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General Certificate of Education
 January 2006
 Advanced Level Examination



**BIOLOGY/HUMAN BIOLOGY (SPECIFICATION A)
 Unit 5 Inheritance, Evolution and Ecosystems**

BYA5

Tuesday 24 January 2006 9.00 am to 10.30 am

For this paper you must have:

- a ruler with millimetre measurements

You may use a calculator.

For Examiner's Use			
Number	Mark	Number	Mark
1		9	
2			
3			
4			
5			
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8			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Time allowed: 1 hour 30 minutes

Instructions

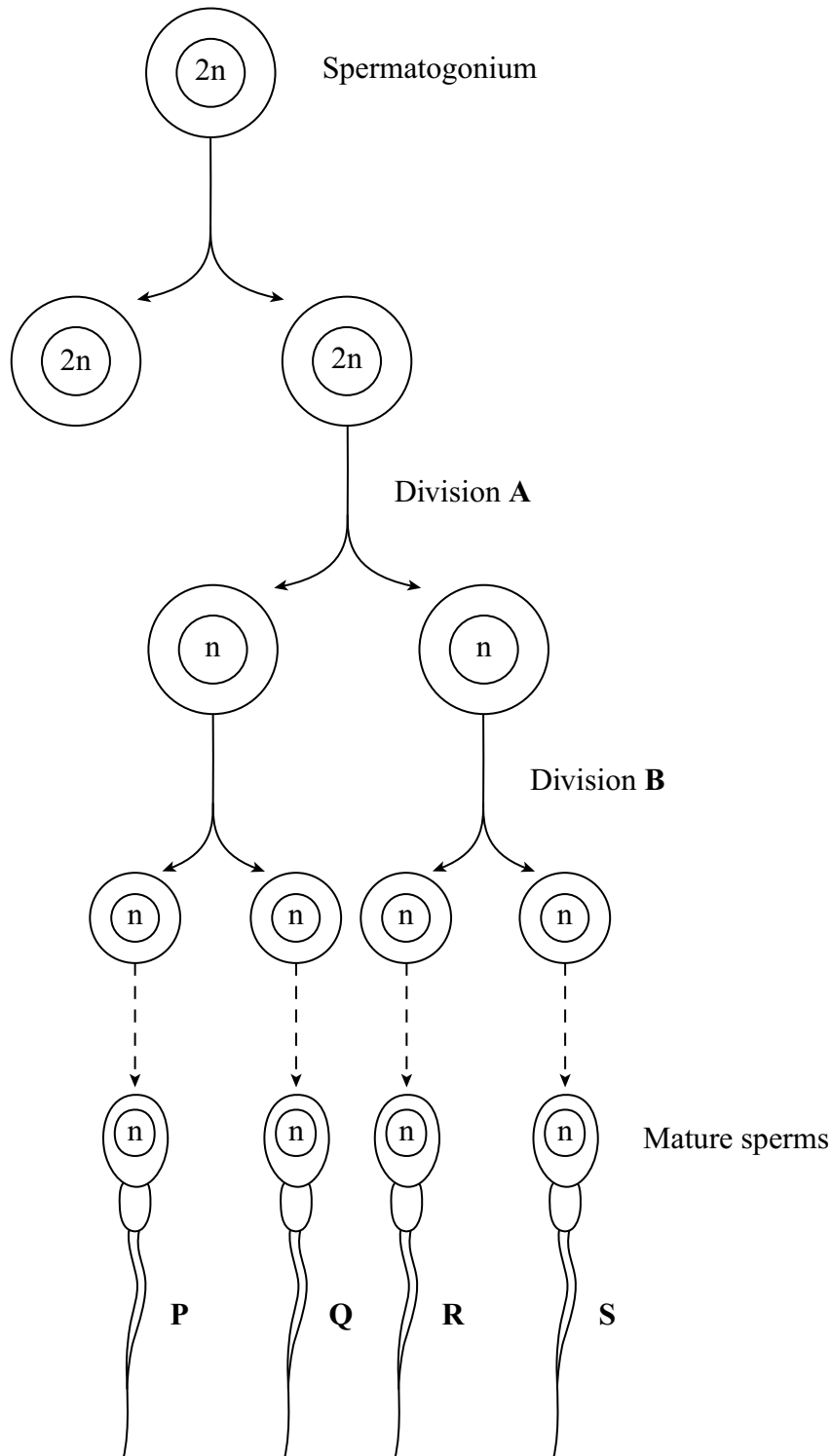
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked.

