

HELPFUL HINTS FOR TEACHERS ON INCUBATION AND EMBRYOLOGY OF THE CHICK

Joseph E. Shrack and Michael J. Darre, Ph.D., P.A.S.
Cooperative Extension System
University of Connecticut

Hatching eggs can be exciting, and a great tool for learning. Watching an egg turn into a baby chick is fascinating. The incubation process is relatively simple, though it may not seem so at first, once you learn the procedures and techniques involved.

GETTING STARTED

Before obtaining any eggs and even thinking about starting the incubation process, you need to become acquainted with the incubator that will be used in the project.

- A. Choose a location for the incubator that is free from drafts and out of direct sunlight.
- B. Sanitation is very important, before setting any eggs clean the incubator. Household cleaners such as a solution of chlorox bleach and water (20 drops per quart of water) or Lysol work very well for disinfecting the inside of the incubator.
- C. Become familiar with the style of incubator you will be using for the project. Plastic or styrofoam still air or fan ventilated incubators are described on page 17 of *Beginning of Life*, the leaders manual that is used with the project. No matter which style of incubator is used, it needs to be calibrated.

Calibration

- A. The wafer thermostat must be adjusted to maintain an average incubation temperature of 100-101°F dry bulb temperature, with an acceptable range from 97-103°F. See manual with incubator. There will be a regular cycle of temperature fluctuations, which is normal. You should try to maintain an average within the range mentioned above. This can be achieved by watching for the highest and lowest temperatures and adding them and dividing by two. If the temperature is too high or low, adjust the thermostat accordingly. Calibration usually takes several hours, and preferably overnight.
- B. The relative humidity within the incubator should be maintained between 60-65%, for the first 18 days of incubation, and 70% for the last 3 days. Relative humidity is calculated by using a wet bulb thermometer to measure the temperature within the incubator. A wet bulb temperature of 88°F and a dry bulb temperature of 101°F, converts to 60% relative humidity (See p.16 in *Beginning of Life* for tables used in calculating humidity in the incubator). If the humidity is too low (Low wet bulb temp) then the size of the evaporative surface must be increased. This can be done by either increasing the size of the pan or by placing a small sponge in the water so that at least half of its surface is still exposed to the air. If the humidity is too high (High wet bulb temp) then the size of the pan must be decreased.

Calibrating the incubator before setting eggs helps to avoid hatching problems brought on by an improper incubator environment. More information will be provided later on maintaining the optimum incubator environment.

Now that the incubator is cleaned, disinfected, and calibrated to proper running temperature and humidity, you are ready to begin incubating eggs.

Obtaining and caring for fertile hatching eggs is outlined on p.13 in *Beginning of Life*.

The starting day of the project should be on a Monday or a Tuesday, this will insure that hatching will take place on a day when the students will be present to observe.

Records will be necessary to keep track of the days of incubation, time eggs are turned, incubator temperature etc. This should be part of the students responsibility for the project. A large wall chart filled in each day will keep focus on the progress of the project.

INCUBATION

Now that the incubator has been calibrated and you are familiar with its operation, you are ready to set some eggs. There are five major points to keep in mind during incubation:

1. Temperature
2. Humidity
3. Ventilation
4. Turning
5. Cleanliness.

Each of these will be discussed in the following text.

SET-UP

- A. Before handling the eggs, one should wash their hands and anything the eggs will come into contact with, good sanitation is very important in obtaining a good hatch.
- B. Operate the incubator for several hours before setting the eggs. This will insure the temperature and humidity are stabilized and will start your eggs on the way to optimum growth. (See CALIBRATION)
- C. If they have been stored in a cool place, allow the eggs to come up to room temperature before setting. This will avoid heat shock and help maintain a constant incubator environment.
- D. Prepare the eggs for incubation by using a pencil and marking the date that the eggs are set on one side, then holding the pencil against the shell, rotate the egg half a turn drawing a line to the opposite side, on the opposite side from the date mark an X on the shell. By marking the egg in this way you will have a way to keep track of turning, and with the line between the two points you will be able to keep track of the direction the egg has been turned, you do not want to rotate the egg in a full circle. This will be important later as it is necessary to turn the eggs 3 to 5 X/day to insure the embryo remains close to the center in the shell and doesn't stick to the shell membranes. By turning the eggs an odd number of times each day, you will always end up with a different side up overnight.
- E. When setting the eggs in the incubator, lay them on their side and space them as evenly as possible allowing room for turning, however, it is alright for eggs to touch each other. Don't allow the eggs to touch the side of the incubator or get too close to the heating elements, that will cause uneven heating

and leads to a poor hatch.

