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| **TEAM Lesson Plan Template** | |
| Teacher: Dr. James Smart | |
| Subject/Grade: Diffusion and Osmosis / Grade 7 | |
| Lesson Title: Diffusion and Osmosis 1.5 hours | |
| **STANDARDS** | **Identify what you intend to teach.** State, Common Core, ACT College Readiness Standards and/or State Competencies; Enduring Understandings and Essential Questions. |
| Caution: This activity calls for students to cut a potato. Ensure that they know proper knife-handling techniques such as those shown in this video: <https://www.youtube.com/watch?v=PmYdU68jpGA>  7.LS1.2. Conduct an investigation to demonstrate how the cell membrane maintains homeostasis through the process of passive transport.  Crosscutting Concepts: Cause and effect relationships that can be explained through a mechanism, Matter conservation through transformations that flow or cycle into, out of, or within a system, Stability and change of systems  SEPs: Planning and carrying out controlled investigations; using mathematics and computational thinking  Related mathematics standards:  7.RP.A.2d. Explain what a point (x, y) on the graph of a proportional relationship  means in terms of the situation, with special attention to the points (0, 0) and (1, r) where r is the unit rate.  7.RP.A.3. Use proportional relationships to solve multi-step ratio and percent problems  7.EE.B.4. Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.  8.F.A.3 Know and interpret the equation y = mx + b as defining a linear function, whose graph is a straight line. | |
| **OBJECTIVE(s)/Sub-Objectives** | **Connect prior learning to new learning.** Clear, Specific, Observable, Demanding, High Quality, Measurable, Aligned to Standard(s), and Integrated with other subjects, build on prior student knowledge  Student-Friendly (I Can Statement) |
| I can demonstrate the movement of molecules by diffusion.  I can observe the effect of hypertonic and hypotonic solutions on plant tissues.  I can draw a line representing the *percentage change in mass* as a function of salt concentration. | |
| **MATERIALS AND RESOURCES** | **Content-related:** Clearly supports lesson objective(s); rigorous & relevant; Incorporates multimedia & resources beyond the textbook. |
| **Resources**  This activity requires 30-60 minutes of waiting for the plant samples to soak in a salt solution. Plan for students to have something else to do during that time. Alternatively, it is possible to prepare, weigh, and soak samples in advance. Then students can do only the second weighing and analyze the data.  **Materials**  Whiteboard, markers, and eraser.  Diffusion & Osmosis notes (attached).  NaCl solutions in the following concentrations: 0M, 0.1M, 0.2M, 0.3M, 0.4M, 0.5M, 0.6M. Prepare enough for each group to have 50 mL of each solution.  Per group: Sharpie, pen, knife, cutting board, 7 weigh boats, ruler, potato, three or four paper towels, worksheet  Balance with 0.01g precision, paper towels for cleanup  **Routine for distributing materials:** Place balances and salt solutions in a central location. Individual students or pairs of students will come from each group to get salt solution and use balances. Place group supplies at a lab table for each group. | |
| **ACCOMMODATIONS/ADAPTATIONS** | **Learning styles and interests.** Anticipate learning difficulties, regularly incorporate student interests & cultural heritage; differentiate instructional methods. |
| **Modifications/Plans for Diverse Learners**  **Differentiation**  **\_\_x\_\_ Product** The grid included with the worksheet may be made even simpler by labeling the vertical axis for scale. The plotting problem may be made more challenging by giving students a blank piece of graph paper on which they have to construct and label axes. It may be made even more challenging by giving students a blank piece of paper so that they must use their rulers to construct and label axes.  **\_\_x\_\_ Content** Prior to the eighth grade, students should construct a line geometrically by aligning their rulers close to their data points. They will visually estimate the isotonic concentration of their plant tissue. It may be appropriate to ask eighth grade students to represent the line with an equation and solve the equation for the isotonic concentration.    **\_\_x\_\_ Process**  There are (at least) three possibilities for cutting potatoes. 1) Give each group of students a knife and potato and tell them to slice the potato. 2) Have each group send one student to a central location where the teacher keeps the knives and has students slice potatoes under close supervision. 3) The teacher pre-slices the potatoes and gives students the slices so that students never touch the knives.  For some students, it may be appropriate to have the students prepare the NaCl solutions. This will depend on the students’ measurement skill and time available. If students are to prepare the solutions, give them the instructions from Step 1 of the Diffusion and Osmosis Notes.  **Accommodations**  ***To be created for particular students*** | |