Information

- The maximum mark for this paper is 75.
- The marks for questions are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.
- Use accurate scientific terminology in your answers.

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

1 The diagram shows the main stages in the formation of sperms in a human testis.



(a) Describe **two** ways, other than size, in which cells at anaphase of division **A** would differ from cells at anaphase in division **B**.

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(2 marks)

(b) Give **two** ways in which meiosis contributes to genetic variation in the mature sperms.

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(2 marks)

(c) This man has haemophilia. Haemophilia is a sex-linked condition. Explain how a child that results from the zygote formed when sperm **P** fertilises an ovum may **not** inherit the haemophilia allele from its father.

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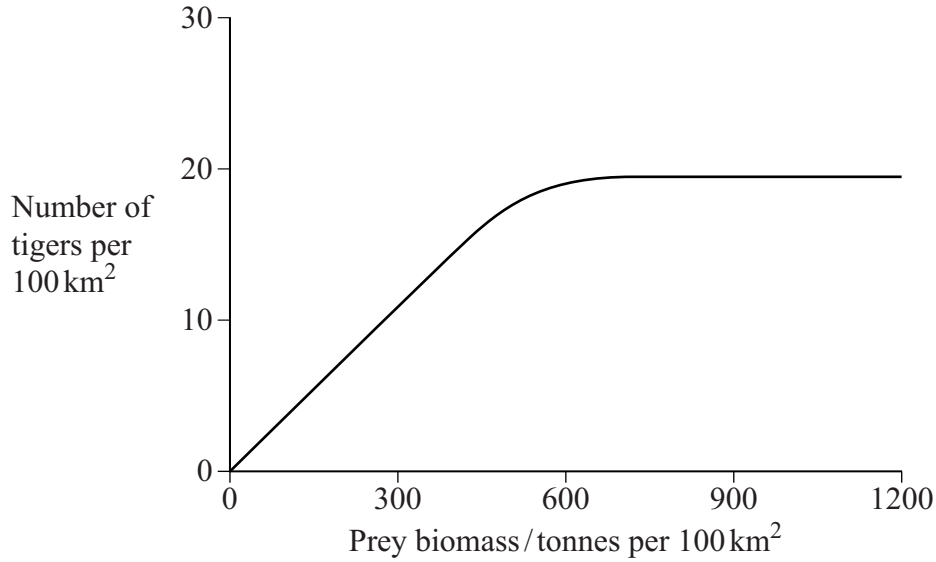
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(2 marks)

2 Tigers inhabit forests where they feed mainly on large prey animals. Over the past fifty years, there has been extensive deforestation in many areas where tigers are found.

(a) The graph shows the relationship between the prey biomass of an area and the tiger population that the area can support.



(i) What is meant by the ecological term *population*?

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 (1 mark)

(ii) Use the graph to explain how deforestation might cause a reduction in the number of tigers in an area.

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 (3 marks)

(b) Tigers and wolves belong to the same order, although they belong to different families. Name **three** other levels of classification that are shared by tigers and wolves.

1 2 3
 (1 mark)

3 New species may arise from populations of existing species. The process is called speciation.

(a) What is a species?

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(2 marks)

(b) Explain the difference between allopatric speciation and sympatric speciation.

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(3 marks)

5

Turn over for the next question

Turn over 

4 Phytoplankton and zooplankton were both found in a lake. Phytoplankton are unicellular protists. Zooplankton are small animals that feed on the phytoplankton.

