CAMBRIDGE
OCR

A Level Biology A
H420/03 Unified biology
Sample Question Paper

Date – Morning/Afternoon
Version 3.0

Time allowed: 1 hour 30 minutes

You can use:
- a scientific or graphical calculator
- a ruler (cm/mm)

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name (s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **24** pages.

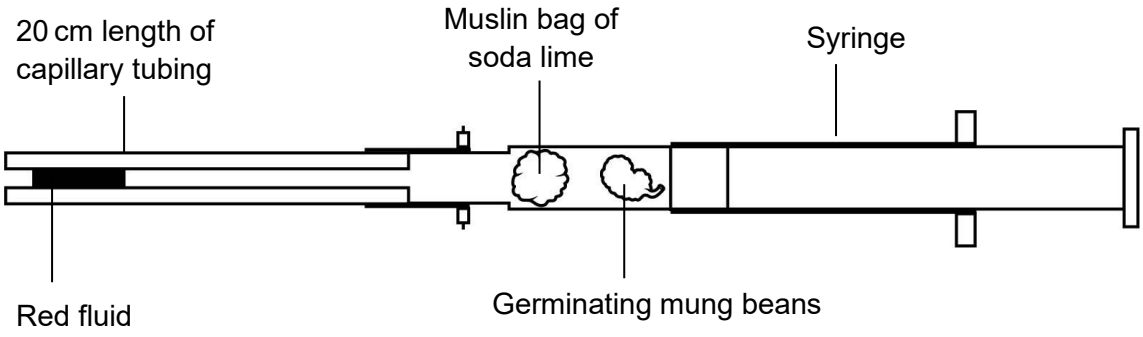
ADVICE
- Read each question carefully before you start your answer.

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1 A group of students investigate the rate of respiration in germinating mung beans.

This is the method they use:

- Place a small muslin bag of soda lime into the syringe and then add five germinating mung beans, which are held in place with the syringe plunger.
- Measure the movement of the red fluid in the capillary tube.
- After each set of readings, reset the plunger to return the fluid to its original position.



The results are shown in the table.

Time (s)	Distance moved by the red fluid in capillary tube (mm)		
	1	**2**	**3**
0	0.0	0.0	0.0
30	11.5	12.0	12.5
60	22.5	21.5	17.5
90	31.0	32.0	32.5
120	41.5	42.0	42.5
150	53.0	54.0	53.5
180	63.0	63.0	64.0
210	72.5	71.0	71.5
240	78.5	79.5	79.0
270	87.5	88.5	87.0

(a) Give **one** limitation of using this method to investigate rate of respiration.

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…… **[1]**

(b) Identify **one** variable that has not been controlled in this experiment **and** suggest an improvement to control that variable.

Variable ……

……

Improvement ……

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[2]

(c) Describe how you would add the red fluid to the capillary tube at the start of the experiment.

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…… **[1]**

(d) The data shows an anomalous result at 60 seconds.

Explain why the result is considered to be anomalous **and** describe **one** correct way of dealing with this type of result.

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…… **[2]**

(e) Calculate the mean rate of respiration for germinating mung beans between 90 and 150 seconds, using the data in the table.

Mean rate = …… **[1]**

(f)

(i) State what additional information is needed to calculate the volume of oxygen used by the mung beans.

…… **[1]**

(ii) State what additional information is needed to calculate the oxygen needed for these mung beans to allow you to compare them with the oxygen needed by another type of bean.

…… **[1]**

(g)* The group of students want to find out if the rate of respiration of a small invertebrate animal is comparable to that of the mung beans.

Outline how the students could modify the method to allow the respiration rate of a small invertebrate, such as a woodlouse or caterpillar, to be compared to the respiration rate of mung beans.

Comment on the results you would expect from this experiment and the conclusions you would draw.

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…… **[6]**

Extra answer space if required.

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2 Many different chemicals and microorganisms can harm plants and animals.

(a) Salts that a plant needs, such as nitrates and phosphates, are taken into root hair cells by active transport.

(i) State the name of a macromolecule that contains nitrogen **and** phosphorus.

…… **[1]**

(ii) Flooding of fields by seawater can damage crops. Seawater contains dissolved salts, including sodium chloride.

