Hatching Eggs in the Classroom: A Teacher’s Guide

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Incubating and hatching chicken eggs is a hands-on learning experience you can use with students from kindergarten to 12th grade. Classroom experiments with chicken embryos can help you teach complex systems such as nutrition and the circulatory system, or more basic skills such as data measurement, collection, and analysis. These projects help students learn biological concepts and develop a deeper understanding of the life sciences. Examining embryos at different stages of growth, and observing a beating heart are just two of the projects you can use.

Below are guidelines for incubating and hatching chicken eggs in a classroom.

**Only fertile eggs will hatch**

Use fresh, clean, fertile eggs. Eggs sold in food stores are not fertile. Eggs from unreliable sources can disappoint and frustrate students because many are infertile and will not hatch. Eggs from commercial hatcheries are reliably fertile; however, some companies will not ship only a few eggs.

The Poultry Science Department at Texas A&M University does ship small quantities of fertile eggs. Ordering instructions and contact information for other reliable hatcheries are listed at the end of this publication.

**Storing fertile eggs**

Fertile eggs are alive and for them to develop then hatch, you must care them properly throughout the project.

Handle the eggs carefully; an egg with a cracked shell will not hatch. Discard cracked eggs to prevent contaminating the incubator and other eggs. Discard extremely dirty eggs. If a small area of an egg is soiled with dirt or fecal material, make sure that what appears to be dirt is not simply a stain on the surface of the egg, then clean the egg by gently rubbing the soiled surface with fine sand-
paper. The eggshell is porous so do not use water to clean the shell.

**Storage time**

Hatchability decreases the longer you store the eggs. For best results, set the eggs to incubate within 7 to 10 days of being laid. Chicken eggs hatch about 21 days after they are set in the incubator. Planning activities around this time frame will allow the students to enjoy the complete process.

**Storage temperature and humidity**

Store fertile eggs at 55 to 69°F. If the temperature is too low, embryos will die; if the temperature is too high, the embryos will develop abnormally and weaken. A normal refrigerator is much too cold for storing fertile eggs to be hatched.

The relative humidity for storing fertile eggs should be about 75 to 80 percent.

Eggshells are porous, which allows air in and out of the eggshell. If the humidity is too low, the shell membrane can become dry, and cause the embryo to die.

Humidity above 80 percent can cause condensation to form on the egg and suffocate the embryo by blocking the shell’s pores. Condensation can also carry contaminants into the egg.

**Position of eggs**

If the eggs will be stored for less than 10 days, place them in egg flats or egg cartons with the large end up. If they will be stored for more than 10 days, position them with the large end down.

**Turning eggs**

Eggs do not have to be turned if they will be incubated within 1 week of being laid. Eggs held for longer than 1 week should be rotated from side to side over a 90-degree angle once a day.

One method for turning the eggs during the holding period is to place a 6-inch block under one end of the carton (or flat) holding the eggs, rotating the block’s location each day.
tion. The incubator and its environment need to be stable for the 3-week duration of the project.

If possible, connect the incubator to a backup power supply to keep the incubator operating during a power failure.

If the power will be shut off or if the air conditioning or heating is changed during the weekend, provide alternative power. Make sure that the possible changes in temperature and humidity do not affect the incubator function.

The temperature in an incubator without a circulating fan fluctuates more than in one that has a fan. As long as the temperature does not exceed 102°F, the hatch should not be harmed.

Do not set the eggs until you have verified that the automatic turner is working and that the temperature and humidity are correct and stable.

**Setting the eggs**

If the eggs have been stored, give them 2 to 4 hours to reach room temperature before setting them in the incubator. Setting the chicken eggs on a Tuesday or Wednesday makes it more likely the chicks will hatch during the school week. Species other than chickens may hatch at different rates, so plan accordingly (Table 1).

If the incubator does not have an automatic turner, use a pencil to mark each egg with an X on one side and an O on the opposite side. These marks will help you verify that the eggs are being turned properly. There is no need to mark eggs if the incubator has a working automatic turner.

Once the eggs are in the incubator, do not change the temperature and humidity settings unless the temperature exceeds 102°F. After the eggs have been in for 4 hours, you may make adjustments. The incubating temperature should vary only from 99 to 100°F.

Place the large end of the egg higher than the small end in the incubator. The embryo orients itself 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; embryos that orient away from the air cell will not hatch.

