**Surface Area : Volume Ratio**

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Purpose: To see the relationship between cell size and diffusion of material.

Hypothesis: *If the surface area to volume ratio of the Agar treated with phenolphthalein* *increases, then the diffusion of the NaOH solution will decrease because the unit of time given does not allow the diffusion to occur at a fast enough rate to absorb efficiently the solution. Whereas in a smaller surface area to volume ratio, diffusion will occur faster because the same given time to allow NaOH to absorb on the Agar cubes has to be done in a smaller area thus allowing diffusion to occur on a less amount of area.*

Materials

Agar treated with phenolphthalein

0.2 M NaOH solution

Ruler

Scalpel

Spoon

Beakers of various sizes

Stopwatch

Cutting board

Paper towel

Variables

**Independent Variables:** Surface Area (cm2), Volume (cm3), Ratio Surface Area: Volume (cm2:cm3)

**Dependent Variables:** Diffusion

**Control:** Time that the cubes are in the NaOH solution (s), room temp (K)

**Data Table:**

**The Surface Area to Volume Ratio v.s. Diffusion**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Independent Variables | | | | | | | | | | | | | | | | |
| Cube size | Cube Surface Areas (Cm²) | | | | | | | Cube Volumes (Cm³) | | | | | | | Average SA : V (Cm² : Cm³) | |
| Trials | | | | | Average | St. Dev | Trials | | | | | Average | St. Dev |
| 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| 1 | 8.76 | 5.99 | 6.52 | 5.37 | 5.43 | 6.41 | 1.39 | 1.37 | 0.67 | 0.76 | 0.84 | 0.80 | 0.89 | 0.28 | 7.22 |
| 2 | 25.85 | 30.89 | 20.85 | 20.03 | 33.52 | 26.23 | 5.97 | 17.87 | 26.20 | 13.60 | 14.63 | 28.08 | 20.08 | 6.67 | 1.31 |
| 3 | 78.41 | 58.29 | 62.78 | 59.08 | 62.15 | 64.14 | 8.20 | 51.29 | 31.93 | 32.30 | 52.89 | 42.97 | 42.28 | 10.01 | 1.52 |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Dependent Variables | | | | | | | | |
| Volume of uncoloured cube (Cm³) | | | | | | | Avg .Vol of coloured portion (Cm³) | Average Diffusion (%) |
| Trials | | | | | Average | St. Dev |
| 1 | 2 | 3 | 4 | 5 |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.89 | 100.00% |
| 0.52 | 0.00 | 0.00 | 0.00 | 0.10 | 0.12 | 0.23 | 19.96 | 99.40% |
| 1.53 | 3.54 | 1.06 | 0.06 | 4.40 | 2.12 | 1.80 | 40.16 | 94.99% |

**Graphs:**

🡪 As we can see from the graph above, the of the best fit allows us to understand that the trend of the increase of SA:V increases the % of the diffusion follows along. Yet because of poor calculations and small differences between calculations, the different points are very close together.

**Formulas:**

* **Volume (cm2)** = l x w x h’

*🡪 1.1 x 0.8 x 0.9 = 0.8cm2*

* **Surface Area (cm2) =** 2 l x h + 2 l x h + 2 l x h + 2 l x h + 2 l x h + 2 l x h

\*length x height of the different sides of the cube including the top and bottom

*🡪 2 x 1.2x0.7 + 2 x 0. 9 x 0.8 + 2 x 1 x0.7 + 2 x 0.6 x 0.8 + 2 x 0.9 x 1.1 + 2 x 0.7 x 0.6 = = 8.31 cm2*

* **Avg .Volume of colored portion (Cm³) =** Volume of color – volume of uncolored

**🡪** *0.89 – 0.0 = 0.89*

* **Average Diffusion (%) =** Volume colored/Overall volume of the cube x 100

**🡪** *0.89 / 0.89 = 1 x100 = 100*

**Conclusion and Evaluation:**

If the surface area to volume ratio of the Agar treated with phenolphthalein increases, then the diffusion of the NaOH solution will decrease because the unit of time given does not allow the diffusion to occur at a fast enough rate to absorb efficiently the solution. Whereas in a smaller surface area to volume ratio, diffusion will occur faster because the same given time to allow NaOH to absorb on the Agar cubes has to be done in a smaller area thus allowing diffusion to occur on a less amount of area. This hypothesis was supported.

As we take a look at the graph, we notice how the diffusion increases as the SA:V ratio is larger. This is because as something becomes bigger, in this case the cubes, the suface are to volume ratio decreases. Therefor, as the surface area to ratio increases, the diffusion becomes slower because of the several layers that the substance is absorbing in. If three cubes with different sizes are given substances in which diffusion, then the bigger cell with the greater amount of layers and the smaller SA:V ratio will only make the outer layers of the cube absorb the substance.

the cubes become bigger, both the Volume the Surface Area and the ratio have an increase. This then mean that both the small and the big cubes that were used in the experiment where given the exact time to diffuse the solution. But because the SA:V ratio was greater on the bigger square, it is not possible to diffuse fast enough as the 1 cm cube. The surface area and volume cause the solution to diffuse at a smaller rate of time because of it having to cover a greater amount of area.

When doing the experiment, we used different amounts of NaOH solution. This affected our data since more solution was given to the cube to absorb, thus causing an imbalance of how much the cube is receiving for them to diffuse. Another error that occurred in this lab is that there was that we left the cubes that were 1 cm 1.16 min longer than any other cubes. This may have cause an over-diffusion thus altering the results of how much the cube was able to diffuse in the solution. If I were to repeat this again, both the 1,2 and 3 cm cubes were to be placed in the same beaker with the same amount of solution to pursue accurate data.

This experiment represented how cells depend on their surface area and volume to decide how much material diffuses from the outside to the inside of the cell. The bigger the cell is, the harder it is going to be to absorb the water, oxygen and nutrients in the given amount of time. This can also represent how the greater the size of the cell, the greater the amount of space in which metabolism reaction cans occur.