**VANDERBILT STUDENT VOLUNTEERS FOR SCIENCE**

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**Osmosis Mini-Lesson**

**Fall 2016**

**Goal:** To demonstrate the concept of osmosis using potatoes and fruit.

***TN Curriculum Alignment:* SPI 0507.1.1**

**Lesson Outline:**

**I. Introduction:** VSVS volunteers will explain the concept of osmosis to students.

**II. Illustration: Osmosis in Potatoes:** Students will observe three potato slices. One that has been freshly cut, one that has been soaking in a salt solution, and one that has been soaking in distilled water. VSVS volunteers will discuss the differences in the potato slices and record them for the class on the board and then discuss the reason for the differences in the three potato slices.

**III. Experiment: Observing Osmosis with a Super Absorbent Polymer:** Students will experiment with osmosis using a super absorbent polymer. When salt is added to the gel, the gel turns into a liquid because the water has moved out of the polymer.

**IV. Examples of Osmosis in Beans and Fruits:** Volunteers will demonstrate the effect of soaking on beans and raisins and explain the effect of osmosis.

**Materials:**

1 plastic bag with:

1 jar containing dry beans

1 jar containing beans that have been soaking in water overnight

1 jar containing dried raisins

1 containing soaked raisins

16 16 oz cups (the large opaque ones)

16 sheets of paper (labeled) for placing potato slices

Several bottles of water (3200 mL needed)

16 10 oz cups (the clear ones, with a black line at the 200 mL mark)

16 plates

4 containers of sodium polyacrylate

16 teaspoons

8 containers of salt

16 potato slices (rectangles) in 1% salt solution or freshly cut

16 potato slices in distilled water

16 potato slices in 40% salt solution

4 sheets of paper towel for blotting potato slices

32 sandwich bags (for students to take home sodium polyacrylate)

32 3.5 oz cups marked to 30 ml

1 small bag of “orbs”, tucked into a 10oz clear cup.

Note: For this activity, new potatoes work best (redskin). Each potato slice should be as long as possible (at least 6 cm), about 1.5 cm wide, and should be as thin as possible. Store potato slices in the 1% salt solution provided, until ready to be used by students.

**In the car ride, read through this quiz together as a team. Make sure each team member has read the lesson and has a fundamental understanding of the material.**

1. During osmosis, water flows in what direction?
2. If we put pieces of fruit with high water content, such as an orange, in distilled water and salt water, what do you think will happen to the fruit in both situations?

**2. During the Lesson:**

**Here are some Fun Facts for the lesson**

Osmosis is responsible for the ability of plant roots to draw water from the soil.

**Reverse osmosis** (RO) is a water purification technology used to desalinate ocean water.

Your kidneys functions as an osmosis and dialysis machine. It utilizes osmosis to maintain your body’s water balance, filtering out excess water from the blood to the urine. Waste produced by your body travels through the bloodstream and into the kidneys where a semi-permeable membrane allows water and certain small molecules to pass through into the urine.

Kidney dialysis machines use osmosis to take over the filtering function of the kidneys. Dialysis machines use a semi-permeable membrane, which is a membrane through which some small molecules can pass (such as water, salts, and metabolites) but through which larger objects (such as proteins and blood cells) cannot.

Osmosis also plays an important role in foods such as pickles, jams, and canned foods. The high salt/sugar content causes the bacteria to die by dehydration as the water moves from their cells to the briny/sugary solution.

**Unpacking the Kit**

**For Part II. Illustration – Osmosis in Potatoes**

16 potato slices (rectangles) in 1% salt solution or freshly cut, 16 potato slices in distilled water, 16 potato slices in 40% salt solution, 4 sheets of paper towel for blotting potato slices 16 sheets of paper (labeled) for placing potato slices, 16 plates

Remove the potato slices from water/salt solutions, blot them on a paper towel and place the three slices on the labeled diagram and on a plastic plate ready to distribute to each **pair** of students.

**For Part III. Experiment – Observing Osmosis with a Superabsorbent Polymer.**

**Count the number of students and prepare enough 16 oz and 10 oz cups for each pair of students: Fill the 10 oz cups with cold tap water to the mark. Put 1 tsp. sodium polyacrylate into each of the 16 oz opaque cups and set aside.**

4 containers of sodium polyacrylate, 16 teaspoons, 8 containers of salt

32 3.5 oz cups marked to 30 ml

**For Part IV. Examples of Osmosis in Beans and Fruits**

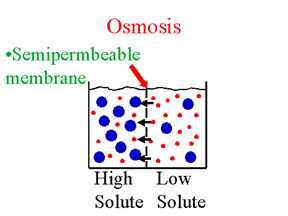
1. plastic bag with:1 jar containing dry beans, 1 jar containing beans that have been soaking in water overnight

1 jar containing dried raisins, 1 containing soaked raisins

**For Part V. Example of Osmosis in “Orbs”and clean-up**

**1** small bag of “orbs”, tucked into a 10oz clear cup, 32 sandwich bags (for students to take home sodium polyacrylate)

