Teachers' Notes

<u>Materials (per class):</u>

- About 16 eggs for a class of 30 students.
- About 1 liter of corn syrup, diluted as outlined below (cannot be reused).
- About 2 liters of vinegar
- About 2 liters of distilled water (I haven't tried tap, it may or may not be equally effective).
- Depending on how you set it up, you may need more or less of these materials. See notes below.

<u>Dilutions</u>

Corn syrup is about 22% water by weight and the rest is mostly sugar (glucose). (USDA). On the label, however, the percentages are difficult to determine and when I calculated them they were a lot different from the USDA numbers. I'm more concerned with the process than the accuracy of the final numbers, so I went with the easier-to-use USDA numbers.

A 1:1 ratio by volume of corn syrup to water yields about a 40:60 sugar to water ratio or a solution that is 60% water.

A 3:1 ratio (by volume) of corn syrup to water yields a 60:40 sugar to water ratio, or a solution with 40% water.

I added a few drops of red & blue food coloring respectively to code the solutions, which also stains the eggs to help students avoid confusion later after they are removed from the solutions for weighing. If students are serially using all the eggs for each of the solutions you may want to skip that step.

<u>Money Saver</u>

All eggs soak in vinegar, obviously. Afterward, you may add all eggs to one solution at a time (all eggs go into the 1:1 solution, weigh, then all eggs go into the 3:1 solution, weigh, then all eggs in the distilled water, weigh). This is both more time consuming and more expensive but may be more effective for the students to see each egg go through the changes. Alternatively, assign each egg a different solution after they have soaked in vinegar and let students compare results from one group to another.

<u>Results</u>

The vinegar is 95% water, so after soaking in vinegar the eggs will gain a considerable amount of weight. If then placed in distilled water (about 100% water) the egg will gain even more weight (a few grams). If placed in 1:1 solution, the eggs lose weight but remain a little heavier than their original masses. In the 3:1 solution the eggs shrivel up nicely and lose weight relative to their original measurements. You get a nice line when the % change is graphed and can interpolate the original concentration of water in the egg.

I have students write up the lab in my standard Experimental Design Worksheet (below).

Egg Osmosis Lab

Eggshell is mainly Calcium Carbonate = $CaCO_3$

Vinegar is acetic acid diluted with water = CH_3COOH
calcium carbonate and acetic acid react :

$$CaCO_3 + 2 CH_3COOH \rightarrow Ca(CH_3COO) + H_2CO_3$$
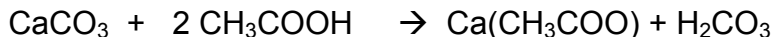
Calcium carbonate plus acetic acid yields calcium acetate plus carbonic acid

Carbonic acid is unstable and decomposes easily to form either water and CO_2 or bicarbonate (HCO_3^-)

$$HCO_3^- + H^+ \rightleftharpoons \mathbf{H_2CO_3} \rightleftharpoons + H_2O + CO_2$$

The CO_2 will be seen as bubbles in the solution and will mostly escape as a gas, driving the reaction to the right. This is the same principle that keeps blood pH stable, but that's another lesson.

Underneath the eggshell is a semi-permeable membrane. When we remove the calcium carbonate we get a "naked egg" on which we will perform a couple of eggs-periments!

Procedures:
1. Obtain an uncooked egg from your teacher.
2. Find the mass of the uncooked egg.
3. Place the egg (GENTLY!) in a beaker and cover with vinegar.
4. Observe the egg for a couple of days until the shell has completely dissolved.
5. Gently remove the egg from the vinegar, gently rinse off and pat dry with a paper towel.
6. Weigh the egg and record.
7. At each table there are at least 4 eggs. Place one egg in each of the following liquids:
   -Vinegar (as a control)
   -Distilled Water
   -Corn Syrup 1:1
   -Corn Syrup 3:1
8. Leave the eggs overnight.
9. Next day, weigh eggs and record results.

Record peripheral observations here (date and point in procedure where observations occur):

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Data Table: Change in egg mass after soaking in test liquids

Liquid	Initial Mass of Egg	Final Mass (After Soaking in the solutions)	△ Mass* (change in mass)	% change (△ mass divided by initial mass X 100). A gain is positive, a loss is negative	Concentrations of each liquid ($\%H_2O$)
Vinegar					Acid 5% Water 95%
Distilled H_2O					--- Water 100%
Corn Syrup 1:1					Sugar 40% Water 60%
Corn Syrup 3:1					Sugar 60% Water 40%

*final mass - initial mass = change in mass. Note that this number may be negative.

Notes:

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Experimental Design Worksheets

1. **Problem Question**

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2. **Hypothesis**

   _____

3. **Independent Variable**

   _____

4. **Levels of the Independent Variable**

   _____

5. **Dependent Variable**

   _____

6. **Measurement**

   _____

7. **Constants**

   _____

8. **Procedure**

   _____

   _____

   _____

   _____

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9. **Data** (*Summarize the data for the class. Calculate average %change)*

Independent variable	Dependent variable										
% H$_2$0	% change in mass										
	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	Average

10. **Conclusion**

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11. **Graph**:
    Data Table Summary in this graph is ONLY for data that will be graphed – usually the *average* from your Data Table.

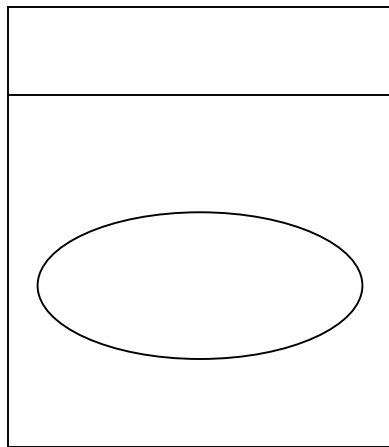| Data Table Summary	
I.V.	*D.V*

12. **Summarize your graph**:

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Interpolating from the graph

Use your graph to estimate the initial concentration of water in the egg before the shell was dissolved by the vinegar. Explain how you arrived at your estimate. Clue – what does the point at which your line intersects the x-axis represent?
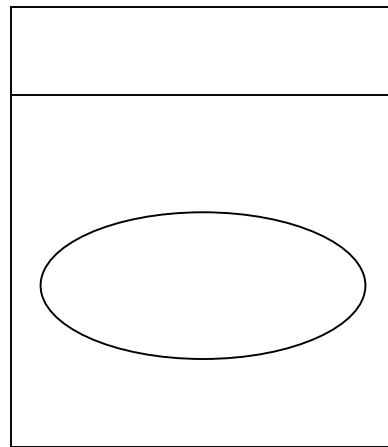
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Modeling the process

Using the letter **W** to represent water, **P** to represent proteins, **S** to represent sugar, and **F** to represent fat, show the relative concentrations of the different substances in this experiment. Use Arrows to show the direction of diffusion of water (osmosis).
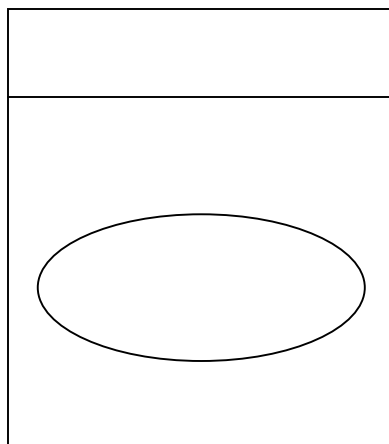
Egg soaking in vinegar	…in distilled H_2O

… in corn syrup 1:1	…in Corn syrup 3:1