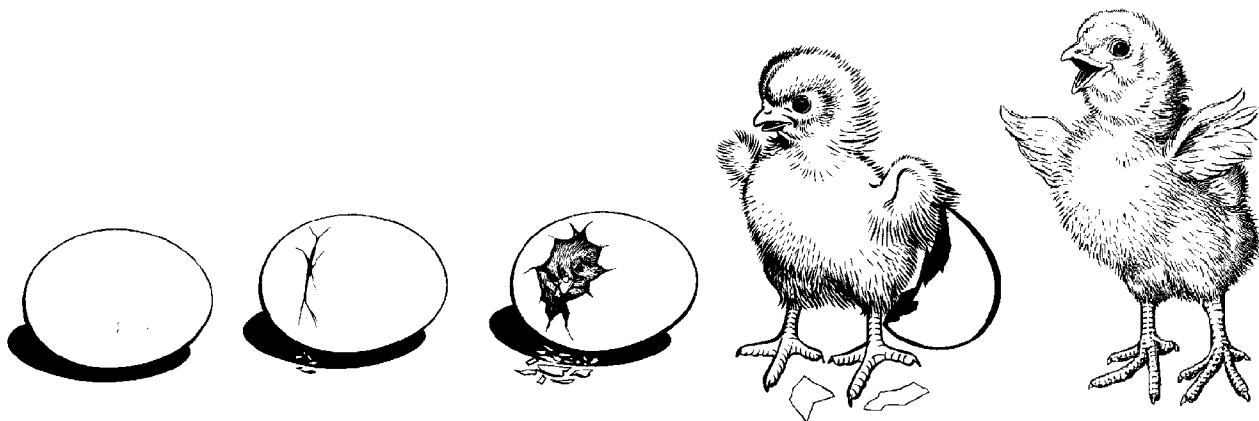




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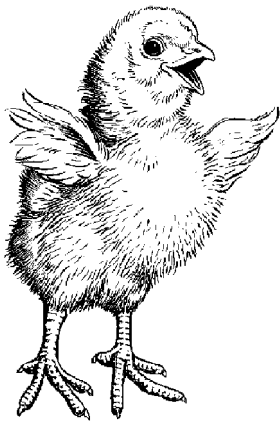
The Egg and Embryo Life Science Series

Hatching Eggs in the Classroom: A Teacher's Guide



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Hatching Eggs in the Classroom: A Teacher's Guide

Many teachers apply the adage, "Tell me and I'll forget; show me and I'll remember; involve me and I'll understand." Teachers include the life sciences in their curricula, but available science projects that involve and excite students are scarce. Hatching chicken eggs, examining embryos, and observing a beating heart offer the involvement and excitement necessary for a good classroom project.

A wide variety of egg and embryo projects can be developed to teach basic scientific principles and techniques to students from kindergarten to grade twelve. An experiment with chick embryos can lay the foundation for understanding subjects as diverse as nutrition and the circulatory system, or it can teach measurement and the collection and analysis of data. These projects expand biological literacy, introduce complex concepts, and develop an intuitive appreciation for life and life science. These experiences are too rare, especially for students in a modern urban environment.

This technical manual supports the efforts of classroom teachers. The manual contains complete information for successfully incubating and hatching chicken eggs in a classroom setting. The manual details the entire process, from ordering the fertile eggs to the time the chicks are 1 day old, and includes a glossary of essential terms. A resource list of helpful publications, visual aids, and sources of information appears at the end of the manual.

The author encourages communication from users of the publications in the Egg and Embryo Life Science Series. The Series includes a slide set with an accompanying text, "Chicken Embryo Development." Soon, other texts and computer software support will be distributed to teachers through Texas Extension Service professionals. Laboratory training sessions are available for groups of interested teachers.

Work by F.-Y. Kuo formed the initial basis for this manual. Please convey comments and inquiries to your county Extension agent or contact the author directly. The author's address and telephone number are included at the end of the publication.

Obtaining Fertile Eggs

A successful project requires fresh, clean, fertile eggs. Eggs purchased in food stores are **not** fertile. Eggs can be obtained from many sources, but some sources do not supply high-quality eggs. Poor-quality eggs yield only disappointment and frustration for students and teachers. Commercial hatcheries ensure good fertility, but some will not ship small quantities of eggs.

