Oak Ridge Institute for Science and Education **ORISE Lesson Plan**

Water Movement

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Target Grade: 10th Grade Biology

Time Required: 85 minutes

Standards

Next Generation Science Standards (NGSS):

- HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Lesson Objectives

Students will be able to:

- Understand what drives the movement of water molecules.
- Explain and predict the movement of water molecules through cell membranes by using water concentrations.
- Follow the scientific method to explain the phenomenon of cell osmosis and diffusion.

Central Focus

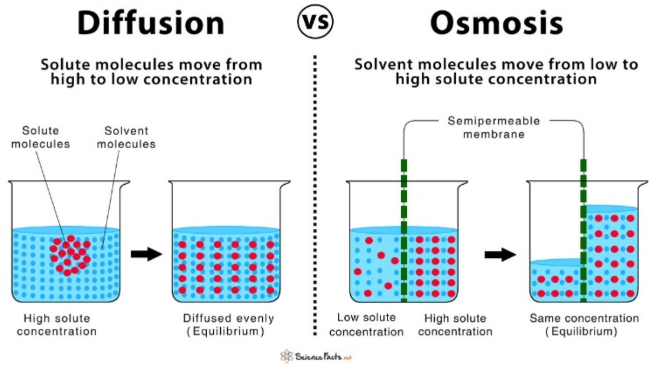
In this lesson, students will collaborate to complete a lab that allows the students hands-on experience with osmosis and diffusion in cells. Students will perform their investigations by adding concentrated salt water to samples of an onion and an *Elodea.* At the end of the lesson, students will model what they learned with a bottle top and string demonstration.

Key Terms: biology, water movement, groups, discussions, phenomenon, cell wall, diffusion, solvent, solute, semipermeable

Background Information

Students should be aware of the scientific process and the following steps: observation, question, hypothesis, experiment, analysis, and conclusion. The scientific process is cyclic and should always allow for further research.

Students should be aware of the definition of osmosis and diffusion. Osmosis is the movement of solvent from the region of high solute concentration to the region of low solute concentration, through a semipermeable membrane. Diffusion is the movement of solutes existing in any state of solid, liquid or gas from a region of their higher concentration to the region of lower concentration, but without a semipermeable membrane.



https://www.sciencefacts.net/diffusion-and-osmosis.html

Materials

- Clothesline
- Location to hang clothesline
- Microscopes
- Coverslips
- Beakers
- Eyedroppers
- Scalpel
- Red onion
- Blue bottle caps
- Yarn
- Plasmolysis Exploration student and teacher worksheet
- Wet clothes
- Clothespins
- Slides
- Water
- Salt
- Paper towels
- Cutting board
- *Elodea*
- Red bottle caps
- Clothesline Questions student and teacher worksheet

Instruction

Before class preparation (30 minutes):

- Set up the clothesline with wet clothes.
- Prepare a 10% salt solution by placing 10 grams of NaCl in a graduated cylinder and adding distilled water to bring the volume up to 100 ml.
- Using the scalpel, cut thin slices of red skin from the red onion and prepare slides for student use.
- Peel off individual *Elodea* leaves and prepare slides for student use.

Introduction:

- Place each student into a lab group with the Clothesline Group Questions packet for each student.
- Allow students time to work in their groups to fill out the packet and ask any questions.

- Once students have finished their packets, take a few minutes as a class to discuss some of the answers.
- While discussing, the teacher will hand out the Plasmolysis Exploration worksheet.
- Students will work within their groups to complete the lab.

Activity:

- To begin the lab, students will be asked to place a piece of red onion skin on a slide and make an observation of the cells.
- The students will then make a prediction as to what the cell will look like when they add the salt solution to the onion.
- Next, the students will add a salt solution to the onion and make an observation with the microscope.
    - Students will be asked to record observations with a drawing and a written description as to why they think the phenomenon occurred.
- Students will then make a prediction for what will happen when they add fresh water to the onion.
- The students will test their predictions by adding the water and recording their observation.
- The students will then repeat the experiment with an Elodea cell as well.
- One the students have finished the lab, they will be required to finish the questions reflecting on what was occurring in their observations.

