VANDERBILT STUDENT VOLUNTEERS FOR SCIENCE

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Osmosis with Potato Slices

2018-2019 VINSE/VSVS Rural

Goal: To demonstrate the concept of osmosis using potatoes and fruit.
TN Curriculum Alignment: SPI 0707.1.5 Observe and explain how materials move through simple diffusion.

Lesson Outline:
I. Introduction: VSVS volunteers will explain the concept of osmosis and diffusion to students. Volunteers will demonstrate the diffusion of molecules out of a balloon into the air using vanilla extract and a balloon.
II. Experiment

A. The Effect of Distilled Water on Potatoes: Petri dish #1
Students will remove a slice of potato from the 1% salt solution and trace it on their Data sheet. They will then place the slice into Petri dish #1 and cover the potato with distilled water.

B. The Effect of Salt Water on Potatoes: Petri dish #2
Students will make a high concentration salt solution. They will remove another potato slice from the 1% salt solution and trace it on their Data sheet. They will place this potato slice in Petri dish #2 and pour their salt solution on top of the potato.

III. Osmosis Illustration Using a Superabsorbent Polymer: While the potato slices are soaking (20-30 minutes), volunteers will demonstrate osmosis using a superabsorbent 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 fruits and explain the effect of osmosis.
V. Example of Osmosis in "Orbs"
VI. Checking the Potato Slices: After about 25 minutes have passed, students will remove the potato slices from the Petri dishes and measure them on the Data Sheet. These measurements will be compared to the before measurements. Volunteers will explain to students that the potatoes are shorter or longer because of osmosis.

Materials:
1 plastic bag containing:
- 1 Balloon
- 1 Balloon pump
- 1 Bottle vanilla
- 1 pipette

1 container with:
- 1 jar containing dry beans
- 1 jar containing beans that have been soaking in water overnight
- 1 jar containing dried fruit
- 1 containing soaked fruit (raisins)

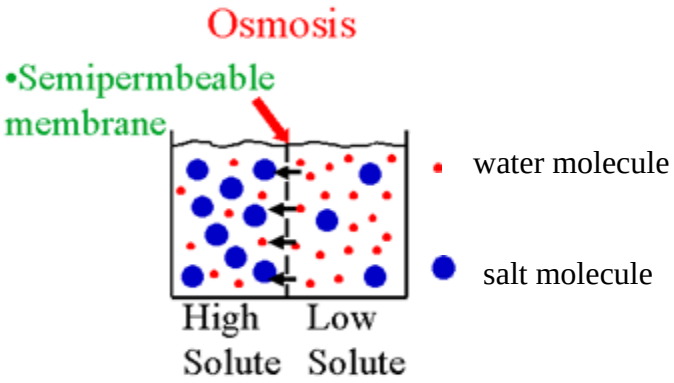
15 16 oz cups
15 10 oz cups marked at 200 mL marl
15 plates
15 containers of sodium polyacrylate (students share)
30 potato slices (rectangles) in 1% salt solution

30 teaspoons
15 containers of salt (students will share)
15 100 mL beakers to be filled with distilled water
1 ziploc bags containing 15 small petri dishes and lids labeled #1- water
1 ziploc bags containing 15 small petri dishes and lids labeled #2- salt
30 3.5 oz cups marked to 30 ml
1 packet "orbs"
1 Binder containing:1Potato Observation Sheet and 1 Data sheet, 15 Instruction sheets, Powerpoint and lesson
Potatoes – you will need to buy at least 11/2 medium red potatoes for 1 class.
Distilled water – each class will need about 1 L distilled water. For 5 classes, send 2 Gallons distilled water.

Preparation notes:

- 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. Cut just before the lesson.
- Fill the 100 mL beakers with distilled water.
- Count the number of students and prepare enough 16 oz and 12 oz cups for each pair of students: Fill the 12 oz cups with cold tap water, to the mark. Put 1 tsp sodium polyacrylate into each of the 16 oz cups and set aside.
- Place two slices of potato on plastic plate ready to distribute to each **pair** of students.

- Draw the osmosis diagram on the board.