TEMPERATURE

- A. Temperature is probably the most important factor to consider that influences the developing embryo.
- B. The optimum temperature in the still air incubator is 100-101°F, however, you should follow the suggested temperature listed by the manufacturer of your particular incubator. This temperature leads to the highest % hatch, a table showing this relationship is on p.15, of *Beginning of Life*.
- C. The thermometer should be 1 inch above the wire mesh screen the eggs are placed on. This corresponds to the approximate top of the eggs where the temperature should be measured.
- D. Abnormal temperatures:
 - 1. Too high a temperature:

Younger embryos are more susceptible due to the upper lethal limit being very close to the optimum incubating temperature. Operating the incubator at 105°F for 30 minutes will seriously effect, if not kill, the embryos. High temperature will lead to nervous problems, heart and circulatory problems, kidney problems and will cause the embryonic membranes to dry out too soon. Chicks that hatch may have clubbed, wiry down and an unsteady gait.
 - 2. Too low a temperature:

Slightly low temperatures for short periods of time will have a less severe effect on the embryo than does too high temperatures. At lower temperatures the embryo will lower its metabolism, and slow its growth until the temperature returns to normal. Low temperature for short periods leads to disproportionate growth, because organs and tissues respond differently to temperature variation, can cause heart and circulatory problems, reduces membrane growth and nutrient uptake by the embryo, can possibly cause liver dysfunction and causes poorer growth after hatching. Older embryos are more susceptible to lower temperatures. A chart outlining incubation problems and possible reasons is located on pp. 20-23 of *Beginning of Life*.

HUMIDITY

Humidity is important, because it keeps the egg from losing too much or too little moisture during the incubation process. Humidity should be balanced with temperature, because different temperatures require different relative humidities. A table outlining the relationship can be found on p.15 of *Beginning of Life*.

- A. Relative humidity should be 60-65% for the first 18 days of incubation, and 70% for the last three days.
- B. The humidity is supplied by a pan , or wells, in the bottom of the incubator. The rate of evaporation from the pan is related to the surface area of the water, if the humidity is found to be too high the surface area must be decreased, this can be achieved by using a smaller pan. If the humidity is found to be too low, the surface area must be increased, this can be achieved by using a sponge in the pan. The pan should be kept full at all times, use warm water for filling.
- C. Opening the incubator to turn the eggs is where a lot of humidity is lost. After turning the eggs sprinkle a little warm water over the eggs, or use a spray bottle and mist the air before closing the

incubator again.

- D. Candling the eggs to determine the water loss is beneficial as it gives another way to check the incubator set-up. On p.16 of *Beginning of Life*, there is an illustration showing the relative size of the air cell after 7, 14 and 18 days of incubation. If the air cell is too large the humidity must be increased, if it remains too low the chick will stick to the shell and membranes at hatching. If the air cell is too small the humidity must be decreased, if it remains too high it will weaken the chick to the point where it can't emerge from the shell at hatching. Building an overhead projector egg candler is outlined on p. 29 of *Beginning of Life*.
- E. From day 19 on, slight condensation on top of the incubator indicates adequate humidity is present. The amount of condensation will vary depending on the temperature of the room where the incubator is located.
- F. Do not open or move the incubator during the last 3 days of incubation for more time than it takes to add water to the pan. The humidity should be 70% at this point, and opening the incubator would lower the humidity. If 70% humidity is not maintained the membranes could dry out too soon and trap the chick inside the egg and not allow hatch. During this time the chick is moving into the hatching position, and if the incubator or the eggs are moved it could cause a malposition and the chick will not be able to hatch.

TURNING EGGS

As mentioned earlier, it is necessary to turn the eggs during incubation. This is when the closest observation of the eggs will take place, and it will be very helpful to keep good records of the time the eggs were turned and who did the turning. If you are going to candle the eggs, you can accomplish two things at the same time by candling at a time that you would normally be turning.

