

The Shape of Things

Skills: Science. Math

Objective: The student will perform an experiment, using eggs, to test the strength of the dome shape.

Background

The eggshell is a hard, three-layered container composed of calcium carbonate. Its purpose is to protect the enclosed embryo from the weight of the parent's body during the 21 days of incubation while allowing the bird to develop inside. With the exception of those birds that warm their eggs in mounds of dirt, all birds use body heat to incubate their eggs and turn them regularly to keep the temperature even. In natural incubation the hen turns the eggs as she gets off the nest and moves them with her beak while she is sitting on them.

All living things must have three things to live—food, water and air. The developing chick must have these three things in order to live, even though it is enclosed in a shell. The food is provided by the yolk, which is mostly protein. Protein helps to build strong bones and muscles. Water comes from both the yolk and the albumen. The albumen is the clear portion of the egg, most commonly called the “egg white.” The albumen is 85 percent water, and the yolk is about 50 percent water. The air necessary for life passes through the shell and the membrane. The chicken uses the oxygen and passes carbon dioxide back through the shell.

Each egg shell has a coating or covering, called a bloom, that seals its pores, prevents bacteria from getting inside and reduces moisture loss. Eggs are washed before they are sent to the market. This is necessary for cleanliness but removes the bloom. To restore this protection, packers give the eggs a light coating of edible mineral oil.

Properly handled and stored, eggs rarely spoil but will simply dry up if kept long enough. Store eggs in the refrigerator. Room temperature is ideal for bacterial growth.

Although the exact shape of an egg is as individual as the hen herself, most eggs are roughly egg-shaped. Some abnormalities that can be found in the shells of fresh eggs are ridges, bulges and rough texture. Eggs having any of these abnormalities would get poor eggshell ratings from the US Department of Agriculture. Some extreme oddities in eggshell shapes include shells that are long, appear bent, or look as though they have been mashed in on one side. It would be very rare to find any of these shapes on grocery store shelves. Wild birds have shells that are more pointed than those of most domesticated varieties.

The size of an egg is an inherited characteristic, and poultry breeders spend large amounts of time and effort to select strains for egg size. When a

P.A.S.S.

GRADE 6

Science Process—1.1,3;
3.1,5; 4.1,2,3,5; 5.1

Life Science—3.1; 4.1

Reading—1.1a; 3.1b

Math Process—1.1,3;
4.1;5.1

Math Content—4.3; 5.1

GRADE 7

Science Process—1.1,3;
3.1,5; 4.1,2,3,5; 5.1

Life Science—2.1,2

Reading—1.1; 3.1a

Math Process—1.1,3; 4.1;
5.1

Math Content—4.2a

GRADE 8

Science Process—1.1,3;
3.1,5; 4.1,2,3,5; 5.1

Life Science—3.1

Reading—1.1; 3.1a

Math Process—1.1,3; 4.1;
5.1

Math Content—5.1

Resources Needed

3-4 fresh eggs

bathroom scale

towel

stack of books

container of ice water

ink, methylene blue solution or food coloring

unbroken egg at room temperature

pullet (a young hen less than a year old) first begins laying eggs, her eggs are small. After 15 to 20 days of laying, the size of her eggs will reach the size of a standard grocery store egg. Egg size varies greatly from one kind of bird to another. The eggs of domestic chickens weigh an average 58 grams. Those of domestic turkey are about 85 grams. Hummingbirds lay eggs weighing a half a gram. Quail eggs weigh an average nine grams, and ostriches lay eggs weighing an average 1,400 grams.

The extraordinary strength of the eggshell inspired one of the most beautiful architectural forms in the world—dome construction. With dome construction, weight is distributed evenly around a central point, like the large end, or air cell end, of an egg. St. Peter's Basilica in Rome is one of the oldest and most famous examples of dome construction. Domes today are constructed with a variety of materials—steel, aluminum, reinforced concrete, glued laminated wood or plastic. The Astrodome in Houston, Texas, has the largest circular-dome roof in the world. It is approximately nine acres of playing field used for baseball, football and other sporting events. Other famous domed buildings include the US Capitol in Washington, DC, and the Palazzo dello Sport in Rome, Italy, designed for the 1960 Olympic Games.

Activity 1

1. Read and discuss background and vocabulary.
2. Demonstrate the strength of the dome shape:
 - Crack an egg, trying to leave more of the shell intact at the larger air cell end.
 - Discard the contents of the egg and the small end.
 - Carefully chip the large end of the shell until its edge is relatively even.
 - Fold the towel once.
 - Place the eggshell on the towel, chipped edge down.
 - Measure the height of the egg as it sits on the towel.
 - Stack books on the towel across from the egg so they are the same height as the egg.
 - Stack books, one at a time, so their weight is evenly distributed between the stack of books and the egg. Do not press down on the books. Simply stack them one at a time.
 - Students will count as you stack books on the eggshell.
 - Stop when the eggshell begins to crack.
 - Explain that the spiral pattern of the crack indicates the weight was distributed evenly over the dome shape.
 - Use the bathroom scale to weigh the books stacked on top of the eggshell.
 - Students will record the weights before you repeat the experiment.
 - Repeat the experiment.
 - Students will count and record the weight of the books again.
 - Students will wash their hands after handling the eggs.
3. Students will graph the weights recorded during the demonstration.

Activity 2

1. Use this demonstration to show that the eggshell has holes or pores to allow air to pass through the eggshell to the chick developing inside:
 - Add ink, methylene blue solution or food coloring to a container of ice water.
 - Immerse an unbroken egg at room temperature in the ice water.
 - Leave the egg in the solution for three minutes.
 - Remove the egg, and dry it gently with a paper towel.
 - Carefully crack the egg.
 - Students will observe the small dots of color on the inside of the shell.
 - Pour out the contents of the eggshell.
 - Students will examine the remaining eggshell. Larger and more numerous dots of color will appear at the large end, the air cell end. Dots of color will also appear randomly throughout the other parts of the eggshell.
 - Students will examine the shell under a microscope.

Extra Reading

- Burton, Robert, *Egg, a Photographic Story of Hatching*, Dorling Kindersley, 1994.
- Sharpe, Susan, *Chicken Bucks*, Bradbury, 1992.

Vocabulary

albumen—proteins consisting primarily of amino acids found in milk, blood, egg whites, muscle and vegetables

bloom—the coating or covering on an egg shell that seals its pores, prevents bacteria from getting inside, and reduces moisture loss

calcium carbonate—a compound which gives strength and shape commonly found in eggshells and chalk

dome construction—construction built with a hemispherical roof or vault

embryo—an organism in its early stages of development, before it has reached a distinctively recognizable form

incubation—the development of a fertile poultry egg within a shell

protein—any of a group of complex organic macromolecules that contain carbon, hydrogen, oxygen, nitrogen, and usually sulfur and are composed of one or more chains of amino acids. Proteins are fundamental components of all living cells and include many substances, such as enzymes, hormones, and antibodies, that are necessary for the proper functioning of an organism. They are essential in the diet of animals for the growth and repair of tissue and can be obtained from foods such as meat, fish, eggs, milk, and legumes.

pullet—an immature female chicken

yolk—the yellow part of a fowl's egg that has a germinal disk located on its outer edge from which the embryo develops.