



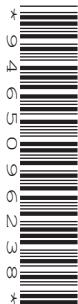
Oxford Cambridge and RSA

Friday 24 June 2022 – Morning

A Level Biology B (Advancing Biology)

H422/03 Practical skills in biology

Time allowed: 1 hour 30 minutes



You must have:

- a ruler (cm/mm)

You can use:

- a scientific or graphical calculator



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

Centre number

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Candidate number

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First name(s)

Last name

StemUp Model Solution

INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- 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.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION

- The total mark for this paper is **60**.
- 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 **20** pages.

ADVICE

- Read each question carefully before you start your answer.

Answer **all** the questions.

- 1 (a) Fig. 1.1 shows a light micrograph of pancreatic tissue.

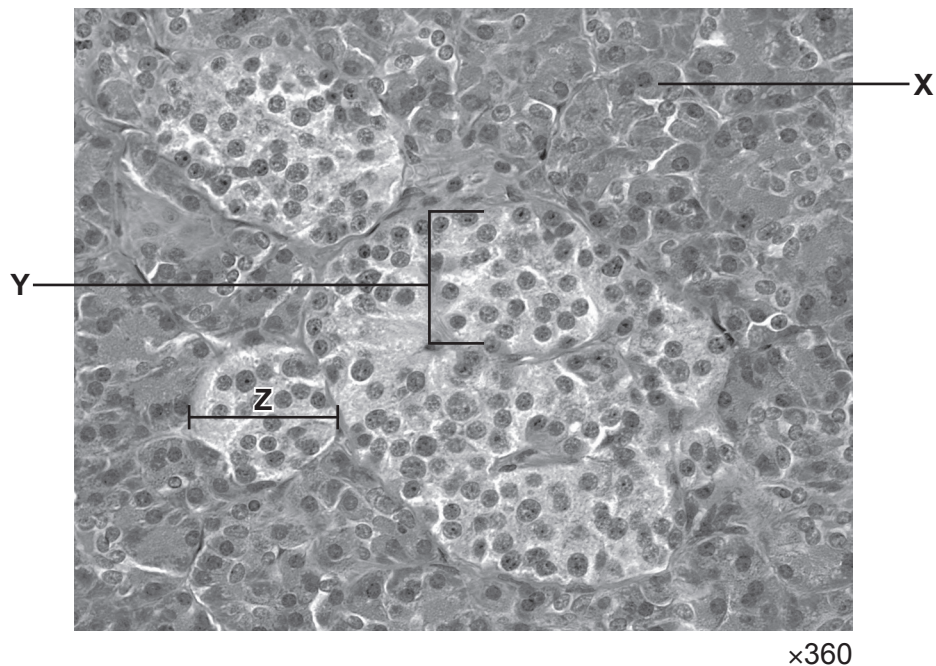


Fig. 1.1

- (i) State **one** function of the cell labelled X.
secretes digestive enzymes (e.g. amylase, trypsin) [1]
- (ii) Name the **two** different types of cell in the region labelled Y.
alpha (α) and beta (β) cells [1]
- (iii) The diameter of one region of pancreatic tissue is represented by the line Z.
 Calculate the actual diameter of the region labelled Z.
 Give your answer in μm and to **3** significant figures.

$$\text{length of Z on image} = 20 \text{ mm} = 20\,000 \mu\text{m}$$

$$\text{actual diameter} = 20\,000 \div 360 = 55.56 \mu\text{m}$$

$$\text{Actual diameter} = \dots\dots\dots 55.6 \dots\dots\dots \mu\text{m} \quad [2]$$

- (iv) A stage micrometer can be used when measuring the linear dimensions of cells, such as those of the pancreatic tissue, viewed under a light microscope.

Outline how a stage micrometer is used to measure the linear dimensions of cells.

Calibrate the eyepiece graticule against the stage micrometer (known length, e.g. 0.01 mm divisions) to find the length of one eyepiece unit. Replace it with the slide at the same magnification; count the eyepiece units across the cell and multiply by the length of one unit.

[2]

- (b) The pancreas has an essential role in controlling blood glucose concentration.

A person was given a glucose tolerance test. Two months later, the same person was given a fasting blood glucose test. The table shows the results of the two tests.

	Glucose tolerance test	Fasting blood glucose test
Blood glucose concentration 2 hours after the beginning of the test (mmol dm^{-3})	10.7	7.0

Suggest what conclusions can be made from the results of the two tests.