Elaboration:

- Once all groups have finished their lab packet, one group will model the cell's response to salt with the yarn. Each material represents a different part of water movement in a cell.
    - Yarn=cell wall
    - Blue colored bottle caps=water molecules
    - Pink/red colored bottle caps=salt molecules

Closing:

- To end the lesson, the teacher will lead a short class discussion having the students explain what they learned that day.

Differentiation

- Groups should have a group leader who has the ability to read the questions clearly to the group – this will help those with reading difficulties understand what is being asked.

- Teacher can take a pad around to the tables and create illustrations for questions to help visual learners, students with special needs, and ELLs further understand a concept.
- Teacher can choose to have students write or illustrate what they learned during the lesson if students do not feel comfortable discussing at the end of class.

Assessment

Summative assessment:

- Teacher can review the worksheets for completion and accuracy to check for students understanding of the lesson.

Formative assessment:

- Each student's bottle cap model will allow the teacher to gauge the student's understanding of water movement in the cell.
- Classroom discussions will allow the teacher to quickly assess students' understanding.

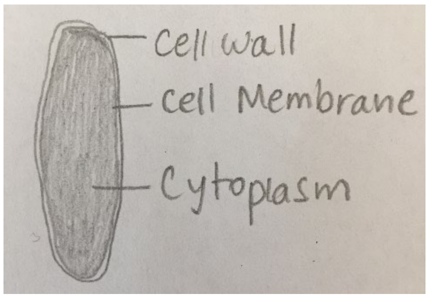
Plasmolysis Exploration NOTES FOR TEACHERS

In this lab, you will make observations of red onion and *Elodea* cells before and after the addition of saltwater.

RED ONION

1. Place a piece of red onion skin on a slide, add a drop of water and cover with a cover slip.
2. Make observations under medium or high power and sketch one cell. Label: **cell wall, cell membrane & cytoplasm**.

BEFORE SALT WATER SKETCH **LABELS** **OBSERVATIONS**

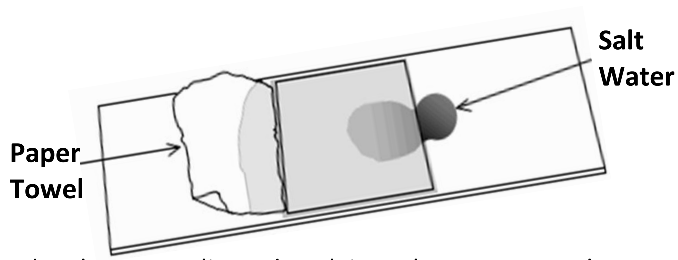


Cells are packed closely together.
Cytoplasm is all cells is pinkish color.

3. Predict and sketch what do you think the onion cells will look like after the addition of salt water.

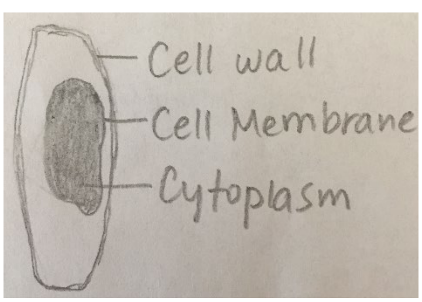
PREDICTION SKETCH **LABELS**

Predictions will vary



4. Add salt water to the slide by tilting the slide long ways and placing one layer of paper towel along the bottom edge of the cover slip. Then, add 15 drops of saltwater to the top edge of the cover slip. The saltwater will be drawn under the cover slip and soak into the paper towel.
5. Under medium or high power, look at the cells that are on the outside edges of the specimen.
6. Sketch one cell. Label the **cell wall, cell membrane and cytoplasm.**

AFTER SALT WATER SKETCH **LABELS** **OBSERVATIONS**



Cytoplasm shrunk inside the cell.
Cell wall did not change.
Cytoplasm is a darker pink.
Cell membrane pulled away from the cell wall and is clearly visible.

7. Why do you think this happened? Is your reasoning consistent with the hypothesis you made concerning the movement of water off clothes?

Students should note that the water went from inside to outside. If water went from high concentration on clothes to the low concentration in the air, then if water moved out of the cell, it must have had a higher concentration inside the cell than outside. Salt water does have a lower concentration of water.

