

# 4-H Embryology

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**Florida Cooperative Extension Service/  
Institute of Food and Agricultural Sciences/  
University of Florida**

Welcome to the 4-H Embryology Project. 4-H is a fun organization for youth interested in learning something new by actually doing it. In this project you will learn how life develops by observing eggs you set in your incubator. You will be responsible for the daily care of the incubator. Also you will be asked to observe and record various scientific information. This record book is designed to help you record this information and to write your observations, reactions, and thoughts about this experience.

## THE INCUBATOR AND HOW IT WORKS

### Hatching Eggs in the Incubator

An incubator is a box that provides and maintains a favorable environment for hatching fertile eggs. Four factors are very important to insure the success of hatching fertile eggs in an incubator. These are:

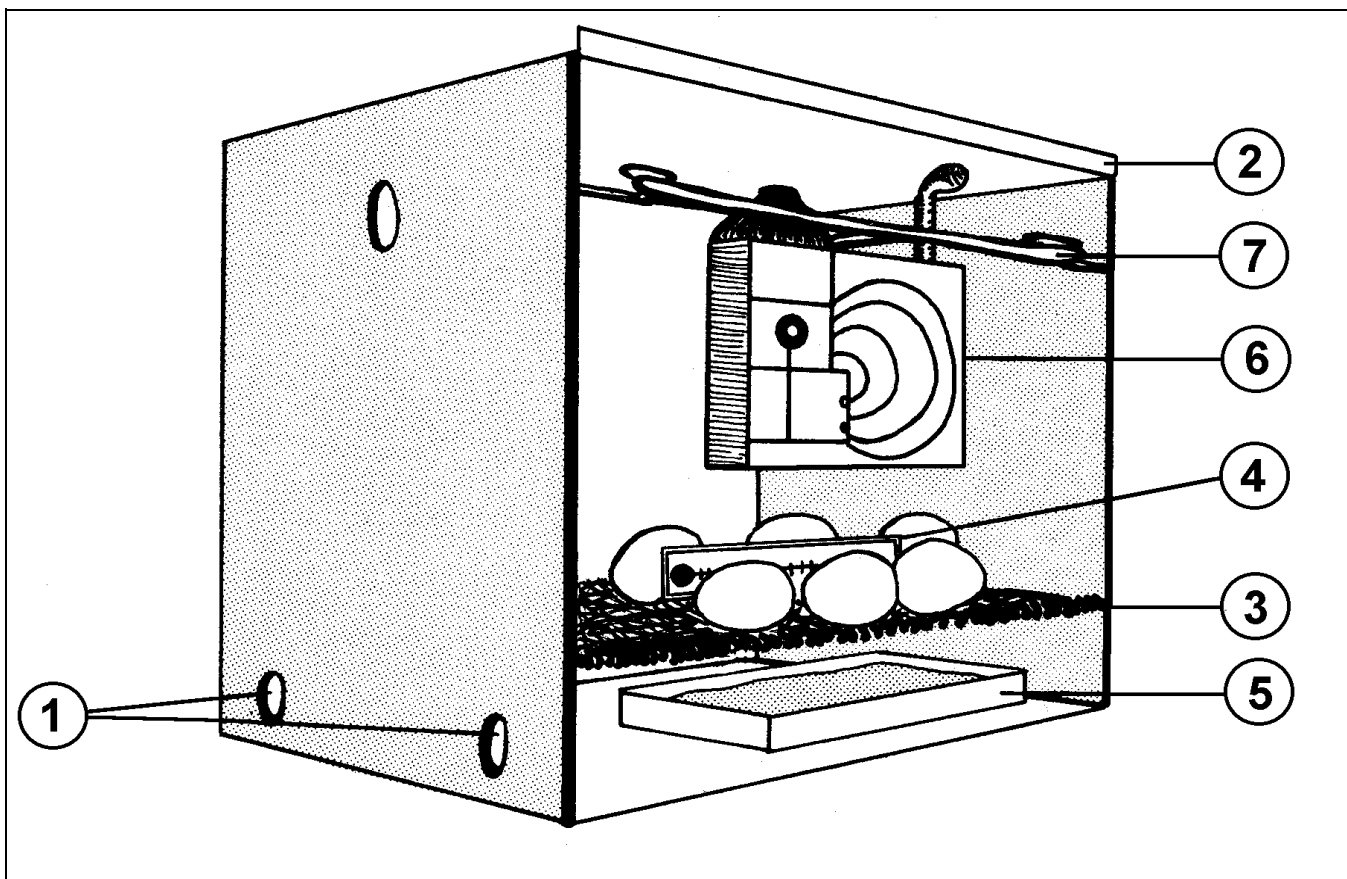
- 1) temperature,
- 2) humidity,
- 3) ventilation,
- 4) turning eggs regularly.

Temperature is the most important of these four factors. Humidity is the measure of moisture in the air while ventilation is movement of fresh air through the incubator. Turning each egg several times daily prevents the embryo from sticking to the shell. Plans for building an incubator are available from the Extension Office.

### Operating Your Incubator

**Location** - The incubator should be placed so that it is free from drafts, direct sunlight and variations in room temperature. This will help you to maintain a more uniform temperature and humidity. Make sure there is plenty of space around all sides of the incubator. This will allow the air to move freely through the ventilation holes.

