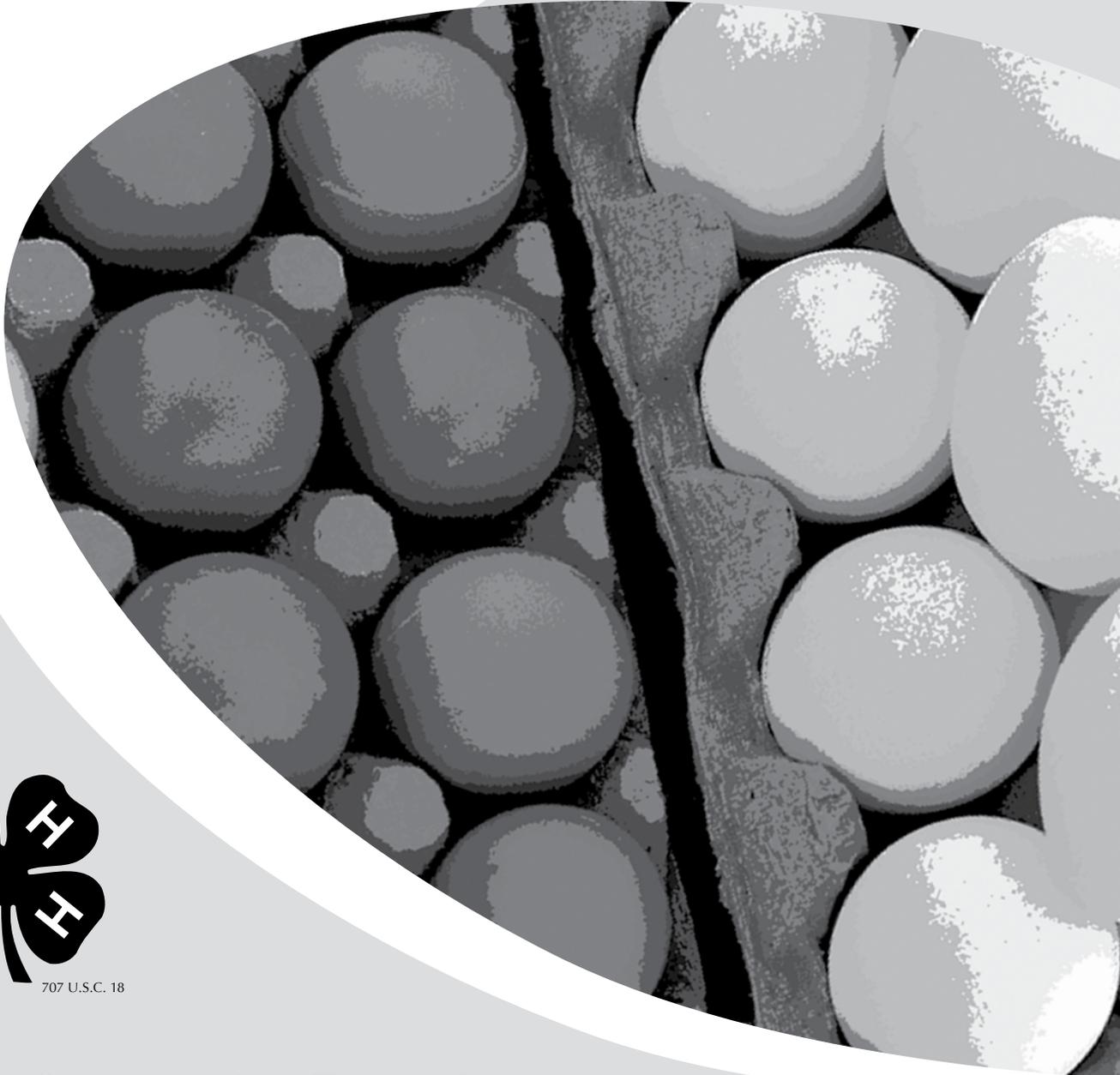


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# THE Egg-citing Egg

Teacher/Leader Guide



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Virginia Cooperative Extension



VIRGINIA STATE UNIVERSITY

# THE Egg-citing Egg Teacher/Leader Guide

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## Cracking the Common Egg

“The Egg-citing Egg” 4-H project is designed to acquaint youth with the avian egg, its parts, and how they relate to human nutrition. Commercial egg production and marketing are also discussed. Not only are eggs one of nature’s most nutritious foods, they can become a classroom teaching resource. This publication is designed to be used in conjunction with “The Egg-citing Egg” record book for 4-H’ers.

### Egg Lore

Eggs have been important to man for many centuries. Since before Biblical times, they have been considered a delicacy. They have been associated with science, sports, and superstition, and were important in pagan and Christian custom.

To many primitive cultures, eggs signified the return of life following the winter season, and have been offered to idols at spring festivals by some tribes in Africa and South America. To the Egyptians, eggs signify the restoration of mankind following the deluge. The Jews use eggs in the Passover Feast to signify deliverance from bondage and to celebrate their departure from Egypt. Our modern custom of decorating eggs at Easter is a symbol of the Resurrection, but history reveals that the custom originated in pre-Christian times.

### Modern Egg Production

As recently as 40 years ago, practically every farm had a small flock of chickens. Hens were allowed the “run of the farm” and were fed table scraps and a little grain. The farmer used the eggs he needed for home consumption and offered the remainder for sale to local retail merchants, neighbors, and friends. The “egg money” generated was in direct relation to the time spent in this small enterprise and the market demands of the community.

This type of egg producer would be awestruck by a modern egg production-processing operation. Today’s mass production is highly scientific and almost totally automated. Hens are housed in environmentally controlled houses under controlled lighting and are fed computer-formulated diets. Eggs are collected on conveyor belts, washed, graded, sized, and automatically packaged for direct shipment to retail stores. In many cases, eggs

reach retail stores within 24 to 48 hours after they are laid and are therefore fresher than the so-called “farm fresh” eggs of yesteryear.

