The Cell Membrane: The Gatekeeper of the Cell

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Target Grade: 7 Science

Time Required: Three 60 minutes classes

Standards:

Tennessee Science Standards:

- 7.LS1.2: Conduct an investigation to demonstrate how the cell membrane maintains homeostasis through the process of passive transport.

Lesson Objectives:

Students will:

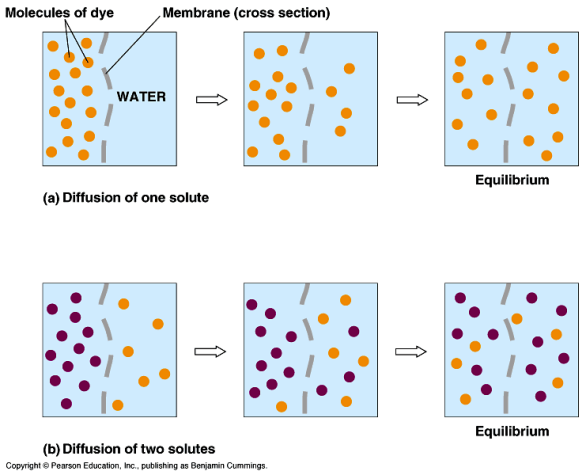
- Understand how the cell membrane maintains homeostasis through passive transport.
- Demonstrate understanding through the creation of a working model of the cell membrane using makerspace materials.

Central Focus:

In this engaging 3 day lesson, students will learn about homeostasis through a lab activity, several hands-on models, and a class discussion. Students will then have the opportunity to demonstrate their understanding of how the process works by creating their own working model of the cell membrane in the makerspace.

Background Information:

Passive transport is a type of cellular transport in which substances are moved across the cell membrane by diffusion, without the use of energy. Materials will move down the concentration gradient to reach equilibrium. As the molecules bounce around on either side of the cell membrane, those molecules which are small enough and have the right charge will be able to pass through without being



facilitated by another factor. Examples of small molecules which are able to permeate the cell membrane in this manner are carbon dioxide, molecular oxygen, and even water (Osmosis is the diffusion of water). If molecules are too large, or have a strong enough charge, they will not be able to pass through, and will require active transport to reach the other side of the cell membrane. For more information, watch this Khan Academy video.

Photo from http://2.bp.blogspot.com/_Ik6MuzljD_Y/TLvJxxAfmOI/AAAAAAAAAAc/Uinv0DpCtR4/s1600/Image128.gif

Materials

Day 1

- Goggles
- Iodine
- Spoon
- Cornstarch
- ½ cup measuring cup
- Water
- Beaker or clear plastic cup
- Eye dropper or pipette
- Food Coloring

Day 2

- Handout to us as worksheets or interactive notebook
- YouTube
- Cellular Transport presentation

Day 3

- Makerspace supplies that can be used to model what happens in the cell membrane during active transport, such as, but not limited to:
    - Dum-dum suckers
    - Play-doh
    - Plastic bottle caps, rings
    - Balloons
    - Paper towel rolls
    - Yarn
    - Marbles
    - Wooden dowels
    - Plastic cups
    - Cheese balls
    - Pretzels
    - Bubble wrap
    - Plastic straws
    - Toothpicks

Instruction

Day 1

Engagement:
Begin class with a teacher demonstration. Teacher will add several drops of food coloring to beaker of water and ask students to explain what they see happening to the food coloring. Make sure that beaker is motionless when food coloring is added. Have students hypothesize about how the particles move or spread out? Why?

Lab Set-up:
Students will set up the starch lab activity at the beginning of class. (See attached.) This works quite well with cheap store brand sandwich baggies as they seem to be more permeable to iodine solution. Make sure students observe the color of the liquid inside the bag and the iodine solution inside the beaker before they add the baggie to the beaker. Students can do the exploration part of this lesson while their baggies sit in the beakers for at least 15-20 minutes.

Activity 1:
Have students group together as closely as possible in the middle of the room. Tell students to slowly and gently bump into each other and continue to do that until they are evenly spaced out. Question students on how and why this happened. Use this opportunity to explain diffusion and how the students modeled it in the activity.

Activity 2:
Have 8 volunteers lie down on the floor, four students on one side and four on the other with their feet pointed at each other. Remind them that this could be considered a model of a cell membrane. Ask them how something could pass from one side to the other? Discuss possible explanations. Have some students try to pass some objects such as marbles between the students from one side to the other. Now have some students try to pass larger objects such as a beach ball between students from one side to the other. What has to happen for the larger object to get between the students? Try to lead the students to discussing that a gap or opening has to be created or that energy has to be used to get the bigger object to pass through. If all the marbles are outside the cell membrane, why do they want to get in? Direct the discussion to homeostasis and reaching equilibrium or stability even though students may not use correct technical vocabulary yet.

