



Rewarding Learning

ADVANCED
General Certificate of Education
2022

Centre Number

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Candidate Number

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Biology

StemUp Model Solution

Assessment Unit A2 3
assessing
Practical Skills in Biology



[ABY31]

ABY31

FRIDAY 24 JUNE, MORNING

TIME

1 hour 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 eight** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 60.

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.

Statistics Sheets are not required for use with this paper.

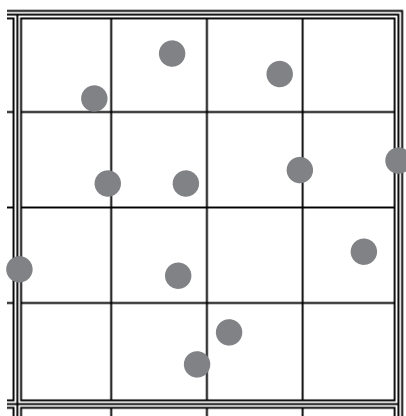
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- 1 (a) The size of a yeast population in a culture can be influenced by numerous factors, including temperature. Several cultures of yeast were set up, each at a different temperature. The numbers of yeast cells were estimated using a haemocytometer, and one sample is represented by the diagram below.

The distance between the surface of the haemocytometer and the overlying coverslip was 0.1 mm.

Type-B square (side 0.2 mm)



- (i) Using the type-B square shown above, calculate the number of yeast cells per mm^3 .

(Show your working.)

Number of cells in the type-B square = 11

Volume = $0.2 \text{ mm} \times 0.2 \text{ mm} \times 0.1 \text{ mm} = 0.004 \text{ mm}^3$

Cells per $\text{mm}^3 = 11 \div 0.004 = 2750$

2750 cells mm^{-3} [3]

- (ii) Some yeast cells may be found at slightly different depths within a sample.

Suggest how a student could ensure that all the yeast cells within a sample on a haemocytometer would be visible for counting when viewed at high power.

Allow time for the cells to settle, and adjust the fine focus of the microscope.

[1]



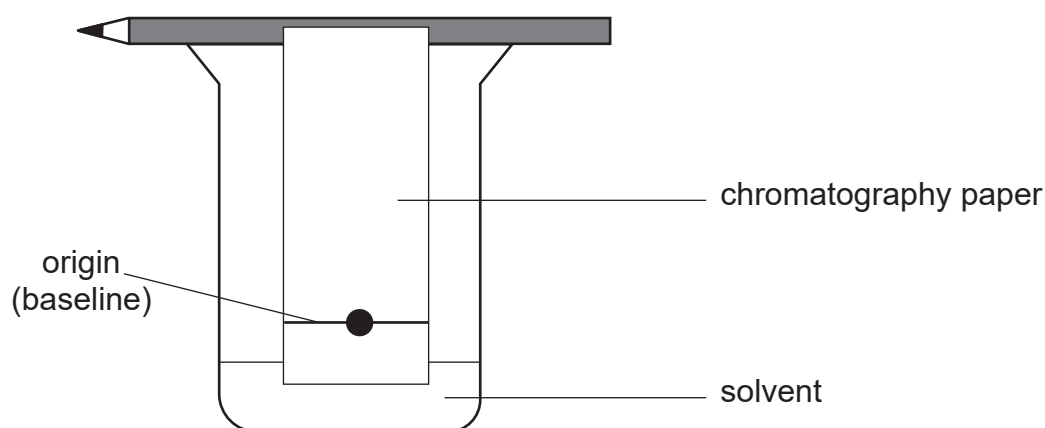
(b) Identify **two** factors, other than temperature, which could influence the size of the yeast population in this investigation.

1. Concentration of sugar (glucose) in the culture.
2. pH of the culture (or initial population size). [2]

[Turn over



- 2 The pigments present in the leaves of the Common Nettle (*Urtica dioica*) were investigated using chromatography, as outlined in the procedure below:
1. Several fresh nettle leaves were finely cut and placed in a mortar with a pinch of sand and 1 cm³ of solvent.
 2. The mixture was ground with a pestle for three minutes.
 3. An origin line was drawn, in pencil, 3 cm from the base of a strip of chromatography paper.
 4. A fine glass tube was used to form a spot of the leaf extract on the centre of the line.
 5. The spot was dried, and five further spots were added on top of it; each spot being dried before the next spot was added.
 6. The top of the paper was taped to a pencil and lowered into a beaker containing solvent, making sure that the origin was above the solvent level as shown below.