The glucose tolerance test indicates impaired glucose tolerance, but the fasting test (7.0) indicates the person probably has diabetes. So glucose tolerance may have worsened over the two months, or one result is due to faulty preparation, e.g. not fasting for long enough.

[2]

(c) An incomplete structure of α -glucose is shown in Fig. 1.2.

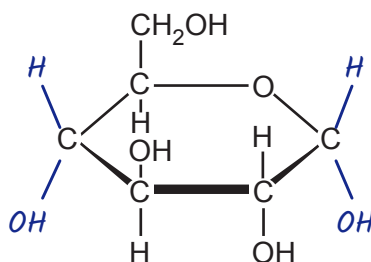


Fig. 1.2

Complete the structure of α -glucose in Fig. 1.2 to show all of the atoms in the structure. [1]

(d) The table lists glucose and two other carbohydrate molecules: lactose and amylose.

Fill in the table to show, for each carbohydrate, a reagent that would give a positive result when used in a test to help identify the carbohydrate **and** the number of glycosidic bonds in each molecule.

Carbohydrate molecule	Reagent used in test for identification	Number of glycosidic bonds per molecule
Glucose	<i>Benedict's reagent</i>	<i>0 (none)</i>
Lactose	<i>Benedict's reagent</i>	<i>1 (one)</i>
Amylose	<i>iodine solution</i>	many

[2]

2 Drugs such as alcohol, heroin and caffeine produce psychological and physical effects in people.

- (a) A group of scientists assessed the harm caused by various drugs, including alcohol and heroin.

The scientists produced weighted 'harm scores' for the drugs in several categories.

Some of the scientists' harm scores for alcohol and heroin are shown in **Fig. 2.1**.



Fig. 2.1

A student looked at **Fig. 2.1** and concluded that 'heroin is more harmful than alcohol'.

Evaluate the student's conclusion.

The data partly support the conclusion: heroin has a higher harm score than alcohol in 3 of the 4 categories (dependency, deaths from drug use and crime). However, alcohol has a much greater economic cost (about 13 compared with about 3.7), which undermines the conclusion. The total harm scores are approximately the same (alcohol about 22, heroin about 23), so heroin is not clearly more harmful overall. Other categories of harm are not shown, e.g. effects on relationships or mental health. Many more people use alcohol than heroin, and no statistical analysis or error bars are shown. [4]

- (b) Alcohol and heroin both affect the activity of neurones.

Fig. 2.2 shows the binding sites of alcohol and heroin at a synapse that uses the neurotransmitter GABA.

