3M Young Scientist Lab

Classroom Activity | Grades 3-5

The Everyday Science of Eggs

GUIDING QUESTION

What is the anatomy of an egg? How will understanding the properties allow for different outcomes when mixing and working with eggs?

LEARNING OBJECTIVES

Students will be able to:

- describe the physical characteristics of an egg.
- write a hypothesis about how an egg white will react when beaten.
- conduct an experiment to test their hypothesis.
- create a visual representation that explains the science behind beating egg whites.

OVERVIEW

Eggs are often called “incredible” and “edible,” but did you also know they are a great tool for teaching science? In this lesson, students will be introduced to the anatomy of an egg and how egg proteins change when they are heated, beaten and conduct an experiment to test their hypothesis. Then they will explain the science behind this reaction and create a visual representation to illustrate it.

NEXT GENERATION SCIENCE STANDARDS

- PS1.B: Chemical Reactions
  - When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)
  - No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.) (5-PS1-2)

- ETS1.C: Optimizing the Design Solution
    - Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3) (secondary to 4-PS4-3)

LESSON TIME FRAME

2, 45 minute class periods

BACKGROUND INFORMATION

Eggs are made up of proteins that change when you heat them, beat them, or mix them with other ingredients. For example, eggs have a tightly coiled chain of molecules. When they're heated, the molecules unwind and break because the bonds are weak, allowing them to attach to other molecules. When the molecules reattach, they create structure; this causes the fluffiness of a cake or other baked item, as the molecules attach to the other ingredients such as flour, sugar, and fats. When eggs are beaten, the fragile molecules break down and unravel just as they do when heating them. The mixing process creates foaming bubbles, incorporating air into the eggs. Mixing or beating eggs creates foam and gives the eggs structure.

Inside of every egg is a clear liquid called albumen, also known as an egg white. These egg whites are about 90% water and 10% protein. Egg-white proteins are long chains of amino acids that fold and curl. When you beat an egg white like students will do in this experiment, these proteins uncurl and stretch out, exploding hidden amino acids. Some of those amino acids are attracted to water and others repel it.

Beaten egg whites are classified in three stages according to the peaks they form when the whisk is lifted: soft, firm, and stiff peaks. Overbeaten eggs take on a dry appearance, and will eventually collapse. Egg whites will not beat correctly if they are exposed to any form of fat, such as cooking oils or the fats contained in egg yolk. This is why it's not good to beat egg whites in a plastic bowl that might have remains of grease or fat from previous use.

MATERIALS

Teacher Materials/Prep

- Home Connection Resource
- 5 Finger Summary Reflection
- 1 egg

Student Materials

- Science notebook

Materials per Student Group

- A few dozen eggs (at room temperature)
- Disposable plastic gloves (found in paint section of hardware store)
- Whisks
- Water
- Egg separator (optional)
- Several small bowls (glass or stainless steel)
- Measuring cups
- Art materials
- Soap and water or disinfectant to clean hands after investigation

*These magnets can be purchased at hardware stores. Either round or rectangular magnets will work as long as they are flat. The rectangular style magnets are often referred to as "cabinet latch magnets" since they are commonly used inside cabinets to hold a door shut. This style would be best to use in the classroom since they likely would be the style found in cabinets at home.

CLASSROOM ACTIVITY

Warning: *Check for food allergies to eggs before beginning this investigation. This allergy is not airborne, so students who have a food allergy to eggs and egg products can help in other ways during the lesson. Have all students use disposable plastic gloves to handle the eggs. Encourage students to be careful with the raw eggs as they explore. Some raw eggs and egg shells contain salmonella bacteria that can make them sick. Students should always keep their hands out of their mouths and wash their hands well with soap and water after handling raw eggs.*

Day 1

Engage

1. Hold up a raw egg for students and ask them to describe it. Allow students to hold the egg, tap it, shake it, etc., to help with their observations. (Talk with students about keeping their hands out of their mouths while handling raw eggs and about the importance of washing hands with soap and water after handling.)
2. Ask for a student volunteer to help you crack the egg open. Put the open shell on a plate and ask students to continue to share their observations. Encourage them to identify the following parts of the egg:

a. Shell- Outer, hard casing of an egg.
b. Membrane- Thin film inside the shell that allows air to enter the shell but keeps the liquid safe inside.
c. Albumen- The slimy clear liquid inside of the egg that is also known as an egg white.
d. Yolk- Center, yellow part of an egg. They may also be able to see strings that keep the yolk fastened in the center.

