Write your name here

| Surname | Other names |
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**Edexcel GCE**

| Centre Number | Candidate Number |
|---|---|
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# Biology

## Advanced

## Unit 4: The Natural Environment and Species Survival

Monday 25 January 2010 – Afternoon
**Time: 1 hour 30 minutes**

Paper Reference
**6BI04/01**

**You do not need any other materials.**

Total Marks

### Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

### Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- Candidates may use a calculator.

### Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over* ▶

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**Answer ALL questions.**

**Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.**

**1** The process of photosynthesis has two main stages. The first of these involves the light-dependent reactions.

(a) The statements below describe important parts of the light-dependent reactions of photosynthesis. Place a cross ☒ in the box next to the term that completes each statement correctly.

(i) When light is absorbed by chlorophyll, it excites

**(1)**

☒ **A** electrons

☒ **B** neutrons

☒ **C** photons

☒ **D** protons

(ii) Oxygen is produced when water molecules are split in the process of

**(1)**

☒ **A** analysis

☒ **B** autolysis

☒ **C** hydrolysis

☒ **D** photolysis

(iii) The products of the light-dependent reactions that are used in the light-independent reactions are reduced NADP and

**(1)**

☒ **A** ATP

☒ **B** GALP

☒ **C** DNA

☒ **D** RuBP



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(b) Describe the structures in a chloroplast that are involved in the light-dependent reactions of photosynthesis.

**(3)**

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(c) In an investigation, wheat plants were grown using artificial lighting. Three different types of lighting were used. When the wheat plants were mature, the total biomass of the plants and the mass of the grain (seeds) they produced were measured for each type of lighting.

The table below shows the results of this investigation.

| **Type of lighting** | **Total biomass / kg** | **Mass of grain / kg** | **Grain yield as a percentage of total biomass (%)** |
|---|---|---|---|
| Low pressure sodium lamps | 171 | 61.7 | 36.1 |
| High pressure sodium lamps | 159 | 58.8 | 37.0 |
| Metal halide lamps | 162 | 62.4 | |

(i) Calculate the grain yield, as a percentage of total biomass, for the wheat grown under metal halide lamps. Show your working.

**(2)**

Answer ..... %



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(ii) With reference to the data in the table, suggest the conclusions the investigators may have made about the effect of using different types of lighting on grain yield.

**(3)**

(iii) Suggest **two** advantages of growing crops of wheat in glasshouses with artificial lighting rather than growing them in open fields.

