

# Incubation

The bird egg is a marvel of nature. What is more fascinating than to see a fully developed baby chick emerge from an egg? Just three weeks of incubation transforms a seemingly lifeless chicken egg into an active living being.

Nothing can be more interesting than the study of the chicken egg and its development from the unincubated stage to the emergence of the chick from the shell. The developing chick in an egg is called an embryo, and a careful study of the different stages of embryonic development will uncover many interesting facts.

Incubation of eggs will show you the effects of heat, air, and moisture on hatchability. You will find out how an egg is formed, what its different parts are and their functions, and how a chick embryo develops.

Eggs have been incubated by artificial means for thousands of years. Both the Chinese and the Egyptians are credited with originating artificial incubation procedures. The Chinese developed a method in which they burned charcoal to supply the heat. The Egyptians constructed large brick incubators that they heated with fires right in the rooms where the eggs were incubated.

Over the years incubators have been refined and developed so they are almost completely automatic. The greatest development has occurred in this century. Modern commercial incubators are heated by electricity, have automatic egg-turning devices, and are equipped with automatic controls to maintain the proper levels of heat, humidity, and air exchange. Present-day commercial incubators vary in capacity from a few thousand to many thousands of eggs, and they have made possible the development of modern hatcheries that produce almost 100 percent of all the chickens grown in this country.

Both still-air and forced-draft incubators are used in hatcheries. However, all the new incubators are forced-draft; that is, they have fans to circulate the air. They are capable of maintaining more even temperature, humidity, and oxygen levels than still-air incubators. Many modern commercial hatcheries also use separate setter and hatcher machines.

# Obtaining Hatching Eggs

Obtaining fertile eggs may present a problem, especially if you live in an urban area. Most of the eggs sold in supermarkets are not fertile and cannot be used in incubation. Fertile eggs usually can be obtained from hatcheries and poultry breeders.

If possibly, pick up the eggs yourself rather than having them shipped or mailed. It is difficult for hatcheries, post office, and transportation companies to handle small order of eggs properly.

## Care of Eggs Prior to Incubation

The hatchability of eggs can be severely reduced by improper care prior to incubation. Because it may not be practical for you to put the eggs in an incubator as soon as you get them, protect them from extreme variations in temperature. Ideally, eggs should not be more than 7 days old when they are set (placed in an incubator). Beyond that point, hatchability declines.

If it is necessary to hold the eggs before you set them, turn them daily and keep them in a room in which the temperature is around 55°F and the relative humidity is 70 – 80 percent. (The vegetable section of your refrigerator could be used for holding the eggs until it is time to place them in the incubator.) Temperatures below 40°F reduce hatchability. Under no circumstances should the eggs be held at room temperature because temperatures of this level are detrimental to hatchability. Embryos will begin to develop at subnormal rates when the temperature reaches above 80°F.

## Location of Incubator

Locate you incubator in a room in which the temperature is between 70 – 75°F, and which is free from drafts and excessive variations in temperature. Do not place the incubator near windows so it will be exposed to the direct rays of the sun. The sun's rays may raise the temperature so much that the embryos all will be destroyed.

# Readying the Incubator for Operation

Before you set the eggs be sure that the incubator is in good working order. Put some warm distilled water in the water pan, place the thermometer so that the bulb of the thermometer is 1 inch above the screen, close the top of the incubator, and then operate the incubator until the temperature inside it hold at 99 to 103°F. The recommended temperature is 100.5°F.

Adjust the thermostat to control temperature in the incubator. Make certain that the sides and top of the incubator fit closely so no air is lost. You may need to make many adjustments to reach a proper setting.

Cleaning can be made easier if you place a layer or two of cheesecloth or crinoline on the rack on day 17 or 18 of incubation to catch the egg shells and other debris. This also will help to prevent injury to the chick's naval. After the chicks are removed, the cheesecloth can be discarded.

# Preparing the Eggs for Incubation

Eggs must be turned while in the incubator. So before you put in the eggs, mark them with a pencil so you can tell when they have been properly turned. An excellent method is to put an "X" on one side and an "O" on the opposite side. Then you can always tell when the eggs have been turned, because either all "O"s or all "X"s turned up at the same time.

# Humidity

Nature has decreed that the eggs will dry out to some extent during incubation. This water loss should be about 11 percent of the original weight, but any more than this is detrimental. Water must be placed in the incubator to avoid excessive moisture loss. Keep water in the channels in the bottom of the incubator at all times.

**Caution:** Do not let the eggs come into direct contact with water at any time.

The number of times the incubator is opened will influence the level of humidity. Never block the vent holes in the incubator. Weather conditions also will affect the relative humidity in the incubator.

The ideal moisture level is about 50-55 percent relative humidity (83-87°F on a wet bulb thermometer) for the first 18 days and about 65 percent (89-90°F wet bulb) for the last 3 days. Excessive drying because of low humidity will cause the chick to stick to the shell and fail to survive. Some variations above or below the ideal level usually will not affect hatchability drastically. Frequently, school incubators have too much ventilation, and, therefore, too little moisture. This results in delayed or reduced hatches.

When you refill the water channels, use warm, distilled water. Hot or cold water will affect the temperature of the incubator too much. To increase the humidity level the last 3 days, place wet sponges in the incubator to raise the humidity.

## Temperature

The recommended temperature for the still-air incubator is 100.5°F. The temperature can vary from 99-103°F with no harmful effects. If the temperature stays at either extreme for several days, the hatch may be reduced. Overheating is much more critical than underheating. Overheating will result in abnormal embryos, speed up development, and lower hatchability. A thermometer should be level with, but not touching, the tops of the eggs.

## Ventilation

Proper ventilation is very important during the incubation process. While the embryo is developing, oxygen enters the egg through the shell, and carbon dioxide escapes in the same manner. As the chicks begin to hatch, it is essential that they receive an increasing supply of oxygen. This means that the air openings need to be opened gradually to increase the flow of air.

# Length of Incubation

Chicken eggs require 21 days to hatch, but the incubation period for the eggs of other species of poultry varies. The approximate periods of incubation required for various species of poultry and game birds are:

	Days
Chicken	21
Turkey	28
Duck	28
Muscovy Duck	33-35
Goose	29-31
Guinea	26-28
Pigeon	16-18
Ring-neck Pheasant	23-24
Mongolian Pheasant	24-25
Bobwhite Quail	23
Japanese Quail	17-19
Chukar Partridge	22-23
Peafowl	28

## Turning the Eggs

When the eggs are put in the incubator, lay them on their sides and turn them at least three times a day. Turning prevents the embryo from sticking to the shell membranes, as it will if it is left in one position too long. Good results can be obtained by turning the eggs the first thing in the morning, again at noon, and the last thing at night.

It is best to turn the eggs more than three times a day; they should be turned an odd number of times so the side that is up longest will be staggered from day to day. Otherwise the egg will be in the same position every night, which is the longest stretch of time between turns.

When you turn the eggs, move them to a different part of the tray to offset variations in temperature in the different parts of the incubator. Continue to turn the eggs day 2 through day 17, but do not turn them after day 17.

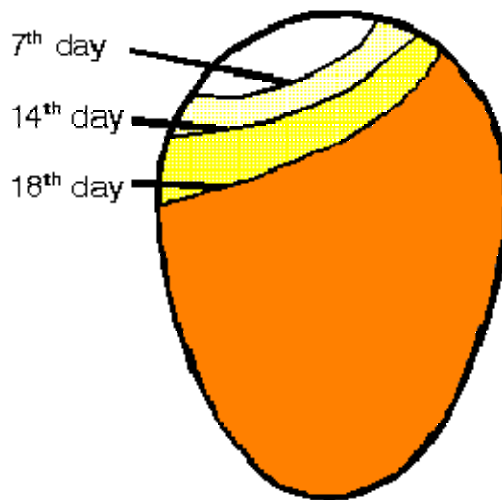
# Testing the eggs

Although it is not necessary to test eggs for fertility, you can eliminate the eggs that are not going to hatch by doing so. It is also an interesting phase of the project because it is possible to see clearly the developing embryo. Looking through the egg to see if it's fertile or to see the embryo is called candling.