7. The paper was left in place for several hours, until the solvent had almost reached the top.
8. The paper was removed from the beaker and the position of the solvent front was marked immediately.



(a) Explain the following:

- in step 3, the origin line was drawn with pencil

Pencil (graphite) does not dissolve in the solvent, so the origin line is not dissolved and the extract is not contaminated by ink.

- in step 5, the spot was dried between each successive additional spot

To build up a small, concentrated spot of pigment, so the separated pigments are distinct.

- in step 6, the origin was above the level of the solvent

So the pigments do not dissolve directly into the solvent in the beaker; they must move up the paper.

- in step 8, the solvent front was marked as soon as the paper had been removed.

So the solvent front is still clearly visible, since the solvent evaporates quickly in air.

[4]

(b) Chromatography is often carried out in a sealed container, so that the solvent vapours saturate the container causing the solvent to rise further up the paper.

Suggest **one** other reason for carrying out chromatography in a sealed container.

To prevent harmful solvent vapours escaping into the lab and to reduce the risk of spilling.

[1]

[Turn over



- (c) Three distinct coloured spots were evident in the chromatogram produced from the nettle leaves. These are recorded in the table below, along with the R_f values which were calculated for each spot.

Colour	R_f value
Blue-green	0.28
Green	0.21
Yellow	0.09

- (i) In addition to measuring the distance from the origin to the solvent front, state the other measurement required to calculate an R_f value.

The distance from the origin to the centre of the pigment spot.

[1]

- (ii) Determine the colour of the spot which was closest to the origin.

Yellow

[1]

- (iii) State what can be concluded about the pigment which is found closest to the origin.

This pigment is the least soluble in the solvent.

[1]





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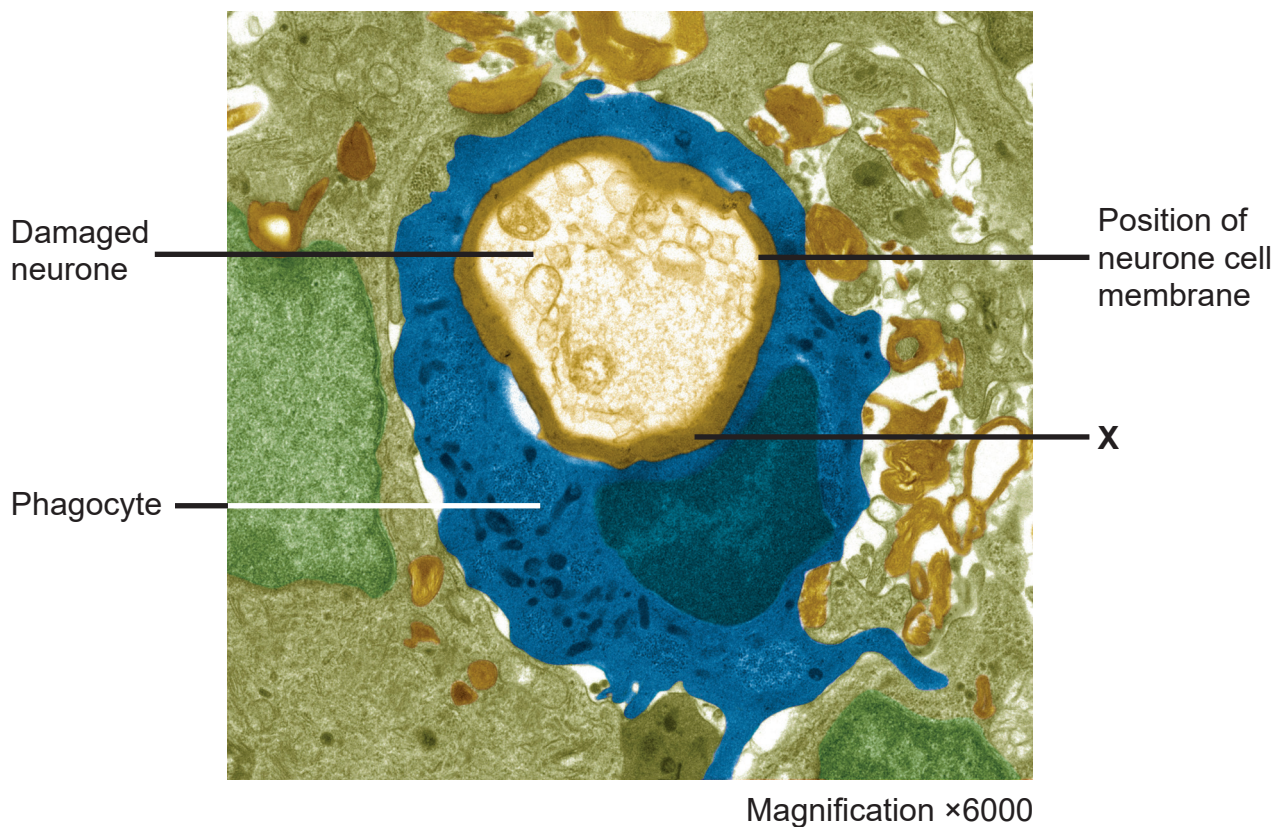
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- 3 (a) Some types of white blood cell can engulf body cells by phagocytosis. The micrograph below shows a phagocyte which has engulfed a damaged neurone in the human body. The image has been artificially colour-enhanced to show the phagocyte in blue.



