



Discover the Eggstraordinary Egg

name

Time Frame

1-2 class periods

Overview

In this lesson, students will investigate the properties of eggs; conduct several experiments to learn about proteins and the denaturation of proteins; design an investigation using the scientific method; and develop digital presentations.

Objectives

- Describe the physical characteristics of an egg.
- Conduct several investigations to determine how different variables affect the reaction of egg whites when beaten.
- Communicate the results of experiments.

Materials

- Several dozen raw eggs
- Metal bowls
- Wire whisks
- One plastic bowl
- "Egg Composition" activity sheet (one per student)
- "Eggcellent Investigations" activity sheet (one per student)



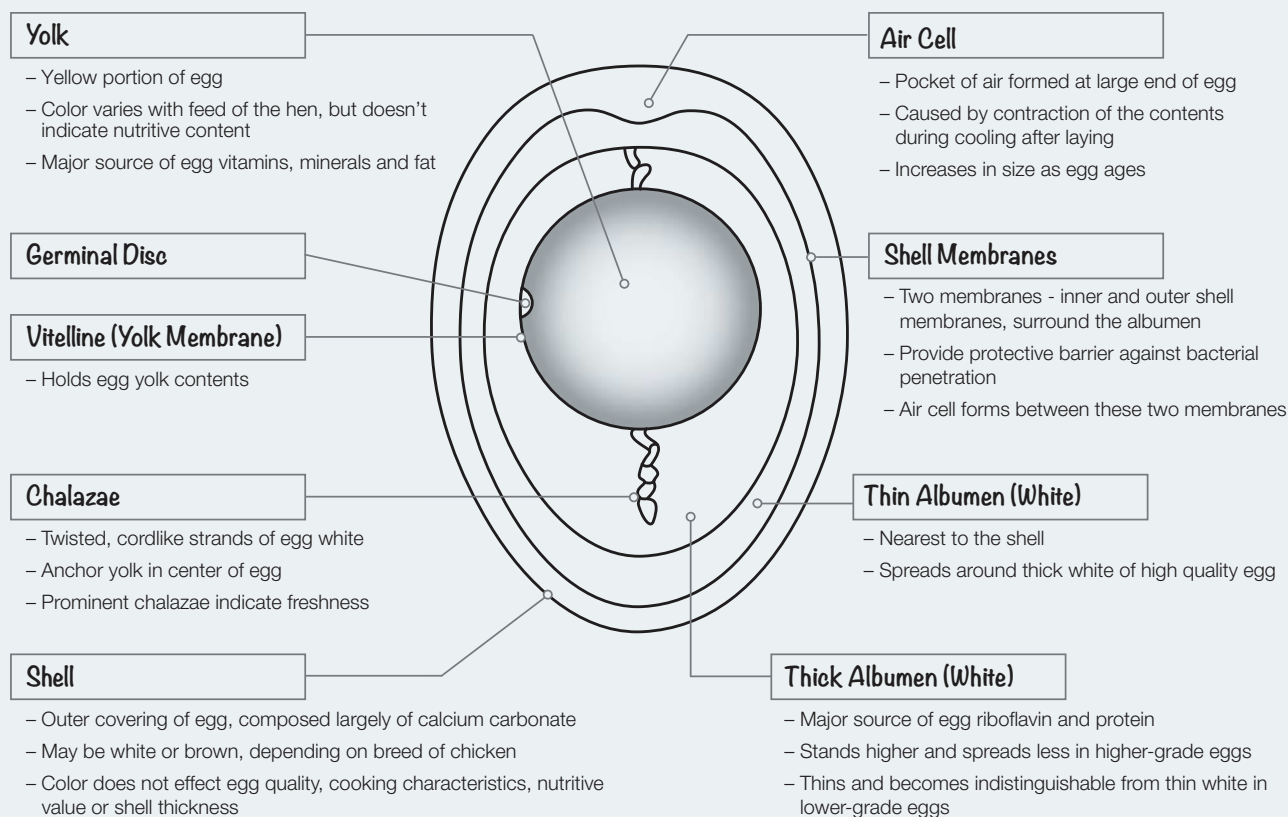
Lesson Background

Eggs have been a versatile food and vital recipe ingredient for centuries. You can fry, scramble, poach, bake and cook them in their shells or turn them into omelets, frittatas, quiches, custards, soufflés, meringues, cakes, sauces and a host of other dishes.

Eggs perform many functions in cooking: binding, leavening, thickening, emulsifying, coating or glazing, clarifying, fortification, crystallization and flavor. In addition to providing nutrients in recipes, they affect texture and color. No other single food or combination of ingredients has been found to duplicate all of the egg's functions.