Revisit Lab:
If it has been at least 15 minutes, allow students to go back and examine their baggies and complete the questions on the lab activity sheet. Question students as to why the iodine could move into the baggie, but the starch could not move out. Why did the iodine want to move into

the baggie? Students will examine the baggies from the beakers very carefully and record their observations on the lab sheet. When students are finished recording lab results, allow them to keep the baggies overnight in the iodine solution and look at them again the next day.

Day 2

Explanation:
Begin by allowing students to view and discuss the following videos.

Students will view BrainPop video (more basic)
Diffusion: https://www.brainpop.com/science/cellularlifeandgenetics/diffusion/
Passive Transport:
https://www.brainpop.com/science/cellularlifeandgenetics/passivetransport/

Teachers may decide to go to a discussion of active transport at this time based on the ability level of their students.
https://www.brainpop.com/science/cellularlifeandgenetics/activetransport/
Another option is Amoeba Sisters (more technical, but covers everything) depending on the level of your students and what media your students have access to.
https://www.youtube.com/watch?reload=9&v=Ptmlvtei8hw

Students will complete pages for the interactive notebook, or can be used as notes (See attached.) Teacher can use the Powerpoint and complete the worksheet/notebook pages whole group with students. A memory strategy that I use for learning the way a concentration gradient moves from high to low is that "H" comes before "L" in the alphabet. Students learn that "salt sucks" and to "follow the water" to learn the three states of tonicity. Students are given time to turn and talk with a partner to practice the vocabulary. Students are encouraged to give examples of what would be expected to happen if a cell was placed in a hypotonic solution or a hypertonic solution.

Day 3

Elaboration:
Students will be given an engineer design challenge to make a model of a cell membrane with supplies and tools found in the makerspace area. Teachers will need to review safety procedures for the use of the hot glue guns and Exacto knives. Teachers will need to demonstrate the safe use of the drill and bits and any other tools that might be used in the makerspace.

Students will use knowledge learned from the exploration starch lab activity and from class notes to brainstorm and construct a model of a cell membrane using tools and materials in the makerspace. Once directions have been explained to students, students should have 10-15

minutes to brainstorm with their group on what items they want to use and at least 30 minutes to construct a model of a cell membrane.

Alternate Activity:
This activity could be used for students that struggle with hands on activities or as an example to give students an idea of what they are trying to accomplish.
https://teach.genetics.utah.edu/content/cells/BuildAMembrane.pdf

Differentiation

Students can be purposefully placed in groups with peer tutors if needing extra supports. Also, students who may not be able to handle the makerspace activity can be given the "Build a Membrane" sheet listed above. Student who need more extension get it naturally within the makerspace activity. These students can extend their model by making it more accurate or detailed. They will likely need to be prompted by the teacher to do so.

Assessment

Formative:
Students will observe models made by other groups and discuss how materials would be allowed to pass through and demonstrate an understanding of how a cell membrane works by using the appropriate vocabulary---concentration gradient, hypotonic, isotonic, hypertonic, osmosis, and diffusion. Students would need to accurately explain the difference between active and passive transport and list two kinds of passive transport.

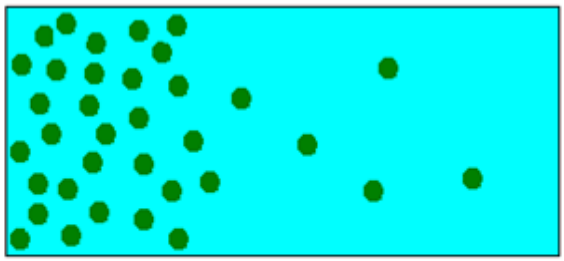
Summative:
Students will be given a written quiz to assess their knowledge of cellular transport and the cell membrane.

Name_____

Diffusion Lab

Purpose: In this lab, students will observe the diffusion of a substance across a selectively permeable membrane.

Simple diffusion is the movement of a substance from an area of high concentration to an area of low concentration. This process will put particles in a state of equilibrium or homeostasis. **Osmosis** is the diffusion of **water** through a selectively permeable membrane. The cell membrane is a selectively permeable membrane that can be found in all cells. It allows some substances to pass through freely without the use of energy. This is known as **passive transport**. The passage of substances through the membrane with use of energy is known as **active transport**.



High Concentration Low Concentration

DIFFUSION

Safety--students should wear goggles during when setting this lab up.
MAKE SURE STUDENTS ARE NOT ALLERGIC TO BETADINE
Caution---Iodine is toxic and will stain your clothes.

