

SCIENCE
Life Science and Science as Inquiry
Grade 8
Guided Inquiry Module on Cell Transport

Overview

This module of guided inquiry lessons can be used in middle school (grades 5-8). *A simple content topic was deliberately chosen, so that the teacher and students can focus on the inquiry process and skills in addition to the content.*

Ideally this module is used during life science units following the study of cell parts. This module can also be used as the first step in developing students who can comfortably conduct inquiry investigations. Lesson length should be adapted to suit the school schedule and student ability level for each class.

In a *guided inquiry* investigation, students are led to conclusions through observations, activities, research, and guided questions as opposed to being a totally *open-ended inquiry* investigation based on student concerns and questions. The primary function of this module is to provide teachers with a model sequence that utilizes the learning cycle and allows students to construct understanding as they investigate the movement of materials across a cell membrane.

Benchmarks:

- LS-M-A1** describing the movement of molecules into and out of cells
- SI-M-A2** designing and conducting a scientific investigation
- SI-M-A3** using mathematics and appropriate tools and techniques to gather, analyze, and interpret data
- SI-M-A4** developing descriptions, explanations, and graphs using data
- SI-M-A7** communicating scientific procedures, information, and explanations
- SI-M-B4** using data and logical arguments to propose, modify, or elaborate on principles and models

Objectives (the learner will):

- Record observational data in clear language
- Conduct research to locate unknown information using available references
- Formulate and record predictions
- Write a hypothesis correctly
- Design an investigation to test the stated hypothesis
- Write step by step procedure for the experimental design
- List materials required for their investigation.
- Observe, then record experimental data in concise language

- Formulate and record logical conclusions based on data collected
- Follow laboratory safety rules
- Clean and correctly store laboratory equipment
- Associate terms with definitions or processes

Time:

This module would occur over 5-6 days in 45-50 minute classes or 4 days on the 90-minute block schedule.

Teacher Notes

Background Information: All cells live at least partly in touch with water solutions. Nutrients, water, or waste materials must cross the cell membrane between the solution inside and outside the cell.

1. **Semi-permeable or plasma membrane** - the barrier between a plant or animal cell's cytoplasm and the surrounding extra-cellular fluid. This membrane lets certain molecules pass through and prevents others from crossing. Small molecules move back and forth freely. Large molecules cannot cross the membrane barrier without assistance.
2. **Passive transport** (across plasma membrane) - the movement of substances across the plasma membrane that does not require the expenditure of cellular energy. Diffusion and osmosis are natural, passive transport processes.
3. **Active transport** (across plasma membrane) - the movement of substances across the plasma membrane that requires the expenditure of cellular energy. This form of transport requires effort and special membrane structures to move in or out of the cell.
4. **Diffusion** - the movement of particles *from* areas of *higher* concentration *to* areas of *lower* concentration.
5. **Diffusion Direction Rule** - the movement of solute particles occurs from a region of higher solute concentration to a region of lower solute concentration. Water molecules also move from areas of higher concentration to areas of lower concentration across the cell membrane through the process of osmosis.
6. **Osmosis** - a special case of diffusion that involves the diffusion of water through a semi-permeable membrane (such as a plasma membrane).
7. **Brownian motion** - a random movement of microscopic particles suspended in liquids or gases resulting from the impact of molecules of the fluid surrounding the particles. It causes diffusion to occur.


8. **Dialysis** - the process of *solute* movement across a semi-permeable membrane.
9. **Iodine test** - a chemical test used to detect the presence of starch
10. **Solution types:**
 - **Hypotonic solution** - a solution which has higher water concentration (lower solute concentration) than the cells it surrounds; a dilute solution.
 - **Hypertonic solution** - a solution which has lower water concentration (higher solute concentration) than the cells it surrounds; a concentrated solution.
 - **Isotonic solution** - a solution in equilibrium (same solute and water concentration) as the cells it surrounds; of equal concentration to the cell.
13. **Equilibrium** - a state of equilibrium is reached when the concentrations of solutes and water is the same inside and outside the cell. At equilibrium, materials move back and forth across the membrane maintaining equal concentrations on both sides of the barrier.
14. **Inference** - an assumption or conclusion based on observations. It is a reasoned guess regarding conditions, causes or consequences.
Example: Describing a glass of clear liquid as a glass of water when you do not know for a fact that it is water. It could be alcohol, vinegar, 7-Up, etc.
15. **Objective observation** - a description that contains no assumptions or conclusions. It concisely describes only that which is observed. For a complete description, include what is seen, heard, smelled, and behavior. Include attributes such as color, shape, state of matter, and texture.
16. **Independent variable** - the factor (variable) that the experimenter varies. Often called the experimental variable, it is the condition being tested.
17. **Dependent variables** - the conditions (variables) that will be observed and/or measured and recorded to determine the result of changing the independent variable.
18. **Control for an experiment** - part of an experiment conducted with no changed variable in order to show that any resulting data from experimental set-ups was due only to the change in the independent variable being tested.
19. **Tincture of iodine** – iodine in an alcohol solution.

Prior knowledge or skills students are likely to have:

- How to write a hypothesis
- Identification of variables
- Filling in data table for experiments
- Cell parts, diffusion, and the components of a solution
- Safety guidelines for lab

Direction of molecular motion in diffusion or osmosis:

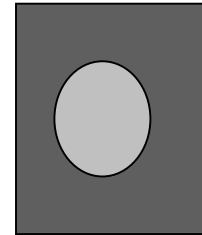
Use the diagrams below to analyze the movement of **water** by osmosis. Each diagram illustrates a cell submerged in a solution. Beside each is an explanation to aid understanding.

Key:  low concentration of solutes

 high concentration of solutes

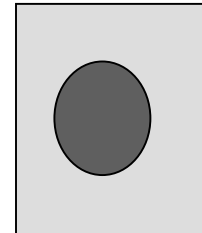
This diagram represents an animal cell immersed in a highly concentrated solution (**hypertonic**). There is a higher concentration of water in the cell than outside it. There is a higher concentration of solutes outside the cell.

