The reproductive system and fertilization

The rooster

The male fowl has two testes along its back. These never descend into an external scrotum, as do those of other farm animals. A testis consists of a large number of very slender, convoluted ducts. The linings of these ducts give off sperm. The ducts eventually lead to the ductus deferens, a tube that conducts the sperm to a small papilla. Together, the two papilla serve as an intermittent organ. They are on the rear wall of the cloaca.

The rooster responds to light in the same way as the hen. Increasing day length causes the pituitary to release hormones. These, in turn, cause enlargement of the testes, androgen secretion and semen production, which stimulates mating behavior.

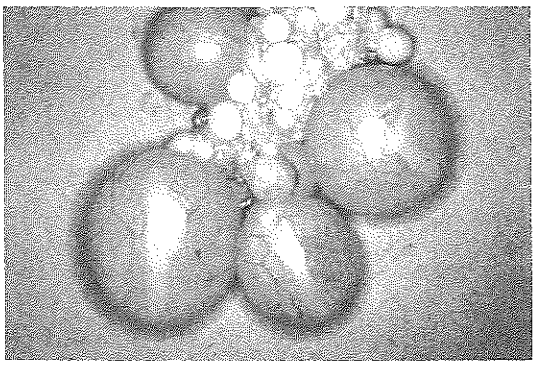


Figure 7 – Ovary

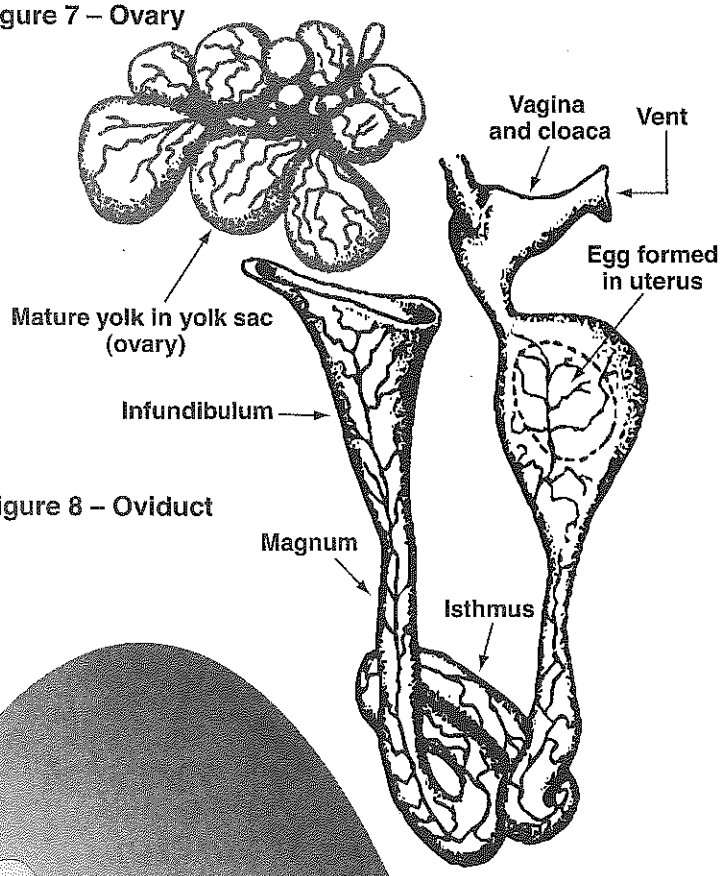


Figure 8 – Oviduct

The hen

The reproductive system of the female chicken is in two parts: the ovary and oviduct. Unlike most female animals, which have two functioning ovaries, the chicken usually has only one. The right ovary stops developing when the female chick hatches, but the left one continues to mature.

The ovary is a cluster of sacs attached to the hen's back about midway between the neck and the tail. It is fully formed when the chick hatches and contains several thousand tiny ova – each ovum within its own follicle. As the female reaches maturity, these ova develop a few at a time into yolks. **(Figure 7)**

The oviduct is a tube-like organ lying along the backbone between the ovary and the tail. In a mature hen, it is about 25 to 27 inches long. The yolk is completely formed in the ovary. When a yolk is fully developed, its follicle ruptures at the stigma line, releasing it from the ovary. It then enters the infundibulum, the entrance of the oviduct **(Figure 8)**.