(a) The biomass of the phytoplankton and zooplankton per cubic metre of water was estimated on several occasions over a period of three months. These data were used to calculate the productivity of the phytoplankton and zooplankton. In this instance, productivity was described as the amount of biomass produced per cubic metre per day.

(i) What calculation would have to be made to find the productivity of the phytoplankton?

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(1 mark)

(ii) The ratio of productivity of phytoplankton to productivity of zooplankton per year in this lake was 9.2 : 1. How is this figure consistent with the principles of energy transfer through an ecosystem?

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(2 marks)

(b) Suggest why the kingdom Protista is sometimes referred to as ‘a taxonomic dumping ground’.

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(1 mark)

5 Biologists studied the process of succession in an area of wasteland over a period of ten years. They calculated the index of diversity of the area every year. After three years, the index of diversity was 1.6. After ten years, it had risen to 4.3.

(a) What information concerning the organisms present in the area is suggested by the increase in the index of diversity?

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(2 marks)

(b) The increase in the index of diversity is one indication that a biological succession is taking place in the area. Describe those features of a succession that would bring about an increase in the index of diversity.

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(3 marks)

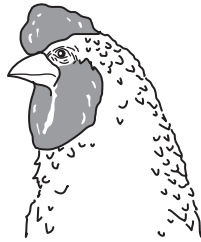
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Turn over for the next question

Turn over 

- 6 Chickens have a structure on their heads called a comb. The diagram shows four types of comb: walnut, pea, rose and single.

Walnut



Pea



Rose



Single



Two genes control the type of comb; each gene has a dominant and a recessive allele. The two genes are inherited independently, but interact to produce the four types of comb.

Genotype	Phenotype
A- B-	Walnut
A- bb	Pea
aa B-	Rose
aa bb	Single

The symbol - indicates that either the dominant allele or recessive allele could be present

- (a) A male with a pea comb, heterozygous for gene A, was crossed with a rose-combed female, heterozygous for gene B. Complete the genetic diagram to show the offspring expected from this cross.

Phenotypes of parents	Pea comb	Rose comb
Genotypes of parents
Gametes formed
Offspring genotypes	
Ratio of offspring phenotypes	
	

(3 marks)

- (b) Chickens with rose or single combs made up 36% of one population. Assuming the conditions of the Hardy-Weinberg equilibrium apply, calculate the frequency of allele **a** in this population. Show how you arrived at your answer.

Frequency of allele **a** = (2 marks)

5

Turn over

7 Some students investigated the effect of light intensity in the environment on the size of leaves of nettles. They measured leaves on sixty plants in each of two sites. The results are summarised in the table.

Dimensions of leaves / mm	Site with high light intensity	Site with low light intensity
Length of longest leaf	113	116
Length of shortest leaf	41	42
Mean length	86	92
Mean maximum width	68	74
Standard deviation of lengths	11	16
Standard deviation of maximum widths	7	11

(a) Each leaf to be measured was selected in the following way.

- The top left hand corner of a quadrat frame was placed at coordinates given by a random number table; the nettle plant nearest the centre of the quadrat was selected,
- The sixth leaf from the tip of the plant was selected.

Explain the importance of

(i) the method of selecting the nettle plant;

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(2 marks)

(ii) measuring the sixth leaf.

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(2 marks)

- (b) (i) Use the data about the length of leaves in the two sites to explain why standard deviation is more useful than range as a measure of variation within a population.

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(4 marks)

- (ii) What other statistic could be calculated from the standard deviation that would give an indication of how the mean leaf length might vary in other samples from the same population of nettles?

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(1 mark)

- (c) (i) The area of a nettle leaf can be estimated using the formula

$$\text{area} = \text{length} \times \text{maximum width} \times 0.5$$

Calculate the ratio of the mean area of the leaves from the site with low intensity to the mean area of the leaves from the site with high light intensity. Show your working.

