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**ADVANCED**  
General Certificate of Education  
2018

Centre Number

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Candidate Number

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# Biology

## Assessment Unit A2 2

*assessing*

Biochemistry, Genetics and  
Evolutionary Trends



**[ABY21]**

\*ABY21\*

**MONDAY 11 JUNE, AFTERNOON**

### TIME

2 hours 15 minutes.

### 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. **Do not write with a gel pen.**

Answer **all nine** questions.

### INFORMATION FOR CANDIDATES

The total mark for this paper is 100. Section A carries 82 marks. Section B carries 18 marks.

Figures in brackets printed down the right-hand side of pages 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.

**Statistics Sheets are provided for use with this paper.**

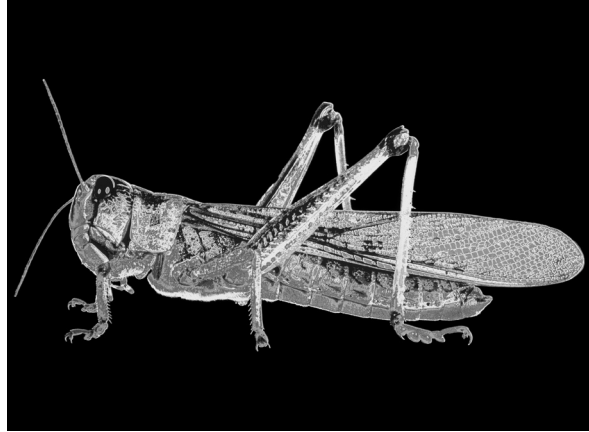
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## Section A

- 1 The photograph below shows a locust.



© John Wells / Science Photo Library

- (a) Identify **two** features visible in the photograph that are characteristic of Phylum Arthropoda.

1. \_\_\_\_\_
2. \_\_\_\_\_ [2]



(b) Locusts are insects that show bilateral symmetry.

(i) Describe what is meant by bilateral symmetry.

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[1]

(ii) Suggest **two** advantages of bilateral symmetry.

1. \_\_\_\_\_  
\_\_\_\_\_

2. \_\_\_\_\_  
\_\_\_\_\_

[2]

(c) Insects are the most successful animal group in terms of the number of species.

Give **one** reason for this.

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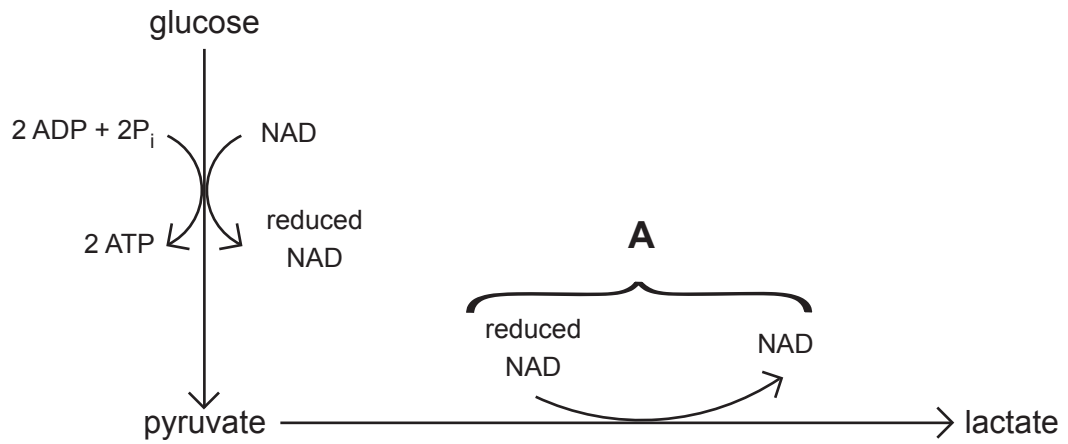
[1]

[Turn over



2 Anaerobic respiration is not limited by the availability of oxygen.

(a) The main stages of anaerobic respiration in mammals are summarised in the diagram below.



(i) Name the part of the cell where anaerobic respiration takes place.

\_\_\_\_\_

[1]

(ii) Energy release in anaerobic respiration is a very rapid process. Using the diagram above and your knowledge, suggest an explanation for this.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

[1]

(iii) Explain the importance of A.

