

# 2.2 Why Cells Stay Small

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Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

Total: 12 marks

## Objective

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Build the skills to answer exam questions on **why cells stay small** —the surface-area-to-volume ratio.

### 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

## 1 Worked examples

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Study these first. Each one shows the method for a question type used later —follow the steps and you can do the Practice and Exam-style questions yourself.

### ■ 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.

### ■ 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.

### ■ 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.

### ■ Solutions to size limits

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

## 2 Practice

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Now apply the methods above.

**2.1** As a cell gets bigger, which grows faster: surface area or volume? [1]

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

**2.3** Why is a high surface-area-to-volume ratio helpful? [1]

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### 3 Exam-style questions

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**3.1** A small cell exchanges materials more efficiently because it has a [1]

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

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**3.2** Two cube-shaped cells have sides 2 and 5.

(a) Find the surface-area-to-volume ratio of each. [3]

(b) State which exchanges materials more efficiently. [1]

**3.3** Explain how microvilli (tiny membrane folds) help a cell overcome the size limit on exchange. [2]

### 4 Go further

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You are now ready for the real exam questions on this subtopic:

- work through the **2.2 Why Cells Stay Small** lesson on the **Learn** page;
- read the **Why Cells Stay Small** section of the AP Biology handout on the **Know** page.

## Solutions

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**2.1** Volume.

**2.2**  $SA = 6(3^2) = 54$ ;  $V = 3^3 = 27$ ; ratio =  $54/27 = 2$ .

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

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

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

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