Rewarding Learning

ADVANCED
General Certificate of Education
2023

Centre Number

Candidate Number

Biology

Assessment Unit A2 3
assessing
Practical Skills in Biology

[ABY31]

ABY31

THURSDAY 22 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 seven** 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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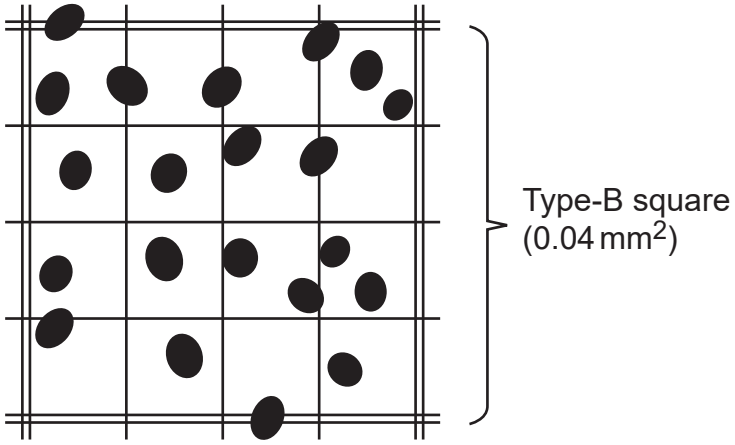
1 The population density of a yeast suspension can be estimated using a haemocytometer.

The diagram below represents a type-B square from a sample taken from a yeast suspension. The depth of suspension between the surface of the haemocytometer grid and the overlying coverslip is 0.1 mm.



(a) Some yeast cells lie across grid lines. Explain how this can be taken into account when counting yeast cells.

_____

_____ [1]

(b) Using the information provided and the diagram, calculate the number of yeast cells in 1 mm^3.

(Show your working.)

_____ cells [2]

(c) Suggest a variable that should be controlled when sampling the yeast suspension.

_____ [1]

[Turn over

2 **(a)** The capture–mark–recapture method can be used to estimate the size of animal populations.

(i) State the formula used to estimate population size by this method.

_____ [1]

(ii) The use of this method involves several assumptions. List **three** of these assumptions.

1. _____

2. _____

3. _____ [3]

(iii) The population of the bald eagle (*Haliaeetus leucocephalus*) in Alaska was investigated using the capture–mark–recapture method. The table below shows the data collected in this investigation.

Number of bald eagles captured in the first sample	Number of unmarked bald eagles in the second sample	Number of marked bald eagles in the second sample
10 265	2135	1165

Using the data in the table, estimate the size of this bald eagle population.

(Show your working.)

_____ [3]

(b) Alaska also has a mountain goat (*Oreamnos americanus*) population on one of its islands.

Researchers estimated the size of the population on several occasions over two consecutive winters. Their results are shown in the table below.

Year	Mean number of mountain goats	Standard deviation	Standard error
2010–2011	9.0	0.92	0.08
2011–2012	16.3	1.00	0.00

(i) State the most appropriate statistical test which could be used to determine if there is a significant difference in the population over the time period involved.

_____ [1]

(ii) It is thought that changes in the mountain goat population may be linked to climate change. Suggest a reason why the data shown in the table above can **not** be used to support this theory.