Water would move out of the cell in this environment until equilibrium is reached. The cell would shrivel.



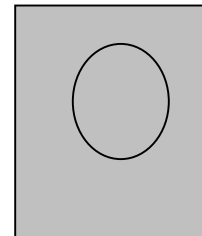
The diagram to the right represents a cell immersed in a dilute solution (**hypotonic**). Dilute solutions are usually composed mostly of water so there would be a higher concentration of water outside the cell than inside it.

Water would move from the solution into the cell until equilibrium is reached or until the cell bursts.



This last diagram represents a cell immersed in a solution of equal concentration to that of the cell. This type of solution is called **isotonic**.

When the concentrations of solutions inside and outside the cell are equal, equilibrium has been reached. In a state of equilibrium, water would move back and forth across the cell membrane maintaining equilibrium.

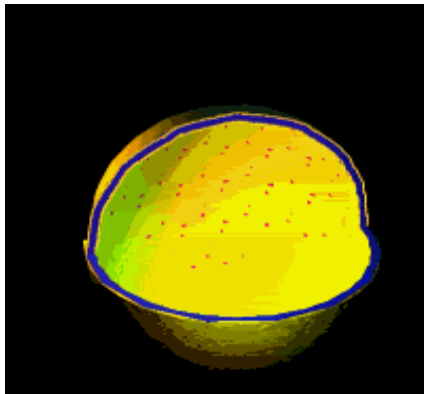


Many textbooks do not explain that movement occurs in both directions during the state of equilibrium. You can draw diagrams similar to these on the chalkboard and explain this to students when necessary to aid in their understanding. Arrows can be used to indicate the direction of movement for water molecules. Teachers should assist students in understanding that even at equilibrium, molecules are crossing back and forth across the cell membrane.

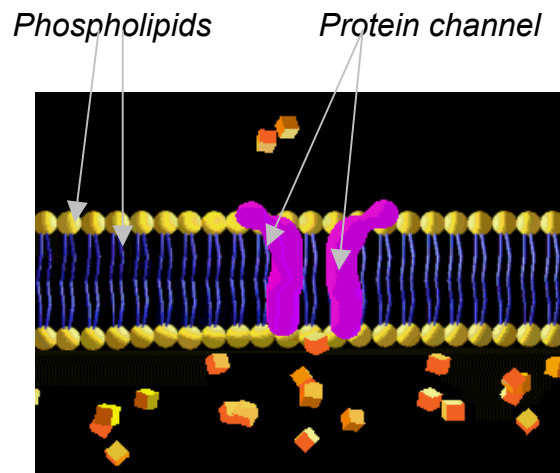
When giving directions, be sure that students understand whether they are analyzing the motion of water or the motion of solutes. For either, molecules and ions will move from where there is a higher concentration to where there is a lower concentration.

Cell membrane Diagrams

The diagrams below show the structure of the cell membrane that allows most materials to cross the membranes. The plasma membrane is porous and allows smaller molecules to pass across its barrier. There are protein channels that allow passage for some molecules unable to pass across the phospholipid bilayer of the membrane. *Phospholipid* refers to fat (lipid) molecules that contain phosphorous in their formula. *Bilayer* indicates a composition of two layers of these molecules.



Porous cell membrane



Structure of the cell membrane

Lessons in Sequence

Inquiry-Based Sequence

Movement Across Cell Membranes Module

Day 1

Time 50 minutes *(Adjust the timing for your class schedule.)*

Teacher Preparation

1. Gather materials: a large zip-lock bag, six raw eggs, and a pint or .5L of vinegar.
2. Place the vinegar in the large zip-lock bag and seal it.
3. Copy the diagram analysis sheet of Movement Across Membranes, the Observation of Demonstrations sheet, and the scoring rubric for the observation for each student. (pages 169-171 and 174 & 175 -- Teachers' Keys are on pages 172 & 173 and 176 & 177.)
4. Have available reference books containing information about diffusion, osmosis, solution strengths, and the cell membrane. Most life science textbooks contain this information and students may use their textbooks. It is nice to have encyclopedia or other books available for research. If computers with Internet is available, students can gather information from the following sites:

<http://www.marlboro.edu/~tolman/osmosis.htm>

<http://personal.tmlp.com/Jimr57/textbook/chapter3/cm.htm>

<http://www.encyclopedia.com/printablenew/09675.html>

Open: Setting the Stage

The teacher demonstrates placing six eggs in the vinegar. This should engage students and make them curious. Follow the directions below and allow students to observe the set-up and record observations.

1. Issue observation data sheet and its rubric, give directions for recording observations, and have students record observational data for only Day 1 as you set up the demonstration.
 - Cover 6 medium raw eggs with vinegar in large zip-lock bag, a bowl, a large clear glass container, or 1000 mL beaker.
 - Allow students time to record their observations. Remind them to write in complete sentences.
 - Collect observation sheets and keep them until Day 2 demonstration.

*Allow the eggs to remain in vinegar solution for 24 hours.
(Vinegar reacts with the CaCO_3 shells to decompose them.
When the shell is removed, the eggs represent a cell.)*

Body of the Lesson: (Determining prior knowledge and student research skills)

Allow students to work in pairs or threes for this part of the lesson.

1. Issue the diagram analysis activity sheet to each student. (attached)
Be sure to tell the students that you do not expect them to know all the answers at this time. Explain that this activity will allow you to determine what they do know or can find out through research.
Allow students to use their prior knowledge and judgement to hypothesize. Student misconceptions give you a very good idea of their backgrounds on the concept of cellular transport. This allows you to determine how to direct future instruction in order to correct their misconceptions. This part of the activity is like a pretest.
2. Have students use reference and textbook to complete the diagram analysis and their predictions.
This activity is designed to have students gain information on cell transport methods and use the information to predict. The results will allow you to determine if they understood what they read or if you need to provide additional direct instruction later.
3. Collect the *Diagram Analysis* activity sheets to be evaluated for completion, student prior knowledge, research ability, and comprehension. Do not score accuracy. Score it on the basis of clarity and completion.