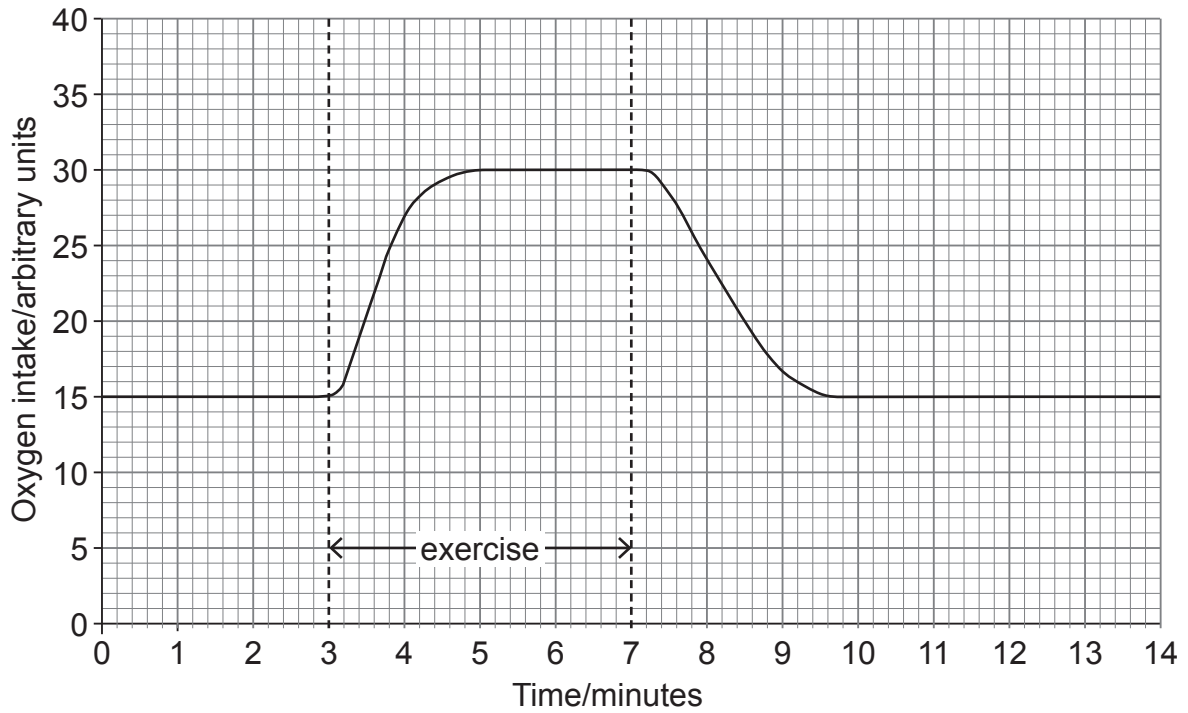
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[1]





(c) The graph below shows how the intake of oxygen in an individual changes during and after exercise.



(i) On the graph, shade the area which represents the oxygen debt. [1]

(ii) State the function of the oxygen debt.

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[1]

(d) Describe **two** differences between the process of anaerobic respiration in plants and animals.

1. \_\_\_\_\_

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2. \_\_\_\_\_

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[2]









(ii) In order to compile the data in the table, blood tests were carried out on individuals from each ethnic group. The individuals were given codeine and blood morphine levels were then measured.

Suggest **two** variables that would have been controlled.

1. \_\_\_\_\_  
\_\_\_\_\_

2. \_\_\_\_\_  
\_\_\_\_\_ [2]

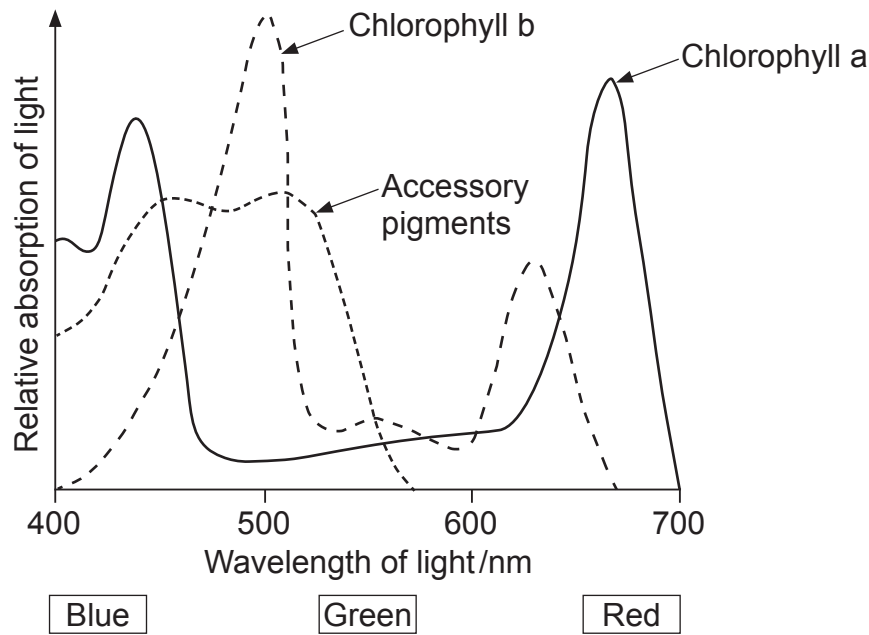
(c) Poor metabolisers may be homozygous for an allele which codes for a non-functional enzyme.

