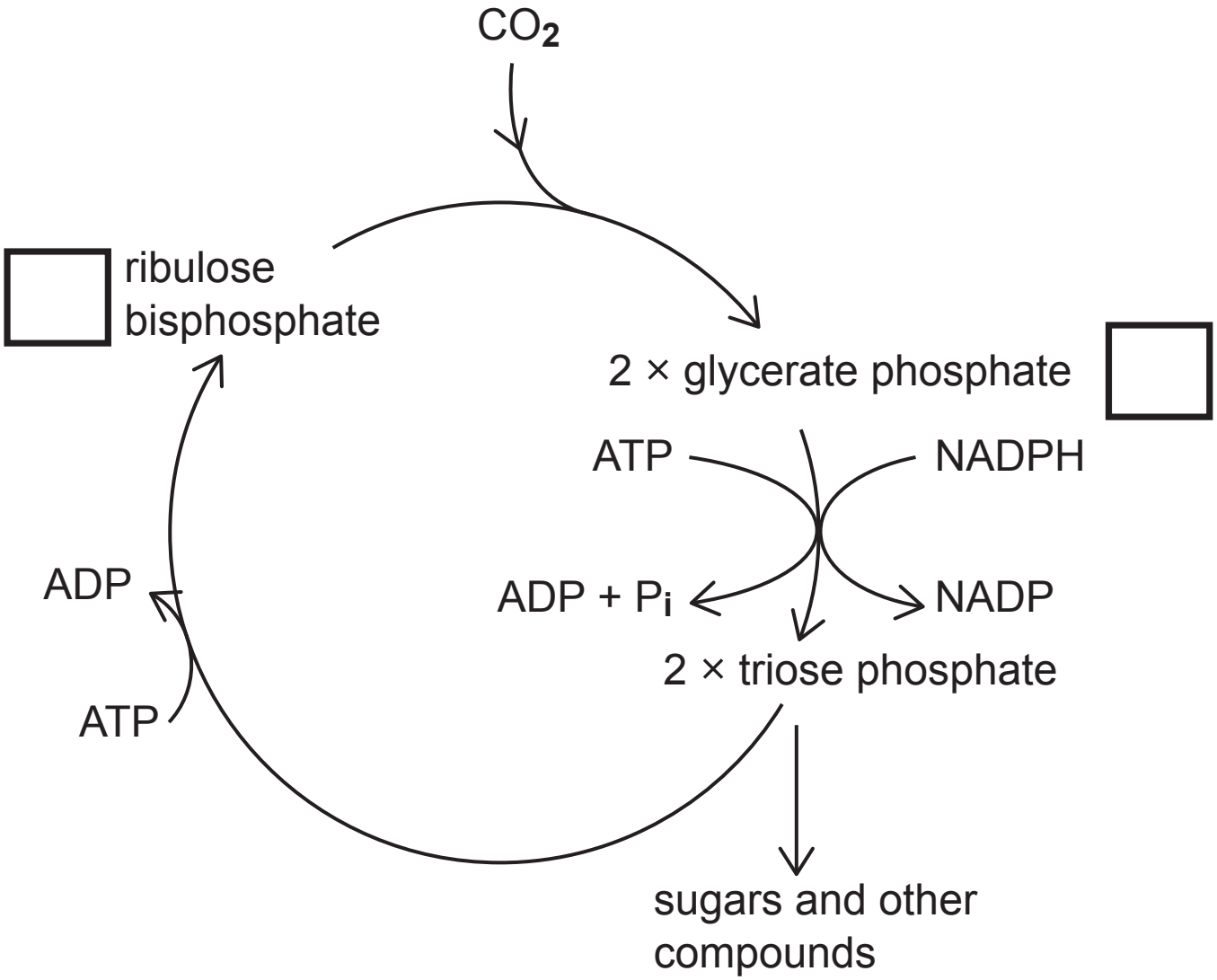


(i) Name structure **X**. [1 mark]

_____

(ii) Using the information in the diagram, describe precisely the sequence of events which results in the attachment of the next amino acid in this polypeptide chain. [4 marks]