The Poultry Science Department at Texas A&M University is a dependable source of small quantities of fertile eggs at a reasonable cost. One dozen fertile chicken eggs costs \$3.00, plus \$1.00 for packaging, plus shipping charges. Shipping charges usually range from \$5 to \$10 for an average order. Costs vary according to the number of eggs you order and your distance from the shipping point. The eggs are shipped by bus and usually arrive either the day of or the day after shipment.

You can order eggs from Texas A&M by writing to this address:

Poultry Science Teaching, Research,
and Extension Center
Texas A&M University
College Station, Texas 77843-2472.

Or you can order by telephone by calling (409)845-4367. Whether you write or call, be sure to say that you want to buy fertile chicken eggs for a school embryo project. Indicate the number of eggs you want to buy, your shipping address, your billing address, and the date by which you need to receive the eggs. You will be billed at the end of the month.

Storing Fertile Eggs

Fertile eggs are alive. Each time a fertile egg is handled improperly, its chance of hatching is reduced. Before they are placed in the incubator, fertile eggs must be handled as described in this section. You must follow all steps and instructions precisely to avoid the disappointment of an unsuccessful or unhealthy hatch.

General Care

Remember that each egg contains a living cell mass that develops into an embryo and finally into a chick. Be very careful to prevent damage to the eggshell. An egg with a cracked shell will not hatch and should be discarded to prevent contamination of other eggs. Also discard extremely dirty eggs. If a small area of an egg is soiled with dirt or fecal material, clean the egg by gently rubbing the soiled surface with fine sandpaper. Examine the egg carefully to make sure that what appears to be dirt is not a stain. **Never wash an egg with water.**

Storage Time

A good rule of thumb is to set the eggs in the incubator as soon as possible. Eggs that are set less than 7 to 10 days after they were laid yield the best hatchability results. But remember that chicken eggs hatch about 21 days after they are set in the incubator. For a classroom project, set chicken eggs on a Tuesday or Wednesday. This way, the chicks will be more likely to hatch during the week when school is in session. If a hatch progresses more quickly or more slowly than planned, your students still experience the fun and excitement of watching eggs hatch. Incubation times for species other than the chicken are included later in this publication.

Temperature and Humidity

Fertile eggs should be stored at temperatures between 55° and 65° F. Embryos will begin to develop abnormally and weaken if the temperature is too high. If the temperature is too low, embryos will die. In either case, hatchability decreases.

Relative humidity in the storage room should be approximately 75 percent. When eggs are exposed to excessive humidity, condensation forms on the eggshells. Condensation clogs the pores in the eggshell, suffocating or contaminating the embryo. If the humidity is too low, the shell membrane becomes dry, which also causes embryo death.

Position of Eggs

If the eggs will be stored for less than 10 days, place the eggs on egg flats or in egg cartons with the large end **up**. Eggs should be stored with the large end **down** when they are held for more than 10 days.

Turning Eggs

If the eggs will be incubated within 1 week from the time they are laid, there is no need to turn the eggs during storage. Eggs held for longer than 1 week should be rotated from side to side over a 90-degree angle once a day.

To turn eggs during the holding period, place a 6-inch block under one end of the carton (or flat) holding the eggs. The next day, remove the block and place it under the opposite end of the carton.

Storage Reminders

Remember these important points when storing fertile eggs.

- Temperature: 55° to 65° F
- Relative humidity: 75 percent
- Turn the eggs if they are stored longer than a week.
- Set the eggs on Tuesday or Wednesday.
- Handle the eggs with care!

Incubating Eggs

Before Incubation

Prepare and adjust the incubator for 2 or 3 days **before** setting the eggs. During this time, you can adjust the temperature and humidity without affecting the eggs. Adjustments made

while the eggs are set will either lengthen or shorten the time of hatch or kill the embryos. If the incubator has an automatic turner, make sure it is functioning properly. Select a location for the incubator that is protected from drafts and direct sunlight. Seek environmental stability for the 3-week duration of the project. **Do not set the eggs until the temperature and humidity are correct and stable.**

The Day the Eggs Are Set

If the eggs have been stored in a refrigerator, allow them to warm to room temperature for 2 to 4 hours before setting them in the incubator. Set the eggs on Tuesday or Wednesday if possible. Immediately before placing the eggs in the incubator, use a pencil to lightly mark an “X” on one side and an “O” on the opposite side of each egg. These marks help verify that the eggs are being turned in the incubator. If the incubator has an automatic turner that is working properly, marking the eggs is not necessary.

