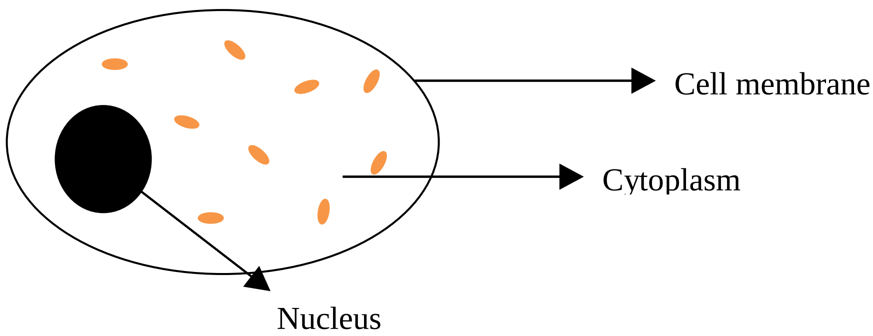
Cell Diffusion & Permeability: See-Through Eggs
Student Version

In this lab, students will learn about the permeability of the cell membrane. By studying the ability of a shell-less egg to absorb various solutions, students can see how membranes can regulate a cell's interaction with its environment.

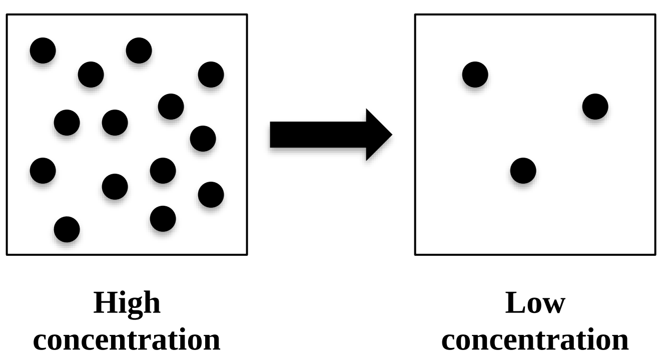
Key Concepts:

- A human cell has a protective layer called a **cell membrane**.



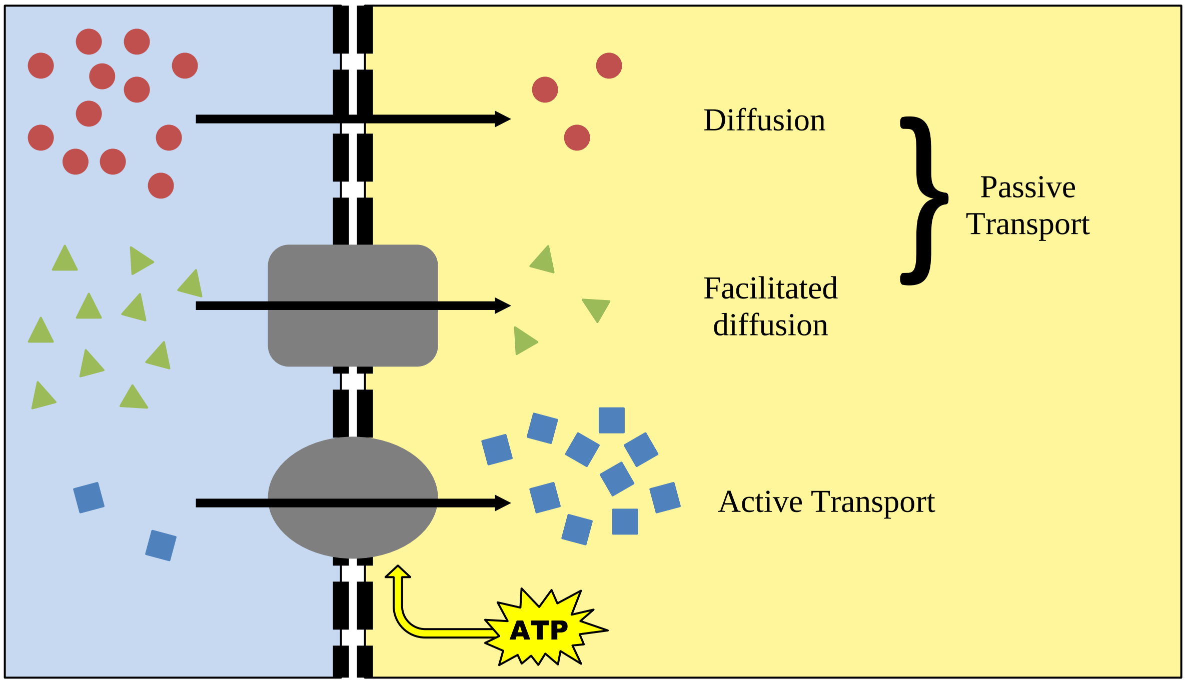
- This cell membrane is **semi-permeable**, meaning that some molecules easily move across the cell membrane, some cannot.
- When solutions containing different amounts of ingredients are separated by a semi-permeable membrane, **diffusion** of molecules occurs. Diffusion is the movement of molecules from an area of high concentration to an area of low concentration. For example, diffusion can occur across biological membranes or down concentration gradients.