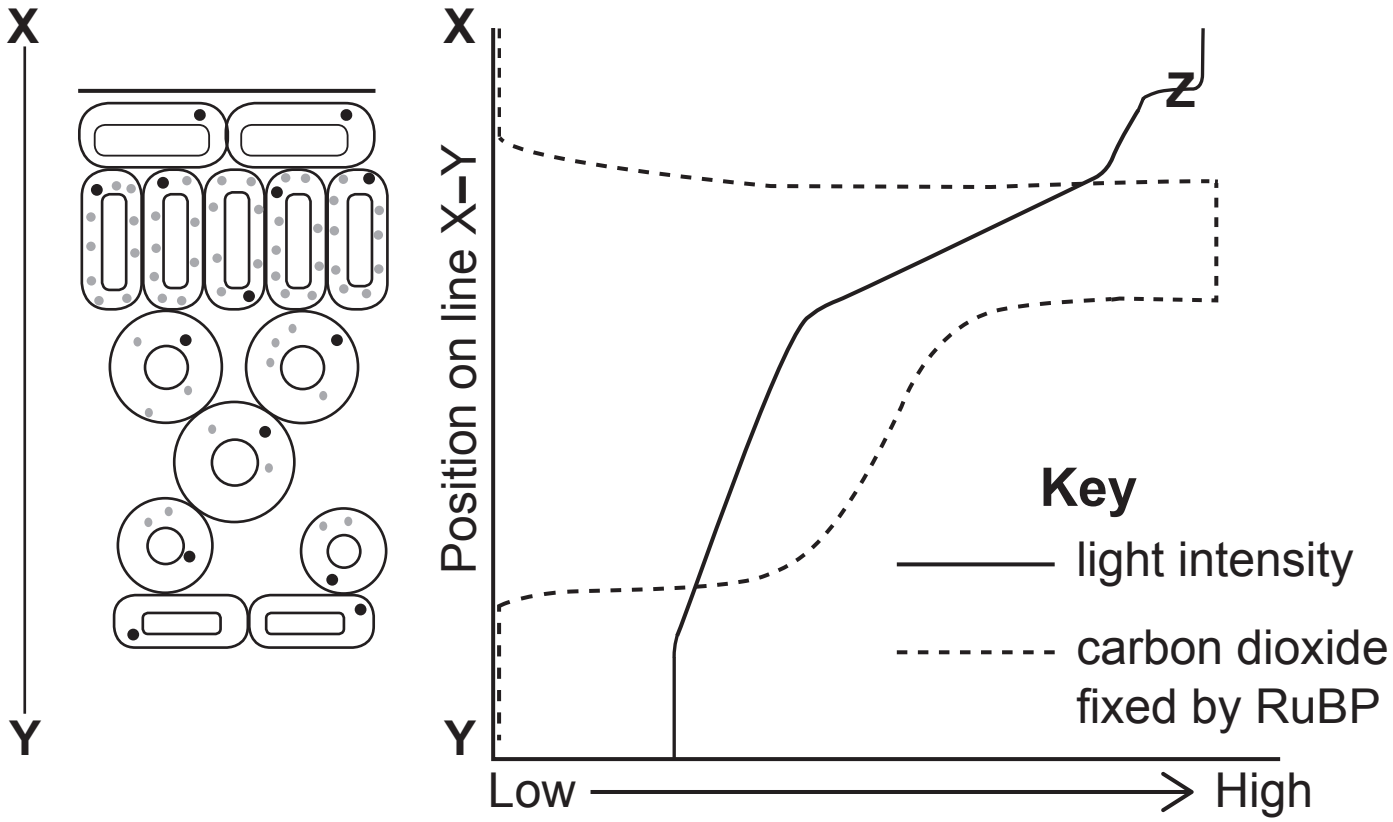
4 **(a)** The diagram below summarises the reactions of the light-independent stage (Calvin cycle) of photosynthesis.