You may also want to share with students that there are important parts of an egg that they can't see. For example, eggs consist of proteins that change when you heat them, beat them, or mix them with other ingredients. The way that these proteins uncurl and react to each other and other substances are what form scrambled eggs, causes egg whites to foam, and makes a hard boiled egg hard! In fact, lots of everyday science can be learned from an egg!

Explore

3. Divide students into groups and distribute a glass or stainless steel bowl, a cup of water, and a hand whisk to each group. Demonstrate for students the proper and careful use of the whisk. Ask students what they think will happen if they pour the water into the bowl and try to mix it with a whisk. Have students record their answers in a science notebook.
4. Then have students pour the water into the bowl and use the whisk to try to mix the water. What happens? Have students write their observations. Note: When mixing water, air bubbles will temporarily form, but there will be no other change in the liquid. That's because bubbles that form in plain water quickly pop. Water molecules are electrically attracted to each other so they won't spread out to form a bubble film unless you add something that lessons the attractions.
5. Now, distribute the following additional materials to each group: 3 room temperature eggs, and egg separator (optional), and a glass or stainless steel bowl.
6. Crack open one egg in front of the students and separate the yolk from the egg white with either the egg separator or by pouring the egg from hand to hand to separate the egg white from the yolk. Show students the egg white and ask them if they have any idea what will happen when they beat the egg white. How will the egg white react? Will it react the same way that the water did? Why or why not? Have them write a hypothesis for one or more of these questions in their science notebooks. Have student groups share their hypothesis with the class.
7. Then have students conduct an experiment to test their hypothesis. Direct them to separate the egg whites of their three eggs into a glass or stainless steel clean bowl. Tell students that even a small amount of the yolk or its residue can change this experiment, so they will want to carefully pour the egg whites one by one into one small bowl, and use the other small bowl for the yolks.

8. Direct them to use the whisk to beat the egg whites for several minutes until they are pure white in color and stiff to the touch. Group members can take turns whisking. This step will take some time so encourage them not to give up! (They should beat until the eggs can stand up by themselves if they pull the whisk out and maintain stiff peaks). Note: Students can take this experiment a step further by adding different variables such as plastic vs. glass bowls, room temperature eggs vs. cold eggs, or egg whiter with a little bit of yolk mixed in vs. none at all..

Explain

9. Have students write down their observations in their science notebook. How did their observations compare to their hypothesis? Challenge each group to come up with a scientific explanation for what they observed. Why do students think that the egg whites formed into foamy peaks when being beaten? Encourage them to think about what they learned at the beginning of the lesson about egg proteins.

Day 2

Elaborate

10. Challenge students to create a visual representation of the science behind egg whites. Their representation can be in the form of a poster, video, series of photographs, or other creative product!

Evaluate

11. Finally, challenge students to present their visual representation and explain the science behind beating an egg white to the rest of the class.

