Georgia Performance Standards Framework for Biology 9-12

Unit: Equilibrium
Inquiry Task

How Do Cells Use Osmosis To Maintain Homeostasis?

Overview: This task is written to be used as a guided inquiry lab to investigate how materials move across a simulated cell membrane using plastic sandwich baggies (or some other comparable material) to learn how diffusion helps organisms maintain homeostasis. The goal of this task is to stimulate discussion and thinking throughout the investigation in order for students to conceptualize how the process of diffusion works and learn of its significant role in cellular homeostasis.

Standards:

SB1. Students will analyze the nature of the relationships between structures and functions in living cells.
   a. Explain the role of cell organelles for both prokaryotic and eukaryotic cells, including the cell membrane, in maintaining homeostasis and cell reproduction.
   d. Explain the impact of water on life processes (i.e., osmosis, diffusion).

SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.
   a. Exhibit the above traits in their own scientific activities.
   b. Recognize that different explanations often can be given for the same evidence.
   c. Explain that further understanding of scientific problems relies on the design and execution of new experiments which may reinforce or weaken opposing explanations.

SCSh2. Students will use standard safety practices for all classroom laboratory and field investigations.
   a. Follow correct procedures for use of scientific apparatus.
   b. Demonstrate appropriate technique in all laboratory situations.
   c. Follow correct protocol for identifying and reporting safety problems and violations.

SCSh3. Students will identify and investigate problems scientifically.
   a. Suggest reasonable hypotheses for identified problems.
   b. Develop procedures for solving scientific problems.
   c. Collect, organize and record appropriate data.
   d. Graphically compare and analyze data points and/or summary statistics.
   e. Develop reasonable conclusions based on data collected.
   f. Evaluate whether conclusions are reasonable by reviewing the process and checking against other available information.

SCSh4. Students use tools and instruments for observing, measuring, and manipulating scientific equipment and materials.
   a. Develop and use systematic procedures for recording and organizing information.
   b. Use technology to produce tables and graphs.
   c. Use technology to develop, test, and revise experimental or mathematical models.

SCSh6: Students will communicate scientific investigations and information clearly.
   a. Write clear, coherent laboratory reports related to scientific investigations.
   b. Write clear, coherent accounts of current scientific issues, including possible alternative interpretations of the data.
   c. Use data as evidence to support scientific arguments and claims in written or oral presentations.
   d. Participate in group discussions of scientific investigation and current scientific issues.

SCSh8: Students will understand important features of the process of scientific inquiry.
   Students will apply the following to inquiry learning practices:
   a. Scientific investigators control the conditions of their experiments in order to produce valuable data.
   b. Scientific researchers are expected to critically assess the quality of data including possible sources of bias in their investigations’ hypotheses, observations, data analyses, and interpretations.
   c. Scientists use practices such as peer review and publication to reinforce the integrity of scientific activity and reporting.
   d. The merit of a new theory is judged by how well scientific data are explained by the new theory.
   e. The ultimate goal of science is to develop an understanding of the natural universe which is free of biases.
   f. Science disciplines and traditions differ from one another in what is studied, techniques used, and outcomes sought.

Georgia Performance Standards Framework for Biology 9-12

Enduring Understanding: Organisms must use cell transport for survival at all levels of organization to maintain equilibrium.

Essential Question(s): How do organisms use diffusion and osmosis to maintain overall survival?

Pre-Assessment: Have students try to answer why a piece of gel candy swells when placed in a glass of water and left over a period of time (the teacher could conduct this small investigation a day earlier before giving this as a pre-assessment). Students could write responses on chart paper or teacher may write responses on the chalkboard/overhead. TEACHER: You could use the Potato click to view lab task for a more advanced pre-assessment option.

| Outcome/Performance Expectations | 1. Students will be able to explain the movement of materials across a selectively permeable membrane and its impact on homeostasis.  
2. Students will further connect the cellular movement of materials to the tissues and organs of a multicellular organism. |
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<td>Write a concept statement...How would you formulate an expert idea?</td>
<td>1. Before starting the lab, students could pose various hypotheses, predictions, and procedures of a controlled experiment in which student’s will test hypotheses or predictions about how molecules move across a membrane.</td>
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| Write a concept statement / question...What kind of situation would cause this concept to become apparent in students’ understanding? | 1. What variables would change the outcome of the experiment?  
2. What is the purpose of test tube C.?  
3. What does the plastic bag represent or simulate?  
4. What would happen to the movement of molecules if the water was decreased by half? Make a prediction of the outcome. Outline a procedure to support ideas your ideas. |

### Identify necessary data and observations...

What data would demonstrate the mastery of the concept by ALL students in the classroom?