**Turning the eggs**

The first 19 days of incubation are known as the set stage. Turning the eggs during this stage prevents embryo death and unhealthy hatches. Eggs must be turned at least three times every day (five times is even better), even over the weekend.

An automatic turner is recommended if your school restricts access to classrooms on weekends. However, hand-turning eggs is a great way to involve students in the process directly.

To turn eggs by hand, rotate the egg 180 degrees so that the X and the O alternately face up at each turn. Because dirt and oils can block the pores of the egg, the students must wash their hands before touching the eggs during incubation.

Throughout the incubation process, the large end of the egg should always be higher than the small end.

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**Table 1. Incubation periods for common birds. (Do not incubate different species together because their incubation periods may differ.)**

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of days</th>
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</thead>
<tbody>
<tr>
<td>Chicken</td>
<td>21</td>
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<tr>
<td>Duck</td>
<td>28</td>
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<tr>
<td>Muscovy duck</td>
<td>33–35</td>
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<tr>
<td>Goose</td>
<td>29–31</td>
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<tr>
<td>Guinea</td>
<td>26–28</td>
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<tr>
<td>Chukar partridge</td>
<td>22–23</td>
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<tr>
<td>Peafowl</td>
<td>28</td>
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<tr>
<td>Ring-neck pheasant</td>
<td>23–24</td>
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<tr>
<td>Mongolian pheasant</td>
<td>24–25</td>
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<tr>
<td>Pigeon</td>
<td>16–18</td>
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<tr>
<td>Bobwhite quail</td>
<td>23</td>
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<tr>
<td>Japanese quail</td>
<td>17–18</td>
</tr>
<tr>
<td>Turkey</td>
<td>28</td>
</tr>
</tbody>
</table>
end. Always replace the incubator lid quickly to keep the temperature inside constant.

**Ventilation, temperature, and humidity in the incubator**

The chick embryo consumes oxygen and gives off carbon dioxide. This gas exchange is small during the early part of incubation or when just a few eggs are being incubated. Follow the manufacturer’s recommendations to guarantee that the developing chicks have adequate oxygen. Leave enough space around the incubator and ensure that all ventilation holes are unobstructed. Doing this will allow fresh air in and stale air out.

The temperature in the incubator should be 99.5°F. If the temperature fluctuates more than 0.5° either side of 99.5°F, the hatch is likely to be poor. Place a thermometer in the incubator and check the temperature at least twice a day.

Relative humidity is vital for the incubation process. To maintain humidity, every incubator must have a moisture source. 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 pan every day to maintain proper humidity.

Although humidity monitors are readily available, it is easy to make such an instrument with your students as an added science lesson. You need only a normal thermometer, a 6-inch piece of shoelace, and a short piece of dental floss:

1. Slip the bulb end of the thermometer about 1 inch into the open end of the shoelace.
2. Tie the dental floss around both the shoelace and the thermometer directly above the bulb. This will keep the shoelace from sliding off.
3. 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 (Figure 1). The wet bulb temperature is an index of relative humidity and because of evaporation; it will be less than that of a dry thermometer.

The wet-bulb temperature should be 85 to 87°F (55 to 60 percent RH). Humidity should not fluctuate more than 1 or 2 wet-bulb degrees.

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

The eggs should decrease in weight during incubation as they will lose moisture during incubation.

**Record keeping**

Record the incubator environment daily using a record sheet like the one in Figure 1. Record keeping can teach measurement skills, time series perception, and data manipulation; however, its main purpose is to monitor and correct conditions that might damage the project. These records can also be reviewed in the event of a poor hatch (Figure 2).

**Candling**

Shining a light through an egg to observe embryo development is called “candling.” You can use a
small flashlight for candling or you can buy a candler at a reasonable price. White eggs are easier to candle than are dark or speckled eggs, and candling in a dark room will give the best visibility.

Embryos can be seen easily after 8 to 12 days of incubation. The embryo appears as a dark spot that becomes larger and fills the egg as incubation progresses. It will often move away from the light during candling. Eventually, only a dark mass and the air cell will be visible. You can use a sterile, or unincubated, egg for comparison.

Only 80 to 90 percent of incubated eggs are fertile; you can use this technique to identify infertile or dead eggs. These should be removed because they can rupture and contaminate the incubator. If you are apprehensive about these decisions, contact someone with experience for advice.