© Steve Gschmeissner / Science Photo Library

Structure X is found on the outside of the neurone cell membrane as shown.

- (i) Identify structure X.

Myelin sheath (Schwann cell). [1]

- (ii) Identify precisely the type of microscope which was used to obtain this image.

Transmission electron microscope (TEM). [1]



- (b) Structure **X** in the micrograph is much thinner on damaged neurones than on undamaged neurones. One way in which such damage can occur is as a result of the medical condition multiple sclerosis (MS).

The speed of nerve impulses in five undamaged neurones and five neurones damaged by MS was recorded as shown in the table below.

Neurone number	Speed of nerve impulse / ms ⁻¹	
	Undamaged neurones	Damaged neurones
1	38	12
2	20	2
3	42	15
4	42	14
5	38	3
Median	38	12

- (i) Complete the table by determining the **median** speed of the nerve impulse in damaged neurones. [1]
- (ii) Suggest why the median was used to compare the effect of the damage, rather than the mean.

There are outliers in the data (e.g. 20 for undamaged, 2 and 3

for damaged), which would distort the mean. [1]

[Turn over



- (iii) The values in the table were obtained at 20°C. Suggest and explain how the speed of nerve impulses in the **undamaged** neurones would be affected if a temperature of 30°C was maintained during the investigation.

The speed of the nerve impulses would be higher at 30 °C.

At the higher temperature the ions have more kinetic energy, so they diffuse faster, and membrane permeability increases.

This gives faster depolarisation, so action potentials are generated more quickly and the impulse travels faster along the neurone.

[3]





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- 4 (a) With reference to aseptic techniques, outline a procedure which could be used to produce a 'lawn' of the bacterium *Staphylococcus aureus*, given a culture of *S. aureus* in nutrient broth, a Petri dish containing sterile nutrient agar and access to normal laboratory apparatus.

Disinfect the bench and wash hands; work close to a lit Bunsen burner.

Remove the lid of the broth bottle and hold it in the little finger, not setting it down on the bench.

Flame the neck of the culture bottle after opening it and before closing it.

*Use a sterile dropper (or sterile syringe) to remove a small volume of the *S. aureus* culture.*

Lift the Petri dish lid only slightly, at an angle, and transfer the drops onto the agar.

Spread the culture evenly over the whole agar surface with a sterile (flamed) spreader to give a lawn.

Replace the lid at once and place the used spreader and dropper (syringe) in disinfectant.