Eggs are composed of several distinct parts:

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Shell color may range from white to brown to deep brown and depends on the breed of the hen. Hens with white features and earlobes lay white-shelled eggs. Hens with red features and brown earlobes lay brown-shelled eggs. The color of the shell has no effect on the nutrients or quality of eggs.

Yolk color depends on the hen's feed. Mashings containing yellow corn and alfalfa result in eggs with medium yellow yolks. Heat or barley mashings produce lighter yellow yolks, while those made from white cornmeal can produce almost colorless yolks. Yolk color does not affect an egg's nutrients or quality. Egg yolks contain the nutrients needed to nourish a growing chick.

Albumen (egg white) is nearly clear and doesn't appear white until beaten or cooked. In raw white, a yellow or greenish cast indicates that riboflavin is present. In very fresh eggs, the white may appear cloudy due to the presence of carbon dioxide which hasn't had time to escape through the thousands of pores on the shell (from 7,000-17,000) concentrated on the large end.

Egg whites consist of about 90% water into which is dissolved 10% proteins. The shape of a protein molecule plays an important part in determining how it behaves. Protein molecules in egg whites are like tiny balls of yarn. Their round, compact shape enables them to dissolve in water. The mechanical action of incorporating air into the watery protein mixture of the egg white causes the proteins to unfold. This is called denaturation. Some parts of a protein are water-loving (hydrophilic) and other parts are water-fearing (hydrophobic). Normally the hydrophobic parts of the protein in an egg white stay tucked inside the structure and the hydrophilic parts are pushed to the outside, so that they can dissolve well in water. However, as they are beaten and we incorporate air bubbles into the mix, the strands of protein hit the boundary between the air bubble and the watery mixture. This causes the hydrophilic parts to turn themselves around to stay dissolved in the water and the hydrophobic parts to move into the air bubble. As the protein strands unfold, they bond to one another in this new arrangement and the air bubbles become trapped within their structure. The more that the whites get whipped, the more air is incorporated into the mixture and the proteins bond with each other more strongly, producing 'stiff' egg whites.

Several factors affect the formation and stability of egg white foams, including fat and temperature. The addition of even a small amount of fat will interfere with the formation of foam. Fat is present in the egg yolk, so it is very important that all of the egg yolk is separated from the egg white. It is also better to whisk an egg white in a non-plastic bowl such as a metal bowl because plastic is porous and remnants of fat or grease can remain in a plastic bowl and interfere with the formation of egg foam. Temperature can also play a role. Egg white foam is formed and reaches greater volume more quickly when egg whites are at room temperature.



Engage (20-30 minutes)

1. Put these words on the board and ask students what they all have in common: omelet, meringue, soufflé and custard. The answer is eggs! Explain to students that, because of their makeup, eggs can take many forms. They can be scrambled, turned into foam, used as the glue to hold a cake together or baked into a quiche. Hold up a raw egg and ask students to identify everything they know about the parts and functions of an egg. List answers.
2. Divide students into small groups and distribute a room temperature raw egg, a metal bowl, flip chart paper and marker to each group.
3. Direct each group to break open its egg into the bowl and observe its contents.
4. Distribute the “Egg Composition” activity sheet and ask each group to read the definitions on the sheet and use what they know about eggs to label each corresponding egg part. You may need to give students a word bank with the following egg parts: air cell, shell, yolk, thin albumen, thick albumen, germinal disc, vitelline (yolk) membrane, chalazae.
5. Review answers (answers can be found in the background information) and direct students to look for each part in the raw egg in their bowls.

Explore (20-30 minutes)

6. Distribute the “Eggsellent Investigations” activity sheet to each student. Ask each group to write down its prediction of what will happen to the egg when the egg is beaten with a whisk.
7. Then, direct the groups to whisk their eggs for about three minutes and record observations. Have students wash and dry the bowls and whisks.
8. Distribute a second room temperature raw egg, an egg separator (optional) and a small bowl to each group. Ask students to write predictions about what will happen when they separate the yolk from the egg white and whisk the egg white alone.
9. Direct groups to separate the egg white from the egg yolk using a separator or another technique. The egg white should go in one bowl and the egg yolk in another. You may need to model this for students.



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10. Then, direct them to pour the egg white only into the metal bowl and whisk it for several minutes. Again ask them to record observations and share the results with another group, forming a larger group.
11. Then, ask each large group to brainstorm the science behind why egg whites foam into peaks. You may want to give them a hint that it has something to do with the proteins found in the egg whites and how those proteins react to the whisking.
12. Ask students to conduct research and/or share information from the “background information” section about what happens to an egg white when it is whisked.