**Temperature** - Temperature is the most important



**Figure 1.** 1. Ventilation holes 2. Glass 3. Metal platform 4. Thermometer 5. Evaporation pan 6. Micro-switch assembly - (regulates temperature) 7. Heating cable.

key in obtaining a good hatch. You should operate the incubator with a pan of water in it for several hours before you place the fertile eggs in the incubator. This will give you time to make the necessary temperature adjustments. This ideal temperature is 101° to 103° Fahrenheit (F) at a position level with the top of the eggs. The acceptable range for good embryonic development is 98° F to 103° F. Short periods of time below 98° F will usually not affect the number of eggs hatched, but will slow up embryonic development. This will delay the hatch and could cause an increase in the number of deformed or weak chicks. The embryos, however, are more sensitive to temperatures over 103°F. Operating at higher than ideal temperatures will increase mortality and number of crippled and deformed chicks. A temperature of 104°F or higher for even a short time will kill the embryos.

**Humidity** - You should keep water in the evaporation pan at all times to maintain humidity in the incubator. Humidity is maintained by water evaporating from the pan. During the last three days of incubation you will want to raise the level of humidity in the incubator by sprinkling the eggs with

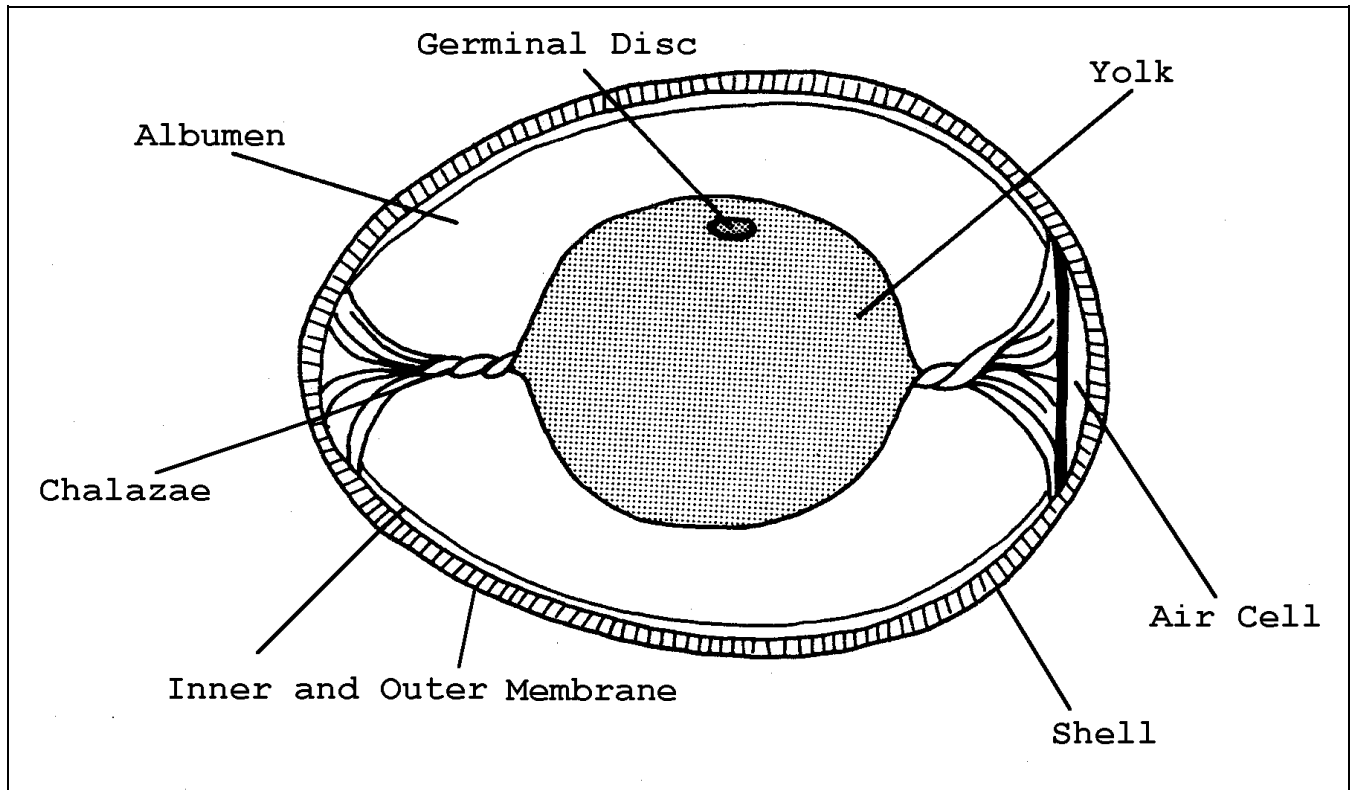
water. (It is all right if moisture collects on the glass during the last three days.) Low humidity will cause the chick to stick to the shell and thereby keep it from hatching.

**Ventilation** - Ventilation is very important to the developing embryo. The embryo needs oxygen to live while the gases given off by the embryos need to be removed from the incubator. This is accomplished by air moving through the holes in the side of the incubator.

**Turning the eggs** - It is necessary to turn the eggs from the first to the eighteenth day. After the eighteenth day the eggs can remain in one position. Turning prevents the developing embryo from sticking to the shell. It is desirable to turn (roll) the eggs to the opposite side an odd number of times each day. Three times daily is a minimum (morning, noon and night). By turning the eggs an odd number of times, the eggs will not rest all night in the same position as the previous night. Mark each egg with a pencil as an aid in determining that all eggs have been rolled at each turning.