**(2)**

**(Total for Question 1 = 13 marks)**



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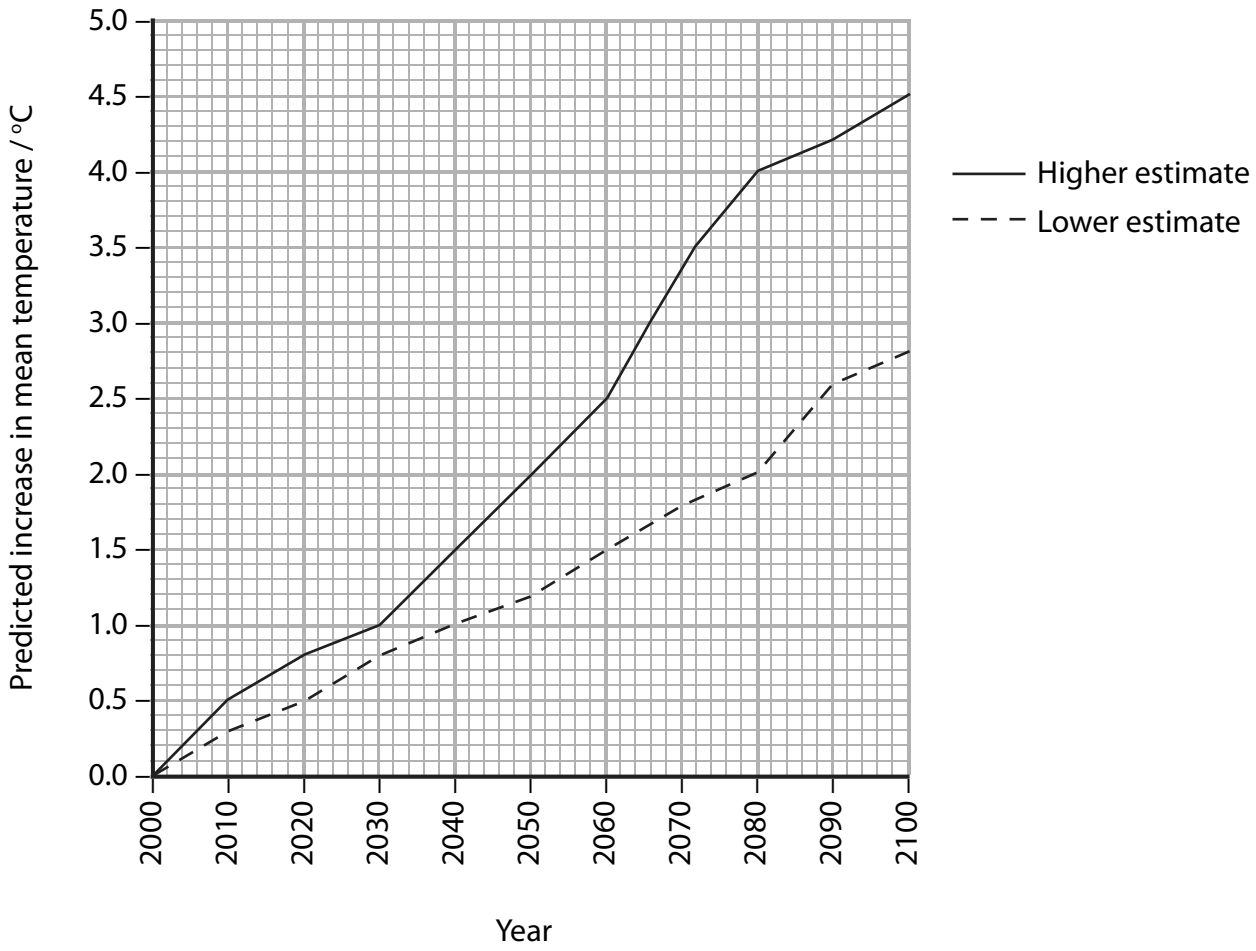
**2** The mean global temperature is expected to increase as a result of climate change. The graph below shows the predicted changes in mean temperature in New Zealand, during the 21st century. A higher and lower estimate of these changes have been made.




(a) (i) Explain how increases in carbon dioxide and methane, released into the atmosphere, may be contributing towards the estimated changes in mean temperature shown in the graph.

**(3)**



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(ii) Suggest why a higher estimate and a lower estimate were made.

**(1)**

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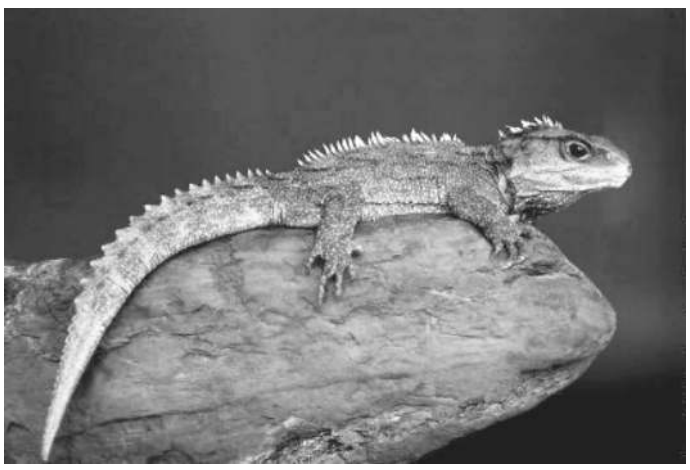
(b) Tuataras are reptiles found only on a group of small islands off the coast of mainland New Zealand. Adult tuataras grow to approximately 65 cm in length. They feed on small mammals, bird chicks and invertebrates such as insects and worms.