Draw the osmosis diagram on the board

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osmosis2 water molecule

osmosis2 salt molecule

**I. Introduction**

* Ask students if they know what a cell membrane is?
  + It is a thin layer with tiny pores that makes up the outside of the cell. It is like a soap bubble.
* What does the cell membrane do?
  + It protects the cell from its environment.
  + It controls what enters and leaves the cell.
* What are some things that enter and leave a cell?
  + Water, oxygen, nutrients, waste products.
* Tell students that the movement of molecules across a cell membrane is called **diffusion.**
  + Tell students that the **movement of water molecules** is a special case of diffusion and is called **osmosis.**
  + Discuss the motion of liquid molecules striving to achieve a balance or equilibrium between a low area of concentration and an area of higher concentration. Have students look at the diagram above to explain that the water molecules will move from a higher concentration to lower concentration of water molecules.
* Tell the students that we are going to see how water can move **into** and **out of** a potato slice.
* Tell them that potatoes contain water and minerals. One of the minerals in a potato is **salt**.

**II. Illustration – Osmosis in Potatoes**

* Give the following materials to each pair**:**
  + 1. plate with 3 potato slices on labeled paper (1 potato slice that has been soaked in distilled water, 1 soaked in a 40% salt solution and 1 fresh cut or in a 1% salt solution (the control)
* Ask the students to observe all three potato slices. Tell the students to very carefully feel how rigid or floppy the potatoes are. (Warn them to NOT break them.)

Compare the salt and distilled water-soaked potatoes with the control slice.

Students should observe the following, with your guidance:

* The potato slice in the distilled **water** is **stiffer**, indicating that more water molecules went into the potato than came out.
* The potato slice in the **40 %** **salt** solution is **limp**, indicating that more water molecules came out of the potato than went in.
* Share the following explanation with students (adapt to the age of the student), along with the diagram drawing on the board:
  + **Osmosis** refers to the movement of water molecules across a membrane trying to achieve equilibrium.
  + Because there are no salts in distilled water, there is a higher concentration of water molecules in the distilled water compared to inside the potato. Therefore water moves INTO the potato**.**
  + **Because the salt water contains a lot of salt** then there is less water in the salt solution compared with the concentration of water in the potato. This means that the water from the potato will pass out of the potato in effort to achieve a balance.
  + In all cases, water is moving across the membrane to equalize the concentration of the solutions.

### III. Experiment – Observing Osmosis with a Superabsorbent Polymer.

* At this point, have 2 pairs join together so that students can share chemicals.
* Give each pair a large (16 oz) cup containing the sodium polyacrylate and a 10 oz cup containing 200 mL water.
* Tell them to pour the water into the cup with the sodium polyacrylate.
* Observe that all the water is absorbed (forms a gel) immediately. This is osmosis - the water moved into the white powder.
* Tell them to take out about 2 tsps. of the gel and put in to the 3.5 oz cup. Add 1 tsp salt and stir.
* Observe that the gel will return to liquid. This is osmosis again – the water moved out of the gel.
* Tell the students that this is similar to what happens when the potatoes are placed in water.
  + When the potato is put into the distilled water, it will absorb the water. The water

is trying to dilute the salt inside the potato.

* When the potato is put into salty water, it will lose water. The water in the potato

moves towards the salty water to try to dilute it.

**Uses for sodium polyacrylate** include high absorbency disposable diapers and moisture absorbent for automobile and jet fuels.

When the super-absorbent polymer is added to a sandy soil, it improves the soil’s ability to retain moisture and improves its ability to support agriculture. It is sold in gardening stores for this purpose.

This polymer absorbs about 300 times its weight of tap water (800 times its weight of distilled water because the ions in tap water reduce the absorbing properties of the polymer).

The addition of the salt (sodium chloride) breaks the "gel" polymer apart as water leaves the polymer to dilute the salt concentration outside the polymer network

**IV. Examples of Osmosis in Beans and Fruits**

* Show the students the dried beans and fruit and the fruit and beans that have been soaking in water overnight.
* Explain to them that water was absorbed through **osmosis**.

**V. Example of Osmosis in “Orbs”**

* Show students the orbs and tell them they are the same as a product sold in gardening stores (see above), with dye added.
* Put the “orbs” into a clear 10 oz cup and add water so that it is about ¾ full. Tell students they can observe the orbs over the next few days.
* Give the cup with orbs to the teacher to keep. Tell the class that the orbs can be reduced to their original size by putting them on a plate and left to dry for several days. They can then be rehydrated and used again. Some can be sprinkled with salt and water observed being drawn out.

**Clean-up: Return all cups to the VSVS lab in the garbage bag. Do not put the sodium polyacrylate down the sink. The students can keep the sodium polyacrylate if they wish (there are some plastic bags included for this), but warn them to treat it as a chemical.**

**Observation Sheet**

Fresh Soaked in salt water Soaked in distilled water