If your students do not complete this in class, collect the papers and begin the next day by completing the diagram sheet in small groups.

Close (whole group)

1. Ask why some materials move into or out of a cell's membrane.
Guide responses to include for food, water balance, and waste removal.
2. Explain solution concentrations and provide examples:
 - hypotonic (dilute - mostly water),
 - isotonic (equal in concentration), and
 - hypertonic (high concentration, saturated, or super saturated)

You may conclude with a series of questions that stimulate recall of examples of each type of solution. Students may use the terms *dilute*, *equal*, and *saturated*.
If you have a class that is slower in completing the diagram sheet, allow them time at the beginning of day two to complete their information gathering. With more advanced classes, you may wish to discuss composition of the cell membrane if students ask questions on this topic.

Day 2

Materials

250 mL beakers or medium size clear beverage glasses
clear corn syrup, water, vinegar, and plastic wrap
saturated salt solution
graduated cylinder or measuring cup
soup spoon or tablespoon
an type of starch such as a potato slice, cracker, or bread slice
small bottle of tincture of iodine (available at drug stores)
student observation sheets from Day 1

Teacher Preparation

1. Prior to class: *Under gently running water, gently rub the shells off the eggs leaving just the cell membrane. You will only need four of the eggs. The extra eggs were to allow for breakage when removing the shells. Immerse the eggs in the same vinegar again until class time.*
2. Prepare 4-250mL beakers or glasses labeled A, B, C, and D.
3. Assemble clear corn syrup, plain water, saturated salt solution, vinegar, plastic wrap, and a soup spoon or tablespoon.
4. Prepare the beakers with 150 mL (or 0.6 c.) of the solutions listed below:
 - Beaker A - plain water
 - Beaker B - clear corn syrup
 - Beaker C - an unknown concentration (saturated) of salt solution. Stir as much salt into the water as you can. *(You determine the concentration. Discover with your students what type of solution it is in relation to the egg.)*
 - Beaker D – vinegar (control)
5. Assemble tincture of iodine and a starch such as bread, potato slice or a cornstarch solution for your demonstration of the starch test.
6. Copy and have ready the lab investigation directions and plan sheets.

Open

Allow students to see the eggs in the vinegar solutions to pique their interest. Request student hypotheses regarding what happened to the shell. They may notice bubbles allowing you to explain that a chemical reaction occurred that decomposed the shells. Explain how you removed the shell prior to class.

Return the scored *Diagram Analysis* sheets. Explain to students that they will be gaining information in class that will allow them to answer all the questions accurately prior to being evaluated. They may keep their papers and revise their answers as they proceed. *(If you found that the students had great difficulty with part of the Diagram Analysis sheet, you may wish to take time to explain or demonstrate the correct answer on that part.)*

Demonstration - Day 2

1. Display four 250 mL beakers or large, clear glasses each containing 150 mL of the different solutions listed below:
 - Beaker A - plain water
 - Beaker B - clear corn syrup
 - Beaker C - an unknown concentration of salt solution
 - Beaker D – vinegar (control)
2. Return the observation data sheets to students and give directions for Day 2 observational data. Remind students that they are to write their own observation and not talk aloud until the observations sheets have been turned in to you.
3. Use a spoon to lift one of the eggs from the zip-lock bag to show it to the class.
 - Gently lower the egg into the 1st solution.
 - Allow the students to hypothesize aloud regarding what may happen to the egg.
 - Repeat this process until all 4 beakers have eggs in them.
 - Cover each beaker with plastic wrap.

Do not tell students what will happen or which beaker contains the control. Explain that the eggs will be left in the solutions overnight.

3. Allow time for students to complete their recorded observations for Day 2.
4. Collect student observation data sheets and hold them until Day 3.

Close: Teacher Demonstration

Demonstrate what happens when Iodine is dropped on a starch.

- Drop tincture of iodine on bread, crackers, a potato slice, cornstarch solution, or any starchy material that you may have available.
- Allow all students to observe the color change.
- Ask students to describe the color change that they observe.
- Explain to the students that this is a test for the presence of starch.
- Tell them that when iodine is in the presence of starch, it turns blue or black.

If time allows, have students name examples of starches.

Day 3

Teacher Preparation:

1. Copy investigation directions, practice sheets, rubric, and model lab report sheets.
2. Display the eggs in the beakers that you prepared Day 2.
3. Get out student observation sheets and a spoon for lifting the eggs.
4. Be sure that you have adequate supplies of small and large zip-lock bags, tincture of iodine, and cornstarch.

Open: Student Observations

- Place the display of eggs in beakers A, B, C, and D so that students can see them.
- Allow students to observe the beakers of eggs briefly to determine changes that have occurred. (*Do not provide them with any information – allow them to observe.*)

Body of the Lesson

1. Observation of eggs that have been in the solutions:
 - Return student observation data sheets.
 - Instruct students to record their observations as you lift and display each egg. Remind them that this is individual work. They are not to give their opinions aloud until the observation sheets have been turned in.
 - Allow students time to complete parts III. and IV. of the observations sheet.
 - Collect student observation sheets for evaluation. *You will use the same rubric that you provided the students to evaluate their observational data.*

Investigation

2. Give oral and written directions for student planned investigations involving the movement of materials across a cell membrane. (see attached)
3. Divide students into cooperative groups of four to plan their investigation. Have them choose whether they will investigate starch moving across the membrane or the iodine moving across the membrane. *Warn students to work with their own group and not share information with other groups. This way you will get a variety of investigation plans rather than all the*

groups copying each other. Be sure that students share the work within the group and reach a consensus prior to recording information.

