Helicate

HELICATE · AS AND A-LEVEL BIOLOGY · TOPIC BANK

3.2.3 Transport across cell membranes

Topic question bank

Version 1 · 2 October 2026

Name

Date

QUESTIONS	TOTAL MARKS	TIME	YOUR SCORE
8	62	No time limit	/ 62

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Total		**62**

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 3.2.3. Not affiliated with or endorsed by AQA.

Do not write outside the box

Structure of cell membranes 3.2.3

0 1 . 1 Which statement about the fluid-mosaic model of membrane structure is correct?
Tick (✓) one box.

[1 mark]

The carbohydrate chains of glycoproteins point into the centre of the bilayer. ☐

Phospholipid molecules can move sideways within their own layer of the bilayer. ☐

Cholesterol makes the membrane more fluid at body temperature. ☐

Each protein molecule is held in a fixed position in the bilayer. ☐

0 1 . 2 When phospholipids are added to the surface of water in a dish, they form a single layer, with their phosphate heads in the water and their fatty acid tails in the air above.
Explain why the phospholipids in a cell-surface membrane form a bilayer instead.

[2 marks]

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3

Turn over for the next question

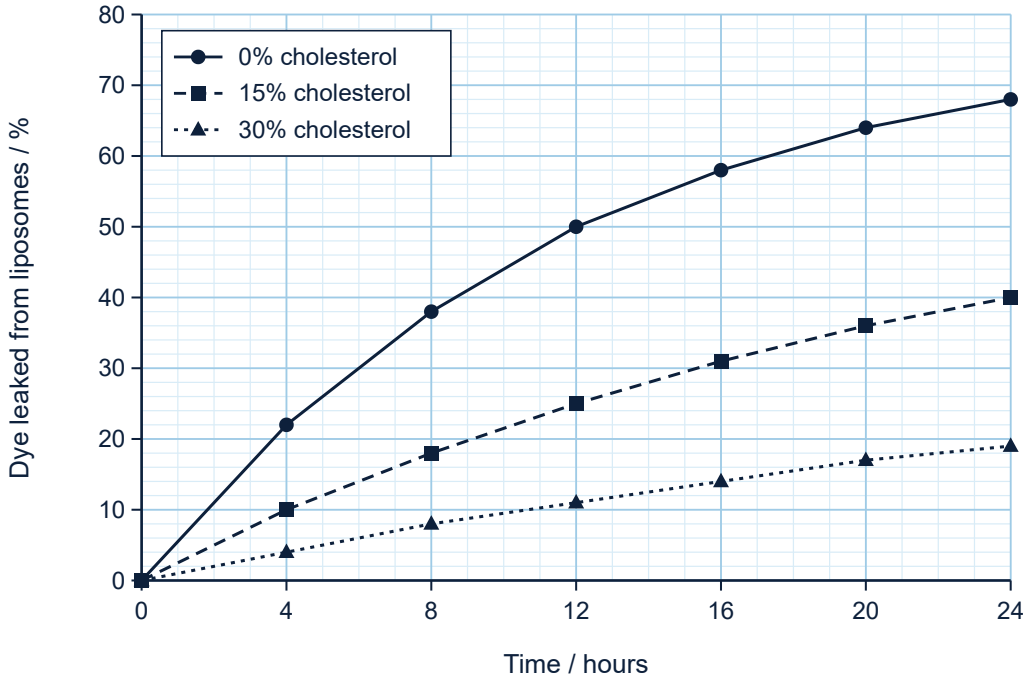
Do not write outside the box

Liposomes are tiny hollow spheres made from a phospholipid bilayer, with a watery solution inside. They can be used to carry drugs in the blood.

Scientists made three batches of liposomes containing a water-soluble dye. The batches contained 0%, 15% or 30% cholesterol in their bilayer. The scientists kept the liposomes at 37 °C and measured the percentage of the dye that had leaked out of the liposomes over 24 hours.

Figure 1 shows their results.