Answer (2 marks)

Question 7 continues on the next page

Turn over 

- (ii) The nettle leaves with the larger area had more chloroplasts, which produce ATP and reduced NADP. Explain how ATP and reduced NADP are used in the synthesis of glucose in the chloroplasts.

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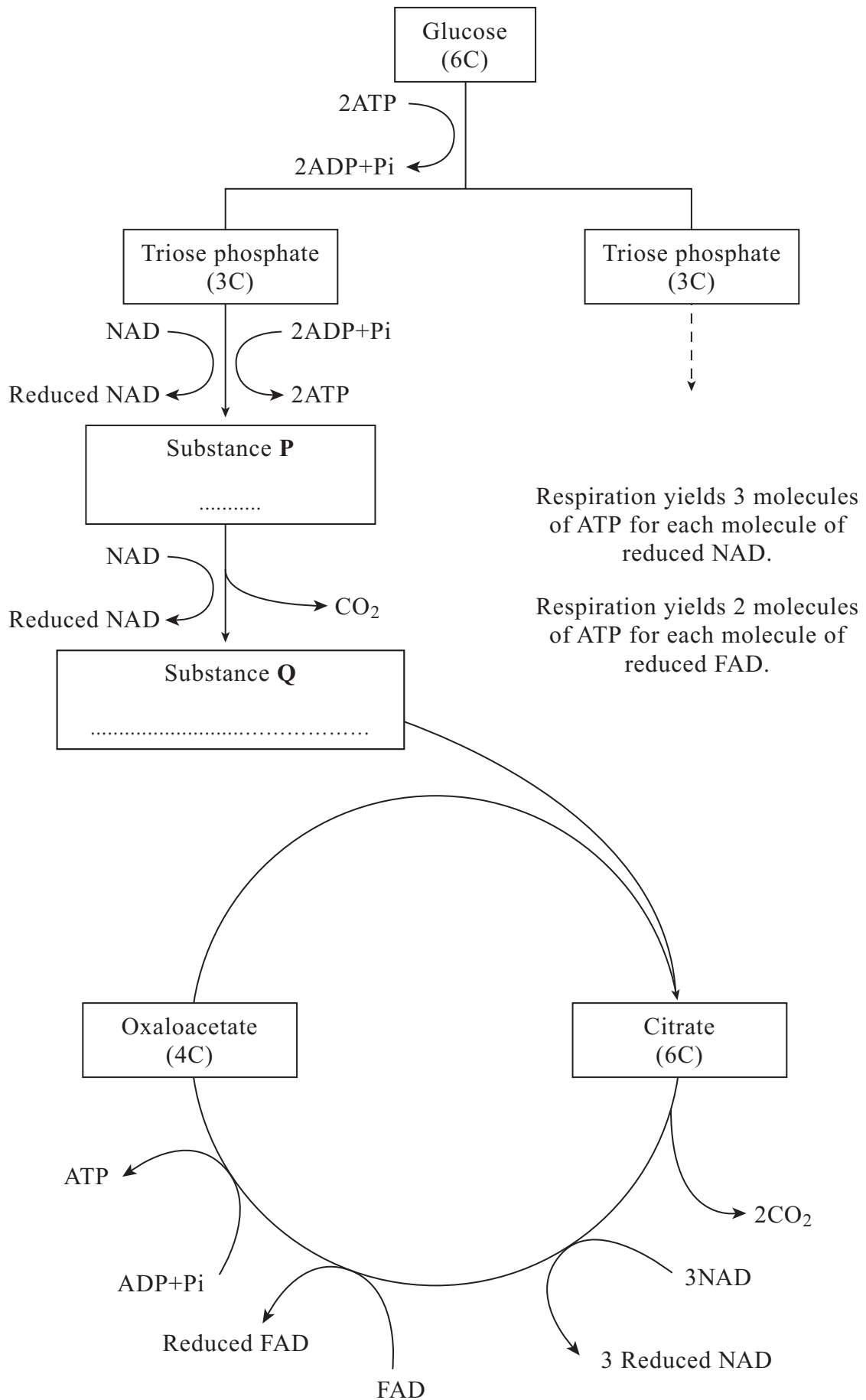
(4 marks)

15

Turn over for the next question

Turn over 

8 (a) The flow chart shows the main stages in aerobic respiration.