4. Explain that they will be testing to determine if either starch or iodine solution will move across the zip-lock bag membrane. Tell them that they may use pint bags, tincture of iodine, starch solution, and water as needed. The pint zip-lock bag represents a cell with its membrane. In addition, they will use a larger container such as a bowl, large beaker, or large zip-lock bag to represent the environment and contain the experiment.
5. Remind them to list the materials and equipment they will need to conduct their investigation and to write their hypotheses first. Remind them that the investigation will prove or disprove their hypothesis. The hypothesis does not have to be correct. Circulate to monitor and check written hypotheses.
6. Have students begin to write a rough draft of their of their procedure on plain paper. There is not just one way to set up this investigation. Check their procedure to determine if it tests the hypothesis written. *Use questions and suggestions to encourage improvements in their written procedure. You may suggest that one student quietly read the steps aloud and have a second try to follow the directions. This helps students spot errors or gaps in their procedure.*

Close (whole group)

Hold a “wrap up” discussion (debriefing) with student questions regarding procedure.

Assignment: Have students think of ways to improve the writing of their procedure. Tell them to review the reference materials they used for research so that they can analyze their results accurately to draw the correct conclusions.

Day 4

Teacher Preparation

- Set up egg display
- Assemble student papers

Open

1. Return observation data sheets.
2. Display beakers containing eggs in solution.
3. Lift eggs in a spoon so that students may observe the differences.
4. Have students record their observations and conclusions.
5. Collect these observation sheets to evaluate based on accuracy of the observation records and the logic of their conclusions using the rubric provided.

Investigation

(small group)

1. Allow students to complete their experimental design in small groups.
2. Once a group has approval for their rough draft, allow them to rewrite their plans in their final lab report. (They should complete procedure and plans for recording data today)
3. Those finishing early can assemble their materials for their experiment.
4. Fifteen minutes prior to the end of class have the groups hand in their rough drafts of procedure and plans for data collection if they have not already done so

Wrap Up

(whole group)

Allow students to discuss their conclusions formed from observing the eggs in solutions A, B, C, and D.

Accurate conclusions: Beaker A was hypotonic and water moved into the egg causing it to swell; Beaker B was hypertonic (highly concentrated) and water moved out of the egg causing it to shrivel; Beaker C could have been isotonic or hypertonic – determine by the condition of the egg; and D is the control.

Day 5

Teacher Preparation

1. Prepare a starch solution by taking one quart of water, adding 1/4 cup of cornstarch, stirring well, and cooking this solution until it turns from white to semi-clear. Store the starch solution in a container of your choice.
2. Assemble pint zip-lock bags, large zip-lock bags, bowls, iodine and water for student set-ups. Look at student lab sheets to determine other items you should provide.

Open

1. Return the rough drafts of students' written procedure. Have them improve it if necessary. They should write a final copy of the procedure on their data sheets if they have not already done so.
2. While students are rewriting procedure, display any needed supplies and monitor their work.
 - 100 mL of starch solution for each group,
 - iodine,
 - one pint bag per group, and
 - the larger container of their choice.

Body – Investigation

1. When you have approved the written the procedure, allow each group to set up their investigation. Warn them to carefully seal the pint zip-lock back because leakage will invalidate their results. Explain that they will observe the results tomorrow and complete their lab reports.
2. Have each group clean up and replace supplies and equipment when finished.
3. Collect data sheets (lab reports).

After collecting all data sheets and everyone has returned to his or her desk, elicit students' questions. Call on other students to provide answers whenever possible. Provide direct instruction as needed. Review all major concepts regarding the movement of materials across a cell membrane.

Close

Explain that the investigation is a performance task and will be equivalent to a test grade. It will be evaluated with the rubric provided them.

Assign a written assessment on the concepts discovered during the investigations.

Explain or describe the types of test items to be included, such as diagram analysis, to determine the direction of material movement across the cell membrane, enhanced multiple choice, and short answer essay questions.

Respond to student questions.

Day 6

Teacher Preparation

Have your assessment prepared and copied.

The assessment should consist of the same Diagram Analysis sheet that students completed on Day 1, plus selected multiple choice and short answer questions such as those provided at the end of this module.

Do not tell them ahead of time that they will be answering the same questions as before.

Open

Tell students to get out their Diagram Analysis sheet that they answered at the beginning of this module.

Call on students to provide the correct answers and provide explanations. If one student answers incorrectly, call on a second student to help him/her.

Provide explanations on any content that they seem to find difficult.

Body - Assessment

Administer the examinations that you have prepared. Monitor as students complete these individually. Collect their papers.

Close

Begin with the introduction of your next unit of study.

Resources

Activity Pages, Rubrics,
and Lab Reports Follow

Name: _____

Date: _____

**Observation of Teacher Demonstration
Cell Membranes and Osmosis/Diffusion**

Record your data on this sheet. Record clearly worded observations/descriptions. Use complete sentences and correct grammar. When you analyze to draw a conclusion, explain what you think happened and why.

I. Day 1: Describe what happens to the eggs. (3 points)

II. Day 2: Describe what the teacher does with the eggs. (3 points)

Hypothesize what type of solution you think is in each container – isotonic, hypertonic, or hypotonic. *(1 point for completion)*

Solution A, water – _____

Solution B, syrup – _____

Solution C, salt water – _____

Which solution is the control? _____

III. Day 3: Describe the results. Clearly describe what has happened to the egg in each solution when the teacher lifts it up for observation. If you notice a change in the solution, you should also describe it. (3 points each)

Beaker A: _____

Beaker B: _____

Beaker C: _____

IV. Conclusions

For each solution draw a conclusion about the direction of water movement across the membrane (osmosis). Explain the direction of water movement and tell why it moved in that direction. Use complete sentences.

Phrases to use in explaining the direction of water movement:

- Into the cell
- Out of the cell
- Both Into and out of the cell
- No movement

(3points each)

Solution A :

Solution B:

Solution C:

Scoring:

Total points possible on the observation performance task is **25**.