(i) Complete the diagram to indicate the number of carbon atoms in ribulose bisphosphate and glycerate phosphate. [1 mark]

(ii) Describe the different roles of ATP in the cycle, as shown in the diagram. [2 marks]

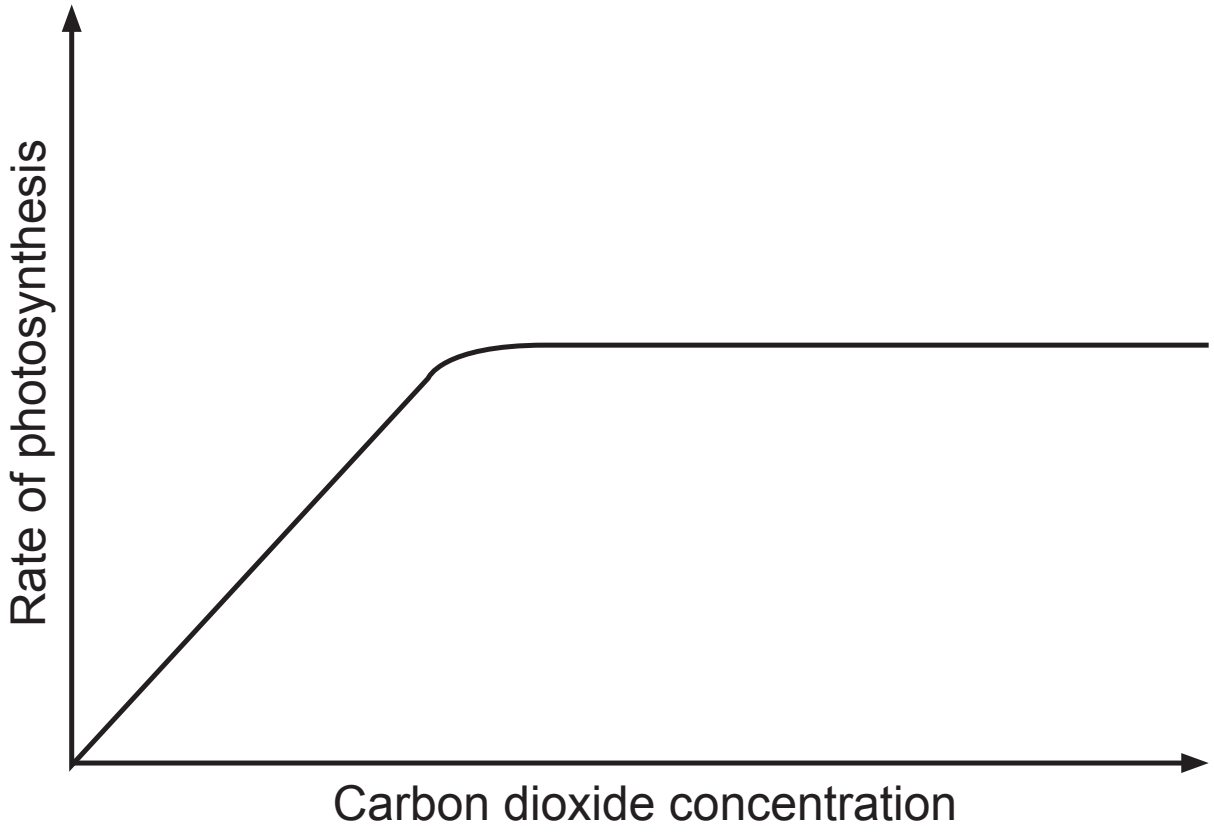
(b) The diagram below shows how both the light intensity and the amount of carbon dioxide fixed by ribulose bisphosphate (RuBP) change across a vertical section of a leaf.



(i) Suggest **one** reason for the steep reduction in light intensity at position **Z**. [1 mark]

(ii) Explain the pattern of carbon dioxide fixation through the leaf section, along the line **X**–**Y**, with reference to the different tissue layers in the leaf. [3 marks]

(c) The graph below shows how carbon dioxide concentration affects the rate of photosynthesis.



Research is currently taking place to develop crop plants that can produce increased levels of RuBP in their chloroplasts.