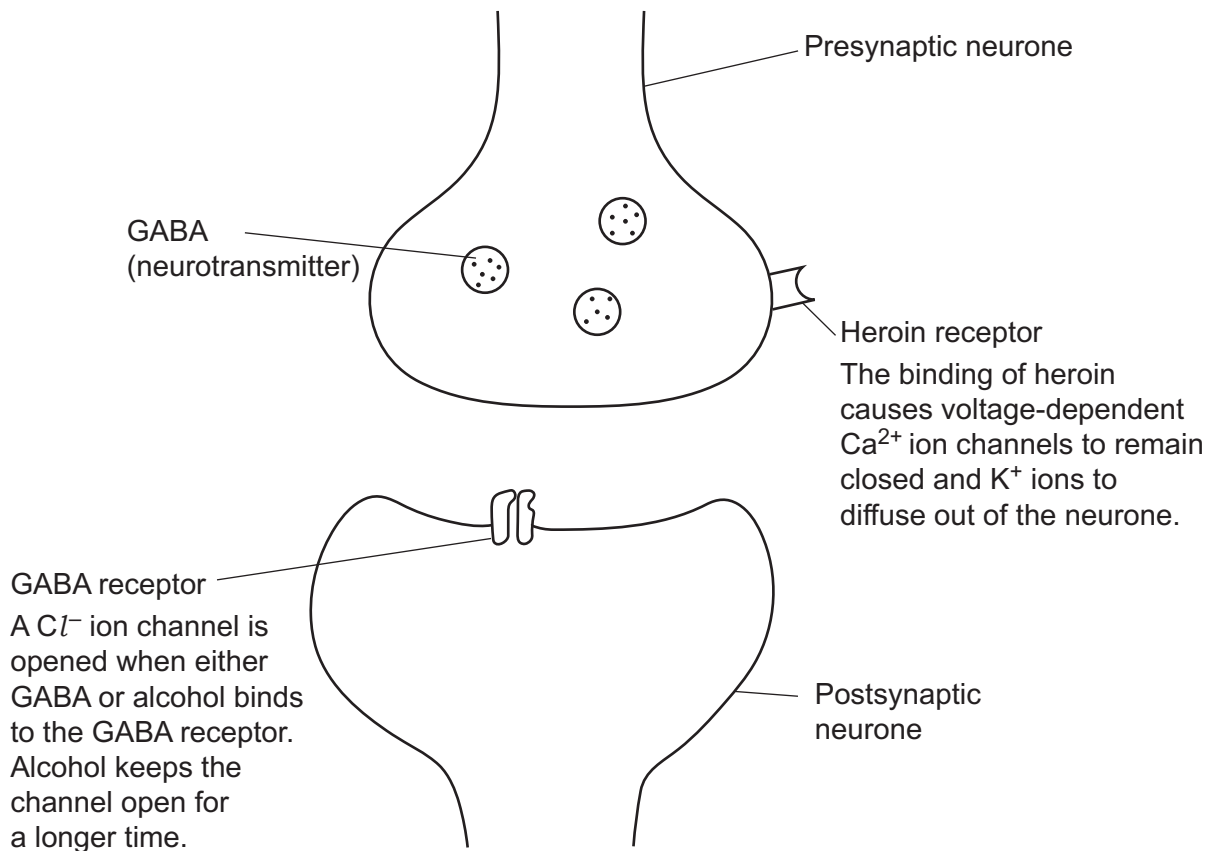


Fig. 2.2

- (i) State the type of membrane protein represented by the GABA receptor.

intrinsic (integral) protein: a ligand-gated ion channel [1]

- (ii) Compare **and** explain the effects of alcohol and heroin on the postsynaptic neurone in Fig. 2.2.

Heroin reduces the release of GABA from the presynaptic neurone into the synaptic cleft, whereas alcohol mimics GABA and binds to the GABA receptors.

With heroin, less GABA reaches the postsynaptic neurone, so fewer Cl^- channels open and the inhibition is reduced, making generation of an action potential more likely.

Alcohol keeps the Cl^- channel open for longer, so more Cl^- ions enter, causing hyperpolarisation and reducing the chance of an action potential. [3]

(c)* A student planned to test the effect of caffeine on reaction time.

The student decided to assess reaction time using a 'ruler drop' test. They planned to record the time taken for each participant to catch a ruler after it was dropped.

The student had access to standard laboratory equipment, including rulers, and a caffeinated drink of known concentration.

Outline an experimental plan that the student could use to investigate **and** statistically test the effect of caffeine on reaction time.

Obtain informed consent and carry out a risk assessment: exclude people with heart conditions, allergies or caffeine sensitivity, or contraindications to caffeine.

Use two groups of at least 10 participants each, of similar age, sex and typical caffeine intake, assigned randomly. The independent variable is caffeine vs no caffeine: one group drinks a set volume (e.g. 200 cm³) of the caffeinated drink, the control group drinks the same volume of a decaffeinated drink.

Wait a standard time, e.g. 30 minutes, for caffeine to be absorbed.

Standardise the test: the participant sits with the same (dominant) hand, thumb and finger level with the 0 cm mark; the ruler is dropped without warning from the same height.

Record the distance fallen (cm) where the ruler is caught and convert it to reaction time using a conversion table ($t = \sqrt{2d/g}$). Repeat 5 times per person. [6]

Additional answer space if required.

Identify and exclude anomalies, calculate the mean and standard deviation for each group, then use an unpaired t-test to see if the difference in mean reaction time is significant ($p < 0.05$).

- 3 Photosynthetic pigments absorb light energy, which is used during the production of ATP and NADPH in the light-dependent reactions of photosynthesis.

(a) Fig. 3.1 shows a paper chromatogram produced with four photosynthetic pigments.