Get a shoe box or a box of similar dimensions, and cut a hole in one end about 1 inch in diameter. Use an extension cord, and mount a 60-watt bulb in the box. Darken the room and hold the large end of the egg towards the light. What you will see depends mostly on the age of the embryo. It is difficult to see much development until day four or five of incubation.

The first parts of the embryo you will be able to see by candling will be the head and the eye, and they will appear as a dark object. If the embryo is alive and circulation is established, the contents of the egg will have pinkish color or cast. But if the embryo is dead, the contents will appear muddy or brownish. The live and growing embryo eventually will occupy all of the interior of the egg and will not transmit light; thus, it will be impossible to see anything at the end of the incubation period but the air cell. Infertile eggs and early dead embryos can be detected readily because they appear clear.

Removing the eggs from the incubator for candling does little harm if you handle them gently. But it may slow up development of the chicks if the egg is cooled too much. Generally, if the eggs are removed from the incubator two or three times for a period of no more than 15 minutes each, such cooling will make little difference in the total incubation time required for hatching. However, if the eggs are cooled for several hours because of power failure or some other reason, hatching time may be delayed. It is important not to cool the eggs too long as it is to avoid overheating.



Size of air cell on 7<sup>th</sup>, 14<sup>th</sup>  
and 18<sup>th</sup> day of incubation

## Final Stages of Incubation

After day 17, eggs should not be turned, and the incubator should not be opened unless it becomes necessary to add water. Chicks will start to pip (peck) the shell around day 19. All chicks that are going to hatch should be out of their shell by day 21. If the eggs were chilled or you ran into operational difficulties during the incubation period, the hatch may be delayed. Chicks that hatch beyond day 22 usually are not healthy and vigorous.

When most of the eggs are hatched, lower the temperature to approximately 95°F. This permits the newly hatched chicks to dry off. At this time all the air vents should be opened.

## How the Chick Emerges from the Shell

The head of the chick develops at the large end of the egg. Between day 15 and 16, the chick orients itself so that its head is near the air cell at the large end of the egg. Not long before the chick is ready to attempt to make its way out of the shell, its neck acquires

a double bend so that its beak is under its right wing and pointed toward the air cell. About day 19, the chick thrusts its head forward. Its beak quickly breaks through the inner shell membrane, and the chick's lungs begin to function. Complete breathing by the lungs usually does not occur until day 20 of incubation.

Using its egg tooth (a tiny, sharp, horny projection on the end of its beak), the chick pecks at the shell thousands of times. Finally, the young bird pips its way through the shell and begins to breathe air directly from the outside. After the chick has made a hole in the shell, it stops pipping for three to eight hours and rests. During this time, it is acclimating its lungs to the outside atmosphere. After the resting stage is completed, the second stage of pipping begins.

The chick begins to turn slowly inside the egg. As it turns, usually counter-clockwise, the cutting edge of the egg tooth continues to chip away. In two to five hours, the chick had made about three quarters of a turn inside the egg. As the chick progressed in its movement around the shell, it begins pushing on the egg cap (large end). Squirming and struggling, the chick works feverishly for about 40 minutes pushing the cap. Finally, with a vigorous shove, the chick breaks free from the shell, still wet and panting.

When the chick is freed completely from the shell, it lies still. Its energy virtually has been exhausted, and it is extremely tired. After a few minutes of rest, the chick begins to rise to its feet and gain coordination of its muscles. Within a few days the egg tooth, its usefulness over, will disappear.

## What To DO after the Chicks Hatch

As soon as the chicks have dried and fluffed up completely, remove them from the incubator and place them in holding quarters with the temperature approximately 95°F. Then give them chick starter and fresh water. Rearing the chicks as a project has certain limitations. Chickens cannot be raised in the city.

Reasons for Poor Hatches
<ol style="list-style-type: none"><li>1. Infertile eggs.</li><li>2. Eggs too old when set.</li><li>3. Parent stock weak, unhealthy, fed a nutritionally deficient diet.</li><li>4. Improper care of eggs prior to incubation.</li></ol>



5. Shell contamination.
6. Eggs not turned often enough.
7. Temperatures too high, too low, or too variable during incubation.
8. Too little humidity in the incubator or occasionally too much.
9. Improper ventilation.
10. Oxygen starvation.

## Development of Embryos

### Stages of Embryonic Development

Shortly after the ovum has been released from the hen's ovary, it is picked up by the funnel or infundibulum. Sperm from the male are found in the folds of the infundibulum. Soon after the ovum is picked up by the infundibulum, many sperm contact the germinal disc, but only one unites with the germinal disc. Thus fertilization occurs about 24 hours before the egg is laid.

Because the fertilized germinal disc, or blastoderm, spends about 24 hours in the warmth of the hen's body (about 107°F) while the egg is being completed, certain stages of embryonic development occur during that time. About 3 hours after fertilization, the newly formed single cell divides and makes two cells. Then there are 4, 8, 16, and more. Cell division continues until there are many cells grouped in a small, whitish spot visible on the upper surface of the egg yolk.

When the egg is laid and its temperature drops below about 80°F, cell development ceases. Cooling at ordinary temperature will not kill the embryo, and it will begin to develop again when the egg is placed in the incubator. If the eggs are held before incubation, hold at a temperature of about 55°F.

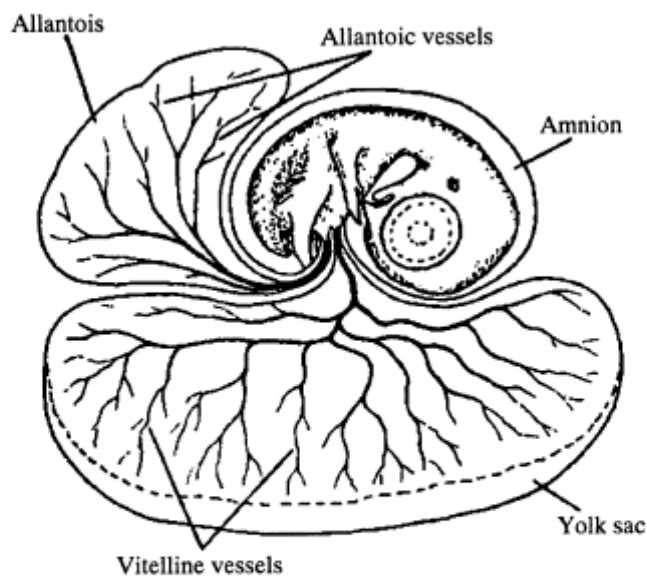
During incubation, various processes occur. They are mainly respiration, excretion, nutrition, and protection. Extra embryonic membranes are membranes outside the embryo's body that make these functions possible. The extra embryonic membranes are the yolk sac, amnion, allantois, and chorion.