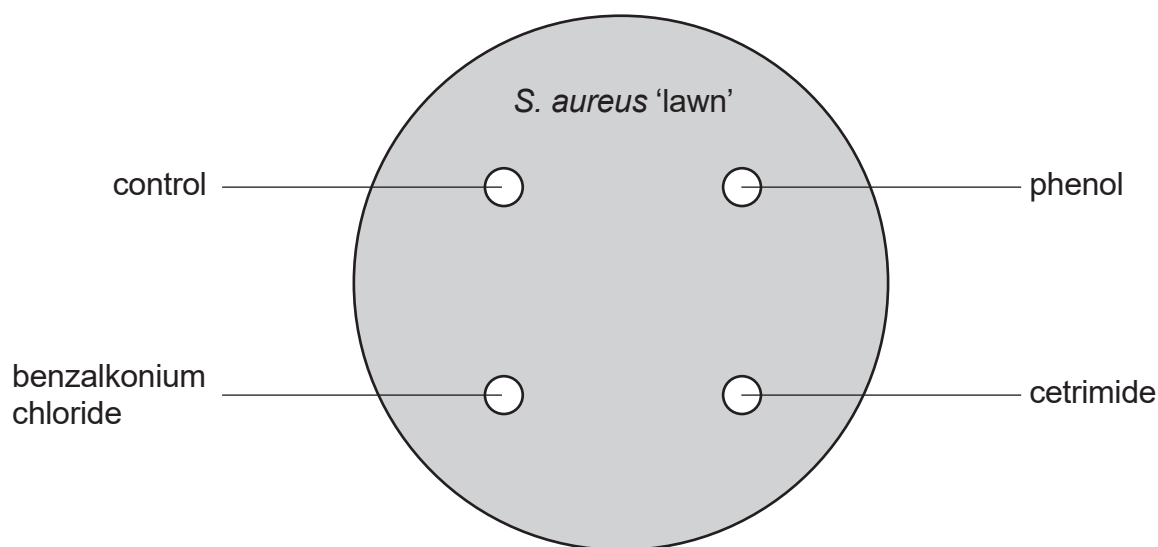
[5]



In order to clean minor skin wounds, creams can be used to kill microbes which could potentially enter the body and cause an infection. There are several types of antimicrobial ingredients in such creams, including benzalkonium chloride, phenol and cetrimide.

Discs of filter paper of diameter 5 mm were soaked in 1% solutions of each of these substances and placed on a 'lawn' culture of *S. aureus* growing on nutrient agar. A control disc was also included in the investigation.

Ten Petri dishes were set up. An example is shown below.



(b) Suggest a suitable substance in which the control disc could be soaked.

Sterile (distilled) water. [1]



(c) This investigation was carried out in a specialised microbiology laboratory. The Petri dishes were incubated at 37°C for 48 hours.

- (i) Explain why this incubation temperature is not normally used in a school laboratory.

There is an increased chance of culturing (contaminating) human pathogens at body temperature.

[1]

- (ii) Explain why the microbiologists considered this temperature suitable for this investigation.

It matches the conditions (body temperature) at which the antiseptic creams would be used on skin.

[1]

- (iii) Describe **one** method of preventing accidental release of *S. aureus*:

- during the incubation

Seal the lids on the Petri dishes with tape.

[1]

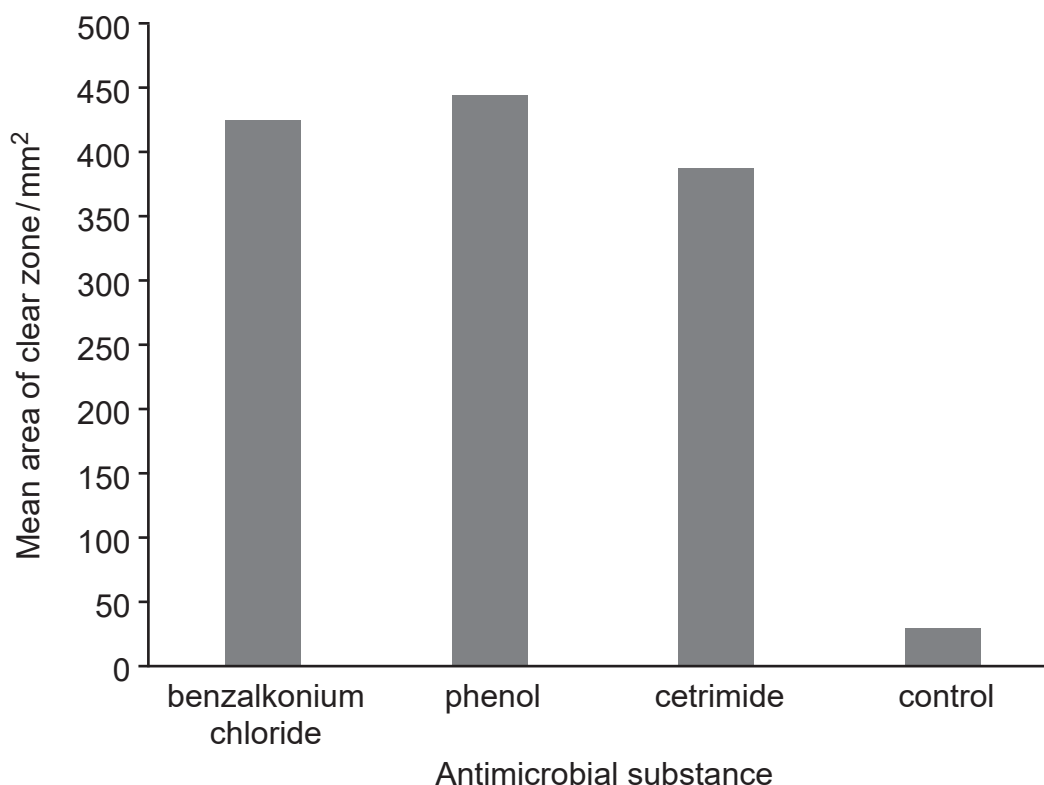
- after the investigation.

