| Surname | | Other Names | |
|---|---|---|---|
| Centre Number | | | Candidate Number | | | | | | | | | |
| Candidate Signature | | | | | | | | | | | | |

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General Certificate of Education
June 2005
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

# BIOLOGY/HUMAN BIOLOGY (SPECIFICATION A) BYA5
# Unit 5 Inheritance, Evolution and Ecosystems

Tuesday 21 June 2005 Morning Session

**In addition to this paper you will require:**
- a ruler with millimetre measurements.

You may use a calculator.

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 in the spaces provided. All working must be shown.
- 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.
- Mark allocations are shown in brackets.
- You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate.
- The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.

| For Examiner's Use | | | |
|---|---|---|---|
| Number | Mark | Number | Mark |
| 1 | | | |
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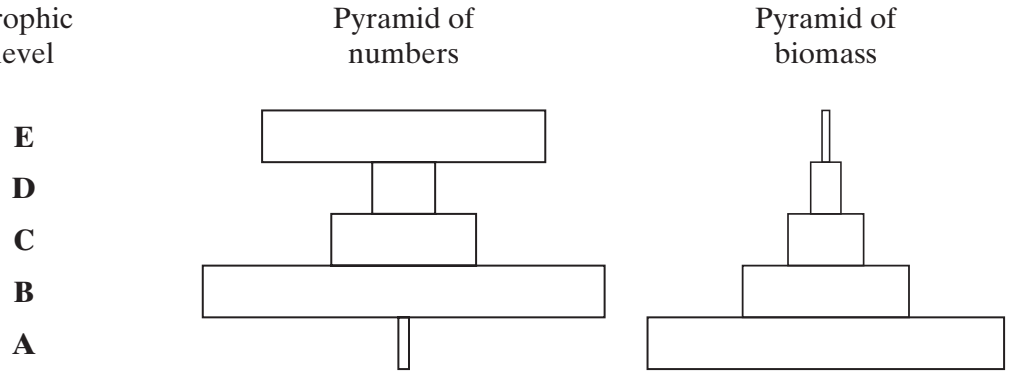
| Total (Column 2) → | | | |
| TOTAL | | | |
| Examiner's Initials | | | |

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

**1** A food chain found in oak woodland is shown below.

| Organism | Oak tree → | Aphid → | Hoverfly → | Great tit → | Parasitic mite |
|---|---|---|---|---|---|
| Trophic level | **A** | **B** | **C** | **D** | **E** |

The pyramid of numbers and pyramid of biomass representing this food chain are shown in the diagram.




(a) Not all the light energy entering the leaves of the oak tree is used in photosynthesis. Give **one** reason for this.

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*(1 mark)*

(b) Give **two** ways in which energy is lost between trophic levels **A** and **B**.

1 .....

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2 .....

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*(2 marks)*

(c) Explain the difference between the shapes of the two pyramids at trophic levels **D** and **E**.

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*(2 marks)*

5

**2** Deforestation often involves clearing large areas of forest for use as agricultural land.

(a) Deforestation reduces the diversity index of an area cleared in this way. Explain why.

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*(2 marks)*

(b) Because the forest soil is often nutrient-poor, nitrogen-containing fertilisers may be applied to ensure good crop yields. Use your knowledge of the nitrogen cycle to explain the potential benefit of applying a fertiliser containing ammonium nitrate rather than one containing potassium nitrate.

