Student Guide

When a cell talks, everyone listens!

Introduction: With the evolution of science and the new innovations in technology, we are now able to see life at the smallest of scales.....the nanometer scale. Nano refers to the 10^{-9} power, or one billionth. In these terms, it refers to a meter, or a nanometer, which is on the scale of atomic diameters. For comparison, a human hair is about 80,000 to 100,000 nanometers thick!

Most plant and animal cells are between 1 and 100 micrometers and therefore are visible only under the microscope. Most cells in your body are about 5,000 nm across or less, which is about 1/20th the width of a strand of hair. Cell membranes are only 10 nm thick!!

The cell membrane (*plasma membrane*) serves as a boundary between the cell and its external environment. The plasma membrane is selectively permeable meaning that it only allows select nano-sized molecules to move across it. Transport through the plasma membrane occurs in two basic ways: *passive* and *active* transport. *Diffusion* plays a major role in the movement of materials in and out of the cell.

Embedded in the cell membrane are specialized receptors called integrins that provide vital communication links between the interior and exterior of the cell. These receptors function in a number of ways to ensure the homeostasis within the cell. Changes can lead to the activation of integrins which in turn influences the relationship of the cell with its environment.

Nanoscience is the study of atoms, molecules, and objects whose size is on the nanometer scale (1 - 100 nanometers). It is where unique properties occur which scientists and engineers are exploring to create new materials and devices. Biologically speaking, while most cells are micrometers in size, cellular activity occurs at the level of nanometers!

In Part 1, you will explore diffusion using a macomodel of the cell membrane. The activity in Part 2 serves as an introduction to cellular communication. In this activity, you will determine if one cell has an effect on the cellular condition of other cells within close proximity.

Part 1. Diffusion and Cell Signaling: a nanoscale phenomena

Your teacher may ask you to define these before proceeding to the activity.

Vocabulary and Definitions:

1. *Selectively permeable*
2. *Diffusion*
3. *Osmosis*
4. *Homeostasis*

5. *Active transport*
6. *Passive transport*
7. *Hypertonic*
8. *Hypotonic*
9. *Isotonic*
10. *Integrins*
11. *Nanoscale*
12. *Nanometer*
13. *Nanotechnology*

Safety Information: Goggles should be worn in any lab where liquids and chemicals are used. Aprons and gloves are recommended as the Lugol's solution can stain clothing.

Directions for the Activity:

Materials: (per group)

- One clear/translucent soap storage box (approximately 7 in x 5 in)
- Four pieces of dialysis tubing* (soaked overnight)
- 1% starch solution
- Lugol's solution
- String
- Distilled water

Procedure:

1. You have been provided with 4 pieces of soaked dialysis tubing (or plastic bags). Tie or clamp one end of each of the dialysis tubing.
2. Fill two of the tubes with 1% starch solution and seal the open ends of tubing or bags.
3. Fill the remaining tubes with the Lugol's solution and seal the open ends.
4. Pour just enough water into the soap box to cover the bottom. Then, place the four tubes into the soap box starting first with the Lugol filled tube, then the starch tube, then the other Lugol tube and finally ending with the starch tube.
5. Cover the soap box with the lid to keep the tubes moist (This mimics the cellular environment. Remind students that cells are in a warm, moist environment.).
6. Record your observations every 5 minutes on the student sheet or lab notebook. Record any color changes.

Time (min)	Tube 1	Tube 2	Tube 3	Tube 4
5				
10				
15				
20				
25				

Analysis of the Results: Answer the following questions.

1. Were there color changes in any of the tubes? Which tubes changed color first? Did you notice a pattern?
2. Explain why it was important to keep the system moist.
3. Hypothesize why there was a color change?
4. How does the proximity of the dialysis tubing mimic the proximity of cells?
5. The dialysis tubing bags serve as a model for a community of living cells. In what ways is the model an accurate portrayal of cell systems and in what ways is it flawed?
6. Describe two specific examples of cell-to-cell communication, naming the type of cell and what chemical message is passed.

Part 2. Rescue Me: A Cell's Call for Homeostasis

You should have viewed either a PowerPoint or an online video about cell signaling. Pay attention as you will need information contained within to complete the following activity.

Directions for the Activity:

1. You will receive cards that have been randomly laid on your desk, face down.
    a. There are three types of card categories:
        i. Environmental change
        ii. Protein
        iii. Response
2. Turn over the cards that are on your desk. At this time, spread out around the class. Do not begin moving in class.
3. When the teachers yells "GO," you should call out what's on your card and search for the "environmental change," the "protein" that recognizes the change, and the "response." You should continue to call out until your pathway is complete.
4. Once complete, you will share and record your pathway.

Follow-Up: Once activity is completed, as a homework assignment, you should trace the pathway for each event. Below is the list of the environmental changes along with a list of proteins and responses. Provide a correct pathway using all three.

Environmental Change

1. Ouch! You cut your finger
2. Time to Divide!
3. My blood sugar is low!
4. Help! I can't breathe!
5. It's a Bear!
6. Puberty
7. Puberty
8. Achoooo!
9. Time to wake up!!

Protein	Response
1. Insulin	1. Smooth muscle contraction
2. Histamine	2. Growth of body hair
3. Epinephrine	3. Increased vascular permeability
4. Testosterone	4. Increased wakefulness
5. Fibronectin	5. Increased bone density
6. Histamine	6. Flight of fight response
7. Fibronectin	7. Regulates blood sugar
8. Epinephrine	8. Plays a major role in the formation of blood clots
9. Testosterone	9. Cellular adhesion to the ECM