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Lab Investigation: Limits on Cell Size

Introduction:

Amoebae are single-celled organisms that live in pond water. They are so small, you have to use a microscope to see them. Once they get to a certain size, they duplicate their parts and divide. Why can’t amoebae grow to be much larger?

Most cells are between 2 micrometers and 200 micrometers - too small to be seen with the naked eye. (1 micrometer = 1 millionth of a meter) Why can’t cells become larger than that? Why don’t we regularly find one-celled organisms the size of small multicellular animals like worms? Why can’t there ever be an organism which is visible to the naked eye and that is one giant cell?

Materials:

Beet (1)

Scalpel (1)

Bleach (approximately 100 mL)

Paper towels (3-5)

Gloves (1 pair per person)

Tweezers (1)

Metric ruler (1)

Safety glasses (1 per person)

Beaker: 250 mL size

Apron (1 per person)

Parafilm (large enough to cover 250 mL beaker opening)

Procedure: Check off the box after you complete each step.

1. Cut the beets into three cubes: 1cm x 1cm x 1cm 2cm x 2cm x 2cm 3cm x 3cm x 3cm ***(PLEASE be careful with the scalpels. Make sure you cut AWAY from yourself.)*** ⬜
2. Place the 3 cubes into a beaker and add just enough bleach to cover up the cubes. Cover with Parafilm to minimize fumes. ***(Be careful with the bleach! It will permanently stain your clothes!)* ⃞**
3. The cubes need to sit in the bleach for at least 30 minutes. Record the starting time here: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_⬜
4. Thoroughly clean up your beet mess. Carefully wash, rinse, and dry the scalpels. **⃞**
5. Perform the following tasks while you wait for the remainder of the 30 minutes to pass:
   1. Complete the chart (except for the “sketch” column) in the results section below to investigate the relationship between surface area and volume as a cube increases in size. Refer to your formula sheet as needed. ⬜
   2. Complete the prediction section below. ⬜
6. After 30 minutes, place several layers of paper towels on the lab counter. Put on gloves and then GENTLY remove the cubes from the beaker with the tweezers and place them onto the paper towel. ⬜
7. Pour out the bleach down a sink drain right away with plenty of water. Rinse the beaker with water to minimize fumes.⬜
8. Cut each cube in half with the scalpel. Hold the beet gently with the tweezers, NOT your fingers. ⬜
9. Measure (in mm) the depth to which the bleach penetrated the beet and sketch the inside of each cube in the “Sketch of Results” portion of your data table.⬜
10. Thoroughly clean up your lab station and leave it as you found it.⬜

Prediction: **Predict** which cube (1cm3, 2cm3, or 3cm3) will be most efficient at diffusing the bleach. **Justify** your prediction.

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Results:

| Cube (cm) | Surface Area (Show work!) | Volume (Show work!) | SA:V Ratio (Show work!) | Sketch of Results |
| --- | --- | --- | --- | --- |
| 1 x 1 x 1 |  |  |  |  |
| 2 x 2 x 2 |  |  |  |  |
| 3 x 3 x 3 |  |  |  |  |

Reflection:

In order for cells to survive, they must constantly exchange ions, gases, nutrients, and wastes with their environment. These exchanges take place at the cell’s surface - across the cell membrane. The movement of these materials is accomplished mostly by diffusion across the cell membrane.

Assume that the bleach represents the nutrients that a cell needs. Nutrients must circulate throughout the cell or the “unfed” parts will die and eventually, the cell will die. Assume the purple/red part of the beet represents accumulated waste. If waste can’t get out of the cell, the cell will be poisoned with its own waste and die.

Analysis:

1. **Describe** what happens to the surface area to volume ratio as the cube increases in size.

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1. What is more favorable for cells, a large SA:V ratio or a small SA:V ratio? **Justify** your response.

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1. Cells have various shapes and sizes. Because of this, and because structure is related function, certain shapes are optimal for certain processes. Complete the table below to compare the following cells. Refer to your formula sheet as needed.

Cell 1 (spherical): radius = 3 mm

Cell 2 (flat and rectangular): length = 4mm, width = 2mm, height = 0.5mm

| Cell Type | Surface area (Show work!) | Volume (Show work!) | SA:V Ratio (Show Work!) |
| --- | --- | --- | --- |
| Spherical |  |  |  |
| Flat & Rectangular |  |  |  |

1. **Identify** which of the two cells above would be more efficient (claim) and **justify** your choice (evidence and reasoning).

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