## QUESTIONS

- 1) What is an incubator? \_\_\_\_\_  
\_\_\_\_\_
- 2) What are four (4) factors very important in hatching fertile eggs successfully in an incubator?  
\_\_\_\_\_
- 3) What is an ideal temperature for hatching chicken eggs? \_\_\_\_\_
- 4) How many times should the eggs be turned each day? \_\_\_\_\_  
\_\_\_\_\_
- 5) What do we mean by the term ventilation? \_\_\_\_\_  
\_\_\_\_\_
- 6) Chicken eggs should be turned the last three days of incubation. TRUE or FALSE \_\_\_\_\_
- 7) Location of the incubator in a room is of no importance. TRUE or FALSE? \_\_\_\_\_
- 8) What is humidity? \_\_\_\_\_
- 9) What will usually happen to the number of days until the chick hatches if the temperature is held below the recommended levels? \_\_\_\_\_
- 10) How do you adjust the level of humidity in an incubator? \_\_\_\_\_



**Figure 2...**Parts of the egg.

## LIFE IS A MARVELOUS THING

Life begins from the single cell. Under proper conditions this cell divides first into two, then into four, eight, sixteen, thirty-two, until a new individual is developed. For a fertile egg (remember, not all eggs are fertile) to develop into a bird, the egg must be held at a certain temperature for a given number of days. This is called incubation time. This time is different for different kinds of birds. For chickens it is 21 days, for turkeys 28 days, and for most ducks 28 days. Muscovy ducks and geese require 30-35 days incubation time. In nature the mother bird sits on a nest of eggs and the warmth from her body causes the eggs to develop into baby birds. For this project we will study this life development process using chicken eggs and an incubator.

Looking at the egg from the outside we see the **SHELL**, which is a hard, protective covering composed primarily of calcium. The shell contains pores, somewhat like those in your skin, that are porous and allow for the passing of gases through the shell. Carbon dioxide and moisture pass from

the inside out and oxygen and other gases pass from the outside in, much the same way your lungs work.

Immediately beneath the shell are two membranes like a "thin skin" called the **INNER and OUTER SHELL MEMBRANES**. The membranes help protect the contents of the eggs from outside bacteria or germs.

At the large end of the egg you will find the **AIR CELL**. This is formed from the rapid cooling of the egg after it has been laid and from evaporation of water from the egg during storage or incubation. As the embryo develops the air cell will serve a two-fold purpose:

- 1) it serves as a tiny shock absorber for the developing embryo,
- 2) on the 20th day the baby chick will poke its beak through the membrane and take its first breath.

While the embryo is growing, the shell membranes surround and contain the white or **ALBUMEN** of the egg. The albumen provides the liquid medium in which the embryo develops, but it also contains a large amount of protein necessary for proper development.

In a fresh egg, one can see two white cords attached to the yolk sac. These two cords, called **CHALAZAE**, are made of twisted strands of mucin fibers that are a special form of protein. The chalazae hold the yolk in the center of the egg.

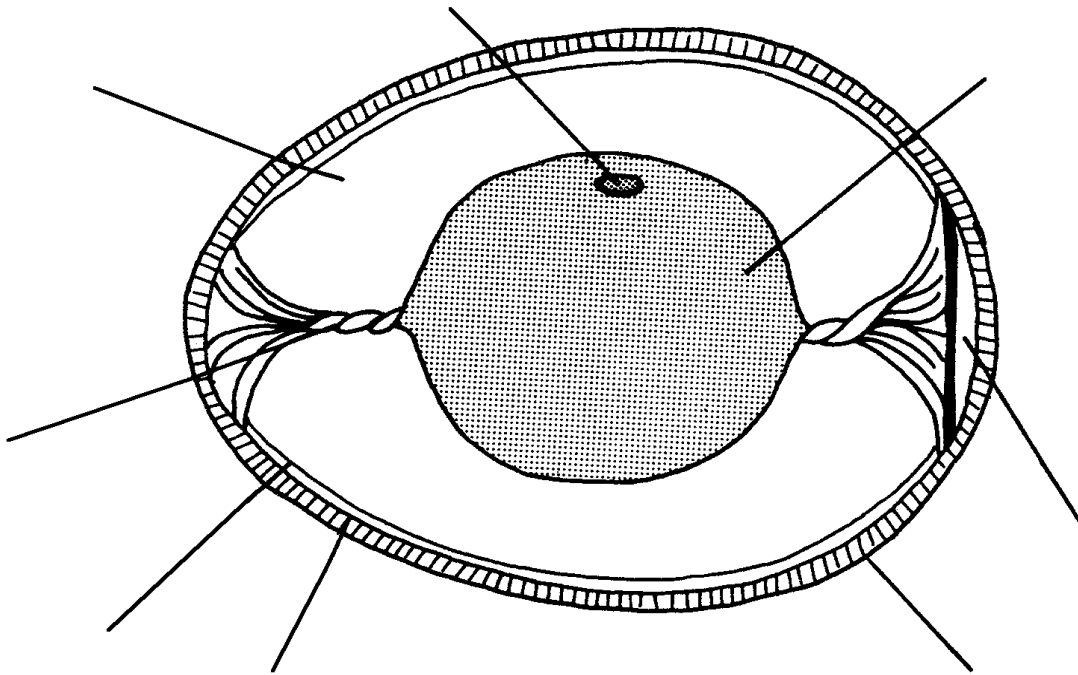
The **YOLK** contains fat, protein, minerals, vitamins and small amounts of carbohydrates. The egg white (albumen) is almost pure, high quality

protein. These substances combine with oxygen taken in through the pores of the shell, and provide an abundant source of nutrients for the embryo. By-products of this process are carbon dioxide and water. Water is used by the embryo to replace moisture lost through the pores of the shell. Calcium absorbed from the yolk and shell is used by the embryo to make its bony structure, or skeleton.

On the yolk you will find a white looking spot called the **GERMINAL DISC**. All yolks have it and it is the spot at which the baby chicks begin to grow.

**QUESTIONS TO HELP YOU REMEMBER**

- 1) What is the shell made of? \_\_\_\_\_
- 2) At what point on the yolk does the baby chick start? \_\_\_\_\_
- 3) What are the two functions of the shell membranes? \_\_\_\_\_
- 4) To what part of the human body can you compare the pores of an egg? \_\_\_\_\_
- 5) What are the two purposes of the air cell? \_\_\_\_\_
- 6) What is the chalazae and its function? \_\_\_\_\_
- 7) What part of the egg can be compared to the human lung? \_\_\_\_\_
- 8) How many days does it take for the chicken to hatch? \_\_\_\_\_
- 9) At which end the egg do you find the air cell, the large end or the small egg? \_\_\_\_\_
- 10) Identify the parts of the egg pictured below.