(i) Draw a line on the graph above to suggest how a higher level of RuBP would affect the rate of photosynthesis in different carbon dioxide concentrations. [1 mark]

(ii) In certain environmental conditions, carbon dioxide can be a limiting factor of photosynthesis. Suggest why carbon dioxide is frequently a limiting factor in summer. [1 mark]

BLANK PAGE

DO NOT WRITE ON THIS PAGE

(Questions continue overleaf)

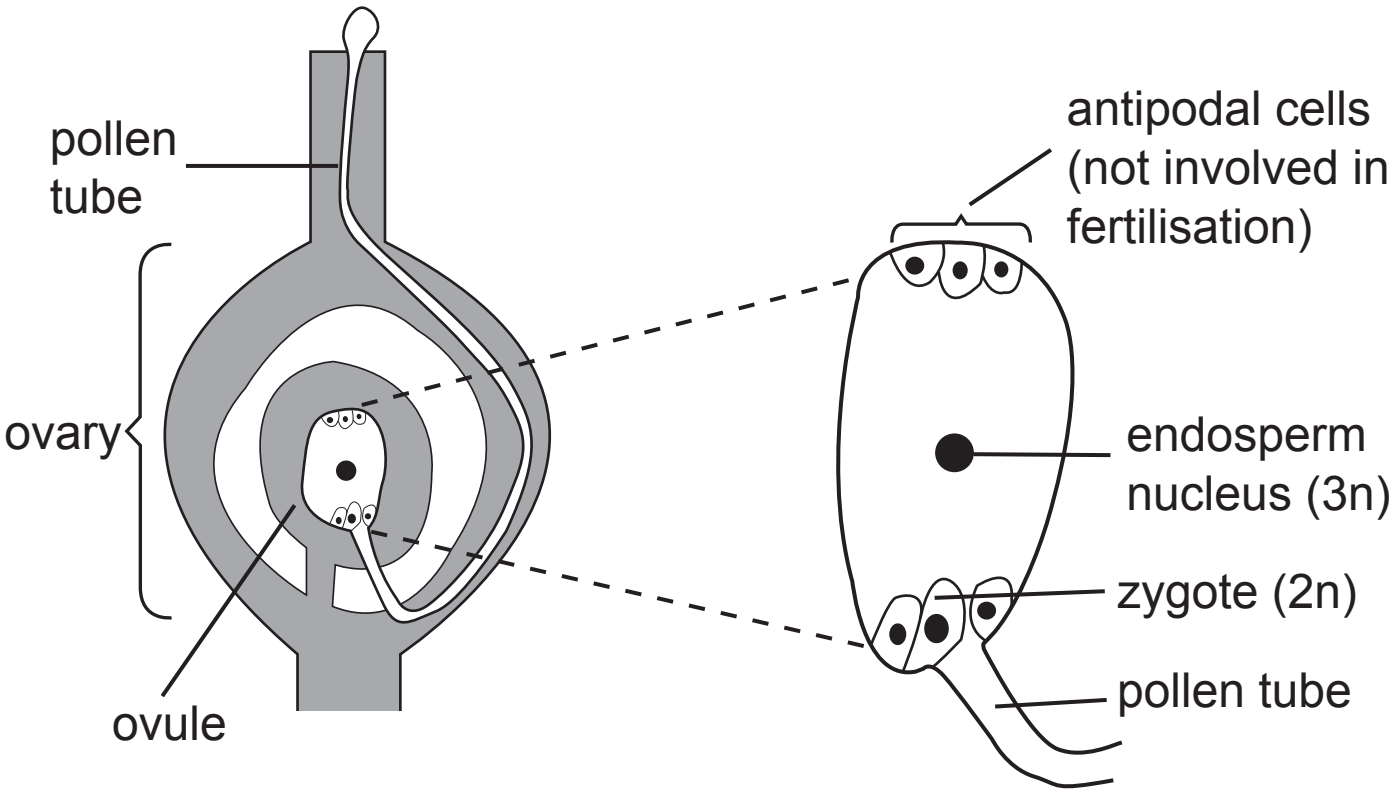
5 **(a)** Many species of flowering plant have strategies to encourage cross-fertilisation. Describe **one** advantage of this. [1 mark]

_____

_____

_____

(b) The diagram below shows a section through part of a flower and represents the stage immediately following fertilisation.



