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, and (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 Service Office.

1. Ventilation holes
2. Glass
3. Platform
4. Thermometer
5. Water dish
6. Micro-switch assembly (regulates temperature)
7. Heating cable
Operating Your Incubator

Location - The incubator should be placed so that it is free from drafts and direct sunlight. 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 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 for hatching chicken eggs in a still air or gravity ventilated incubator is 102° to 103 degrees Fahrenheit at a position level with the top of the eggs. The acceptable range for good embryonic development is 97° to 103°F. Short periods of time below 97° 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 108°F will kill the embryos.

Humidity - You should keep water in the pan at all times to maintain humidity in the incubator. Humidity is maintained by water evaporating from the pan. You adjust the level of humidity by opening or closing the ventilation holes. Some of the holes should be closed if water is not evaporating from the pan or opened if moisture is collecting on the glass. During the last three days 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 the chick from hatching.

Ventilation - Ventilation is very important to the developing embryo. This 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 second 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? _________________
LIFE IS A MARVELOUS THING

Life begins from the single cell. Under proper conditions this cell divides first in 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 the chicken it is 21 days, for turkeys 28 days, and for ducks 28 days. 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.

Parts of the Egg -

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. 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 and, (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 carbohydrates, fat, protein, minerals and vitamins. 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 function of the egg can be compared to the human lung?  

8. How many days does it take for a chicken egg to hatch?
9. At which end of the egg do you find the air cell, the large end or the small end?

10. Identify the parts of the egg pictured below.
SETTING THE EGGS AND THE INCUBATION PERIOD

Before You Set - Before you place the eggs in your incubator you must stabilize the 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 egg 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 pre-set 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 overheat and kill the developing embryos.

Placing the Eggs - 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 embryo from sticking to the shell membrane thus causing their death. Eggs should not be turned the first day or the last three days. During the last three days the eggs should not be 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 rooster (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 in 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 and 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.

HIGHLIGHTS IN LIFE OF CHICK EMBRYO

Once the fertile egg is placed in the incubator, cell division occurs very fast. After 24 hours has passed the heart has begun to form and after 42 hours the heart begins to beat. The 3rd and 4th days are most critical in an embryo's life because many of the major body systems begin to function. If all systems in the incubator and in the egg are not right, the chick will die.

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. How many hours after incubation has started does the heart begin to beat?
7. What are the most critical days of incubation? ______________________

8. What does the thermostat do on the incubator? ______________________

9. What is the function of a small pan of water in the incubator? ______

10. 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.

2. Record the number of infertile eggs, embryos that died 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, 14th, and 18th days and preserve the embryos in a jar. Record the following observations on page 10.

   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?

   C. On the 18th day - does the chick have feathers
      - does the chick look real
      - is the beak and feet developed

5. Candle the eggs on the 4th, 6th, 10th, and 15th days. Record the following observations also.

   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 looking lines you see
      - can you see it move
      - is the air cell bigger

   C. On the 10th day - can you see the chick move
      - does it look darker in the egg
      - is the air cell bigger, if so why?

   D. On the 16th day - is the chick bigger
      - does it look darker in the egg
      - can you see it move
      - can you identify any chick parts
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OBSERVATIONS FROM DISSECTING AND CANDLING

Take notes on the various things you saw and learned as a result of this project.
PROJECT STORY

Write an interesting story of your experiences with the 4-H Embryology Project.
PROJECT SUMMARY

Source of eggs ____________________________________________

Date Eggs Set ____________________________________________

Type Eggs Used __________________________________________

Number Eggs Set _________________________________________

Number Eggs Fertile ______________________________________

Number Dead Embryos _____________________________________

Number Abnormal Chicks Hatched _____________________________

Type Abnormalities Observed _______________________________

Number Normal Chicks Hatched ______________________________

Date Hatched ____________________________________________

PROJECT RECORD SCORE

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| Incubator Record | 10       | _______
| Story          | 30       | _______
| Observations   | 25       | _______
| Project Summary| 5        | _______
| Interest in Project | 10     | _______
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