Once the eggs are in the incubator, **do not** adjust the temperature or humidity for a few hours unless the temperature exceeds 102° F. After 4 hours, you may make the proper adjustments. The final temperature should vary only 0.5° above or below 99.5° F. The temperature of an incubator without a circulating fan fluctuates more than that of an incubator with a fan. As long as the temperature does not exceed 102° F, the hatch should not be harmed.

The large end of the egg should be **higher** than the small end of the egg when it is set in the incubator. An embryo orients during incubation so that the head develops toward the large end of the egg, where the air cell is located. If the small end of the egg is higher than the large end, the chick’s head can orient away from the air cell. An embryo oriented in the wrong direction will not hatch.

Set Stage

The “set stage” refers to the first 19 days of incubation in chickens. Chicken eggs hatch in 21 days. Incubating different species in the same incubator at the same time is not recommended, because other species hatch at different times

(See the table on page 6 for incubation periods of other species.).

Birds in the wild frequently turn their eggs in the nest. Turning eggs during incubation prevents embryo death and unhealthy hatches. Hand-turning eggs interests students and builds anticipation. Eggs must be turned at least three times every day; five times is even better. This turning schedule must be maintained even over the weekend. For this reason, an automatic turner is recommended, since many school districts restrict access to classrooms on weekends. If your incubator is equipped with an automatic turner, the eggs will be turned every hour.

To turn eggs by hand, rotate the egg 180 degrees so that the X and the O alternately face up at each turn. Emphasize that students should wash their hands before touching the eggs. Eggs can become contaminated with germs during incubation, and dirt and oils can block the pores of the egg. Remember that the large end of the egg should always be higher than the small end. Also, remember to quickly replace the incubator lid so that the temperature inside will remain constant.

Ventilation, Temperature, and Humidity of the Incubator

The chick embryo uses oxygen and gives off carbon dioxide. The impact of this gas exchange is small during the early period of incubation or when a small number of eggs are incubated. However, follow the recommendations of the incubator manufacturer to ensure that adequate oxygen is available to the developing chicks.

The temperature in the incubator should be 99.5° F. If the temperature fluctuates more than 0.5° from 99.5°, a poor hatch is likely. Check the temperature at least twice a day.

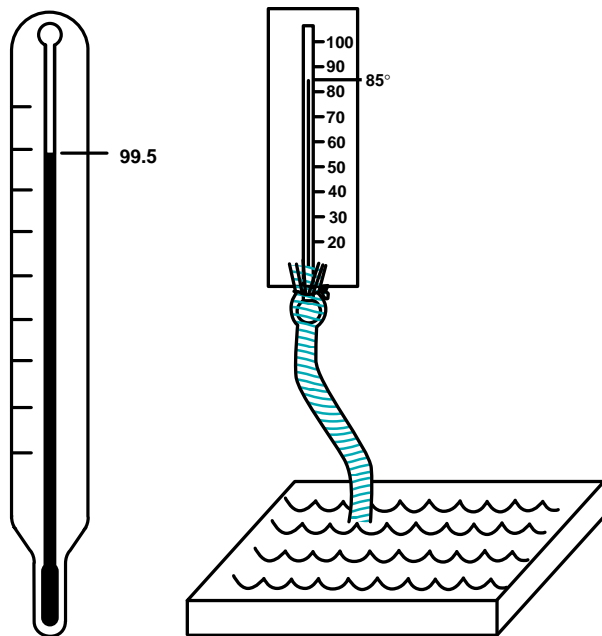
Relative humidity should be set at 86° F wet-bulb temperature. Humidity should not fluctuate more than 1 or 2 wet-bulb degrees.

Relative humidity, which measures the amount of moisture in the air, is extremely important in the process of egg incubation. To maintain humidity, every incubator must have a source of moisture. The easiest way to provide this moisture is to put a shallow pan of water in

the bottom of the incubator. Add water to the water pan (or trough) every day to ensure proper maintenance of humidity.

It is easy to make an instrument to measure the humidity inside the incubator. To do this, you need a normal thermometer, a 6-inch piece of shoelace, and a short piece of dental floss. First, slip the bulb end of the thermometer about 1 inch into the open end of the shoelace. Next, tie the dental floss around both the shoelace and the thermometer directly above the bulb. This will keep the shoelace from sliding off. Then place the opposite end of the shoelace directly in the pan of water. The reading on the thermometer will now be your **wet-bulb** temperature (see figure). The temperature reading of the wet bulb will be less than that of a dry thermometer because of evaporation. The wet-bulb reading is used as an index of relative humidity.

