The Science of Incubation

You can hatch your own eggs without the help of a broody hen, thanks to science!

If you've been buying chicks from mail-order companies or feed-supply stores, you might consider hatching them yourself (and not with the help of one of those dratted broody hens always in a corner somewhere!). To do this, you'll want to do incubation the scientific (and fun!) way — with an incubator!

Incubators

The subject of incubators is large enough for its own article. However, there are four big points you want to make sure your incubator matches so that it will meet your needs. There are many reviews online to help you choose which incubator best suits you.

SIZE: Is it big enough for the number of eggs you want to hatch? Is it too big for the number of eggs you want to hatch? A larger incubator may be easier for hatching large clutches, but it's more difficult for a backyard enthusiast to heat and maintain. An incubator that is too small will prevent you from hatching more than a few chicks at a time and generally requires a more hands-on approach when it comes to turning and humidity. Many choose the in-between sizes that allow for 15 to 25 eggs.

QUALITY: This primarily matters for the quality of the construction and seal; an incubator that leaks and has drafts will be more trouble than fun. Many incubators are built from high-grade foam, which is an excellent insulator and, with the right design, can have a good seal.

COST: As with all things in life, how much are you willing to spend? A few hundred dollars will often get you an excellent quality incubator.

EXTRAS: Fans, automatic turners and built-in thermometers all cost extra but will make the process easier and more successful.

PHOTO CREDIT

Candling lets you judge how many eggs are fertile or are developing correctly.

Selection and Preparation

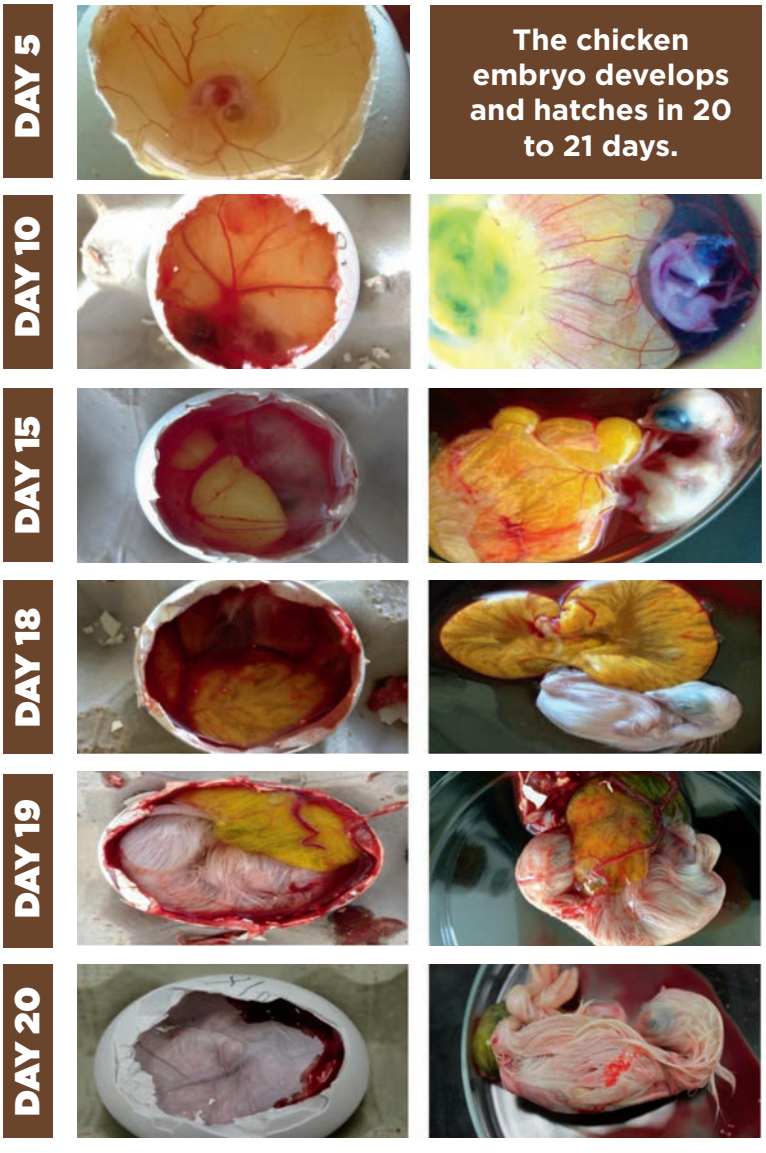
Preparing your eggs properly for incubation is as important to the success of your final hatch as the incubation itself. Selection of the eggs you will hatch should be based on size (average), shape (normal) and shell (no wrinkles, not too thin, no cracks and clean). Because you don't want to wash eggs before incubation — it washes off their natural protection against bacteria that just love to grow in a developing egg — it's best to choose eggs that are already clean rather than bringing feces into the incubator. An egg that is oddly shaped or has incongruities in its shell can create problems for the chick as it grows or attempts to hatch. Larger eggs are not better; double yolks or the incorrect ratio of yolk to albumin can result in weak or dead embryos; and small eggs result in weaker, smaller chicks.