### Egg Structure and Composition

The major parts of the egg are shown in Figure 1. The yolk is the living center of the egg, and in the fertilized egg it is the nutritive material that supports the growth of the embryo. The yolk is located near the center of the egg, and in the freshest eggs tends to rise to the top of the albumen that surrounds it. The yolk is primarily composed of fat but also includes proteins, vitamin, minerals, and water. The albumen (white) is a clear, viscous material that sometimes has a greenish-yellow cast caused by the pigment ovoflavin. The albumen is made up of protein and water. In very fresh eggs, you will notice thick albumen surrounding the yolk, and a thinner albumen on the outside. The albumen is surrounded by two shell membranes that are cemented to each other, except at the blunt end where an air cell is formed between the two membranes after the egg is laid. At each end of the yolk is a twisted, rope-like structure of concentrated albumen called the “chalazae” (kuh-lay-zee), which anchor the yolk to the membranes surrounding the albumen and serve to keep the yolk centered in the eggshell. Chalazae vary in size and do not negatively affect cooking performance or nutritional value. In fact, they are most noticeable in fresh eggs.

Although proportions vary, albumen makes up about 58 percent of the weight of the whole egg with the yolk and shell representing 31 percent and 11 percent, respectively. Water makes up about 74 percent of the edible portion of the egg and is the medium in which chemical and physical changes occur. Protein makes up about 13 percent, fat 12 percent, and ash 1 percent of the edible portion of the whole egg.

The egg yolk contains orange, red, and yellow pigments which belong to the carotenoid groups. Carotenoids are long-chained hydrocarbon compounds of plant origin. Animals cannot synthesize lutein, though they have the ability to absorb carotenoids from their diet and deposit them into tissue. Metabolically, plants use carotenoids to protect against light damage to chlorophyll. Animals use the absorptive and antioxidant properties of carotenoids in a similar fashion (Novak and Troche,

## Shell

- Outer covering of egg, composed of calcium carbonate.
- May be white or brown, depending on breed of chicken.
- Color does not affect quality, cooking characteristics, or nutritional value.

## Yolk

- Yellow portion of egg.
- Color varies with feed of the hen, but doesn't indicate nutritional content.
- Major source of vitamins, minerals and fat (The yolk contains more than 90 percent of the calcium, iron, phosphorus, zinc, thiamin, B<sub>6</sub>, folate, and B<sub>12</sub>, and 89 percent of the pantothenic acid [9 items]). The white does not contain more than 90 percent of any nutrient, but contains over 80 percent of the magnesium, sodium, and niacin).
- Germinal disc.

## Vitelline (Yolk) membrane

- Clean seal that holds egg yolk.

## Chalazae

- Twisted, cordlike strands of egg white.
- Anchor yolk in center of egg.
- Prominent chalazae indicate high quality.

## Air cell

- Pocket of air formed at the large end of the egg.
- Caused by contraction of contents during cooling after laying.
- Increases in size with age.

## Shell Membranes

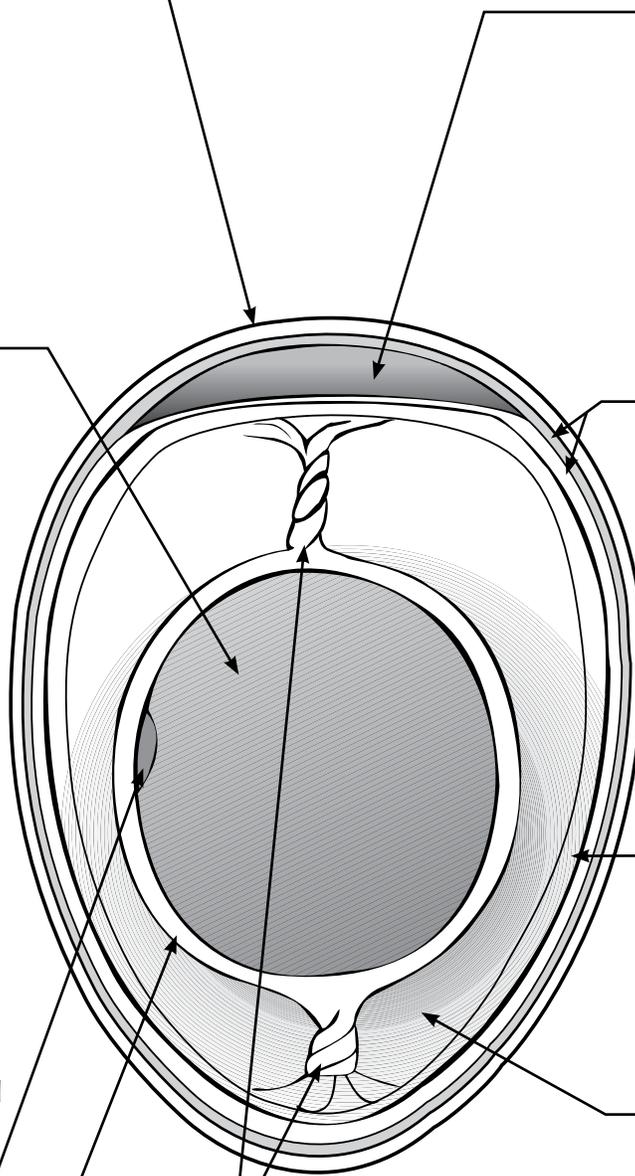
- Two membranes – inner and outer shell membranes – surround the albumen.
- Provide protective barrier against bacterial penetration.
- Air cell forms between these two membranes.

## Thin Albumen

- Nearest to the shell.
- Spreads around thick white of high quality egg.

## Thick albumen (White)

- Excellent source of riboflavin and protein.
- Stands higher and spreads less than thin white in high quality eggs.
- Thins and becomes indistinguishable from thin white in low quality eggs.



2006). Yolk color can vary from dark orange-red to light yellow, depending on the hen's food. Most eggs on the market today have a uniformly colored yolk because the hens are caged and fed a standard corn/soybean-meal diet.