To increase the humidity, add a second pan of water. To decrease the humidity, use a smaller pan. If the incubator temperature is correct, the only factor governing humidity is the surface area of water inside the incubator.



A wet-bulb thermometer is easily made using a dry thermometer. The wet bulb registers a lower temperature than the dry bulb because evaporation cools the thermometer. The wet-bulb reading is an index of relative humidity.

Record Keeping

Keep a daily record of the incubator environment. A sample record sheet is shown on page 7. Record keeping can be used to teach measurement skills, time series perception, and data manipulation. Proper records also bring to your attention deviations that could damage the project.

Candling

Not all incubated eggs will hatch. Most probably, only 80 to 90 percent of incubated eggs are fertile. Removing eggs that can be identified as infertile or dead will allay disappointment and remove possible sources of contamination from the incubator. Some of these eggs can be identified by candling.

Shining a light through the egg to observe embryo development is called "candling." White eggs are more easily candled than dark or speckled eggs. You can make a simple candling device using a slide projector. First, roll several thicknesses of typing paper into a cone, leaving a hole at the tip. The hole, which will allow light to pass through, should be about the size of a quarter. Tape the open end of the cone over the lens of the slide projector. Then darken the room and hold the egg to the tip of the cone. You will be able to see the contents of the egg. Careful examination of eggs for short periods of time (less than 10 minutes) does not harm the embryos' development.

The presence of embryos can be confirmed easily after 8 to 12 days of incubation. The embryo appears as a dark spot that becomes more massive as incubation progresses. Eventually, only a dark mass and the air cell is visible. Use a sterile, or un-incubated, egg for comparison. Dispose of infertile or non-growing eggs. If you are apprehensive about these decisions, contact someone with experience for advice.

Hatch Stage

The hatch stage refers to the final 2 to 3 days of incubation. Chicks hatch out of the shell during this stage. After day 18, **do not** turn the eggs

at all. If you have an automatic turner, remove the turner and lay the eggs on cloth or rough paper (not newspaper) inside the incubator. This will give the chicks a good surface to walk on. Make sure the paper does not obstruct air flow or contact the water or the heating element.

The temperature should remain at 99.5° F, and humidity should be at least 86 to 90° F, wet bulb. The humidity can be increased by adding a wet sponge or wet paper towels to increase the evaporative surface in the incubator. On the twenty-first day of incubation, the chicks should start to pip out of the shell.

When Chicks Hatch

The hatching process requires great exertion on the part of the chick. The chick alternates between periods of activity and lengthy periods of rest. The entire hatching process requires nearly 24 hours. Do not be concerned about the time any individual chick requires to hatch, unless the process exceeds 24 hours.

Once chicks successfully leave the shell, they should remain in the incubator for 24 hours.

Leaving chicks in the warmth of the incubator gives them a chance to rest and dry. Increase the ventilation so that the chicks will have enough oxygen. When all the chicks have hatched, lower the temperature to 95° F.

Eggs that remain unhatched by the end of the twenty-second day should be discarded. Do not attempt to help a chick free itself from the shell. Weak or deformed chicks should be disposed of humanely.

Do not worry about providing feed for the chicks right away. Just before hatching, the chick absorbs the yolk of the egg, and the yolk continues to nourish the chick for the first 2 or 3 days of life. The chicks may be moved to a brooder 24 hours after hatching.

Incubation Reminders

Remember these important points for successful egg incubation.

- Locate the incubator in a room with a stable temperature, away from drafts.
- Incubate only species with the same length of incubation at the same time in the same incubator.

Possible Causes of Hatching Problems	
Observation	Possible Causes
Eggs exploding	Dirty eggs; improperly cleaned eggs
No embryonic development	Infertile eggs; rough handling of eggs; incubation temperature too high; incubation temperature too low
Blood ring	Old eggs; incubation temperature too high; incubation temperature too low
Dead embryos, second week	Incubation temperature too high; incubation temperature too low; electric power failure; eggs not turned
Air cell too small	Large eggs; humidity too high, days 1-19
Air cell too large	Small eggs; humidity too low, days 1-19
Chicks hatch early	Small eggs; temperature too high; humidity too low
Chicks hatch late	Large eggs; old eggs; temperature too low; humidity too high
Chicks dead after pipping shell	Eggs not turned first 2 weeks; thin-shelled eggs; incorrect temperature, days 1-19; temperature too high, days 19-21; humidity too high, days 1-19; humidity too low, days 19-21
Unhealed navel	Temperature too low, days 19-21; wide temperature variation in incubator; humidity too high, days 19-21
Malformed legs and toes	Improper temperature, days 1-21; improper humidity, days 1-21