(i) Describe the sequence of events following pollination, and resulting in the stage shown in the diagram. [4 marks]

In flowering plants, a fertilised ovule develops into a seed. In many species of flowering plant, this happens at the end of the growing season (late summer/autumn).

(ii) The seeds of many local flowering plant species must experience several months of cold weather before they are able to germinate and develop into seedlings.

Suggest and explain **one** advantage of this.
[2 marks]

(c) (i) Seed shape in a particular species of flowering plant can be round or oblong. The allele for round seed (**R**) is dominant to the allele for oblong seed (**r**).

In one population of this species, 10**%** of the alleles for this gene were found to be **r**.

Using the Hardy-Weinberg equation, calculate the percentage of plants that would be expected to be heterozygous for seed shape in this population. [3 marks]

(Show your working.)

_____**%**

(ii) State **one** condition required for the application of the Hardy-Weinberg equation. [1 mark]

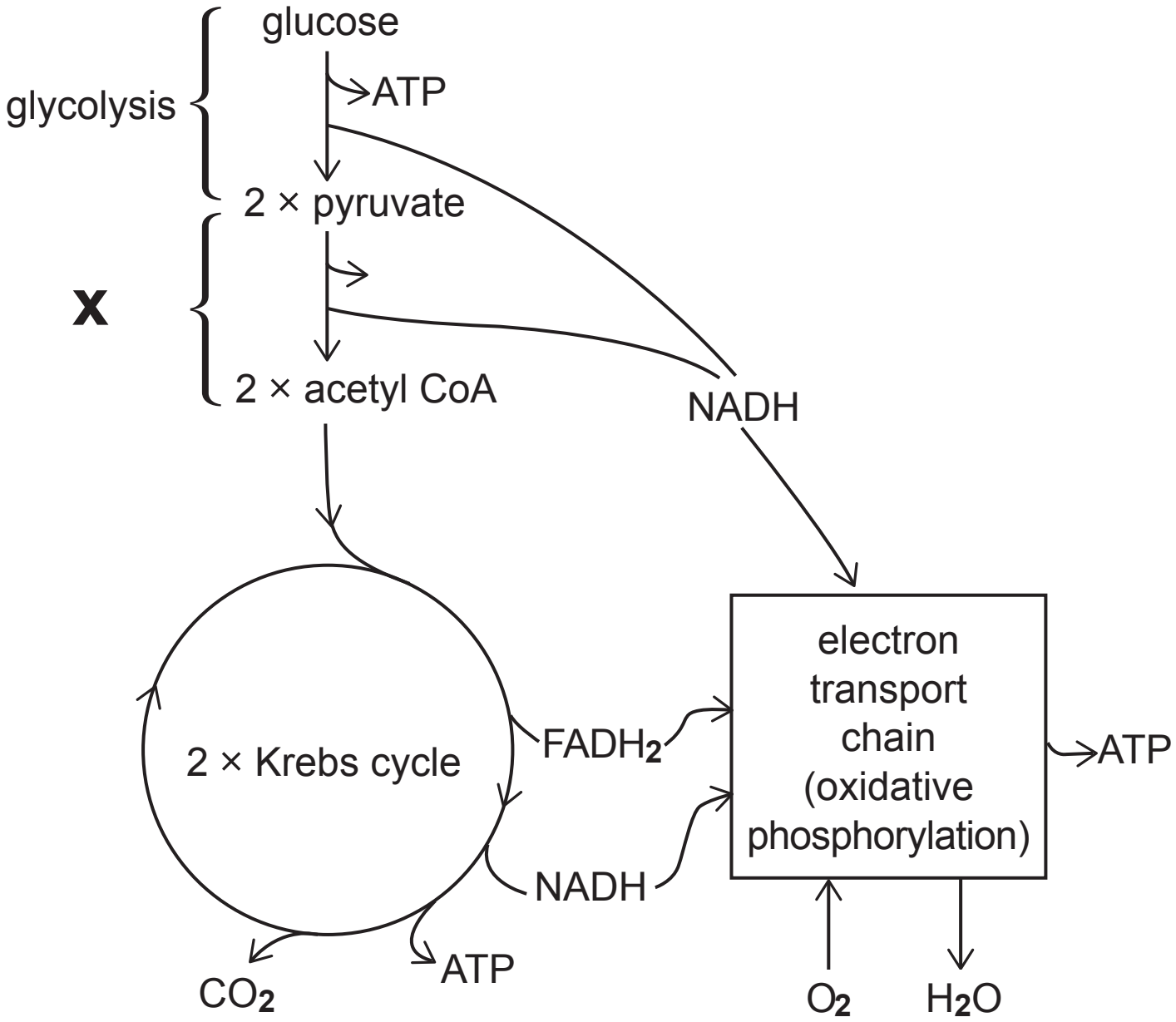
_____

_____

6 **(a)** Aerobic respiration can be summarised by the equation:

$$6O_2 + C_6H_{12}O_6 \rightarrow 6CO_2 + 6H_2O + \text{energy}$$

The diagram below provides more detail of the stages involved.



Using the information provided and your knowledge, answer the following questions.