Excellent = 23-25 Good = 20-22 Needs Improvement = 17- 21

Unsatisfactory = below 17

General Rubric for Scoring Science Demonstration Observation Assessments

For each observation (except section IV.) recorded, use the rubric below.

- 0** **Makes no observations or inaccurate observations.**
- 1** **Makes partially accurate observations using appropriate vocabulary; contains some flaws, errors, or false assumptions.**
- 2** **Makes accurate observations, but poorly worded.**
- 3** **Accurate observations, appropriate wording, and complete description is included.**

For Section IV, use the rubric below.

- 0** **Makes no observations or inaccurate assumptions.**
- 1** **Makes partially accurate inference using appropriate vocabulary; contains errors in either evidence cited or an inference is based on a false assumption.**
- 2** **Uses accurate inferences based on the evidence in observations, but poorly worded or rambles.**
- 3** **The hypothesis/explanation is logical and accurate for the observations recorded in addition to being concisely and clearly worded.**

(Teachers may wish to make a transparency or student copies of this rubric to inform students how their observations will be evaluated)

KEY

**Observation of Teacher Demonstration
Cell Membranes and Osmosis/Diffusion**

Record your data on this sheet. Record clearly worded observations/descriptions. Use complete sentences and correct grammar. When you analyze to draw a conclusion, explain what you think happened and why.

I. Day 1: Describe what happens to the eggs. (3 points)

Students should indicate that the teacher put the eggs into a large bag containing a clear fluid (vinegar) and sealed the bag.

II. Day 2: Describe what the teacher does with the eggs. (3 points)

The eggs now have shells (or very little of the shell is left).

There are bubbles in the vinegar around the eggs. (optional)

The teacher lifts an egg, shows it to us and puts it into beaker A.

Eggs are put into each of the beakers and then each beaker is covered with plastic wrap.

Hypothesize what type of solution you think is in each container – isotonic, hypertonic, or hypotonic. (1 point for completion)

Solution A, water – _____ **hypotonic or dilute** _____

Solution B, syrup – _____ **hypertonic or highly concentrated** _____

Solution C, salt water – _____ **accept any answer** _____

Which solution is the control? _____ **D - vinegar** _____

V. Day 3: Describe the results. Clearly describe what has happened to the egg in each solution when the teacher lifts it up for observation. If you notice a change in the solution, you should also describe it. (3points each)

Beaker A: *The egg in Beaker A has gotten larger (swollen). When the egg is held up, the yolk appears to float around. There appears to be less fluid (water) in the beaker.*

Beaker B: *The egg in this beaker is smaller (has shrunk). The membrane is loose and the yolk has turned a darker yellow. The solution in the beaker appears to have a layer of clear fluid (water) on top of it.*

Beaker C: *The answers depend on how concentrated you made the salt solution.*

Conclusions

For each solution, draw a conclusion about the direction of water movement across the membrane (osmosis). Explain what the direction of water movement and tell why it moved in that direction. Use complete sentences.

Phrases to use in explaining the direction of water movement:

- Into the cell
- Out of the cell
- Into and out of the cell
- No movement

(3points each)

Solution A : *The water moved into the cell in Beaker A because there was more water outside the egg than in it. Water moved by osmosis from the area of high concentration to the area of low concentration.*

Solution B: *In Beaker B, water moved out of the egg because there was more water inside the egg than in the solution. (They may indicate that it was a highly concentrated solution so it caused the water to leave the egg.) Water moved by osmosis from the area of high concentration to the area of low concentration.*

Solution C: *Determine your own answer based on the appearance of the egg and the amount of fluid in the beaker.*

Scoring:

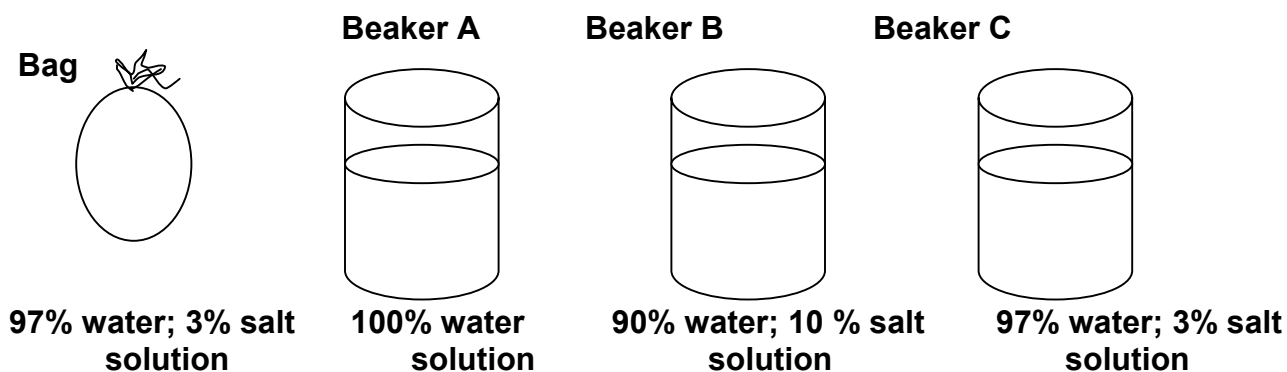
Total points possible on the observation performance task is **25**.

Excellent = 23-25 Good = 20-22 Needs Improvement = 17- 21

Unsatisfactory = below 17

Movement Across Membranes Diagram Analysis – Day 1

In the illustration below, the bag represents a selectively permeable cell membrane around a cell. The contents of the bag are a solution of 97% water and 3% salt (NaCl). Use the illustration below and the textbook or other references to answer the questions that follow. Answer with complete sentences.



1. Compare the solution concentration of water in the bag to Beaker B. Is the water concentration higher in the bag or in the beaker.