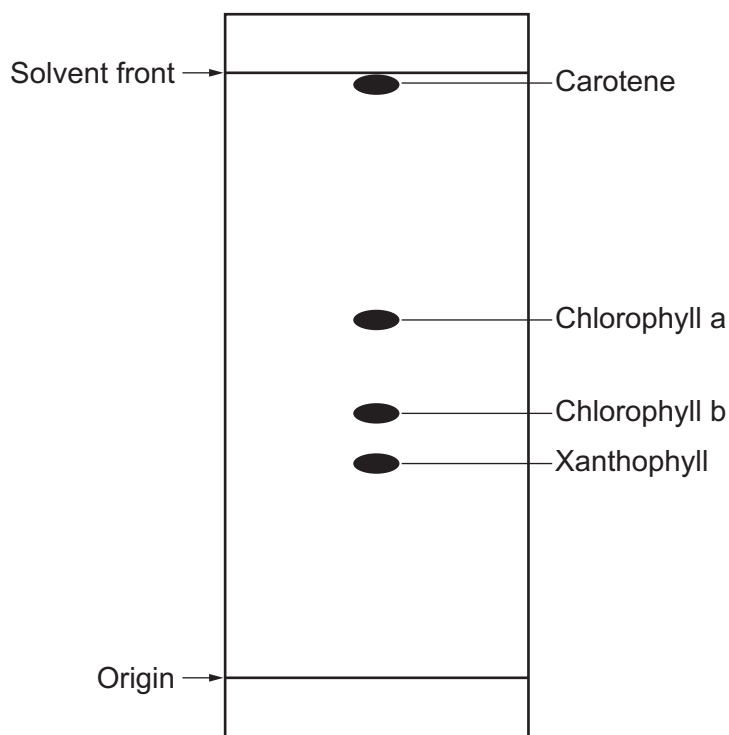


Fig. 3.1

- (i) Use Fig. 3.1 to calculate the R_f value of chlorophyll a.

Give your answer to 2 significant figures.

distance moved by chlorophyll a = 47 mm

distance moved by solvent front = 80 mm

$$R_f = 47 \div 80 = 0.5875$$

$R_f = \dots\dots\dots 0.59 \dots\dots\dots$ [2]

- (ii) Another student carried out paper chromatography on the four photosynthetic pigments but they used a different solvent.

Suggest why the R_f values obtained by the student would have been different to those obtained from the chromatogram shown in Fig. 3.1.

*...The pigments have different solubilities in (affinities for) the different
...solvent (mobile phase), so they travel different distances.....* [1]

- (iii) Photosynthetic pigments have colours that make them visible on a chromatogram.

Amino acids that are separated on a chromatogram are not visible.

State the name of the chemical that is used to make amino acids visible on a chromatogram.

ninhydrin..... [1]

- (b) The student used DCPIP solution to test the activity of photosynthetic pigments in the light-dependent stage of photosynthesis.

The student used a pestle and mortar to grind spinach plant leaves. The student then obtained extracts from the spinach in two forms:

- leaf extract pellets (solid green pellets)
- supernatant (containing liquid and a low concentration of organelles from the spinach cells).

The student stored the leaf extracts in an ice-cold water bath before adding DCPIP solution to four test tubes:

- Tube 1: sucrose solution + DCPIP (in light)
- Tube 2: resuspended leaf extract pellet + DCPIP (in light)
- Tube 3: resuspended leaf extract pellet + DCPIP (in dark)
- Tube 4: supernatant + DCPIP (in light).

- (i) Describe **and** explain how the student obtained the leaf extract pellets and supernatant.

The ground leaves (in buffer) were centrifuged, i.e. spun at high speed in tubes, which separates the components by density.

The denser chloroplasts settle at the bottom as the pellet; the supernatant is decanted (poured off) to leave the pellet.

..... [2]

- (ii) Explain why the student stored the leaf extracts in an ice-cold water bath before they added the DCPIP solution.

To reduce enzyme activity in the chloroplasts (slow down reactions and breakdown) until DCPIP was added...... [1]

- (iii) The student monitored the colour change in the four tubes using colorimetry.

State **and** explain the colour of filter that the student should have placed in the colorimeter during this experiment.

A red (or orange) filter.
DCPIP is blue, and red light is absorbed by blue solutions, so the
decrease in intensity of the blue colour (absorbance) as DCPIP is
reduced can be measured.

[2]

- (iv) The sentences below describe some of the details of the colorimetry procedure used by the student.

Complete the sentences using the most appropriate words or phrases.

Every minute, the student transferred a sample of the solution from each tube into a small container called a*cuvette*....., which they placed in the colorimeter.

The DCPIP changed colour in two tubes because it was*reduced*.....

by electrons from the light-dependent reactions of photosynthesis. The student did not observe a colour change in the tubes numbered*1*..... and*3*..... .