Studies have shown that eggs actually have a better chance of hatching if they are stored for 5 to 10 days before incubation is started. Any shorter or any longer a storage time reduces the fertility of your hatch. This is believed to be related to how hens naturally nest — laying an egg a day until the clutch is complete and then starting her 21-day incubation. To properly store eggs, you should keep them in a cool (65 degrees Fahrenheit), dark room where they are unlikely to be moved or disturbed. Store them in an egg carton with the large end (where the air cell resides) facing up.

Incubator Prep

You should always clean and disinfect an incubator between hatches. This includes any pans or bowls that may hold water, your thermometer, and trays or turning apparatus. Use a 10 percent bleach solution, and fully air out the incubator before placing eggs. If you have an automatic turner, you should place the tray in the incubator and run it for a day to verify function. Eggs should be turned at least three times a day, either by hand or by the turner. No cloth or straw should ever be in your incubator; these materials will grow mold and bacteria in the warm, humid environment and may infect your eggs or chicks.

An accurate thermometer and hygrometer are vital to incubation. Many people prefer to use two thermometers, in case one breaks or becomes inaccurate during the incubation. Even a few degrees variation or a few percentage changes in humidity can cause significant differences in your chick strength or hatch rate.



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Candling

Candling is highly recommended for incubating your own eggs at home. It lets you judge how many eggs are fertile and discard eggs that are infertile or stopped developing. It also tremendously fun! White-shelled eggs are easiest, but any egg can be candled using either a candler or a high-powered flashlight. Candlers are generally easier, as they have a hooded area around the light source that fits an egg and are brighter than your average flashlight, LED lanterns are a good candler option.

The best times to candle your eggs are at 7, 10 and 18 days of incubation. These are times when it is easiest to differentiate an infertile egg from a fertile egg and identify any embryos that may have died.

A 7-day egg should have blood vessels clearly visible against the shell and a dark spot the size of a quarter where the embryo is in the center of the egg.

A 10-day egg will still have visible blood vessels against the shell, but the embryo will be larger.

An 18-day egg should be entirely dark except for the air cell. Blood vessels may still be apparently in some areas or may not be visible due to the embryo filling the egg and blocking the light. The growing chick may even move in response to your light!

An egg that is entirely clear (no blood vessels and only a murky area in the middle where the yolk is suspended) at day 7 is infertile and should be discarded. An egg that has a red blood ring around the bottom 1/3 is considered a dead embryo, no matter the stage of incubation. Other signs of death are gas bubbles below the air cell, the dark embryo sticking to the shell on one side of the egg or lack of growth between candlings.

Not discarding eggs that are infertile or dead may result in “bombs” — eggs that explode in

the incubator due to bacterial growth and gases. These bombs then coat other eggs (and your incubator) with those bacteria. This can result in more infected eggs, plus a difficult-to-clean incubator.

If you have dead embryos, always break open the egg and look at the contents. This may give you information of why the embryo died and if there is something abnormal or inappropriate in terms of humidity and temperature going on in the incubator.