Teacher Scoring Key for Evaluate

Student presentations will take many forms but should include some or all of the following information:

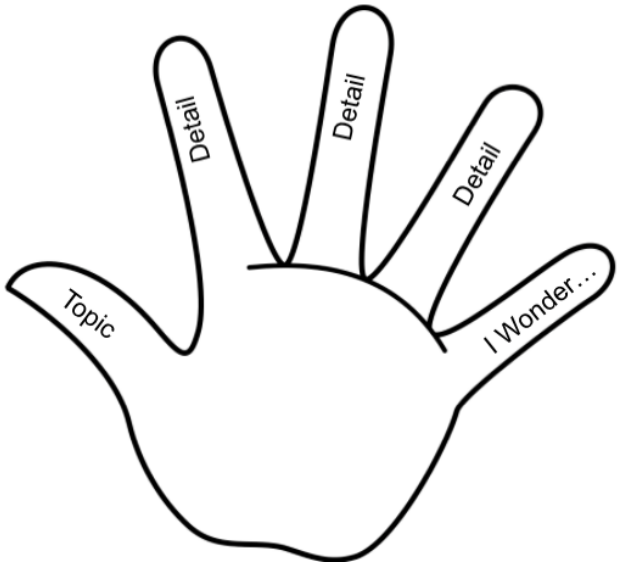
- Eggs are made up of proteins that change when you heat them, beat them, or mix them with other ingredients.
- Egg whites are about 90% water and 10% protein.
- Egg-white proteins are long chains of amino acids tht fold and curl. When you beat an egg white, these proteins uncurl and stretchout. That's called denaturation. When proteins uncurl, they expose hidden amino acids. Some of those amino acids are attracted to water and others repel it.
- Whisking the egg whites also mixes air into them, causing the proteins to come out of their natural state.
- These denatured proteins gather together where the air and water meet and create multiple bonds with the other unraveled proteins, and thus become foam, holding the incorporated air in place. This is because the proteins consist of amino acids; some are hydrophilic (attracted to water) and some are hydrophobic (repelled by water). This process is called coagulation.

- When beating egg whites, they are classified in three stages according to the peaks they form when the whisk is lifted: soft, firm, and stiff peaks.
- Egg whites will not beat up correctly if they are exposed to any form of fat, such as cooking oils or the fats contained in egg yolk. That's why it's not good to beat egg whites in a plastic bowl that might have remains of grease or fat from previous use.