Figure 1



0 2 . 1 Use your knowledge of the role of cholesterol in membranes to explain the results in Figure 1.

[2 marks]

Question 2 continues on the next page

Do not write outside the box

0 2 . 2 Calculate the percentage decrease in the dye leaked after 12 hours when the cholesterol content of the liposomes was increased from 0% to 30%.

[2 marks]

Answer ..... **%**

0 2 . 3 The scientists then tried to use the liposomes to carry a small, non-polar drug molecule. The drug leaked out of all three batches of liposomes within a few minutes.
Explain why.

[2 marks]

6

Turn over for the next question

Do not write outside the box

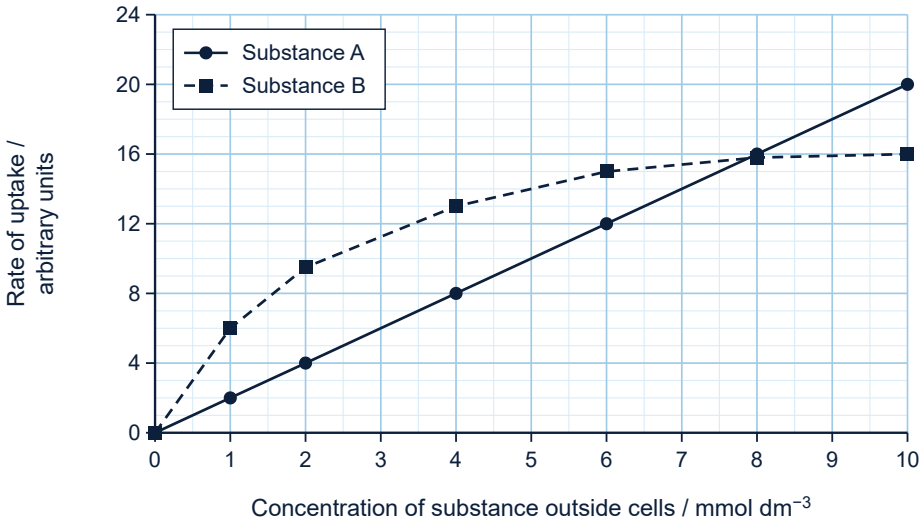
Simple diffusion and facilitated diffusion 3.2.3

Scientists investigated how cultured animal cells take up two substances, **A** and **B**. At the start of the investigation, the cells contained neither substance.

The scientists put samples of the cells into solutions containing different concentrations of each substance. They then measured the initial rate at which each substance entered the cells.

Figure 2 shows their results.

Figure 2



0 3 . 1 One substance enters the cells by simple diffusion and the other by facilitated diffusion.
Use Figure 2 to identify which substance enters by each process. Explain your answer.

[3 marks]

Question 3 continues on the next page

Do not write outside the box

0 3 . 2 Substance **B** is a polar molecule.
Explain why substance **B** cannot enter the cells by simple diffusion.

[1 mark]

0 3 . 3 The scientists repeated the investigation with substance **B**, but this time they added a substance that stops respiration in the cells. The rate of uptake of substance **B** did not change.
Explain how this result supports the conclusion that substance **B** enters by facilitated diffusion and **not** by active transport.

[2 marks]

0 3 . 4 Which statement is true of facilitated diffusion but **not** of simple diffusion?
Tick (✓) one box.

[1 mark]

- It moves substances from a higher to a lower concentration. ☐
- It involves channel proteins or carrier proteins. ☐
- It needs energy released by the hydrolysis of ATP. ☐
- It is a passive process. ☐

7

Turn over for the next question

Do not write outside the box

Osmosis and water potential (Required practical 3) 3.2.3

A student investigated the water potential of parsnip tissue.

The student:

- made sucrose solutions with a range of concentrations from a 1.00 mol dm^{-3} sucrose solution and distilled water
- used a cork borer to cut cylinders of parsnip of the same length and diameter
- blotted each cylinder dry and recorded its initial mass
- placed one cylinder in 20 cm^3 of each solution for 20 hours at 25 °C
- removed each cylinder, blotted it dry and recorded its final mass.