8. Predict what you think will happen if you change the concentration of water outside the cells by adding fresh water to the slide. Why do you think this will happen?

   Most students think that it will rehydrate

9. Using the same method described above, add plain water to the slide, and observe cells on the outside edges of the specimen. Did the cells return to their original condition? Explain why or why not.

   The cells will rehydrate, but it takes longer for them to rehydrate than dehydrate and it is only visible at first on the cells along the edges of the piece of onion skin

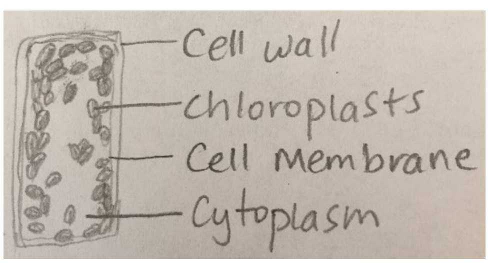
10. Do you think all cells respond to salt water in this way? Why or why not?

    Answers vary, most say yes.

Elodea (aquatic plant - hydrophyte)

1. Place an *Elodea* leaf on a slide, add a drop of water and cover with a cover slip.
2. Make observations under medium or high power and sketch <u>one</u> cell.
   Label: **chloroplasts, cell wall, cell membrane & cytoplasm.**

   BEFORE SALT WATER SKETCH **LABELS** **OBSERVATIONS**



Green chloroplasts scattered around the interior of the cell.

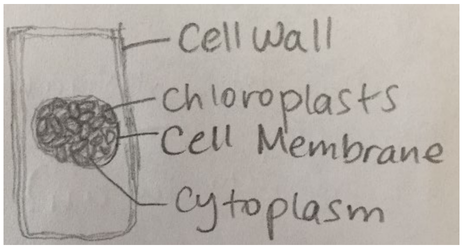
3. Predict and sketch what do you think the *Elodea* cells will look like after the addition of salt water.

   PREDICTION SKETCH **LABELS**

   Predictions will vary

4. Use the same method described in the onion section to add salt water to the slide.
5. Under medium or high power, look at the cells on the outside edges of the specimen.
6. Draw one cell. Label the **chloroplasts, cell wall, cell membrane and cytoplasm.**

AFTER SALT WATER SKETCH **LABELS** **OBSERVATIONS**



Chloroplasts are bunched up in a ball.
Cell membrane pulled away from the cell wall and is clearly visible.

7. Why do you think this happened? Where was the concentration of water the greatest?

   Concentration of water was the greatest on the inside of the cell.

8. We used a 10 % salt solution.
   a) Do you think the amount of salt in the solution affects the results? **yes**

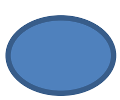
   b) Would the results be different with a 5% solution? Explain.
   Yes, the reaction would have occurred slower and not been as dramatic.

   c) Would the results be different with a 15% solution? Why or why not?
   Yes the reaction would have been faster and more dramatic.

9. Would the result have been different if we had used a marine plant leaf? Why or why not?
   Yes, marine plants are adapted to live in a salt water environment. If the salt solution was the same as the marine environment, there would have been no movement of water (students generally do not know the concentration of salt in salt water)

10. When you eat salty foods, such as pretzels, you create a salt water solution around your cells. How do your cells respond? Explain why this happens and show before and after sketches of what it might look like.

