High School Lesson Plans

Walking on Eggshells?

Overview:

Even though eggshells have a reputation for being fragile, they are extremely strong! In this lesson, students balance, float, and step on eggs to test their unique structural properties. They then propose a method to dissolve an egg's strong outer shell, design an experiment, and test their hypothesis to see what can pass through the now exposed membrane.

Time Frame: 3 class periods (45 minutes each)

Objectives:

Students will:

- Determine the direction of water movement based on solution concentrations
- Examine the properties of an eggshell to explain their unique design

Next Generation Science Standards

- **HS-PS1-3** Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles
  - The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.

Materials:

- Station Directions handout
- Properties of Eggs recording sheet
- Passing Through! Investigation handout
- Water
- Celery stalks (for the teacher)
- Plastic containers/cups
- Eggs
- Books
- Salt
- Vinegar
- Corn syrup

High School Lesson Plans

Walking on Eggshells?

Background Information:

Eggshells are extremely strong. They are actually a natural example of an arch. The shape of an arch distributes the forces evenly along the weight-bearing piers that support the arch. The overall shape allows it to eliminate tension stress.

Once through this hard outer shell of an egg, you will find a very unique membrane. A selectively permeable membrane allows some types of molecules to pass through, but not all. Organisms have a cell membrane that is selectively permeable and regulates what enters and leaves the cell. Food and oxygen move into cells across the membrane through the process of diffusion. Osmosis diffuses water across a selectively permeable membrane. In this lesson, students will be experimenting with an egg membrane to explore this concept.

Engage: (20 minutes)

1. Students will visit different stations to investigate basic properties of eggs and capture their observations. Invite students to visit several stations in groups of 3 or 4.
2. Guide students to use the information gathered during their station investigations to complete the questions on the ***Properties of Eggs*** recording sheet. Students may also incorporate their prior experiences or background knowledge.

Explore: (40 minutes)

1. Explain to students that eggs need to be strong for adult birds to sit on them (without breaking them) and keep them warm. The eggshell is made of a protein and calcium. This allows oxygen to enter and carbon dioxide to leave. A membrane lines the shell and is very strong. This enables the egg to hold the contents in, even without the shell! Is it possible to see the cell membrane without the shell?
2. Present the following molecule on the board: ***CaCO3***.
3. Invite students to identify the elements that make up the molecule. It is anticipated students will identify ***Calcium***, ***Carbon***, and ***Oxygen***.
4. Explain that eggshells are made of ***calcium carbonate***, CaCO3. When an eggshell is successfully dissolved it produces a ***carbon dioxide*** gas. The equation is shown below.
   CaCO3 + CH2COOH -> Ca2++ H2O + 2CO
5. Ask students to identify what substance was used to dissolve the shell using the following equations:
   - Vinegar: ***CH3COOH***
   - Citric Acid: ***C6H8O7***
   - Ammonia: ***NH3***

Walking on Eggshells?

6. Explain to students that in order to dissolve the shell, they will soak the eggs overnight in vinegar. Guide teams to place a raw egg in a container and submerge it in vinegar.
7. On Day Two, after the membrane is exposed, ask students if they think anything can get in and out of the now-exposed membrane. Students might remember that gasses are able to pass through the shell, but can anything else get in or out?
8. Invite students to read the following explanations and select one that they believe best answers the question, ***How do different solutions effect the movement of water across an egg cell membrane?***:
   - Water molecules move out of the cell because the concentration of water is greater inside the cell than outside the cell.
   - Water molecules move out of the cell because the concentration of water is less inside the cell than outside the cell.

   Ask students to provide an explanation for their selection.