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*(3 marks)*

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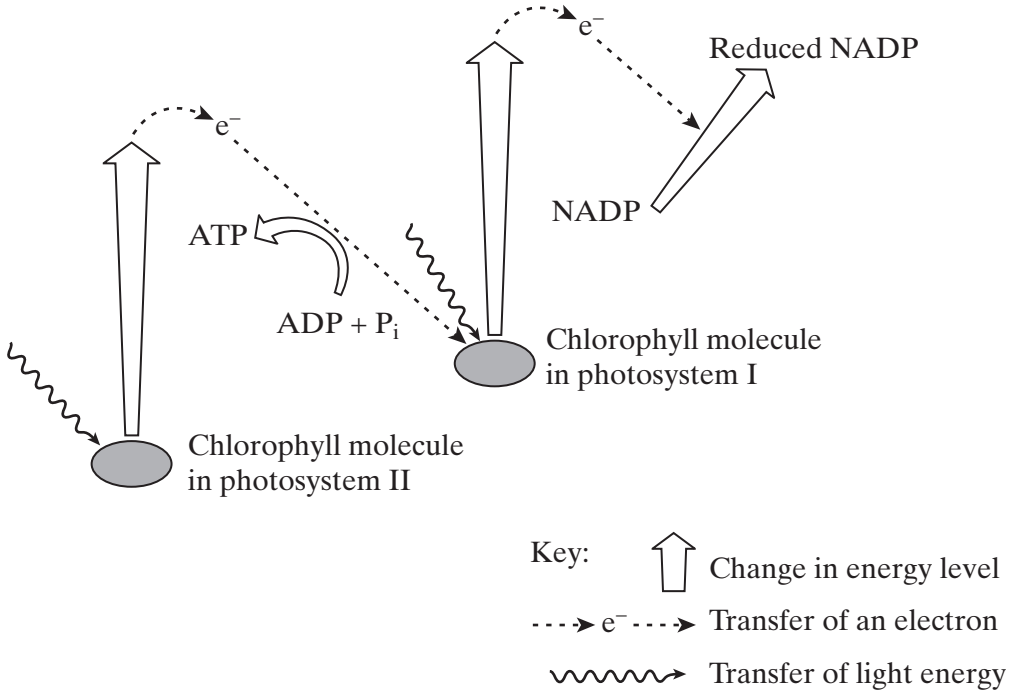
**TURN OVER FOR THE NEXT QUESTION**

**3** (a) The diagram summarises some of the light-dependent reactions of photosynthesis.




(i) Use the diagram to describe what happens to a molecule of chlorophyll in photosystem II when it absorbs a photon of light.

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*(2 marks)*

(ii) Molecules of ATP are formed as electrons are transferred from photosystem II to photosystem I. Explain how this is possible.

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*(1 mark)*

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(b) Reduced NADP produced during the light-dependent reactions of photosynthesis is used in the light-independent reactions. Explain how.

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*(2 marks)*

5

**TURN OVER FOR THE NEXT QUESTION**

**4** Human ABO blood groups are determined by the presence or absence of two antigens (A and B) on the plasma membrane of the red blood cells. The inheritance of these blood groups is controlled by three alleles:

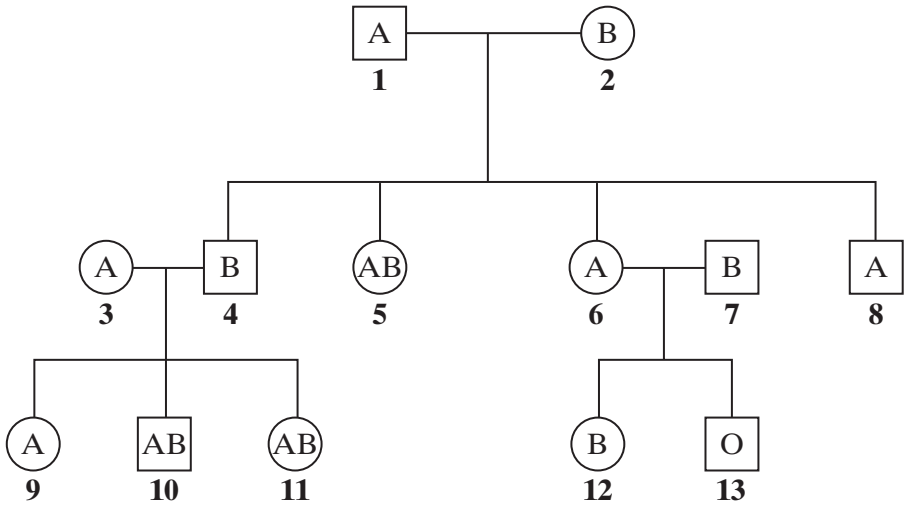
$I^A$ – determines the production of antigen A

$I^B$ – determines the production of antigen B

$I^o$ – determines the production of no antigen

Alleles $I^A$ and $I^B$ are codominant. Allele $I^o$ is recessive to both.

The pedigree shows the pattern of inheritance of these blood groups in a family over three generations.




(a) (i) How many antigen-determining alleles will be present in a white blood cell? Give a reason for your answer.

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*(1 mark)*

(ii) Which antigen or antigens will be present on the plasma membranes of red blood cells of individual **5**?

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*(1 mark)*

(b) If individuals **6** and **7** were to have another child, what is the probability that this child would be male and blood group A? Explain your answer.