    Cells before eating salty foods Cells after eating salty foods



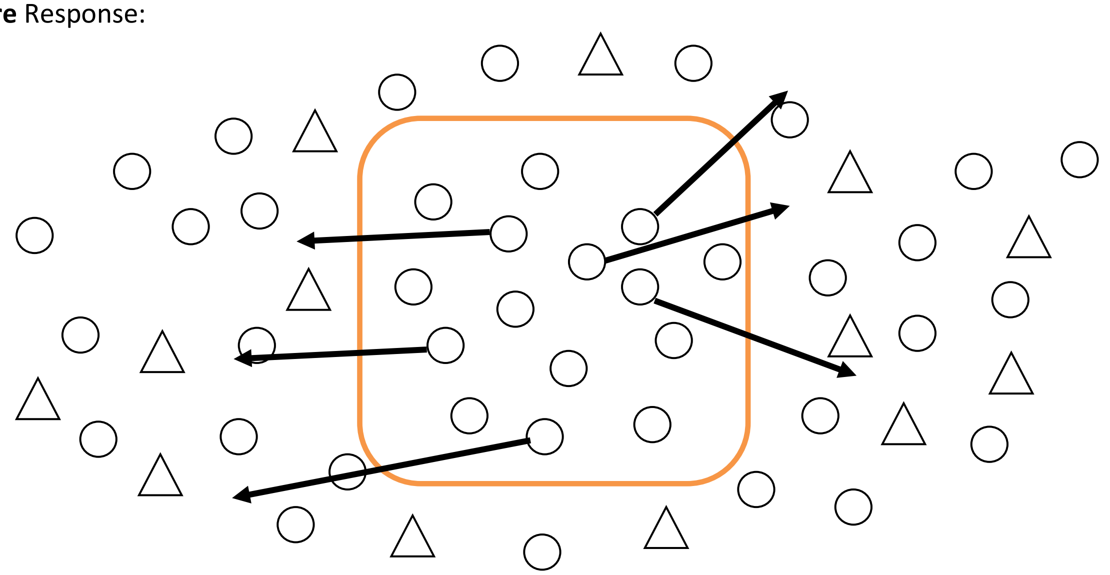
Salt creates a salt water solution in your saliva which lowers the concentration outside your cells, so water leaves your cells.

How do your dehydrated cells respond if you drink water? **They will rehydrate like the onion cells**

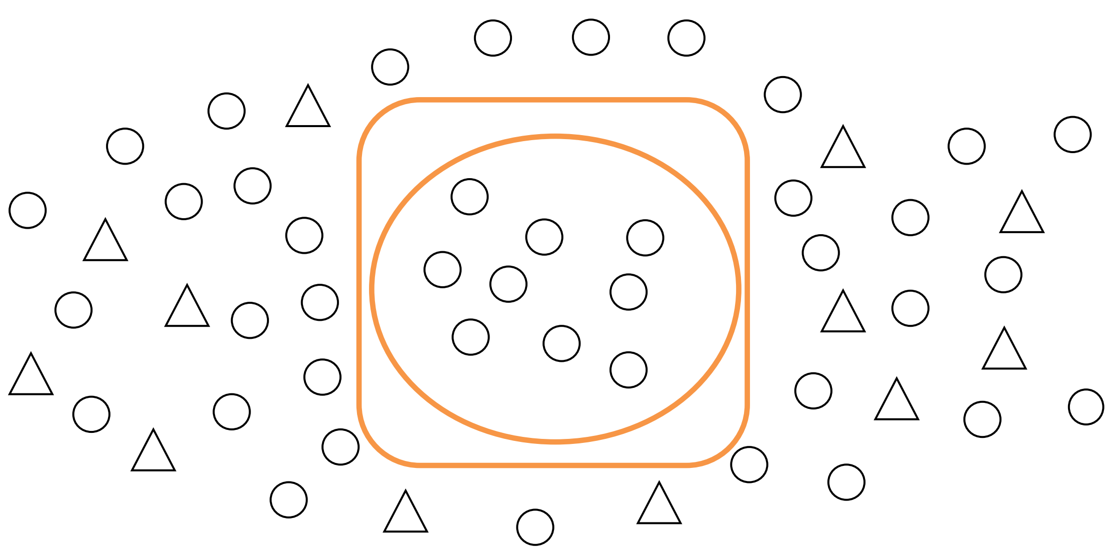
11. A cellular response occurs when you add salt water to onion, *Elodea* and your own cells. This response involves the movement of water. Think about the clothesline and what causes water molecules to leave the clothes. Think about how the concentration of water molecules might be different in a salt water solution and inside of your cells. With this in mind, explain using arrows and a diagram, what you think salt and water molecules are actually doing when this response occurs.

Use the following symbols for water molecules and salt molecules: salt = △ water = ○

Cell in salt water
Before Response:



Cell **After** Responding to
Salt water



Water is more concentrated inside the cell and less concentrated outside, due to the presence of salt in the water. Water moves from high to low concentration, so water molecules will move from the inside of the cell to the outside of the cell. This causes the cytoplasm to shrink and the cell membrane to pull away from the cell wall.