0 4 . 1 The student made 20 cm^3 of 0.30 mol dm^{-3} sucrose solution.
Which volumes of 1.00 mol dm^{-3} sucrose solution and distilled water did the student mix?
Tick (✓) one box.

[1 mark]

Volume of 1.00 mol dm^{-3} sucrose solution / cm^3	Volume of distilled water / cm^3	
3.0	17.0	☐
6.0	14.0	☐
14.0	6.0	☐
0.3	19.7	☐

Question 4 continues on the next page

Do not write outside the box

The water potential of pure water is 0 kPa. Table 1 shows the student's results and the water potential of each sucrose solution.

Table 1

Concentration of sucrose solution / mol dm^{-3}	Water potential of solution / kPa	Initial mass / g	Final mass / g	Percentage change in mass
0.00	0	2.46	2.69	+9.3
0.10	−260	2.53	2.70	+6.7
0.20	−540	2.38	2.45	+2.9
0.30	−820	2.61	2.57	−1.5
0.40	−1120	2.44	2.31	
0.50	−1450	2.57	2.35	−8.6
0.60	−1800	2.50	2.25	−10.0

0 4 . 2 Complete Table 1 by calculating the percentage change in mass of the cylinder in the 0.40 mol dm^{-3} sucrose solution.
Give your answer to **one** decimal place.

[2 marks]

Answer ..... **%**

0 4 . 3 Explain why the student calculated the percentage change in mass, rather than the change in mass.

[1 mark]

Question 4 continues on the next page

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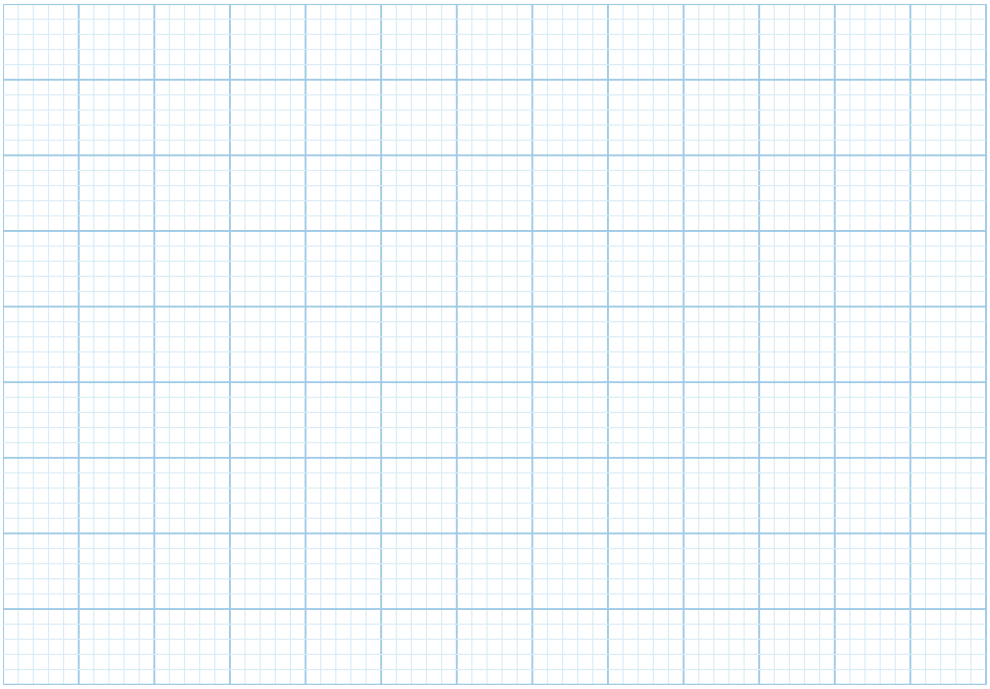
0 4 . 4 Plot a graph of the percentage change in mass against the water potential of the solution on the grid below. Use your answer to 04.2.