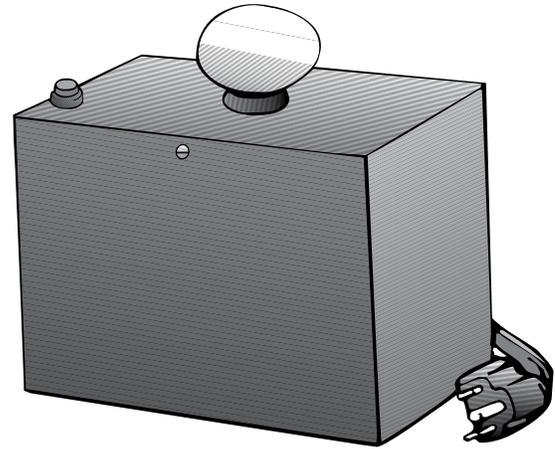
**Egg Size and Egg Quality**

There is no relationship between size and grade of eggs. Sizes of eggs range from Jumbo to Peewee. While one or two eggs in a dozen may be smaller by one size or larger than others, the weight of the whole carton of eggs is what counts. Size is expressed in ounces per dozen.

Eggs offered for sale in retail stores are typically graded. They are also grouped into size or weight categories. Grade A eggs have the same qualities whether they are small or large. Both grade and size affect price. Some eggs are sold as ungraded.

USDA eggs are candled and graded according to U.S. Department of Agriculture grading specifications. Candling is a method for examining the interior of the egg without breaking the shell. Eggs are passed before a bright light which makes it possible to judge albumen quality and location of the egg yolk. The light also reveals the size of the air cell or any interior defects and makes any abnormalities in the shell visible. The air cell is also a factor in candling. As an egg ages, moisture escapes via pores in the cell. The longer an egg sits, the larger the air cell becomes. Grade AA eggs have air cells less than one-eighth of an inch in depth. Grade A eggs have air cells between one-eighth and three-sixteenths of an inch in depth and Grade B air cells are larger than three-sixteenths of an inch.

As a backup method to candling, USDA graders also break out a small percentage of eggs on the line. Breakouts are evaluated on the appearance of their albumen and yolk (see standards for breakouts

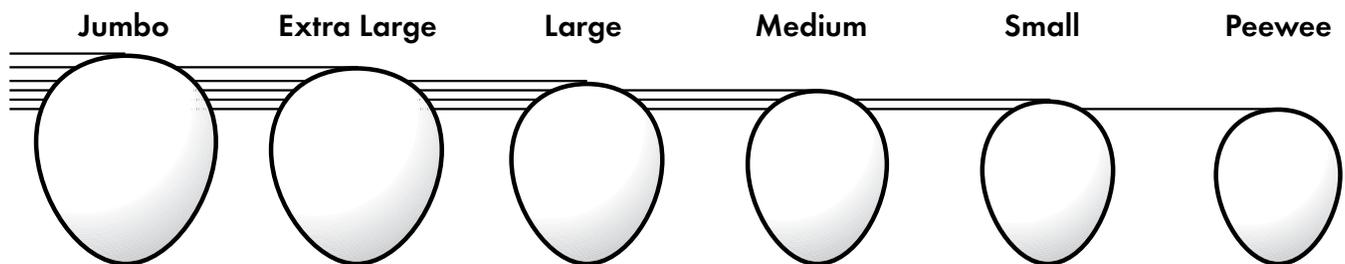


Egg Candler

table below). They are graded differently from interiors in that each grade (AA, A, and B) is further broken into three grades; i.e., AA's are classified as either a 1, 2, or 3, 1 being the best example of a AA egg and 3 being the worst example of a AA egg.

Small blood or meat spots are sometimes found in the albumen or on the surface of the yolk. This is caused by the rupture of a small blood vessel while the egg is being formed. These eggs are referred to as "loss eggs". On occasion, a carton egg will have a blood or meat spot. These imperfections can be easily removed and the egg can be used for general cooking.

Dirty, cracked, or defective eggs are removed during the grading process and are not offered for sale in retail stores. Eggs that are not removed during candling are graded either AA, A, or B. Sometimes a cracked egg will be found in an egg carton at the store. Such cracks are due to handling after the eggs have been graded and packaged. The table below briefly outlines the USDA standards for interior and exterior grading.



### Standards for Interior Quality

	AA	A	B	Loss
Air cell	<ul style="list-style-type: none"> <li>• 1/8 inch or less in depth.</li> <li>• May show unlimited movement and may be free or bubbly.</li> </ul>	<ul style="list-style-type: none"> <li>• 1/8 inch to 3/16 inch in depth.</li> <li>• May show unlimited movement and may be free or bubbly.</li> </ul>	<ul style="list-style-type: none"> <li>• Greater than 3/16 inch in depth.</li> <li>• May show unlimited movement and may be free or bubbly.</li> </ul>	<ul style="list-style-type: none"> <li>• Blood or meat spots over 1/8 inch in diameter.</li> </ul>

### Standards for Exterior Quality

	A	B	Loss
Shell soundness	Unbroken	Unbroken	Unbroken (see below) or Broken
Shell exterior	<ul style="list-style-type: none"> <li>• Approximately the usual shape and is sound and free from thin spots. Ridges and rough areas that do not materially affect the shape and strength of the shell.</li> <li>• A shell that is free from foreign material and from stains or discolorations that are readily visible.</li> </ul>	<ul style="list-style-type: none"> <li>• May be unusual or decidedly misshapen, or faulty in soundness or strength. May show pronounced ridges or thin spots.</li> <li>• May have slightly or moderately stained areas covering less than 1/32 of the shell surface if localized, or 1/16 of the shell surface if scattered.</li> </ul>	<ul style="list-style-type: none"> <li>• An egg with an unbroken shell with adhering dirt or foreign material.</li> <li>• Prominent or moderate stains covering more than 1/32 of shell surface if localized, or more than 1/16 of shell surface if scattered.</li> </ul>

### Standards for Breakouts

	AA <sub>1</sub> , AA <sub>2</sub> , AA <sub>3</sub>	A <sub>4</sub> , A <sub>5</sub> , A <sub>6</sub>	B <sub>7</sub> , B <sub>8</sub> , B <sub>9</sub>
Albumen appearance	White is thick and stands high, chalazae prominent.	White is reasonably thick, stands fairly high, chalazae prominent.	Small amount of thick white; chalazae small or absent. Appears weak and watery.
Yolk appearance	Yolk is firm, round and high.	Yolk is firm and stands fairly high.	Yolk is somewhat flattened and enlarged.
Usage	Ideal for any use, but are especially desirable for poaching, frying and cooking in shell.		Good for scrambling, baking and use as an ingredient in other foods.