Tuataras build nests in which their eggs are laid. The gender (sex) of the tuatara, that hatches from an egg, is determined by the incubation temperature in the nest. A temperature of 22 °C or above will mean that a male tuatara will hatch. Female tuataras only hatch from eggs incubated below 22 °C.

During the breeding season in 2000, the temperature of the nests ranged between 18 °C and 24 °C.



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(i) Suggest how the changes in the mean temperature, shown in the graph on page 6, might affect the tuataras on the islands off the coast of New Zealand.

**(4)**

(ii) Suggest how other animal populations on these islands might be affected by changes in the tuatara population.

**(2)**

**(Total for Question 2 = 10 marks)**





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**3** The distribution and abundance of an organism within its habitat can be influenced by both abiotic and biotic factors.

(a) Explain the difference between **abiotic** and **biotic** factors.

**(1)**

(b) Periwinkles are similar to snails and are one of the common invertebrates found on many seashores around Britain. A study of the distribution of two species of periwinkle, *Littorina littorea* and *Littorina obtusata*, was carried out.

Areas of a sloping seashore were selected at different heights above sea level. Within each of these areas, the mean density (individuals per $m^2$) of each of the periwinkle species was recorded.

(i) Place a cross ☒ in the box next to the name of the most suitable piece of apparatus for obtaining the data for the density of the periwinkles.

**(1)**

☒ **A** quadrant

☒ **B** quadrat

☒ **C** quadrille

☒ **D** quartile

*(ii) Explain how this piece of apparatus would be used to obtain the mean density of the two species of periwinkle in each area.

**(3)**







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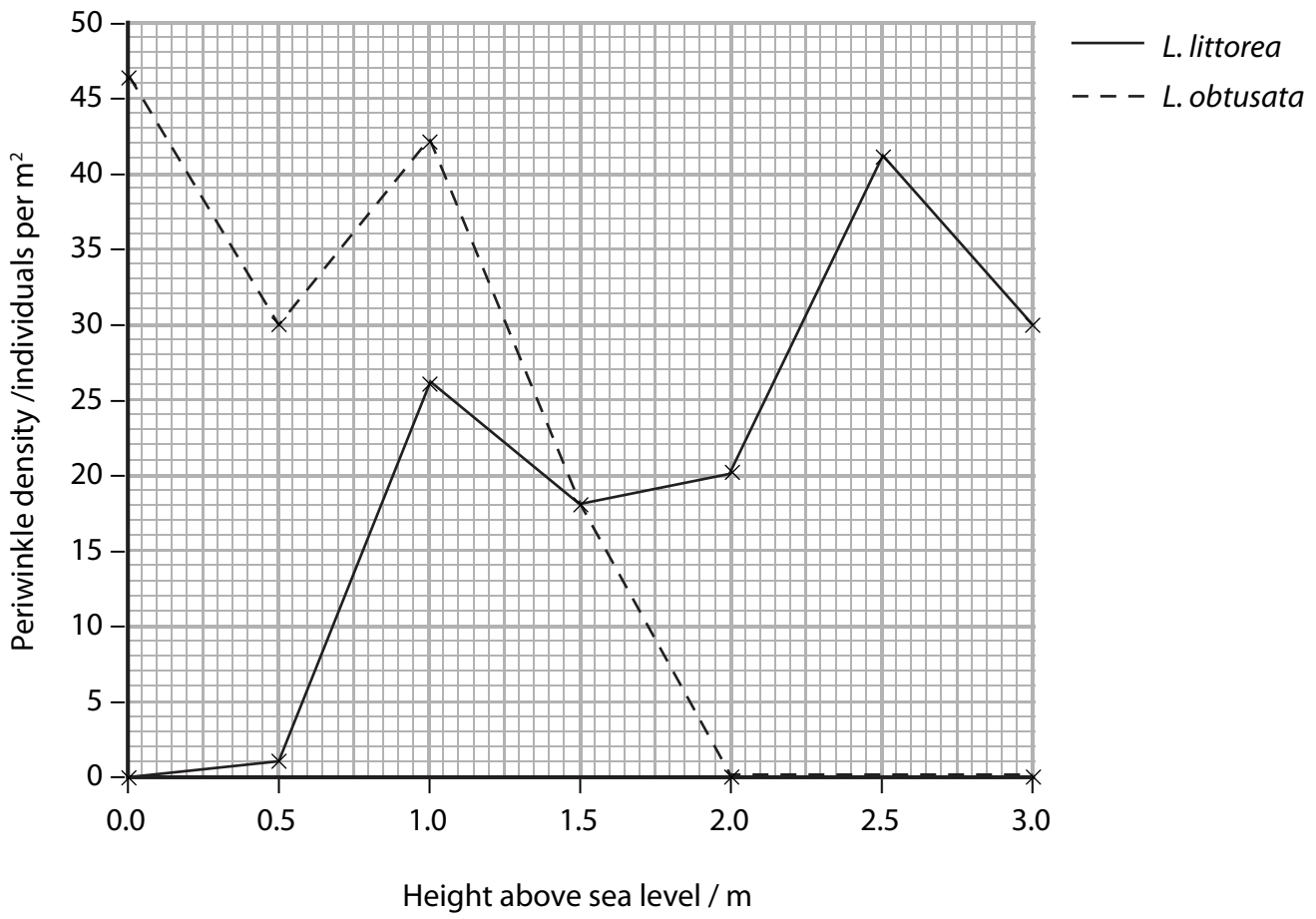
(iii) Suggest **one** abiotic factor and **one** biotic factor that may influence the distribution of the periwinkles on the seashore.

