

Cell Size

Learning objective 2.2.A Explain the effect of surface area-to-volume ratios on the exchange of materials between cells or organisms and the environment.

Name:

Date:

Period:

Use the tool **The Surface Area Problem**. Work on the **Grow a cell** tab for Parts 1 to 4, then switch to **Apply it** for Part 5. The formulas you need are given in Part 1. Predicting: wherever a Part asks you to predict, write a specific number or word and one reason before you touch the tool, in the form “I think ... because ...”. A wrong prediction costs nothing; a prediction made after looking is not a prediction.

*switch tab**scroll down**work it on paper**record from the tool**score yourself*

The purple bar in the margin names the AP science practice a question uses.

Part 1 · Calculate before you slide



Use the **Grow a cell** tab. It is the one showing when the tool opens.



Keep the shape on **Cube** and the folding slider at **none**. Work these out on paper first using $SA = 6s^2$ and $V = s^3$, then move the size slider to check. Show your working for at least two rows.

Side length	Surface area	Volume	SA : V ratio
1			
2			
4			
6			
8			
10			

Part 2 · Name the pattern



Stay on the **Grow a cell** tab.

Use your completed table to answer these.

1. Describe what happens to the SA : V ratio as the cube gets bigger.

2. Going from a side length of 1 to a side length of 5, by what factor does the surface area increase? By what factor does the volume increase?

3. Explain why those two factors are different. Refer to squares and cubes in your answer.

4. Write down a shortcut formula for the SA : V ratio of a cube of side s , and show that it gives the same answer as your table for $s = 4$.

Part 3 · When supply cannot reach the middle



Stay on the **Grow a cell** tab and scroll down to **the Can supply reach the middle? readout**.



Watch the **Can supply reach the middle?** readout as you move the size slider from 1 up to 10.

5. At what size does the tool first report that the core is unsupplied?

6. The tool holds the supply depth constant and only changes the size of the cell. Explain why that makes it a fair test of the effect of size.

7. List four things a cell needs to do across its surface that get harder as the SA : V ratio falls.

Part 4 · Two ways out



Stay on the **Grow a cell** tab and scroll down to **the folding slider and the Shape matters too panel**.

First set the size to 6 and move the **Membrane folding** slider up. Then set folding back to none and use the **Shape matters too** panel.

Setting	Surface area	Volume	SA : V ratio
Cube, size 6, no folding			
Cube, size 6, moderate folding			
Cube, size 6, extreme folding			

8. State what folding does to the surface area, and what it does to the volume.

9. Using the equal-volume panel, list the four shapes in order from the least surface area to the most, and state which shape is therefore the worst at exchange.

10. Explain why comparing a sphere and a cube at the same size tells you nothing useful about which shape is better for exchange.

Part 5 · Scale it up to organisms



Stay on the **Grow a cell** tab and scroll down to **the It scales up to whole organisms panel at the bottom**.



Open **It scales up to whole organisms**. Answer these in complete sentences.

Grow a cell

Apply it



Then click the **Apply it** tab at the top of the tool and work the cards there.

11. Describe what happens to an animal's surface area-to-volume ratio as its body mass increases.

12. Predict which loses heat faster relative to its body mass, a shrew or an elephant, and justify your prediction using the ratio.

13. State the relationship between body size and metabolic rate per unit of body mass.

14. A student says a cell could grow to any size at all as long as it kept folding its membrane. Evaluate that claim.

Part 6 · Learning check self-report



Scroll down to the **Learning check** at the bottom of the tool. Type each answer in your own words, check it, and tick the points you earned. Then record your score here and, for every point you did not earn, write what the rubric asked for that your answer left out.

Question	Points possible	Points I earned	Missed opportunities (what the rubric wanted that I left out)
1	3		
2	2		
3	2		
4	2		
Total	9		

What the model simplifies

The cell is drawn as a two-dimensional cross-section, but every surface area and volume is calculated from the CED's real three-dimensional formulas, so the numbers are correct even though the picture is flat.

The shaded rim uses one fixed supply depth for every cell size, so that size is the only variable. Real diffusion depth depends on the substance, the concentration difference and how quickly the cell consumes it.

Membrane folding is modeled as a plain multiplier on surface area. Real folds have a shape and occupy some volume themselves.

In the tool the 'size' of a sphere is its diameter and the 'size' of a cylinder is its diameter, with the height set at twice that. The equal-volume panel is the comparison to use when shapes are being judged against each other.

Organism ratios treat each animal as a sphere of the same density. That is enough to show the direction of the relationship the CED asks for; it is not a body measurement.