(i) Complete the flow chart by writing, in the appropriate boxes, the number of carbon atoms in substance **P** and the name of substance **Q**. (2 marks)

(ii) Some ATP is formed in the cytoplasm and some in the mitochondria. Use the information given to calculate the number of molecules of ATP formed in a mitochondrion from one molecule of glucose in aerobic respiration. Show how you arrived at your answer.

Answer (2 marks)

(iii) In the presence of oxygen, respiration yields more ATP per molecule of glucose than it does in the absence of oxygen. Explain why.

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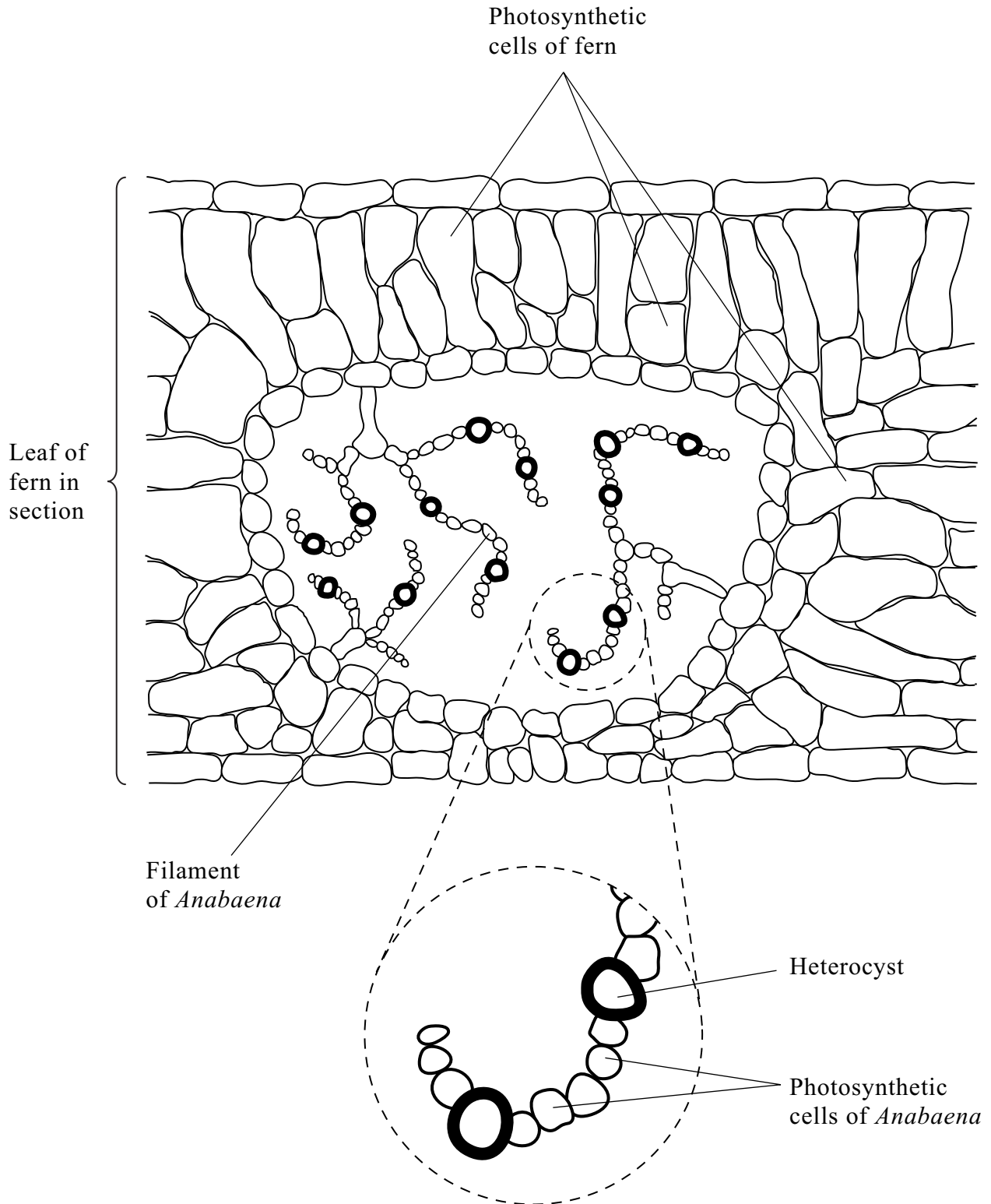
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(3 marks)

