Helicate

HELICATE · AS AND A-LEVEL BIOLOGY · TOPIC BANK

3.1.8 Inorganic ions

Topic question bank

Version 2 · 10 October 2026

Name

Date

QUESTIONS	TOTAL MARKS	TIME	YOUR SCORE
5	48	No time limit	/ 48

Contents

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Total		**48**

Instructions

- Answer the questions in the spaces provided. Show all your working.
- The marks for each question are shown in brackets. Use them to judge how much detail to give.
- Work through a subtopic at a time, then mark your answers with the matching mark scheme.

Original questions by Helicate for AQA AS and A-level Biology (7401/7402), specification section 3.1.8. Not affiliated with or endorsed by AQA.

Do not write outside the box

Hydrogen ions and pH 3.1.8

0 1 . 1 The fluid inside a lysosome is more acidic than the cytoplasm of the cell.
Which row correctly compares the fluid inside a lysosome with the cytoplasm?
Tick (✓) one box.

[1 mark]

Concentration of hydrogen ions	pH	
Higher	Higher	☐
Higher	Lower	☐
Lower	Higher	☐
Lower	Lower	☐

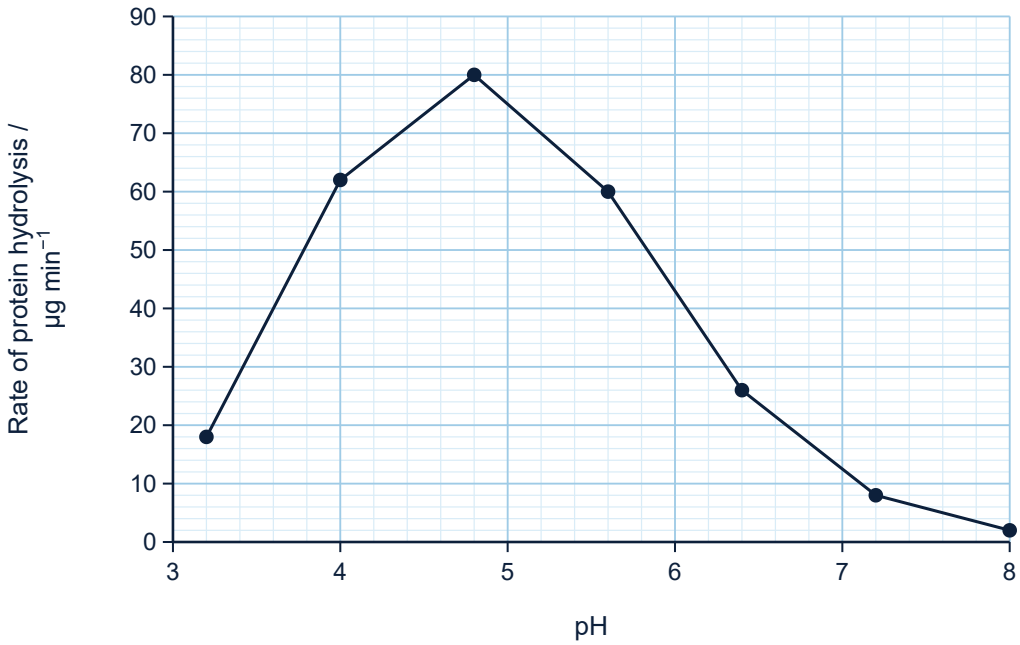
Question 1 continues on the next page

Do not write outside the box

Protease X is an enzyme found inside lysosomes. Scientists measured the rate at which protease X hydrolysed a protein at different pH values. They used buffer solutions to keep the pH constant.

Figure 1 shows their results.

Figure 1



0 1 . 2 The pH of the cytoplasm is 7.2
Calculate the rate of reaction at pH 7.2 as a percentage of the maximum rate of reaction shown in Figure 1.

[2 marks]

Answer ..... **%**

Question 1 continues on the next page

Do not write outside the box

0 1 . 3 The pH inside a lysosome is 4.8
Occasionally, a lysosome releases a small amount of protease X into the cytoplasm.
Use Figure 1 and your knowledge of hydrogen ions to explain why this causes little damage to proteins in the cytoplasm.

[3 marks]

Phagocytes destroy bacteria they have engulfed. Lysosomes fuse with the phagosome containing a bacterium and release enzymes, including protease X, into it.

Some pathogenic bacteria survive inside phagocytes. When they are engulfed, these bacteria release substance Z into the phagosome. Substance Z combines with hydrogen ions.