**(2)**

Abiotic .....

Biotic .....

(iv) The results of this study into periwinkle density are shown in the graph below.



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The three statements below show the conclusions recorded by different students following the seashore study of periwinkles.
Place a cross ☒ in the box next to one statement that could form a valid conclusion using the information shown in the graph opposite.

**(1)**

☒ **A** All periwinkles are affected by the height above sea level

☒ **B** The height above sea level influences the distribution of different species of periwinkle

☒ **C** Neither of the species of periwinkle is affected by the height above sea level

(v) With reference to the data in the graph, discuss the validity of statements **A**, **B** and **C**.

**(4)**

**(Total for Question 3 = 12 marks)**







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**4** The bases in a gene code for the synthesis of a protein. Gene mutations can influence the metabolism of an organism.

(a) (i) The diagram below shows the bases on the template strand of DNA in the part of a gene that codes for a short sequence of amino acids in an enzyme.

A A C T A G T T G G C A A G T G G T C A C

Each of the following statements is about this sequence of bases. For each statement, place a cross ☒ in the appropriate box to show whether it is true or false.

**(3)**

| Statement | True | False |
|---|---|---|
| This sequence of bases could be used as a template during translation | ☒ | ☒ |
| A strand of mRNA could be synthesised using this sequence | ☒ | ☒ |
| This sequence codes for 7 amino acids during protein synthesis | ☒ | ☒ |

(ii) Name and describe the structures where the polypeptide chain of this enzyme would be synthesised.

**(2)**

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(b) *Chlamydomonas* is a single-celled photosynthetic organism that lives in well-illuminated ponds. In populations of *Chlamydomonas*, a gene mutation occasionally occurs. This mutation enables *Chlamydomonas* to take in organic compounds produced by other organisms and use them as a source of energy.

(i) Explain what is meant by the term **gene mutation**.

**(2)**

(ii) A population of *Chlamydomonas* was found in a pond in the centre of a developing forest of fast-growing trees. Suggest how the allele frequency for this mutation could change as the forest develops. Give reasons for your answer.