## SETTING THE EGGS AND THE INCUBATION PERIOD

### Before You Set

Before operation of your incubator you should thoroughly wash and disinfect it. If you continually use your incubator without proper cleaning and sanitation bacteria and fungi will build up causing a health hazard for the chicks. Any household disinfectant will work. Also, feed and farm supply stores carry disinfectants for incubators.

Now that you've prepared your incubator, you must stabilize its temperature. With temperature being your most critical element it is most important that your incubator is cycling in the correct temperature range before placing your eggs inside. To do this you need to place your incubator in a location where it can remain for the entire incubation period. Turn it on and watch the temperature. The incubator is equipped with a thermostat. The thermostat automatically controls the temperature inside the incubator. All you have to do is set the thermostat by adjusting the special screw. This screw turns the heat on and off manually. By slowly adjusting the heat manually you can set the temperature inside the incubator. You should begin the stabilizing process the day before you are to set the eggs. This gives plenty of time to "fine tune" your heat range.

**Important:** You will notice that after you place the eggs in the incubator the temperature will drop and seem to take a long time to return to the proper temperature. This is because the eggs are cooler than the temperature in the incubator and must heat up before the temperature returns to the pre-set temperature.

**Do not adjust** the temperature right after placing the eggs in the incubator. Give the incubator plenty of time to return to the pre-set temperature. If for some reason it does not return to the preset temperature in 8 to 10 hours, you can re-adjust the screw to increase the heat. **But**, do it a little at a time so as not to over heat and kill the developing embryos.

### Placing the Eggs

Clean eggs should be placed horizontally in a single layer on the metal platform in the incubator. It is very important that the eggs are turned at least three times a day. This prevents the embryos from sticking to the shell membrane thus causing their death. During the last three days the eggs should not be turned, moved or disturbed. The developing embryos have assumed the hatching position in the eggs. By not opening the incubator the last few days, you also help to maintain the needed high humidity. It will help you to know which eggs have been turned, if you will place a pencil mark on one side of the egg. This mark will either be facing up or facing down on the metal platform.

Put a small pan of water in the incubator at the time the eggs are placed. This prevents the eggs from drying out too quickly and should be checked, to be sure there is water, throughout the incubation period.

### Candling Incubated Eggs for Fertility and Mortality

Remember not all eggs are fertile. Fertile eggs are obtained only when roosters are kept with the laying hens. Eggs you buy from the grocery store are usually infertile eggs since these eggs are laid by hens on farms with no roosters (males).

Incubated eggs are candled to determine whether they are fertile and to check on the growth and development of the embryo. Candling is the process of looking inside of the egg without cracking it to see if the chick has begun to develop. Fertility is more easily determined in white shelled eggs, which may be candled on the third or fourth day of incubation. Brown shelled eggs should be checked on the fifth or sixth day of incubation.

When candling fertile eggs on the fourth or fifth day of incubation, the embryo appears as a small reddish area with blood vessels extending out into the egg. At this stage the embryo gives the appearance of a large red spider.

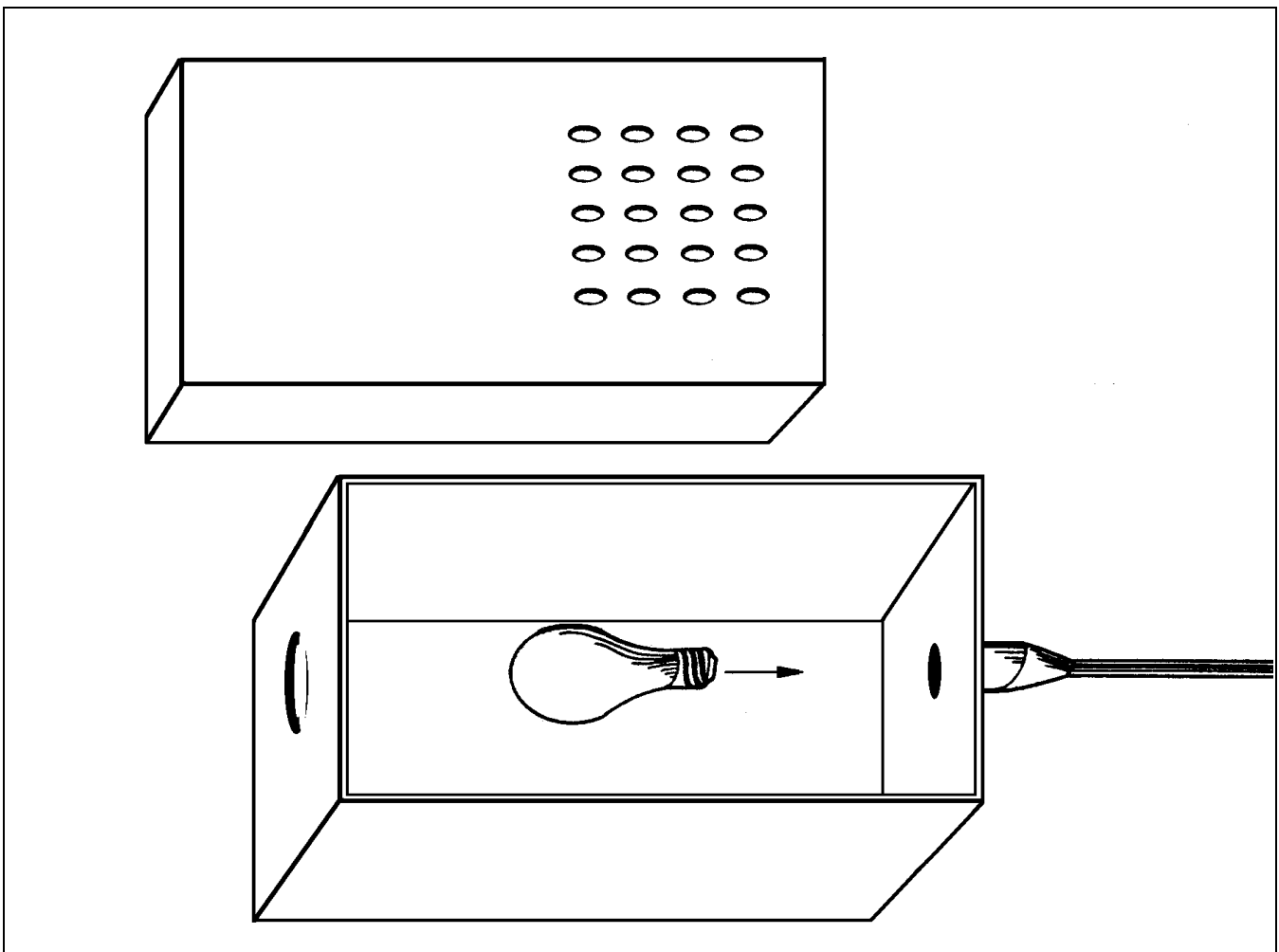
Infertile eggs will appear clear with no embryonic development. In some eggs the embryo will die after a few days of development. In such cases the blood will accumulate at the outer ends of the blood vessels and will form a blood ring or streak. After a few days this will turn black as the egg starts to decompose. If these eggs contain bacterial contamination they may explode, therefore, they should be removed.