2. If you put the bag into Beaker B, would the salt concentration remain the same? Explain why or why not.

3. If you placed the bag into Beaker A, in what direction would the water move? Why?

4. If you put the bag into Beaker C, would the salt concentration in the bag change? Why or why not?

[See the back of this page for the rest of the activity.]

5. On this page, sketch the bag inside each of the three beakers.
Label the beakers as Beakers A, B, and C.

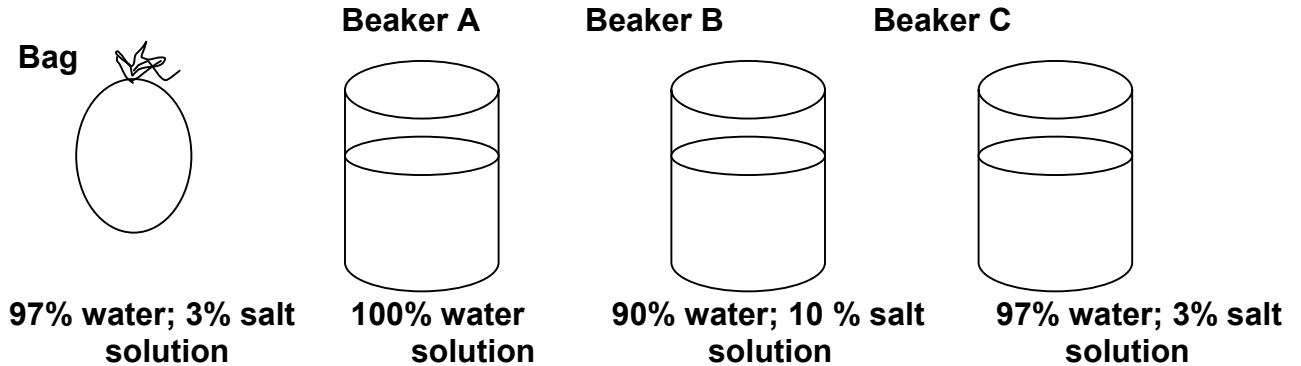
Draw arrows that show the direction in which the water would move. Would it move into the bag, out of the bag, or both into and out of the bag?

Drawings

Movement Across Membranes - **KEY**

Diagram Analysis – Day 1

In the illustrations below, the bag represents a selectively permeable cell membrane around a cell. The bag contains a solution of 97% water and 3% salt (NaCl). Use the illustration below and the textbook or other references to answer the questions that follow.



1. Compare the solution concentration of water in the bag to Beaker B. Is the water concentration higher in the bag or in the beaker? Answer with a complete sentence.

The water concentration is higher in the beaker than in the bag.

2. If you put the bag into Beaker B, would the salt concentration remain the same? Explain why or why not.

No, it would not remain the same. The solution has less water than the bag (or the bag has a greater water concentration than the solution) The water would move until there is an equal concentration in both places. Students may say that water would move out of the bag. [It is possible for salt to diffuse across a membrane, so students may say that the salt would move from the solution into the bag until the concentrations are equal.]

3. If you placed the bag into Beaker A, in what direction would the water move? Why?

The water would move into the bag because there is more water outside than inside the bag. It would move from the area of higher concentration to the area of lower concentration.

4. If you put the bag into Beaker C, would the salt concentration in the bag change? Why or why not?

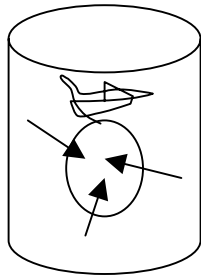
If you put the bag into beaker C, there would be no change in the concentration. When concentrations are equal (at equilibrium), materials move back and forth, but the concentrations will remain equal.

5. On this page, sketch the bag inside each of the three beakers.
Label the beakers as Beakers A, B, and C.

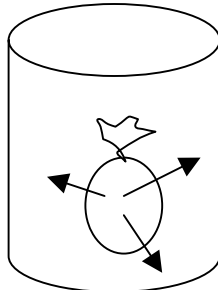
Draw arrows that show the direction in which the water would move. Would it move into the bag, out of the bag, or both into and out of the bag?

Drawings

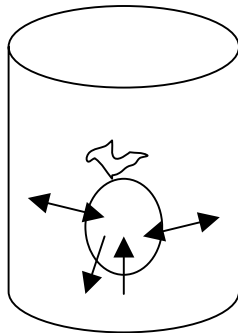
A.



B.



C.



Movement Across Membranes

Design Your Own Experiment!

Directions:

Semi-permeable membranes such as cell membranes allow certain atoms and molecules to pass through. If a molecule can pass through the membrane, we say the membrane is permeable to that molecule. The movement of most molecules is called diffusion. The movement of water across a membrane is called osmosis.

Use information that you have gained during this study of cell transport and review materials if necessary. Work together in groups of four. Agree with each other on the best responses before recording anything on your plan sheet or data sheet.

In this activity, you will write a hypothesis, design a procedure, conduct an experiment, record data, and analyze the results from the data collected to form a conclusion.

Experimental Design:

The following model design pages provide you with a brief format for your experimental design and lab report. You may use your own paper if there is not enough space on the model design pages that follow. Be sure to include all the sections listed on the next page in your lab report that you turn in to the teacher.

Write a step-by-step lab procedure in pencil on plain paper and take it to your teacher for approval. If the teacher tells you to revise the steps, read what you have written aloud to each other and revise your steps until they are clear enough that a stranger could follow your directions.

Data Recording:

Keep in mind that you can't include data when planning, but you can plan a data section for recording your daily observations. Allow space for Day 1 observations and Day 2 observations. You may wish to plan a data table or log for recording your observations.

Analysis/Interpretations:

Tell what you think caused your results. Infer from the data to explain the results based on what have learned.

Conclusion: Write a one-sentence conclusion.

Safety Procedures:

- Wear goggles.
- Waft to detect odors rather than sniffing over the container.
- Seal the zip-lock bags well.
- Wash your hands after handling iodine.
- Never taste anything in a science lab.