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*(3 marks)*

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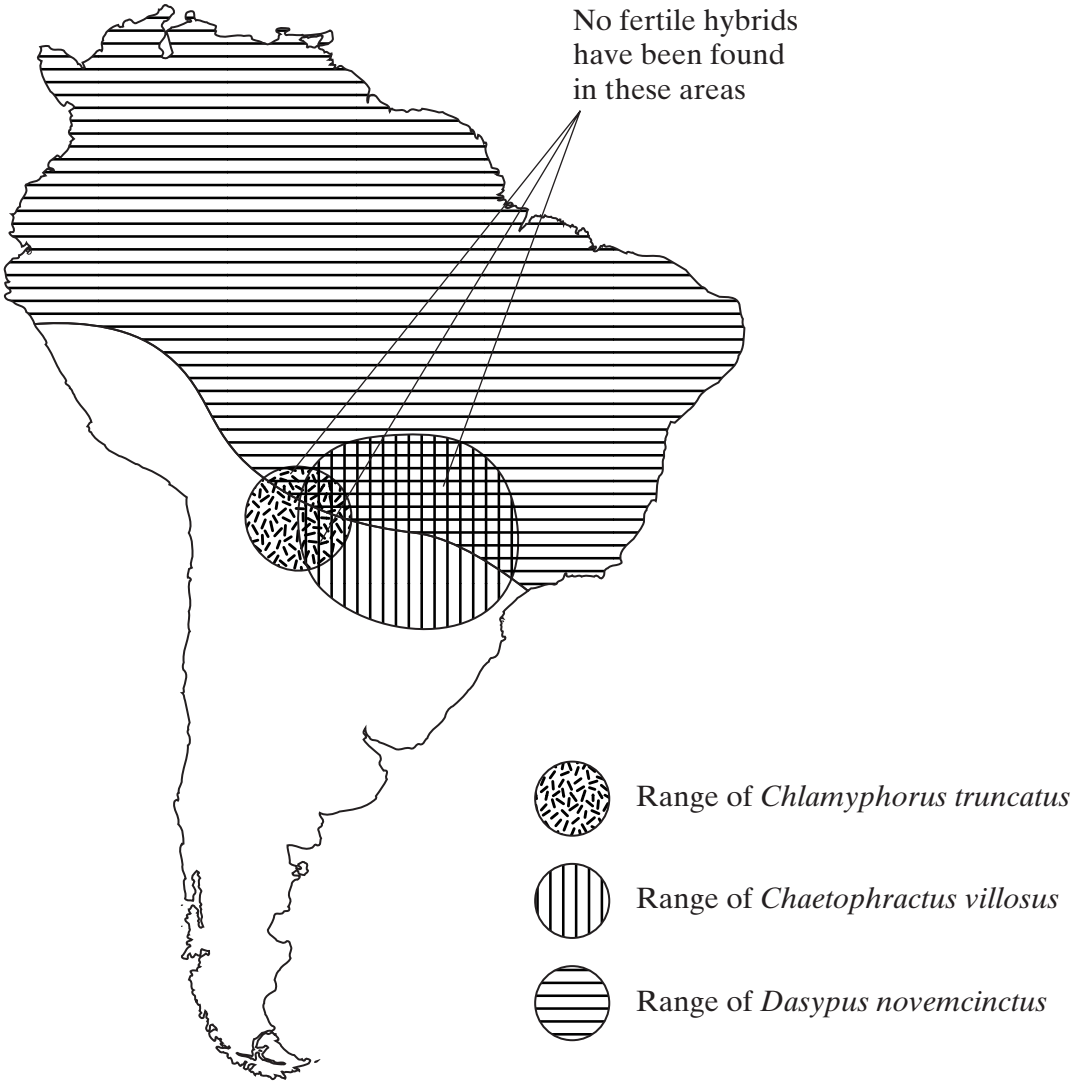
**TURN OVER FOR THE NEXT QUESTION**

**5** Armadillos are mammals. The map shows the ranges of three species of armadillo in South America.




(a) (i) What evidence in their ranges suggests that the three armadillos belong to different species?

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*(1 mark)*

(ii) What further evidence would confirm that the three armadillos belong to different species?