Autoclave the Petri dishes before disposal (dispose of them safely).

[1]



- (d) Following incubation, the clear area around each disc was measured and the mean values were plotted, as shown below.



- (i) Suggest a suitable caption for the graph.

*The effect of different types of antimicrobial substance on the mean area of the clear zone of *S. aureus* growth.*

[2]

- (ii) From the graph it appears that phenol is the most effective substance in preventing growth of *S. aureus*.

Identify **one** statistical analysis which could be undertaken to determine if the mean value for phenol is significantly different from the means of the other two antimicrobial substances.

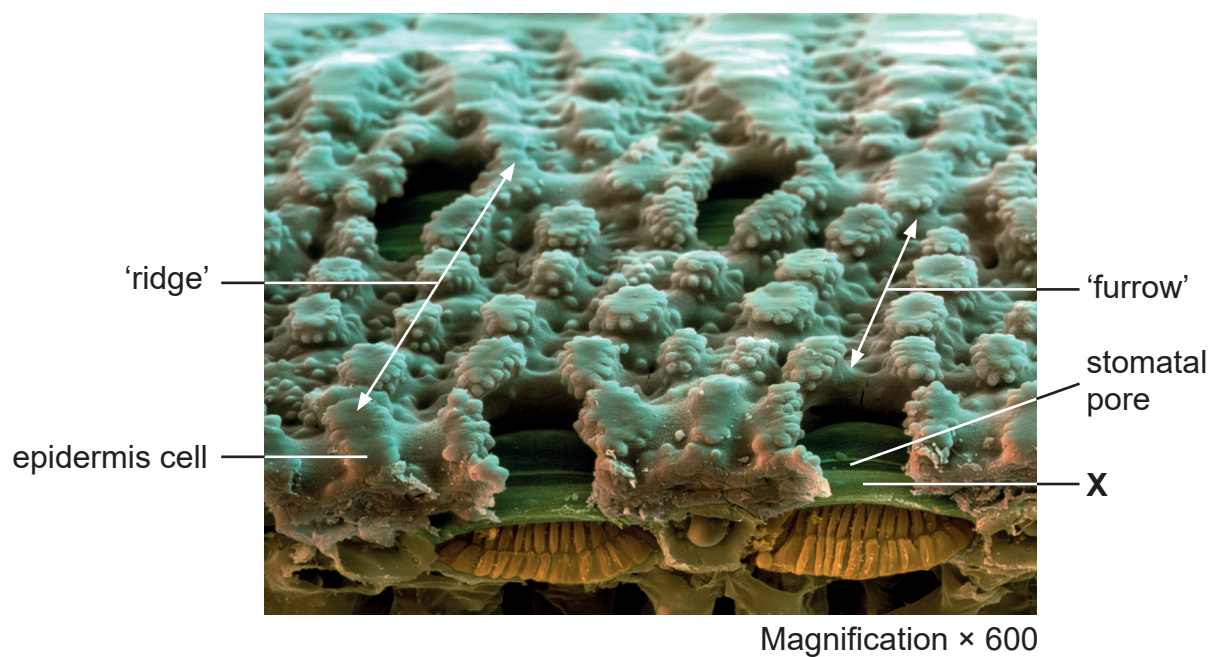
Plot 95% confidence limits (or carry out t-tests).

