MODELING LIMITS TO CELL SIZE

Name_________________________________________Date________________Section_______

Abstract
Why can't cells continue to grow larger and larger to become giant cells, like a blob? Why are most cells, whether from an elephant or an earthworm, microscopic in size? What happens when a cell grows larger and what causes it to divide into two smaller cells rather than growing infinitely larger? This investigation provides you with an opportunity to discover the answers to these questions.

Making Model Cells
Working with another student, cut out, fold, and glue the copies of the Cubic Cell Models that have been duplicated on heavy, colored paper.

Using the Models
The models represent one cube-shaped cell at increasing stages of growth. The smallest stage represented is 1 Unit long on a side; the largest stage is 4 Units on a side.

Using the materials available to you in the classroom quantify the physical qualities of the cell at each of the four stages of its growth. The following questions might help guide your thinking.

Comparing Cell Sizes

1. Give the formula for computing the following data about the cell models when the length of one side equals "s":

   Area of one face of a cell: ______________________________
   Total surface area of a cell: ____________________________
   Volume of a cell: ________________________________
   Distance from the center of cell to center of each wall: __________________

2. Compute the data above for each cell. The smallest cell has \( s = 1 \) unit, and the largest cell has \( s = 4 \) units. Enter you findings in the blank data table provided (Table 1).

3. Using a scale, find the weight of each sand-filled cell in grams. Enter your findings in the blank data table provided (Table 1).

4. Compute the Surface Area to Volume Ratio and Surface Area to Weight Ratio for each cell. Enter your findings in the blank data table provided (Table 2).

5. Anything that the cell takes in, like oxygen and food, or lets out, such as carbon dioxide, must go through the cell membrane. Which measurement of the cells you quantified best represents how much cell membrane the models have?
6. The cell contents, nucleus and cytoplasm, use the oxygen and food while producing the waste. Which two measurements you quantified best represent the cell content?

7. As the cell grows larger and gets more cell content, will it need more or less cell membrane to survive?

8. As the cell grows larger, does the Total Surface Area -to- Volume Ratio get larger, smaller, or remain the same?

9. As the cell grows larger, what happens to the Total Surface Area -to- Weight Ratio?

10. Why can't cells survive when the Total Surface Area -to- Volume ratio becomes too small?

11. Which size cell has the greatest Total Surface Area -to- Volume Ratio?

12. Which size cell has the greatest chance of survival?

13. What can cells do to increase their Total Surface Area -to- Volume Ratio?

14. How many s = 1 unit cells would fit into an s = 3 unit cell?

15. Which has more Total Surface Area, one s = 3 cell or 27 s = 1 cells?

Table 1. Measurements of Cube Cell Models

<table>
<thead>
<tr>
<th>Cell Size s Units</th>
<th>Area of One Face</th>
<th>Total Surface Area</th>
<th>Volume of Cube Cell</th>
<th>Distance from Center to Edge</th>
<th>Weight of Cell Filled W/ sand</th>
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Table 2. Ratios of Cube Cell Models

<table>
<thead>
<tr>
<th>Cell Size Units</th>
<th>Total Surface Area -to- Volume Ratio</th>
<th>Total Surface area -to- weight ratio</th>
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