Planning Sheet - Practice Sheet

Write your agreed upon hypothesis below. Be sure to word it as an "if, then" statement. Use a complete sentence.

Hypothesis:

Experimental Design

Design an experiment to test your hypothesis. Be careful to match the independent variable (factor that you change) with your hypothesis. Complete the design components below. Before listing other materials or equipment, check with the instructor to determine if they are available.

Materials list:

Identify the follow design features:

Independent (experimental) variable _____

Dependent variable(s) _____

Conditions to be controlled _____

Step by step procedure: (Be sure that it is detailed enough that others could follow your directions and duplicate your experiment.)

Get the instructors approval before you conduct your investigation.

Plans for how you will record data:

Observations:

You will describe the results (what occurs) before and after you conducted your experiment. Remember - no inference or conclusions here. When you record objective observations or descriptions for data, it is called *qualitative* data. Illustrate below your data-recording format.

Analysis/Interpretations:

Conclusion:

Write a one-sentence conclusion that states whether you proved or disproved your hypothesis. Recall that we are concentrating on the process and it does not matter if your hypothesis was right or wrong. What does matter is that you have a design that matches the hypothesis, that the procedure is clear, that the procedure actually tests the effect of changing the independent variable, that observations are detailed, that your analysis is logical and based on sound scientific knowledge, and that your hypothesis is correctly written.

Be sure to clean up your lab station when you finish the experiment. Place all supplies and equipment back in their original location. Be sure that your recorder turns the final lab report sheet into the instructor.

Self - Evaluation:

What did your group do well? _____
What can you improve upon? _____

Lab Report

Names of group members: _____

Lab or table number: _____ Date: _____

Problem: Circle the question your group chose.

- Will the starch move across a polyethylene membrane?
- Will iodine move through a polyethylene membrane?

Hypothesis: _____

Materials:

Procedure in numbered steps:

Data:

Analysis:

Conclusion:

Rubric for Design Your Own Experiment Performance Task

<i>Dimension</i>	<i>possible / actual score</i>
<u>Problem Definition</u>	
A. The problem is clearly stated. The variables are clearly identified.	3
B. The problem is stated adequately and variables are identified.	2
C. The problem is poorly stated. Variables are not identified.	1
D. Inaccurate problem statement. Variables are not identified.	0 _____
<u>Experimental Design</u>	
A. The design matches the description of the stated problem. The experiment tests what it should. <i>Independent and dependent variables</i> are clearly identified. Procedure is clearly described so that it is replicable. A control is included and described.	5
B. The experimental design generally matches the stated problem. Some attempt is made at variable control. Procedures are complete if not well described. Minor clarifications are needed.	3
C. The design matches the problem to some extent. Very little attempt at control of variables evidenced. Procedures are incomplete. Major design modifications are needed.	1
D. The experimental design doesn't match the stated problem, is very incomplete or missing, or there is no attempt to control variables.	0 _____
<u>Data Presentation</u>	
A. Data are well organized and presented clearly in an appropriate manner.	3
B. Data are organized and presented appropriately. Minor errors or omissions may be present.	2
C. Poorly organized data. Inappropriate presentation. Major errors or omissions are present.	1
D. Poorly organized data; unclear or missing components.	0 _____
<u>Conclusions</u> <i>A conclusion statement is included and directly relates back to the hypothesis.</i>	
A. Analyses or conclusion(s) relate to the stated problem and hypothesis. Conclusion(s) are accurate, that is, supported by the data analysis.	3
B. Conclusion(s) are supported by the data and related to the stated problem. Minor errors in interpretation or the statement are present.	2
C. Conclusion(s) are supported by the data and related to the stated problem to some extent, but major errors are be present.	1
D. Conclusion(s) are not well related to hypothesis or problem, not supported by data analysis, or are missing.	0 _____

Name: _____

Your Total _____

Back of Science Performance Task Rubric

Scale Interpretation:

12-14 = EXCELLENT 10-12 Proficient 8-9 Needs Improvement

7 Marginal, must improve Below 7 is Unsatisfactory

Teachers, if you must use a letter grade use the scale below:

12-14 = A

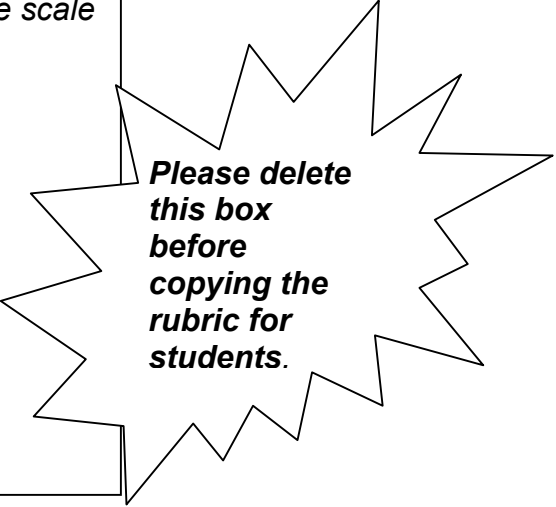
10-12 = B

8-9 = C

7 = D

Below 7 is F

Please delete this box before copying the rubric for students.



LAB KEY: Teacher Information

Possible Correct Lab Set-Ups

Do not tell students how to design their procedure. Let them determine what they must do to test their hypothesis. If students want to determine if starch will move across the bag membrane, they may use one of the two following set-ups:

1. Testing the movement of starch:

- They may put the 100 mL of starch solution in the small zip-lock bag and seal it.
- Next, place the small, filled bag into the larger container.
- Add water to cover the bag and store it overnight.

If they introduce the iodine during set-up, it will invalidate this test, because the iodine will cross the membrane. They would not be testing starch movement.

- The next day, they should add a couple of drops of the iodine to the water in the larger container as their test for the presence of starch outside the bag.
- If starch moved out of the bag, they will see a color change. If there was no movement, the iodine remains light orange in the water.