Materials:

Goggles
½ cup measuring cup
Spoon
cornstarch
Sandwich baggies (cheap store brand works best)
Eyedropper or plastic pipette
beaker
water

Name_____

Iodine solution (Lugol's or Betadine solution from drug store)

Procedure:

1. **Place one spoon of cornstarch into plastic baggie.**
2. **Add ½ cup of water to baggie and tie top or close with rubber band.**
3. **Mix gently and record color of solution on lab form.**
4. **Fill beaker about half full with water. Do not use beaker larger than 500ml.**
5. **Add 15-20 drops of iodine to beaker and swirl gently. Record the color on the lab form.**
6. **Gently lower the baggie into the Iodine solution and allow to sit undisturbed 15-20 minutes.**

DATA:

	Starting Color	**Color after 20 minutes**
Solution in beaker		
Solution in bag		

Vocabulary

Indicator----a substance that changes color in the presence of the substance it indicates.

Solution---a homogeneous mixture of two or more substances

Solute----the substance dissolved in a solution-starch

Solvent---the substance that dissolves the solute-water

Hypotonic---the solution on one side of a membrane where the solute concentration is less than on the other side.

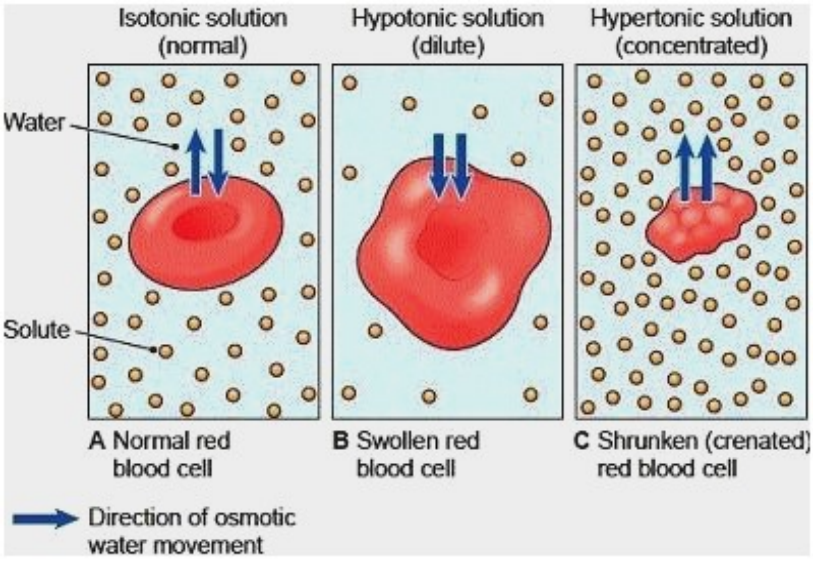
Name_____

Hypertonic---the solution on one side of a membrane where the solute concentration is greater than on the other side.

Isotonic---the concentration of the solute is the same on both sides of the membrane.

Concentration gradient---change in the concentration of a substance from one area to another. Normal gradient is from an area of high concentration to an area of low concentration.

Selectively permeable---a barrier that allows some substances to pass through but not other substances



Results Analysis:

1. **Based on your observations, which substance moved, the iodine or the starch?**

2. **How did you determine this?**

Name_____

3. **The plastic bag acted as a cell membrane in this lab and was permeable to which substance?**

4. **If the baggie was permeable to starch, what color would you expect the solution in the beaker to turn?**

5. **Make a prediction about what you think will happen if you did an experiment in which the iodine solution was place in the baggie, and the starch solution was in the beaker? Be detailed with you answer and use the correct vocabulary and sketches of the movement of particles.**

Passive Transport	Active Transport
Molecules move _____the concentration gradient. High low	Molecules move _____the concentration gradient. High low
ENERGY is _____	ENERGY _____
EXAMPLES: Diffusion Osmosis	EXAMPLES: Endocytosis Exocytosis

Terms to Know

Hypotonic	
Isotonic	
Hypertonic	
Selectively Permeable	
Concentration Gradient	
Solution	
Solvent	

**********Salt Sucks!**********

Draw a picture to demonstrate the following types of solutions that a cell might be in.

Hypotonic	Isotonic	Hypertonic

Cellular Transport

Cellular transport----the transport of molecules across the cell membrane to maintain homeostasis

What it homeostasis?_____

****Cell membrane (plasma membrane, phospholipid bilayer)regulates what enters and leaves the cell****

Cellular Transport			Cellular Transport
	DIFFUSION Osmosis	Passive Transport	
	Endocytosis **Exocytosis**	Active Transport	