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

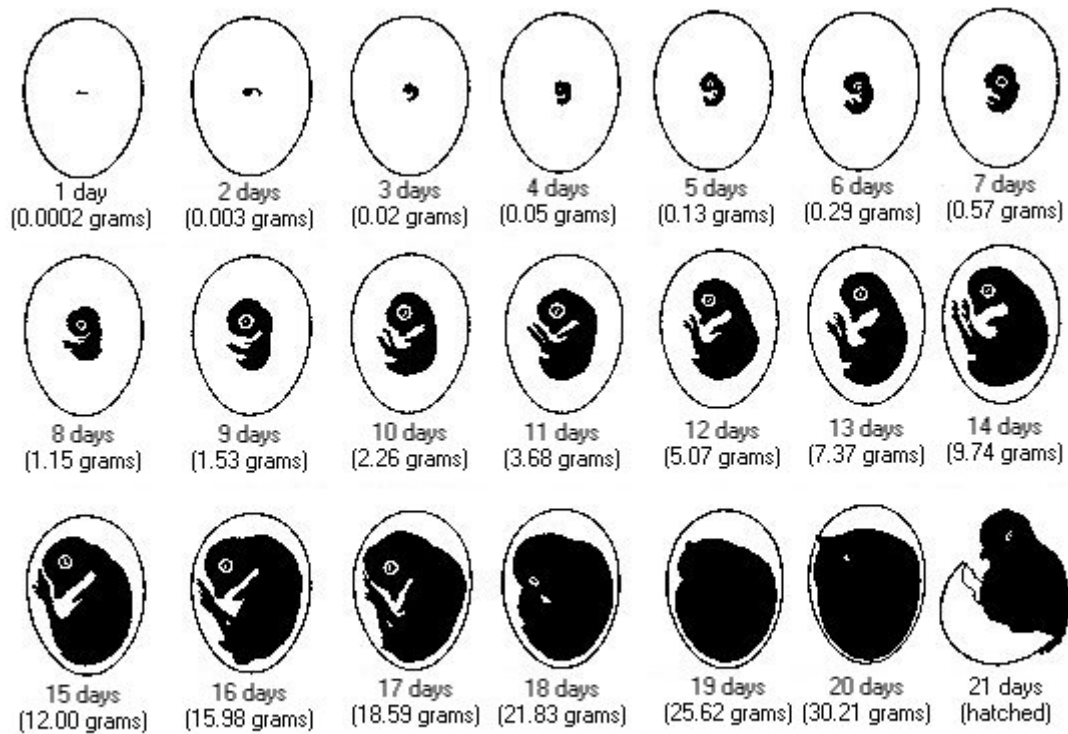
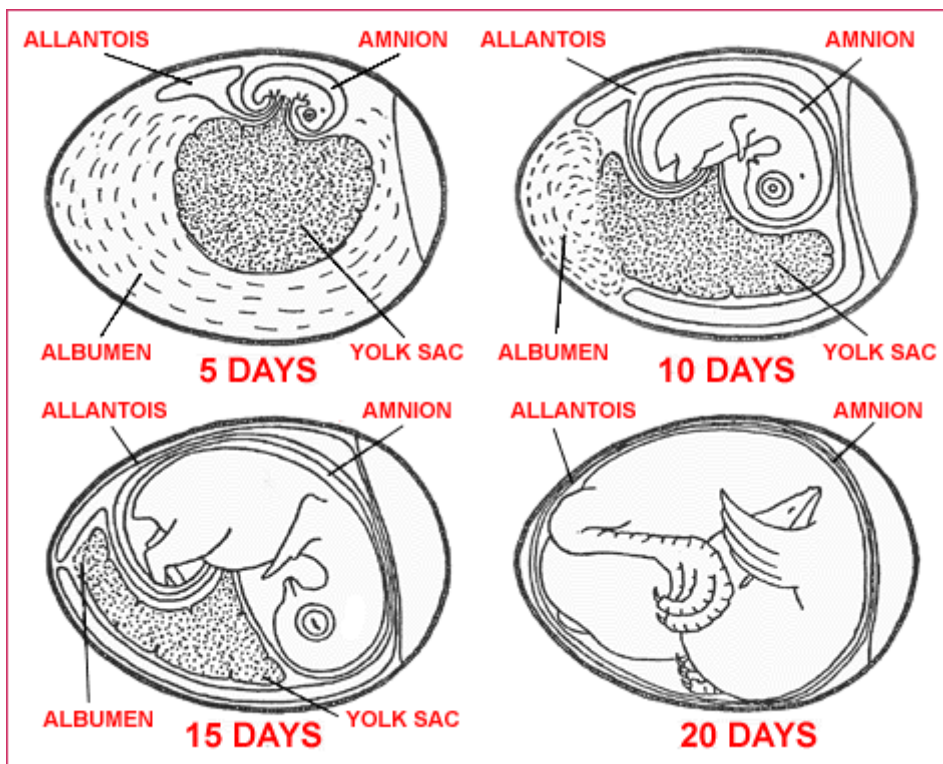
the yolk material. The amnion is a transparent sac filled with a colorless fluid. The amnion and amniotic fluid provide protection of mechanical shock and permit the developing embryo to exercise.

Respiration by the embryo is made possible by the allantois. Blood vessels in the allantois bring oxygen to the embryo and take carbon dioxide away. The allantois also stores excretion, absorbs albumen used as food by the embryo, and absorbs calcium from the shell for the structural needs of the embryo. The allantois ceases to function when the chick punctures the air cell and starts to breathe on its own.

A fourth membrane the chorion, surrounds both the amnion and yolk sac. Initially the chorion has no apparent function, but later the allantois fuses with it to form the chorio-allantois membrane. None of these extra embryonic membranes become a part of the chick.



**Figure 15. 7-Day embryo with its embryonic membranes and blood vessels**  
(From *Egg to Chick*, Northeast States Extension Service)



DAILY CHANGES IN THE WEIGHT AND FORM OF THE DEVELOPING CHICK EMBRYO (WHITE LEGHORN)

# IMPORTANT EVENTS IN EMBRYONIC DEVELOPMENT

## BEFORE EGG LAYING

Fertilization  
Division and growth of living cells  
Segregation of cells into groups of special function

## BETWEEN LAYING AND INCUBATION

No growth; stage of inactive embryonic life

## DURING INCUBATION

### FIRST DAY:

16 hours - First sign of resemblance to a chick embryo  
18 hours - Appearance of alimentary tract  
20 hours - Appearance of vertebral column  
21 hours - Beginning of formation of nervous system  
22 hours - Beginning of formation of head  
23 hours - Appearance of blood islands - vitelline circulation  
24 hours - Beginning of formation of eye

### SECOND DAY:

23 hours - Beginning of formation of heart  
35 hours - Beginning of formation of ear  
42 hours - Heart begins to beat

### THIRD DAY:

50 hours - Beginning of formation of amnion  
60 hours - Beginning of formation of nose  
62 hours - Beginning of formation of legs  
64 hours - Beginning of formation of wings  
70 hours - Beginning of formation of allantois

### FOURTH DAY:

Beginning of formation of tongue

### FIFTH DAY:

Beginning of formation of reproductive organs and differentiation of sex

### SIXTH DAY:

Beginning of formation of beak and eggtooth

### EIGHTH DAY:

Beginning of formation of feathers

### TENTH DAY:

Beginning of hardening of beak

### THIRTEENTH DAY:

Appearance of scales and claws

### FOURTEENTH DAY:

Embryo turns its head toward the blunt end of egg

### SIXTEENTH DAY:

Scales, claws, and beak becoming firm and horny

### SEVENTEENTH DAY:

Beak turns toward air cell

### NINETEENTH DAY:

Yolk sac begins to enter body cavity

### TWENTIETH DAY:

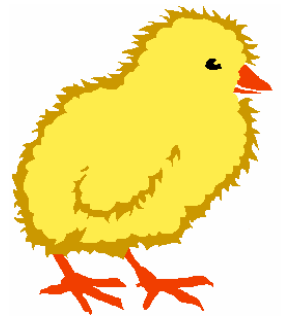
Yolk sac completely drawn into body cavity; embryo occupies practically all the space within the egg except the air cell

### TWENTY-FIRST DAY:

Hatching of chick



# Emerging From the Shell



- Using its egg tooth, the chick pips through the shell and begins breathing.
- After making a hole in the shell, the chick stops and rests for 3 to 8 hours.
- Later, it cuts an egg cap and pushes about 40 minutes, finally breaking it loose.
- After emerging from the shell, the chick is virtually exhausted and rests.
- It will be 8 to 20 hours before the chick is dry and completely alert.