It would also be acceptable for them to put water in the smaller bag and the starch in the larger container. Be sure that their procedure indicates that they put the iodine in the water, not the starch, on the second day of the experiment.

2. Testing the movement of iodine:

- For this procedure, they should put some starch inside the smaller bag and seal it.
- Next, place the small, filled bag into the larger container.
- Add water to cover the bag.
- Add a couple of drops of iodine to the water in the large container.
- Store their set-up over night

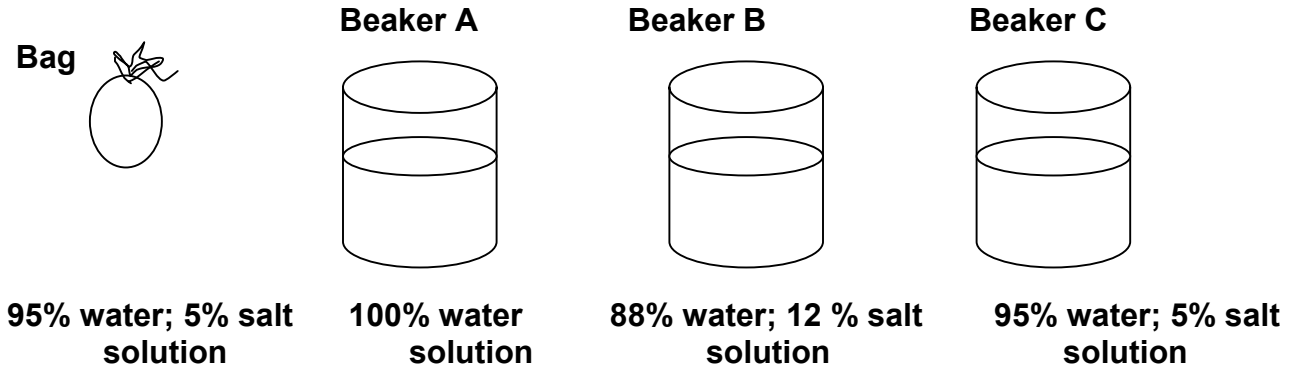
It would also be acceptable for them to put water and iodine in the smaller bag and the starch in the larger container.

- The next day they will know immediately when they observe their set-up that the iodine diffused across the bag membrane because the starch will be blue to blue-violet in color.

Whether or not the starch will move across the bag membrane cannot be predicted. It depends on the quality or brand of bag used. It crosses out of some bags, but not others.

Other Assessment Items

In the illustration below, the bag represents a selectively permeable cell membrane around a cell. The contents of the bag is a solution of 97% water and 3% salt (NaCl). Use the illustration below to answer the questions that follow.



1. If the bag is placed in Beaker A, the water will move

A. out of the cell	C. into and out of the cell equally
B. into the cell	D. it will not move

2. If the bag is placed into Beaker B, the water will move

A. out of the cell	C. into and out of the cell equally
B. it will not move	D. into the cell

Use the diagrams provided to analyze and predict. Answer the constructed response questions that follow in complete sentences. (Short Answer)

The images below illustrate cells and environments for cells. Observe the color key to determine concentrations for the cells and the environmental solutions.

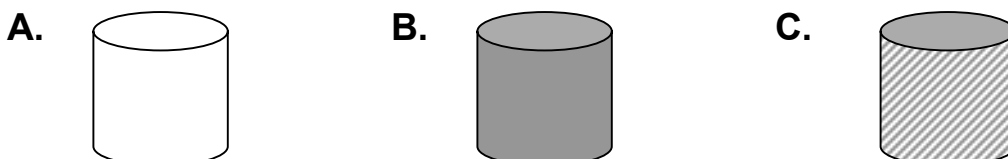
Color Key for concentrations:



Cells



Environments



Short Answer Questions

3. If **cell 2** were in **environment B**, how would this environment affect cell 2? Explain your reasoning.

Rubric for Question 3

Points	Answer Criteria
2	The student explains that the cell would be harmed by environment B because it is a highly concentrated solution (hypertonic). This environment would cause the cell to lose water. They may say that the cell would shrivel or die.
1	The student indicates that there would be a negative (bad) response by the cell when placed in environment B. The student's reasoning is flawed, or incomplete.
0	No response. The response was irrelevant or totally incorrect.

4. Choose the **best** environment for **cell 1** and explain why you chose that environment.

Rubric for Question 4

Points	Answer Criteria
2	The student explains that the best environment for cell 1 is C because the concentrations are equal. (or) The cell is in equilibrium with the environment. The student may mention that the other environments would harm the cell.
1	The student correctly identifies environment C, but does not provide a correct or clear reason for his/her selection. (or) The student names the wrong environment, but explains that the environment and the cell need to be of equal concentration (at equilibrium).
0	No response. The response was irrelevant or totally incorrect

KEY for questions numbered 1. and 2.: 1. B 2. A

REFERENCE LINKS

Basic primer on the process of diffusion including diagrams

<http://windows.ivv.nasa.gov/glossary/diffusion.html>

<http://www.biologylessons.sdsu.edu/classes/lab5/semnet/diffusion.htm>

Diffusion and passive transport are defined and elaborated with diagrams showing the process reaching equilibrium.

<http://www.botany.utexas.edu/facstaff/facpages/ksata/ecpf96/5/diff.htm>

Osmosis as presented by Encyclopedia.com

<http://www.encyclopedia.com/printablenew/09675.html>

Additional information on osmosis including types of solutions, a demonstration, and lab

<http://www.marlboro.edu/~tolman/osmosis.htm>

A basic lesson on cell membrane structure can be located at the *Virtual Cell Web Page*. This site contains animations in addition to many diagrams.

<http://personal.tmlp.com/Jimr57/textbook/chapter3/cm.htm>

Teacher site: MIT's HyperBiology Book contains cell structures along with explanations of their functions.

<http://cyberbio.mit.edu:8001/esgbio/cb/org/organelles.html>

