Name Period Date

Developed by Kim B. Foglia • www.ExploreBiology.com • 2010

**LIMITS TO CELL SIZE LAB – Day 1 / 20**

**STARTER –** read the information and answer the question below (4pts)

Most cells are between 2 micrometers and 200 micrometers—too small to be seen with naked eye. Remember, a micrometer is 1 millionth of a meter! Why can’t cells ever become larger than that? Why don’t we regularly find one-celled organisms the size of small multicellular animals, like frogs or even flies? In other words, why can’t there ever be an organism which is visible to the naked eye and that is one giant cell? 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 (flow of solutes down a concentration gradient) across the cell membrane. Consequently, factors that affect diffusion can affect the survival of a cell. One of the core principles that governs the efficiency of diffusion is the ratio of surface area to volume. Surface area is the amount of cell membrane available for diffusion. So for a cell, surface area actually represents how much diffusion that can happen at one time. Whereas volume is the amount of cytoplasm contained within the cell membrane. So for a cell, volume is how long It takes to get from the membrane to the center of the cell by diffusion. Therefore, to perform diffusion efficiently, there must be an adequate ratio between the cell’s surface area and its volume. But as a sphere (the simplest model of cell shape) gets larger, its volume increases at a different rate than its surface area. In this lab, we will investigate this relationship and how it affects diffusion time. The prime limitation to cell size is the limitation imposed by diffusion. Diffusion is a very slow process. If a cell were 20 cm (~8 inches), it would take days for nutrients to reach its center or for wastes to reach the cell membrane. The cell would quickly starve to death or poison itself with its own wastes. So what’s the solution, if a cell approaches its maximum size? It’s time to divide! If cells receive the proper signals, they will divide by mitosis before they become too big.

**Use the text above to help explain why cells are so small.**

**PART 1 PROCEDURE**

In this lab activity, you will use agar cubes as cell models. You will investigate how increasing a cell’s size affects the time for diffusion to move material across the cell. The agar for the cubes has been dyed with bromothymol blue—a pH indicator. When the agar cubes are placed in vinegar, they will begin to turn yellow as the vinegar diffuses into the agar. You will time this diffusion process for 3 different sized cells and compare them. Diffusion will be considered complete when the blue color completely disappears from the center of the cell.

Cube 1 needs to be 1 cm x 1 cm x 1 cm

Cube 2 needs to be 2 cm x 2 cm x 2 cm

Cube 3 needs to be 1 cm x 1 cm x 8 cm

**Create a table for the data you are about to collect. For each of the 3 cubes, your table needs to include the cell size (see dimensions of each cube on previous page), surface area, volume, surface area to volume ratio (SA:V), and time for complete diffusion.**

**Put your table here: 12 pts**

**Table Grading Rubric**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **0** | **1** | **2** | **3** |
| **Title** | **No title** | **Title somewhat describes data in table** | **Title mostly describes data in table** | **Title accurately describes data in table** |
| **Neatness/Organization** | **Not legible and/or not organized into columns and rows** | **Somewhat legible and/or somewhat organized into columns and rows** | **Mostly legible and/or mostly organized into columns and rows** | **Legible and well organized into columns and rows** |
| **Required data** | **No data** | **Some of the required data is included** | **Most of the required data is included** | **Has all required data** |
| **Units of measure** | **Units of measure are not included** | **Units of measure are included some of the time** | **Units of measure are included most of the time** | **Units of measure are included** |

**Homework: (4 pts)**

1. **Finish your starter if you did not have time to complete it during class.**
2. **Which cell dimension allowed for the fastest diffusion rate?**
3. **Compared to the other cells, was its surface area to volume ratio the biggest or the smallest?**