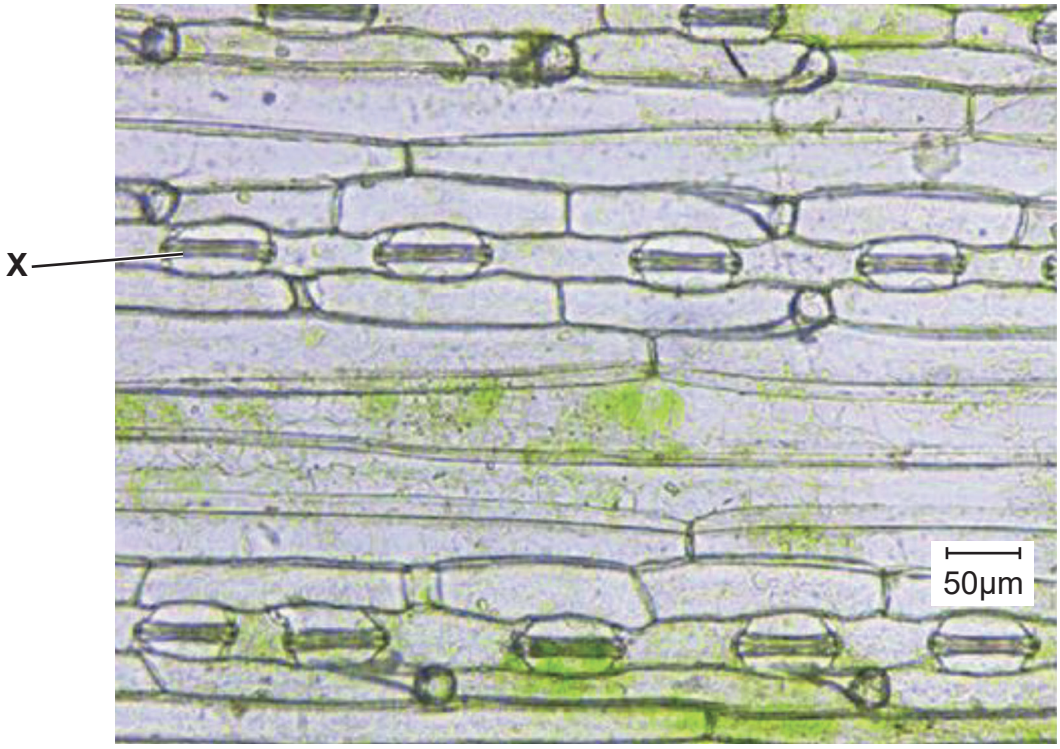
_____

_____ [1]

3 The procedure described below can be used to prepare a leaf scrape for viewing under a light microscope.

- Place a section of grass leaf on a microscope slide, top surface facing upwards, and add a few drops of water.
- Holding the end of the leaf with the thumb of one hand, use the other hand to slide a razor blade along the grass leaf. (This will remove cell layers from the top of the leaf.)
- Repeat several times until the leaf has an almost transparent appearance.
- Add a drop of water onto the leaf scrape and place a cover slip on top.
- Examine with a light microscope.

The photomicrograph below shows a leaf scrape produced using this procedure.



Source: Front. Plant Sci., 25 February 2020, https://doi.org/10.3389/fpls.2020.00133

(a) (i) Suggest the identity of structure **X**.

_____ [1]

(ii) Identify the leaf tissue layer that remains on the slide after using this procedure.

_____ [1]

(iii) Suggest why it is important that water is added to the leaf scrape before a cover slip is placed on top.

_____

_____

_____ [1]

(iv) Suggest **one** reason why the procedure may need to be repeated before obtaining a leaf scrape suitable for viewing.

_____

_____ [1]

(v) A flat grass leaf should be used rather than one which is rolled. Suggest a reason for this.

_____

_____ [1]

(b) Using the scale bar on the image, calculate the magnification of the micrograph.

(Show your working.)

_____ [3]

[Turn over

4 Plants have historically been used to treat bacterial infections, since many species produce antimicrobial substances. For example, garlic (*Allium sativum*) produces the antimicrobial substance allicin.

The effect of allicin on the growth of the bacterium *Escherichia coli* (*E. coli*) was investigated. The researchers began with an allicin extract which had a concentration of 10 000 arbitrary units (AU).

(a) Determine the number of 1 in 10 serial dilutions required to obtain a concentration of 10 AU from a starting concentration of 10 000 AU.

_____ [1]

(b) State **two** aseptic techniques that should be used when working with microorganisms such as *E. coli* to prevent contamination.

