Why Cells Don’t Grow Indefinitely?

Many cells grow until they reach a certain size and then divide. Why don’t cells grow indefinitely until they become the size of basketballs? What problems arise when a cell grows larger? Why does a cell divide into two smaller cells when it reaches a certain size? These are all questions that scientists have attempted to resolve.

Cell division is a necessary part of the life of any multicellular organism and allows for growth, repair, and formation of cells for reproduction. Growth of an organism occurs mainly by an increase in the number of cells rather than by the enlargement of individual cells. This process seems to be controlled by simple physical laws.

**Background Information:**

**Surface Area:**

**Volume:**

**Mass:**

**Objectives:**

- Determine the relationship between surface area and volume of a model cell.
- Determine the relationship between surface area and mass of a model cell.
- Apply these mathematical relationships to living cells.

**Materials:** photocopy of 3 cell models, glue, sand, scissors, balance

**Hypothesis:** As the cell grows larger, the surface area to volume ratio will __________. As the cell grows larger, the surface area to mass ratio will __________.

**Procedure:**

1.) Cut out the three cell models. Fold and tape together all sides of each model. You will have three structures that resemble open boxes. These models represent a cell in three different stages of growth. The smallest box (1 side = 1 unit) represents the youngest cell and the largest box (1 side = 4 units) represents the oldest cell.
2.) Fill each cell with sand, using the scoop.
3.) Determine the mass of each sand-filled model cell and record in Table 1. Using the given formulas, calculate the measurements for each cell to complete Table 1.
4.) Using the data from Table 1, calculate the ratios for Table 2. Put the ratios in fraction format and reduce to a whole number by dividing the denominator into the numerator (the bottom number into the top number).

**Ex:** Total Surface Area = $\frac{10}{2} = 5$

Volume 2
### Data:

#### Table 1: Measurements of Cell Models

<table>
<thead>
<tr>
<th>Cell Size (length of 1 side)</th>
<th>Formulas</th>
<th>Area of one Face</th>
<th>Total Surface Area of Cell</th>
<th>Volume of Cell</th>
<th>Distance from Center to Edge</th>
<th>Mass of Cell (grams)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$A = s^2$</td>
<td>TSA = $6s^2$</td>
<td>$V = s^3$</td>
<td>$D = 1/2 s$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$s = 1$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$s = 2$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$s = 4$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Table 2: Ratios of Cell Model Measurements

<table>
<thead>
<tr>
<th>Cell Size (length of 1 side)</th>
<th>Total surface area to volume</th>
<th>Total surface area to mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>$s = 1$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$s = 2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$s = 4$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Analysis:

1.) Anything that the cell takes in, such as oxygen or food, or lets out, such as carbon dioxide, must pass through the cell membrane. Which of the measurements best represents the surface area of the cell membrane? This is not a trick question!

___________________________

2.) The cell contents, including the nucleus and the cytoplasm, use food and oxygen and produce wastes. Which two measurements best represent the contents of one of your model cells?

___________________________ & ___________________________

3.) As a cell grows larger and accumulates more contents, will it need more or less cell membrane to survive? Explain.

4.) As a cell grows larger, does the surface area to volume ratio get larger, smaller or remain the same?

___________________________

5.) As a cell grows larger, what happens to the surface area to mass ratio?

___________________________

6.) Which cell model has the greatest surface area to volume and surface area to mass ratios?

___________________________

7.) Why can cells not survive when the surface area to volume ratio and the surface area to mass ratio become too small?

8.) Which cell model has the greatest chance of survival?

___________________________
9.) How many cells with $s = 1$ would fit into a cell with $s = 3$?

10.) Which has more total surface area, one cell with $s = 3$ or 27 cells, each with $s = 1$?

11.) How can the surface area to volume and surface area to mass ratios be increased in a large cell?

12.) As the length of a side doubles in a cell, what happens to the distance the nutrients must travel to reach the center of the cell? 

13.) Was your hypothesis supported by your data? Why or why not?