## Chick Development

- Day 1 - Eyes begin to form
- Day 2 - Heart begins to beat
- Day 5 - Formation of reproductive organs
- Day 8 - Feathers begin forming
- Day 10 - Beak starts to harden
- Day 12 - Toes fully formed
- Day 14 - Embryo turns head towards blunt end of egg
- Day 15 - Small intestines taken into body
- Day 16 - Fully covered with feathers
- Day 18 - Growth nearly complete
- Day 19 - Yolk sac drawn into body
- Day 20 - Embryo becomes chick and starts breathing air in air cell of egg
- Day 21 - Chick hatches

# BROODING (HOLDING QUARTERS)

## CHECK LIST



### BEFORE CHICKS HATCH

- \_\_\_\_\_ Prepare holding quarters (brooder box) for the chicks. The brooder should provide sufficient room for chicks to move about, eat and drink. This can be a large cardboard, plywood, Plexiglas or glass box. For 10 -12 chicks the box should be about 28 - 30 inches long, 25 inches wide and 14 inches high.
  
- \_\_\_\_\_ Obtain a waterer and feeder to go in the box. Commercial items are available at feed stores or hatcheries. You can also use plastic containers with short sides. You may want to put marbles in the bottom of the containers to keep them from tipping over easily.
  
- \_\_\_\_\_ Obtain a light source to provide heat for the chicks. A safety light, clamp light, gooseneck lamp or brooder lamp are all possibilities. Use only a 40 or 60 watt bulb in the light. This is to maintain a temperature of 92 - 95 degrees F. in the brooder box at the level of the chicks. The heat lamp should be on 24 hours a day.
  
- \_\_\_\_\_ Obtain soft pine wood shavings (or those used for hamsters or guinea pigs) to place in the bottom of the brooder. **DO NOT USE NEWSPAPERS.** You will need to provide a layer about 2 – 3 inches deep and may need to replace the layer of shaving every few days. Peat moss or unscented cat litter also works well.
  
- \_\_\_\_\_ Obtain a cover for the holding quarters. This can be a welded wire screen or Plexiglas. This is to keep the chicks in and the predators out. If you use a Plexiglas be certain that there is adequate ventilation for the chicks inside the box.

### AS SOON AS CHICKS HAVE DRIED AND FLUFFED COMPLETELY

- \_\_\_\_\_ Put water in the waterer for the chicks. Keep litter out of waterer.
  
- \_\_\_\_\_ Put chick starter feed in the feeder. (This was given to you when you picked up your eggs. This should be enough to last for the few days that you will have the chicks in the classroom.)
  
- \_\_\_\_\_ Place the thermometer from the incubator in the holding quarters. The temperature should be approximately 92 - 95 degrees F. You may have to adjust the height of the lamp to maintain this temperature. **Do not add a higher wattage bulb!**

\_\_\_\_\_ Move the chicks to the brooder box. Dip each chicks beak in the water and feed so that they know where it is and will begin to drink and eat.

\_\_\_\_\_ Place the cover over the top of the brooder to protect the chicks.

## **WHILE CHICKS ARE IN THE HOLDING QUARTERS**

\_\_\_\_\_ Replace water on regular basis. Fresh water is important.

\_\_\_\_\_ Be sure they have adequate feed while they are in the brooder.

\_\_\_\_\_ Change the shavings as they are dirtied. Never place chicks on a smooth surface. They cannot grip a slippery surface and their legs tend to go out to the side. This disjoints the legs and cripples the chicks. This condition is commonly called "spraddle leg."

\_\_\_\_\_ Be sure that the chicks are kept warm and well fed. This means checking the feeders, waterers, and heat every morning, noon and before you leave the school.

\_\_\_\_\_ Watch the temperature in the brooder box for the comfort of the chicks. If the chicks are huddled together in a small circle, the temperature is probably too low. If they are all spread out away from the heat source, the temperature may be too high.

## **TAKING THE CHICKS TO PERMANENT QUARTERS**

\_\_\_\_\_ The Extension Staff shared procedures with you at training about permanent homes for the chicks. The Illinois Humane Animal Act prohibits giving chicks as pets to children.

\_\_\_\_\_ Your local Extension Office provided you with information about permanent facilities for the chicks. This information may have included: a) list of "suitable" homes where you may take the chicks; b) information about date and time the Extension staff will pick up the chicks; or c) information about where you are to take the chicks so that they can be transported to a farm.



# INCUBATION - EMBRYOLOGY

## CHECKLIST



### PRE-HATCH CHECKLIST--EQUIPMENT

#### When You Receive Your Incubator

- \_\_\_ Wash it thoroughly with a damp cloth using a diluted chlorox solution; then let dry.
- \_\_\_ Set it up away from drafts, direct sunlight and traffic path.
- \_\_\_ Regulate the temperature between 99° F. - 101° F., preferably 100° F., for two to seven days before you begin incubation of fertile eggs. Maintain room temperature between 70° F. and 75° F.
- \_\_\_ Make sure you have a reliable and accurate thermometer.
- \_\_\_ Be sure the thermometer is placed at egg level.
- \_\_\_ Fill the water rings in the bottom of the incubator with distilled water and keep full.

#### Incubation Checklist

- \_\_\_ **Wash your hands thoroughly before setting eggs in the incubator. Wash your hands after setting eggs in the incubator.**
- \_\_\_ Be sure the incubator water channels are full of water. Refill with water that is at room temperature.
- \_\_\_ Mark an "x" on one side and an "o" on the other side of each egg with a pencil.
- \_\_\_ Set your fertile eggs on a Tuesday or Wednesday, so they don't hatch on a weekend.
- \_\_\_ Regulate temperature between 99° F. and 101° F., most preferably at 100° F., if you use a still air incubator.
- \_\_\_ Turn your fertile eggs three times a day beginning on day two until the 18th day of incubation.
- \_\_\_ Wash your hands thoroughly before and after handling the eggs. Keep records on turning the eggs.



## At the End of Day 18

- \_\_\_ Place a thin layer of cheese cloth over the wire rack; then place the eggs on the cheese cloth.
- \_\_\_ Add wet sponges to bottom channels to increase moisture and, if your incubator has vent plugs, remove them as appropriate.
- \_\_\_ When chicks hatch, lower incubator temperature to 95 degrees F. Do not remove chicks from incubator until they are dry and fluffy.

## When Hatching Begins - Day 21

- \_\_\_ Set up a brooder box.
- \_\_\_ Get out feeder and waterer.
- \_\_\_ Place wood shavings or other litter in the bottom of the brooder box.
- \_\_\_ Regulate the temperature to around 95 degrees F.
- \_\_\_ Provide water for chicks after they are placed in the brooder box. Place marbles or rocks in the waterer to keep chicks from drowning.
- \_\_\_ Return hatched chicks to the Extension Office or take them to the farm at the agreed upon time.

## After Hatching

- \_\_\_ Clean your incubator with a diluted chlorox solution.
- \_\_\_ Allow to dry.
- \_\_\_ Wash and dry feeder and waterer.
- \_\_\_ Put the incubator and other equipment away for next year.
- \_\_\_ Return the evaluation.

# University of Illinois Extension

## Incubation and Embryology

### INCUBATION-EMBRYOLOGY QUESTIONS AND ANSWERS

The following is a list of questions and answers frequently discussed in the incubation-embryology short course. They are arranged by a major subject heading.