1. _____

_____

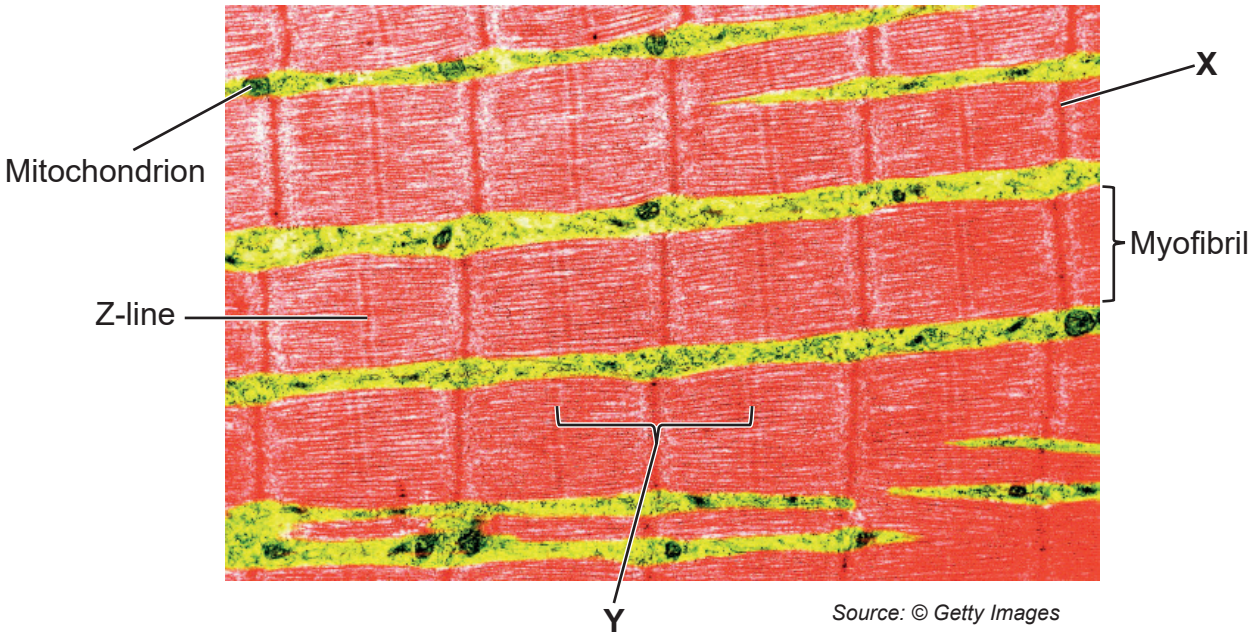
2. _____

_____ [2]

(c) Describe a method that could be used to test the effectiveness of different concentrations of allicin extract against *E. coli*.

[6]

5 The micrograph of contracted voluntary (skeletal) muscle shown below was taken using a transmission electron microscope (TEM).
(The image has been artificially coloured.)



Source: © Getty Images

(a) **(i)** Identify the structures labelled **X** and **Y**.

X _____

Y _____ [2]

(ii) Using the micrograph, identify **one** piece of evidence which shows that the muscle is contracted.

_____

_____

_____ [1]

(iii) This type of muscle contains a large number of mitochondria.
Suggest why only a small number are visible in this micrograph.

_____

_____

_____ [1]

(b) Describe **two** differences that would be seen in a micrograph of this tissue taken using a **light** microscope rather than a TEM.

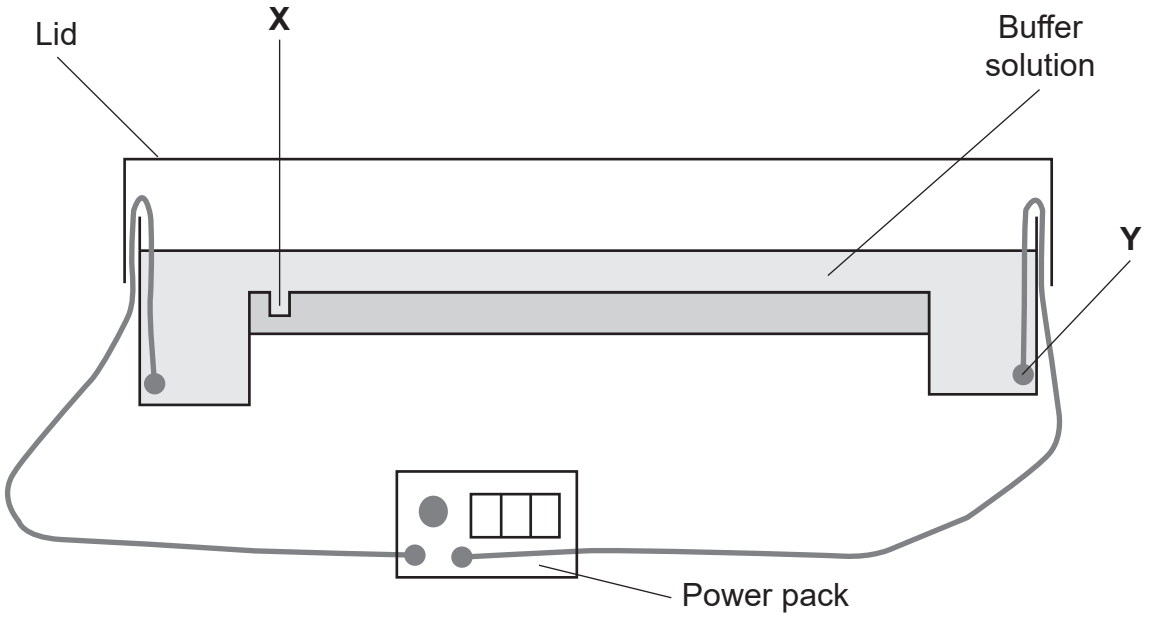
1. _____

_____

2. _____

_____ [2]

6 **(a)** The diagram below represents the side view of a gel electrophoresis tank. Gel electrophoresis can be used to separate fragments of DNA.



