Sodek

Cell Size: Surface Area to Volume Ratio

Introduction:

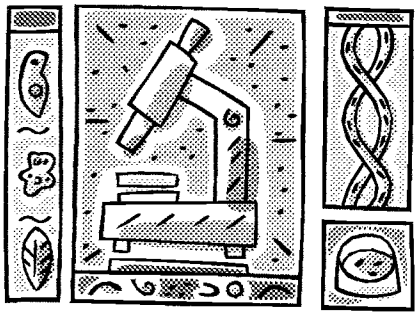
All organisms are composed of cells. The size and shape of a cell determines how well it can deliver nutrients to its interior. Since all cells and organisms depend upon the efficient delivery of gases, nutrients, and other important molecules, the relationship between a cell's surface area and its volume is an important regulating concept.

Purpose:

This demonstration illustrates why cells stop growing when they reach a certain size, why virtually all cells are about the same size, and finally, how the ratio of surface area to volume affects the way organisms have adapted to their environments!

Materials & Methods:

Plastic spoon
Potato
Beaker
Food color
Paper towel(s)
Plastic knife
Metric ruler



Remember safe laboratory techniques and to keep the lab area as neat and clean as possible. Use the metric ruler to cut 3 cubes from the potato: a 1 cm cube, a 2 cm cube and a 3 cm cube. Fill a beaker with enough water so that it will generously submerge the potato cubes. Add a few drops of food coloring. Using the spoon, gently submerge the potato cubes into the colored water. Allow the blocks to remain in the solution undisturbed for 10 minutes. After 10 minutes, remove the blocks with the plastic spoon. Place them on the paper towel and blot them dry. Cut each block in half with the knife. Using the metric ruler, measure the distance in millimeters that the food color has diffused into each block. Then measure the distance from the end of the food color to the center of the cube. Record these measurements in the data table. Please note the helpful information below:

- **Surface area of a cube= length x width x number of sides**
- **Volume of a cube = length x width x height**
- **Ratio of surface area to volume = surface area/volume**

Example: *A cube 5 cm on each side*
Surface Area = 5 cm x 5 cm x 6 = 150cm^2
Volume = 5 cm x 5 cm x 5 cm = 125cm^3
Ratio = 150 / 125 = ***1.2 : 1***

Results:

Data Table 1

Cube Size	Surface Area (cm^2)	Volume (cm^3)	Surface Area to Volume Ratio
3 cm			
2cm			
1cm			

Data Table 2:

Cube Size	Distance food coloring has diffused into block (mm)	Distance from end of food coloring to block's center (mm)
3 cm		
2 cm		
1 cm		

1. Compare your calculations of surface area and volume. Discuss the changes in the surface area to volume ratio as the potato blocks get larger.
2. How does the ratio of surface area to volume explain the efficiency of cells?
3. Using what you observed, explain why cells stop growing when they reach a certain size and why all cells are about the same size?
4. What prediction can you make about the efficiency of a very small cell in: getting oxygen, getting rid of wastes, keeping water in a dry environment, keeping heat in a cold environment?
5. What prediction can you make about the efficiency of a very large cell in: getting oxygen, getting rid of wastes, keeping water in a dry environment, keeping heat in a cold environment?

Conclusions:

6. Compare the appearance of a rabbit that lives in a desert and a rabbit that lives in the arctic. Explain their appearances using the ratio of surface area to volume.
7. What are some modifications that animals have evolved to increase their surface area for food absorption, exchange of gases, or getting rid of wastes?
8. Compare the ear shape and size of an African and Indian elephant. What advantages does each have to the respective animal?
9. In many science fiction movies and books, a misguided scientist is determined to use a device to enlarge an organism to gigantic proportions. Use what you know about the surface area to volume ratio to explain the biological impossibility of such a scenario.