- Why does water move easier through the plastic bag rather than the starch?
- Explain why some molecules diffused through the bag.
- Can you predict the size of the molecules based on the diffusion of the contents through the simulated cell membrane? Explain the reason for your answer.
- Kidneys filter out waste in the form of urine. Write a summary statement of how diffusion and osmosis can filter out the waste and keep water as a vital nutrient for life.

### Write procedures that will cause students to organize data...

**Test a procedure using known concepts.**

Teacher Note: Directions modified from the Baggie Diffusion Lab from the Equilibrium Framework

Possible Materials: Teacher note on procedures: In order to achieve a higher level of inquiry, the teacher may choose to give only the materials provided to students in groups with little to no direction of how to test the plastic baggie as a permeable membrane with the substances provided from the list below. In addition, the teacher may choose for students to create their own written procedures for testing a hypothesis.

Starch solution, glucose solution, water, glucose test strips, iodine solution, beakers, test tubes, two plastic fold over sandwich bags (per lab group):

*Teacher note: these directions can be provided to help guide through the inquiry process. Directions have been modified from Biology Equilibrium Framework Task titled Baggie Diffusion.*

1. Label three beakers A, B and C.
2. Add 50 ml of water to each beaker.
3. Add 10 ml of iodine to beakers A and C.

Georgia Performance Standards Framework for Biology 9-12

4. Add 10 ml of starch to beaker B.
5. Put 10 ml starch in sandwich bag.
6. Twist tie shut and put in beaker A.
7. Put 10 ml iodine in another sandwich bag.
8. Twist tie shut and put in beaker B.
9. Put 10 ml starch in test tube and place in beaker C.
10. Allow to sit for 15 minutes. Teacher Note: During the fifteen minute wait period, you may want to discuss the definitions of diffusion and osmosis. This could be done as a Venn Diagram. You could also discuss what students think will happen?
11. Collect data and create a data table.
12. Write a lab report on your findings. (Teacher Note: Please encourage students not to say “we proved” our hypothesis, use SUPPORT or REFUTED. Science’s goal is not to prove anything, only to understand nature. (Students may use the lab report template in the equilibrium unit task on page 41).

Teacher notes:

Quantities of materials may need to be adjusted depending on the materials available.

Dialysis tubing is a very good semi or selectively permeable membrane that is often used in osmosis and diffusion labs.

Be sure to follow appropriate safety guidelines for chemicals if iodine is used.

| Write questions or activities to use or apply the concept (represent, model, visualize, or predict) | • Predict the size of the molecules based on the diffusion of the contents through the simulated cell membrane. Explain the reason for your answer. |
| | • Kidneys filter out waste in the form of urine. Write a summary statement of how diffusion and osmosis can filter out the waste and keep water as a vital molecule for life. |

| design new experiments) | • Diabetics often experience excessive thirst and frequent urination. Using what you have learned in this activity, explain how these symptoms are examples of cells attempting to maintain homeostatic balance.

• A marine diatom floats into a tidal creek after a summer rain storm. The rainwater runs off into the tidal creek changing the salt concentration of the water. Describe how the diatom would maintain homeostasis in this new environment.

• A fresh celery stalk was placed in 10% salt water. After 24 hours, what observations can you conclude about the turgor pressure of the cells? Based on your observations, could it be possible for a celery farmer to plant celery in soil that has high salt concentration. Explain your answer. |

| Homework/Extension | **Option 1-**
Use the [Gummy](#) click to view bear lab for post lab assessment, give students 2 days to do the assignment. After two days, students are to bring in rough drafts of the assignment to bring to a pair-share grouping.

**Option 2-**
Students can observe these two pictures of red onion skin cells. The AFTER picture is a result of adding salt water to the external environment of the red onion cells. Give reasons for why the cells in the AFTER picture shrank after administrating salt water? |

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### Instructional Tasks

#### Accommodations for ELL Students
- Modify language requirements for lab report
- Pair with more advanced native language speaking partner (allow for translation in native language for comprehension) as needed
- Provide paragraph summary template (fill in the blank format)
- Provide bilingual support using word to word translation such as dictionaries, and glossaries
- Use visuals (Lab symbols) for safety precautions
- Highlight key points/key words
- Adapt homework requirement to reflect stage of language development

#### Accommodations for Students with Disabilities
- **Review and Implement IEP accommodations for specific student needs**
  - Other Accommodations may include:
    - Word banks for written lab report
    - Discuss a summary statement as a group and give an oral response to the summary statement
    - Provide template of rough draft for rough experimental design
    - For the homework research, have students bring in a picture of a dialysis machine or draw one labeling key parts and how it works

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Instructional Tasks
Accommodations for Gifted Students

Option 1:
Kidney dialysis machines act as a substitute kidney for patients who have major kidney problems. Based on the concept of diffusion, design a kidney dialysis machine and present or write a report about this prototype to your peers and teacher for evaluation.