(i) Identify stage **X**. [1 mark]

_____

(ii) State precisely where oxidative phosphorylation takes place in the cell. [1 mark]

_____

(iii) Account for the fact that **six** molecules of CO_2 are produced during the respiration of one molecule of glucose. [4 marks]

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

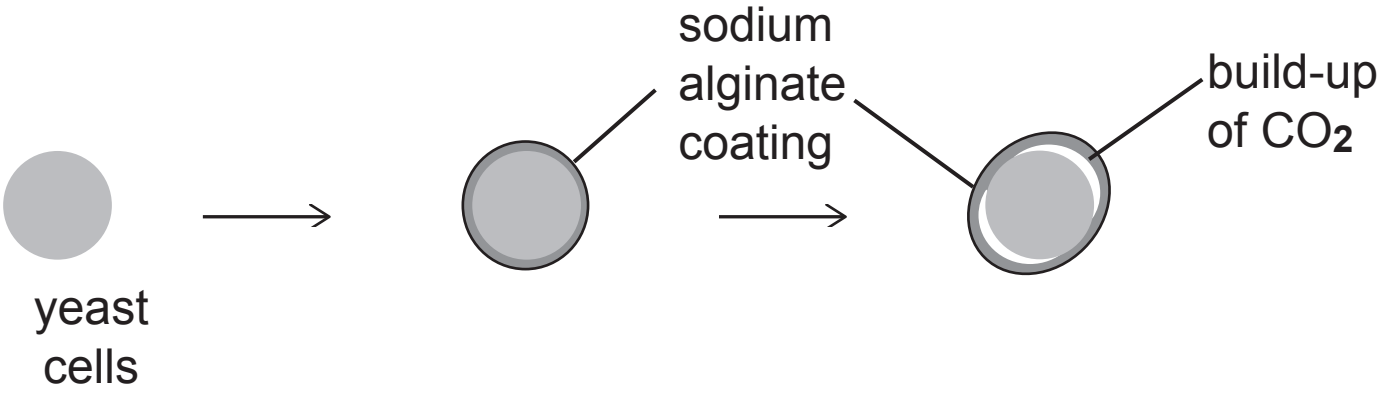
_____

_____

_____

(b) In an investigation into the effect of temperature on respiration in yeast, yeast cells were coated with a chemical called sodium alginate to form yeast 'beads'. Twenty yeast 'beads' were then added to each of two solutions of glucose and kept at 20°C and 40°C respectively.

The surrounding coat of sodium alginate is relatively impermeable to gases and therefore restricts carbon dioxide escaping from the respiring yeast cells.



Over time, the build-up of carbon dioxide causes the 'beads' to rise to the surface of the glucose solutions.

In the investigation, the time taken for each of the beads to rise to the surface of the glucose solutions was recorded.

(i) State **two** variables that should have been controlled in this investigation. [2 marks]

1. _____

2. _____

(ii) In this investigation it was important that an organism was used that could respire anaerobically. Suggest why. [1 mark]

_____

_____

_____

The results of the investigation are summarised in the table below.

