Membranes—One More Time

Overview

The teacher will set up a demonstration of diffusion and osmosis using dialysis tubing, corn syrup, food coloring, and water. Students will observe the two processes during a class period as a way to summarize the **Looking into Eggs** and **Size Matters** exercises and to clear up any unanswered questions or misconceptions they might have.

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

This demonstration, set up by the teacher, simulates what happens to the de-shelled eggs in the **Looking into Eggs** activity. The dialysis tubing takes the place of the egg membrane and the blue corn syrup simulates the concentrated material inside the egg. When the limp corn syrup 'sausage' is placed in the cup of water, several things happen:

- At first, the tube swells as water moves in from the cup. This should be noticeable even after about 10 minutes. The water in the cup will probably continue to look clear at this point. Note that water actually goes both ways, but that since the concentration of water is so much greater outside, the net flow is toward the inside of the tube and it swells up. (Refer to the background section in the **Looking into Eggs** activity.)
- After 30-40 minutes the sausage should be looking quite stiff (see figure below).
- Also after 30-40 minutes, a blue tint may be visible in the cup *outside* of the tube. So food coloring must be moving out from the tube.
- Testing the water in the cup with a glucose test strip after 30-40 minutes reveals that some corn syrup has also moved out of the tube.

Materials

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

Materials for the whole class

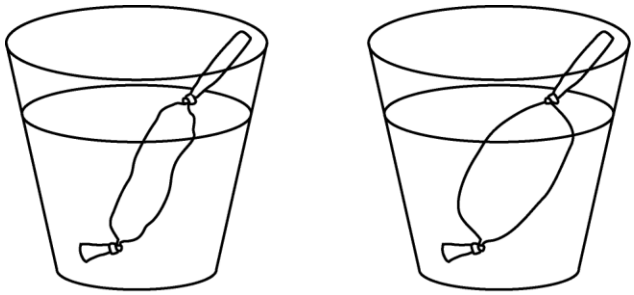
- 1 piece of dialysis tubing (20 cm or 8 inches long)
- 1 cup (9 oz)
- Corn syrup (about 10 ml or 2 teaspoons)
- Blue food coloring (2-3 drops)
- 1 pipette
- 2 glucose test strips
- Digital scale
- *Tap water

Materials for individual students

- *Science notebook

Preparation

- Prepare the dialysis tubing:
  - Cut off about 20 cm (8 inches) of dialysis tubing—one piece for each class.
  - Hold the tubing under running water or just set it in a cup of tap water for a few seconds to moisten it and make it flexible.
  - Rub the softened tubing gently between your thumb and forefinger to open it up along its entire length.
  - Tie a single loop at one of the tubing. Make the knot very tight so that it won't leak.
- Add 6-8 drops of blue food coloring to about 10 ml (2 teaspoons) of corn syrup for each piece of tubing you will need. Make a nice dark solution.
- Cut the narrow section off a pipette to use for transferring the blue corn syrup. The syrup is too thick to go through the narrow tip.
- Holding the tube open with one hand, carefully fill it with about 10 ml of blue corn syrup. This is a sticky operation, and you probably won't be able to do it without getting some syrup on the outside of the tube.
- Tie a knot in the open end of the tubing. Your goal is to produce a limp sausage, 1.5 to 2 inches long, which will expand and get turgid later (see figure below).
- Rinse the outside of the tubing *very thoroughly* to remove any syrup that has dripped onto the outside. Be especially careful to rinse the region around the knot. This is probably best done under running water.
- Set the tube aside until ready for use.



Procedure

- Fill the cup with plain tap water enough to cover the tube—about ¾ full.
- Test the water with a glucose test strip to show that no sugar is in the water. Remember to let the test strip 'develop' for about a minute before comparing it to the color chart.
- Determine the mass of the cup of water and the limp tube separately. Record these values.
- Place the limp tube in the cup of water and set it in a place where the whole class can watch it during the class period. You can be doing other class work, but be sure to call everyone's attention to the tube from time to time, as follows:
- After about 10 minutes:
  - Hold up the tube and ask the students to write in their science notebooks what they see and what they think is happening. [It will probably have swelled a little bit as water has begun moving into the tube.]
  - Hold up the cup of water and ask the students to write what they see and what they think is happening. [The water will probably still look clear, so they will probably report that nothing is moving out of the tube.]

- *After* the students have written their observations, ask a few of them to share what they have written with the class.

- After another 10 minutes:
  - Repeat the above steps. [They should report more swelling. The water will probably still look clear, though a slight blue tint may now be visible.]
- After another 10 minutes:
  - Repeat the above steps. [The tube should now be looking quite full. The water in the cup will now start having a blue tint, indicating that some of the blue food coloring has moved out of the tube into the water in the cup.]
  - Ask the students if they think any corn syrup has moved out of the tube and how this could be tested.
  - Test the water with a new glucose test strip. It will probably show that some sugar has 'escaped' from the tube. Ask the students to explain this result in their notebooks.
  - Determine the mass of the cup of water and the tube separately. Record these values and compare them to the original values.
- Hold a class discussion to get all students on track with what is actually happening. See **Reflection/Discussion** section below.
- If there is time, you might want to repeat the observations one more time at the end of class.

Reflection/Discussion

Ask students to explain what they have observed in this demonstration based on their previous observations in the **Looking into Eggs** and **Size Matters** exercises and their reading in the textbook. Be sure to cover the following points and clear up any lingering misconceptions.

- Water moved *into* the tube because the corn syrup is a concentrated solution. Or to put it another way, the concentrated corn syrup solution has *fewer* water molecules per milliliter in it, so water from the cup moves into the tube.
  - This is similar to what they saw when the de-shelled egg was soaked in plain water and swelled as water moved *into* the egg.
  - It is also similar to, but the opposite of, what they saw when the de-shelled egg was soaked in corn syrup. In that case the egg shriveled up as water moved *out* of the egg.
  - Use information about the mass of the cup of water and the tube, before and after, to provide evidence.
- Blue food coloring moved *out* of the tube, indicating that it *and* some water also moved out of the tube.
  - This is similar to, but the opposite of, what they saw when the de-shelled egg was soaked in water with blue food coloring.
  - It also indicates that diffusion/osmosis is a two-way process, but that the net flow is from a region of higher concentration of water to a region of lower concentration of water (see the **Background** section in the **Looking into Eggs** exercise).
- Some corn syrup is moving out of the tube, indicating that the sugar molecules are small enough to go through the dialysis membrane pores.
  - Note that this is different from what happened with the *cornstarch*, which was too big to pass through the plastic bag 'membrane' that was used in **Size Matters**. Be sure to stress the difference between corn syrup (sugar, a relatively small molecule with a lower molecular weight) and cornstarch (a relatively large molecule with a higher molecular weight). In a sense, the corn syrup is like the Lugol's solution (iodine) that could move through the plastic bag.

Assessment

Students can be asked to write a report summarizing their understanding of diffusion and osmosis based on all three of the diffusion/osmosis exercises: **Looking into Eggs**, **Size Matters**, and **Membranes—One More Time**.