[3]

(v) Fig. 3.2 shows the results from two of the student's tubes.

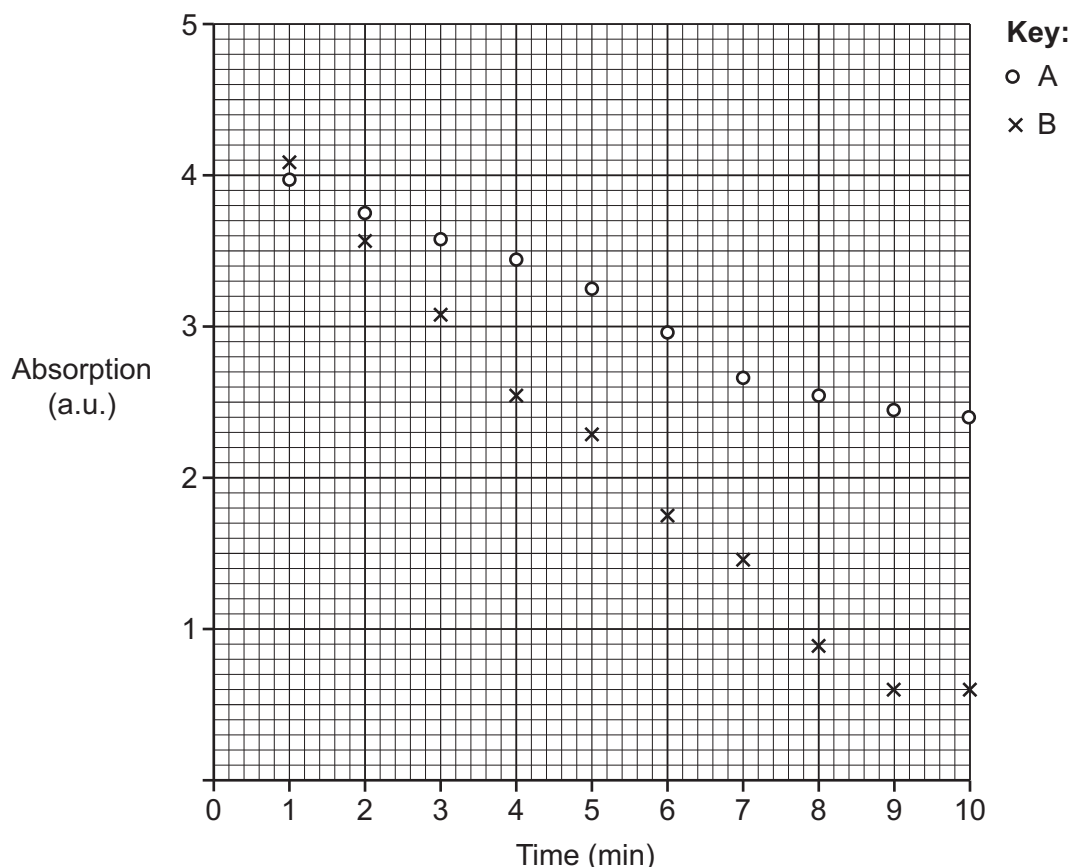


Fig. 3.2

The student forgot to label the two tubes for which the results are shown in Fig. 3.2.

Identify the two tubes and explain your conclusion.

A *tube 4* B *tube 2*

Explanation ..DCPIP is decolourised when it is reduced, i.e. when it accepts.....
.....*electrons from the light-dependent reactions.*.....

.....*B (tube 2, pellet in light) has a higher concentration of chloroplasts*.....
.....*(photosynthetic pigments) than A (tube 4, supernatant), so the rate of*.....
.....*light absorption and of the light-dependent reactions is faster, and*.....
.....*absorbance falls faster.*..... [3]

12
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- 4 The structure of bacterial cells determines how they are identified and the type of antibiotics that are used against them.

(a) The table shows some of the features of Gram-positive and Gram-negative bacteria.