## Egg Nutrition

The egg is one of nature's most nutritious, ready-packaged foods. Eggs contain high quality protein and are used as a standard to measure protein in other foods. Protein is necessary for the body to build and repair body tissues. Because of their protein content, eggs are classified in the Meat and Beans Group of the USDA's MyPyramid Food Guide ([www.mypyramid.gov](http://www.mypyramid.gov)). One egg is considered a one-ounce serving in this food group. Children ages 9 to 18 should have five to six ounce-equivalents a day from this food group.

Eggs are also high in Vitamins A, D, E, K, and the B-complex and are rich in minerals, particularly iron. Furthermore, eggs contain a large amount of essential amino acids. Essential amino acids are the most basic components of protein which cannot be synthesized by the body. Humans need nine essential amino acids, they are: *histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine*. Eggs provide some amount of all nine of these compounds.

The yolk makes up just over one-third of an egg. It provides three-fourths of the calories; all of the fat and the fat-soluble vitamins; most of the choline, phosphorus, iron, and calcium; and almost half of the protein and riboflavin in the egg. The white (albumen) has more than half of the total protein and riboflavin.

Even though eggs are considered a powerhouse of nutrients, they are low in calories. One large egg has approximately 80 calories, 60 of which come from the yolk. Because of their high nutritive content and the fact that they are easily digested, eggs can belong in the diet of people of every age. Designer eggs are being produced which cater to people with special diet needs.

## Niche Market Egg Production

Recently, egg producers began catering to consumers who were looking for specialty egg products. Because consumers are willing to pay higher prices for these eggs, producing for niche markets is a way for farmers to boost profits. Niche market eggs are generally classified into two main categories: designer and specialty (PS-51, 2000).

Eggs in which the content has been modified are termed designer eggs. Altering the content of the egg is achieved though supplementing the hen's

diet. Currently the market carries various brands of designer eggs which promise: higher Vitamin E content, lowered cholesterol (185 mg versus the typical 220 mg), increased amounts of omega-3 fatty acids, and eggs with increased amounts of pigments which may act as antioxidants. Though currently not available, designer eggs focusing on mineral (increased selenium and chromium) and pharmaceutical (eggs which carry additional antibodies) supplementation are being researched.

Specialty eggs are marketed to those consumers who are typically concerned with animal welfare. *Cage-free* or *free-roaming* eggs are produced from birds raised in a closed house system but are not placed in cages. These types of systems may have advantages for the bird in terms of available space, but this system also presents challenges in terms of labor and food safety (eggs are exposed to the floor and feces). It is also important to note that "cage-free" hens aren't exposed to the outdoors. They have still been raised in controlled indoor environments, just not cages. *Free-range* eggs are produced by birds that have access to the outdoors; the flock is usually locked in the house at night in order to deter predators. *Organic* eggs are produced by hens that have been fed organically certified feed. That is, feed that has not been exposed to synthetic pesticides or herbicides, antibiotics, or genetic modification. More often than not, organic birds are also raised in cage-free systems. *Fertile* eggs are eggs which come from broiler (meat birds versus layers) breeders. These eggs usually only hit the market when there is an excess of hatching eggs in the broiler market. The hens that produce these eggs have been exposed to roosters, and therefore may lay fertile eggs. Though fertile, the embryos from these eggs haven't had time to develop due to refrigeration. Therefore, there are no nutritional differences between fertile and infertile eggs.

## Egg Trivia

- Don't believe all the old wives' tales you have heard about eggs. White-shelled eggs are as nutritious as brown-shelled eggs.
- Those white, twisted strings in the eggs are protein; don't throw them out.
- Two eggs are equivalent in nutrients to one serving of meat and supply an average of 20 percent to 30 percent of the minimum daily requirement for protein and vitamins.

- Eggs should be stored in the refrigerator and covered, with the large end up.
- An average eggshell has 6,000 to 8,000 pores.
- One hen produces 330 eggs a year.
- To produce one egg it takes a hen 24 to 26 hours.
- A hen must eat 3.5 pounds of feed to produce a dozen eggs.
- Europe has had the domesticated hen since 600 B.C.
- Chickens came to the New World with Columbus on his second trip in 1493.
- There are now over 200 breeds of chickens.
- The largest single chicken egg ever laid weighed one pound and had a double yolk and double shell.

## I. The A-Maze-ing-Egg

### Learning Outcomes:

- Students will articulate how a purchased product is delivered to the market.

### Life Skills:

- Learning to learn
- Decision making
- Communication (see additional activities)
- Critical thinking (see additional activities)

### SOLs:

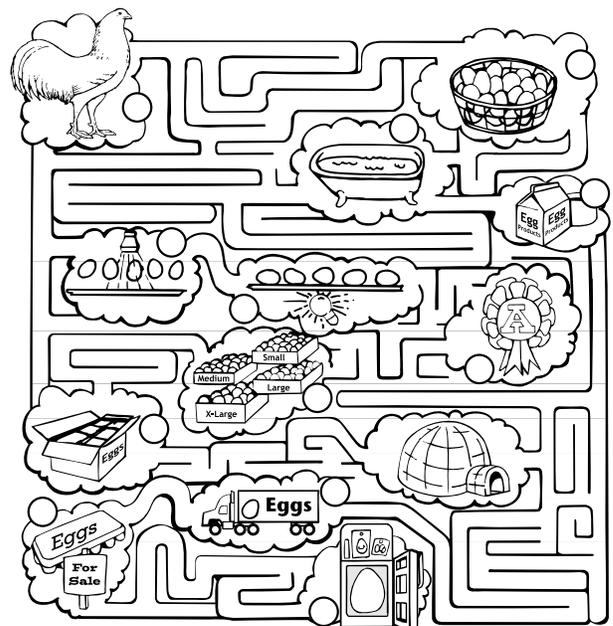
English 3.2, 4.2, 5.1, 5.3, 6.1 (see additional activities)

Have students turn to the maze in “The Egg-citing Egg” record book. At a given signal, the students may begin the activity, number the pictures in sequence, and trace the correct path through the maze. The winner will be the student who traces the path in correct order in the shortest time.