Diffusion



- There are 3 main types of diffusion:
  - **Passive Transport** is when molecules diffuse without the use of energy from the cell, from areas of high amounts to areas of low amounts.

- **Active Transport** is when molecules diffuse with the use of energy from the cell (and a special pump), from areas of low amounts to areas of high amounts.
- **Facilitated Transport** is when molecules diffuse from areas of high amounts to areas of low amounts without the use of energy from the cell, but with the help of proteins that form channels across the cell membrane. Remember that to facilitate means to “help” so sometimes molecules need help getting across the cell membrane and special proteins facilitate this!



Part 1 – Modeling Cell Semi-Permeability

Even though a membrane may appear to be impermeable, certain molecules may still be able to pass through. In this section, students will simulate the semi-permeability of a membrane using plastic bags.

1. **Pour approximately 50mL of water into a plastic sandwich bag and add 10mL of starch.**

2. **Secure bag** with the twist tie and **shake gently** to mix the starch.

3. **Put on gloves.**

4. **Pour 250mL of water into a 500mL beaker. Add 15 drops of iodine**.

5. **Place the sandwich bag of starch solution into the beaker of iodine solution.**

6. Allow the sandwich bag to soak in the iodine solution for at least 20 minutes.

7. *Record any observations noted* at the beginning, during, and at the end of the experiment.

8. In between observations, please continue to Part 2: Cell Diffusion.

9. Once you are finished with recording your observations for Part 1: Semi-Permeability, you may *answer the concept questions below the data table*.

Cell Permeability Observations

Initial	During	End

Concept Questions

Q1. What cellular structure is modeled by the sandwich bag?

Q2. What observations did you make that occurred outside of the sandwich bag? What observations did you make that occurred inside the sandwich bag?