- Keep a daily record of incubator data. Check the temperature daily: 99.5° F. Verify that the water trough is full: 86° F wet bulb.
- Always wash your hands before touching eggs. Keep germs, dirt, and oil away from incubating eggs.
- Turn the eggs three or five times a day for the first 18 days.
- The large end of the egg should always be higher than the small end.
- Do not turn the eggs for the last 3 days of incubation.
- When the chicks hatch, provide a cloth or rough paper surface for them to walk on.

Glossary

Air cell: A compartment of air located under the shell in the large end of the egg. The chick “taps” into the air cell and begins to breathe air on the twentieth day of incubation.

Blood ring: A ring formed when an embryo dies during the first 4 days of incubation. When examined, the egg looks normal except for a small circle of blood on the yolk.

Brooder: Housing that provides the environmental requirements of chicks from 1 day to 3 weeks of age.

Candling: Examining an egg in front of a light to observe the development of the embryo.

Egg flats: Containers or cartons designed for egg storage. Egg flats do not have lids and hold 30 eggs.

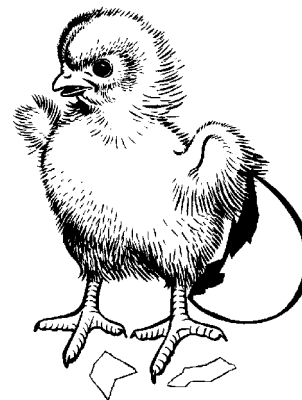
Hatchability: The percentage of eggs that hatch successfully.

Pipping: The first stage of hatching, when a bird breaks or pecks a hole through the eggshell.

Setting: Correctly preparing and placing eggs into an incubator for incubation.

Incubation Periods For Common Birds

Bird	Days
Chicken	21
Duck	28
Muscovy duck	33-35
Goose	29-31
Guinea	26-28
Chukar partridge	22-23
Peafowl	28
Ring-neck pheasant	23-24
Mongolian pheasant	24-25
Pigeon	16-18
Bobwhite quail	23
Japanese quail	17-18
Turkey	28



Incubator Data Chart

This record is important. Keeping data will help you prevent problems during your incubation project.

Day#	Date	Time Eggs Are Turned					Temperature			Water Checked	Remarks
		1	2	3	4	5	Room Temp.	Incubator Temp.	Wet Bulb		
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19		XXX	XXX	XXX	XXX	XXX					
20		XXX	XXX	XXX	XXX	XXX					
21		XXX	XXX	XXX	XXX	XXX					





Helpful Resources

Professional Advice and Support

1. The office of the Texas Agricultural Extension Service in your county (listed in the telephone directory under the county name).
2. Dr. A. Lee Cartwright
Associate Professor and Extension Specialist
Poultry Science Department
107 Kleberg Center
Texas A&M University
College Station, Texas 77843-2472
Telephone: (409)845-4319
Fax: (409)845-1921
E-mail: lcart@poultry.tamu.edu
3. A slide set and supporting text are available for loan through your county Extension office, or the 40-slide set can be purchased from Dr. Cartwright.

Sources of Fertile Eggs

There are many sources of fertile eggs. Some of these sources are convenient and affordable, but egg quality and fertility can be a problem. One source of fertile eggs is Texas A&M University. This source will ship small quantities of fertile eggs for a reasonable charge. Prices and other information are subject to change.

Poultry Science Teaching, Research, and Extension Center
Texas A&M University
College Station, Texas 77843-2472
Telephone: (409)845-4367

Costs: \$3.00 per dozen fertile chicken eggs
\$1.00 packaging charge per order plus shipping

Shipping charges vary according to the number of eggs ordered and the distance from shipping point. Eggs are shipped by bus and usually arrive the day after shipment. Shipping charges are usually \$5.00 to \$10.00 for the average order.

When ordering, say that you want to buy fertile chicken eggs for a school embryo project. Specify the number of eggs you want to buy,

your shipping address, your billing address, and when you would like the eggs shipped. You will be billed at the end of the month.

Sources of Incubators and Equipment

Many Texas Agricultural Extension Service professionals maintain or will purchase incubators that can be loaned to schools and civic organizations for educational purposes. Inquire at your county Extension office about the availability of resources for this program.