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| **MOTIVATING STUDENTS/ANTICIPATORY SET** | **“Hook”: Engage students’ attention and focus on learning.** Personally meaningful and relevant. |
| Can we learn **by** osmosis? Probably not, but can we learn **about** osmosis? Certainly. That is what we will do in this lesson.  ( or )  Mention the importance of regulating ion concentrations in our bodies. Heat cramps, heat exhaustion and other problems can occur if ion concentrations are wrong. We use saline solutions for IVs in medical settings, not pure water, because it’s lethal! | |
| **INSTRUCTIONAL PROCEDURES** | **Step-by-Step Procedures-Lesson Sequence: Basic to Complex.** Lesson includes visuals, modeling, logical sequencing and segmenting (beginning, middle, ending); essential information; concise communication; grouping strategies; differentiated instructional strategies to provide intervention & extension; seamless routines; varied instructional strategies; key concepts & ideas highlighted regularly. |
| ***Introductio*n**  With the whole group’s attention, explain what is going to happen. The students are going to weigh potato slices, soak them in solutions with different concentrations of salt, wait, dry the slices and weigh them again, record the results, and draw conclusions about the results.  Have students record their names on their worksheets. Within their groups, have students discuss and answer the question about the osmotic content of the potatoes.  Regain the whole group’s attention. Show a potato slice of the appropriate size and state its dimensions (approximately 5cm x 5cm x 0.5cm). Ask students why the slices need to be the same size (experimental control: everything needs to be the same except for the salt solution concentration. Changing the size can change the ratio of surface area to volume). Ask students why the slices need to be about 5x5x0.5 (The slices must fit in the weigh boats that we have).  Have students label their 7 weigh boats with the concentrations 0M, 0.1M, 0.2M, 0.3M, 0.4M, 0.5M, 0.6M, and have them pour 50mL of solution in the respective boats. Other members of each group can be slicing potatoes at the same time.  Have the students pat dry their potato slices. One slice at a time, they should weigh a slice, record its mass on their worksheet, and then place it in the appropriate weigh boat. (If they weigh all of the slices first, then try to put them in the boats, they could more easily get a slice in a boat contrary to the data recorded on the worksheet).  Have a group member note the time.  **Middle**  After each group has its potatoes soaking, regain the whole group’s attention. Ensure that students know how to calculate change in mass and percent change. In particular, ensure that they know that these values can be negative. Work the following examples:  An apple growing on a tree has an initial mass of 0.1Kg. After four days, its mass is 0.16Kg. What is its change in mass?  (Final minus initial is 0.16 – 0.1 = 0.06. The change in mass is 0.06 Kg).  What is the percent change in mass? (0.06/0.1 = 0.6 = 60%).  A cucumber in a grocery store has an initial mass of 425g. After two days the unsold cucumber has a mass of 300g. What is the change in mass?  (Final minus initial is 300 - 425 = -125. The change in mass is -125g).  What is the percent change in mass? (-125/425 ≈ -0.294 = -29.4%).  After working the arithmetic problems, discuss what is going on. Help students understand that the semipermeable membrane in this activity is actually many, many cell membranes.  Describe the difference between *diffusion* and *osmosis*. Molecules move from areas of higher concentration to lower concentration. When the molecules are water molecules, we call the process osmosis.  