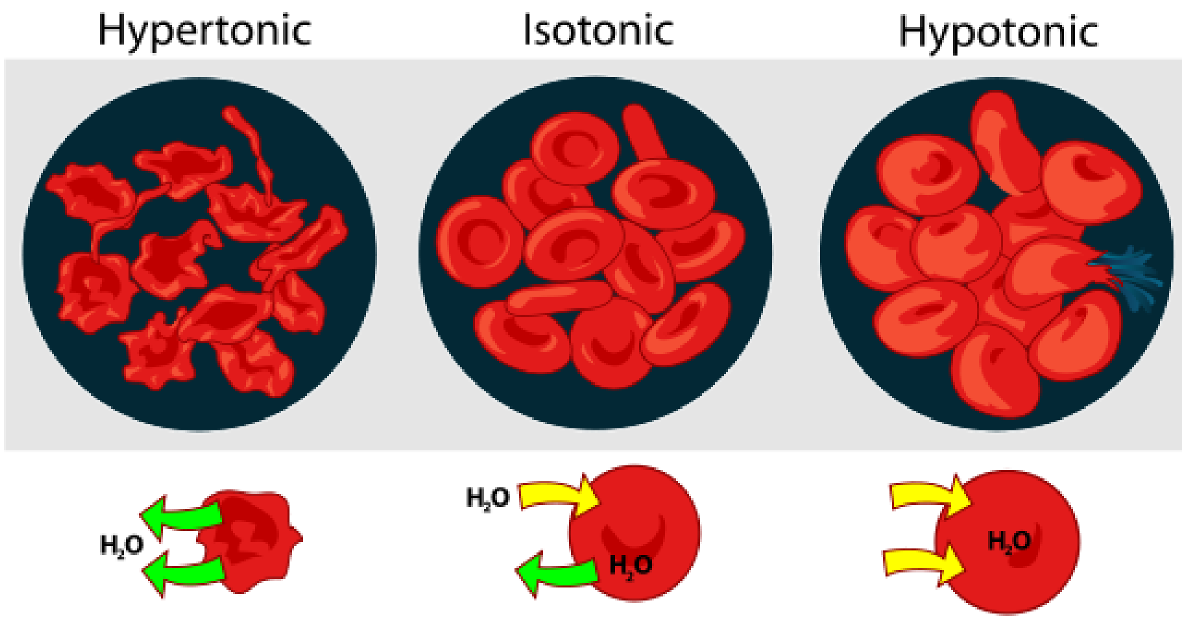
Q3. What property of the sandwich bag allows for the results you observed during the experiment and recorded for Concept Questions #2 above?

Part 2 – Cell Diffusion

Key Concepts:

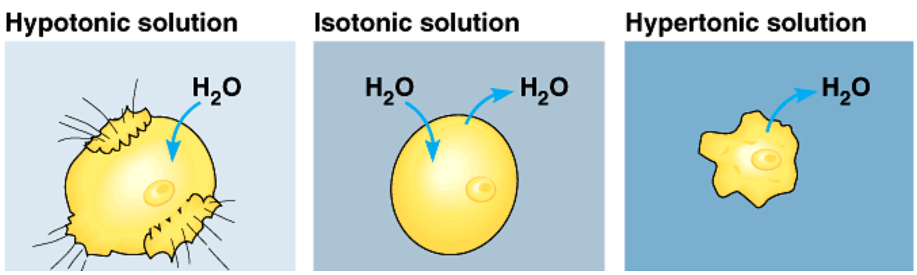
- The prefix **hyper-** refers to "high" as in hypertension (high blood pressure). A **hypertonic** solution has a higher amount of **solute** (the solid that is being dissolved) and a lower amount of **solvent** (the liquid that is dissolving the solute). As diffusion of molecules takes place across a biological membrane, the high amounts of solvent (water) from inside the cell rushes out toward the low amounts of solvent and high amounts of solute outside the cell, thus causing the cell to shrink.
- The prefix **hypo-** refers to "low" as in hypotension (low blood pressure). A **hypotonic** solution has a lower amount of solute and a higher amount of solvent. As diffusion of molecules takes place across a biological membrane, the high amounts of solvent (water) from outside the cell rushes toward the low amounts of solvent and high amounts of solute inside the cell, thus causing the cell to gorge and possibly explode.
- **Isotonic** solutions have equal amounts of solvent and solute on both sides of a biological membrane, thus the molecules diffuse through the cell at a steady and balanced rate maintaining equilibrium in the cell.

In the Cell:



http://paramedicine101.com/files/2010/10/Osmotic_pressure.png

The Egg:



Q4. What will happen to eggs (cells) that are separately placed in syrup, distilled water, and liquid egg whites?

If I place an egg in syrup, then ____,

because ____.

If I place an egg in distilled water, then ___________________________________,

because ____.

If I place an egg in liquid egg whites, then _________________________________,

because ____.