- A. Before touching the eggs in the incubator **WASH YOUR HANDS**. Incubators are a great environment for harmful bacteria and other germs to grow, by keeping your hands clean, it will help to insure the incubator environment doesn't become infected.
- B. Plan to turn the eggs a minimum of 3X/ day. The first thing in the morning and right before going home for the night are two good times, and at least two more spaced in between. Turning the eggs an odd number of times (5,7,9) each day is recommended.
- C. Marking the eggs as described in the "SET UP" section provides a good way to keep track of turning. All dates up before turning and all X's up after and vice versa.
- D. Turning keeps the embryo from floating and coming in contact with the shell, to which it may stick. Sticking to the shell may result in a poor hatch. Turning the egg, prevents premature adhesion of the embryonic membranes, facilitates movement of the embryo into the normal hatching position, (thereby reducing abnormalities and malpositions), stimulates the growth of the membranes and increases the heart rate. The increased heart rate and membranal growth facilitates increased absorption of the nutrients from the yolk and albumen and improves the oxygen-carbon dioxide exchange within the egg.
- E. Turning should be done from day 1 through day 17, after which the incubator should not be moved or opened as the chick is readying itself for the hatching process. The most important period is from day

1 through day 12, at which time the chorion and allantois are developing and eventually fuse forming the chorioallantois. During this time the most critical period is from day 3 through day 7 when the circulatory system is developing and beginning to function in supporting the embryo.

- F. Make an effort to turn the eggs at least once each day on the weekends, especially the first weekend of the project. It may be helpful to have a janitor, or someone else who might be in the building on the weekend, do the weekend turning for you.

VENTILATION

The still air incubator needs holes in the sides to provide air circulation within the incubator.

The embryo is living tissue, and as such needs to exchange oxygen and carbon dioxide throughout the growth process. Atmospheric air is best for ventilation since it contains 21% oxygen and produces optimum hatching results. It is critical to supply just enough fresh air without overworking your temperature control system.

PREPARING FOR THE HATCH

In preparing for the hatch it will be necessary to place 3 or 4 layers of cheesecloth or crinoline over the wire mesh on the bottom of the incubator, 4 days prior to hatch. This provides a smooth surface to help keep the chicks from injuring their navels or getting their legs caught in the mesh. This also helps keep the incubator clean and the shells out of the water pan.

INCORPORATING EMBRYOLOGY INTO YOUR CURRICULUM

Incubation and Embryology does not have to be just part of the science curriculum. The many aspects of the project lend itself to other parts of the learning experience, including language arts, math and social studies. Examples follow.

- A. **LANGUAGE ARTS** It is quite simple to have the students write a paragraph or short story about the project. They could write about their particular job, where the eggs came from, what the chicken provides to humankind, etc.
- B. **MATH** For the younger children, just counting the eggs each day is practice for them and maybe even counting how many times the egg has been turned since being placed into the incubator. For older children, doing calculations, such as days left till hatch, percent hatch, average temperatures, etc., will give them practical experience in the use of their math skills.
- C. **SOCIAL STUDIES** Students can learn about the behavior and social skills that chicks and chickens exhibit and why they do them. They may also discuss the value of the chicken to humans, such as diet, companions, clothing, bedding, etc. They may also discuss the value of other aspects of farming, along with poultry production, relative to providing for the food and fiber needs of humans, both in the U.S.A and in other countries, especially developing countries.
- D. **OTHER** Teachers are encouraged to use their imagination in developing ways that the project can be used in other parts of the curriculum, such as art, music, history, etc.

SOME PLACES TO PURCHASE FERTILE EGGS

University of Connecticut Poultry Farm
(860) 486-2039
Storrs, CT

Hardys Hatchery
62 Johnwise Avenue
Essex, MA 01929
Ph/Fx: 978-768-3447

Old Maple Farm
32 Pinewoods Road
N. Stonington, CT 06359
(860) 599-8296

Hoffman Hatchery
Gratz, PA 17030
717-365-3694

Burr Farm, Inc.
RFD 1, Box 99
Hampton, CT 06247
(860) 455-9964 / 774-2786

Morris Hatchery, Inc.
18370 S.W. 232 Street
Goulds, FL 33170
305-247-1070 www.morrisinc.com

Caprine Farm
Santo Vinci Jr.
191 Coles Road
Cromwell, CT 06416
860-759-2282/860-635-3189

Murray McMurray Hatchery
P.O.Box 458
191 Closz Drive
Webster City, IA 50595-0458
800-456-3280 www.mcmurrayhatchery.com

Strombergs
Box 400
Pine River, MN 56474-0400
218-587-2222

SOME BOOKS AND PUBLICATIONS ON POULTRY

Diseases of Poultry, Edited by Hofstad, Calnek, Helmboldt, Reid and Yoder. Iowa State University Press. ISMN 0-8138-0430-2

American Standard of Perfection, The American Poultry Association, Inc. Estacada, Oregon. Contact Nona Shearer, Secretary Treasurer, 26363 S. Tucker Rd. Estacada, OR 97023 507-630-6759.