Describe the difference between *solvent* and *solute*. Here our solvent is water, and the solute is NaCl, table salt. Another example is food dye (Solute) and milk (solvent). A real world example is sugar (solute) in coffee (solvent). Ask students for other examples [sweet tea, Gatorade, . . . ]  Describe the differences between *hypertonic*, *hypotonic*, and *isotonic*. These terms are always relative. We are comparing the concentration of one solution to the concentration of another. Also help students understand that the concentration of the solvent has an inverse relationship to the concentration of the solvent.  Diagram  Description automatically generated  For the potato slices in the salt solutions, what does it mean if the mass of a slice changes? What does it mean if the mass of a slice of potato does not change? How can the mass decrease? What role does osmosis play?  If the potato slices have soaked for at least 30 minutes, have students return to their groups and note the time. One slice at a time, they should remove their potato from the salt solution, pat the slice dry with a paper towel, weigh the slice, and record its mass in the table on their worksheet. After weighing potatoes, some group members should begin cleanup while others complete the chart and graph. Have them make calculations and complete the tables and then plot percent changes in mass on a graph. After the chart and graph are complete, the entire small group (including the students who were cleaning) should discuss the results.  **End/Closure**:    Regain the whole group’s attention. Remind students to put their names on the worksheets. Discuss: What have we learned? What caused a potato slice to change mass? (Osmosis, water molecules moved from an area of higher to lower concentration). What concentration of salt would result in no change in the mass of the potato slice? (Use experimental data to find answer. ) Why? (This salt concentration matches the salt concentration in the potato, resulting in no net change in the amount of water in the potato slice).  Have students dispose of their potato slices, paper towels and salt solutions from the weigh boats. Have them turn in the worksheets.  **Motivating Students**  \_x\_ Relate to Real World Cells in our body are constantly maintaining a proper balance of chemicals inside and outside the cell  \_x\_ Verbal Reinforcement The teacher will monitor students’ work throughout the activity to provide reinforcement.  **Presenting Instructional Content**  \_x\_ Hands on Students slice and weigh the potato slices  \_x\_ Lecture / Work Examples While the potato slices are soaking, there will be a whole-group discussion of vocabulary and presentation of arithmetic examples  \_x\_ Modeling The teacher will demonstrate proper knife handling and will show a potato slice of the correct size.  ***Instructional strategies:***  **Modeling and Guided Practice *–*** The teacher will demonstrate comparison and measurement. The teacher will monitor students’ work and ask questions to prompt them if they are stuck.  **Check for Understanding (CFU) –**  ***What am I doing for students that progress at different rates?***  During potato slicing and weighing, if a group gets behind, the teacher can help slice. The teacher’s main job during this phase is to ensure a smooth flow of students to the balances and solutions. Students will wait for the potato slices to soak at the same pace. After soaking, if a group finishes before others, prompt them with questions about how to modify the experiment for future trials.  ***What do I do if they get it?***  Have students reflect on their answer to the question about osmotic content. Do the results support that answer? Introduce other scenarios, e.g. “What would happen if we used a cooked potato instead of a raw potato?”  ***What do I do if they don’t get it?***  Make sure that students understand that 0.6 > 0.1 in this context means “saltier.” Show the diagram of osmosis from page 5. Remind students that the water is made of molecules, too, and that the water molecules can pass through the cell membrane. | |
| **QUESTIONING/THINKING/PROBLEM SOLVING (embedded throughout)** | **Balanced mix of question types.** Utilizes Blooms Taxonomy/Webb’s Depth of Knowledge; high frequency; purposeful & coherent; require active responses; balance based on volunteers/non-volunteers, ability, & gender; lead to further inquiry & self-directed learning.  **Implement four types of thinking (Analytical, Practical, Creative, & Research-based) & Teach/Reinforce problem-solving types**. Provide opportunities for students to generate ideas & alternatives; analyze, evaluate & explain information from multiple perspectives& viewpoints. |
