Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Period: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Surface Area to Volume Ratio in Cells**

**Introduction:** Living cells bring in food, water, and oxygen, and excrete wastes through the process of diffusion. Diffusion is the movement of molecules across a membrane from an area of higher concentration to an area of lower concentration. In this way, digested food molecules are absorbed into villi in the small intestine, and oxygen moves into and carbon dioxide out of lung cells.

Cells depend upon diffusion. They must have an adequate surface area to allow needed molecules in and unwanted molecules out fast enough to maintain homeostasis. A single cell which grows too large will not be able to take in sufficient food and oxygen or eliminate waste molecules fast enough. For this reason, large organisms have to be composed of many small cells.

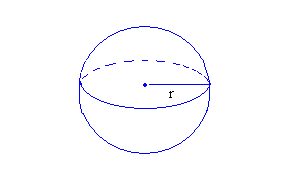
**Questions:**

1. What is diffusion?
2. How is diffusion used by cells?
3. List two systems in animals that are dependent on diffusion.
4. Why can’t a single cell grow very large?
5. Why must large organisms be multicellular?

Finding Volume and Surface Area

Three dimensional objects will have a volume and surface area. Volume is measured in cubic units (cm³) while surface area is measured in square units (cm²).

Sphere: Formula for volume = 4/3 π r³ Formula for surface area = 4 π r²



Radius = 2cm

Volume = 4/3 (3.14) (8) Surface Area = 4 (3.14) (4)

Volume = 33.5 cm³ Surface Area = 50.2 cm²

Calculating Surface Area to Volume Ratios

A ratio is how two numbers are related, and it is used to compare numbers to each other. To find the surface area to volume ratio, make the surface are the numerator and the volume the denominator. Divide the numbers.

|  |
| --- |
| Example 1 Example 2  Surface Area/Volume = 76/40 = 1.9 Surface Area/Volume = 50.2/33.5 = 1.5  (Units are not used to calculate the ratio.) |

1. Which of these two cells – Example 1 or Example 2 – Would have more diffusion? Why?
2. Does a cell need a high or low surface area to volume ratio? Why?

**Practice Problems:**

Calculate the surface area to volume ratios for these two rectangular solids:

1. Radius = 4cm
2. Diameter = 1.5mm
3. Rank the order of the SA/V to volume ratios for questions 8 & 9. Which cell is the most efficient? Which is the least efficient?

**Hypothesis:** Predict what will happen to the surface are to volume ratio as the baggie (cell) is filled with more and more water. Write your hypothesis below

**Laboratory – Surface Area/Volume Ratio in a Growing “Cell”**

Materials: plastic baggie (cell), string, ruler, 100mL graduated cylinder, water, and a calculator.

**Procedure:**

1. Fill the corner of a baggie with 100mL of water, and seal it. Hold the baggie so that one corner holds the water.
2. Measure the circumference in cm at the widest point with a string and record in your data table.
3. Fill the baggie with another 100mL of water (total = 200mL), and measure the circumference in cm.
4. Repeat step 3 for 300mL and 400mL.
5. Calculate the surface area for each “cell” using the formulas for a sphere.
6. Calculate the SA/V ratio for each cell and record.

**Data Table**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Volume (mL) | Circumference (cm) | Radius (C/π)/2 | Surface Area (4 π r²) | SA/V Ratio |
| 100 |  |  |  |  |
| 200 |  |  |  |  |
| 300 |  |  |  |  |
| 400 |  |  |  |  |

**Post Lab Analysis**

1. Which “cell” would have the most efficient diffusion? Why?
2. On a piece of graph paper - graph the volume on the X axis and the SA/V ratio on the Y axis.
3. What happens to the SA/V ratio as the cell’s volume grows larger?
4. Using the information from the graph, explain why cells are small.

Staple your graph to this lab!