When checking embryo development the large end of the egg should be placed to the opening of the candler since the embryo will be found near the air cell. Care should be taken not to twist or twirl the egg since this can damage the embryonic membranes. The candling of eggs should be done in a darkened room.

Egg candlers may be purchased from poultry equipment dealers or they may be made. A satisfactory candler may be made by placing a 60 watt light bulb in a small box with an opening cut in the side. This opening should be 1" to 1 1/4" in diameter with the light bulb centered directly on the hole. A shoe box lined with aluminum foil and with small holes cut in the top (to let heat escape) may be used.

### CRITICAL AND EXCITING TIMES

Once the fertile egg is placed in the incubator, cell division occurs very fast. During the first four days of development, many key organs begin to function. If all systems (temperature and humidity) in the incubator and in the embryo are not coordinated, increased embryonic death and crippling deformities will result.



**Figure 3.** The egg candler.



**QUESTIONS TO HELP YOU REMEMBER**

1) All eggs are fertile and will develop into a chick when placed in an incubator. TRUE or FALSE

\_\_\_\_\_

2) Why must chicken eggs be turned during incubation? \_\_\_\_\_

3) How should eggs be placed in the incubator? \_\_\_\_\_

4) Why should eggs containing dead embryos be removed as they are observed? \_\_\_\_\_

5) What is the candling of eggs? \_\_\_\_\_

6) What are the most critical days of incubation? \_\_\_\_\_

7) What does the thermostat do on the incubator? \_\_\_\_\_

8) What is the function of a small pan of water in the incubator? \_\_\_\_\_

9) Why does the temperature go down when the eggs are first put into the incubator? \_\_\_\_\_

\_\_\_\_\_

## THINGS TO DO

During the course of this activity you should do the following:

- 1) Record the temperature of the incubator each time the eggs are turned. (See page 11.)
- 2) Record the number of infertile eggs, embryos that die and number of eggs broken open for observation.
- 3) Remove infertile eggs and dead embryos as soon as they are observed. This may be done with a candling light in a dark room. Dead embryos give off poisonous gases that could affect the other developing embryos.
- 4) Try to break open fertile eggs on the 7th and 14th days and preserve the embryos in a jar. Record the following observations on page 12.
  - a) On the 7th day
    - is the chick fully developed
    - what was the most developed part of the chick
    - does the embryo appear transparent
  - b) On the 14th day
    - is the chick fully developed
    - what is the yellow sac attached to the embryo
    - is yolk sac shrinking, if so, why.
- 5) Candle the eggs on the 4th, 6th, 10th, and 16th days. Also record the following observations on page 12.
  - a) On the 4th day
    - what does the embryo look like
    - draw a picture of the embryo
    - can you see the heart beat
  - b) On the 6th day
    - what are the red lines you see
    - can you see it move
    - is the air cell bigger than on the 4th day
  - c) On the 10th day
    - can you see the chick move
    - does it look darker in the egg than on the 6th day
    - is the air cell bigger than on the 6th day, if so why
  - d) On the 16th day
    - is the chick bigger than on the 10th day
    - does it look darker in the egg than on the 10th day
    - can you see it move
    - can you identify any chick parts?

