

Exercise walk-through

Cell Size ■ 2.2

eXercise

You must be able to

- calculate a **surface-area-to-volume ratio** 表面积体积比
- explain why a high ratio helps exchange
- link small size (or folded shapes) to efficient transport

Method — Surface area vs volume

As a cell grows, its **volume** (needs) grows faster than its **surface area** (exchange). So a large cell cannot exchange materials fast enough across its membrane.

Method — The ratio

A **high surface-area-to-volume ratio** means lots of membrane per unit of contents — good for fast exchange of nutrients, gases, and waste. Small cells have high ratios.

Method — A worked ratio

A cube of side 2: surface area = $6(2^2) = 24$; volume = $2^3 = 8$; ratio = $24/8 = 3$. A cube of side 4: SA = 96, V = 64, ratio = 1.5 — lower. Bigger = lower ratio.

Method — Solutions to size limits

Cells stay **small**, or increase surface area by **folding** the membrane (like microvilli), to keep exchange efficient.

Practice 2.1 ■ 1 mark

As a cell gets bigger, which grows faster: surface area or volume?

Solution 2.1

Method: Surface area vs volume

Worked steps

Volume **B1**.

Practice 2.2 ■ 3 marks

For a cube of side 3, find the surface-area-to-volume ratio.

Solution 2.2

Method: A worked ratio

Worked steps

$$SA = 6(3^2) = 54; V = 3^3 = 27; \text{ratio} = 54/27 = 2 \quad \text{M1} \quad \text{M1} \quad \text{A1}.$$

Practice 2.3 ■ 1 mark

Why is a high surface-area-to-volume ratio helpful?

Solution 2.3

Method: The ratio

Worked steps

It provides more membrane per unit volume for faster exchange of materials **B1**.

Exam-style 3.1 ■ 1 mark

A small cell exchanges materials more efficiently because it has a

A lower surface-area-to-volume ratio

B higher surface-area-to-volume ratio

C larger volume

D thicker membrane

Solution 3.1

Method: Surface area vs volume

- A lower surface-area-to-volume ratio
- B higher surface-area-to-volume ratio**
- C larger volume
- D thicker membrane



Worked steps

B — a higher surface-area-to-volume ratio.

Exam-style 3.2 ■ 3 marks

Two cube-shaped cells have sides 2 and 5.

- (a) Find the surface-area-to-volume ratio of each.
- (b) State which exchanges materials more efficiently.

Solution 3.2

Worked steps

(a) Side 2: $SA = 24$, $V = 8$, ratio = 3; side 5: $SA = 150$, $V = 125$, ratio = 1.2
M1 **M1** **A1**. (b) The smaller cell (side 2), with the higher ratio **B1**.

Exam-style 3.3 ■ 2 marks

Explain how microvilli (tiny membrane folds) help a cell overcome the size limit on exchange.

Solution 3.3

Method: Solutions to size limits

Worked steps

Folds greatly increase the membrane surface area without adding much volume, raising the surface-area-to-volume ratio and speeding exchange **M1** **A1**.