To identify dead embryos look for a ring or smear of blood in the egg or a dark spot dried inside the shell. A living embryo will appear as a dark spot in the large end of the egg surrounded by a faint outline of blood vessels. Infertile, dead, or dirty eggs should be removed from the incubator when possible as they may explode and contaminate the incubator.

**Hatch stage**

The hatch stage is the final 2 to 3 days of incubation. Chicks communicate with each other while inside the egg and synchronize their hatching; most chicks will hatch out within a 24-hour period.

After Day 18, do not turn the eggs at all. If you have an automatic turner, remove it 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 heating element.

The temperature should remain at least 86 to 90°F, wet bulb. You can increase the humidity by adding a wet sponge or wet paper towels to the incubator. On Day 21 of incubation, the chicks should start to pip out of the shell.

**When the chicks hatch**

Hatching requires great exertion by the chick, which alternates between activity and long periods of rest. The entire hatching process requires nearly 24 hours. Do not be concerned about the amount of time that any individual chick requires to hatch, unless it takes more than 24 hours.

Chicks use an egg tooth to peck their way out of the shell. Once chicks leave the shell, leave them in the incubator for 24 hours. The warmth of the incubator helps them rest and dry. Increase the ventilation to give the chicks enough oxygen. Some incubators have plugs that can be removed for this purpose. When all the chicks have hatched, lower the temperature to 95°F.

Discard eggs that do not hatch by the end of Day 22. Do not help a chick free itself from the shell; that does more harm than good. Weak or deformed chicks should be disposed of humanely.

There is no need to provide food or water for the first 2 or 3 days the chick is outside the shell. Just before the chick hatches, it absorbs the remaining yolk in the egg and uses it as nourishment for several days after hatching. The chicks may be moved to a brooder 24 hours after hatching.
Incubation reminders

- Set the incubator in a room with a stable temperature, away from drafts and direct sunlight.
- Incubate together only species with the same incubation period.
- Keep a daily record of incubator data. Check the temperature daily to make sure it is 99.5°F (Table 2). Verify that the water trough is full and that the wet bulb temperature is 86°F.
- Always wash your hands before touching eggs. Keep germs, dirt, and oil away from incubating eggs.
- Turn the eggs three to 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 air cell and begins to breathe air on Day 20 of incubation.

Blood ring – A ring formed when an embryo dies during the first 4 days of incubation; 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 old.

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

Egg flats – Containers or cartons that store eggs; 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.

Table 2. Possible causes of hatching problems.

<table>
<thead>
<tr>
<th>Observations</th>
<th>Possible causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eggs rupturing</td>
<td>Dirty eggs; improperly cleaned eggs</td>
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<tr>
<td>No embryonic development</td>
<td>Infertile eggs; rough handling of eggs; incubation temperature too high; incubation temperature too low</td>
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<tr>
<td>Blood ring</td>
<td>Old eggs; incubation temperature too high; incubation temperature too low</td>
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<tr>
<td>Dead embryos, second week</td>
<td>Incubation temperature too high; incubation temperature too low; eggs not turned</td>
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<tr>
<td>Air cell too small</td>
<td>Large eggs; humidity too high, days 1–19</td>
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<tr>
<td>Air cell too large</td>
<td>Small eggs; humidity too low, days 1–19</td>
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<tr>
<td>Chicks hatch early</td>
<td>Small eggs; temperature too low; humidity too high</td>
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<tr>
<td>Chicks hatch late</td>
<td>Large eggs; old eggs; temperature too low; humidity too high</td>
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<tr>
<td>Chicks dead after pipping shell</td>
<td>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</td>
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<tr>
<td>Unhealed navel</td>
<td>Temperature too low, days 19–21; wide temperature variation in incubator; humidity too high, days 19–21</td>
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<tr>
<td>Malformed legs and toes</td>
<td>Improper temperature, days 1–21; improper humidity, days 1–21</td>
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</table>
**Incubation Data Chart**

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

<table>
<thead>
<tr>
<th>Day #</th>
<th>Date</th>
<th>Time Eggs are Turned</th>
<th>Temperature</th>
<th>Remarks</th>
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<td>Room Temp</td>
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<td>21</td>
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<td>XXX  XXX  XXX  XXX  XXX</td>
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Resources

Professional advice and support

The Texas A&M AgriLife Extension Service office in your county listed in the telephone directory under the county name.