Suggest an explanation for ultra-rapid metabolism.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]



- 4 (a) The graph below shows the absorption spectrum for the photosynthetic pigments in a typical plant.



- (i) Using the information provided, explain why plant leaves are normally green in colour.

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[2]

- (ii) An action spectrum may also be plotted. Describe what is meant by the term 'action spectrum'.

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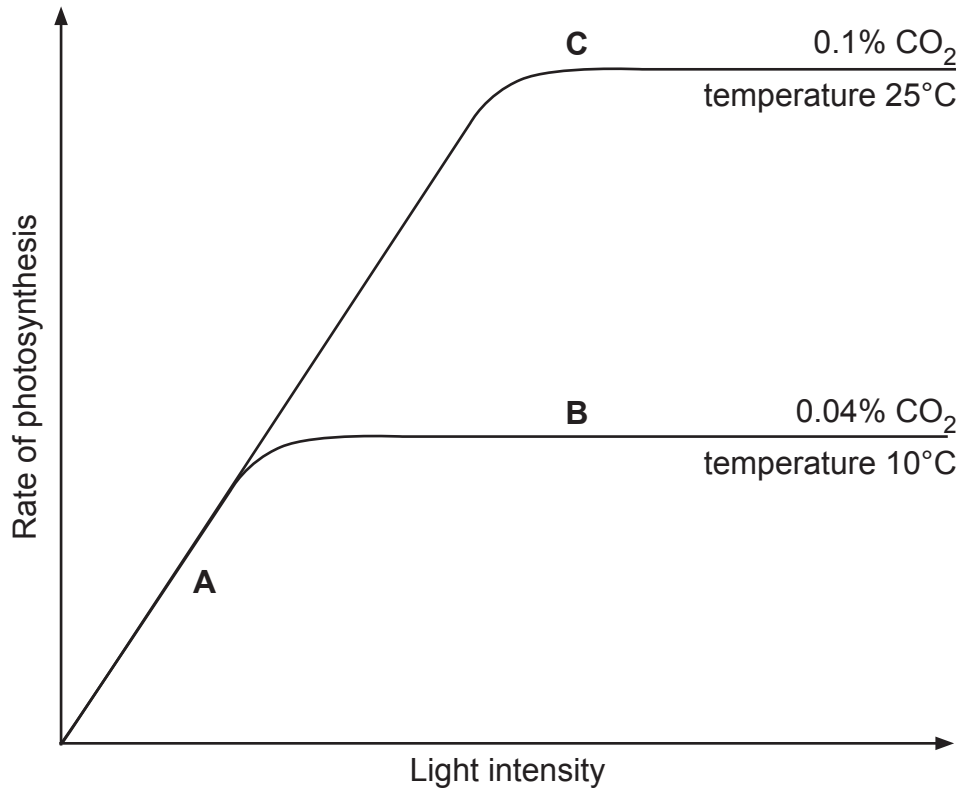
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[1]



(b) The graph below summarises the relationship between light intensity and rate of photosynthesis in different conditions of temperature and CO<sub>2</sub> availability.



(i) Suggest how scientists investigating this relationship would have accurately measured the **rate** of photosynthesis.

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[2]

[Turn over





- (c) Many British plant species grow fastest at a temperature of approximately 25°C. Temperatures greater than this can cause a very high rate of transpiration. The plants' response to this can result in a reduction of growth rate.

With reference to the response of plants to high transpiration rates, explain why growth is faster at 25°C than at 30°C.

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[2]

[Turn over



- 5 Bacteria are prokaryotes and their chromosomal DNA is found as a single large loop within the cell. A number of smaller rings of DNA called plasmids are also present. Genes for antibiotic resistance are often present in plasmids.