Poultry Press. P.O. Box 542, Connersville, IN 47331. 317-827-0932. A monthly newspaper about poultry shows and advertising for the poultry fancier.

A guide to raising chickens. Gail Damerow. Storey Communications, Inc. Schoolhouse Road, Pownal, Vermont 05261. ISBN 0-88266-897-8

Story=s Guide to Raising Poultry. Leonard S. Mercia and Michael J. Darre. Storey Communications, Inc. Schoolhouse Road, Pownal, Vermont 05261. ISBN 1-58017-263-6

DEVELOPMENT OF THE CHICKEN EMBRYO

DAY	STAGE OF DEVELOPMENT
1	Blastoderm appears as donut-shaped ring; Area pellucida and area opaca. Infertile germinal disc appears as an undefined mass. 18 hrs - appearance of alimentary tract, 19 hrs beginning of brain crease, 20 hrs- appearance of vertebral column, 21 hrs - beginning of formation of brain and nervous system. 22 hrs - beginning of formation of head, 23 hrs - appearance of blood islands. 24 hrs - beginning of formation of eyes.
2	Appearance of blood islets; Formation of head process, Blood vessels in yolk sac. 25 hrs - beginning of formation of veins and heart, 30 hrs - second, third and fourth vessicles of brain clearly defined, as is 2 chamber heart, starts beating. 35 hrs - ear pits form, 36 hrs - first sign of amnion, 46 hrs - first signs of throat. 48 - 52 hrs - partly to fully turned on left side , 50-55 hrs - Optic cup completely formed.
3	Vascular system well developed. Left side of embryo on yolk; Nose, wings and allantois forms. Amnion surrounds embryo. leg and wing buds begin as swellings of approximately equal size (52-64 hrs).
4	Increase in size of brain and heart. limb buds approximately as long as they are wide (legs longer); 4 1/2 days - limb buds longer than wide. Allantois breaks through amnion.
5	Distinct eye development; elbow and knee joints and demarcation of three toes distance; Proventriculus and gizzard formed. Formation of reproductive organs, sex division. 5.5 - 6 days - ear opening very distinct.
6	Beak being formed; 6-6.5 days - wing bent in elbow joint, no egg tooth yet. Voluntary movement begins.
7	Egg tooth visible, eyes increasing in size , indications of digits in legs and wings, abdomen more prominent due to visceral development. 6.5 - 7 days, leg bent at knee, feather germs along spine and legs visible. 7.5 days - gap narrow between upper and lower beak, distinct feather papillae on thigh.
8	Feet and wings well developed, down formations starts, 7.5 days - nictitating membrane starting to cover eye.
9	Feather follicles on all tracts, large egg tooth, eyelids extend toward beak and start to overgrow eyeball, mouth opening appears
10	Beak starts to harden, digits separated, claws just visible, flight feathers conspicuous. Comb appears a prominent ridge.
11	Claws flattened, curved; comb more prominent and serrated. foot pads conspicuous and smooth. proportions of head and body changing.
12	Down feathers on body and over eyes; eyelids cover 2/3 to 3/4 of cornea. covert feather germs become conical.
13	Appearance of scales and claws. beak hardened up to egg tooth, ear opening nearly covered with

- feathers; eyelid opening reduced to thin crescent. appearance of wattles and prominent comb.
- 14 Embryo turns toward blunt end of egg.
 - 12-16 Embryo rotates parallel to long axis of egg with head normally toward large end.
 - 15 Small intestines taken into body, increase in size and feathering.
 - 16 Scales and claws and beak becoming hard, fully covered with down; albumen nearly gone and yolk increasingly important as nutrient.
 - 17 Normal hatching position (head under right wing, pointed toward air cell) ; decrease in amniotic fluid.
 - 18 Albumen gone, yolk retraction starts; translucent outer covering of beak peeling away at base.
 - 19 Absorption of allantoic fluid completed, yolk sac about half enclosed by body.
 - 20 Yolk sac completely drawn into body cavity and umbilicus closing over; inner shell membrane pierced, pipping begins, embryo breaks into air cell and breathing begins; allantois ceases to function and starts to dry up.
 - 21 Hatch, usually takes 10-20 hours.