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*(1 mark)*

(b) (i) Complete the table to show the classification of *Dasypus novemcinctus*.

| | |
|---|---|
| Kingdom | |
| Phylum | Chordata |
| | Mammalia |
| | Xenarthra |
| | Dasypodidae |
| Genus | |
| Species | |

*(2 marks)*

(ii) What is the lowest taxonomic grouping that the three species of armadillos can share? Explain your answer.

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*(1 mark)*

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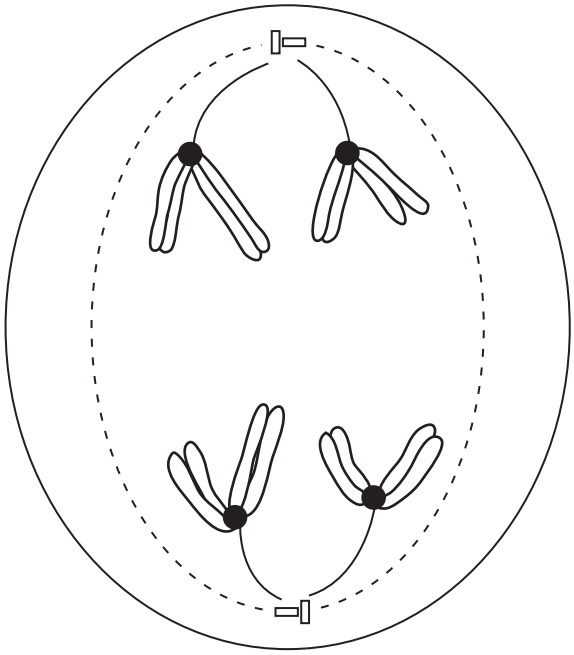
**TURN OVER FOR THE NEXT QUESTION**

**6** (a) The diagram shows a cell undergoing cell division.



Identify the type and stage of cell division shown. Give evidence from the diagram to support your answer.

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*(3 marks)*

(b) Describe how crossing over occurs during meiosis I.

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*(2 marks)*

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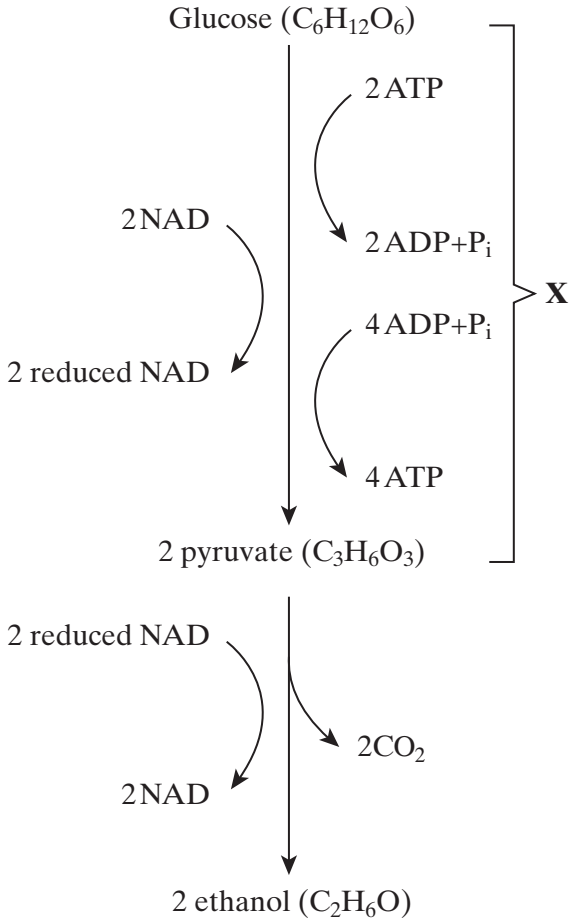
**7** (a) The main stages in anaerobic respiration in yeast are shown in the diagram.




(i) Name process **X**.

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*(1 mark)*

(ii) Give **one** piece of evidence from the diagram which suggests that the conversion of pyruvate to ethanol involves reduction.

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*(1 mark)*

**QUESTION 7 CONTINUES ON THE NEXT PAGE**

(iii) Explain why converting pyruvate to ethanol is important in allowing the continued production of ATP in anaerobic respiration.

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*(2 marks)*

(b) Give **two** ways in which anaerobic respiration of glucose in yeast is

(i) similar to anaerobic respiration of glucose in a muscle cell;

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2 .....

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*(2 marks)*

(ii) different from anaerobic respiration of glucose in a muscle cell.

1 .....