The genomes of some bacteria can be more prone to change than the genomes of eukaryotes. For example, plasmids can be exchanged between bacterial cells when they are in close contact, even if the bacteria are different species. In addition, the DNA repair process in plasmids is less effective than in chromosomal DNA, contributing to a high mutation rate.

Antibiotic resistance genes work in a variety of ways. For example, some code for membrane carriers which are able to remove antibiotics from inside bacterial cells. Globally, the number of antibiotic-resistant populations of bacteria is increasing.

A bacterial population can grow very rapidly; in optimum conditions bacteria can reproduce every 20 minutes by division, during which a fully grown cell splits into two daughter cells.

- (a) Apart from organisation of DNA, state **one** difference between prokaryotic and eukaryotic cells.

\_\_\_\_\_ [1]

- (b) (i) As with plant and animal populations, bacterial populations show genetic variation which can arise from various sources. Using the information provided, describe **one** feature of bacteria which increases genetic variation and **one** feature which decreases genetic variation in populations.

Feature which **increases** genetic variation

\_\_\_\_\_  
\_\_\_\_\_

Feature which **decreases** genetic variation

\_\_\_\_\_  
\_\_\_\_\_ [2]





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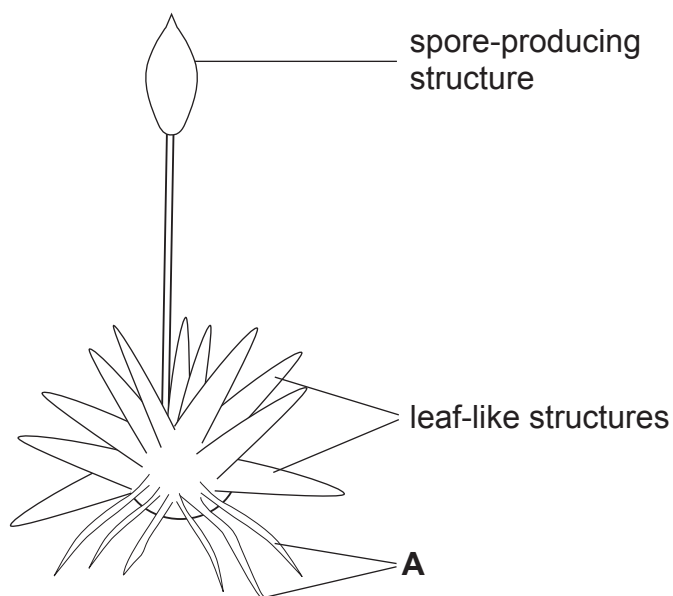


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- 6 (a) In terms of evolutionary development, mosses (bryophytes) are the least evolved group in the plant kingdom. The typical moss structure is represented in the diagram below.



© Chief Examiner

- (i) Identify the structures labelled **A**.

\_\_\_\_\_

[1]

- (ii) State **two** ways in which the leaf-like structures are different from true leaves.