Temperature /°C	Time for bead to rise to surface/s	Mean time/s
20	124, 169, 99, 201, 190, 133, 215, 110, 85, 144, 148, 187, 233, 98, 166, 204, 139, 177, 147, 209	159
40	62, 105, 99, 177, 105, 164, 86, 101, 99, 100, 194, 90, 133, 150, 151, 122, 88, 76, 123, 111	117

(iii) Describe and explain the trend shown by the mean results. [2 marks]

(iv) The data indicates that the results are very variable. Suggest **two** reasons for this variability. [2 marks]

1. _____

_____

2. _____

_____

(v) Suggest the most appropriate way to display these results graphically, in order to communicate both the trend and the variability of the data. [2 marks]

_____

_____

_____

_____

_____

7 The banded snail (**Cepaea nemoralis**) is very variable in shell pattern and colour. Dark horizontal bands may be present running around the shell. Additionally, the shells can be yellow, pink or brown as shown in the photograph below. Presence or absence of banding and shell colour are genetically determined.

(a) The colour gene (**C**) has multiple alleles, with a dominance series of $\mathbf{C^B}$ (brown), $\mathbf{C^P}$ (pink) and $\mathbf{C^Y}$ (yellow). Therefore $\mathbf{C^B}$ is most dominant and $\mathbf{C^Y}$ is least dominant.

A cross between a brown snail and a pink snail produced offspring in the ratio:

2 brown : 1 pink : 1 yellow

In the space below, use a genetic diagram to show how this ratio could have arisen. [3 marks]

(b) This particular cross was repeated a number of times and 200 offspring were obtained. 89 were brown, 55 were pink and 56 were yellow.

(i) Complete the table below and calculate $\mathbf{X^2}$ for these results. [2 marks]

Category	**Observed (O)**	**Expected (E)**	**(O – E)**	**$(O - E)^2$**	**$\frac{(O-E)^2}{E}$**
brown	89				
pink	55				
yellow	56				

Calculated $\mathbf{X^2}$ value _____

(ii) On the basis of your calculated $\mathbf{X^2}$ value, state the following: [2 marks]

- the degrees of freedom for the test

  _____

- the probability value

  _____

(iii) State the conclusion that can be drawn from this statistical test. [1 mark]