**(4)**

**(Total for Question 4 = 11 marks)**







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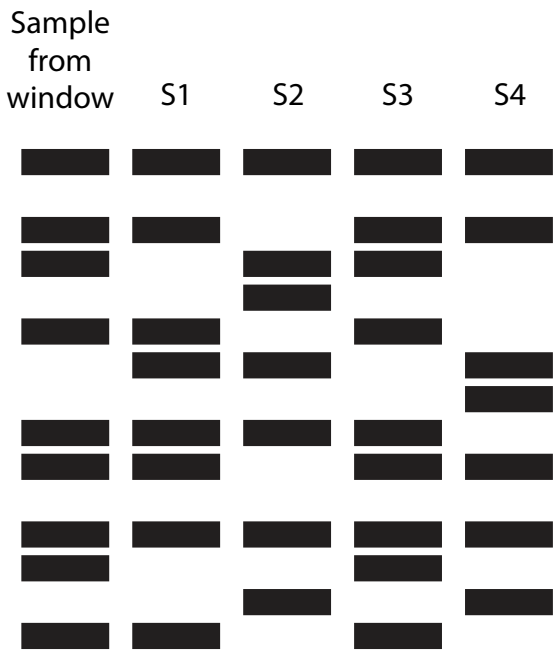
**5** Following a burglary, a DNA profile was created using a small sample of blood left behind on a broken window pane. This DNA profile was then compared with DNA profiles from four suspects, S1, S2, S3 and S4. These DNA profiles are shown in the diagram below.




(a) (i) Place a cross ☒ in the box next to the name of the enzyme used in the process used to amplify the DNA in the small sample of blood taken from the crime scene.

**(1)**

☒ **A** endonuclease

☒ **B** invertase

☒ **C** polymerase

☒ **D** transcriptase

(ii) Place a cross ☒ in the box next to the name of the process that could be used to separate DNA fragments to create the profiles shown in the diagram above.

**(1)**

☒ **A** amniocentesis

☒ **B** electrophoresis

☒ **C** endocytosis

☒ **D** chromatography



N 3 6 3 6 4 A 0 1 4 2 4

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(iii) Suggest which of the suspects is most likely to have left the blood sample on the broken window pane. With reference to the theory used in DNA profiling, explain how you came to this conclusion.

**(5)**

Suspect .....

Explanation .....

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(b) Explain why evidence from DNA profiles may not be absolutely conclusive.

**(2)**

(c) Suggest how DNA profiling could be useful to scientists who examine fossils of animals and plants.

**(2)**

**(Total for Question 5 = 11 marks)**



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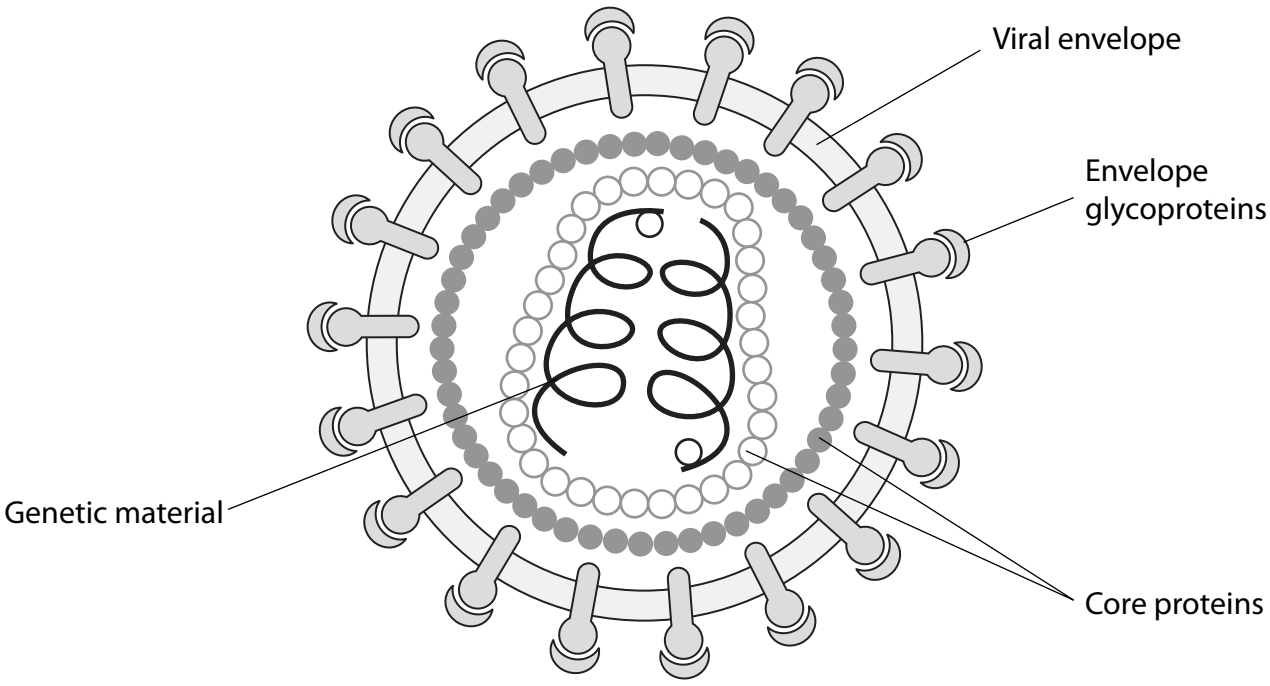
**6** The diagram below shows the structure of Human Immunodeficiency Virus (HIV).