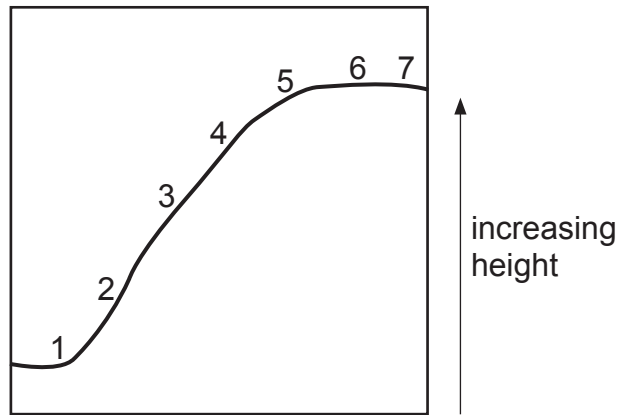
1. \_\_\_\_\_

2. \_\_\_\_\_

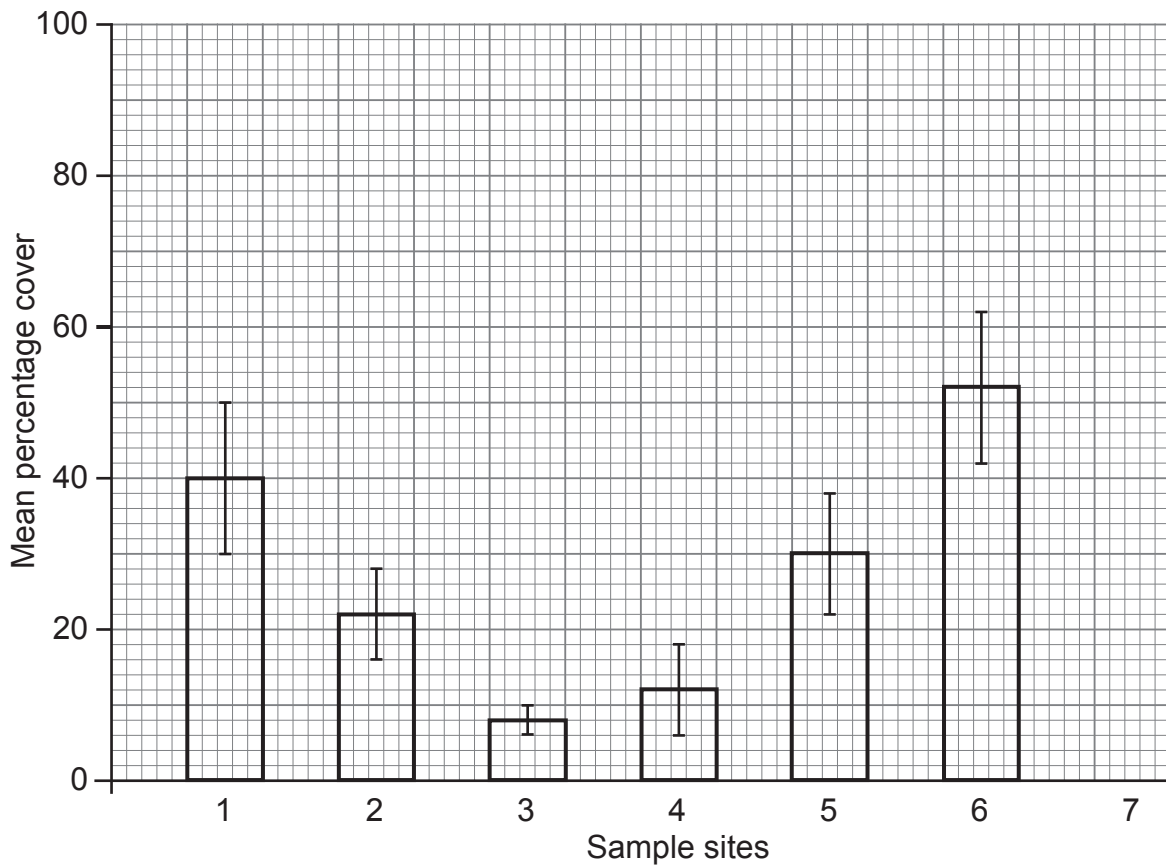
[2]



(b) Mosses of the genus *Sphagnum* are typically found in wet habitats with high levels of rainfall and poor drainage. The mean percentage cover of *Sphagnum* was investigated at a number of sites on a mountain. The position of the sample sites is shown in the diagram below.



The mean percentage cover of *Sphagnum* for sample sites 1–6 is shown in the graph below. Associated 95% confidence limits are included.



- (i) The mean percentage cover of *Sphagnum* in site 7 was 58% and the standard deviation of the mean (standard error) ( $\hat{\sigma}_{\bar{x}}$ ) was 2.422 (n=25).

Using the information given and the Statistics Sheets provided, calculate 95% confidence limits for site 7.

(Show your working.)

upper limit \_\_\_\_\_

lower limit \_\_\_\_\_ [3]

- (ii) Complete the graph by plotting mean percentage cover and 95% confidence limits for site 7. [1]

- (iii) Describe the trend shown by the results and suggest an explanation for the distribution of *Sphagnum* on this mountain.

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[2]

[Turn over



Ferns (pteridophytes) are more highly adapted than mosses for terrestrial life. Ferns are common in hedgerows and woodland and are easily recognised by their finely-divided leaves and the presence of spore-producing sporangia on the lower surface of leaves. Mature plants of some fern species can grow to heights of one metre or more.

(c) Using the information provided, explain fully **one** advantage of ferns reaching heights of one metre or more.

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[2]





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**(Questions continue overleaf)**



- 7 (a) Mendel's second law of inheritance is known as 'the law of independent assortment'. Explain the meaning of this law with respect to dihybrid inheritance.