0 1 . 4 Use Figure 1 to explain how releasing substance Z helps these bacteria to survive inside phagocytes.

[3 marks]

9

Turn over for the next question

Do not write outside the box

Iron ions and haemoglobin 3.1.8

0 2 . 1 Which statement describes the role of iron ions in red blood cells?
Tick (✓) one box.

[1 mark]

- They are part of haemoglobin, and oxygen binds to them ☐
- They are molecules that carry oxygen in the cytoplasm ☐
- They form peptide bonds between the polypeptide chains of haemoglobin ☐
- They lower the water potential of the cell, so oxygen enters by osmosis ☐

0 2 . 2 Each haemoglobin molecule can carry a maximum of four oxygen molecules.
A red blood cell from a healthy adult contains 2.8×10^8 haemoglobin molecules.
What is the maximum number of oxygen molecules that the haemoglobin in this red blood cell can carry?
Tick (✓) one box.

[1 mark]

- 7.0×10^7 ☐
- 2.8×10^8 ☐
- 1.1×10^9 ☐
- 1.1×10^{12} ☐

Question 2 continues on the next page

Do not write outside the box

Scientists measured the concentration of haemoglobin and the number of red blood cells in the blood of two groups of adults:

- group H had enough iron in their diet
- group D had iron deficiency caused by a diet low in iron.

Table 1 shows the mean values for each group.

Table 1

Group	Mean concentration of haemoglobin in blood / g dm^{-3}	Mean number of red blood cells in 1 dm^3 of blood
H	150	5.0×10^{12}
D	96	4.0×10^{12}

0 2 . 3 Calculate the mean mass of haemoglobin in one red blood cell of a person in group D.
Give your answer in standard form.

[2 marks]

Answer ..... **g**

0 2 . 4 A student concluded that the lower concentration of haemoglobin in group D is caused only by group D having fewer red blood cells.
Use Table 1 and your answer to 02.3 to evaluate this conclusion.

[2 marks]

Question 2 continues on the next page

Do not write outside the box

0 2 . 5 People in group D often feel tired during exercise.
Use Table 1 and your knowledge of the role of iron ions to explain why.

[3 marks]

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Turn over for the next question

Do not write outside the box

Sodium ions and co-transport 3.1.8

0 3 . 1 Absorption of which pair of substances by epithelial cells of the mammalian ileum involves co-transport with sodium ions?
Tick (✓) one box.

[1 mark]

- Amino acids and glucose ☐
- Amino acids and fatty acids ☐
- Fatty acids and glucose ☐
- Glycerol and monoglycerides ☐

Question 3 continues on the next page

Do not write outside the box

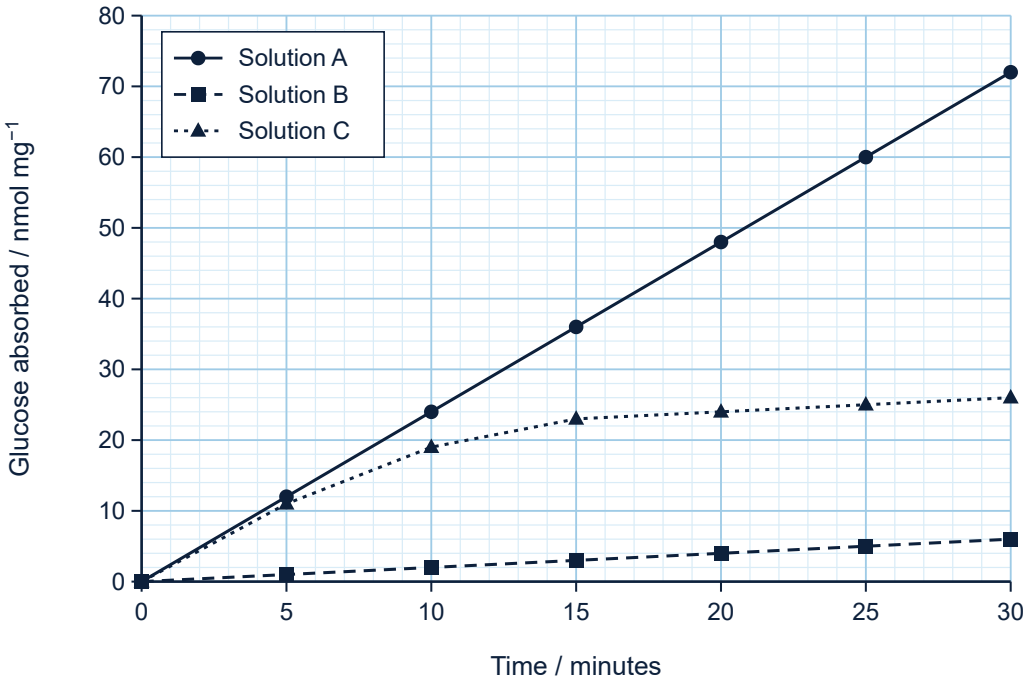
Scientists investigated glucose uptake by epithelial cells from the mammalian ileum. They put samples of the cells into three solutions at 37 °C. Each solution contained the same concentration of glucose.