#### POULTRY INDUSTRY AND PRODUCTION QUESTIONS:

1. Why do brown shelled eggs cost more than white shelled eggs?

*Brown shelled eggs cost more because the chickens that produce these eggs eat more feed and are less feed efficient.*

2. Why are brown shelled eggs bigger than white shelled eggs?

*Brown shelled eggs are bigger than white shelled eggs because they are produced from a dual purpose breed (eggs - meat) that is larger in size (6-7 lbs.) than a Leghorn breed that is smaller in size (3-4 lbs.).*

3. Does the time of the year affect the fertility rate?

*Extreme cold (winter) or extreme heat (summer) can lower fertility rate dramatically.*

4. How many females can one male service?

*One male egg producing chicken (Leghorn) can service 10-15 females. One male dual purpose chicken (Rhode Island Red) can service 6-8 females.*

5. What is the average life of the male chicken?

*A male chicken would live on the average of 3-5 years.*

6. How long do chickens live?

*Broilers reach market age in six to eight weeks. On most commercial egg farms, laying hens have completed their usefulness when they are 18 to 20 months old. Records show that when chickens are allowed to live out their lives naturally, many of them will live in the range of six to ten years, and some claims have been made of some chickens living as long as 22 years.*

7. How large are female chickens?

*A female White Leghorn is about 4 lbs. and a female Rhode Island Red is about 6-7 lbs.*

8. How can you tell a hen from a rooster?

*It is difficult to tell at hatch unless they are feather-sexed (female primary feathers are longer at 3-4 days of age) In adults, males are larger with longer wattles and larger combs.*

9. How can you tell if the chick is male or female?

*Unless the males and females have been bred to be different colors or have different rates of feather growth, you cannot tell them apart without special training. Trained chick sexors can determine the sex of a chick by:*

*Examining the chick's vent for tiny differences in the shape inside.*

10. Do you need sunlight to formulate hard shells on eggs?

*No. An adequate source of calcium (3.5) in the diet is needed.*

11. Do chicken houses need to be heated?

*No. Usually chickens in large commercial houses provide their own heat.*

12. How much light is needed in a chicken house?

*Only enough light is needed to read a newspaper at arms length (about a 1 foot candle).*

13. When does production begin?

*Production begins at sexual maturity. This is about 17-18 weeks of age for the female hen.*

14. What factors affect egg production?

*Many factors affect egg production. The most important are diet (nutrition), temperature, humidity, length of artificial light (14 hours of constant light is recommended) and other nutritional and environmental factors.*

15. How long after a chick hatches is it considered an adult?

*In the case of those developed for egg production, about five months (19 to 22 weeks). Those developed for meat (bigger birds) take longer – about six months.*

16. How long does it take to raise a fryer?

*It takes about 42-49 days; 6-7 weeks to market weight of 4.5 lbs. to raise a fryer.*

17. Can we hold the chicks as soon as they hatch?

*Chicks should not be handled until the hatch is completed, and the chicks are dry*

*and completely fluffed up.*

18. If I find a bird egg, such as a robin's, can I hatch it?

*First, these are much more difficult to incubate than chicken or quail eggs. Even if you were able to get the chick to hatch, a young bird, like the robin, requires the skilled care of its parents to survive. People cannot provide the same kind of care, and the baby bird will most likely die from starvation, cold, or mismanagement.*

19. If a mother hen sits on a fertile egg will it always hatch? If not, what does she do with it?

*Not all fertile eggs will hatch even when incubated either by a broody hen or in an incubator. Under some conditions they will contain weak or defective embryos.*

*Hatchability is influenced by:*

- ◆ *Age of eggs at setting*
- ◆ *Conditions under which they were held before incubation*
- ◆ *Parent stock, including its breeding potential, health, and diet*
- ◆ *Conditions while the eggs are being incubated*

*So, the fact that a hen is doing the incubating does not guarantee that a fertile egg will hatch. If an egg or eggs do not hatch, the hen eventually leaves them in the nest. She leaves because the hormone that caused her to go broody is no longer secreted, so she stops setting on the eggs. In a way, it could be said that nature has told her to quit the nest.*

20. How long can the mother hen be off the nest during the day? What will happen if she stays off too long?

*A setting hen can be off the nest 15 to 20 minutes or a little longer at one time without harming the embryos, unless the weather is extremely cold. If she remains off too long, the embryos will be chilled too much. Then, some of the chick may be so weakened that they cannot hatch, and so will die in the shell.*

21. What is a blood spot?

*A blood spot occurs from a broken blood vessel across the stigma line on the yolk follicle when the yolk is released into the reproductive tract.*

22. What is a meat spot?

*A meat spot occurs when a part of the oviduct peels off, as when the egg is formed.*

23. Is there one kind of egg carton that is better than another?

*A styrofoam carton is preferred to a paper carton because it protects the egg better.*

24. What is salmonella?

*Salmonella is a bacteria that can form on the outside of the shell when an egg or its contents become contaminated. It can cause food poisoning if eggs are not properly handled and cooked.*

25. What are the critical issues related to salmonella?

*Issues are: Eggs and other food should be properly handled and cooked. Salmonella poisoning is not a problem if food products are properly prepared.*

26. How often are eggs infected with salmonella?

*It has been shown that possibly one egg in one million eggs produced may have some salmonella growing inside an intact egg.*

27. What is the proper way to cook an egg?

*Eggs can be cooked in many different ways. Thoroughly cooked eggs include: eggs cooked until the whites and yolks are not runny, hard-cooked eggs, baked eggs and other egg-rich foods cooked to an internal temperature of at least 106 degrees F.*

28. Do brown eggs have more cholesterol than white eggs?

*Brown and white shelled eggs have the same amount of cholesterol (200-210 mg per egg).*

29. How many eggs does a chicken lay per year?

*A chicken lays 250-270 eggs per year.*

30. What causes a double yolk egg?

*It is an egg which has two yolks in it. Both yolks were ovulated (released) at or about the same time and enclosed in the same shell. Many eggs with double yolks occur when a young hen first starts producing eggs. Their egg-forming organs are not adjusted or well synchronized yet, so two yolks of about the same size are released together. Within a few weeks after egg production starts, the chickens' bodies adjust, and for the most part, they then lay eggs with only one yolk. But, there are some chickens which inherit the characteristic to lay eggs with two **or more** yolks (as many as **nine** for one extraordinary hen!) and these hens usually continue to do so throughout their life.*

31. Is the shell hard or soft when laid?

*The shell is hard when laid by the hen.*

32. How is the egg fertilized?

*When the rooster inseminates the hen, the male sperm swim up the reproductive tract and localize in sperm host glands in the infundibulum. When a yolk is released one sperm penetrates the germinal disc and fertilization has begun.*

33. How can one tell a fertile egg from an infertile one? How can one tell when an egg was fertilized?

*It is not possible to visually distinguish between fresh fertile and infertile eggs unless you break them out of the shell. After they have been incubated three days, a small reddish area with blood vessels extending from it will be visible in fertile eggs when they are candled or broken out; infertile eggs will not show this (clear eggs). When broken out, fresh infertile eggs show a smaller, solid white germ spot than fertile ones. This is because cell division has not occurred in infertile eggs but has in fertile ones. Fertile eggs have larger germ spots that usually have a darker central region (a white ring around a darker center).*

*By 24 hours of incubation, you can often see a small, thumb-shaped shadow on the yolk extending towards the air cell.*

34. When do the chicks need water?

*Chicks need water immediately. They need to drink water when they are transferred to the brooder box.*

35. When do they need food?

*The chicks need food preferably the first day, but can survive for up to 3 days after hatching.*

36. What are hackle feathers?

*Hackle feathers are neck feathers on a chicken. A rooster has long pointed ones and the female has short rounded ones.*

37. What are saddle feathers?

*Saddle feathers are feathers toward the tail end of the chicken. The size and shape of these are the same as these of the hackle feathers.*

38. Can you tell the sex of the chicken from the feathers alone?

*You can if the breed is feather sexed. The female chick's primary feathers will be longer than the males. It is difficult to tell the sex of a newly hatched chick if the breed does not have the feather sexed characteristic.*

39. Is there a pecking order?

*Yes, within a group from 2 chickens to hundreds they establish a pecking order of dominance.*

40. If a female chicken is hatched with about 14,000 ova and lays only 240 to 250 eggs a year, what happens to the remainder of the ova?