(i) Identify **X** and **Y** in the diagram.

X _____

Y _____ [2]

(ii) Apart from maintaining a constant pH, state **one** function of the buffer in the gel electrophoresis tank.

_____ [1]

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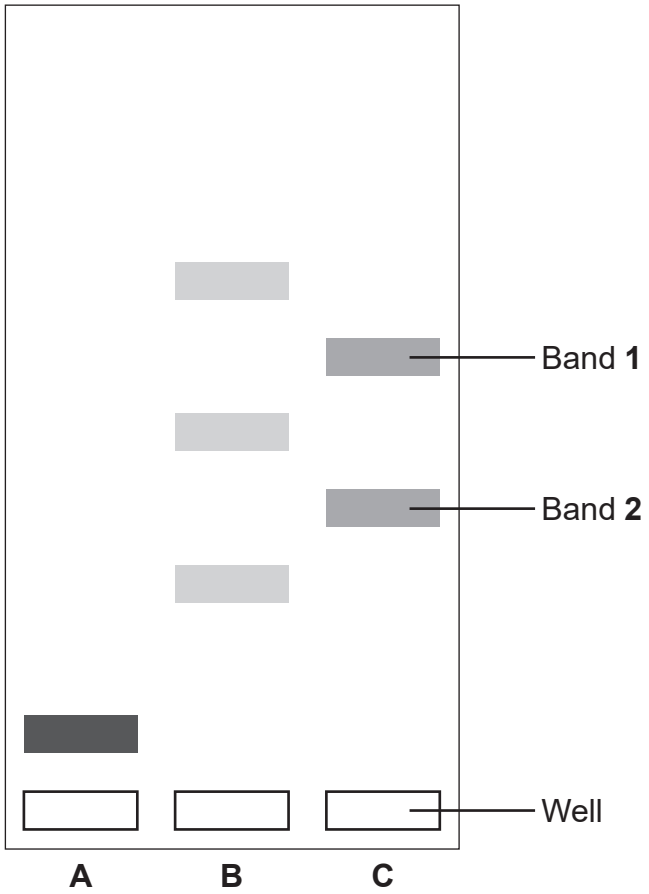
(Questions continue overleaf)

(b) In an investigation, three batches of identical sections of human DNA were incubated, each with a different restriction endonuclease enzyme. Following incubation, the three batches of DNA were added to the wells of three lanes (**A**, **B** and **C**) in a gel electrophoresis tank. The diagram below represents the gel following the migration of DNA fragments.



Source: Principal Examiner

(i) Describe the movement of the two bands (**1** and **2**) in lane **C** and suggest an explanation for their different positions in the gel, with reference to fragment length.

_____

_____

_____

_____ [2]

(ii) Describe the results for the number and distribution of bands in lanes **A**, **B** and **C**. Using your understanding of restriction enzymes, suggest explanations to account for your answer.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ [4]

(iii) Suggest how the investigators might be able to determine the size of the DNA in each band.

_____

_____

_____ [1]

7 Methylene blue is an example of a redox indicator – an indicator which changes colour when it gains or loses hydrogen.

Redox indicators can be used to investigate the biochemistry of respiration, particularly the activity of dehydrogenase enzymes. Methylene blue can be used to compare the rate of dehydrogenase activity when yeast cells respire different sugars.

These enzymes catalyse the removal of hydrogen from respiratory substrates.

(a) (i) Outline a procedure which could be used to compare dehydrogenase activity in yeast respiring glucose and yeast respiring sucrose. You should make reference to an appropriate control experiment.

_____ [5]

(ii) Suggest and explain how using peas rather than yeast would affect the validity of this investigation.

_____

_____

_____

_____

_____

_____ [2]

In a separate investigation, the effect of temperature on the rate of dehydrogenase activity was investigated using a redox indicator. The results are shown below.

Temperature / °C	**Time taken to change colour / s**	**Rate of colour change / s^{-1}**	**Rate of colour change in standard form / s^{-1}**
20	170	0.0059	5.9×10^{-3}
30	90	0.0111	11.1×10^{-3}
40	130		
50	150	0.0067	6.7×10^{-3}
60	210	0.0048	4.8×10^{-3}

(b) **Complete the table** by calculating the rate of colour change at 40°C and converting this to standard form.