[1]

[Turn over]



- 5 (a) The micrograph below shows tissue layers in part of the stem of Southern Giant Horsetail (*Equisetum giganteum*). This plant shares many features with ferns and is therefore classified in the same taxonomic group.



© Eye of Science / Science Photo Library

- (i) Identify the type of cell labelled X which surrounds a stomatal pore.

Guard cell.

[1]



- (ii) As can be seen in the micrograph, the epidermal cells of *E. giganteum* are highly specialised and organised into a series of 'ridges' and 'furrows' on the external surface of the stem. Comment on the position of the stomata in relation to the epidermis and suggest an explanation for this positioning.

The stomata are sunken, lying in the furrows below the level of the surrounding epidermis (ridges).

Moist air is trapped above the stomata, reducing the water potential (diffusion) gradient between the leaf and the air.

This reduces transpiration, so water is conserved.

[3]

- (b) Identify the organ on which these cells (X) would usually be found.

Leaf

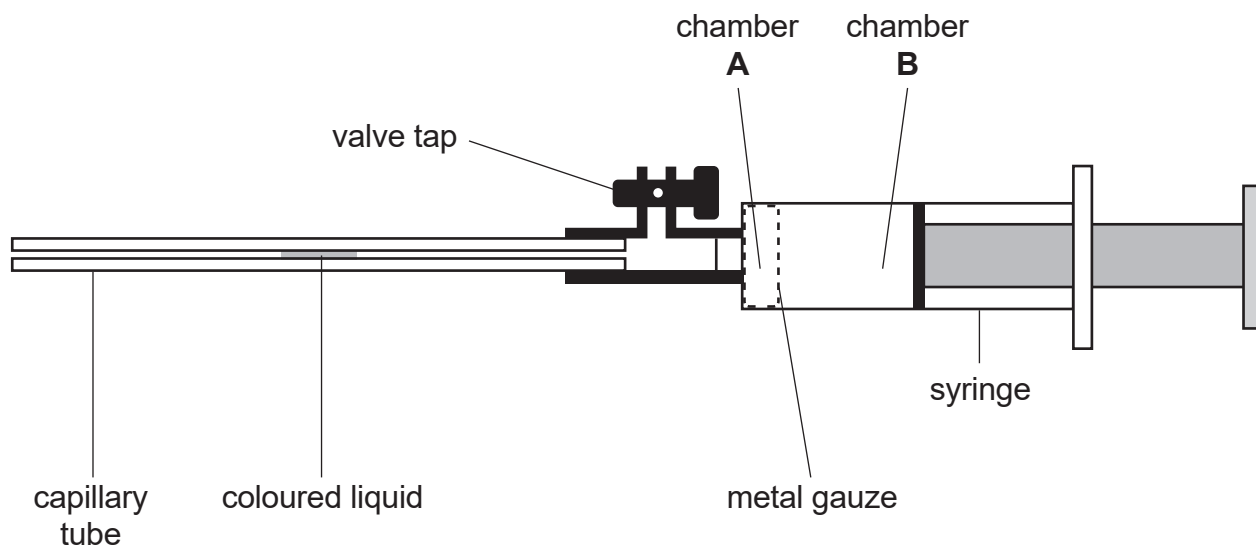
[1]

[Turn over]



- 6 A respirometer can be used to determine the respiratory quotient (RQ) value for small invertebrates such as mealworms.

The apparatus below shows a simple respirometer.



Ten mealworms were placed in chamber **B**. In order to measure the consumption of oxygen by the mealworms, solid soda lime was added to chamber **A**. The coloured liquid was drawn into the capillary tube, by pulling back the syringe.

- (a) Explain why soda lime was added to chamber **A**.

To absorb the carbon dioxide produced in respiration.

[1]

- (b) (i) After placing the mealworms in chamber **B**, it is recommended that there is a 10-minute interval before readings are recorded. Explain the reason for this.

To allow the mealworms time to acclimatise (adjust) to the conditions, e.g. the temperature, so the rate is steady.

[1]



- (ii) Describe the change which needs to be made to the apparatus before obtaining the results necessary to calculate carbon dioxide production.

Remove the soda lime from chamber A.

[1]

- (c) With the soda lime in chamber **A**, the coloured liquid moved 8 mm to the right during the measuring period.

The calculated RQ value for the mealworms was 0.875. Determine the direction and distance moved by the coloured liquid when carbon dioxide production was being measured.