**Table 1.** Incubator record.

| Day | Time Turn I | Temp. | Time Turn II | Temp. | Time Turn III | Temp. | Notes |
|-----|-------------|-------|--------------|-------|---------------|-------|-------|
| 1.  |             |       |              |       |               |       |       |
| 2.  |             |       |              |       |               |       |       |
| 3.  |             |       |              |       |               |       |       |
| 4.  |             |       |              |       |               |       |       |
| 5.  |             |       |              |       |               |       |       |
| 6.  |             |       |              |       |               |       |       |
| 7.  |             |       |              |       |               |       |       |
| 8.  |             |       |              |       |               |       |       |
| 9.  |             |       |              |       |               |       |       |
| 10. |             |       |              |       |               |       |       |
| 11. |             |       |              |       |               |       |       |
| 12. |             |       |              |       |               |       |       |
| 13. |             |       |              |       |               |       |       |
| 14. |             |       |              |       |               |       |       |
| 15. |             |       |              |       |               |       |       |
| 16. |             |       |              |       |               |       |       |
| 17. |             |       |              |       |               |       |       |
| 18. |             |       |              |       |               |       |       |

**Do not turn the eggs after the 18th day.**





## PROJECT SUMMARY

Source of eggs \_\_\_\_\_

Date Eggs Set \_\_\_\_\_

Type Eggs Used \_\_\_\_\_

Number of Eggs Set \_\_\_\_\_

Number Eggs Fertile \_\_\_\_\_

Number Dead Embryos \_\_\_\_\_

Number Abnormal Chicks Hatched \_\_\_\_\_

Type Abnormalities Observed \_\_\_\_\_

Number Normal Chicks Hatched \_\_\_\_\_

Date Hatched \_\_\_\_\_

## PROJECT RECORD SCORE

|                     | <b>Possible</b> | <b>Member</b> |
|---------------------|-----------------|---------------|
| Questions           | 10              | _____         |
| Incubator Record    | 10              | _____         |
| Story               | 30              | _____         |
| Observations        | 25              | _____         |
| Project Summary     | 5               | _____         |
| Interest in Project | 10              | _____         |
| Neatness            | 10              | _____         |
| <b>TOTAL</b>        | <b>100</b>      |               |

## " WORD SEARCH"

Circle the word in the puzzle and cross out the word on the list below. (Words may be backwards, vertical, horizontal or diagonal.)

```

O T E M P E R A T U R E
B I I E L I T R E F D C
S S N Y T I D I M U H A
E T A G E S T A T I O N
R A I F Z A L A H C R D
V B R C L U Z C K X I L
A I C A L C I U M Y Z I
T L E D E Z Y N T Y O N
I I L E H C O I G R N G
O Z L F S Y L O O O T C
N I G I R A L N P T A A
S N D B T O M L Q A L L
S G M R Y K L R K B S B
H E O R I N K E R U T U
E M B R Y O N I C C U M
J M C H A L A Z A N V E
E V E N T I L A T I O N

```

### WORD LIST:

embryology  
ventilation  
temperature  
air  
stabilizing

incubator  
fertile  
yolk  
cell  
embryo

observation  
embryonic  
albumen  
horizontal  
candling

humidity  
mortality  
shell  
calcium

**"SCRAMBLED EGGS"**

Unscramble the words on the unit Embryology, use the list below to help solve the puzzle.

1) ormtytial \_\_\_\_\_

2) leshl \_\_\_\_\_

3) okly \_\_\_\_\_

4) bake \_\_\_\_\_

5) acuiclm \_\_\_\_\_

6) pteemraur \_\_\_\_\_

7) meylrgbooy \_\_\_\_\_

8) bumaenl \_\_\_\_\_

9) rehat \_\_\_\_\_

10) yeombr \_\_\_\_\_

11) iar elcl \_\_\_\_\_

12) cenchik \_\_\_\_\_

13) aaaelchz \_\_\_\_\_

14) nnier brmeenma \_\_\_\_\_

15) iihumdy \_\_\_\_\_

16) andcginl \_\_\_\_\_

17) ationvobser \_\_\_\_\_

18) eralgmin iscd \_\_\_\_\_

19) iiattnveol \_\_\_\_\_

20) eeftilr \_\_\_\_\_

21) batincoru \_\_\_\_\_

22) mnebricyo \_\_\_\_\_

23) ttterahmos \_\_\_\_\_

24) oorizhtaln \_\_\_\_\_

25) touer brmmeen \_\_\_\_\_

**WORDS:**

embryology  
 observation  
 fertile  
 outer/inner membrane

germinal disc  
 temperature  
 embryonic  
 air cell

thermostat  
 humidity  
 mortality  
 shell

incubator  
 ventilation  
 yolk  
 chalazae

chicken  
 beak  
 heart  
 candling

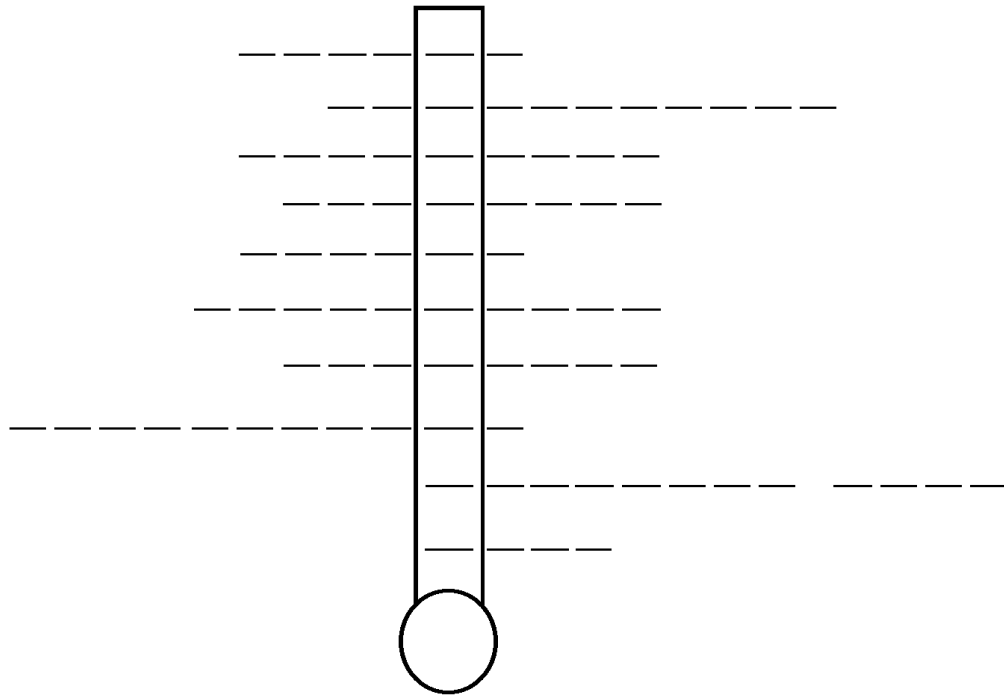
albumen  
 calcium  
 embryo  
 horizontal



### " ARRANGE-A-LETTER"

Place the words from the list on the lines, one letter per space. When done correctly the word in the block area in the center will be common to all.