| **Questioning** These questions will occur throughout the activity as prompts based on groups’ or individual students’ progress.  **Knowledge:**  What size do our slices need to be? (5cm x 5cm x 0.5cm)  **Comprehension:**  Why do our slices need to be about 5cm x 5cm x 0.5 cm? (To fit in the weigh boats)  Plot data on a graph.  **Application:**  An apple growing on a tree has an initial mass of 0.1Kg. After four days, its mass is 0.16Kg. What is its change in mass? What is the percentage change in mass?  Complete the data table on your worksheet.  **Analysis:**  Is it more important that the potato slices be exactly 5x5x0.5 or that all of a group’s slices be the same size? (same size)  What is the isotonic concentration for your potato slice?  The osmotic content of the blood of a healthy individual should be about the same as a NaCl solution between 275 and 325 mM. Do you think the osmotic content of a potato will be more than, less than, or about the same as blood?  **Synthesis:**  If it is important for the slices to fit in the weigh boats, then why don’t we use even smaller slices, say 1cm x 1cm x 1cm? (Our balance has 1/100th gram precision. That amount is a much larger percentage of the mass of a tiny slice than of a larger slice. The percentage error in our measurement is minimized by using as large a slice as we can that we can submerge in solution in the weigh boat.)  Suppose your lab partner made slices that were all different shapes instead of the consistent prisms that we made. How would you have to modify your procedure to get meaningful results? (The ratio of surface area to volume would be different for different shapes. We would have to keep measuring the weight until it quits changing.)  What are some ways that we might modify this experiment? (Different vegetable, different variety of potato, meat instead of vegetable, cut different size or shape slices)  With these modifications, would we expect different results?  **Evaluation:**  **Thinking**    \_x\_ **Practical** – Slicing food is a practical skill. Some awareness of osmosis helps patients understand the purpose of a saline IV (and future medical professionals design such solutions properly).  \_x\_ **Creative**– Students answer a question before the experiment, essentially creating a hypothesis .  \_x\_ **Analytical** – Students compare the results from potatoes soaked in different solutions. They must decide on a line of best fit for their data.  \_x\_ **Research-based** – This activity is an experiment where students conduct independent (though highly directed) research.  **Problem Solving**  **\_x\_\_** **Observing and Experimenting**. Students conduct an experiment.  **\_x\_\_ Predicting Outcomes** Students answer a question before the experiment, essentially forming a hypothesis. | |

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| **GROUPING** | **Maximize student understanding & learning** Varied group composition (race, gender, ability, & age); clearly understood roles, responsibilities & group work expectations; accountability for group & individual work; student opportunities for goal setting, reflection & evaluation of learning. |
| * Whole group for discussion * Heterogeneous groups of 4 to 6 students conduct the experiment: slicing potatoes, weighing them, recording the results, and analyzing the data. * Product. Students complete a worksheet as a small group. The completed worksheet will include an answer to the prediction question, a completed table, graph, and an answer to a question about isotonic concentration for their plant tissue sample. | |
| **ASSESSMENT** | **Formative and/or summative assessment.** A variety of assessments, including rubrics, measure achievement of objectives and informs instruction. |
| **\_\_x\_ Worksheet** The teacher will evaluate the submitted worksheets to see if students did their arithmetic correctly and if their hypotheses and answers indicate understanding.  **\_\_x\_ Observation** The teacher will directly observe if the students are measuring correctly and filling in their tables with the matching data. | |
| **CLOSURE** | **Reflection/Wrap Up.** Summarizing, reminding, reflecting, restarting, connecting. |
| We are using the same potatoes. Do we expect the isotonic concentrations to be the same?  Have each group announce their isotonic concentration and write these on the board. Are they all the same? Are they close?    ***Reflection: You must reflect on every lesson you teach.*** | |

**NOTES:**

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