[3 marks]



0 4 . 5 Use your graph to find the water potential of the parsnip tissue.

[1 mark]

Answer ..... **kPa**

0 4 . 6 Explain the change in mass of the cylinder in the 0.50 mol dm^{-3} sucrose solution.

[2 marks]

Question 4 continues on the next page

Do not write outside the box

0 4 . 7 Suggest how the student could change the concentrations of sucrose solution used, to find a more accurate value for the water potential of the parsnip tissue.

[1 mark]

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11

Turn over for the next question

Do not write outside the box

Active transport, co-transport and adaptations for rapid transport 3.2.3

0 5 . 1 The concentration of glucose in the lumen of the ileum is often lower than the concentration of glucose inside the epithelial cells that line the ileum.
Describe how glucose is transported from the lumen, through an epithelial cell, and into the blood.

[5 marks]

Question 5 continues on the next page

Do not write outside the box

Oral rehydration solutions are drinks used to treat people who have lost a lot of water from the body. The solutions contain sodium ions and glucose dissolved in water.

When a solution of sodium ions and glucose is drunk, more water is absorbed from the ileum than when a solution containing only sodium ions is drunk.

0 5 . 2 Use your knowledge of co-transport to explain why.

[3 marks]

8

Some bacteria take up the sugar lactose using a protein in their cell-surface membrane. Each time this protein moves one lactose molecule into the cell, it also moves one hydrogen ion (H^+) into the cell.

The bacteria use ATP to pump hydrogen ions out of the cell. This keeps the concentration of hydrogen ions in the cytoplasm lower than the concentration outside the cell.

0 6 . 1 Lactose can enter these bacteria even when the concentration of lactose inside the cell is higher than outside.
Explain why the uptake of lactose by this protein is co-transport and **not** facilitated diffusion.

[2 marks]

Question 6 continues on the next page

Do not write outside the box

Scientists measured the initial rate of lactose uptake by these bacteria in solutions with different pH values. The pH of the cytoplasm stayed at 7.6 throughout.

The lower the pH of a solution, the higher its concentration of hydrogen ions.

Table 2 shows their results.

Table 2

pH of solution outside the bacteria	Rate of lactose uptake / nmol min^{-1} mg^{-1}
5.5	46
6.0	33
6.5	19
7.0	8
7.6	1

0 6 . 2 Use Table 2 to explain the effect of the pH of the solution on the rate of lactose uptake.

[3 marks]

Question 6 continues on the next page

Do not write outside the box

0 6 . 3 The scientists repeated the investigation at pH 5.5, but added substance D. Substance D allows hydrogen ions to pass freely through the phospholipid bilayer. The rate of lactose uptake fell from 46 to 2 nmol min^{-1} mg^{-1}. Suggest an explanation for this result.

[3 marks]

0 6 . 4 Name the process that moves hydrogen ions out of these bacteria, and the type of membrane protein involved.

[1 mark]

Process .....

Type of protein .....

9

Turn over for the next question

Do not write outside the box

Scientists compared two types of epithelial cell from the lining of the small intestine of a mammal. Cell **P** was a mature cell and cell **Q** was an immature cell.

For each cell, they measured:

- the surface area of the cell-surface membrane facing the lumen of the intestine
- the number of mitochondria
- the rate of glucose uptake from the lumen.

Table 3 shows their results.

Table 3

Cell	Surface area of membrane facing the lumen / μm^2	Number of mitochondria	Rate of glucose uptake / arbitrary units
P	1200	520	1800
Q	80	210	48

0 7 . 1 Cell **P** has more mitochondria than cell **Q**.
Explain how this could lead to the higher rate of glucose uptake by cell **P**.

[3 marks]

Question 7 continues on the next page

Do not write outside the box

0 7 . 2 Calculate how many times greater the rate of glucose uptake per μm^2 of membrane facing the lumen is for cell **P** than for cell **Q**.

