

A Study of the Relationship between Diffusion and Cell Size

When cells grow to a certain size, their rate of growth slows down until they stop growing entirely. They have reached their size limit. When one of these larger cells divides into two smaller cells, the rate of growth again increases. We will study one of the factors that limits cell size and growth rate.

Materials needed for cell activity and growth must in some way gain entrance into the cell, and at the same time, wastes must be eliminated from the cell. It would seem reasonable that the larger the cell, the greater the surface area for the passage of materials into and out of the cell. However, the bigger the cell gets, the greater its volume. This greater volume increases the cell's needs for materials that must pass through the cell's surface. Some questions to consider in this lab are the nature of the relationship between surface area and volume of the cell and how this relationship affects the rate of diffusion of materials that pass into and out of the cell.

Procedure:

1. Measure three agar cubes and trim as necessary to obtain cubes 3 cm on edge, 2 cm on edge, and 1cm on edge.
2. Place the three agar cubes in a 250 ml beaker and pour enough 0.1M sodium hydroxide (NaOH) over the cubes to cover them.
3. Wait 10 minutes and while waiting, record your observations and fill in the following table:

| <u>Cube Dimension</u> | <u>Surface Area</u> | <u>Volume</u> | <u>Simplest Ratio</u> |
|-----------------------|---------------------|---------------|-----------------------|
| 3 cm/side | | | |
| 2 cm/side | | | |
| 1 cm/side | | | |
| 0.1 cm/side | | | |
| 0.01 cm/side | | | |

Surface Area = length x width x number of surfaces.

Volume = length x width x height

Simplest Ratio = Surface Area/Volume

4. After 10 minutes, carefully remove the agar cubes from the NaOH and blot them dry. Slice each cube in half and record your observations by drawing each cube using colored pencils. Measure the depth of diffusion in each cube of the NaOH in cm. Record the temperature of the room.



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Drawings and Measurements

Analysis Questions

1. a) List the agar cubes in order of size, from largest to smallest.
b) List the agar cubes in order of surface area to volume ratio, from largest to smallest and compare the two lists.
2. a) Why did we include 0.1 cm and 0.01 cm cubes in the table?
b) When comparing a cube 3 cm/side and a cell the size of an onion cell, which has the greatest surface area?
c) Which of the two cells in part b has the greatest surface area in proportion to its volume?
3. a) What evidence is there that the sodium hydroxide diffuses into the agar? Explain.
b) Is there any evidence that something diffused out of the agar? Explain.
4. If the agar cubes were living cells and the sodium hydroxide was a vital nutrient, which block would have the most efficient ratio of surface area to volume? Explain why.
5. What happens to the surface area to volume ratio of a cell as a cell grows?
6. a) Why does the growth rate of a cell slow down as it gets larger?
b) How does cell division affect the cell's ability to absorb material for growth? Rate of diffusion should be included in your answer.