State how flooding by seawater would affect soil water potential.

…… **[1]**

(iii) Sodium chloride in solution breaks down into Na^+ and Cl^-.

Explain how the Casparian strip prevents these ions from reaching the xylem of the plant by the apoplast pathway.

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…… **[2]**

(b) Herbicides work in a number of different ways.

(i) Some herbicides, known as phenoxy herbicides, mimic the action of auxin.

State the role of auxin in plant cells.

…… **[1]**

(ii) The herbicide atrazine works by disabling plastoquinone, one of the proton pumps in photosystem 2.

Explain why a plant exposed to atrazine would die.

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…… **[4]**

(c) Plague is a disease caused by the bacterium *Yersinia pestis* and effects animals.

(i) *Y. pestis* is a rod-shaped cell that is approximately 3μm long.

Y. pestis is viewed using a light microscope with a magnification of ×1250.

Calculate the length of the *Y. pestis* cell in the image produced by this microscope in mm.

Length = …… mm **[2]**

(ii) Images obtained by the light microscope could be further enlarged using a projector.

Suggest why the enlarged image might **not** give any additional information about the structure of *Y. pestis*.

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…… **[1]**

(iii) Outbreaks of plague still sometimes occur. Plague is transmitted by several methods including droplet infection, close contact between people and fleas moving between infected rats and people.

Suggest **two** ways to minimise the spread of an outbreak of plague.

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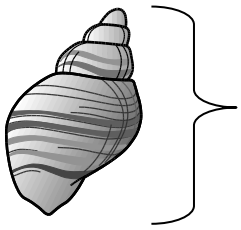
…… **[2]**

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3 Students investigate the effect of wave action on the height of the shells of the dog whelk, *Nucella lapillus*, by comparing an exposed shore and a sheltered shore.

- The students use a random sampling technique to collect 50 shells from an exposed shore.
- The shell height is measured from the base to the conical tip. The whelk is returned to its original location.
- The process is repeated for the sheltered shore.



The table shows the students' results.

Location	Height of shell (mm)										Range	Mean	Standard deviation
Sheltered shore	26	28	27	26	28	23	28	23	26	28			
	29	29	29	29	29	28	29	29	29	29			
	30	31	30	29	32	29	30	29	30	32			
	33	35	34	32	35	32	34	32	33	35			
	37	39	38	37	39	35	38	36	37	39	16	31.3	4.1
Exposed shore	15	17	16	15	23	15	23	16	13	15			
	17	24	18	17	17	14	17	18	16	17			
	19	19	20	24	18	20	19	20	18	20			
	23	14	24	14	21	20	23	17	21	23			
	25	25	28	26	25	27	25	28	25	27	15	20.0	4.2

(a) The Student's *t*-test can be used to determine the significance of the differences between shell height on the exposed shore and the sheltered shore.

(i) Calculate the *t* value for the data using the formula:

$$t = \frac{\left|\overline{X}_A - \overline{X}_B\right|}{\sqrt{\frac{S^{2}_A}{n_A} + \frac{S^{2}_B}{n_B}}}$$

where,

$\left|\overline{X}_A - \overline{X}_B\right|$ is the difference in mean values of sample 1 and sample 2

S^{2}_A and S^{2}_B are the squares of the standard deviations of the samples

n_A and n_B are the sample sizes.

Give your answer to **2** decimal places.

t = ... **[3]**

(ii) The null hypothesis is that there is no difference between the means of the shell heights in the two populations.

The critical values at 98 degrees of freedom are shown in the table.

Degrees of freedom	***p* = 0.10**	***p* = 0.05**	***p* = 0.01**	***p* = 0.001**
98	1.67	2.00	2.64	3.41

Explain whether the student would be able to accept or reject the null hypothesis as a result of the *t* value you calculated in part **(i)**.