Go over the correct route with the class. Use the master to show the correct route. At each stop, review the following information. The first three steps of egg processing are the same, regardless

if the eggs are table eggs or egg-product eggs. Be sure to explain to the class that there are two possible destinations for eggs produced. They may be destined to become table eggs, in which case the entire maze is followed as is, or they may become egg-product eggs. Explain to the class how an egg is used to make egg products and what egg products are. Give some examples of egg products; i.e., Egg Beaters™, or dried egg whites.

1. Laying: Today, hens no longer roam in a farmyard. They are kept in a controlled environment so that their diet and production schedule can be regulated.
2. Collecting: In many operations, the eggs roll automatically from the hen’s cage to a conveyor belt below.
- 3a. Washing: All eggs are mechanically washed and sanitized before any other steps in the process.
- 3b. Egg products: The term “egg products” refers to eggs that are broken out of their shell. The entire processing scheme includes: breaking eggs, filtering, mixing, stabilizing, blending, pasteurizing, cooling, freezing or drying, and packaging. After the washing/sanitization step, eggs are broken and the whites and yolks are separated and/or a mixture of both white and yolk is made. The liquid egg product is filtered, mixed, and then chilled prior to additional processing.



Egg Maze



4. **Treating:** Since washing eggs removes some of their bloom, (the natural protective covering) they are sprayed with tasteless, odorless, harmless and invisible oil. This seals the pores and slows down aging even better than the original bloom.
5. **Candling:** Eggs are passed over an intense light and rotated mechanically so that the contents can be examined without cracking the shell. A candler checks for certain factors in the shell such as the size of the air cell and the condition of the albumen and yolk. Inferior eggs or under-grade eggs (under grades) are removed.
6. **Grading:** Eggs are graded as USDA Grade AA (fresh fancy), A, or B. Grades AA and A are preferred for poaching, frying, and cooking in the shell because of their superior appearance.
7. **Sorting:** Eggs are also sorted according to size. Government standards have established the minimum weight per dozen: Jumbo, 30 oz.; Extra Large, 27 oz.; Large, 24 oz.; Medium, 21 oz.; Small, 18 oz.; and Peewee, 15 oz. A dozen large eggs weigh at least one and one-half pounds.
8. **Packing:** Finally, eggs are placed in cartons marked with the appropriate size and grade. The cartons are specially designed to minimize breakage.
9. **Cooling:** The temperature of the eggs is lowered to 45°F to insure their freshness. Eggs kept at room temperature would lose more quality in one day than they would lose in one week in the refrigerator.
10. **Shipping:** Eggs are shipped in refrigerated trucks and delivered to the stores. The entire process takes about 36 hours and sometimes less than 24 hours.
11. **Selling:** Stores keep eggs in refrigerated display cases to help maintain their freshness.
12. **Storing:** At home, eggs keep best in their original carton on a shelf in the refrigerator. The egg-keeper slots in the door of refrigerators are subject to warm drafts whenever the door is opened, so it's best not to store them there. Properly stored, eggs will remain fresh for up to four or five weeks.

You might want to take a poll to see how many families store their eggs in the carton rather than in

the door. At the end of the unit, take another poll to see if there have been any significant changes in the number.

### Additional Activities:

1. Make arrangements to take your class on a field trip to an egg producer and/or supermarket to see how eggs are processed or stored. Or let a few students go and report to the class on their findings.
2. Let the students experiment with candling. Give students raw fresh eggs and ask them to examine them. Let them try to see through the shell by holding it in front of the ceiling light, a flashlight, or candle (hence the original term, candling).

To make a candling machine, cut a hole slightly smaller than the eggs in the bottom of a lidless shoebox. Darken the room except for an ordinary light bulb. Hold the box upside down over the light bulb and place the egg on the hole. A piece of red cellophane between the hole and the egg may help. Prick the large end of an egg and let it sit at room temperature for a few hours. Compare that egg to an unpricked, refrigerated one; there should be a noticeable difference in the size of the air cell.

## II. Question Board and Response

### Learning Outcomes:

- Students will be able to identify nutritional components of eggs.

### Life Skills:

- Learning to learn
- Communication
- Critical thinking

### SOLs:

English 4.1, 5.1, 5.2, 6.1

**Objective:** Students will be able to answer a series of questions concerning the nutritional content of an egg and will reach the conclusion that an egg is a nutritionally valuable food. Remind students that “designer eggs” are available for those with special dietary needs; i.e., lower cholesterol eggs for those watching their cholesterol intake.

**Materials:** Scissors, construction paper, and paste (optional).



**Instructions:** Distribute “The Egg-citing Egg” record book page 3 and scissors to students. Instruct them to cut out the nine boxes. If you wish, students can trace the boxes on construction paper, cut out the patterns, and glue construction paper patterns onto the back of the activity sheet boxes. This will make the Question Board pieces more durable.

Allow the students enough time to answer and check all eight questions. The students can find the answers by trial and error, using resource materials or online sources. Then as a group, discuss each question in detail. Provide additional information for each question.

