

Gas exchange, membranes and transport: practice questions

8 questions • 27 marks • mark scheme at the back

For Pearson Edexcel International AS Biology XBI11 and International A Level Biology YBI11. **A Level only** is IA2 content (Units 4 to 6), not needed for the International AS.

Name

Total / 27

1 UNIT 1 STYLE**[1 mark]**

Which change would cause the greatest decrease in the rate of diffusion of oxygen across the wall of an alveolus?

- A. ☐ Doubling the surface area of the alveolus
- B. ☐ Doubling the thickness of the alveolar wall
- C. ☐ Doubling the oxygen concentration in the alveolus
- D. ☐ Halving the thickness of the capillary wall

2 UNIT 1 STYLE**[3 marks]**

A gas exchange surface has an area of 80 mm^2 , a thickness of $0.4 \text{ }\mu\text{m}$ and a difference in oxygen concentration across it of 15 arbitrary units. A second surface has an area of 40 mm^2 , a thickness of $0.4 \text{ }\mu\text{m}$ and a concentration difference of 15 arbitrary units. Use Fick's law to calculate the relative rate of diffusion across each surface, and state the ratio of the first to the second.

Answer = ...

3 UNIT 1 STYLE

[4 marks]

Explain how the structure of the mammalian lung is adapted for rapid gaseous exchange.

4 UNIT 1 STYLE

[1 mark]

Which statement about cholesterol in an animal cell-surface membrane is correct?

- A. ☐ It forms channels through which ions pass
- B. ☐ It lies between the phospholipid tails and helps to regulate the fluidity of the membrane
- C. ☐ It forms the outer carbohydrate layer used in cell recognition
- D. ☐ It is a protein that carries glucose across the membrane

5 UNIT 1 STYLE

[4 marks]

In an investigation of membrane fluidity, a human cell and a mouse cell were fused. The surface proteins of the human cell were labelled with a green fluorescent marker and those of the mouse cell with a red fluorescent marker. The fused cells were kept at different temperatures. The table shows the percentage of the fused cells in which the two markers had completely mixed after 40 minutes. Use the data to explain how the experiment supports the fluid mosaic model of membrane structure.

Mixing of fluorescent markers after 40 minutes

Temperature / °C	Cells with markers completely mixed / %
4	5
15	20
25	55
37	95

6 UNIT 3 STYLE

[6 marks]

A student wants to investigate the effect of temperature on the permeability of the membranes of beetroot cells. Describe how the student could carry out this investigation, including how to control variables, how the results would be measured and one safety precaution.

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7 UNIT 1 STYLE

[4 marks]

Cylinders of potato were left in sucrose solutions of different concentrations for 24 hours. The percentage change in mass of the cylinders was calculated. Determine the sucrose concentration at which there would be no net movement of water into or out of the potato cells, and explain what happens to the cells at 0.8 mol dm⁻³.

Percentage change in mass of potato cylinders	
Sucrose concentration / mol dm ⁻³	Percentage change in mass
0.0	+14
0.2	+8
0.4	+1
0.6	-6
0.8	-12

Answer = ...

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Compare and contrast facilitated diffusion and active transport.

Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [1]

B B. Rate is inversely proportional to thickness, so doubling thickness halves the rate. A, C and D all increase the rate.

2. [3]

- rate = (area × concentration difference) ÷ thickness (1)
- first surface: $(80 \times 15) \div 0.4 = 3000$ (arbitrary units); second surface: $(40 \times 15) \div 0.4 = 1500$ (arbitrary units) (1)
- ratio 2 : 1 / first is twice as fast (1)
- Accept correct working shown for one mark if the values are not worked out. Ignore units.

3. [4]

- many alveoli / alveoli are small sacs, giving a large surface area (to volume ratio) (1)
- wall of alveolus and capillary wall are one cell thick / thin / flattened cells, so a short diffusion distance (1)
- dense network of capillaries / rich blood supply, so oxygen is removed and a steep concentration gradient is maintained (1)
- ventilation brings in fresh air / removes carbon dioxide, maintaining concentration gradients (1)
- elastic fibres allow recoil to expel air (1)
- Max 4

4. [1]

B B. Cholesterol sits between the phospholipid tails and regulates fluidity. It is a lipid, not a protein or a carbohydrate, and it does not form channels.

5. [4]

- markers mixed in most cells at 37 °C / mixing increases with temperature (e.g. 5 % at 4 °C to 95 % at 37 °C) (1)
- so proteins (of both cells) can move within the membrane / are not fixed in position (1)
- supports the fluid part of the model: the membrane is not rigid / the phospholipids can move, allowing proteins to move sideways (1)
- proteins are scattered within the bilayer, not in a continuous layer, so they are free to mix (supports mosaic) (1)
- less mixing at low temperature as phospholipids have less kinetic energy / membrane less fluid (1)
- Max 4

6. [6]

- cut beetroot cylinders of the same diameter and length / same surface area, and rinse them to remove pigment from damaged cells (1)
- put the same volume of distilled water in each tube, and use a range of temperatures (water baths) such as 10 to 70 °C (1)
- leave the same time in each (e.g. 10 minutes) / same mass of beetroot (1)
- measure the colour of the liquid with a colorimeter (blue-green filter), zeroed using distilled water / compare with colour standards (1)
- repeat at each temperature and calculate a mean (1)
- control: a tube at room temperature / identical tube without heating (1)
- safety: use a thermostatic water bath / take care with hot water / wear eye protection / use tile when cutting (1)
- Max 6

7. [4]

- where line / values cross zero change in mass, between 0.4 and 0.6 mol dm⁻³ (1)
- 0.43 mol dm⁻³ (accept 0.41 to 0.46) (1)
- at 0.8 mol dm⁻³ the solution has a lower water potential than the cells, so water leaves the cells by osmosis (1)
- through a partially permeable membrane, down the water potential gradient, so the cells lose mass / the cells become flaccid / plasmolysed (1)

8. [4]

- similarity: both involve (specific) transport proteins / carrier proteins (1)
- similarity: both move substances across a membrane (1)
- difference: facilitated diffusion is down a concentration gradient, active transport is against a gradient (1)
- difference: active transport uses ATP / energy, facilitated diffusion does not (1)
- difference: facilitated diffusion can use channel proteins, active transport uses only carrier proteins (1)
- Max 4