

Over Easy

A Study of Diffusion



Introduction

Diffusion of water into and out of cells is often demonstrated by treating cells with various concentrations of solutions and then examining them under a microscope. This activity will allow students to use a “giant” cell (chicken egg) to view dramatic changes caused by osmotic pressure.

Concepts

- Diffusion
- Osmosis

Materials

| | |
|---|--------------------------|
| Beaker, 250-mL | Metric ruler, 1 mm scale |
| Chicken egg, raw, medium or small works fine | String |
| Corn syrup, e.g., Karo [®] | Vinegar (any kind) |
| Cover for beaker, e.g., Parafilm M [®] | Water, distilled |

Safety Precautions

The materials in this activity are considered nonhazardous. Normal laboratory safety procedures should be followed. Once food grade items are brought into the laboratory they are considered chemicals and should not be consumed. Safety glasses should be worn during this activity. Wash hands thoroughly with soap and water before leaving the laboratory.

Procedure

1. Obtain a raw egg. Handle it carefully.
2. Use string and a ruler to measure the long circumference and the short circumference of the egg (see Figure 1 on page 2). Measure to the nearest millimeter. Record the measurements in Table 1.
3. Place the egg in a beaker. Pour enough vinegar into the beaker to cover the egg. Cover the beaker to prevent evaporation. Label the beaker and store it in a safe place.
4. After 24 hours, carefully remove the egg from the beaker. Note the bubbles on the shell. What is happening to the shell? If the egg is completely soft, and the shell is gone, go on to Step 5. If the shell is not completely dissolved, change the vinegar, and return the egg to the beaker for another 24 hours.
5. When the shell is completely dissolved, remove the egg from the beaker and rinse off any excess vinegar. Observe the egg. Measure both the long and short circumference, and record the measurements in Table 1. Handle the shell-less egg carefully.
6. Clean the beaker thoroughly with soap and water. Place the egg in the beaker. Pour enough corn syrup into the beaker to cover the egg. Cover the beaker and store for 24 hours.
7. After the shell-less egg has soaked 24 hours in corn syrup, examine the egg. Record the observations in Table 1. Carefully remove the egg from the beaker, rinse it off, and measure the two circumferences again. Record measurements in Table 1.
8. Wash and rinse the beaker. Place the egg into the beaker and cover it with distilled water. Cover and store for 24 hours.
9. After 24 hours, remove the egg. Measure the egg again and record all observations in Table 1.

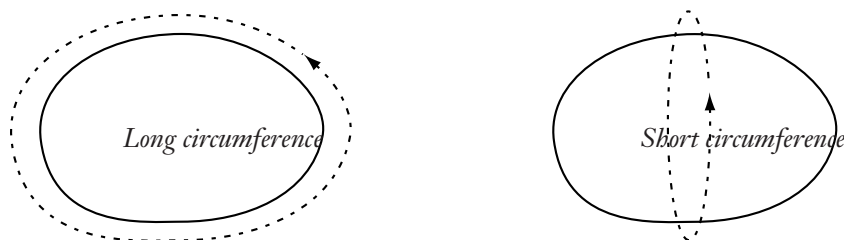


Figure 1. Measuring the egg

Table 1

| | Short Circumference (mm) | Long Circumference (mm) | Other Observations |
|------------------------|--------------------------|-------------------------|--------------------|
| Egg with shell | | | |
| Egg with shell removed | | | |
| Egg in corn syrup | | | |
| Egg in distilled water | | | |

10. Examine the results in Table 1 and consider these questions:
- Explain your observations and measurements when the egg was soaked in corn syrup for 24 hours. Be sure to discuss water concentration and water diffusion in your explanation.
 - Explain your observations and measurements when the egg was soaked in distilled water for 24 hours. Be sure to discuss diffusion of water in your explanation.
 - Predict other substances that may “shrink” or “expand” the egg. Explain your predictions.
 - The eggshell is made up mostly of calcium carbonate (CaCO_3). Research the chemical composition of vinegar and develop an explanation why the shell was dissolved by the vinegar. Write a chemical equation for the reaction if possible. What observations support this chemical equation?
11. Going further—If the egg hasn’t spoiled or if additional experiments are desired:
- Demonstrate how molecules move into or out of the cell using a criteria other than size of the egg.
 - Can the contents of the egg be removed and the “membrane” bag used for other diffusion experiments? Very delicate work!
 - Use your imagination to develop other experiments!

