1.11 Transport in and out of Cells: 30-minute Pack

AQA 8464 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

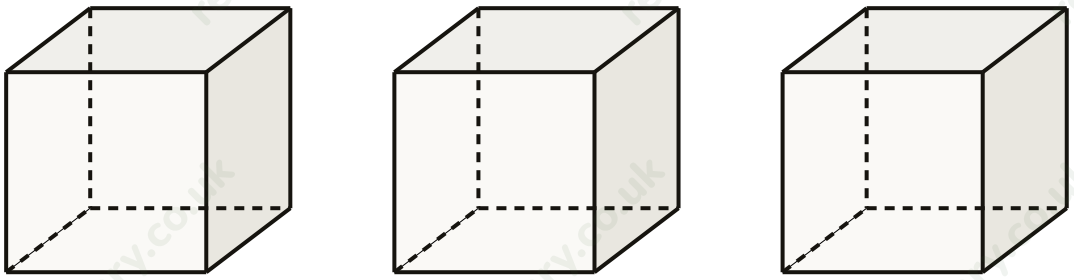
Answer ALL questions. Show all your working.

1 A teacher gives three groups of students agar cubes of different sizes, each containing sodium hydroxide and phenolphthalein indicator (pink in alkaline conditions, colourless in acidic conditions). Each cube is placed into hydrochloric acid, and the time taken for the pink colour to disappear completely from the cube is recorded.

Cube side length (mm)	Surface area (mm^2)	Volume (mm^3)	Surface area to volume ratio	Time for colour to disappear (s)
10	600	1000	0.6:1	240
20	2400	8000	0.3:1	580
30	5400	27000	0.2:1	1020

Explain the relationship between surface area to volume ratio and the time taken for the pink colour to disappear, using data from the table.

Diagram NOT accurately drawn



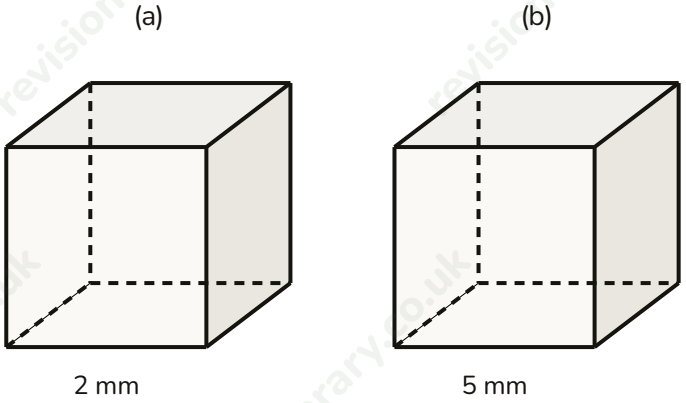
10 mm 20 mm 30 mm

(Total for Question 1 is 6 marks)

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2 A biologist models cells as cubes to compare their surface area to volume (SA:V) ratio.

Diagram NOT accurately drawn



(a) A cube-shaped cell has sides of length 2 mm. Calculate its surface area, volume, and SA:V ratio. Give your ratio in the form n:1. **(3)**

(b) A second cube-shaped cell has sides of length 5 mm. Calculate its SA:V ratio, in the form n:1. **(3)**

(c) Use your answers to (a) and (b) to explain why smaller cells are more efficient at exchanging substances, such as oxygen, with their environment. **(2)**

(Total for Question 2 is 8 marks)

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3 A plant biologist investigates the uptake of nitrate ions by active transport in root hair cells at different temperatures, up to the plant's optimum temperature.

(a) Predict what would happen to the rate of active transport of nitrate ions if the temperature increased from 20°C to 30°C. **(1)**

(b) Explain your prediction from part (a) in terms of respiration. **(3)**

(Total for Question 3 is 4 marks)

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4 The small intestine is adapted for the efficient diffusion of digested food molecules into the blood.

(a) Name two adaptations of the small intestine that increase the rate of diffusion of digested food into the blood. **(2)**

(b) Using ideas about surface area, concentration gradient or diffusion distance, as appropriate, explain how each adaptation you named in part (a) increases the rate of diffusion. **(2)**

(Total for Question 4 is 4 marks)

5 Osmosis is a special case of diffusion.

(a) Define osmosis. **(3)**

(b) State one similarity and one difference between osmosis and diffusion. **(2)**

(Total for Question 5 is 5 marks)

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Mark scheme · 1.11 Transport in and out of Cells: 30-minute Pack

Question 1

Level 1 Simple, isolated statements about surface area to volume ratio or diffusion, with little or no reference to the data provided. Limited linkage between ideas. **1-2**

Level 2 Some clear links are made between surface area to volume ratio, diffusion distance and time taken, with reference to some of the data in the table. **3-4**

Level 3 A detailed, logically structured explanation linking surface area to volume ratio, diffusion distance and time taken, supported throughout by correct use of the data provided. **5-6**

Indicative content:

- As cube side length increases, volume increases faster than surface area (volume is cubed, surface area is squared), so the surface area to volume ratio decreases (from 0.6:1 to 0.2:1 as side length increases from 10 mm to 30 mm)
- Acid must diffuse from the surface to the centre of the cube; larger cubes have a greater distance for the acid to diffuse relative to their surface area
- Smaller cubes have a larger surface area to volume ratio, so acid can diffuse in relatively faster per unit volume, reaching the centre (and turning the whole cube colourless) more quickly
- This explains why the time taken increases from 240 s for the 10 mm cube to 1020 s for the 30 mm cube as the surface area to volume ratio falls
- Correct use of data, e.g. the 30 mm cube has a surface area to volume ratio 3 times smaller than the 10 mm cube, but takes over 4 times as long for the colour to disappear
- Rate of diffusion depends on surface area, concentration gradient and diffusion distance; a smaller surface area to volume ratio means the surface area is not large enough, relative to the volume needing supply, for diffusion to keep pace

Question 2

(a) surface area = 6 x 2^2 = 24 mm^2, oe **M1**

(a) volume = 2^3 = 8 mm^3, oe **M1**

(a) ratio = 3:1 cao (ft from their surface area and volume) **A1**

(a) Answer: Surface area = 24 mm^2, volume = 8 mm^3, SA:V ratio = 3:1.

(b) surface area = 6 x 5^2 = 150 mm^2, oe **M1**

(b) volume = 5^3 = 125 mm^3, oe **M1**

(b) ratio = 1.2:1 cao (oe e.g. 6:5, ft from their surface area and volume) **A1**

(b) Answer: Surface area = 150 mm^2, volume = 125 mm^3, SA:V ratio = 1.2:1.

(c) the smaller cell has a larger SA:V ratio (3:1 compared with 1.2:1 for the larger cell), ft from (a) and (b), oe **B1**

(c) so a greater surface area is available for diffusion/exchange per unit of volume, meaning substances can diffuse into/out of the cell more quickly relative to its needs, oe **B1**

(c) Answer: The smaller cell has a larger SA:V ratio (3:1 vs 1.2:1), meaning it has more surface area available for exchange relative to its volume, so substances can diffuse in and out more quickly relative to its needs.

Question 3

(a) the rate of active transport would increase **B1**

(a) Answer: The rate of active transport would increase.

(b) a higher temperature increases the rate of (aerobic) respiration, up to the optimum, oe **B1**

(b) more energy is released/becomes available per unit time, oe **B1**

(b) so more energy is available to actively transport nitrate ions against the concentration gradient, increasing the rate of active transport, oe **B1**

(b) Answer: A higher temperature increases the rate of respiration, releasing more energy per unit time. This extra energy allows nitrate ions to be actively transported against the concentration gradient more quickly.

Question 4

(a) any one valid adaptation, including: villi (and microvilli) providing a large surface area; a single layer of thin epithelial cells; a good/rich blood supply, oe (naming the adaptation is sufficient) **B1**

(a) any second, different valid adaptation from the list above, or another correct adaptation, oe **B1**

(a) Answer: Villi (and microvilli), which increase the surface area, and a good blood supply, which maintains a steep concentration gradient.

(b) any one valid explanation matching an adaptation named in (a), including: a larger surface area (from villi/microvilli) means more molecules can diffuse across per unit time; a good blood supply removes absorbed molecules quickly, maintaining a steep concentration gradient, which keeps the rate of diffusion high; a single layer of thin epithelial cells gives a short diffusion distance, so molecules cross the exchange surface more quickly, ft from (a), oe **B1**

(b) any second, different valid explanation from the list above, or another correct explanation, matching a different adaptation named in (a), ft from (a), oe **B1**

(b) Answer: The large surface area of the villi means more molecules can diffuse across at once. A good blood supply removes absorbed molecules quickly, maintaining a steep concentration gradient and keeping the rate of diffusion high. If thin epithelium was named in (a), a single layer of thin epithelial cells gives a short diffusion distance, so molecules cross the exchange surface more quickly.

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Question 5

(a) the diffusion of water (molecules), oe (cso: 'osmosis' is the term being defined and must not be confused with 'diffusion' alone) **B1**

(a) from a dilute solution to a concentrated solution (from a region of higher water concentration to a region of lower water concentration), oe **B1**

(a) through a partially permeable membrane **B1**

(a) Answer: Osmosis is the diffusion of water molecules from a dilute solution to a concentrated solution, through a partially permeable membrane.

(b) similarity: any one of: both involve net movement of particles down a concentration gradient (from high to low concentration); both are passive processes and do not require energy, oe **B1**

(b) difference: any one of: osmosis only involves the movement of water, while diffusion can involve any particle/solute; osmosis requires a partially permeable membrane, diffusion does not, oe **B1**

(b) Answer: Similarity: both are passive processes involving net movement down a concentration gradient. Difference: osmosis only involves water molecules, whereas diffusion can involve any type of particle.

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