The other parts of the egg are added to the yolk as it passes through the oviduct. The chalazae, albumen, shell membranes and shell then form around the yolk to make the complete egg, which is then laid. This complete cycle usually takes from 23 to 32 hours. About 20 minutes after the egg is laid, another yolk is released and the process repeats itself. Development takes place as follows:

Parts of oviduct	Length of part	Time there	Function of part
Infundibulum	2 in.	15 min.	Picks up yolk, egg fertilized
Magnum	13 in.	3 hr.	40–50% of white laid down, thick albumen
Isthmus	4 in.	1¼ hr.	10% albumen shell membrane laid down, shape of egg determined
Uterus	4.2 in.	20¾ hr.	40% of albumen, shell formed, pigment of cuticle laid down
Vagina and cloaca	4 in.	—	Egg passes through as it is laid

How eggs are fertilized

Each gender, the rooster and the hen, contributes something to the egg. The rooster provides sperm; the hen provides an ovum. When a rooster mates with a hen, it deposits sperm in the end of the oviduct. These sperm, containing male germ cells, travel the length of the oviduct and are stored in the infundibulum. On the surface of every egg yolk there can be seen a tiny, whitish spot called the blastodisc. This contains a single female cell. If sperm is present when a yolk enters the infundibulum, a single sperm penetrates the blastodisc, fertilizing it and causing it to become a blastoderm. Technically, the blastoderm is the true egg. Shortly after fertilization, the blastoderm begins to divide into two, four, eight and more cells. The first stages of embryonic development have begun and continue until the egg is laid. Development then subsides until the egg is incubated. The joining of sperm and ovum is called fertilization. After fertilization, the egg can develop and become a chick.

The rooster must be present for an egg to be fertilized. Supermarket eggs are from hens that are raised without a rooster. Roosters are not necessary at farms where eggs are produced for people to consume. Eggs for incubation are grown at special farms called breeder farms where roosters are with the hens.

Development during incubation

As soon as the egg is heated and begins incubation, the cluster of cells in the blastoderm begins to multiply by successive divisions. The first cells formed are alike. Then, as the division of cells progresses, some differences begin to appear.

These differences become more and more pronounced. Gradually the various cells acquire specific characteristics of structure and cell grouping or layer. These cell groupings are called the ectoderm, mesoderm and endoderm. These three layers of cells constitute the materials out of which the various organs and systems of the body develop.

From the **ectoderm**, the skin, feathers, beak, claws, nervous system, lens and retina of the eye, linings of the mouth and vent develop. The **mesoderm** develops into the bone, muscle, blood, reproductive and excretory organs. The **endoderm** produces the linings of the digestive tract and the secretory and respiratory organs.

Development from a single cell to a pipping chick is a continuous, orderly process. It involves many changes from apparently simple to new, complex structures. From the structures arise all the organs and tissues of the living chick.

Physiological processes within the egg

Many physiological processes take place during the transformation of the embryo from egg to chick. These processes are respiration, excretion, nutrition and protection.

For the embryo to develop without being connected to the hen's body, nature has provided membranes outside the embryo's body to enable the embryo to use all parts of the egg for growth and development. These "extra-embryonic" membranes are the yolk sac, amnion, chorion and allantois.

The **yolk sac** is a layer of tissue growing over the surface of the yolk. Its walls are lined with a special tissue that digests and absorbs the yolk material to provide food for the embryo. As embryonic development continues, the yolk sac is engulfed within the embryo and completely reabsorbed at hatching. At this time, enough nutritive material remains to feed the chick for up to three days.

The **amnion** is a transparent sac filled with colorless fluid that serves as a protective cushion during embryonic development. This amniotic fluid also permits the developing embryo to exercise. Specialized muscles developed in the amnion gently agitate the amniotic fluid. The movement keeps the growing parts free from one another, preventing adhesions and malformations.

The **chorion** contains the amnion and yolk sac. Initially, the chorion has no apparent function, but later the allantois fuses with it to form the choric-allantoic membrane. This enables the capillaries of the allantois to touch the shell membrane, allowing calcium reabsorption from the shell.

The **allantois** membrane has many functions. It:

- serves as an embryonic respiratory organ
- receives the excretions of the embryonic kidneys
- absorbs albumen, which serves as nutriment (protein) for the embryo
- absorbs calcium from the shell for the structural needs of the embryo.

The allantois differs from the amnion and chorion in that it arises within the body of the embryo. In fact, its closest portion remains within the embryo throughout the development.

Building an eggs-ray Viewer

Embryology skill:
Preparing a candler

Life skill:
Relating to others, cooperation

Science skills:
Comparing and measuring

School subjects supported:
Math

Preparation time:
An hour to secure the needed materials. This can be shortened if you ask the students to bring the cardboard and small boxes from home.

Activity time:
30 to 40 minutes

What you need:

- ☐ Heavy cardboard boxes at least 1 foot by 1 foot in size
- ☐ Small box, such as a pencil box (at least 3 inches by 4 inches, and 1 inch deep)
- ☐ Scissors
- ☐ Electrical or duct tape
- ☐ Overhead projector (with light source from below the glass surface)
- ☐ Copies of Student Activity Sheet "Building an Eggs-ray Viewer" (page 39)

Introduction

If you like sneak previews, then candling is for you. Candling fertile eggs plays an important role in the embryology project. A candler is used to examine fertile eggs by shining a bright light through the egg. Candling serves three important functions.

