



ANSWER BOOK

Surface area to volume ratio: why size limits diffusion

Exchange surfaces and gas exchange · Unit B07

AQA 3.3.1 · OCR A 3.1.1 · CAIE 8.1, 9.1

5 questions · 16 marks

NAVY EDITION

SECTION A · Short, 1 to 2 marks

- A1** **B1** rate of diffusion is proportional to the surface area multiplied by the difference in concentration. **B1** and inversely proportional to the thickness of the surface, so a thinner barrier gives a faster rate. [2]
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SECTION B · Standard, 3 to 5 marks

- B1** **M1** ratio is surface area divided by volume, which for a cube simplifies to 6 divided by the length of a side. **A1** smaller organism: $6 \div 0.5 = 12 \text{ mm}^{-1}$, with the unit given as one over length. **M1** larger organism: $6 \div 2.0$, worked in the same length unit as the first. **A1** larger organism gives 3 mm^{-1} , so the smaller ratio is four times greater. [4]
- B2** **B1** surface area rises with the square of length while volume rises with the cube, so the surface area to volume ratio falls as an organism gets thicker. **B1** demand for oxygen goes with the volume of respiring tissue, so each unit of surface has more tissue to supply in the larger body. **B1** diffusion time rises with the square of the distance, so ten times further takes about a hundred times as long. **A1** over a centimetre diffusion would take hours and could never meet demand, whereas the flatworm's flattened shape keeps every cell a fraction of a millimetre from the outside. [4]
- B3** **B1** the sheet's ratio is about 3.7 times the sphere's, even though the two contain the same volume of material. **B1** the sheet therefore has far more surface serving each unit of volume, while the sphere is the shape with the least surface possible for a given volume. **B1** the centre of the sphere is also much further from the nearest surface than any point in the sheet, so the diffusion distance is longer in the sphere as well. [3]
- B4** **B1** curling brings the body closer to a sphere, which is the shape with the smallest surface area for a given volume. **B1** the surface area to volume ratio is therefore lowered without any change in the volume of the animal. **A1** heat is lost across the body surface, so less surface per unit of body volume means a slower rate of heat loss. [3]
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