_____

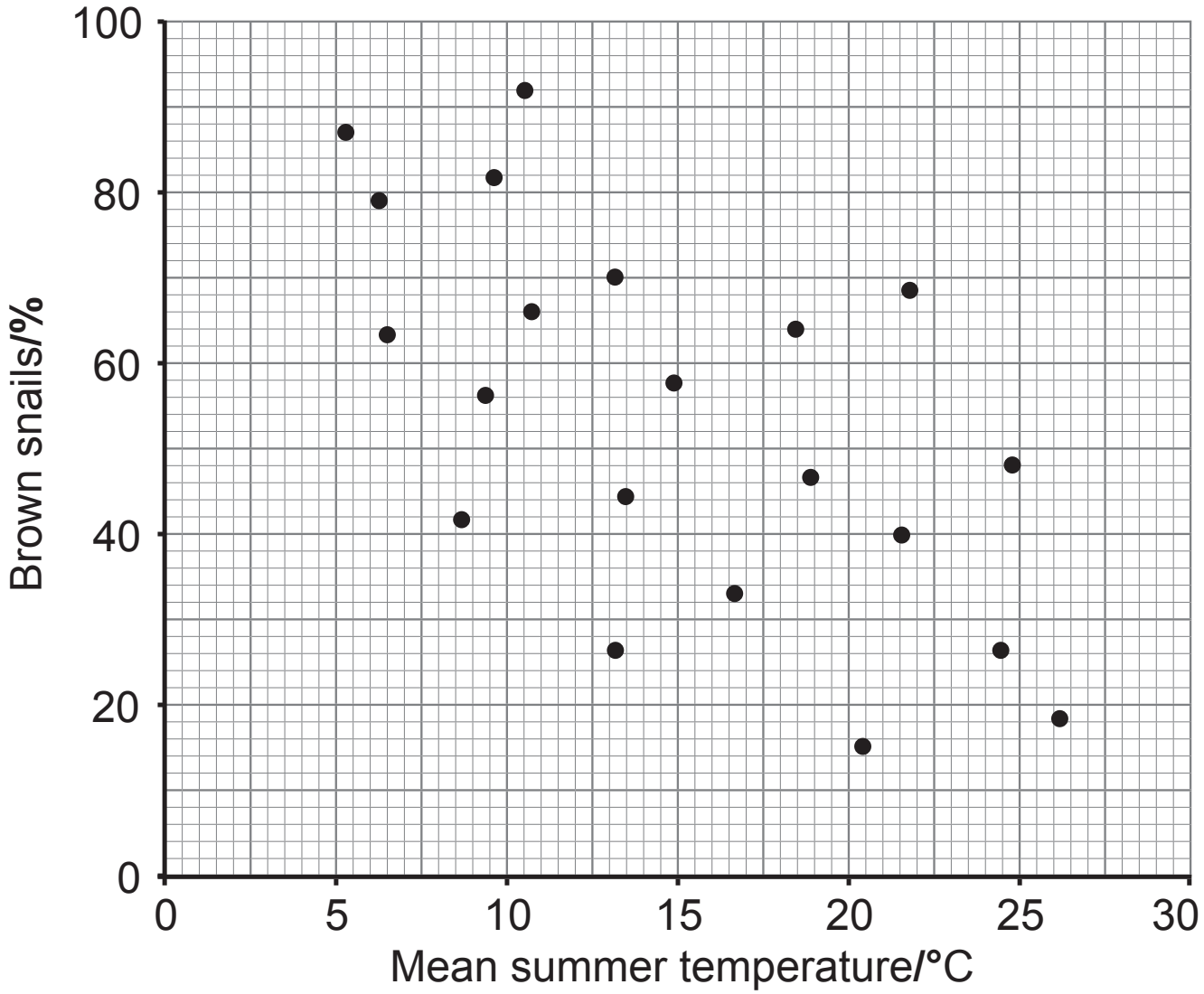
_____

_____

(c) The gene for banding is independently inherited from the gene for shell colour. The allele for absence of banding (**A**) is dominant to the allele for presence of banding (**a**).

In the space below, complete the genetic cross between snails with the genotypes **AaC^{B}C^{P}** and **AaC^{Y}C^{Y}** to show the ratio of offspring produced and the possible offspring genotypes and phenotypes. [5 marks]

(d) Brown shells are good at absorbing heat, but poor at reflecting heat. The proportion of brown snails in populations of this species has been calculated in many European countries. The graph below shows the relationship between mean summer temperature and the percentage of snails that had brown shells, in a range of locations across Europe.



(i) Describe and suggest an explanation for the pattern shown in the graph. [4 marks]

(ii) Some scientists believe that increasing levels of atmospheric carbon dioxide could influence the future distribution of brown snails in Europe. Suggest and explain how the distribution could change. [2 marks]

Section B

Quality of written communication is awarded a maximum of 2 marks in this section.

8 Gene technology continues to contribute to a greater understanding of the genetic code and an increasing ability to manipulate the code.

(a) Explain the term 'genome (gene) sequencing'. Describe the potential benefits (both current and future) of genome sequencing and the ethical issues raised by the use of this technology. [12 marks]

(b) For gene transfer (genetic engineering), it is necessary to obtain the desired gene. Describe the methods available for obtaining this gene. [4 marks]

Quality of written communication [2 marks]

(a) Explain the term ‘genome (gene) sequencing’. Describe the potential benefits (both current and future) of genome sequencing and the ethical issues raised by the use of this technology.

(b) For gene transfer (genetic engineering), it is necessary to obtain the desired gene. Describe the methods available for obtaining this gene.

THIS IS THE END OF THE QUESTION PAPER

SOURCES

Q7 .....© George Bernard / Science Photo Library

DO NOT WRITE ON THIS PAGE

For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
6	
7	
8	
Total Marks	

Examiner Number