1. Candling eggs before they are set identifies cracked eggs that might burst.
2. Candling helps detect which eggs are developing into an embryo.
3. Candling the eggs every few days allows you to watch the embryo grow and develop without damaging the egg.

In the poultry industry, eggs are candled for two reasons.

1. At the hatchery, eggs are candled to help remove cracked eggs before setting and infertile eggs that are not developing after a week of incubation.
2. At the consumer egg grading plants, eggs are candled to help remove cracked eggs and those that have defects making them undesirable for human markets.

Get ready

Involve the students in building a candler by dividing the class into teams. Supply each team with the same supplies and ask each group to design and build their own candler. Plans for an overhead candler are also included so that you (the teacher) can build a candler for class use if you would like. However, you are encouraged to use a candler designed and built by one of the teams.

Do it

1. Divide the class into teams of three to five students. Each team should use the Building an Eggs-ray Viewer sheet *(see activity on page 39)* to help them design and build a candler. Explain that they have 30 minutes to design and build an egg candler with the supplies you give them. Also, show them the overhead projector and explain that it will be the source of light for their candler. Basic questions to answer include:

   Does the candler provide enough light to see cracks in an eggshell or the embryo inside the egg?

   Can you candle eggs without damaging them?

   Does the candler limit the amount of light that escapes so the room can be darkened properly to allow seeing inside the egg?

   Does the way the egg sets on the candler allow optimal viewing of the different parts of the egg and embryo?

2. Have the teams share their candler with the class. Ask them to explain:

   How the team decided on the plan before they began to build.

   What was unique about their plan.

   How their plan met the basic needs of a candler mentioned in step 1 above.

3. Try each candler in a darkened room and discuss which candler best allows the students to see inside the egg. If you already have a candler, compare it with the class designs.

Break Out

Have students design and make their own egg candler at home (with a flashlight rather than an overhead projector).

Candle some eggs at home and show your family how to look at eggs. Why does the store-bought egg look different from the ones at school?

Talk it over

Share

- How did your candler differ from the others that were built?
- What do you like about your team's plan compared to the others? Why?

Process

- Why do we candle eggs?
- What things make a good candler?
- How would you improve your candler?
- What plans did you have to make before starting this project?

Generalize

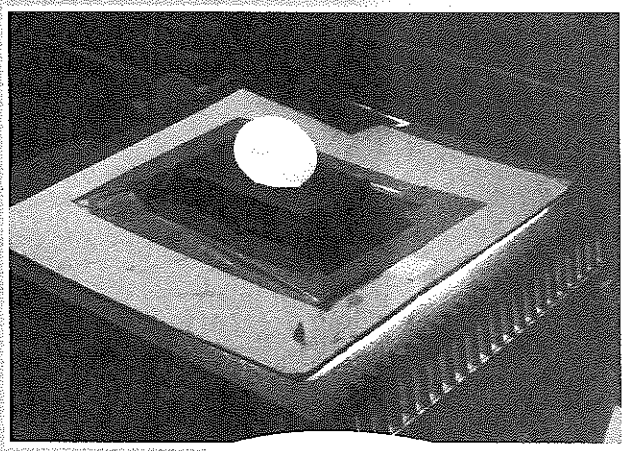
- What other items have you built? How was this building process like or different from those?
- How can planning and organizing help you in other parts of your life?
- How did not having instructions and specifications affect the building process?

Apply

- What did you learn about working as a group that you can use in the future?
- What will you do differently the next time you plan to build something?

The following instructions provide information for development of a typical candler. You may want to build one of these for use in class or to compare it to the candlers developed by the class.

1. Cut out a flat 1 by 1 foot piece of cardboard.
2. Remove one of the large sides of the small box.
3. Cut an egg-shaped hole 1.5 inches by 1 inch in the topside of the small box (opposite from the side you just removed). This hole holds the egg so you can see the embryo while handling the egg as little as possible.
4. Place the small box on the center of the piece of cardboard and trace the box outline. Cut a hole in the center of the piece of cardboard the same size as the small box.
5. With duct tape, fasten the small box to the piece of cardboard (with the egg-shaped hole up).



6. Place the cardboard on top of the glass base of the overhead projector, and you are ready to candle.

Evaluate it

- ☐ Did the students learn the three reasons why candling is performed?
- ☐ Were the students able to make measurements to construct a candler?
- ☐ Did all students make a contribution to constructing the candler?