Explain (20-30 minutes)

13. Direct students to create and present a five-panel comic strip that explains the science behind why egg whites stiffen when they are whisked. Their comic strip should include information about the unraveling of the protein strands and the way in which the hydrophobic and hydrophilic parts of the protein react to the mechanical energy of the whisking.

Elaborate (30-45 minutes)

14. Explain that each group is now going to design and conduct an investigation where they ask a question about how changing one variable in the process of whisking egg whites into foam impacts the result.
15. Review the steps in a scientific investigation with students. They include:
 1. Ask a Question
 2. Do Background Research
 3. Construct a Hypothesis
 4. Test Your Hypothesis by Doing an Experiment
 5. Analyze Your Data and Draw a Conclusion
 6. Communicate Your Results





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16. For Step 1, ask each group to come up with one variable they could change. Examples include the temperature of the eggs, the type of bowl (plastic vs. metal) adding in a little yolk or even the amount of time the whites are whisked. Once they determine the variable they will change, direct them to turn that into a question. For example, "How would using a plastic bowl instead of a metal bowl impact the formation of egg foam?"
17. Depending on their question, give groups time to conduct research to help them form a hypothesis for what will happen.
18. Then, direct groups to use that information to write their hypothesis.
19. Ensure that groups have the appropriate materials to conduct their experiment. Once they do, direct them to conduct their experiments and record their data and observations.
20. Give students time to analyze the data and draw a conclusion about their experiment.
21. To help students communicate their results, form new groups made up of one person from each original group. Direct students to take turns sharing the results of their original group's experiment with their new group.

Evaluate (30-45 minutes)

22. Finally, challenge each new group to write a two-minute script for an imaginary cooking show about the perfect way, based on scientific concepts, to form egg foam from egg whites. Their scripts should incorporate the results of all of the investigations the groups conducted.
23. Have each group create a video or animation based on their script.
24. Challenge the class to evaluate which one best represents the investigation and the scientific reasons behind the results.