Question 8 continues on the next page

- (b) *Anabaena* is a prokaryote found inside the leaves of a small fern. *Anabaena* can produce ammonia from nitrogen (nitrogen fixation). This reaction only takes place in the anaerobic conditions found in cells called heterocysts. Heterocysts are thick-walled cells that do not contain chlorophyll. The drawing shows the relationship between *Anabaena* and the fern.



- (i) Suggest how the features of the heterocysts improve the efficiency of the process of nitrogen fixation.

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(3 marks)

- (ii) In China, the fern is cultivated and ploughed into fields to act as an organic fertiliser. Explain how ploughing the fern plants into the soil results in an improvement in the growth of the rice crop grown in these fields.

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(5 marks)

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- 9 There is evidence that the first photosynthetic organisms were primitive water-dwelling bacteria. The very first of these lived near the surface of the water in lakes and contained a purple pigment that absorbed light most strongly in the green region of the spectrum. Later, other bacteria evolved that lived on the top of sediment at the bottom of the lakes (**Figure 1**). Gene mutations had enabled these bacteria to synthesise chlorophyll instead of the purple pigment present in the bacteria living near to the surface. Chlorophyll absorbs light most strongly in the blue and red regions of the spectrum (**Figure 2**).

Figure 1

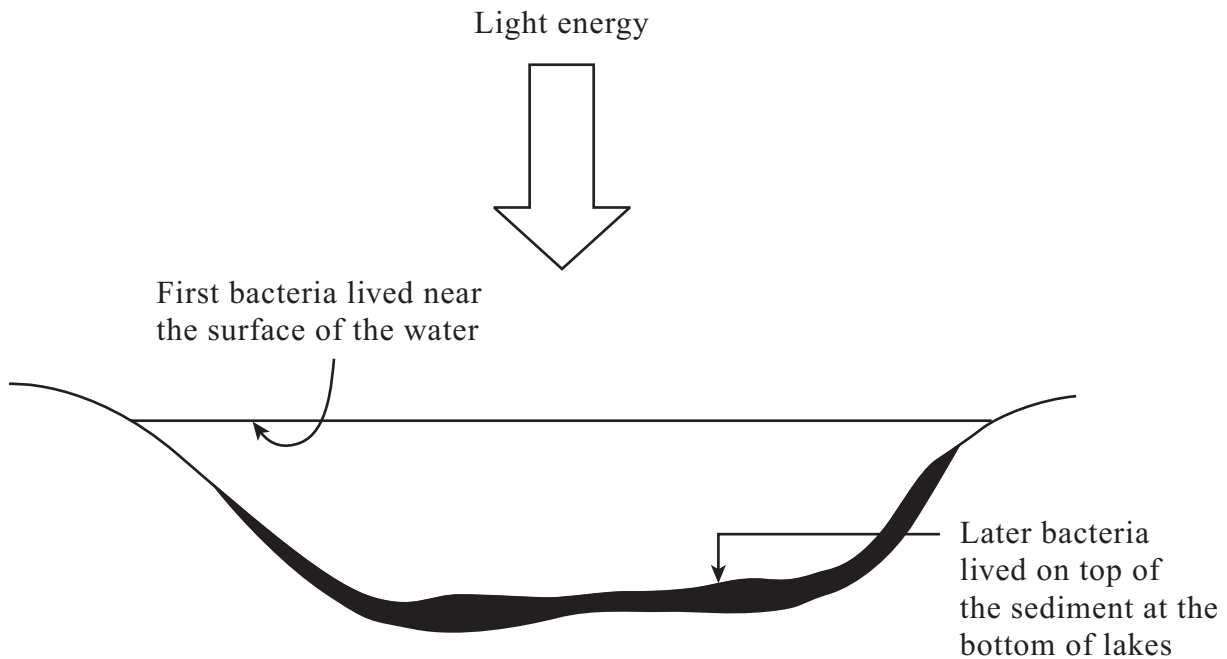
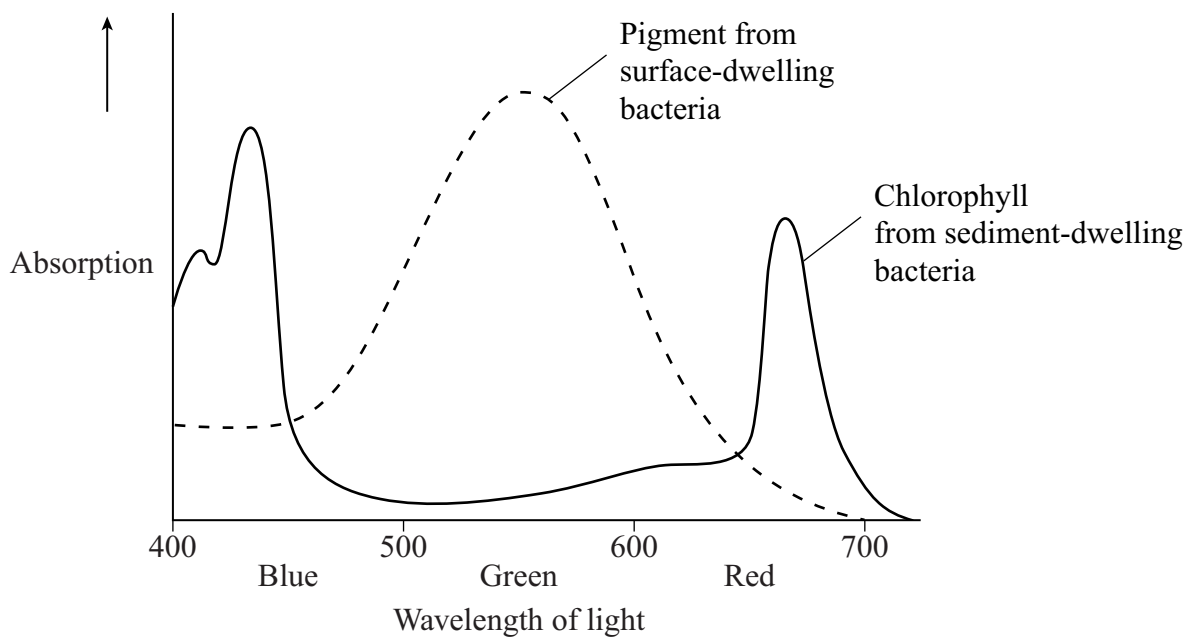


Figure 2



- (a) Describe how light energy absorbed by chlorophyll molecules is used to synthesise ATP.

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(5 marks)

- (b) Use **Figure 2** to explain how natural selection would favour the evolution of sediment-dwelling bacteria containing a different photosynthetic pigment from those living near the surface of the water.

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(6 marks)

Question 9 continues on the next page

Turn over 

- (c) Some gene mutations can result in major changes in the amino acid sequence of the polypeptide for which the gene codes. Name **two** such gene mutations and describe how they result in extensive changes to the polypeptide formed.

Name

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Description

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(4 marks)

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END OF QUESTIONS

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