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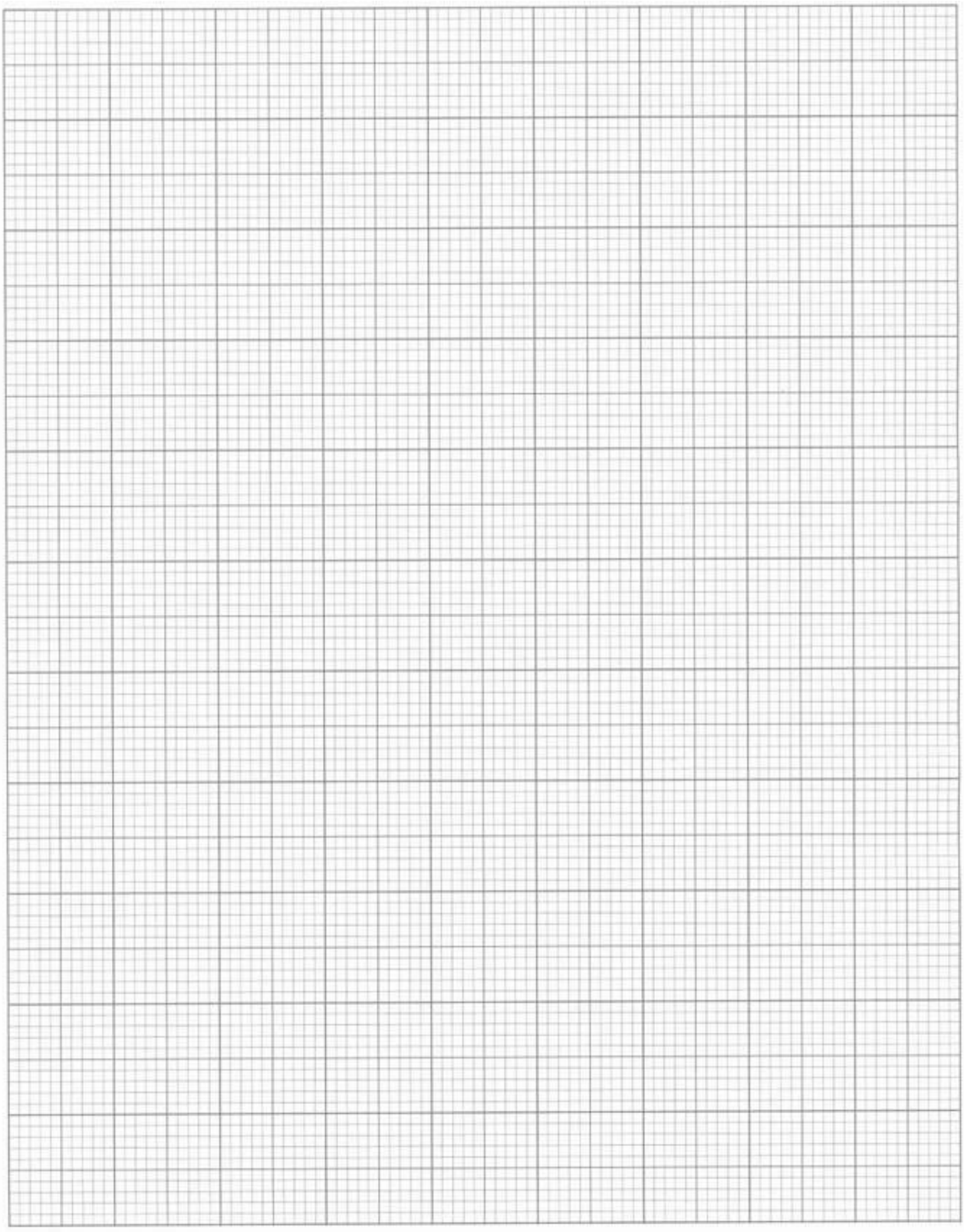
…… **[1]**

(b) The students organise their data into classes.

The organised data is shown in the table.

Sheltered shore			**Exposed shore**		
Height (mm)	**Tally**	**Total**	**Height (mm)**	**Tally**	**Total**
23–26	𝍸	5	11–14	IIII	4
27–30	𝍸 𝍸 𝍸 𝍸 II	22	15–18	𝍸 II	7
31–34	𝍸 𝍸 I	11	19–22	𝍸 𝍸 II	12
35–38	𝍸 IIII	9	23–26	𝍸 𝍸 II	12
39–42	III	3	27–30	IIII	4

Plot the most suitable graph of the data given in the table.