- Solution A contained sodium ions.
- Solution B was the same as solution A, except that the sodium ions were replaced by the same concentration of ion Y. Ion Y is a positive ion that is not transported by the co-transporter protein.
- Solution C was the same as solution A, but also contained a substance that stops the cells producing ATP.

Some of the glucose molecules in each solution contained a radioactive atom. Every 5 minutes, the scientists removed some cells and rinsed them in a solution that contained no glucose. They then measured the radioactivity of the cells to find the amount of glucose absorbed per milligram of cell protein.

Figure 2 shows their results.

Figure 2



0 3 . 2 Suggest why the scientists rinsed the cells in a solution that contained no glucose before measuring their radioactivity.

[1 mark]

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Question 3 continues on the next page

Do not write outside the box

0 3 . 3 Calculate the rate of glucose uptake by the cells in solution A.

[2 marks]

Answer ..... **nmol min^{-1} mg^{-1}**

0 3 . 4 In solution B, the scientists replaced the sodium ions with ion Y, rather than simply leaving the sodium ions out.
Suggest why.

[2 marks]

In epithelial cells of the mammalian ileum:

- a carrier protein uses energy from the hydrolysis of ATP to move sodium ions out of the cell, keeping the concentration of sodium ions inside the cell low
- a co-transporter protein in the cell-surface membrane moves sodium ions and glucose into the cell together.

0 3 . 5 Use this information to explain the difference in glucose uptake between solution A and solution B.

[3 marks]

Question 3 continues on the next page

Do not write outside the box

0 3 . 6 Use Figure 2 and the information about ileum cells to explain the results with solution C.

[5 marks]

14

Turn over for the next question

Do not write outside the box

Phosphate ions in DNA and ATP 3.1.8

0 4 . 1 Phosphate ions are components of DNA.
Name the type of bond that joins adjacent nucleotides in a DNA strand.

[1 mark]

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0 4 . 2 Complete Table 2 by giving the number of phosphate groups in one molecule of each substance.

[2 marks]

Table 2

Molecule	Number of phosphate groups in one molecule
ATP	
ADP	
DNA nucleotide	
Phospholipid	
Triglyceride	

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Turn over for the next question

Do not write outside the box

Scientists grew one species of bacterium in media with different concentrations of phosphate ions. They:

- prepared six flasks of liquid culture medium that were identical except for the concentration of phosphate ions
- added 1.0×10^6 bacteria per cm^3 to each flask
- incubated the flasks at 30 °C for 24 hours
- measured the absorbance of each culture using a colorimeter, and used a calibration curve to convert each absorbance into the number of bacteria per cm^3.

Table 3 shows their results.

Table 3

Concentration of phosphate ions in medium / mmol dm^{-3}	Number of bacteria at the end of incubation / $\times 10^6$ cm^{-3}
0.0	3
0.1	90
0.5	380
1.0	690
2.0	960
4.0	970

0 5 . 1 This method might overestimate the number of living bacteria in each culture. Suggest why.

[1 mark]

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Question 5 continues on the next page

Do not write outside the box

When phosphate ions are plentiful, these bacteria store phosphate ions in long chains called polyphosphate.

The bacteria added to every flask had been grown in a medium with a high concentration of phosphate ions.

0 5 . 2 The number of bacteria increased from 1.0×10^6 to 3×10^6 per cm^3 in the medium with no phosphate ions.
Use this information to suggest why.

[2 marks]

Question 5 continues on the next page

Do not write outside the box

0 5 . 3 Use Table 3 and your knowledge of the roles of phosphate ions to explain the effect of the concentration of phosphate ions on the number of bacteria between 0.0 and 2.0 mmol dm^{-3}.

[6 marks]

Question 5 continues on the next page

Do not write outside the box

0 5 . 4 A student concluded that a low concentration of phosphate ions limits the growth of these bacteria because phosphate ions are needed for DNA replication.
Evaluate this conclusion.

[4 marks]

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END OF QUESTIONS

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