1.3 Organisms Exchange Substances with their Environment: 30-minute Pack

AQA 7402 · Calculator allowed · about 30 minutes

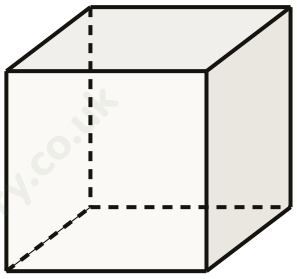
Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A student investigated the rate of diffusion using agar cubes containing phenolphthalein indicator, which is pink in alkaline conditions. A cube of side length 2 cm was placed in a beaker of dilute hydrochloric acid. Acid diffuses in from all six faces, and the agar loses its pink colour as it is neutralised. The cube took 320 seconds to become completely colourless throughout.

Diagram NOT accurately drawn



2 cm

(a) Define the term diffusion. **(1)**

(b) Calculate the mean rate of diffusion of the acid into the cube, in mm per second. Show your working. **(3)**

(c) State three factors, other than distance, that affect the rate of diffusion across a surface. **(3)**

(d) The agar cube models diffusion into a living cell. Suggest one limitation of using an agar cube as a model for diffusion into a real cell. **(2)**

(Total for Question 1 is 9 marks)

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2 Blood vessels are structurally adapted to their function.

(a) Name the blood vessel best matching each description. (i) Thick wall containing a relatively large amount of smooth muscle and elastic tissue; carries blood at high pressure away from the heart. (ii) Contains valves at intervals to prevent the backflow of blood; wide lumen and relatively thin wall; carries blood at low pressure back to the heart. (iii) Wall only one cell (endothelium) thick; narrow lumen, often only just wide enough for red blood cells to pass through in single file. **(3)**

(b) Explain why arteries have walls containing a thick layer of smooth muscle and elastic fibres. **(3)**

(c) Explain why the wall of a capillary is only one cell thick. **(2)**

(d) State one feature of capillaries, other than the thickness of their wall, that adapts them for efficient exchange of substances with tissue cells. **(1)**

(Total for Question 2 is 9 marks)

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3 This question tests key facts about mass transport and gas exchange systems. For each part, identify the correct option.

(a) In the countercurrent system of a fish gill, which statement correctly describes the relative direction of blood flow and water flow? **(1)**

- ☐ A) Blood and water flow in the same direction
- ☐ B) Blood and water flow in opposite directions
- ☐ C) Blood flows only within the gill filament while water is stationary
- ☐ D) Water flows only over alternate lamellae

(b) Which vessel carries oxygenated blood away from the heart to the body? **(1)**

- ☐ A) Pulmonary artery
- ☐ B) Pulmonary vein
- ☐ C) Vena cava
- ☐ D) Aorta

(c) Which structure prevents backflow of blood from the ventricles into the atria during ventricular systole? **(1)**

- ☐ A) Semilunar valves
- ☐ B) Atrioventricular valves
- ☐ C) The septum
- ☐ D) The sinoatrial node

(d) In the tracheal system of an insect, which structure allows gas exchange directly with individual cells without the involvement of a blood transport system? **(1)**

- ☐ A) Spiracles
- ☐ B) Tracheae
- ☐ C) Tracheoles
- ☐ D) Haemolymph

(Total for Question 3 is 4 marks)

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Mark scheme · 1.3 Organisms Exchange Substances with their Environment: 30-minute Pack

Question 1

(a) the net movement of particles (molecules or ions) from a region of higher concentration to a region of lower concentration, down a concentration gradient, resulting from the random motion of particles oe **B1**

(a) Answer: Net movement of particles from high to low concentration (down a concentration gradient) due to random motion.

(b) acid diffuses inward from all 6 faces, so the greatest distance travelled to the centre of the cube = half the side length = 10 mm oe **M1**

(b) rate = distance / time = 10 / 320 **M1**

(b) = 0.031 mm/s (2 s.f.) awrt 0.031 **A1**

(b) Answer: 0.031 mm/s (2 s.f.).

(c) temperature (higher temperature increases rate, as particles have more kinetic energy) **B1**

(c) concentration gradient/difference in concentration (a steeper gradient increases rate) **B1**

(c) surface area (a larger surface area increases rate); do not accept membrane/barrier thickness, as this is diffusion distance **B1**

(c) Answer: Temperature, concentration gradient and surface area.

(d) agar has a uniform composition throughout with no cell membrane/selectively permeable barrier, whereas a real cell membrane controls what enters the cell (e.g. via channel/carrier proteins) oe **M1**

(d) so the agar model cannot show the effect of active transport, facilitated diffusion, or membrane selectivity on the movement of substances into a real cell oe **A1**

(d) Answer: Agar has no selectively permeable membrane, so it cannot model membrane-controlled processes such as facilitated diffusion or active transport.

Question 2

(a) (i) artery **B1**

(a) (ii) vein **B1**

(a) (iii) capillary **B1**

(a) Answer: (i) artery (ii) vein (iii) capillary.

(b) arteries carry blood at high pressure, produced by the pumping (contraction) of the ventricles oe **M1**

(b) elastic fibres allow the artery wall to stretch and then recoil as the pressure pulse from each heartbeat passes, helping to maintain/even out the high pressure between heartbeats oe **M1**

(b) smooth muscle allows the diameter of the artery to be adjusted (constrict/dilate) to help control blood flow/pressure to different organs oe **A1**

(b) Answer: Elastic fibres stretch and recoil to maintain high pressure between heartbeats; smooth muscle allows the vessel diameter to be regulated.

(c) a capillary wall consisting of a single layer of flattened endothelial cells provides the shortest possible diffusion pathway/distance oe **M1**

(c) allowing substances (e.g. oxygen, glucose, carbon dioxide, waste products) to diffuse rapidly/efficiently between the blood and surrounding tissue cells oe **A1**

(c) Answer: A one-cell-thick wall gives the shortest diffusion distance, allowing rapid exchange of substances between blood and tissues.

(d) a very narrow lumen/diameter, so red blood cells are squeezed close against the capillary wall, reducing the diffusion distance to tissue cells oe (allow: a large branching network/large total surface area; allow: small gaps/pores between cells allowing plasma to leak out) **B1**

(d) Answer: Narrow lumen, so red blood cells pass close to the wall, reducing diffusion distance (or another valid feature such as a large branching network).

Question 3

(a) B **B1**

(a) Answer: B

(b) D **B1**

(b) Answer: D

(c) B **B1**

(c) Answer: B

(d) C **B1**

(d) Answer: C

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