

## INTRODUCTION

As a cell grows, it must take in more nutrients and get rid of more wastes. For a cell to survive, it must have enough surface area through which materials can pass. That is, every cell needs a large enough surface area for its volume. This is called a surface area/volume ratio, or SA/V ratio.

## Activity Overview

### In this activity we will

- examine surface area and volume of cells
- describe the relationship between surface area and volume of cells

**Approximate Total Time: 15 minutes**

## Science Objective

Math concepts are used to illustrate the limits on a cell's size. Students answer the question of why living things are made of many small cells rather than a few large cells.

## PROCEDURE

1

Turn on your calculator by pressing  $\text{ON}$ . Open the List Editor by pressing  $\text{STAT}$ ,  $\text{ENTER}$ .

2

Clear any existing data from the lists. Press  $\text{2nd}$ ,  $[\text{MEM}]$  and scroll down to highlight 4: CLR ALL LISTS. Press  $\text{ENTER}$ ,  $\text{ENTER}$ .

3

Press  $\text{STAT}$ ,  $\text{ENTER}$  to get to a data list. Enter the cell diameter data in list L1.

4

The formulas for volume and surface area of a sphere use radius, not diameter. To convert the values in the data table to radii, do the following: Use the arrow keys to highlight the L1 heading. Press  $\text{2nd}$ ,  $[\text{L1}]$ ,  $\text{÷}$ ,  $\text{2}$ ,  $\text{ENTER}$ .

$\text{L1}$	$\text{L2}$	$\text{L3}$	1
1	-----	-----	
2	-----	-----	
3	-----	-----	
4	-----	-----	
5	-----	-----	
6	-----	-----	
7	-----	-----	
8	-----	-----	
9	-----	-----	
10	-----	-----	
$\text{L1} = \text{L1} / 2$			

5

The formula for surface area of a sphere is given in the data table. Use it in the calculator to compute the surface area of each of the 10 spherical cells. First, highlight L2. Then enter the formula into the calculator by typing  $\text{4}$ ,  $\text{2nd}$ ,  $[\pi]$ ,  $\text{2nd}$ ,  $[\text{L1}]$ ,  $\text{^}$ ,  $\text{2}$ ,  $\text{ENTER}$ . Record the surface area values in your data table. Be sure to include units.

$\text{L1}$	$\text{L2}$	$\text{L3}$	2
.5	-----	-----	
1	-----	-----	
1.5	-----	-----	
2	-----	-----	
2.5	-----	-----	
3	-----	-----	
3.5	-----	-----	
$\text{L2} = 4\pi\text{L1}^2$			

6

Calculate the volume of each cell. Highlight L3. Type in the formula for volume of a sphere:  $\text{4}$ ,  $\text{÷}$ ,  $\text{3}$ ,  $\text{2nd}$ ,  $[\pi]$ ,  $\text{2nd}$ ,  $[\text{L1}]$ ,  $\text{^}$ ,  $\text{3}$ ,  $\text{ENTER}$ . Record the volume values in your data table. Be sure to include units.

$\text{L1}$	$\text{L2}$	$\text{L3}$	3
.5	3.1416	-----	
1	12.566	-----	
1.5	28.274	-----	
2	50.265	-----	
2.5	78.54	-----	
3	113.1	-----	
3.5	153.94	-----	
$\text{L3} = 4/3\pi\text{L1}^3$			

# Giant Cells

7

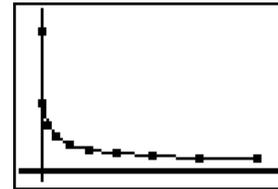
Find the surface area/volume ratio for each cell. Highlight L4. Enter the formula for the ratio of surface area to volume:  $\boxed{2\text{nd}}, \boxed{[L2]}, \boxed{\div}, \boxed{2\text{nd}}, \boxed{[L3]}, \boxed{\text{ENTER}}$ . Record the SA/V values in your data table.

L2	L3	L4	4
3.1416	5236	-----	
12.566	4.1888		
28.274	14.137		
50.265	33.51		
78.54	65.45		
113.1	113.1		
153.94	179.59		
L4=L2/L3			

8

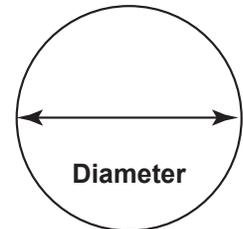
Make a graph comparing volume of each cell with the surface area/volume ratio.

- Press  $\boxed{\text{APPS}}$  and scroll to SCI TOOLS. Press  $\boxed{\text{ENTER}}$ ,  $\boxed{\text{ENTER}}$ . Highlight 3:DATA/GRAPHS WIZARD and press  $\boxed{\text{ENTER}}$ .
- Press  $\boxed{\text{WINDOW}}$  to select PLOT DATA. Press  $\boxed{\text{WINDOW}}$  to select a line graph. Highlight L3 and press  $\boxed{\text{ENTER}}$ . This is your independent variable. Highlight L4 and press  $\boxed{\text{ENTER}}$ . This is your dependent variable. Sketch your graph, and label the axes. Your graph should look similar to the one here.



## DATA TABLE

Cell Measurements			
Diameter (in mm)	Surface area (in _____)	Volume (in _____)	SA/V ratio
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			



Surface area of a sphere:  
 $4\pi r^2$

Volume of a sphere:  
 $\frac{4}{3}\pi r^3$

## DATA ANALYSIS

- What happens to volume as surface area increases?
- Do volume and surface area increase at the same rate?
- Describe the trend in your graph. What happens as volume increases?
- What do you think will happen if a cell's volume gets too big?
- Do you think cell size increases as the size of the organism increases (for example, do you think a whale has larger cells than a mouse)? Why or why not?
- Could a cell exist that was the size of an elephant? Explain your answer.
- Why are plants and animals made of many tiny cells rather than a few large ones?