**THE BIGGER THE BETTER?**

**Exploring Cell Diffusion with Gelatin**

[A modified version of Gelatin “Cell” Diffusion by K.E. Kalumuck, Exploratorium Teacher Institute]

Form follows function: the sizes and shapes of cells vary greatly, and the sizes and shapes of cells are related to cell function and the environment in which the cell lives (e.g. floating through blood vessels, lining the lungs, or even inside a pond in the case of single-celled organisms). Which evolutionary processes might have resulted in such form-function associations in cells?

Remember that cells are the smallest units of life, and to live, they need to take in energy and other nutrients and to get rid of wastes. This movement of nutrients in and wastes out often occurs through the process of **diffusion** acrossthe cell membrane. Diffusion is the movement of a substance from an area of higher concentration to an area of lower concentration of that substance. In order to enter in or exit out of a cell, substances must reach then pass through the cell membrane to diffuse across. This process takes time, and you can actually measure how long this takes in terms of **diffusion rate** (the amount of distance the substance travels per unit time, e.g. cm/min.). Other factors, like temperature, also affect diffusion rate. Diffusion rate is very important to cells, because cells can’t wait a long time to get nutrients or to get rid of wastes – a cell will die if diffusion occurs too slowly!

In this activity, you will explore the factors that affect diffusion rate.

**Exploration: Part I**

Read all of Part I. Then, design a data collection sheet on which you can record your calculations and observations. Be sure that it is in a format that is easy to follow and can be shared with others. Then do the activity.

**Materials Available**

* Trays of solidified agar/gelatin mixed with bromothymol blue (a pH indicator which goes from blue to yellow in acidic conditions) – three thicknesses of agar are available: 1 cm, 2 cm, and 3 cm
* Vinegar solution
* Tap water
* Knives
* Spoons
* Plastic cups
* Small plastic boxes with lids
* Rulers
* Weight scales
* Scissors
* Post-it Notes
* Hole punchers
* White paper

**Procedures**

* Cut the gelatin to obtain four cubes of each of three sizes of agar (12 cubes total) of the following sizes: 1 cm3, 2 cm3, and 3 cm3.
* Place three of each size cube into a container and cover the cubes with an acidic solution. *Why are you using an acidic solution? What is in the solution?* Cover the box after adding the solution.
* Leave one block of each size outside of the acidic solution. *What is the purpose of this step?*
* At three different time intervals (e.g. 5 min., 15 min., 30 min.), remove one cube of each size from the acid (use a spoon). Dip briefly in water. Place on white paper, and cut the cube in half.
* Observe any color changes. How has the color changed? What do you think caused the color change?
* Measure the distance the color change has penetrated from the outside surface of the cube toward the inside of the cube. Which substance has penetrated (**diffused into**) the cube?
* Based on your measurements, how could you calculate the rate of color change – or diffusion rate of the substance? Record your data and final observations.
* If these cubes represented actual cells, which ones do you predict would be more likely to survive and which ones would be more likely to die? Explain your prediction.

**Exploration: Part II**

Choose Option A or Option B (described below) to continue your investigation. Design a new data collection sheet for that option. Complete the second option if time permits, using another data collection sheet.

Option A

* Predict what would happen if you tried the experiment again but changed the temperature of the acidic solution.
* Test your prediction. Record what you did, what you observed, and your calculations of diffusion rate.
* Repeat this experiment under a different temperature.

Option B

* Predict what would happen to diffusion rate if you repeated the experiment using a different shape (not a cube)?
* Think about which factors you would need to control for in order to only test the effect of shape.
* Test your prediction. Record what you did, what you observed, and your calculations of diffusion rate.
* Repeat this experiment using yet another different shape.
* CHALLENGE: Can you cut out a gel shape that results in a really fast rate of diffusion?

**Summary**

1. Analyze and summarize the results of your experiments on your data collection sheet.

2. Explain what you have observed and how your results may or may not support that the factors you varied had an effect on diffusion rate.

3. List any questions you have on your data collection sheet.

4. What other variables would you like to investigate?