#### WORD LIST



embryology  
incubator  
temperature  
yolk  
albumen

embryo

chalazae  
thermostat  
horizontal  
ventilation  
germinal disk

### FILL-IN THE "WORDS"

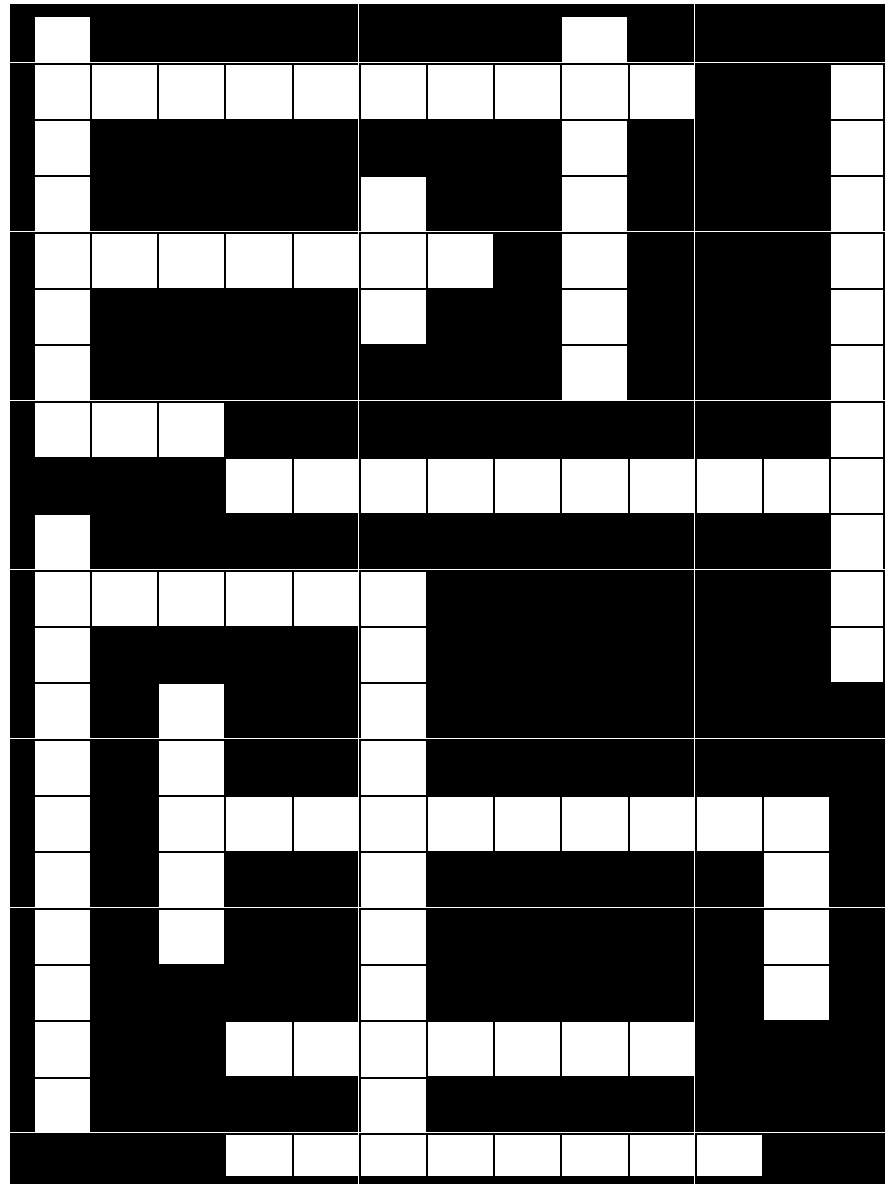
Use the list below to solve this puzzle. The answers will be read from left to right and from top to bottom. Use each word just once.