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[1]

- (b) Coat colour in Doberman dogs is determined by the interaction between two genes. One gene determines the overall colour and has the alleles **B/b**. The second gene dilutes the colour and has the alleles **D/d**.

Black coat colour occurs when the dog possesses at least one **B** allele. Dark red coats are found in dogs which lack the dominant **B** allele.

These colours can be diluted by the presence of two recessive **d** alleles to produce a faded colour. The effect of this in the presence of a **B** allele is blue coat (faded black) while the double homozygous recessive genotype results in a fawn coat (faded red).

- (i) State all the genotypes that produce:

- dark red coat colour \_\_\_\_\_
  - blue coat colour \_\_\_\_\_
- [2]



- (ii) Complete a genetic diagram to show the ratio of genotypes and phenotypes produced from the following cross:

**BbDd × Bbdd**

[5]

[Turn over



- (c) The Xolo is a breed of dog native to Mexico. A dominant allele **H** gives rise to a hairless variety of the dog, while the recessive allele for the gene, **h**, produces a normal hairy coat.

Breeding two hairless dogs together produces both hairless and hairy offspring, in the ratio of 2 hairless : 1 hairy. This ratio can be best explained by a combination of alleles that is lethal.

Draw a genetic diagram to explain this ratio.

[3]

- (d) In terms of dog populations in general, suggest **one** reason why it would not be appropriate to use the Hardy-Weinberg equation to calculate allele and genotype frequencies.

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[1]





8 (a) Gene technology has many applications, one of which is the manufacture of substances of medical importance such as insulin. Before the application of genetic engineering, the insulin required for the treatment of diabetes had to be extracted from pigs and cows in abattoirs.

(i) Name the group of organisms that is used to produce insulin in genetic engineering.

\_\_\_\_\_

[1]

(ii) Suggest **one medical** advantage of making insulin for the treatment of diabetes by genetic engineering, rather than obtaining insulin from dead livestock.

\_\_\_\_\_  
\_\_\_\_\_

[1]

(b) Gene therapy is another application of gene technology. Cystic fibrosis is caused by the presence of two recessive alleles for a particular gene. Impaired lung function is one symptom of this condition and part of a treatment programme can involve the use of liposomes or viruses to insert functioning genes into the cells of the lung.

However, the use of gene therapy to treat cystic fibrosis has not been very successful for a number of reasons. One of these is the difficulty of getting functional genes into a high enough proportion of lung cells.

Suggest **one** reason why only a small number of lung cells gain the functional gene in gene therapy.

\_\_\_\_\_  
\_\_\_\_\_

[1]

[Turn over



- (c) Gene technology has recently been trialled in a new treatment for the genetic disease sickle cell anaemia. This disease is caused by a mutation in one of the genes which codes for haemoglobin. As a result, red blood cells have a distorted shape and may block narrow capillaries.

Bone marrow transplants can be used to treat sickle cell anaemia, since red blood cells are produced from stem cells in bone marrow. However, these transplants are often unsuccessful.

- (i) Using your knowledge of the immune system, suggest why a bone marrow transplant may be unsuccessful.

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[1]



It is hoped that the new treatment involving gene technology will prove more successful in treating sickle cell anaemia.

Scientists have been able to ‘edit’ the genes in the stem cells in the bone marrow of the patient. This involved removing the mutated sequence and replacing it with a functional version.

(ii) With reference to the limitations of traditional gene therapy, explain fully the advantages of this technique.

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[4]

(iii) Suggest **one** possible disadvantage of this technique.

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[1]

[Turn over



**Section B**

*Quality of written communication will be assessed in this section.*

**9** Protein synthesis is the process by which polypeptide and protein molecules are made in the cell. This is based on the genetic code carried by DNA in the nucleus.

**(a)** Describe and explain the roles of DNA, RNA and ribosomes in protein synthesis. [12]

**(b)** In humans, almost all cells in the body contain the same 21 000 (approx.) genes but do not all produce the same proteins. Explain what is meant by 'epigenetics' and, in relation to this, explain why enzymes associated with liver function are only produced in liver cells. [6]

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**(a)** Describe and explain the roles of DNA, RNA and ribosomes in protein synthesis.

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**(b)** In humans, almost all cells in the body contain the same 21 000 (approx.) genes but do not all produce the same proteins. Explain what is meant by 'epigenetics' and, in relation to this, explain why enzymes associated with liver function are only produced in liver cells.

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<b>Total Marks</b>	
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Examiner Number

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