(a) State how the genetic material in HIV differs from the genetic material in the bacterium *Mycobacterium tuberculosis* that causes TB.

**(2)**







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(b) One of the ways in which HIV may enter the blood is through the use of infected needles. Explain why unbroken skin is an effective barrier against HIV infection.

**(2)**

(c) The table below shows the changes in the number of CD4 T-lymphocytes in the blood of a person infected with HIV, during the first 10 weeks after infection.

| Time after infection / weeks | CD4 T-lymphocyte count / cells per $mm^3$ of blood |
|---|---|
| 0 | 1050 |
| 1 | 980 |
| 2 | 810 |
| 3 | 600 |
| 4 | 520 |
| 5 | 490 |
| 6 | 480 |
| 7 | 500 |
| 8 | 530 |
| 9 | 580 |
| 10 | 600 |

(i) Describe the change in numbers of CD4 T-lymphocytes during the first 6 weeks after infection with HIV.

**(2)**



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*(ii) Explain the change in numbers of CD4 T-lymphocytes during the first 6 weeks after infection with HIV.

**(5)**

(iii) Suggest **one** effect that this change would have on one other component of the infected person's blood.

**(1)**

**(Total for Question 6 = 12 marks)**







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**7** Cow pats, formed from the faeces dropped by cattle, are a familiar sight in any field where cattle have been grazing. Apart from water, a cow pat consists of a mixture of organic compounds left over from the digestive processes in the cow.

Cellulose and plant fibres are efficiently digested in cattle. Therefore, the texture of a cow pat is relatively soft in comparison to the faeces of some other herbivores.

(a) (i) Place a cross ☒ in the **two** boxes next to the types of bond that would need to be broken during the digestion of cellulose in cattle.

**(2)**

ester ☒

hydrogen ☒

glycosidic ☒

peptide ☒

(ii) Name **two** types of plant fibre that may be present in the material eaten by cattle.

**(2)**

1 .....

2 .....

(b) The first stage in the decomposition of a cow pat is known as putrefaction. Explain how carbon dioxide and ammonia are formed during this stage of decomposition.

**(4)**

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(c) The table below shows the mean time taken for a cow pat to decompose, at different times of the year, in a field in southern Britain.

| Season | Decomposition time for cow pat / days |
|---|---|
| Early spring | 140 |
| Late spring | 125 |
| Early summer | 110 |
| Late summer | 90 |
| Early autumn | 120 |
| Late autumn | 150 |

With reference to the data in the table, suggest why the time taken for a cow pat to decompose changes at different times of the year.

