Concept Laboratory

Cell Size and Surface Area-to-Volume Ratios

Goal

To gain an understanding of how a cell's surface area-to-volume ratio limits its size.

Scenario

Imagine you are a cell biologist. You want to show that, as a cell gets larger, some areas within the cell become too distant from the external environment for adequate rates of exchange of materials.

As you perform this experiment, think about how the surface area-to-volume ratio of a cell affects how rapidly it can exchange materials with its environment.

Materials

raw potatoes
paper cups
Food coloring
knife
tweezers
paper towels
beaker
millimeter ruler
calculator

Procedure *

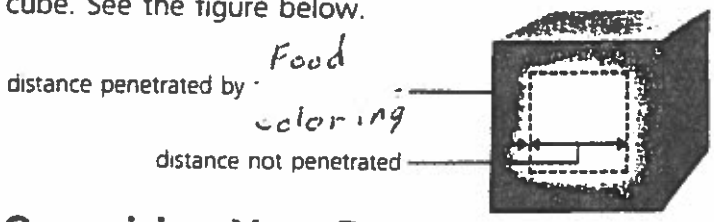
A. Using a knife, cut a slice about 5 cm thick from a potato. From the slice, cut 10 mm, 20 mm, and 40 mm cubes.

B. Place the cubes in a paper cup and cover them with Food coloring. Every 10 minutes for 90 minutes turn the cubes over with tweezers.

C. While the cubes are in solution, calculate the surface area (length × width × 6), volume (length × width × height), and surface area-to-volume ratio (surface area ÷ volume) for each cube. Record these numbers in a chart like the one below.

D. After 90 minutes, remove the cubes from the cup with tweezers and blot them dry on a paper towel. Pour the solution into a waste beaker.

E. Slice each cube in half. Measure and record the distance the coloring diffused into each cube. See the figure below.



Organizing Your Data

1. For each cube, calculate the volume that was not penetrated by the coloring. First, measure the distance not penetrated in each cube. Then, cube this number for the total, unpenetrated volume.

2. For each cube, calculate the percent of the total volume not penetrated: divide the unpenetrated volume by the total volume. Record these values.

Drawing Conclusions

1. What do the cubes of potato tissue represent? What does the coloring. represent?

2. How does the surface area-to-volume ratio and the percent of the total volume not penetrated vary as cube size increases?

3. How small must a potato cube be for the Food coloring to completely penetrate it in 90 minutes?

Thinking Further

1. What would happen to a single-celled organism the size and shape of a 40 mm cube? Explain.

2. Suppose the organism in question 1 were made up of 64 000 cube-shaped cells, each 1 mm on a side. Why would this organism need a circulatory system?

3. Based on your results, explain why you think nearly all cells are smaller than 1 mm on a side.

Side of Cube (mm)	Surface Area (mm^2)	Volume (mm^3)	Surface Area-to-Volume	Distance Penetrated (mm)	Distance not Penetrated (mm)	Vol. not Penetrated (mm^3)	% total vol. Not Penetrated
10	600	1000	0.6	2	6	216	21.6

*For detailed information on safety symbols, see Appendix B

Name:_____
Class_____

Biology 2201 Cell size and surface to area volume ratios.

Goal /Purpose

Observations:

Side of Cube mm	Surface Area mm^2	Volume mm^3	Surface area to volume	Distance Penetrate mm	Distance not penetrate mm	Volume not penetrate mm^3	% total Vol Not penetrate
10 mm							
20 mm							
40 mm							

Answer to Questions Drawing Conclusions

1_____

2_____

3_____

Thinking Further Questions

1._____

2._____

3_____