**Across**

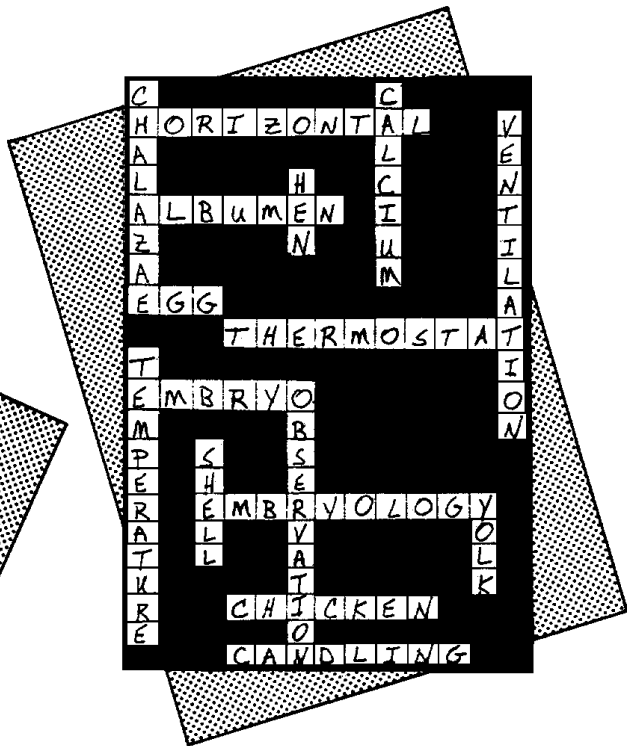
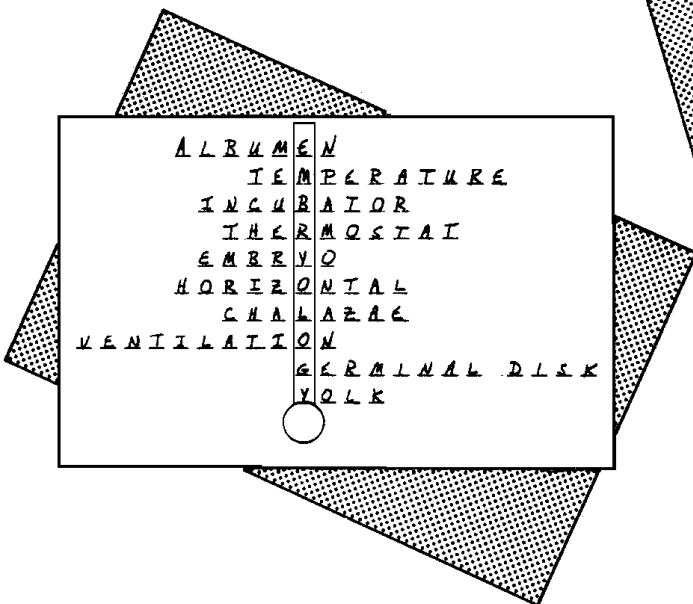
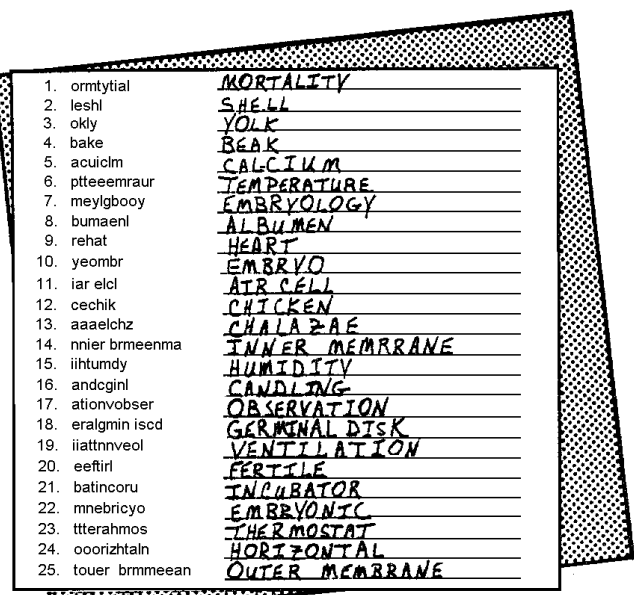
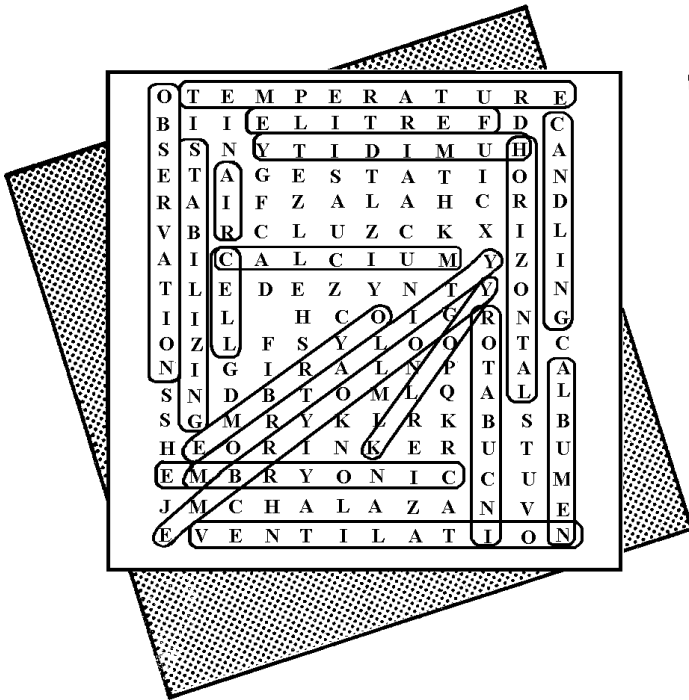
- candling
- horizontal
- embryology
- chicken
- albumen
- thermostat
- embryo
- egg

**Down**

- observation
- chalazae
- temperature
- shell
- hen
- calcium
- ventilation
- yolk



ANSWERS



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Mrs. Linda Alexander, Howard Bishop Middle School, Marion County, FL, for development of word games used in this publication.

## 4-H Club Pledge

I pledge:

- my head to clearer thinking,
- my heart to greater loyalty,
- my hands to larger service, and
- my health to better living,

for my club, my community, my country, and my world.



## 4-H Club Motto

"To Make the Best Better"

## 4-H Colors

Green and White

Name \_\_\_\_\_

Age \_\_\_\_\_

Address \_\_\_\_\_ City \_\_\_\_\_ State \_\_\_\_\_ Zip code \_\_\_\_\_

Name of Club \_\_\_\_\_

Leader's Name \_\_\_\_\_

Name of Project \_\_\_\_\_

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2. Robert L. Renner, Extension Agent III (4-H), Marion County; Michael D. Ouart, Extension Poultryman, Poultry Science Department; Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, 32611.



**UNIVERSITY OF  
FLORIDA**

Cooperative Extension Service  
Institute of Food and Agricultural Sciences

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