I. Introduction

- Ask students: What is osmosis?
  - Discuss the motion of molecules using examples such as the smell of cooking from a distance or the smell of perfume in the air when someone wearing perfume walks by. This happens because molecules are in constant motion and gas molecules (perfume, aroma of cooking) mix (diffuse) with the air in the vicinity.
- Show the students the balloon and Vanilla. Pipette some vanilla into the balloon, blow it up and tie it.

Your Notes:

- Pass the balloon around and have the students smell it. Ask them if they can smell the vanilla.
    - The balloon has very small holes that you cannot see, so some molecules can pass through the balloon into the air. .
    - These holes are too small for the liquid vanilla to pass through, but the vanilla vapor molecules are small enough.
    - This movement of molecules through a membrane (the balloon) is called **diffusion**.

- **Osmosis** is a special case of diffusion, and refers specifically to the diffusion of water. Water molecules can move in and out of cells in vegetables, flowers, and animals (including people). The cell wall is like the balloon membrane.
- 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.

II. Experiment: Osmosis in Potatoes

Monitor student groups to make sure instructions are followed accurately.

Give the following materials to each pair**:**

- 1 Potato Activity Sheet
- 1 beaker of distilled water
- 2 3.5 mL cups, marked to 30 mL
- 1 container of salt
- 1 spoon
- 1 petri dish and lid labeled #1- water
- 1 petri dish and lid labeled #2- salt
- 1 plate with 2 rectangles of potato on a sheet of paper towel.

Have each student do the following:

1. Pour distilled water into the two small cups, to the 30 mL mark.
2. Place the 2 petri dishes on the appropriate sections of the Potato Activity Sheet.
3. Very carefully feel how rigid or floppy the potatoes are. (Warn them to NOT break them.)

A. The Effect of Distilled Water on Potatoes: Petri dish #1

Ask students if they know what distilled water is?

It is pure water with all its dissolved minerals removed.

Tell them to:

1. Trace one of the pieces of potato on the first section of the Potato Activity Sheet.
2. Place it in the bottom of the petri dish that is next to its tracing.
3. Pour distilled water from one of the cups into this petri dish #1, so that the potato slice is completely covered and place the lid over the petri dish.

B. The Effect of Salt Water on Potatoes: Petri dish #2

Tell students to:

1. Make the salty water by putting 1 tsp of salt into the other 3.5 ml cup and stirring until it is dissolved (it will not matter if there is some solid remaining).
2. Trace the other piece of potato on the second section of the Potato Activity Sheet.
3. Place it in the bottom of the petri dish #2, which is next to its tracing.
4. Pour the salt solution into this petri dish #2, so that potato slice is submerged and place the lids over

_____

_____

_____

the petri dish.

5. **Leave the experiment undisturbed for 20-30 minutes until instructed to return to check the results.**
6. The longer the potatoes soak - the better. While students are waiting for the potatoes to change, do the following activities.

III. Observing Osmosis with a Superabsorbent Polymer.

- Give each pair a large (16 oz) cup containing the sodium polyacrylate and a 10 oz cup containing 200 mL tap water.
- Tell them to:
  1. Pour the water into the cup with the sodium polyacrylate and stir with a spoon.
  2. Observe that all the water is absorbed (forms a gel) immediately. This is osmosis - the water moved into the white powder.
  3. Take out about 2 tsps of the gel and put back in to the 10 oz cup. Add 1 tsp salt and stir.
  4. 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 moving into the potato because there is a lower concentration of water in 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 balance the water concentrations.

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.
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 try to balance the water concentration inside and outside the polymer network

IV. Examples of Osmosis in Beans and Fruits

- Show the students the dried beans and the beans that have been soaking in tap water overnight, the soaked and the unsoaked dried fruit.
- 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.

Your Notes:

- 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.

VI. Checking the Potatoes

After 25 minutes, tell the students to do the following:

1. Remove the first potato slice from the distilled water and very gently blot it on a paper towel.
2. Place the potato slice on the original drawing and compare. Fit the potato to one short end of the trace (rather than a long end) and note changes in the length.
3. Notice how the potato feels (can it be bent?).
4. Remove the slice from the salt solution, blot gently, and compare to original tracing. Again, notice how the potato feels.

