

Investigative Lab 26

Suitcases for Life on Land

Discovering the Adaptations of a Bird Egg

Question What are the structures in a bird egg that support the growth and development of the embryo?

Lab Overview In this investigation you will take apart an unfertilized chicken egg. You will locate and observe the many structures that support the growth and development of the chick and examine certain structures with a microscope.

Introduction To start your investigation, you will examine a diagram of the inside of a chicken egg to become familiar with the structures that you will observe in your investigation. (Note that you will observe an unfertilized egg in this lab.) Then, you will explore the formation of an egg in the hen's reproductive system.

Prelab Activity Read the following descriptions of the major structures of a bird egg and study the cross-section diagram of an unfertilized chicken egg on the next page. Then, study the diagram showing how the egg forms inside the hen.

(NOTE: *The yolk sac, allantois, chorion, and amnion membranes discussed in Concept 26.1 only develop in fertilized eggs. You will not observe them in this investigation.*)

Shell: The hard shell, made of calcium carbonate, plays an important role in helping to prevent water loss from the embryo inside. (Note that in a fertilized egg, the amnion also protects the embryo from water loss.) The shell has small pores that allow for oxygen to enter the egg and carbon dioxide to escape. The shell is deposited onto the outer shell membrane during the egg's journey through the hen's reproductive system.

Yolk: The yolk is a highly concentrated source of sugars, fat, proteins, vitamins, and minerals. For the three weeks that a chicken embryo develops inside the egg, the yolk serves as the main supply of nutrition.

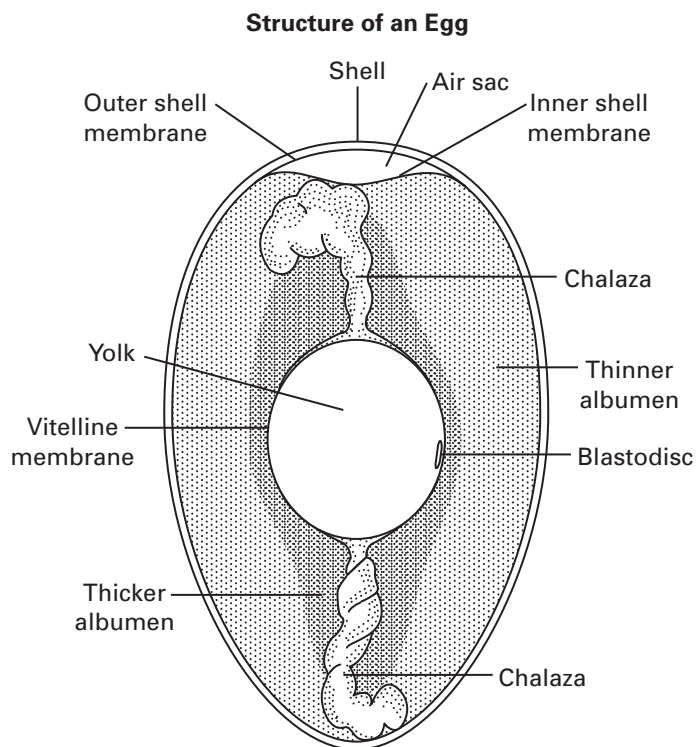
Attached to the yolk is the blastodisc, which in a fertilized egg would develop into the embryo. Surrounding the yolk is a membrane called the vitelline membrane. In a fertilized egg, this membrane, along with cells from the embryo, develops into the yolk sac.

Egg White: The egg white (albumen) is a gel containing water and proteins called albumin. The egg white has two layers. The outer, thinner layer contains more liquid and less protein than the thicker layer closer to the yolk. In addition to providing nutrients for the embryo, the egg white contains enzymes that attack bacteria. The egg white also functions as a shock absorber.

Chalazae: Each egg contains two chalazae (singular, *chalaza*), one on each end of the yolk. The chalazae are twisted cords of albumin that hold the yolk centered in the middle of the egg and keep the developing embryo on top even if the egg is turned in the nest.

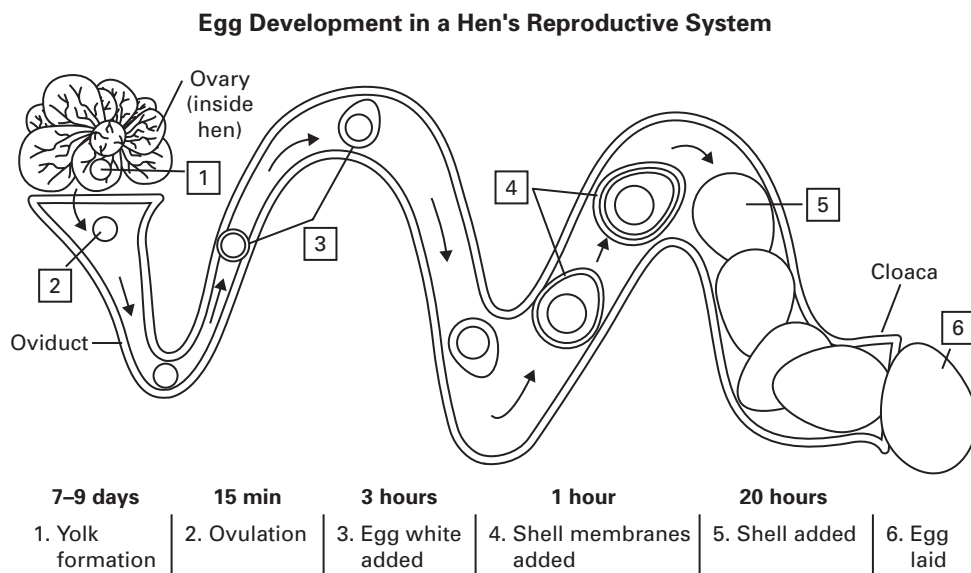
Membranes: There are two shell membranes just under the eggshell, an inner shell membrane and an outer shell membrane made of a web of protein fibers called keratin. This protein is similar to the one that makes up your hair and fingernails. The two membranes are semipermeable barriers that allow gas exchange and help prevent water loss from the egg interior. (In a fertilized egg, the amnion and chorion play the major role in enabling gas exchange and protecting the embryo.) They also help prevent bacteria that get through the shell from reaching the embryo.