- Eggs provide Vitamins A, D, E, K, B<sub>6</sub>, B<sub>12</sub>, thiamine, riboflavin, and niacin in varying amounts. Vitamin C is the only vitamin that eggs do not contain.
- Eggs are one of the best sources of protein, in terms of both quality and quantity. Egg protein is complete protein; i.e., it includes all the amino acids needed to build and replace body tissues. Plant protein sources do not provide the proper balance of certain essential amino acids; eggs are one of the few foods that contain all of the essential amino acids. A serving of two large eggs contain almost one-third of the U.S. recommended daily allowance of protein.
- Eggs are in the Meat and Beans group. Nutritionists recommend 1-3 servings daily from this high-protein cluster of eggs, meat, fish, poultry, and legumes (dried beans).
- Because the calcium is found primarily in the shell, you will probably want to find a more palatable source of calcium.
- Given a choice, most students will probably prefer eggs to fish liver oils as their source of vitamin D.
- Dieters like eggs because they provide a lot of nutrition with relatively few calories. But people trying to gain weight also like eggs because they help build muscles and other tissues and are a light and easy-to-digest way to supplement a regular diet.
- The yolk contains about 75 percent of an egg’s calories and 100 percent of its Vitamin A. The albumen, however, contains about 55 percent of the protein.

<p><b>1.</b> Eggs contain all necessary vitamins except</p> <p>A. vitamin A B. vitamin B C. vitamin C D. vitamin D</p> 	<p><b>2.</b> An egg’s _____ is so nearly perfect that the _____ of all other foods is compared to it.</p> <p>A. Protein B. Fat C. Vitamin C D. Iron</p> 	<p><b>3.</b> Eggs are part of which food group?</p> <p>A. Milk group B. Vegetable-fruit group C. Bread-cereal group D. Meat group</p> 																				
<p><b>4.</b> Most of an egg’s calcium is found in the _____</p> <p>A. yolk B. albumen C. chalaza D. shell</p> 	<p><b>5.</b> An egg’s _____ is so nearly perfect that the _____ of all other foods is compared to it.</p> <p>A. Protein B. Fat C. Vitamin C D. Iron</p> 	<p><b>6.</b> Dieters like eggs because _____</p> <p>A. they don’t have any calories B. they have only 80 calories C. they provide all the necessary vitamins D. all the fat is in the shell layer</p> 																				
<p><b>7.</b> The _____ of an egg has the most calories and Vitamin A in the egg.</p> <p>A. Yolk B. Albumen C. Chalaza D. Shell</p> 	<p><b>8.</b> How long can an egg be stored before it loses its nutritional value?</p> <p>A. One day B. One week C. Four weeks D. Nutritional value isn’t lost</p> 	<p style="text-align: center;"><b>Question Board</b></p> <table border="1" style="width: 100%; height: 100%;"> <tbody> <tr> <td style="text-align: center;">B</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td style="text-align: center;">D</td> </tr> <tr> <td></td> <td></td> <td style="text-align: center;">C</td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td style="text-align: center;">A</td> <td></td> </tr> </tbody> </table>	B									D			C						A	
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*Question Board*

- Eggs will lose moisture and carbon dioxide but not nutritional value.
- Eggs have the same nutritional value whether they are raw or cooked.

Suggest that the student study these cards until they know the information. Then pair the students and let them review the data using the cards as flash cards.

### Additional Activities:

- Make up additional questions for the Question Board. These questions can cover other related topics such as the processing, proper cooking methods, and parts of an egg. Much of the information can be taken from this curriculum guide.
- Have each student bring in an egg carton. Compare the many different types collected. List the information given on the cartons. Do they all provide the same amount and types of information? Let the student design their own egg cartons by either pasting over an existing one or drawing their own. Be sure they include the USDA label, grade, and size.
- The class can make a large Question Board which could be displayed on the bulletin board or at a school open house.



### III. Idea Hatch

#### Learning Outcomes:

- Students will demonstrate critical thinking skills related to egg knowledge through response to open-ended questions.

#### Life Skills:

- Problem solving
- Critical Thinking

#### SOLs:

English 4.1, 5.1, 5.2, 6.1, 6.6  
Science 5.1, 6.1

The purpose of this exercise is to have students creatively apply the egg information they've gained thus far. Many of these questions have no "correct" answers. The following are answers you can use for the few questions based on biological aspects of the egg.

**Chicks hatched from little versus big eggs:** Chicks will grow to the space capacity of their eggs; a bigger egg typically translates to a bigger chick. Bigger chicks hatch having an advantage over their smaller counterparts in strength and ability to cope with environmental stress. Later in life, larger chicks will reach sexual maturity at an earlier age than smaller chicks.

#### Smooth eggs versus eggs with rough or thin spots:

An egg has to be strong enough to protect the growing embryo, yet weak enough to allow the embryo to hatch out. Rough or thin spots affect the shells structural integrity. Often times, rough spots are due to excess shell being laid in one spot of the egg. Thicker shells may prevent a chick from hatching. In a similar fashion, thin spots make the egg prone to cracking. Cracks may lead to leaks or bacterial invasion. All shell imperfections decrease the chick's probability of hatching.

**Egg shape...why round?:** In order for embryos to not stick to the side of an egg, they must be turned often, either by the mother hen or by automated methods. How easy would it be to turn a square egg through simple body movement? Calcium carbonate (the compound that makes up egg shell) is deposited internally by the hen. The egg "spins" down the oviduct and shell is deposited in a

uniform layer. How would an awkward shape affect the likelihood of uniform shell deposition?

### IV. Let's Eggs-periment

#### Learning Outcomes:

- Students are introduced to the scientific method.

#### Life Skills:

- Keeping records
- Problem solving
- Teamwork
- Critical Thinking

#### SOLs:

English 4.1, 5.1, 5.2, 6.1  
Science 5.1, 6.1

**Objective:** Students will be able to use the scientific methods of observation and recording results during an experiment, and draw conclusions afterwards.

#### Experiment 1: Raw or hard-cooked?

**Materials:** 4 raw and 4 hard-cooked eggs, flashlight.

**Instructions:** Label the hard-cooked eggs "A" and the raw ones "B." Set up the eggs and the flashlight in a darkened corner of the classroom. Send the students to the corner alone or in small groups to complete the questions for this experiment.