Option 2:
Scenario:
A high school football player has become very ill due practicing in the heat of the day during summer football camp. The football player was known to take sinus medications regularly and his favorite drink before practice is RED COW which is loaded with caffeine and sugar. Sinus medications sometimes contain amphetamines which are known to have the chemical structure of caffeine in the make up amphetamines. The football player experienced severe cramping in his legs and lower abdomen. Vomiting and dizziness were reported to the school athletic trainer.
QUESTIONS:
- At the cellular level, what type of osmotic environment is causing a disruption in the homeostatic condition of football player experiencing the symptoms of heat illness?
- What clues in the scenario would warrant severe cramping in the muscle tissues and dizziness in the head?
- As a doctor you are well aware of osmotic movement within cells, please explain how you would treat this patient and describe how your treatment balances out the solute versus solvent levels to return the football player to homeostatic balance.

Teacher Note: Optional tasks have been provided to meet a diversity of learners. Please use and adapt to your students.
From the DOE Equilibrium Framework

Georgia Performance Standards Framework for Biology 9-12

Baggie Diffusion or Diffusion Through a Cell Membrane

Problem: Using a baggie, design an experiment to show how it can be used as a model for a cell membrane.

Possible Materials: Starch solution, glucose solution, water, glucose test strips, iodine solution, beakers, test tubes, two plastic fold over sandwich bags (per lab group)

Sample Procedures:
1. Label three beakers A, B and C.
2. Add 50 ml of water to each beaker.
3. Add 10 ml of iodine to beakers A and C.
4. Add 10 ml of starch to beaker B.
5. Put 10 ml starch in sandwich bag.
6. Twist tie shut and put in beaker A.
7. Put 10 ml iodine in another sandwich bag.
8. Twist tie shut and put in beaker B.
9. Put 10 ml starch in test tube and place in beaker C.
10. Allow to sit for 15 minutes.
11. Collect data and create a data table.
12. Write a lab report on your findings.

Questions to consider:

1. What does the plastic bag represent?
2. What is the purpose of the test tube in beaker C?
3. What diffused through the bag?
4. Explain how you know what diffused.
5. Was this active or passive transport?

Teacher note: Quantities of materials may need to be adjusted depending on the materials available. Dialysis tubing is a very good semi or selectively permeable membrane that is often used in osmosis and diffusion labs.

Be sure to follow appropriate safety guidelines for chemicals if iodine is used.

PRE ASSESSMENT

DIRECTIONS COULD BE USED FOR FURTHER INVESTIGATION OF THE POTATO THROUGH INQUIRY

Potato Osmosis

Problem: How does the concentration of salt water and fresh water affect the movement of water in and out of a cell?

Materials: Two potato slices, two beakers, salt water, distilled or tap water (per lab group)

Procedures:
1. Place one potato in fresh water.
2. Place one potato in salt water.
3. Wait and observe the changes at least 20 min.
4. Record data (make a table).

Questions to Consider:
1. What happened to the potato in salt water?
2. What happened to the potato in fresh water?
3. What do we call the movement of water in and out of a cell?
4. Did water move in or out of the potato cells in salt water? Draw a diagram.
5. Did water move in or out of the potato cells in fresh water? Draw a diagram.
6. What is the term we use when too much water leaves a cell?
7. What do we call it when too much water enters a cell?
8. Did the potato experiment (pre-assessment task) some or all of the following conditions: Please provide evidence from the lab results that would help defend your answer.
   a. plasmolysis
   b. cytolysis
   c. state of turgor

OPTION 1 POST ASSESSMENT

Gummy Bear Osmosis

What will happen to a gummy bear if left in water overnight?

Procedures:
1. Students predict what will happen.
2. Make gummy bear measurements such as color, length, width, height, mass, volume, and density. Record data in table. Sample data table below.
3. Place gummy bear in a labeled cup of 50 ml of water and allow to sit overnight.
4. Remove gummy bear from the water, repeat measurements and record.
5. Determine the change for each measurement and record.

<table>
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<tr>
<th>Experiment Data:</th>
<th>Day</th>
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<th>Length</th>
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Questions to Consider: Gummy Bear Osmosis

1. Was your hypothesis supported? Why or why not?
2. Which change is greater, volume or mass? Explain.
3. Was there a change in density? Why?
4. How do your results compare to those of your classmates?
5. Was the amount of water gained by the gummy bear the same as the amount of water lost in the container? Explain.

Teacher Notes:
Test your gummy bears before trying the lab with your students. Some gummy bears do not absorb water as well as others. Encourage students to investigate further. Ask students to predict what will happen to gummy bears if left in water another day, or if different water temperatures are used. Allow them to investigate their predictions.