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2 .....

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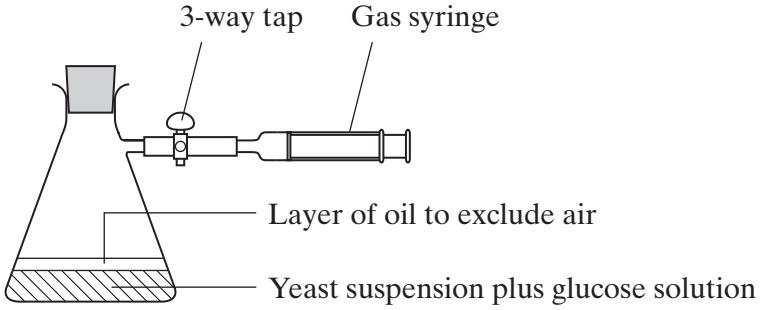
*(2 marks)*

(c) Some students investigated the effect of temperature on the rate of anaerobic respiration in yeast. The apparatus they used is shown in the diagram. The yeast suspension was mixed with glucose solution and the volume of gas collected in five minutes was recorded.



(i) Each student repeated the experiment and the results were pooled. Explain the advantages of collecting a large number of results.

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*(2 marks)*

(ii) At 30 °C, one student obtained the following results.

| Volume of gas collected in 5 minutes / $cm^3$ | Result 1 | Result 2 | Result 3 |
|---|---|---|---|
| | 38.3 | 27.6 | 29.4 |

Calculate the mean rate of gas production. Give your answer in $cm^3 s^{-1}$.

Answer ..... $cm^3 s^{-1}$

*(2 marks)*

(iii) If aerobic respiration had been investigated rather than anaerobic respiration, how would you expect the volumes of gas collected at 30 °C to differ from these results? Explain your answer.

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*(3 marks)*

15

**8** Detritivorous insects feed on the dead remains of plants. Some students estimated the numbers of detritivorous insects at two different sites in an ecosystem. They also obtained data about the net primary production of the sites to see if this influenced the numbers of insects present. Net primary production is a measure of plant biomass formed per year. The results are shown in the table.

| Site | Number of insects per $m^2$ | Net primary production / g $m^{-2}$ $y^{-1}$ |
|---|---|---|
| **A** | 316 | 1440 |
| **B** | 90 | 550 |

(a) Explain how the students could use the mark-release-recapture technique to estimate the numbers of insects.

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*(4 marks)*

(b) The students used the chi-squared ($\chi^2$) test to test the hypothesis that there was no significant difference between the numbers of insects per square metre at sites **A** and **B**. The value they obtained was 125.8. They checked this value in $\chi^2$ tables.

(i) How many degrees of freedom should they check against?

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*(1 mark)*

(ii) What level of probability is normally used to judge whether a difference is statistically significant?

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*(1 mark)*

(iii) The value of $\chi^2$ for the 0.001 level of probability for this number of degrees of freedom is 10.8. What does the value obtained by the students suggest about the difference in numbers of the insects per square metre between the two sites? Explain your answer.

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*(2 marks)*

(c) (i) Explain why the net primary production of an area does not represent the total amount of plant biomass formed per year by photosynthesis.

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*(2 marks)*

(ii) Suggest how the difference in net primary production of sites **A** and **B** might explain the difference in the number of insects between the sites.

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*(1 mark)*

(iii) Explain the role of bacteria in making carbon in dead plant remains available to plants.

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*(4 marks)*

15

**9** (a) Some antibiotics bind with specific receptors in the plasma membranes of bacteria. The structure of these receptors is determined genetically. Bacteria can become resistant to an antibiotic because a gene mutation results in an altered receptor.

(i) Explain how resistance to an antibiotic could become widespread in a bacterial population following a gene mutation conferring resistance in just one bacterium.

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*(5 marks)*

(ii) Deletion and substitution are two types of gene mutation. Explain why a deletion is more likely to lead to a bacterium becoming resistant to an antibiotic than a substitution.

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*(6 marks)*

(b) Some humans have a genetic resistance to infection. A recessive allele gives increased resistance to infection by the malarial parasite. In a population, the proportion of babies born who are homozygous for this allele is 0.01. Use the Hardy-Weinberg equation to calculate the expected proportion of heterozygotes in this population. Show your working.

Answer .....

*(4 marks)*

15

**END OF QUESTIONS**

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