(Show your working.)

$$RQ = CO_2 \text{ produced} \div O_2 \text{ used}$$

$$CO_2 \text{ produced} = 0.875 \times 8 \text{ mm} = 7 \text{ mm}$$

$$\text{Net movement} = 8 \text{ mm} - 7 \text{ mm} = 1 \text{ mm}$$

Distance moved 1 mm

Direction of movement To the right [3]

- (d) Identify **two** variables which should have been controlled in this experiment.

1. Temperature.

2. The same ten mealworms (same mass) used. [2]

[Turn over]



- 7 (a) When carrying out a dissection, some principles are similar regardless of the specimen being dissected.

For a dissection procedure with which you are familiar, describe:

- how the specimen is supported or placed in position
- the apparatus used
- how to observe the structures clearly.

Leaf epidermis: place a leaf on a microscope slide with its lower surface uppermost.

Irrigate the leaf with water and scrape away the upper tissue with a razor blade (scalpel), using forceps to lift off the thin epidermis.

Mount the epidermis in a drop of water under a coverslip and observe it under a light microscope, first at low power and then at high power.

[3]



- (b) Computers can be used to carry out 'virtual dissections'. In this, students perform the steps of the dissection using software which uses images of the biological material.

In a study in the USA, it was found that students who carried out a virtual dissection scored higher in a subsequent test than those who had carried out a traditional dissection.

Suggest **two** other advantages of a virtual dissection compared to a traditional dissection.

1. *Fewer ethical concerns, as no animals need to be killed.*

2. *It is less expensive and the process can be repeated many times, with no waste to dispose of.*

[2]



- 8 The following extract is adapted from a government document providing advice for landowners concerning algal blooms.

Algae occur naturally in inland waters such as rivers, streams and lakes. When conditions are ideal for growth, an algal bloom can occur. During a bloom, the water becomes less clear and may look green or blue-green. Scums can form during calm weather when several bloom-forming species rise to the surface.

Algae can produce toxins. These toxins can kill wild animals, livestock and pets. They can also harm people, producing rashes after skin contact and illnesses if swallowed.

Algal blooms block sunlight from reaching plants in the water and they use up oxygen in the water at night. Oxygen is also used up when the bloom decays, leading to a decrease in oxygen which can suffocate fish and other animals.

Algal blooms are natural features of some waters. Increasing shade and reducing nutrients in the water can control algae. Your local Environment Agency Officer can advise you on prevention, control and long-term management.

Source: Guidance: Algal blooms: advice for the public and landowners Published by Environment Agency 31 January 2017 © Crown Copyright Contains public sector information licensed under the Open Government Licence v3.0.

- (a) Using the information provided, identify **one** way in which algal blooms may be controlled and use your knowledge to explain why this control method is effective.

Increase the shade on the water (e.g. plant trees along the bank).

Less light reaches the algae, which reduces their photosynthesis, so

they grow less.

[2]



- (b) The effects of algae in a lake can be analysed by monitoring abiotic factors. Using the information in the passage, identify **one** such factor and describe precisely how an algal bloom would affect this factor.

Abiotic factor Oxygen level (dissolved oxygen)

Effect of algal bloom Oxygen levels fall at night, as the algae respire,
and when the bloom decays, as decomposers use oxygen.

[2]

- (c) The abundance of algae in a freshwater lake can be monitored by taking a water sample and using a colorimeter to measure transmission of light through the sample.

- (i) Explain why a red filter would be used in the colorimeter.

The algae reflect green (blue-green) light and absorb red light,
which increases the sensitivity of the colorimeter.

[1]

[Turn over]



An Environment Agency Officer monitored a lake which was prone to experiencing algal blooms. Water samples were taken over several months, and % transmission through the sample for each date is shown in the table below.

Sample date	% transmission
13th March	94
24th April	89
10th July	65
14th August	62
11th September	57
23rd October	79

- (ii) Assuming that % transmission values reflect the abundance of algae, describe how the abundance of algae changed over the sample period and suggest which sample date may indicate the most severe algal bloom that year.

Algae abundance rises from March to a peak in September and then falls in October.

11th September (lowest transmission, 57%).

[2]

- (iii) Suggest **one** precaution which must be taken during the sampling procedure to ensure that the results are valid.

All samples taken from the same depth (and site) in the lake.

[1]





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