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Standards

CCSS ELA Standards

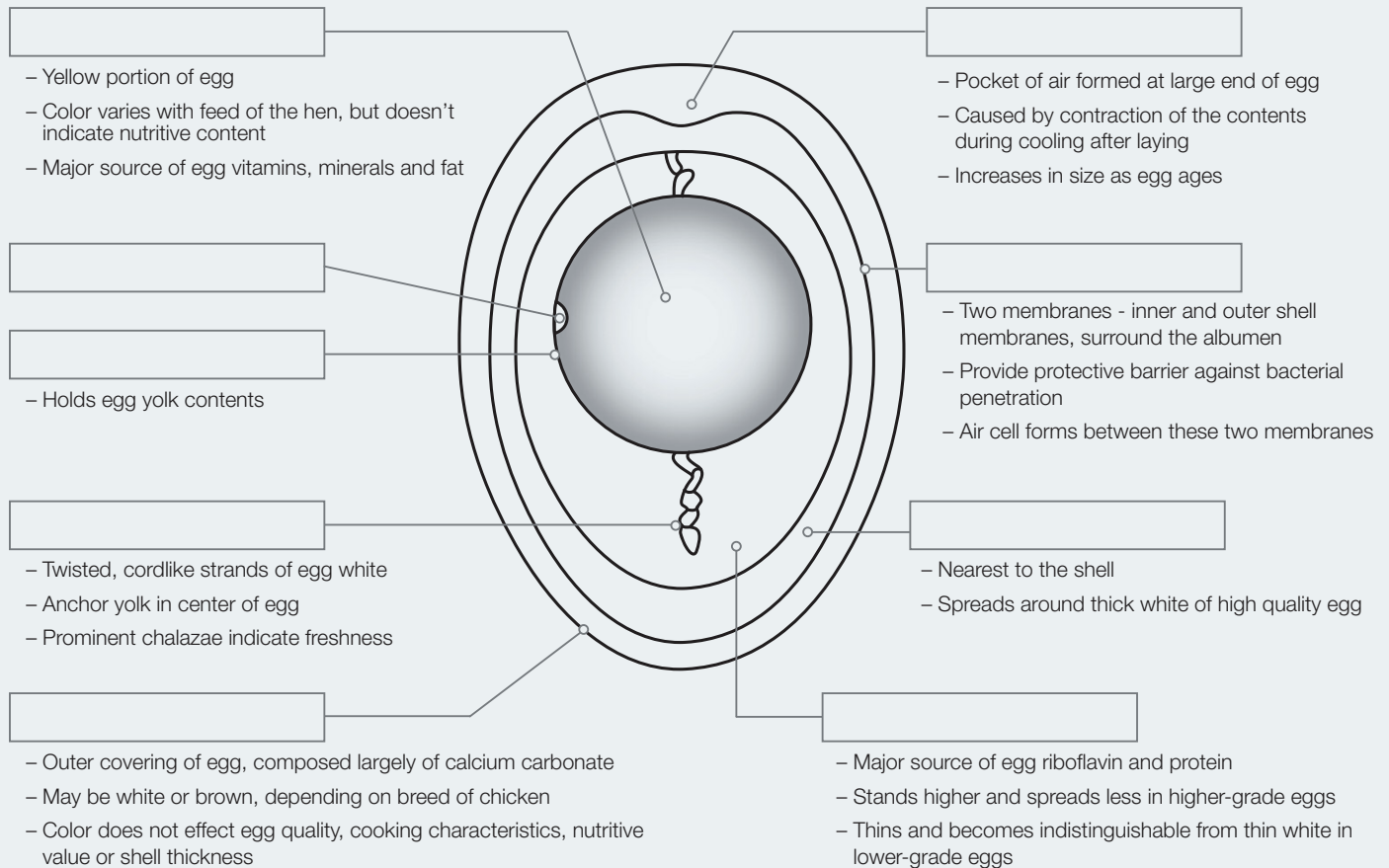
- **CCSS.ELA-Literacy.CCRA.W.7-9.7** - Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.
- **CCSS.ELA-Literacy.CCRA.SL.7-9.1** - Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
- **CCSS.ELA-Literacy.CCRA.SL.7-9.4** - Present information, findings and supporting evidence such that listeners can follow the line of reasoning and the organization, development and style are appropriate to task, purpose and audience.
- **CCSS.ELA-Literacy.CCRA.SL.7-9.5** - Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.
- **CCSS Literacy in Science and Technical Subjects**
- **CCSS.ELA-Literacy.RST.6-8.3** - Follow precisely a multistep procedure when carrying out experiments, taking measurements or performing technical tasks.
- **CCSS.ELA-Literacy.RST.9-10.3** - Follow precisely a complex multistep procedure when carrying out experiments, taking measurements or performing technical tasks, attending to special cases or exceptions defined in the text.
- **CCSS.ELA-Literacy.RST.9-10.7** - Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
- **CCSS.ELA-Literacy.RST.6-8.7** - Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Next Generation Science Standards Framework

- **Core Idea: PS1: Matter and Its Interactions**
PS1: A: Structure and Properties of Matter
PS1: B: Chemical Reactions
- **Core Idea: LS1: From Molecules to Organisms: Structures and Processes**
LS1.A: Structure and Function
LS1.C: Organization for Matter and Energy Flow in Organisms



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Choose from the following answers: Thin Albumen Shell Membranes Shell Chalazae Air Cell Yolk Thick Albumen Germinal Disc Vitelline (Yolk Membrane)





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"Eggsellent Investigations" Activity Sheet

Eggs are not only delicious! They are a great way to learn about scientific concepts. For the following investigations, you will work with a group of classmates to learn about the properties of eggs.



Investigation 1: Whisking an egg

Write a hypothesis below for what you think will happen when you whisk a whole egg in a metal bowl.

Then, do the following:

- Crack open a room temperature egg in a metal bowl.
- Use a whisk to beat the egg for three minutes.
- Write your observations below.





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Investigation 2: Whisking an egg white

Write a hypothesis below for what you think will happen when you whisk an egg white in a metal bowl.



Then, do the following:

- Crack open a room temperature egg.
- Separate the egg white from the egg yolk.
- Place the egg white only in a metal bowl.
- Use a whisk to beat the egg for three minutes.
- Write your observations below.

What is the science behind the results?






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Investigation 3: Change a variable

For the next investigation, your group will design an experiment by changing one variable from Investigation 2. For example, you could use a different type of bowl, change the temperature of the egg, add water or yolk to the egg white, or change the amount of time you whisk the egg. Follow the steps in the scientific method below:



Step 1: Ask a question. Turn your changed variable into a question below.

Step 2: Conduct research. Learn all you can about the science behind the question you have asked.

Step 3: Write a hypothesis. Based on your research and what you already know, form a hypothesis about what will happen. Write the hypothesis below.

Step 4: Conduct the experiment.

Step 5: Write your observations and analyze the data below.

Step 6: Communicate the results. Form a new group with one member from each original group and take turns sharing your results.