If you wish to purchase small incubators for a program in your school, the following companies can supply this equipment.

Buckeye USA
2955 Fairfax
Kansas City, Kansas 66115
Telephone: (913) 621-3366
Fax: (913) 621-1729

Carolina Biological Supply Company
2700 York Road
Burlington, NC 27215
Telephone: (919) 584-0381
1-800-334-5551

G.Q.F. Manufacturing Co.
P.O. Box 1552
Savannah, Georgia 31498
Telephone: (912) 236-0651
Fax: (912) 234-9978

Lyon Electric Company, Inc.
2765 Main Street
Chula Vista, California 91911
Telephone: (619) 585-9900
Cable: "LYONELEC"

Randall Burkey Co., Inc.
P.O. Box 1090
117 Industrial Drive
Boerne, Texas 78006
Telephone: (210) 249-3596
1-800-531-1097
Fax: (210) 249-9223

Stromberg's Chicks and Game Birds Unlimited
Box 400
Pine River, MN 56474
Telephone: (218)587-2222

Val-A Chicago Incorporated
700 W. Root Street
Chicago, Illinois 60609
Telephone: (312)927-9442
Fax: (312)927-6832

Books You Can Use for Class

- Back, Christine, and Jens Olesen. 1984. *Chicken and Egg*. Silver Burdett Co., New Jersey.
- Burnie, David. 1988. *Eyewitness Books: Bird*. Alfred A. Knopf, New York, NY.
- Burton, Jane. 1989. *Chester the Chick*. Gareth Stevens Children's Books, Milwaukee, WI.
- Burton, Jane. 1992. *See How They Grow: Chick*. Lodestar Books, New York, NY.
- Burton, Robert. 1994. *Egg*. Dorling Kindersley, New York, NY.
- Hariton, Anca. 1992. *Egg Story*. Dutton Children's Books, New York, NY.
- Koch, Maryjo. 1992. *Bird, Egg, Feather, Nest*. Stewart, Tabori, & Chang, Inc., New York, NY.
- Martin, Linda. 1994. *Watch Them Grow*. Dorling Kindersley, New York, NY.
- Milgrom, Harry. 1974. *Egg-ventures*. E.P. Dutton & Co., Inc., New York, NY.
- Pflug, Betsy. 1973. *Egg-speriment: Easy Crafts with Eggs and Egg Cartons*. Lippincott, New York, NY.
- Ridout, Ronald, and Michael Holt. 1974. *The Life Cycle Book of Chickens*. Grosset & Dunlap, New York, NY.
- Selsam, Millicent E. 1970. *Egg to Chick*. Harper & Row Publishing, New York, NY.
- Turner, Dorothy. 1988. *Eggs*. Carolrhoda Books, Inc., Minneapolis, MN.

Activity Booklet

Chickens Aren't the Only Ones, Catalog Number FS-2807

This booklet is available from:

Frank Schaffer Publications, Inc.
23740 Hawthorne Blvd.
Torrance, CA 90505

Wall Charts

"Embryo Development Chart"

This wall chart (approximately 27 x 39 inches) has 40 pictures of embryo and chick development with brief text accompanying each picture. This chart can be purchased at a cost of \$15.00 from:

Jamesway Incubator Company
P.O. 1232
12219 Independence Blvd.
Mathews, NC 28106
Telephone: (704)847-2219
Fax: (704)847-1274

"How A Chick Hatches," Catalog Number FS-2423

"Animals That Hatch From Eggs," Catalog Number FS-2468

These wall charts are smaller (17 x 22 inches) and less expensive (less than \$3.00) than the one described above. The full-color illustrations and simple text are more appropriate for younger students. Line-drawn worksheets that can be photocopied are on the reverse side of these charts.

These charts can be obtained from your local teacher's supply store, or ordered from:

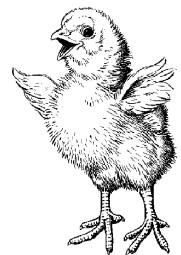
Frank Schaffer Publications, Inc.
23740 Hawthorne Blvd.
Torrance, CA 90505

Technical References

- Harvey, Rob. 1993. *Practical Incubation*. Hancock House Publishers, Blaine, WA.
- Lyon Electric Company, Inc. 1988. *Hatching Manual*. Lyon Electric Company, Inc., Chula Vista, CA.
- Stromberg, Janet. 1975. *A Guide to Better Hatching*. Stromberg Publishing Company, Pine River, MN.



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