After all students have experimented with the eggs, discuss their answers. The only reliable way to differentiate between the cooked and uncooked eggs is to spin them; the raw eggs spin slower because the liquid sloshing inside the eggs creates a resistance as it hits the walls. The hard-cooked eggs spin faster since no braking force is counteracting the momentum.

(This eggs-periment is especially useful in the kitchen where hard-cooked and raw eggs might inadvertently get mixed up)

#### Experiment 2: Super Egg!

**Materials:** 3 raw eggs; empty 6-oz. and 12-oz. juice cans, lidless at one end; a variety of full food packages with marked weights such as 5 lb. sugar, 2 lb. macaroni, etc., or a scale and a set of books, or a set of weights.

**Instructions:** Start this experiment by discussing how easily eggshells seem to break. Ask how many students have accidentally broken eggs before. Then ask for guesses of how many pounds an uncooked-shell egg can hold before the shell cracks. Write these weights on the blackboard.

With students gathered around the table, arrange the materials so that everyone can see. Keep the room relatively quiet so that everyone will also be able to hear the eggshell crack.

For each egg, jot down its size, grade and shell color on the blackboard. The student will need the data to fill in the chart for the strongest egg.

Put the small can with the open end on the table. Place the raw egg on top of the can.

Line the inside of the large can with a piece of paper towel. Cover the egg with the large can. The paper towel should come between the sides of the small and large cans (this helps keep the can from tilting and the egg from dripping). The top of the large can should rest on the egg.

Gently place your weights on top of the large can. Start with heaviest weights first and keep adding smaller ones. Balance them so they don't fall off. Keep adding weights until you hear the egg crack.

Take off the weights and add them up to find the total weight (don't forget to clean up the broken egg!) Record the weight on the blackboard.

Repeat the experiment with the other eggs. Was there much difference in the weights? A good match application would be to find the difference in ounces. Discuss why the weight varied. The size of the egg and the thickness of its shell affect its strength.

Finally, ask the students to fill out the certificate on their activity sheets, using the data for the strongest egg.

## V. The Ins and Outs of Eggs

### Learning Outcomes:

- Students will begin to place the concepts of form and function together.

### Life Skills:

- Learning to learn

### SOLs:

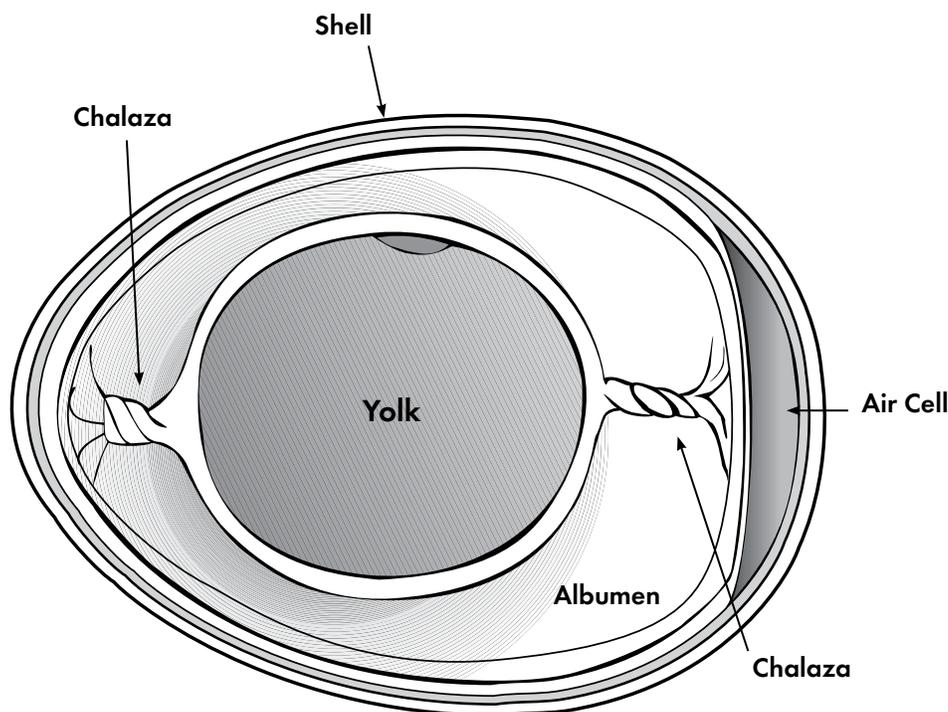
English 4.1, 5.1, 5.2, 6.1

**Objective:** Students should learn the six parts of an egg and be able to label them. They also should be able to identify these parts using a real egg.

**Materials:** A colored dish or plate, an egg, a kitchen knife, white construction paper, scissors, yarn, Scotch™ tape, yellow crayons, gummed reinforcements, and additional crayons or paint (optional).

**Instructions:** Begin by asking the students what they already know about eggs. Make a mental note of any misconceptions you hear. As you discuss each part of the egg in this lesson, present some additional information:

1. The United States Department of Agriculture (USDA) determines the standards for grading eggs. The most common grades are AA and A.



USDA grade AA and USDA grade A eggs have yolks and albumens (whites) that stand tall; eggs graded AA will stand taller and firmer than those graded A. However, both grades have the same nutritional value.

2. **Shell:** While most shells are white, some shells may be brown or another color, depending upon the breed of hen. Shell colors do not affect the nutritional value, quality, or flavor of eggs.
3. **Shell Membrane:** Actually, there are two thin membranes inside the shell. These generally will adhere to the inside of the shell when a raw egg is opened.
4. **Air Cell:** The air cell is found at the large end of an egg. Look inside the shell of a raw egg; the shell membrane traps the air cell against the shell. As eggs age, the air cell will enlarge because moisture is escaping through the shell and air is replacing it.
5. **Albumen:** Albumen, usually called the egg white, makes up over half of an egg's weight. Albumen can be thick or thin. A very fresh egg will have lots of thick albumen and, as a result, will stand tall and firm and not spread very far. Variations in storage temperatures and aging can cause the albumen to thin.
6. **Chalazae:** The chalazae (kuh-LAY-zee), the two thick strands of albumen at each end of the yolk, anchor the yolk in the center of the egg. A chalaza (kuh-LAY-zuh) is a normal part of the egg. In fact, chalazae are sometimes more prominent in fresh, high-quality eggs.
7. **Yolk:** The yolk comprises about one-third of an egg's weight. While yolks vary in color from light yellow to dark orange-red depending upon the hen's diet, all are equally nutritious. The membrane covering the yolk is easily broken; too often this happens accidentally while cracking an egg.