Stages of Incubation

Being able to characterize in which stage of incubation embryo death occurred could be very helpful to correct problems. Following are some of the more easily identifiable features of each stage; there are many more subtle changes, but these should help you identify the embryo within a day or two of development.

Day 1 to 3: Formation begins of the blood circulation, head, brain and trunk of the embryo. The heart begins to beat on day 3.

Day 4 to 5: Embryo begins to take on a "C" shape and experiences a significant increase in size. The front "limbs" have differentiable fingers.

Day 5 to 7: Brain progressively enters the skull cavity, beak formation begins and the embryo now has a clearly defined neck. The front limbs have a winglike formation of fingers, with the second finger being longer than the others.

Day 8 to 9: Beak has upper and lower portions and is now identifiable as a beak. Wings and legs are identifiable as such. The brain is fully settled within the head. The first feather follicles appear.

Day 10 to 11: The embryo now clearly resembles a chick; eyelids begin to grow. Feather follicles now cover the back edge of the limbs. The egg tooth appears.

Day 12 to 13: Claws and leg scales become evident; lower eyelid covers 2/3 to 3/4 of the cornea.

Day 14 to 16: Down covers the entire body of the chick; head moves to pipping position under the right wing.

Day 17 to 18: The albumin has been entirely absorbed; egg should be moved to the hatcher (or removed from turner) on day 18 to 19.

Day 19: Beak is against the inner shell membrane below the air cell. Yolk is being resorbed faster into the embryo's abdominal cavity.

Day 20: Yolk should be fully resorbed and the umbilicus closed. Chick pierces the inner shell membrane and breathes in the air cell. Piercing of the shell may begin this day.

Day 21: Using its wing as a guide and its legs to turn, the chick pips through the eggshell in a circular fashion using its egg tooth and emerges after 12 to 18 hours

BRIANSMITH/FLICKR

By hatching your own chickens, you get to be part of an amazing cycle of life, as the insides of an egg develop into a full-fledged fowl!

Where Things Go Wrong

The most common causes of embryo mortality before hatching are related with breeder or storage-incubation problems. Breeder problems relate to nutritional deficiencies, infectious diseases, management errors and feed toxicity among others. Storage-incubation problems relate to incorrect storage (temperature, humidity, time), handling, incubation practices, incubation humidity, incubation temperature, bacterial contamination and genetic abnormalities. As previously discussed, a bacterial (or fungal) infection can be avoided through eggs from clean nest boxes as well as clean incubators. Improving incubation practices is one of the most controllable ways to increase your hatchability. Always crack open any dead embryos you find with candling or eggs that do not hatch; the information collected can help you improve conditions for the next round of incubation.

HUMIDITY: should be 40 to 60 percent from days 1 through 17 and 70 to 80 percent days 18 through 21. Humidity is a very common problem with at home incubators partially because small incubators are difficult to maintain at a constant humidity and partially because many people don't measure the humidity.

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For a good hatch, you'll need to monitor the incubator's humidity levels, temperature, air circulation, cleanliness and more.

Using a thermometer which accurately shows your humidity and temperature is the first step to a more successful hatch. Wet bulb readings can be used accurately; however, it's generally better to purchase an accurate hygrometer to measure the humidity. You can also weigh your eggs prior to incubation and before hatch; if the incubator/hatcher humidity is correct, 14 percent of the eggs' initial weight should be lost by day 21 prior to hatch.

HUMIDITY TOO LOW: Chicks will hatch weak, die pipping or have a difficult hatch because the egg membranes are too dry. Embryo death may occur due to dehydration. Check chicks' legs and toes; if they look white with crusty appearance at hatch, it may be because of low humidity and subsequent dehydration of the chicks.

HUMIDITY TOO HIGH: Embryo death can occur during incubation. Other issues might be more bacterial and fungal infections within the eggs, enlarged pipping muscle and death during pipping, and "sticky chicks" that don't fluff and dry after hatching.