When an egg is first laid, the shell membranes fill the interior of the shell completely. As the egg cools outside of the hen's body, the inner part of the egg contracts. The inner shell membrane separates at one end from the outer membrane, forming an air sac.



Structure of a Hen's Reproductive System

Female chickens hatch with two ovaries and oviducts, but only the left ovary and oviduct develop and become functional. A hen's ovary produces one yolk about once a day. Yolks are produced whether or not there are sperm present in the oviduct to fertilize them. Once the yolk is released into the oviduct it takes about 23–24 hours for the entire egg to form and be laid. Study the diagram below that shows the development of an egg inside a hen's body. Afterward, answer the Prelab Questions.



Prelab Questions

- Which structures of an unfertilized egg help prevent water loss from the egg interior?

- What structures provide nutrition for the embryo?

- Summarize the formation of an egg.

Materials

- unfertilized chicken egg
- metal spoon
- plastic bowl or cup (disposable)
- microscope slides
- marker
- plastic dropper
- water
- microscope
- stereomicroscope (optional)

CAUTION: *If you are allergic to eggs, notify your teacher before taking part in this investigation.*

Procedure

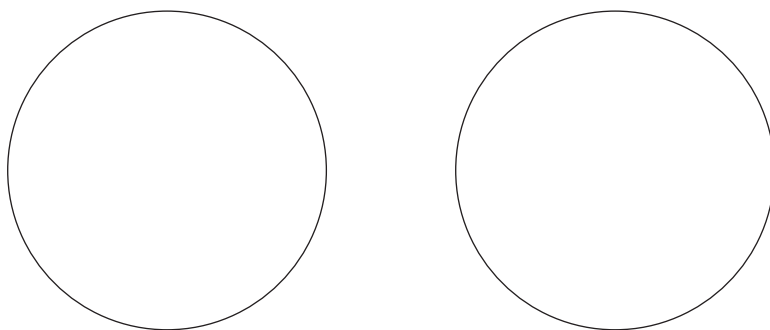
Part A: Taking the Egg Apart

1. Tap the large end of the eggshell gently with the backside of a metal spoon until you see a cluster of small cracks. **CAUTION:** *Raw eggs may contain high numbers of Salmonella and other bacteria that could make you sick. Do not touch your mouth or face while handling the eggs. Wash your hands with antibacterial soap immediately after handling the eggs.*
2. Carefully peel away the shell from the shell membranes beneath it. Try to pull as much shell off from the top portion of the egg as you can without tearing the shell membranes. If you are using a stereomicroscope, save a piece of the shell without the membrane attached to observe under the stereomicroscope.
3. The membrane just beneath the shell is called the outer shell membrane. Take a piece of this membrane off and save it to view under the microscope later. Put it on a slide and label the slide.
4. Now you should be able to see the air sac located between the outer and inner shell membranes. When a chick starts to hatch, it first breaks the inner shell membrane. The air sac provides the chick with its first breaths of air.
5. While holding the egg with the open end up, carefully pull off a section of the inner shell membrane. Place the membrane sample on a second microscope slide and label it.
6. Observe the two layers of egg white inside the egg. One is liquid, while the other is denser. Slowly pour the egg white out of the shell into a bowl or cup. Leave the yolk inside the shell. The liquid layer will pour out first and the denser layer will pour out as a thick glob.

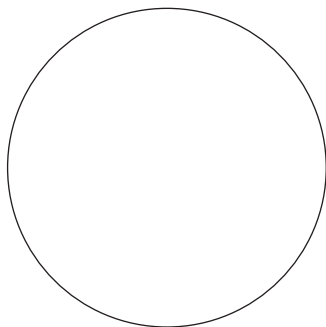
7. Now you will see a third membrane that surrounds the yolk. It is called the vitelline membrane. This membrane separates the yolk from the egg white.
8. Carefully turn the yolk around by tilting the egg or touching it carefully with your finger until you see a white spot. The white spot is called the blastodisc. If fertilized, this structure may grow into a chick.
9. You also should notice a white string-like structure. This structure is one of the two chalazae that hold the yolk centered in the middle of the egg. You cannot see the other chalaza because it is located on the other end of the yolk sac.

Part B: Observing Egg Structures With a Microscope

1. Look at the two shell membranes under the microscope. Place a drop of water on each membrane before viewing. Adjust the lighting on the microscope and find a part of the membrane where you can see the threads. Draw a sketch of the two membranes below. Be sure to label your sketches.



2. Look at the shell under the stereomicroscope if your lab has one. Be sure to turn the light on that shines down from above. Locate the pores on the shell. Draw a sketch of the shell below. Be sure to label your sketch.



Analysis and Conclusions

1. Describe several ways in which the structure of the bird egg fits its function.

2. If a hen were exposed to a pollutant that caused it to produce eggs with very thin shells, what would be the possible effects on the developing chicks?

3. What structures would you see in a fertilized egg that you did not see during this dissection of an unfertilized egg?

Extension

Brainstorm questions about how bird eggs compare to other types of eggs such as turtle or snake eggs. Design hypothetical experiments or research plans to answer your questions.