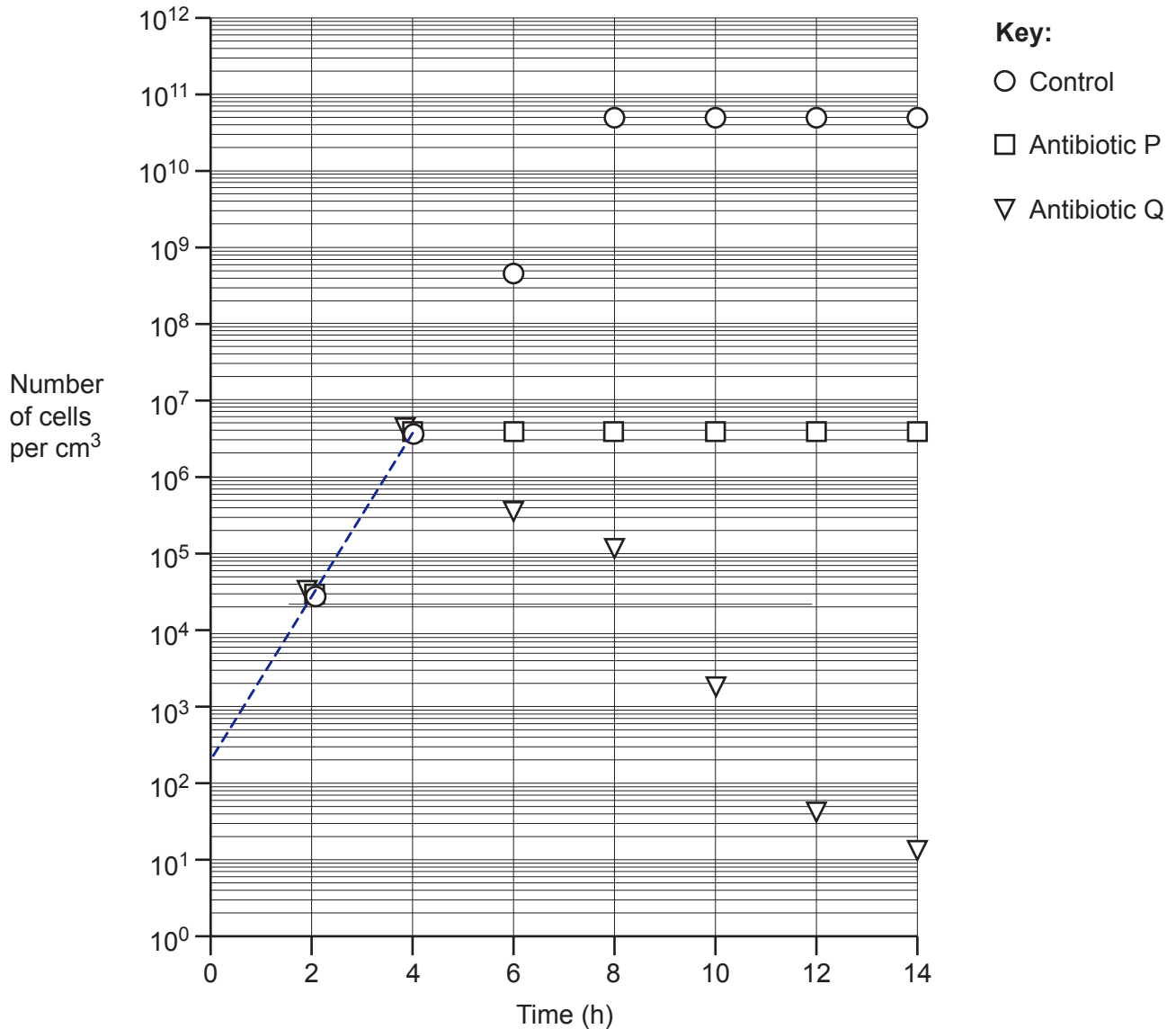
Use ticks (✓) to indicate in the table whether each feature is observed in Gram-positive bacteria, Gram-negative bacteria, or both. The first row has been filled in for you.

Feature	Gram-positive bacteria	Gram-negative bacteria
Peptidoglycan cell wall	✓	✓
Lipopolysaccharide outer envelope		✓
Plasma membrane	✓	✓
Stained with crystal violet during the Gram staining procedure	✓	✓
Final colour of pink after Gram staining		✓

[3]

- (b) A scientist analysed the effect of two different antibiotics, P and Q, on a particular bacterium. The scientist set up three separate populations of the bacterium, one to test antibiotic P, one to test antibiotic Q, and one as a control which was not exposed to an antibiotic.

The results are shown in the graph.



- (i) The bacteria in the control group were suspended in 10 cm³ of a nutrient solution at the beginning of the experiment.

Estimate the number of bacterial cells in the control group population at the beginning of the experiment.