*Depending on the state of health and condition of the chicken, the remaining ova can:*

- *Continue to exist in the hen's body ready to form a yolk*
- *Be absorbed by the hen's body*

41. Can I hatch the eggs I buy at the store?

*No. The eggs in grocery stores are infertile and will not hatch.*

### **BREEDS OF CHICKENS:**

42. Why are brown shelled eggs bigger than white shelled eggs?

*Brown shelled eggs are bigger than white shelled eggs, because they are produced from a dual purpose breed (egg-meat) that is larger in size (6-7 lbs.) than a Leghorn breed that is smaller in size (3-4 lbs.).*

43. How do you know what color shell the eggs will have?

*The earlobes of the chicken dictate the color of the shell (white earlobes = white eggs; red earlobes = brown eggs).*

44. What kind of chicken lays green shelled eggs?

*An Arucana or Ameraucana chickens lay green shelled eggs.*

### **EGG GRADING AND CANDLING:**

45. What is the weight of jumbo, extra large, large, medium, small and pee wee eggs?

*Jumbo - 30 ounces per dozen  
Extra Large - 27 ounces per dozen  
Large - 24 ounces per dozen  
Medium - 21 ounces per dozen  
Small - 18 ounces per dozen  
Pee Wee - 15 ounces per dozen*

46. What are the egg grades?

*Egg grades are: AA - shell clean, air cell 1/8" or less in depth, white clear and firm; A - shell clean, air cell 3/16" in depth, white clear; and B - shell clean to slightly stained, air cell over 3/16" deep, white weaker and watery.*

47. What is a leaker?

*A leaker is a broken egg where the contents leak out of the shell.*

48. What is candling?

*Candling is shining a bright light near the egg to determine the egg quality and embryonic development.*

49. When should the eggs be candled?

*Eggs can be candled anytime from about day 5 of incubation through day 17*

50. How many eggs should be candled at a time?

*Out of two dozen eggs in the incubator probably no more than 5-7 eggs should be candled at one setting.*

51. How long should the eggs be out of the incubator?

*Eggs should be out no more than 5 to 10 minutes at a time.*

## **INCUBATION**

52. What is the best temperature for storing eggs?

*Egg storage temperature should be between 55 and 60 degrees F.*

53. How much humidity is needed?

*Enough humidity is needed to maintain a wet bulb temperature of about 85 to 87 degrees F. (50-55% relative humidity). This is normally attained if water channels in the incubator are kept full.*

54. How does one know when the humidity is enough or too much?

*In small classroom incubators, there is no exact or precise way to measure humidity. Hygrometers do not work well in these incubators. If you have a factory-made incubator, use a water pan or pans equal in size to at least one-half and preferable more of the incubator's floor space. During the last three days of incubation, place moist sponges or cloths in the incubator to increase humidity but don't let the sponges or cloths come into contact with the eggs.*

**Wet Bulb Readings:** *Using a thermometer similar to the one you monitor incubator temperature, slip a small piece of shoelace over the bulb end (this is called a cock or wick). Wet this, then put into incubator. Let sit for at least 10 minutes. There are charts that can be used if you have a "wet" bulb and "dry" bulb.*

55. How do you disinfect the incubator?

*Disinfect the incubator with 10 percent Clorox bleach solution, and then wash with warm soapy water and rinse thoroughly.*



56. Does when the egg was laid affect the hatch date?

*No. If fertile eggs are stored properly (55-60 degrees F.) then hatch date for the chicken will be about 21 days following the time they are placed in the incubator.*

57. When should the incubator be prepared for the eggs?

*The incubator should be prepared about one week before starting the incubation process.*

58. Where should the eggs be stored if they cannot be set right away?

*If they cannot be put in an incubator right away, then they should be kept in the vegetable section of a refrigerator or at a temperature of 55-60 degrees F.*

59. What is the longest time an egg should be held before incubating?

*Eggs should be kept no more than seven days.*

60. What is the correct temperature for incubating fertile eggs?

*Optimum temperature is 100.5 degrees F.*

61. What is the temperature range that is acceptable during incubation?

*Temperature range for incubation is 99-103 degrees F.*

62. What is the lowest temperature?

*The lowest temperature for incubation is 99 degrees F.*

63. What is the highest temperature?

*The highest temperature for incubation is 103 degrees F. NEVER keep at 103 degrees F. for more than a few hours.*

64. How do you check the accuracy of the incubator thermometer?

*Accuracy of an incubator thermometer can be checked by placing a medical thermometer and an incubator thermometer in a pan of 100 degrees F. water or take a good thermometer from the science storeroom and place it next to the incubator thermometer in the incubator at 100 degrees F.*

65. When should the plugs be removed from the incubator?

*Remove plugs (air holes) from the top of the incubator when you see the chicks start to hatch.*

66. What are the factors for success?

*Successful hatches can be obtained by: 1) securing fertile eggs; 2) maintaining the correct temperature; 3) maintaining correct humidity levels; 4) increasing ventilation when chicks hatch; 5) turning the eggs properly.*

67. What should be used to mark the eggs?

*A lead pencil only should be used.*

68. Do I need to take the eggs home for the weekends?

*Yes, you are encouraged to take eggs home on the first two weekends to turn the eggs and regulate temperature.*

69. How do I transport the incubated eggs from school to home and back?

*Carefully. Put the eggs in a Styrofoam egg carton and the carton in a blanket; or leave eggs in the incubator and place a blanket over them so they won't roll around.*

70. Where should the eggs be placed in the car when taking them home?

*Place the eggs on the front floor on the passenger side and turn on the heat.*

71. What is the normal hatch time for a fertile incubated egg?

*Normal hatch time for chicken eggs is 21 days.*

72. What will delay the hatch?

*An average temperature that is too low will delay the hatch.*

73. Why are the chicks sometimes very wet and mushy?

*Chicks are wet and mushy if humidity in the incubator is too high. To lower the humidity at the end of the incubation period, do not place more than one sponge in the bottom of the incubator.*

74. How can I be sure that I have enough humidity?

*If the proper water level is maintained in the bottom of the incubator, the correct humidity should be maintained.*

75. How can I tell if I have too much humidity?

*If there is too much condensation on the inside of the incubator windows, then there is*

*probably too much moisture in it. This usually is not a big problem.*

76. How long should I leave the eggs in the incubator if they do not hatch on the twenty-first day?

*Leave the unhatched eggs until the 23rd or 24th day.*

77. What causes deformed legs?

*Deformed legs are caused by poor nutrition for the hen. Other factors are disease, contamination and improper temperature.*

78. How do I add water?

*Add warm water (100 degrees F.) with a squeeze bottle or turkey baster; do not get eggs wet.*

79. How do I count the days?

*Count the days of incubation from the first day the eggs are placed in the incubator. If eggs are placed in the a.m. that day would be Day 1; if placed in the p.m. that would be Day 0; the next day would be Day 1.*