Explain: (30 minutes)

1. Invite students to complete the Passing Through! Investigation using the eggs with the exposed membrane. This will occur over several days.
   Teacher Note: While the students are investigating with their eggs, set up two celery stalks – one in water and one out of water and allow them to sit for three or four days.
2. Once the student investigation is completed (after three or four days), use the celery stalks to create an analogy of what happened in their experiment. One container shows a healthy celery stalk and the other a wilted stalk. Osmosis is the process that causes water to pass through a living cell. When water moves into a plant cell, the cell expands. The full cells allow the plant to stand upright. If there is not enough water the cells will not be full and the plant will wilt. Water molecules will move from areas of high to low concentration to establish equilibrium. Demonstrate this by drawing the movement of molecules in each of the celery stalks.
3. Ask students to use their data to answer the following questions:
   - Which explanation for the movement of water molecules is the most accurate based on your experiment? If necessary, consider the celery stalk analogy.
   - How did you gather your data?
   - How did you analyze or interpret your data?
   - Why does your evidence support claim?

High School Lesson Plans

Walking on Eggshells?

Elaborate: (45 minutes)

1. Invite students to use the same procedure to test other liquids to see if they will pass through the egg membrane.

Evaluate: (10 minutes)

1. Ask students to describe what happened in each container by drawing the molecules passing in and out of the membrane.

High School Lesson Plans

Walking on Eggshells? Student Handout

Properties of Eggs

Before you begin the stations, which of the following statements are true?

1. I can squeeze an egg without breaking it. _____
2. Books can be piled on an egg without it breaking. _____
3. Eggs can float in water. _____
4. Hard boiled eggs will spin faster than a raw egg. _____

Record your observations at each station. When you complete all of the tasks, answer the provided questions.

Station	Observations	Questions
Strength!		Where have you seen arches that have a similar dome shape as the egg?
Do Eggs Float?		Why did the egg float when salt was added to the water (density of the egg versus the salt water)?
Twirl!		Which egg had more inertia (kept moving)?

Walking on Eggshells? Student Handout

Station Directions

Station #1 Strength!

Test #1:

1. Place a raw egg in the palm of your hand.
2. Squeeze firmly, but with even pressure.

Test #2

1. Place your thumb and index finger on the ends of the egg.
2. Squeeze firmly.

Test #3

1. Collect four raw eggs.
2. Crack off the smaller ends of the eggs and dispose of the inside.
3. Rinse the egg halves with water.
4. Make each shell dome the same size using scissors to trim the edges of the eggshells.
5. Arrange the shells on a flat surface and make a quadrant.
6. Balance a book evenly on the shells. Keep adding books until a shell breaks.

Station #2 Do Eggs Float?

1. Fill a jar with water and place an egg inside.
2. Remove the egg and add salt until the egg floats.

Station #3 Twirl!

1. Collect one raw egg and one hard-boiled egg.
2. Place both eggs on their side.
3. Spin the eggs using your finger.
4. Quickly stop the motion using one finger and lift your finger away.

Source: Adapted from livescience

High School Lesson Plans

Walking on Eggshells? Student Handout

Passing Through! Investigation Sheet

In this activity, you will model how a cell membrane works to let water enter and exit the cell. You will use a chicken egg as a model of a cell membrane. After dissolving the shell in vinegar to expose the membrane, the egg will soak in various liquids. Observe how the size (circumference) of the egg changes as it takes on or loses water through the membrane.

1. Observe the features of an egg and measure its mass. Record your observations and measurements on the table provided.
2. Place your egg in a cup.
3. Cover the egg entirely with **vinegar**. After one day, record your observations and measurements.
4. Pour the vinegar down the sink. Wash and rinse the cup thoroughly.
5. Place your same egg back into the empty cup.
6. Cover the egg entirely with **maple syrup**. After two days, record your observations and measurements.
7. Pour the maple syrup down the sink. Wash and rinse the cup thoroughly.
8. Place your same egg back into the empty cup.
9. Cover your egg entirely with **distilled water**. After two days, record your observations and measurements.

Date	Liquid	Circumference of egg in mm	Other Observations

High School Lesson Plans

Walking on Eggshells? Student Handout

Summary

Directions: Describe what happened in each container by drawing the molecules passing in and out of the membrane.