Give your answer to **3** significant figures.

extrapolating the control line to 0 h gives 200 cells per cm³

number of cells = 200 × 10 cm³ = 2000

Number of cells = ... **2.00 × 10³** [2]

(ii)* Describe **and** explain the results for the three bacterial populations shown in the graph.

All three populations increase rapidly between 2 and 4 hours. The control then shows exponential growth up to 8 hours (from about 4×10^6 to 5×10^{10} cells per cm^3) because there are plenty of nutrients and space, so binary fission is fast. After 8 hours the control plateaus (stationary phase) as the carrying capacity is reached: nutrients become limited and toxic waste products accumulate.

With antibiotic P the population plateaus from 4 to 14 hours at about 4×10^6 cells per cm^3 . P is bacteriostatic: it prevents replication (binary fission), e.g. by stopping protein synthesis (tRNA prevented from binding to ribosomes), but the bacteria are not killed.

With antibiotic Q the population peaks at 4 hours, then decreases to about 15 cells per cm^3 by 14 hours. Q is bactericidal: it kills the bacteria, e.g. by stopping peptidoglycan cell wall synthesis so cells burst, or by damaging the plasma membrane.

Q is the most effective, leaving the fewest cells at 14 hours. [6]

Additional answer space if required.

.....

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.....

.....

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- (c) (i) Many bacterial species can produce ATP only through anaerobic respiration.

Explain why the rate of ATP production in these bacterial species is relatively low.

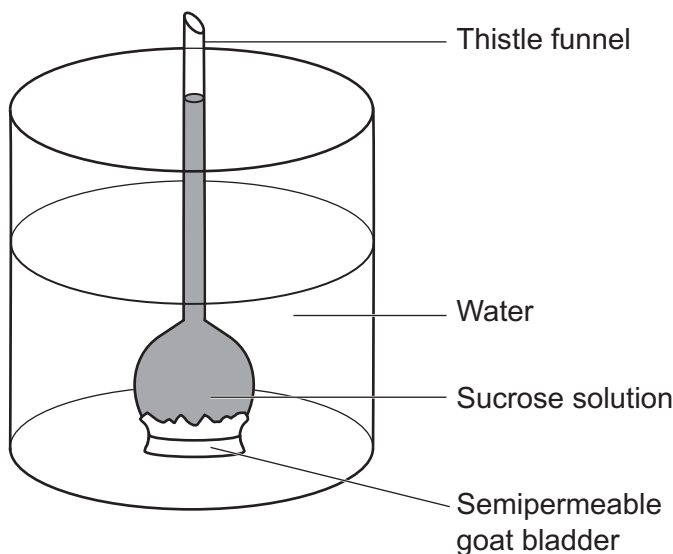
*Only glycolysis (substrate-level phosphorylation) occurs; there is no
Krebs cycle or oxidative phosphorylation.* [1]

- (ii) Some bacterial species can produce ATP through aerobic respiration, using electron transport chains and ATP synthase.

Suggest the location of electron transport chains and ATP synthase in bacterial cells.

in the plasma (cell surface) membrane [1]

- 5 The factors affecting osmosis can be investigated using a thistle funnel, which is shown in the diagram.



- (a) A student wanted to investigate the factors affecting osmosis and used the experimental set-up shown.

- (i) Suggest **and** explain **three** changes that the student could make to the experimental set-up that would **increase** the rate of osmosis.

Change *increase the temperature (water bath at e.g. 35 °C)*

Explanation *water molecules have more kinetic energy, so they move faster and cross the membrane more often*

Change *increase the concentration of the sucrose solution*

Explanation *the water potential gradient between the water and the sucrose solution increases (is steeper)*

Change *increase the surface area of the goat bladder*

Explanation *a larger surface area of membrane for osmosis, so more water molecules can cross at once*

[3]

- (ii) The student decided to measure the rate of osmosis by measuring how the height of the solution changed over time in the thistle funnel.

Suggest appropriate units for the student's dependent variable in the investigation.

mm (or cm)

[1]

- (iii) Suggest a semipermeable material that the student could use instead of the goat bladder.

Visking tubing (dialysis membrane) [1]

- (b) Osmosis occurs in several parts of a kidney nephron.

- (i) State the part of a kidney nephron in which most of the water is reabsorbed.

proximal convoluted tubule (PCT) [1]

- (ii) State a part of a kidney nephron in which ADH can change the permeability to water.

collecting duct [1]

END OF QUESTION PAPER

[illegible]

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