[4]

(c) State the type of correlation that exists between the height of the whelk shell and the type of shore **and** explain this correlation.

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…… **[3]**

(d) Suggest a limitation of the procedure used to gather the data in this experiment **and** suggest how the procedure can be improved.

Limitation ……

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Improvement ……

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[2]

(e) Describe how the students can improve the accuracy of their data.

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…… **[1]**

(f) Discuss the validity of the conclusions you have made during this experiment.

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…… **[3]**

4 Botulism is a condition resulting from the action of botulinum toxin. The main symptom of botulism is skeletal muscle weakness, which can be fatal.

(a) Botulinum toxin is produced by the anaerobic bacterium *Clostridium botulinum*.

(i) State why *C. botulinum* is described as anaerobic.

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…… **[1]**

(ii) Botulinum toxin is initially produced as a large single polypeptide that has low toxicity. After the toxin has been acted on by a protease, two chains are produced. The two chains remain connected by a disulfide bond. In this form the toxin is far more toxic.

Describe the action of the protease when it acts on the toxin.

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…… **[1]**

(b) An experiment with mice was used to determine the median lethal dose of the toxin.

99 mice were used in the experiment.

(i) Suggest what is meant by the term **median lethal dose**.

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…… **[1]**

(ii) The median lethal dose of the toxin ranges from 5 – 50 $\mu g kg^{-1}$ body mass, depending on the toxin type and the method of introduction into the body.

Calculate the probable lethal dose of the **least toxic** botulinum toxin for an individual with a body mass of 85kg.

Give your answer in µg.

Dose = …… µg **[2]**

(iii) The botulinum toxin acts at the cholinergic nerve terminals of motor neurones. Part of the toxin molecule binds irreversibly to receptors on the presynaptic membrane of motor neurones.

The toxin–receptor complex is then taken into the cytoplasm of the neurone and the disulfide bond in the toxin is broken. A section of the toxin molecule is released. The section of the molecule acts to block the release of the neurotransmitter.

Explain why botulism can be fatal.

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…… **[2]**

(c)* There are several strains of the *C. botulinum* bacterium. Different strains produce immunologically distinct forms of the toxin.

Explain why the toxins produced by the different strains are described as being immunologically distinct **and** describe the immune system response to the toxin.

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Extra answer space if required.

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5 Termites are highly social insects. They are thought to have evolved from earlier forms of insect at least 150 million years ago. Termites are related to cockroaches.

(a)

(i) Suggest how scientists working more than a century ago could have estimated when termites evolved.

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…… **[1]**

(ii) State what new source of evidence would help scientists today to estimate how closely related termites are to cockroaches.

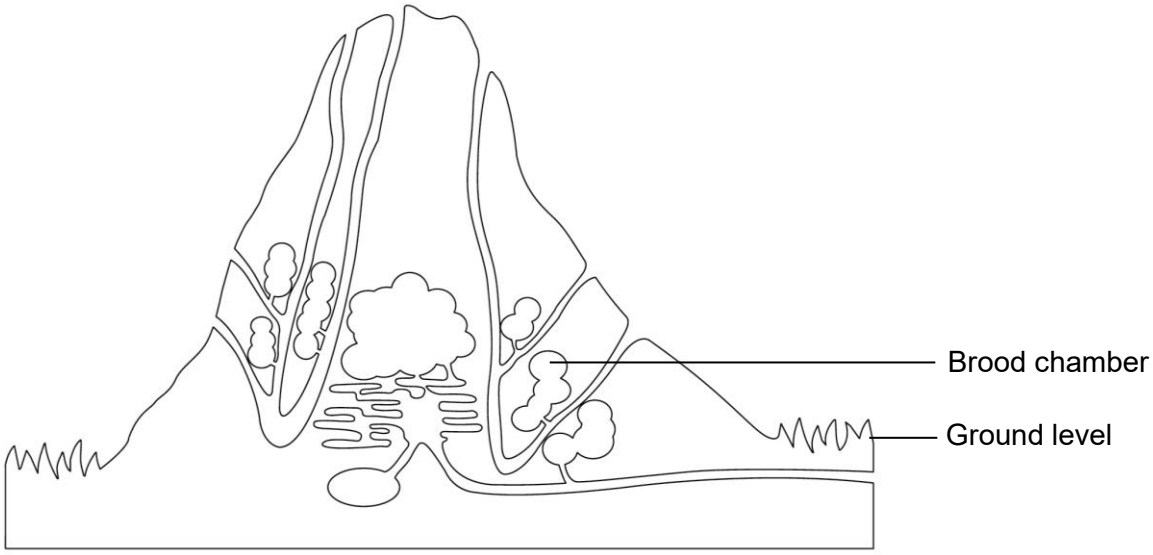
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…… **[1]**

