AP BIOLOGY • EXERCISE SHEET

2.2 Why Cells Stay Small

Name: _____ Class: _____ Date: _____ **Total: 12 marks**

KEY WORDS surface-area-to-volume ratio 表面积体积比

Objective

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

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

Now apply the methods above.

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

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]

3 Exam-style questions

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

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]

Solutions

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.