TEMPERATURE: It should be 99 to 100 degrees days 1 through 17 and 97 to 99 degrees for days 18 through 21. Similar to humidity, an accurate thermometer is the first step. Many people elect to use two thermometers, to check against each other and verify that your incubator doesn't have cold spots or hot spots. Incubators and online resources may tell you that incubation temperatures can range from 99 to 103 degrees; however, 99.5 degrees is where most people have the best results. Placing your incubator in a room that doesn't have large temperature variations can be helpful to avoid drops or increases while you are sleeping or away from home; room temperature should be around 70 to 75 degrees.

TEMPERATURE TOO LOW: This can result in embryo death during incubation, small weak chicks hatching, ruptured yolk sacs during incubation, mal-positioned chicks unable to hatch (particularly head not under right wing), swollen head (edema at the back of the head) or swollen chicks.

TEMPERATURE TOO HIGH: This can result in embryo death during incubation, limb and wing deformities, dwarfism, mal-positioned chicks unable to hatch (particularly with the head in the small end of the egg), exposed brains, eye cataracts, subcutaneous hemorrhage in embryos or swollen head (edema at the back of the head).

AIR CIRCULATION: Some incubators have internal fans, and some do not. Circulating incubators make your job easier; they are less likely to get cold or hot spots and keep the humidity and temperature more evenly

spread. They can also assist with drawing fresh air down from vents over your eggs to keep them well-oxygenated. Proper ventilation prevents dead embryos from improper oxygenation and helps decrease bacterial and fungal infections.

TURNING: Not turning the eggs during days 1 through 17 will result in malformed and dead embryos, as the developing chick may stick to the inside of the shell rather than being suspended in the center. Make your manual turning more accurate by placing an "X" on one side of the egg with a pencil to keep track of which side is up. However, it's equally important to stop turning on day 18, as this is the time period when the chick is rotating and positioning itself to pip out of the egg. Turning during this time can confuse the chick and result in improper positioning.

CLEANLINESS: A clean egg and a clean incubator are your best tools to reduce embryo death due to bacterial and fungal contamination. Eliminating infertile and dead eggs as you find them will also reduce the chances of egg bombs and spread of a contamination. These embryos often have a bad smell, green tinge to the embryo and membranes, or maybe even growth of bacterial or fungal colonies in fuzzy patches.

FLOCK MANAGEMENT: Many of the nutritional deficiencies that can be seen in embryos don't exist in a flock that is fed a commercial feed. Signs of vitamin A deficiency are bow-legged embryos and chicks, magnesium deficiency causes shortened legs and an overlong upper beak, and riboflavin deficiency causes curled clubbed feathers at hatch and incomplete closure of the abdomen. Any of these signs in your dead eggs or live chicks indicate a serious nutritional deficiency in your flock.

ANNEKA/FLICKR

Purchase an incubator that is the right size for the amount of eggs you want to hatch, as well as the size of eggs (depending on if you are hatching bantam eggs, large-fowl eggs, goose eggs, etc.).

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Reduced hen fertility and vertical transmission of diseases is also a cause of infertility and reduced hatchability.

A natural hatch using a hen generally has a 50 to 75 percent hatch rate; commercial operations may get up to a 92 percent. The average, fancier incubator generally falls somewhere between the two. However, by avoiding the common pitfalls, you can increase your hatch percentage and the health of your chicks. Sudden changes in humidity and temperature often cause an equally sudden spike in embryo deaths; for this reason, avoid opening the incubator when at all possible, and don't leave eggs outside the incubator any longer than necessary when candling. Turning can create problems, but generally, automatic turners — or manually turning three times a day — are enough to prevent them.

If you don't have a self-turning incubator, you'll need to manually turn the eggs so that the developing chicks stay suspending in the center of the eggs and don't stick to the inside of the shells.

Incubation at home can be challenging, and there are often unpredictable events. Despite all the possible difficulties incubation is a great experience. Getting to see those little future flock membranes pip their way out of the shell is a rewarding and amazing sight that you will never forget.

Poultry Science is written by faculty from the school of veterinary medicine at the University of California, Davis (www.vetmed.ucdavis.edu) and the University of California Cooperative Extension (www.ucanr.edu). This column was written by Emily Lane and Rodrigo A. Gallardo.