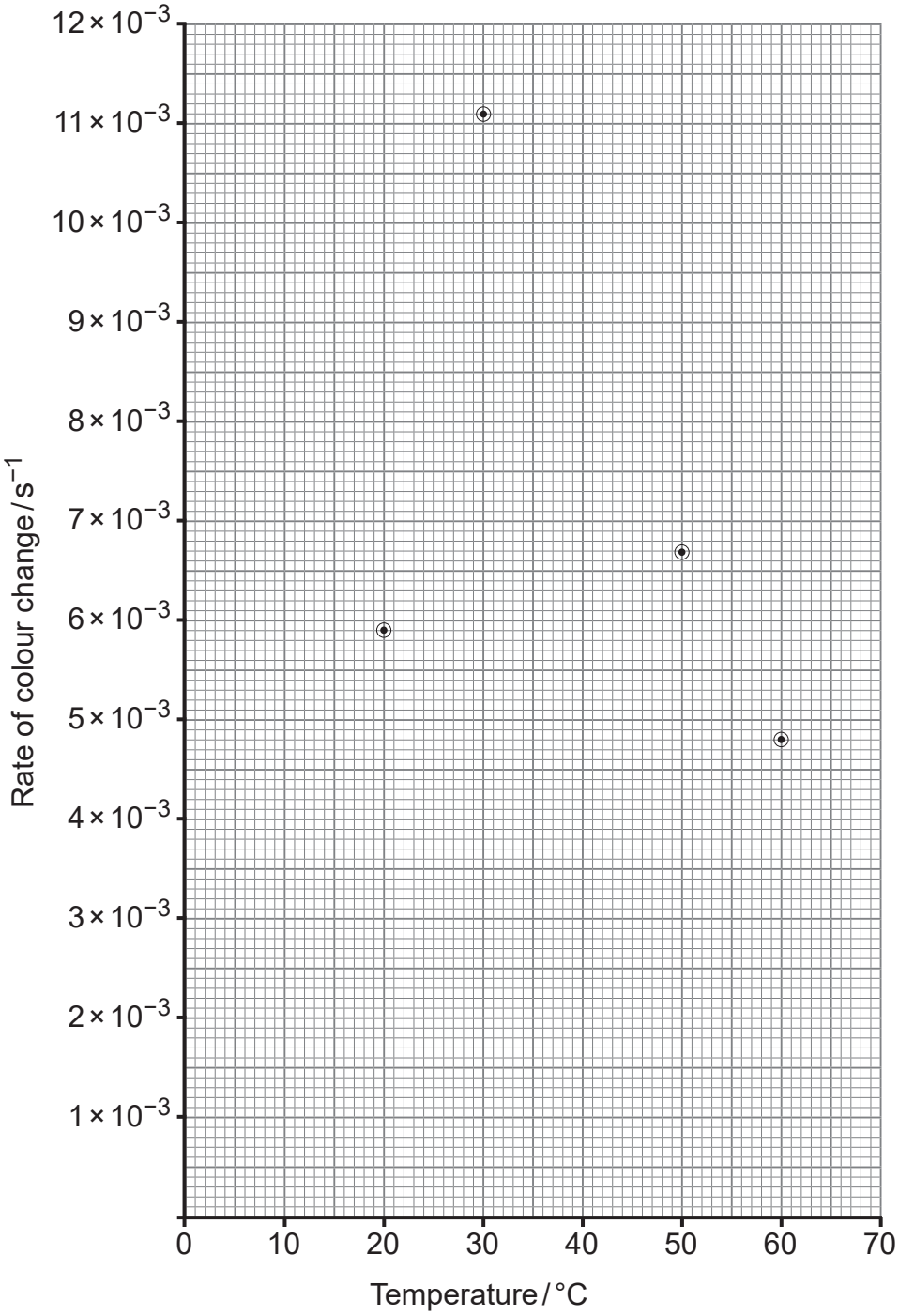
(Show your working.)

[3]

[Turn over

(c) (i) On the grid below:

- add the **missing data** point for 40°C
- join the points using an appropriate graphical technique. [2]



(ii) Using the information provided, describe the effect of temperature on dehydrogenase activity.

_____

_____

_____

_____

_____ [2]

THIS IS THE END OF THE QUESTION PAPER

Sources:

Q3.....© Yuan J, Wang X, Zhou H, Li Y, Zhang J, Yu S, Wang M, Hao M, Zhao Q, Liu L, Li M and Li J (2020) Comparison of Sample Preparation Techniques for Inspection of Leaf Epidermises Using Light Microscopy and Scanning Electronic Microscopy. Front. Plant Sci. 11:133. doi: 10.3389/fpls.2020.00133

Q5.....© Getty Images

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For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
6	
7	
Total Marks	

Examiner Number

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