Students should observe the following:

- The potato slice in the distilled **water** is **longer** (and wider), indicating that more water molecules went into the potato than came out. The potato is also **stiffer**.
- The potato slice in the **salt** solution is **shorter** (and thinner), indicating that more water molecules came out of the potato than went in. This potato is very **limp**.

Share the following explanation with students, using the diagram on the board:

- Tell students to recall that **diffusion** is the movement of molecules across a membrane from an area of higher concentration to an area of lower concentration.
- **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 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.

Your Notes:

OBSERVATION SHEET

Can you smell the vanilla that has been put into the balloon? _____

Is this due to osmosis or diffusion? _____

IIA. Effect of Distilled Water on Potato Slice

How has the potato changed its size? _____

Is this osmosis or diffusion?_____

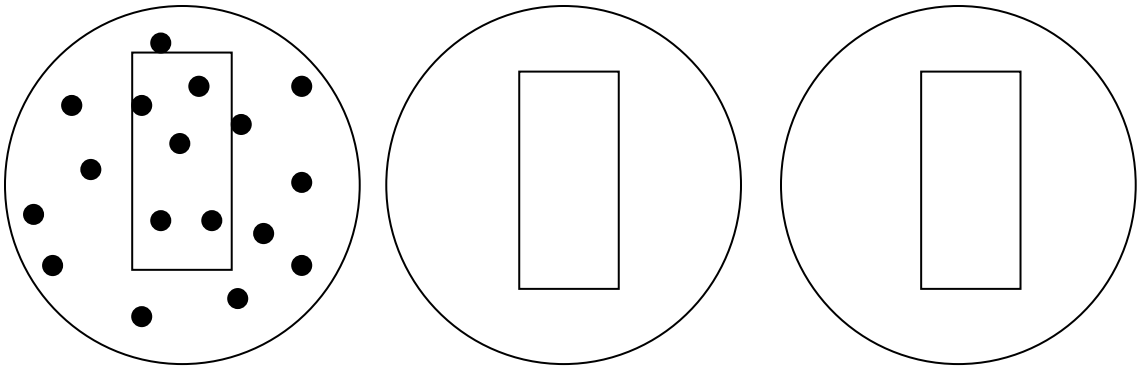
How does it feel different? _____

IIB. Effect of Salt Water on Potato Slice

How has the potato changed its size? _____

How does it feel different? _____

How have the water molecules moved?_____



Time zero | **After 15 minutes in distilled water** | **After 15 minutes in salt water**

Using ● to represent water molecules, draw diagrams to illustrate how the concentration of water molecules changes after the potato is placed in distilled water or salt water.

III. Observing Osmosis with a Superabsorbent Polymer.

What happens when you add water to the sodium polyacrylate?_____

_____

What happens when you add salt to the sodium polyacryalte slush?_____

_____

Describe the osmosis that has occurred. _____

V. Osmosis in "Orbs"

Predict what will happen to the orbs when they are put into water._____

ANSWER SHEET

I. Introduction

Can you smell the vanilla that has been put into the balloon? _____

Is this due to osmosis or diffusion? *Diffusion*

IIA. Effect of Distilled Water on Potato Slice

How has the potato changed its size? *Has become larger*

How does it feel different? *More rigid*

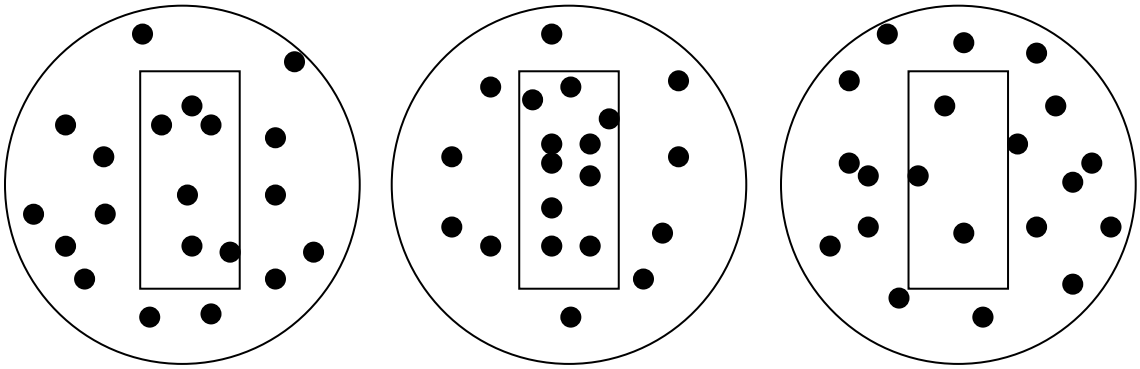
How do you know if this is osmosis or diffusion? *It is osmosis because it involves the movement of water into the potato.*