80. When do I stop turning the eggs?

*Stop turning the eggs on Day 18.*

81. When should I put the crinoline on the wire grate?

*Put the crinoline (cheese cloth) on the wire grate of the incubator at the end of Day 17 or beginning of Day 18.*

82. How can I add additional humidity?

*Add additional humidity on Day 18 by placing 2-3 wet sponges on the bottom of the incubator.*

83. Can I find the egg tooth and keep it after it falls off?

*It peels off, like a tiny sticker, usually in the first couple of days after hatching. As it is very small and thin, it would be difficult to find in the litter.*

84. If an embryo dies during incubation, does it feel pain?

*We cannot know for sure, but it appears more like the embryo just sort of goes to sleep.*

85. What should I do if the chicks do not fluff up?

*If chicks do not fluff up, remove sponges from the incubator and water from the channels.*

86. What is the brooder box?

*A brooder box is a temporary home for baby chicks up to one week of age. It contains 2-3 inches of litter, a feeder and waterer. It also includes a heat source suspended above the box.*

87. How do I make a brooder box?

*Take a cardboard box (2' X 3' X 1') and place in it items mentioned in answer above.*

88. What should be used in the bottom of the brooder box?

*Soft pine-wood shavings, untreated cat litter, sand, rice hulls and ground corn cobs may be placed in the box.*

***DO NOT PUT NEWSPAPER IN BOX.***

89. Do the teachers need to teach the chicks to drink and eat?

*Yes, it would be a good idea to dip the baby chick's beak in the feed and water so they know where it is.*

90. Can you open the shell for the chick?

*Yes, but it is not recommended. To do so frequently kills the chick, as you will usually break open the Chorio-Allantoic Membrane (CAM) vessels which cause the chick to bleed to death. It is best to let the chick hatch individually.*

91. Where should the thermometer be placed in the incubator?

*Place the thermometer on the wire grate away from the heat source and in the center of the incubator.*

92. What is the function of the air cell?

*The air cell function is to provide the chick with air when it first starts to break open the shell.*

93. What is the critical period in hatching?

*The first 3-5 days and Days 18 and 19 are critical since embryo is forming in the early days and it gets in position to hatch the last days.*

94. How often should the eggs be turned?

*Eggs should be turned at least three times a day.*

95. What happens if the eggs are not turned?

*If eggs are not turned, the embryo will die about Day 11.*

96. What causes the embryo to develop fully, but not pip the shell or hatch?

*Too low or too high temperature and too low or too high humidity are causes.*

97. Do you need to do anything to prevent the chicks from drowning?

*Place marbles or rock in the water pan in the brooder box to keep chicks from drowning.*

98. Why shouldn't a chick be helped out of the shell?

*The chick is weak and would not survive on its own.*

99. Why do chicks stick to the shell?

*Too low humidity during incubation causes chickens to stick to the shell.*

100. What causes the navel to be sore?

*Too high temperature during incubation, excessive humidity near the end of incubation or infected embryo early in incubation.*

101. Why does the eye get so big and why does it grow so fast?

*We do not have the exact answer to this. However, it is possible that both size of the eye and speed of its growth could be at least partially due to the eye being so very complex and so important. Thus, considerable time is needed to completely form and develop it.*

102. Why does the heart grow on the outside of the body at first?

*We do not know why it does so. It is known that the heart helps to circulate blood in both the embryo's circulatory system and in the membranes outside the embryo which are carrying food to the embryo as it develops. Actually, in some ways, the early heart is inside, since it is right next to the yolk sac, which is really part of the "inside" of the embryo!*

103. If you break open the shell, say on the 8<sup>th</sup> or 9<sup>th</sup> day, how long can the embryo live?

*The length of time it will live varies with the conditions around it such as temperature. It is not likely to live more than 5 to 10 minutes in most instances. It is possible to remove the shell at the large end of the egg, replace it with a plastic cap, continue to incubate the egg, and the embryo can then live several days, or even go to hatch, if conditions were kept very sterile during the opening and the egg was fully resealed.*

104. What should you do if the chicks pick at one another?

*Separate them from each other in the brooder box or construct another brooder box and separate the chicks.*

105. Can chicks be marked?

*Yes.*

106. How do you color embryos?

*To color embryos you inject about .2 to .5 milliliters of a colored dye into the egg with a hypodermic needle near the bottom of the egg.*

### **EMBRYOLOGY:**

107. How do you preserve embryos using formalin or glycerin and ethyl alcohol?

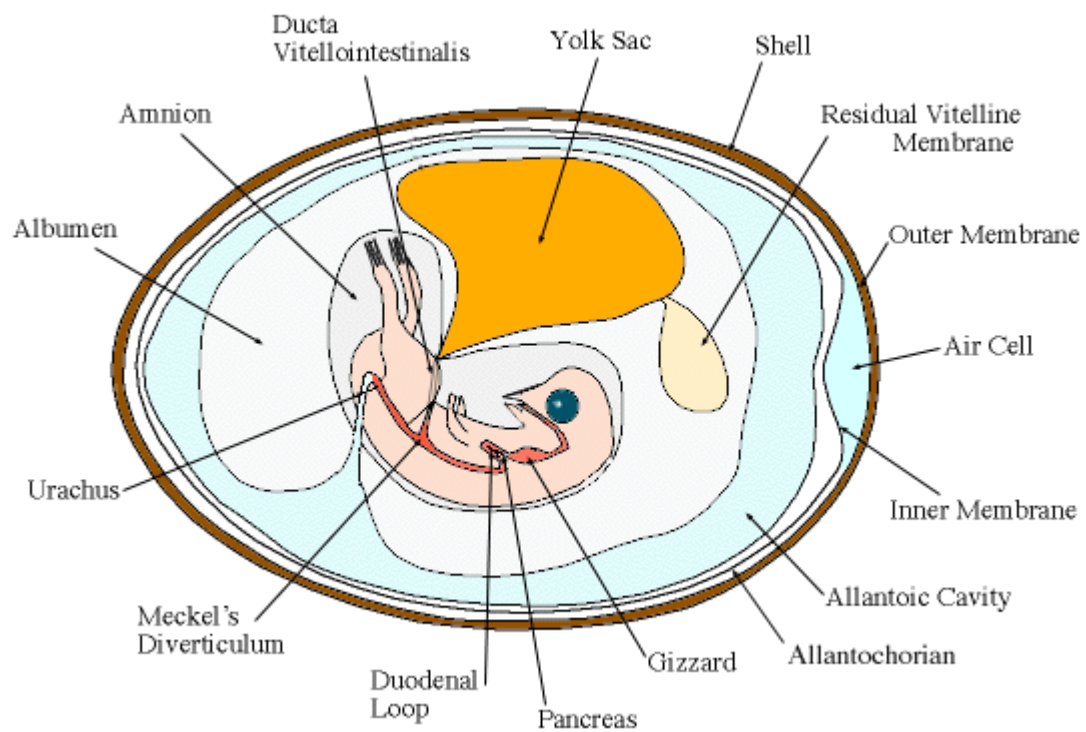
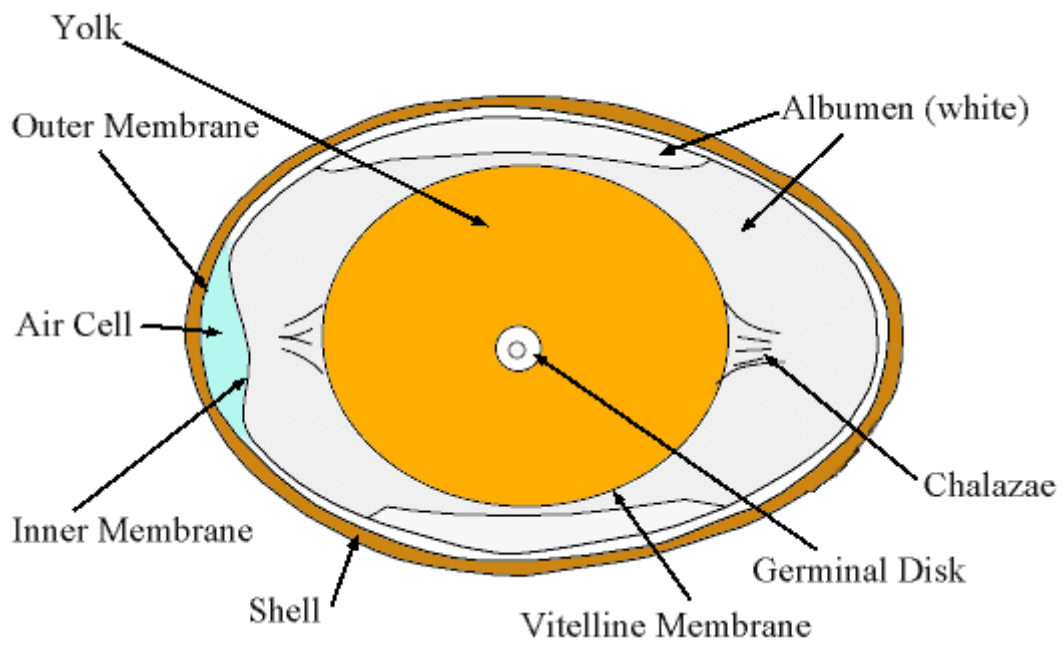
*Embryos can be successfully preserved by storing them in a 10% formalin solution (1 part 37% formaldehyde to 9 parts of water). Or they can be preserved in an alcohol solution (3-4 drops of glycerin on embryo) then immerse in 70% alcohol (14 parts of 95% ethyl alcohol to 5 parts of water). **The preferred method is to use glycerin or ethyl alcohol.***