Plasmolysis Exploration

Name:

In this lab, you will make observations of red onion and *Elodea* cells before and after the addition of saltwater.

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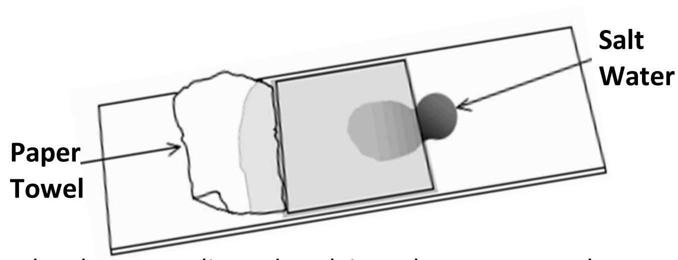
   BEFORE SALT WATER SKETCH **LABELS** **OBSERVATIONS**

3. Predict and sketch what you think the onion cells will look like after the addition of salt water.

   PREDICTION SKETCH **LABELS**



4. Add salt water to the slide by tilting the slide long ways and placing one layer of paper towel along the bottom edge of the cover slip. Then, add 15 drops of saltwater to the top edge of the cover slip. The saltwater will be drawn under the cover slip and soak into the paper towel.
5. Under medium or high power, look at the cells that are on the outside edges of the specimen.
6. Sketch <u>one</u> cell. Label the **cell wall, cell membrane and cytoplasm.**

   AFTER SALT WATER SKETCH **LABELS** **OBSERVATIONS**

7. Why do you think this happened? Is your reasoning consistent with the hypothesis you made concerning the movement of water off clothes?

8. Predict what you think will happen if you change the concentration of water outside the cells by adding fresh water to the slide. Why do you think this will happen?

9. Using the same method described above, add plain water to the slide, and observe cells on the outside edges of the specimen. Did the cells return to their original condition? Explain why or why not.

10. Do you think all cells respond to salt water in this way? Why or why not?

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2. Make observations under medium or high power and sketch one cell.
   Label: **chloroplasts, cell wall, cell membrane & cytoplasm.**
   BEFORE SALT WATER SKETCH LABELS OBSERVATIONS

3. Predict and sketch what you think the *Elodea* cells will look like after the addition of salt water.
   PREDICTION SKETCH LABELS

4. Use the same method described in the onion section to add salt water to the slide.
   Under medium or high power, look at the cells on the outside edges of the specimen.
   Draw <u>one</u> cell. Label the **chloroplasts, cell wall, cell membrane and cytoplasm.**

   AFTER SALT WATER SKETCH **LABELS** **OBSERVATIONS**

5. Why do you think this happened? Where was the concentration of water the greatest?

6. We used a 10 % salt solution.
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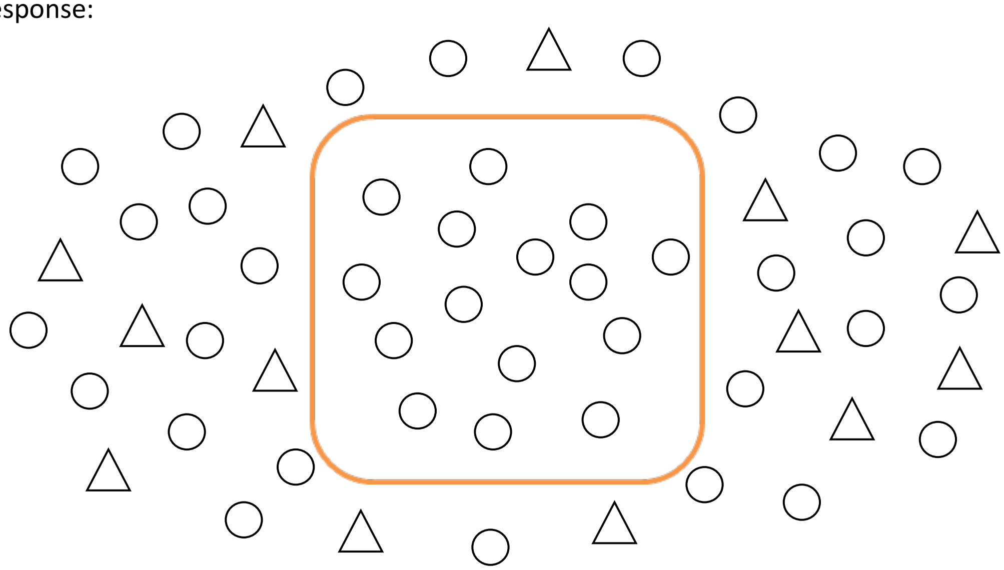
   Cell in salt water
   Before Response:



   After Responding to
   Salt water

Clothesline Group Questions

Discuss and answer each question thoroughly before moving onto the next. Ask for help if you cannot come up with an answer – don't move onto the next question without answering the one before.

1. The clothes are drying. What causes the water to leave the clothes?

2. What makes water molecules move off the clothes - why don't water molecules stay on the clothes? What causes evaporation?

   Make a hypothesis to explain why clothes dry.

3. Does evaporation work in all instances? Do wet clothes always dry no matter where they are? Explain.

4. What conditions could we change in the room to slow down or speed up the rate of drying? Name at least three and explain why these conditions affect evaporation.

   a.

   b.

   c.

5. Decide which of the three conditions listed in # 3 has the greatest impact on evaporation by considering which one can work independently of the other two. Explain your choice.

6. Let’s go back to #2,
   You made a hypothesis to address the question, “What determines whether or not water molecules will move off of clothes?”
   Do you think your hypothesis is correct or do you want to revise it? Explain.

   What is your final answer to the question, “What controls the movement of water molecules?”

Clothesline Group Questions NOTES FOR TEACHERS

Discuss and answer each question thoroughly before moving onto the next. Ask for help if you cannot come up with an answer – don't move onto the next question without answering the one before.

1. What is causing these clothes to dry?

   Most groups will answer evaporation.

2. What makes water molecules move off the clothes - why don't water molecules stay on the clothes? What causes evaporation?

   This confuses students. You can remind them to think of water as molecules, in order to guide them. They then realize that water molecules are leaving the clothes and some will mention that heat makes molecules move faster.

   Make a hypothesis to explain why clothes dry.

   These will vary, but most will include some aspect of molecular movement and heat. Sometimes you may get gravity, especially if the clothes on the line are dripping.

3. Does evaporation work in all instances? Do wet clothes always dry no matter where they are? Explain.

   From past experience, students know that heat increases drying rate and cold will slow it down.

4. What conditions could we change in the room to slow down or speed up the rate of drying?
   Name at least three and explain why these conditions affect evaporation.

   Most students can't get past temperature - hot and cold.
   You can provide them hints:
   Think of your experiences with evaporation and clothes drying in the past.
   What days are best to hang clothes out to dry?
   Are there some places in the country where clothes on a line dry faster?
   With the exception of rain, in what conditions would clothes on a line take hours to dry?
   Are there some days in the summer when your sweat doesn't evaporate fast and it is difficult to stay cool?
   What do custodians do when they want to dry floors in the building? (they use floor fans)
   In addition to heat, what is a blow dryer doing to your hair?

   a. Temperature – heat increases molecular movement

   b. Humidity – 100% humidity creates conditions where water molecules on clothes have nowhere to go

   c. Wind – wind physically interacts with water molecules (students may mention a fan in the room)

5. Decide which of the three conditions listed in # 3 has the greatest impact on evaporation by considering which one can work independently of the other two. Explain your choice.
   Humidity. It doesn't matter what the temperature is or how much wind there is, if there is 100% humidity, clothes will not dry quickly or at all.

6. Let's go back to #2,
   You made a hypothesis to address the question, "What determines
   whether or not water molecules will move off of clothes?"
   Do you think your hypothesis is correct or do you want to revise it? Explain.

   If students were able to reason out #5, then they will realize that water concentration in an environment is the strongest influence on water molecule movement. Clothes will dry in very cold temperatures as long as the humidity is low, but clothes will not dry quickly or at all in a hot room filled with steam.

   What is your final answer to the question, "What controls the movement of water molecules?"

   Answers will vary, but should relate to the amount or concentration of water in the environment.