IIB. Effect of Salt Water on Potato Slice

How has the potato changed its size? *It has shrunk (become smaller).*

How does it feel different? *Floppy, limp*

How have the water molecules moved? *The water molecules have moved from the potato and into the water.*



III. Observing Osmosis with a Superabsorbent Polymer.

What happens when you add water to the sodium polyacrylate? *The powder absorbs all the water and makes a slushy gel*

What happens when you add salt to the sodium polyacrylate slush? *The water comes out of the slush*

Describe the osmosis actions that have occurred. *Water molecules moved into the sodium polyacrylate and when salt was added, the water molecules move out of the slush.*

V. Osmosis in "Orbs"

Predict what will happen to the orbs when they are put into water. *Water will move into the orbs and they will swell up.*

DATA WORKSHEET

POTATO TRACING #1 **PLACE IN PETRI DISH # 1 ADD DISTILLED WATER**

POTATO TRACING # 2 **PLACE IN PETRI DISH # 2 AND ADD SALT SOLUTION**

Osmosis Instruction Sheet

I. What is Osmosis?

Can you smell the vanilla in the balloon? Is this due to diffusion or osmosis?

II. Experiment: Osmosis in Potatoes

- Pour distilled water into the two small cups, to the 30 mL mark.
- Place the 2 petri dishes on the appropriate sections of the Potato Data Sheet.
- Very carefully feel how rigid or floppy the potatoes are. (Treat carefully - do NOT break them.)

A. The Effect of Distilled Water on Potatoes: Petri dish #1

4. Trace one of the pieces of potato onto the Potato Activity Sheet underneath POTATO TRACING # 1.
5. Place it in the bottom of the petri dish next to its tracing.
6. Pour distilled water from one of the cups into petri dish #1, so that the potato slice is completely covered and place the lid over the petri dish.

B. The Effect of Salt Water on Potatoes: Petri dish #2

7. Make the salt water by putting 1 tsp of salt into the other 3.5 ml cup and stirring until it is dissolved (it will not matter if there is some solid remaining).
8. Trace the other piece of potato on the Potato Data Sheet under POTATO TRACING # 2.
9. Place it in the bottom of the petri dish #2 next to its tracing.
10. Pour the salt solution into this petri dish #2, so that potato slice is submerged and place the lid over the petri dish.
11. Leave the experiment undisturbed for 20-30 minutes until instructed to return to check the results.
12. The longer the potatoes soak - the better. While you are waiting for the potatoes to change, do the following activities.

III. Observing Osmosis with a Superabsorbent Polymer.

5. Pour the water from your 10 oz cup into the 16 oz cup containing the sodium polyacrylate and stir with a spoon. What happens?
6. Take out about 2 tsps of the gel and put back in to the 10 oz cup. Add 1 tsp salt and stir. What happens?

IV. Examples of Osmosis in Beans and Fruits

Look at the dried beans and beans in water, the dry and soaked raisins. How do these examples show osmosis?

V. Example of Osmosis in "Orbs"

Your teacher will put a spoonful of "orbs" into a clear 10 oz cup and add water so that it is about ¾ full. Predict what will happen to the orbs. Why?

VI. Checking the Potatoes

5. Remove the first potato slice from the **distilled water** and very gently blot it on a paper towel.
6. Place the potato slice on the original drawing and compare. Fit the potato to one short end of the trace (rather than a long end) and note changes in the length. Notice how the potato feels (can it be bent?).

7. Remove the slice from the **salt solution**, blot gently, and compare to original tracing. Again, notice how the potato feels.
8. How does this experiment illustrate osmosis?