Size Matters

Overview

Students will design an experiment to observe the differential movement of large and small molecules across a semi-permeable membrane. Cornstarch and iodine will be the large and small particles, respectively, and sandwich bags will be the membranes in this model system.

North Carolina Essential Science Standards:

7.L.1.2 Compare the structures and functions of plant and animal cells, including major organelles (cell membrane, cell wall, nucleus, chloroplasts, mitochondria, and vacuoles).

Background

Membranes like those surrounding the egg in the previous exercise (**Looking into Eggs**) may be semi-permeable. That is, they may allow some molecules to pass through while preventing others from crossing. The thin polyethylene of plastic sandwich bags works well as a model membrane. It will allow the relatively small iodine atoms to pass through while blocking passage of the much larger cornstarch molecules. When cornstarch comes into contact with iodine (Lugol's solution in this exercise), it turns a deep blue, purple, or black.

Materials

*Materials marked with an asterisk must be supplied by the teacher or the students.

Materials for the whole class

- 1 stock bottle Lugol's Dilute solution (500 ml)
- 1 box of cornstarch
- 1 empty half-gallon jug for diluted Lugol's solution
- 1 empty half gallon jug for cornstarch solution
- Labels for Lugol's solution and cornstarch solution dropper bottles.
- 4 beakers (250 ml)
- 2 graduated measuring cups (30 ml / 1 oz), 1 for preparing dilute Lugol's solution and 1 for preparing dilute cornstarch solution

Materials for students working pairs

- 1 fold-over sandwich bag
- 1 dropper bottle of dilute Lugol's solution (shared by 2 groups)
- 1 dropper bottle of cornstarch solution (shared by 2 groups)
- 1 cup (1 oz)
- 1 cup (9 oz)
- 1 small rubber band (#8)

Materials for individual students

- *Science notebook

Preparation

- Prepare cornstarch suspension by filling a half gallon jug to its shoulder with tap water and then stirring in approximately 30 ml (1 ounce) of powdered cornstarch. Shake thoroughly to suspend the cornstarch in the water; very little will actually go into solution, and the liquid will look cloudy. With a clean pipette, distribute the cornstarch suspension to the small, labeled dropper bottles provided. Shake the jug often while filling the bottles to re-suspend the cornstarch. Students should shake the dropper bottles immediately before using them.
- If you did not prepare dilute Lugol's (iodine) solution for the **Cells** exercise earlier in this teachers guide, you may do so now. If you do have some left, test it with some cornstarch solution to be sure it still works. To prepare dilute Lugol's solution, fill a half gallon jug to its shoulder with tap water. Using the 1-ounce graduated measuring cup, add approximately 60 ml of Lugol's Dilute stock solution and stir. (The iodine may turn the jug and the measuring cup brown, but save them to make more solution if necessary.) With a clean pipette, distribute this diluted Lugol's solution to the small, labeled dropper bottles provided (or use the dropper bottles already prepared in the **Cells** exercise).

  Lugol's solution will degrade over time. To delay this degradation, store the solution containers in a dark place.

- At a work station accessible to students, set out the half gallon jugs of cornstarch and dilute Lugol's solutions along with the 250 ml beakers.

Procedure

Introducing the lesson:

- Have the students review their results from the de-shelled egg activity and any information they may have learned from their reading in the textbook. Students will explore the food color/water color mystery in this activity.
- Ask students to share some of their speculations as to why the two coloring agents worked differently from each other. If no one mentions particle size as a possible explanation, try to draw them out with gentle hints. Then let them know that this activity will explore particle size and movement across membranes.
- Instruct the class that they will use a sandwich bag as the membrane in this model system, and they will explore two different solutions, cornstarch and iodine.

Part 1

- Each pair of students will begin with a 30 ml (1-oz) cup, 1 dropper bottle of dilute Lugol's solution, and 1 dropper bottle of cornstarch suspension. They should start by transferring 20 drops of Lugol's solution into the cup. They should note the color and write it in their science notebooks.
- After shaking the cornstarch dropper bottle, students should add 5 drops to their cups. Ask them what they observed. They should write this result in their science notebooks.
- After shaking the bottle, they should then add 5 more drops of cornstarch and record their observations again.
- Explain that iodine is an example of an indicator solution, a very useful tool in science. Cornstarch, in the presence of iodine, turns dark purple, blue, or even black.

Part 2

- This activity asks students to explore how the size of particles affects their ability to move across a membrane. **The challenge for the students is to design an experiment using a sandwich bag as a membrane that will shed some light on the relative size of the two molecules, iodine and cornstarch**.
- Show the students the list of materials they can use (1 sandwich bag, Lugol's solution, cornstarch solution, one 9 oz cup and 1 rubber band). Each pair of students should design an experiment and sketch it in their notebooks. They should then describe, in writing, all possible outcomes and provide and explanation for each possible outcome.
- Now lead a discussion to help the entire class understand the 4 possible outcomes and what each one means. See Figure 1 and the table below for an example. Some students will probably come up with other experiments—for example, putting Lugol's in the bag and cornstarch in the cup.

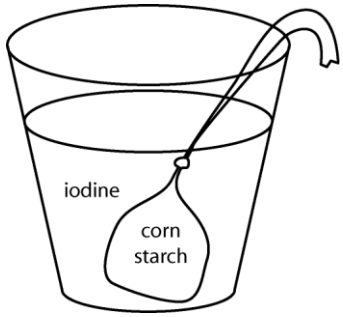

Figure 1.

Possible Outcome	Explanation
Neither the cornstarch nor the iodine changed color.	The membrane did not allow either substance to pass through.
The cornstarch did not change color, but the iodine turned very dark.	Cornstarch could move out through the membrane, but iodine could not move in. When the cornstarch came in contact with the iodine outside the bag, it turned dark.
The cornstarch turned very dark, but the iodine did not change color.	Cornstarch could not move through the membrane, but the iodine could. When the iodine came in contact with the cornstarch inside the bag, it turned dark.
Both the cornstarch and the iodine turned very dark.	Both the cornstarch and the iodine could pass through the membrane.

- After the discussion, have students predict what they think will happen with their experiment and write it in their notebooks.
- *After making their predictions*, they should do their experiments. (Color changes may take 15-30 minutes, and it might be worthwhile to leave setups overnight.)
- As an assessment, have students do a complete write up, including:
    - A description of their procedure with enough detail for someone else to repeat their test.
    - Their predicted result.
    - Their actual result.
    - Their conclusions.

Reflection/Discussion

The class discussion should include an opportunity for students to share their results. Be sure to address *all* the different experiments the students have designed, even ones that may not have worked.