(b) This image represents a termite mound that would be found in Queensland, Australia, about 3000 kilometres south of the equator.

It shows that the interior of the termite mound has many interconnecting chambers. At the top of the mound, some of these chambers open to the air outside.

Worker termites spend all their time working in brood chambers low in the mound, where eggs and larvae develop.



(i) Explain how carbon dioxide produced in the respiring body cells of worker termites is removed to the air outside the termite mound.

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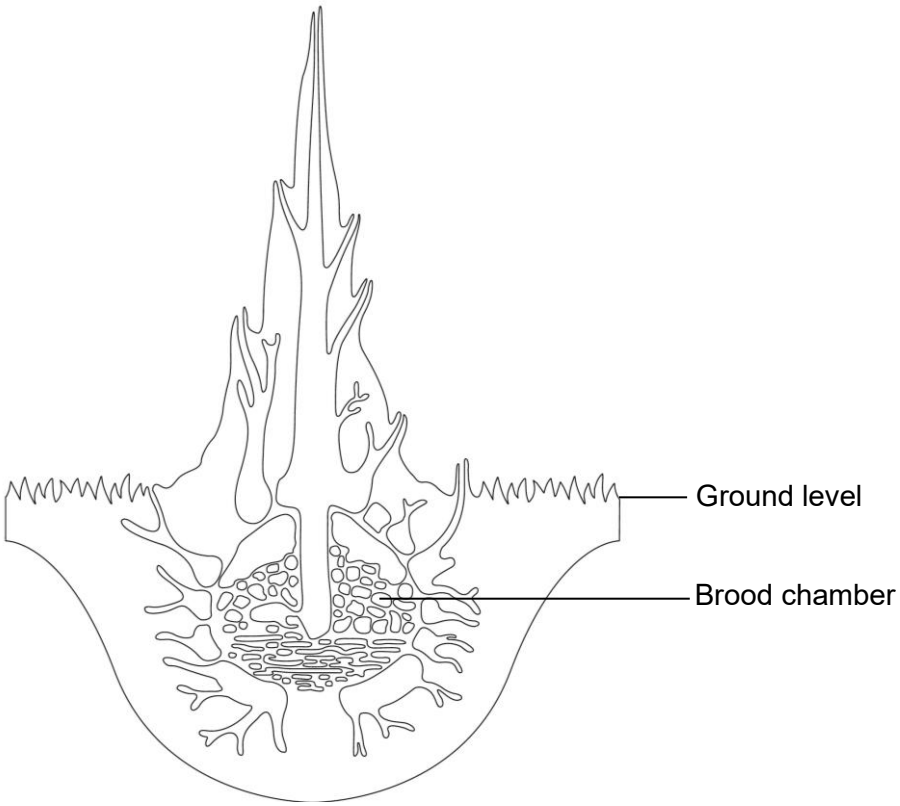
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…… **[4]**

(ii) In Africa, closer to the equator, the mounds built by some species of termite are blade-shaped, with the long axis pointing North–South.



Suggest why the African termites need to build mounds in this shape and orientation.

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…… **[2]**

(c) Most termites eat only dead vegetable material, so their main food source is cellulose. Cellulose is a polymer.

State the name of the monomer in cellulose.

…… **[1]**

(d) Some scientists categorise termites as keystone species.

Suggest **one** reason for termites being categorised as keystone species **and one** reason for them not being categorised as keystone species.

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…… **[2]**

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

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