Day 1 – Initial Observations and Set Up

1. **Take the three cups and label them "syrup", "distilled water", and "liquid egg whites", respectively.**

2. **Take the three eggs with shells dissolved by vinegar, and place an egg in each cup.**

3. **Measure circumference (in centimeters) of the "syrup" egg. Record in the data table.** For circumference, wrap a piece of string around the width of the egg until both ends meet. Then straighten the string and align against a ruler to record the circumference.

4. **Measure mass (in grams) of the "syrup" egg. Record in the data table**. For mass, if not using a triple beam balance, then use the rudimentary scale by placing egg in one bag while you balance the bags with jelly beans in the other bag.

5. **Measure circumference (in centimeters) of the "distilled water" egg. Record in the data table.**

6. **Measure mass (in grams) of the "distilled water" egg. Record in the data table.**

7. **Measure circumference (in centimeters) of the "liquid egg whites" egg. Record in the data table.**

8. **Measure mass (in grams) of the "liquid egg whites" egg. Record in the data table.**

9. Gently **place each egg back into their proper cups**. f

10. **Cover the “corn syrup” egg with corn syrup, completely filling it.** If the egg floats in the corn syrup, add a small amount of corn syrup into a plastic sandwich bag and place over egg to add weight on top of it.

11. **Cover the other two eggs with their respective solution**.

12. Let the eggs soak in their cups overnight.

Day 2 – Final Observations and Clean Up

1. **Gently remove each egg from their respective beaker. Gently rinse the eggs** that were in the corn syrup and liquid egg whites under running water.

2. **Gently dry all three eggs** by blotting with a paper towel.

3. **Measure the circumference in centimeters and mass in grams for each egg just as you did previously**. *Record in the data table.*

4. **Calculate** in the data table the CHANGE in circumference and mass for each egg. *Record in the data table.*

CHANGE = Final Circumference – Initial Circumference

AND

CHANGE = Final Mass – Initial Mass

Note: Be sure to include a (+) sign if it is a positive change or a (-) sign if it is a negative change.

5. **Calculate the PERCENT CHANGE in circumference and mass for each egg using the formula below.** *Record in the data table.*

$$\text{Percent Change} = \frac{\text{Final circumference} - \text{Initial circumference}}{\text{Initial circumference}} \times 100$$

AND

$$\text{Percent Change} = \frac{\text{Final Mass} - \text{Initial Mass}}{\text{Initial Mass}} \times 100$$

Data Table: Egg Measurements Pre/Post Diffusion

		Initial Measurement	Final Measurement	Change (cm/g)	Percent (%) Change
Egg #1: Corn Syrup	**Circumference (cm)**				
	Mass (g)				
Egg #2: Distilled Water	**Circumference (cm)**				
	Mass (g)				
Egg #3: Liquid Egg Whites	**Circumference (cm)**				
	Mass (g)				

Concept Questions

Q5. What role does vinegar play in the investigation? In other words, what did the vinegar "do" to the eggshells?

Q6. Circle one word in each set of parentheses.
A cell placed in a syrup solution is in a(n) (hypertonic/hypotonic/isotonic) environment.
This will cause the cell to (gain/lose) water because the cell is
(hypertonic/hypotonic/isotonic) when compared to its environment.

Q7. Circle one word in each set of parentheses.
A cell placed in distilled water is in a(n) (hypertonic/hypotonic/isotonic)
environment. This will cause the cell to (gain/lose) water because the cell is
(hypertonic/hypotonic/isotonic) when compared to its environment.

Q8. Circle one word in each set of parentheses.

A cell placed in egg whites is in a(n) (hypertonic/hypotonic/isotonic) environment. This will cause the cell to maintain equilibrium because the flow of water is (the same/different) on both sides of the biological membrane.

Q9. Draw illustrations depicting the final outcomes of each egg after soaking in their respective solutions.

Egg in corn syrup	Egg in liquid egg whites	Egg in distilled water