**(3)**

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**(Total for Question 7 = 11 marks)**







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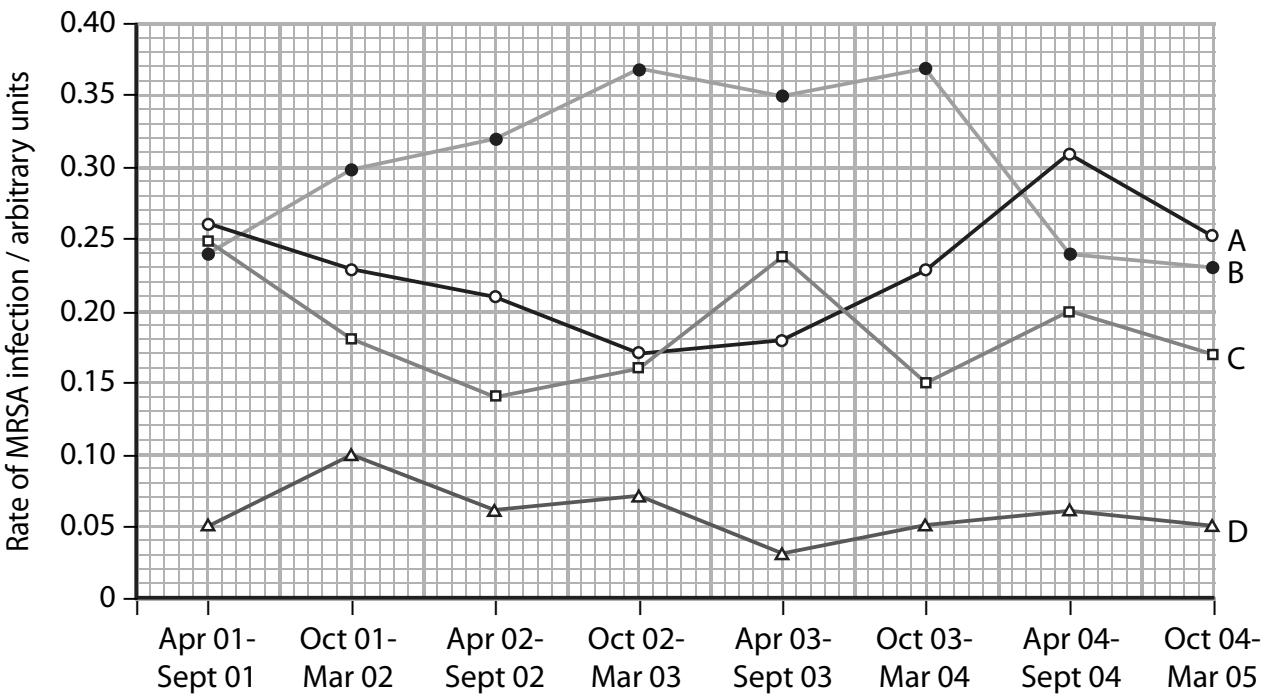
**8** Blood infection caused by the bacterium, methicillin-resistant *Staphylococcus aureus* (MRSA), has become a major concern in hospitals. This infection can be difficult to treat due to increasing resistance of MRSA to bacteriostatic and bactericidal antibiotics.

(a) Explain what is meant by the terms **bacteriostatic antibiotic** and **bactericidal antibiotic**.

**(3)**

(b) The graph below shows the occurrence of MRSA infection in four hospitals, A, B, C, and D for the period from April 2001 to March 2005. The rate of MRSA infection in each hospital during each six-month period was recorded.



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Compare the rates of MRSA infection in hospital A with those in hospital B.

**(3)**

**QUESTION 8 CONTINUES ON THE NEXT PAGE**



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(c) MRSA is present on the skin of approximately 1 in 3 of all patients entering hospitals for treatment.

(i) Describe the most significant difference between the rate of MRSA infection in hospital D compared with those of the other three hospitals.

**(1)**

(ii) Suggest why the rate of MRSA infection in hospital D differs from the rates in the other hospitals.

**(3)**

**(Total for Question 8 = 10 marks)**

**TOTAL FOR PAPER = 90 MARKS**



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