108. What is the correct procedure for breaking out an embryo?

*Break open the shell on the large end of the egg, then pour out the liquid contents and carefully drop the embryo on a pie tin.*

109. How long does it take to pip the shell completely?

*It normally takes two to four hours.*



## **GLOSSARY**

**Air cell-** The air space between the two shell membranes, usually at the large end of the egg, that can be easily seen when the egg is candled.

**Albumen-** The white of an egg, consisting of outer thin, and chalaziferous layers.

**Allantois-** An embryonic membrane which in birds serves as a respiratory organ and a reservoir for waste and facilitates the absorption of albumen and calcium.

**Amnion-** A transparent sac, filled with colourless fluid, surrounding the embryo; the amnion and amniotic fluid protect the developing embryo from shock.

**Avian-** Of or pertaining to birds.

**Beak-** The protruding mouthpart of a bird.

**Blastoderm-** The collective mass of cells produced by the division of a fertilized ovum and from which the embryo develops.

**Blastodisc-** The embryo-forming spot on the ovum, from which the blastoderm develops after the ovum is fertilized by a sperm.

**Broiler-** A young meat-type **chicken**, usually weighs between 1.7 and 2.5 Kg live (3.5-5.5 lbs) and takes from 39-42 days to reach this weight.

**Candling-** Observing the shell and the contents of the egg (air cell, embryo) through the shell by holding the egg up to a bright light focused on the shell.

**Chalazae-** Tiny white cords of protein fiber that are twisted like a rope at each end of the yolk. They anchor the yolk in the center of the egg shell cavity.

**Chick tooth-** A temporary, tiny, sharp projection on the end of the chick's beak used by the chick to break through the shell. Also known as the **egg tooth**.

**Chorion-** A membrane that surrounds both the yolk sac and the amnion.

**Cloaca-** The vent or common opening in birds through which the intestinal, urinary and reproductive tracts empty.

**Comb-** The fleshy, red outgrowth on top of a **chicken**'s head.

**Cornish hen-** A young **chicken**, with very tender meat, usually weighs between 1 and 1.1 Kg live (2.2 lbs) and is ready for market in 28 days.

**Down-** Soft, fine, hair-like feathers on young birds.

**Dry-bulb thermometer-** An instrument that expresses the temperature reading in degrees Fahrenheit or centigrade.

**Egg Tooth** – A tiny, sharp, horny projection on the end of the chick's beak used by the chick to peck holes in the shell.

**Embryo-** A fertilized egg at any stage of development prior to hatching.

**Embryology-** The study of the formation and development of embryos.

**Evaporation-** The changing of moisture (liquid) into vapor (gas).

**Extra embryonic Membranes** – Membranes outside the embryo's body that make respiration, nutrition, and secretion possible and provide protection; they include the yolk sac, amnion, allantois, and chorion.

**Eviscerated** - The internal organs have been removed from the **chicken**.

**Feeder-** A container which holds feed.

**Fertile-** Capable of reproducing.

**Fertilization-** The union of a male cell with a female cell.

**Giblets-** The internal edible parts of the **chicken** and include the heart, liver and the gizzard.

**Gizzard-** An internal organ of birds used for crushing and grinding foods by muscular action and with pebbles or grit.

**Gonad** - A gland that produces reproductive cells; the ovary or testis.

**Hatching eggs-** A fertilized egg with the potential for producing a chick.

**Humidity** – The amount of moisture in the air in the incubator.

**Incubate-** To maintain favorable conditions for developing and hatching fertile eggs.



**Incubator-** A container with the proper humidity and temperature for hatching fertile eggs.

**Infundibulum-** The entrance to the oviduct.

**Layers-** Mature female chickens kept for egg production.

**Litter-** Any bedding material which provides animals with safe footing, and keeps them warm, clean and comfortable.

**Membrane-** A thin, soft, pliable sheet or layer of tissue covering an organ.

**Navel-** The navel is the place where the abdomen closes after surrounding the remains of the yolk.

**Ovary-** The female reproductive gland in which eggs (ova) are formed.

**Oviduct-** The tube through which eggs pass after leaving the ovary.

**Ovum-** The female reproductive cell.

**Papilla-** In the rooster, tiny projections in the cloaca through which semen is ejected.

**Pipping-** A baby chick breaking from its shell.

**Pores-** In the shell of an egg, thousands of minute openings through which gases are exchanged.

**Poult-** A baby turkey.

**Pullet-** A female **chicken** under one year of age.

**Relative humidity-** The amount of moisture in the air compared to the amount the air could contain at that temperature; expressed as a percentage.

**Roaster-** A young meat-type **chicken**, of either sex, that can be cooked tender by roasting, and usually weighing about 3 Kg live (6.6lbs) and is grown in 50 days.

**Sac-** A bag like part of an animal or plant, often containing some special fluid.

**Semen-** The fluid secreted by the male reproductive organs. Serves as a vehicle for the sperm.

**Set-** To put eggs in an incubator or under a broody hen to hatch them.

**Shell-** The hard outer surface of an egg made up largely of calcium carbonate.

**Shell membranes-** Two thin membranes next to the shell and surrounding the albumen and yolk; known as inner and outer shell membranes.

**Sperm-** The male reproductive cell.

**Stewing hen-** A mature **chicken** (generally a laying hen) about one year old having tougher meat, less fat and more connective tissue than a younger **chicken**.

**Testes-** The male genital glands. ( singular - testis)

**Ventilation-** The movement or exchange of stale air for fresh air.

**Wattles-** The fleshy, red growths that hang from the side and base of the **chicken**'s beak.

**Wet-bulb thermometer-** A device that measures moisture or water vapor in the air.

**Yolk-** The round yellow mass upon which the true egg is located and that provides nutrients for the developing embryo.

**Yolk Sac** – The follicle in which an ovum and its surrounding yolk are held until the yolk matures.