[2 marks]

Answer ..... **times**

0 7 . 3 A student concluded that the difference in the rate of glucose uptake between cell **P** and cell **Q** is caused only by the difference in the surface area of their membranes facing the lumen.
Use your answer to 07.2 and the information in Table 3 to evaluate this conclusion.

[2 marks]

7

Turn over for the next question

Do not write outside the box

Required practical 4: permeability of cell-surface membranes 3.2.3

The red pigment in beetroot cells is stored in their vacuoles. It only leaks out of the cells when their membranes are damaged.

A student used beetroot tissue to find out how ethanol concentration affects membrane permeability.

The student:

- cut discs of beetroot tissue of the same diameter and thickness
- rinsed the discs in distilled water and blotted them dry
- placed five discs in 10 cm^3 of each ethanol solution at 25 °C for 20 minutes
- removed the discs and measured the absorbance of each solution using a colorimeter
- repeated the procedure three times at each concentration and calculated the mean absorbance.

A higher absorbance shows a higher concentration of red pigment in the solution.

0 8 . 1 Explain why the student rinsed the discs in distilled water before putting them into the ethanol solutions.

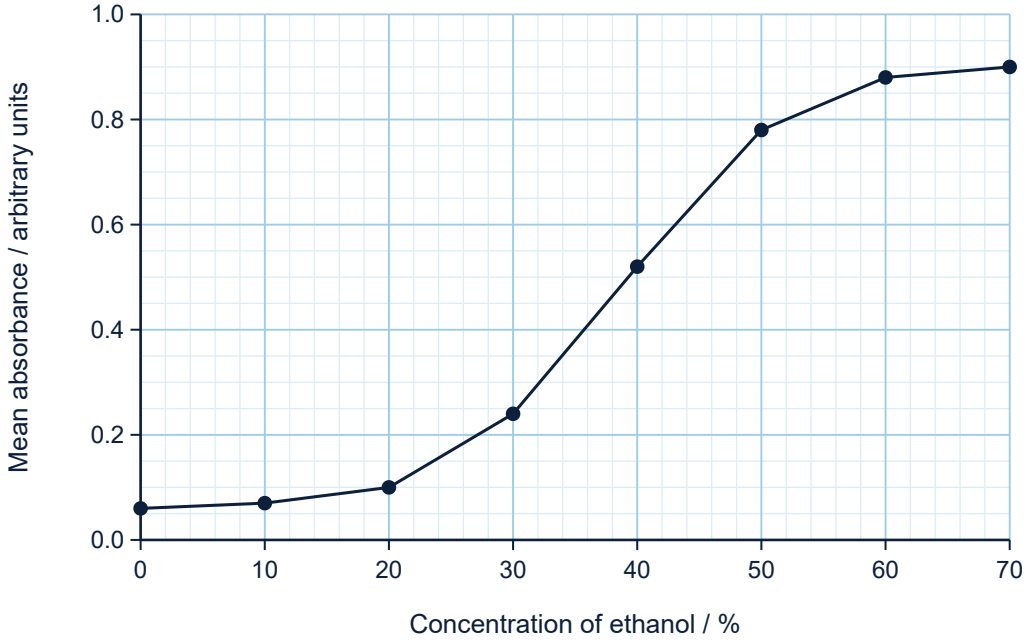
[1 mark]

Question 8 continues on the next page

Do not write outside the box

Figure 3 shows the student's results.

Figure 3



0 8 . 2 Describe **and** explain the results in Figure 3.

[4 marks]

Question 8 continues on the next page

Do not write outside the box

0 8 . 3 Beetroot membranes stay almost intact as temperature rises, until a temperature is reached above which pigment leaks out rapidly.
Using the same type of apparatus, describe a method the student could use to find this temperature as precisely as possible. Include how the student would control variables and make sure the results are reliable.

[6 marks]

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END OF QUESTIONS

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