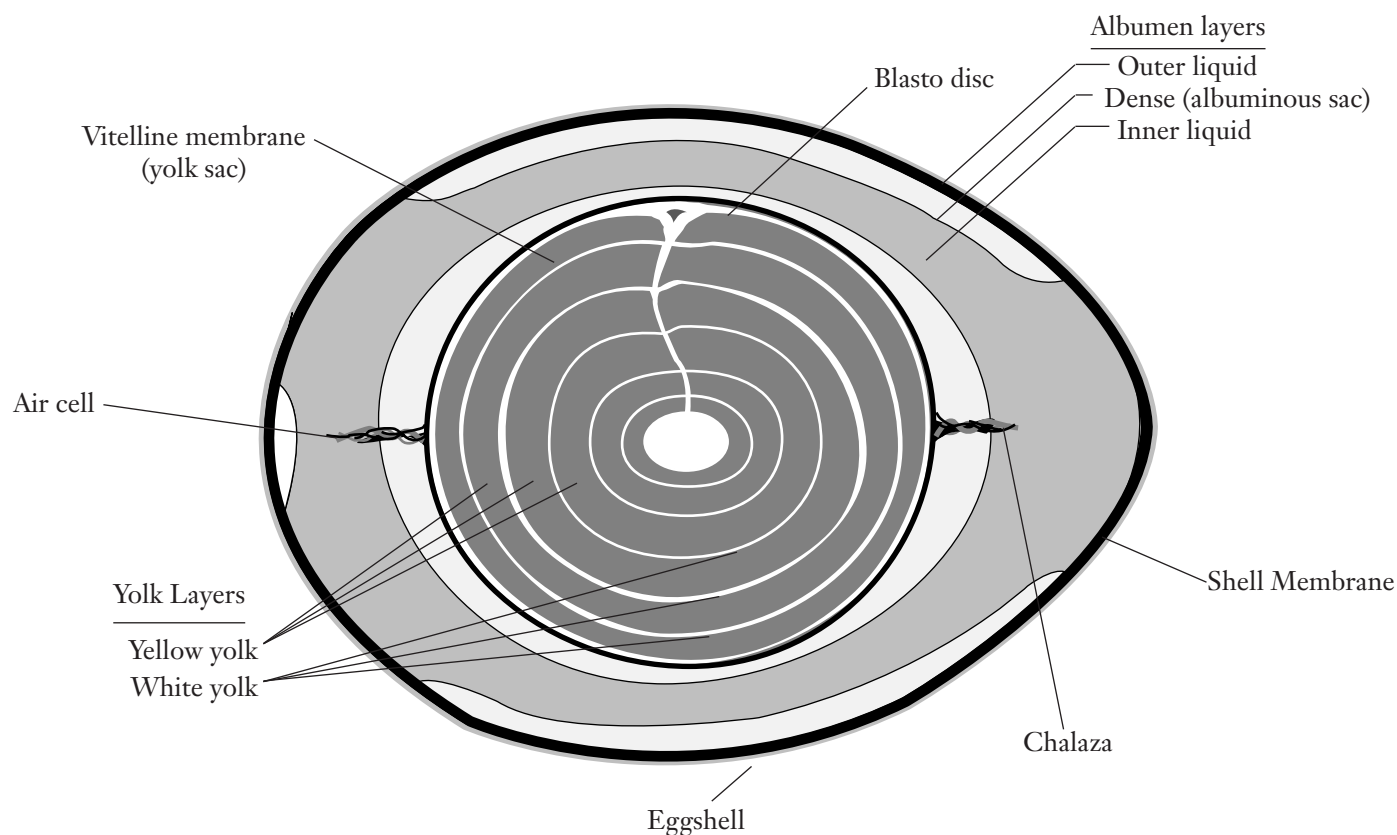


Figure 2. Structure of a freshly laid hen's egg

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. Vinegar may be disposed of according to Flinn Suggested Disposal Method #26b. Flush down the drain with large volumes of water.