**Activities: Make an "Eggmobile"**

1. Cut out the parts of the egg on page 13. Cut only the heavy solid lines. Do not keep the shaded areas. You should have four patterns when you are finished.
2. Find the arrow-shaped pattern. Lay it on the construction paper and trace around it with a

pencil. Also mark the spots on the construction paper and mark an arrow where the holes will be. Now cut out the arrow and punch a small hole through each circle for the yarn. Be sure that your holes do not rip to the edge. Stick gummed reinforcements over the holes if needed. Copy the words from the pattern onto your arrow.

3. Find the outside pattern. What three parts of an egg are included in this piece? Trace this piece twice and cut out both pieces. Draw the lines and dots on the construction-paper pieces. Label the three parts: the shell, the shell membranes, and the air cell.

Starting with the air cell of the first piece, cut along the line from the top to the middle cross lines. Stop there; don't cut all the way through. Punch a hole for the yarn at the hole on the bottom right side of the air space. Then, at the bottom of the shell, cut along the line from the bottom up to the middle. Again, do not cut past the cross line.

Starting with the air cell of the second piece, cut along the dotted line from the bottom up to the cross line. Make a hole for the yarn at the dot on the top left side of the air cell. Then, at the pointed end of the shell, cut along the dotted line from the top down to the middle cross line.

To put the two pieces together, hold the second piece (the one with the yarn hole on top) above the first piece. Now slide them together and match the slots. Turn one so the pieces are crossing each other, like the letter "X" (a right angle). Put a small piece of tape on the inside corner where the two pieces meet.

4. Find the middle pattern. Trace and cut one piece from the construction paper. Mark the three spots where the yarn holes will be; poke holes at these spots. Draw a chalaza (kuh-LAY-zuh) at each end and then label both chalazae and the albumen.
5. The last piece is the yolk. Trace it and cut it out. Mark the spots for the holes and then punch them out. Write the word "yolk" on it.
6. Does an egg have any color? Which part? Color that part or parts now.

- Put a piece of yarn through one of the yolk's holes. Pull the yarn until the yolk hangs freely in the center of the albumen; tie a knot and cut off the extra yarn. Repeat the steps for the bottom yolk hole with another piece of yarn.
- Thread another piece of yarn through the top hole of the albumen and then through the bottom hole of the air cell. Pull up the yarn until the middle piece hangs freely.
- Slip another yarn length through the top hole of the air cell and the bottom hole of the arrow. Tie a knot and then cut off any extra yarn.
- Put a long piece of yarn through the top hole of the arrow and tie a knot. Now your mobile is finished and ready to hang.

#### Variations:

- For a simpler version of the egg mobile, cut only one shell piece. Draw and label the parts; punch a hole in the top and bottom of the air cell.
- For more colorful eggs, use a different color of construction paper with each pattern piece. Or, use white paper and color each egg part of just the shell with a different crayon or paint.
- You may prefer to use the pattern pieces from the master as the mobile itself and substitute string for the yarn. It won't be quite as sturdy, but it will flutter more. Eliminating the construction paper will also save a little time and money.

Once the mobiles are finished, ask the students to identify the same parts in a real egg. Crack an egg and let them point out the parts. Ask them to decide what grade they would assign to that egg. Compare the results to the label on the carton. If a discrepancy arises, remind the students that age and storage conditions will affect the grade of an egg.

If conditions permit, give each student an egg to study. A variety of eggs will reinforce the commonality of the parts and the variances in grade. For a dash of dramatics, break an egg onto an acetate sheet on an overhead projector; then point out the parts on the screen.

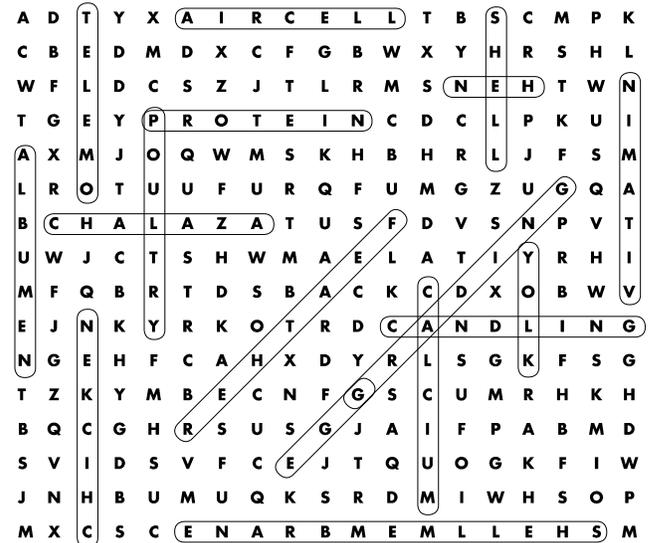
#### Additional activities:

- Enlist the aid of your students to decorate a bulletin board with an enlarged egg. Connect

labels to the corresponding parts with yarn.

- Play the game "What am I?" A student makes a statement that applies to only one part of an egg; the class then guesses what part he or she is.

## VI. Answers to word search:



## VII. Other classroom activities may include:

- Shell art – pictures using egg shells for textures
- Hand-blown and decorated eggs
- Collages with chickens and eggs.

#### Resources

Novak, C.L., and Troche, C. 2006. Dietary lutein and retention in poultry products: potential for aiding macular degeneration in proceedings of The Mid-Atlantic Nutrition Conference, Timonium, MD.

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Eggmobile