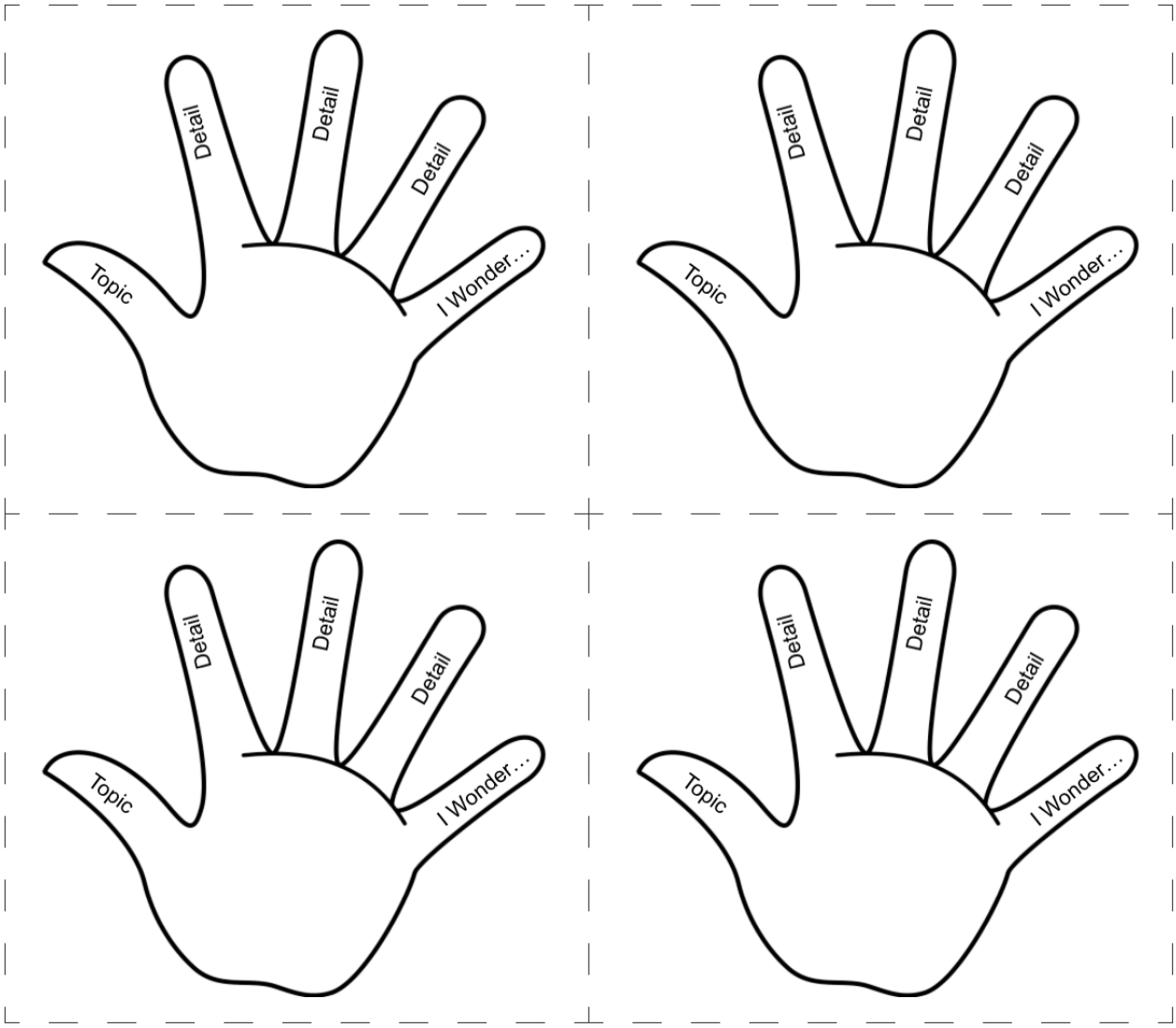
REFLECTION

Students will reflect on their learning by completing the Five Finger Summary. Print off the Five Finger Summary Resource, cut them up, and distribute one to each student. Alternatively, students may trace their hand on a piece of paper or in their science journal.

Students will fill in each finger as shown below:



FIVE FINGER SUMMARY



HOME CONNECTIONS

Parent Background Information:

Families can take the Everyday Science of Eggs lesson a step further by making meringue. Ever wonder how meringue gets its stiff peaks and firm structure? The answer is based on science! When we whip egg whites to make a meringue or soufflè, air bubbles are incorporated into the mixture. When an egg protein is exposed to an air bubble, part of that protein is exposed to air and part is still in water. The protein will uncurl, losing its globular shape, so that its water-loving parts can be exposed to the water and its water-fearing parts to the air. Once uncurled, the proteins bond with each other, creating a network that can hold the air bubbles in place. And voila, we have stiff peaks! When heated, the network surrounding the bubbles solidifies, and the structure holds firm as the air expands so much that the bubbles burst.

- To make meringue, families will need the ingredients listed above (3 room temperature eggs, an egg separator, and a glass or stainless steel bowl) as well as sugar, a baking sheet, a mixing spoon and a heat source. They may also need additional eggs. As they beat their eggs into peaks (Step 8 above), they will need to slowly add sugar and stir it in, being careful not to overbeat. They should then spoon the mixture onto the cookie sheet in small meringue “kisses” a couple of inches apart from each other. Once the cookie sheet is filled, bake the cookies at 225° for about an hour and a half.
- Make food safety an important part of cooking at home! Make sure all family members wash their hands frequently with antibacterial soap when touching food. You can find an entire list of important food safety tips at http://www.foodsafety.gov/. Encourage family members to follow these food safety tips and even create a list of tips to be hung in the kitchen!
- You can also learn how 3M works with food and beverage processors on a variety of food safety solutions by visiting http://solutions.3m.com/wps/portal/3M/en_US/Microbiology/FoodSafety/.