Tips

- The egg with its shell removed is reasonably tough and can be handled without too much difficulty. This lab can be done at home and can be a “home-project” during your work on diffusion. However, depending on the age of the student, adult supervision may be required. It can also be a good vehicle for student experimental designs and the incorporation of controls into an experiment.
- To avoid giving your students all the answers, consider just providing them with the procedure on page 1 and 2 of this activity.
- Clear plastic cups can be used instead of beakers and molasses instead of corn syrup. However, distilled or deionized water should be used for the best results.

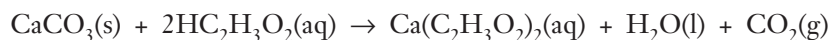
Discussion

The rather dramatic size changes in the size of the “shell-less” egg is explained by the net movement of water molecules in response to the various diffusion gradients set up in the experiment. When the egg is placed in the corn syrup, the concentration of water inside the egg is greater than the water concentration in the sugar-laden corn syrup. Thus, the net movement of water is out of the egg and it shrinks. When placed in distilled water, the water concentration is obviously greater outside of the egg and the net movement of water molecules is into the egg, causing it to swell. This experiment does not provide any evidence about the contents of the egg (mostly large molecules such as protein) nor the possible diffusion of sugar molecules through the egg

membrane.

A bird's egg is one of the most complex and highly differentiated reproductive cells achieved in the evolution of animal sexuality. Initially only microscopic in size, an ovum swells over 1,000 times in volume by the time it is laid. The infusion of yolk, the deposition of egg white (albumin) and the shell layers all contribute to the enlargement. The yolk is added to the ovum prior to ovulation, and the rest of the components of the egg are added during the egg's passage through the oviduct. This passage of the egg down the chicken's oviduct (where successive layers of albumen, shell membranes and shell layers are added) is unique in the animal kingdom. When a chicken's egg is cracked open and dropped into a frying pan, the uniqueness of this giant cell is rarely realized.

In this experiment, the vinegar (about 4–8% acetic acid) dissolves the CaCO_3 from the surface of the egg.



The resulting calcium acetate salt is soluble in water and CO_2 is released. Students will observe the gas release in their beaker and on the surface of the egg.

The acetic acid does not react with the cell membranes like it does with the calcium carbonate shell. The outer membrane is usually firmly attached to the shell. It is pliable and tough, and is generally made of long protein fibers strengthened by albuminous cement (see Figure 2). This membrane is riddled with tiny pores that allow the passage of gases and liquids by osmosis and diffusion. The thin inner membrane is formed just prior to the outer membrane as sticky keratin fibers are being added to the egg surface in the oviduct. The hen's oviduct is like an assembly line—as the egg travels down the oviduct, successive layers are added as the egg is “built.” The shell is added last in the region of the oviduct called the uterus.

When all layers, membranes, and the shell have been added, the egg is ready to be laid. The hen then ejects the egg voluntarily with her powerful vaginal musculature. The final result is one of nature's largest cells.

NGSS Alignment

This laboratory activity relates to the following Next Generation Science Standards (2013):

Disciplinary Core Ideas: Middle School

MS-PS1 Matter and Its Interactions

PS1.B: Chemical Reactions

MS-LS1 From Molecules to Organisms: Structures and Processes

LS1.A: Structure and Function

LS1.N: growth and Development of Organisms

Disciplinary Core Ideas: High School

HS-PS2 Motion and Stability: Forces and Interactions

PS2.B: Types of interactions

Science and Engineering Practices

Developing and using models

Asking questions and defining problems

Constructing explanations and designing solutions

Crosscutting Concepts

Cause and effect

Scale, proportion, and quantity

Energy and matter

Materials for *Over Easy* are available from Flinn Scientific, Inc.

| Catalog No. | Description |
|-------------|--------------------|
| V0002 | Vinegar, 4 L |
| GP1020 | Beaker, 250-mL |
| AP1872 | Ruler, Transparent |
| C0091 | Corn Syrup |
| W0001 | Distilled Water |

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.