Cell Size Lab ANSWERS

Look at the three cubes. Into which cube did the most (greatest amount) of sodium hydroxide diffuse? Why?

The largest cube (3 cm) was diffused with the greatest amount of NaOH. According to the calculations of colored volume in Table 1, although that cube had not been completely diffused in a mere 12 minutes, it still absorbed __ cm$^3$ of the solution. Compare this with __ cm$^3$ absorbed by the smallest cube and __ cm$^3$ absorbed by the medium cube. Because the largest cube was made of more agar, it has more room to fill by diffusion. If this were a cell, it would likely require a lot more resources to fill it up completely than the two smaller “cells” in this experiment.

What was the variable in this experiment? What were the controls?

The only factor that varied in this experiment was the SIZE to which the cubes were cut. All other variables were “controlled”, or kept constant for all three cubes. These included (1) all cubes were cut from the same material, (2) soaked in the same NaOH concentration/solution, (3) soaked for the same amount of time, (4) at the same temperature and pressure, so that these factors could be eliminated as the cause of diffusion differences among the cubes.

Did any phenolphthalein diffuse out of the agar cubes (“cells”)? How can you tell?

Some phenolphthalein did diffuse out of the agars cubes. Over the course of the 12 minutes of soaking in the NaOH solution, the solution changed slowly from clear to pink in color, evidence that the base indicator was diffusing into and reacting with the basic solution surrounding the cubes.

Refer to the chart and graph. In which cube was the largest percentage of volume reached by diffusion?

The smallest cube (0.5cm) was 100% pink after soaking for the 12 minute time allowed. This was the largest percentage of colored agar. Compare this with __% colored pink in the smallest cube and __% colored pink in the medium cube. The graph illustrates a trend in which the percentage of total diffusion decreases as the cubes (cells) continue to increase in size.
Hint: For the next questions, think about the volume of your cubes representing the cell’s interior cytoplasm and organelles, and the surface area representing the outer cell membrane.

What is homeostasis? How does diffusion relate to homeostasis? Make a conclusion about cell size and how it relates to homeostasis, based on your lab findings.

Homeostasis is the process by which cells maintain the internal conditions that they need to support life. Diffusion is the mechanism by which molecules of food, oxygen, wastes and other materials move across cell membranes from where they are more concentrated (source) to where they are less concentrated (where needed). Most of the processes to maintain homeostasis in cells occurs in the form of diffusion of materials across membranes. Diffusion, therefore, is how homeostasis is accomplished.

The graph illustrates a trend in which the percentage of total diffusion decreases as the cubes (cells) continue to increase in size. This indicates that as cells get larger, they would have an increasingly difficult time maintaining their internal homeostasis.

Based on your lab calculations, what does the “surface area to volume” relationship have to do with a cell’s ability to survive? (hint: page 73 in your textbook explains it)

The total volume of the cubes representing the cell’s interior cytoplasm and organelles, and the surface area represents the outer cell membrane. As the results show, the smallest cube/cell (0.5cm) had 12x as much surface area as it had volume to fill. This represents an ideal situation in which the cell has a lot of outer membrane through which to quickly diffuse materials as well as very little internal volume to fill, which can be accomplished in a relatively short amount of time. In comparison, in the same amount of time, the largest cube, with a 2:1 surface area to volume ratio and the medium cube with a 4:1 ratio, were not able to thoroughly diffuse.

When cells grow to a certain size, they frequently divide to form two new smaller cells. Using the information you obtained in this lab, explain why individual cells tend not to grow very large.

You grow by adding more cells to the ones you already have, rather than your cells simply continuing to expand in size. As cells grow in size, their volume mathematically increase faster than their surface area does. As the cell (or the cube models of cells used in this experiment) gets bigger, the surface-to-volume ratio continues to decrease, making diffusion less efficient. This can be seen in Graph 1, which shows the percent diffused drop from ___% in the 0.5cm cube down to as little as ___% in the 3.0cm cube. The larger the size of cell the less surface area for diffusion it possesses and the more materials it takes to fill its volume.