Gregory S. Archer
MS 2472 TAMU
College Station, TX 77843-2472
Telephone: (979) 845-4319
E-mail: garcher@poultry.tamu.edu

PowerPoint presentation: An accompanying slide-show is available at your local Extension office or the Texas A&M Department of Poultry Science.

Sources of fertile eggs

There are many sources of fertile eggs. Some sources are convenient and the eggs affordable, but egg quality and fertility can be a problem.

One source of fertile eggs is Texas A&M University, which will ship as few as 2 dozen fertile eggs. Prices and other information are subject to change.

To order fertile eggs from Texas A&M, please complete and submit the form at http://agrilife.org/poultryforms/egg-order/

Or contact Dale Hyatt at (979) 845-4367

No credit cards are accepted

Eggs are sold in dozen and half dozen quantities only, with a minimum 2 dozen order. Eggs are $7 per dozen plus a $3 handling fee per order, plus shipping.

Shipping within Texas:

Eggs are shipped via Greyhound Bus Lines to the nearest bus terminal.

Please check with Greyhound for shipping times between Bryan, Texas and your destination. Shipping charges vary according to the number of eggs ordered and the distance from shipping point.

When ordering, request fertile chicken eggs for a school project. You will be billed at the end of the month.

Sources of fertile eggs, incubators, and equipment

Cackle Hatchery
PO Box 529
Lebanon, MO 65536
(417) 532-4581
cacklehatchery.com

Carolina Biological Supply Company
P.O. Box 6010
Burlington, NC 27216
(800) 334-5551
www.carolina.com

GQF Manufacturing Co.
2343 Louisville Rd.
Savannah, GA 31415-1619
(912) 236-0651
www.gqfmfg.com

Hoffman Hatchery Inc.
P.O. Box 129
Gratz, PA 17030
(717) 365-3694
www.hoffmanhatchery.com

Ideal Poultry
PO Box 591
Cameron, TX 76520
(254) 679-6677
www.ideal-poultry.com

Kemp’s Incubators
3560 West 18th Ave.
Eugene, OR 97402
(888) 901-2743
www.poultrysupply.com

Lyon Technologies, Inc.
1690 Brandywine Avenue
Chula Vista, CA 91911
(888) 5966-872
www.lyonusa.com

McMurray Hatchery
P.O. Box 458
191 Closz Drive
Webster City, Iowa 50595
(800) 454-3280
www.mcmurrayhatchery.com
Meyer Hatchery
626 State Route 89
Polk, OH 44866
(888) 568-9755
www.meyerhatchery.com

Randall Burkey Co., Inc.
117 Industrial Dr.
Boerne, TX 78006
(800) 531-1097
www.randallburkey.com

Stromberg’s Chicks and Game Birds
P.O. Box 400
Pine River, MN 56474
(800) 720-1134
www.strombergschickens.com

Ridgway Hatcheries, Inc.
615 North High St. Box 306
Larue, OH 43332
(740) 499-2163
ridgwayhatchery.com

Welp Hatchery
P.O. BOX 77
Bancroft, Iowa 50517
(800) 458-4473
www.welphatchery.com

Helpful books


Websites

http://www.enchantedlearning.com/subjects/birds/info/chicken/egg.shtml

http://chickscope.beckman.uiuc.edu/resources/egg_to_chick/development.html

www.4-h.org/Resource-Library/.../Emb-Help-Guide-Beginner.dwn

www.4-h.org/Resource-Library/.../Emb-Help-Guide-Advanced.dwn

Wall charts

*Chicken Development*, Chart by Carolina

http://www.carolina.com/

*Chicken Development*, Poster by Ward’s Natural Science

http://wardsci.com/

*Chicken Embryo*, by American Educational Products, LLC

http://www.amep.com/

*Chicken Embryology, Poster Set*” by eNasco

http://www.enasco.com/

Technical references


Hatching Eggs in the Classroom: Question Set

1. How long does it take for a chicken egg to hatch?
   a. 14 days  
   b. 18 days  
   c. 21 days  
   d. 28 days

2. What is the ideal temperature during incubation?
   a. 97.0°F  
   b. 98.6°F  
   c. 99.5°F  
   d. 105.0°F

3. What is the ideal relative humidity range during incubation?
   a. 25–35%  
   b. 55–60%  
   c. 65–70%  
   d. 80–90%

4. What part of the egg becomes the chicken embryo?
   a. The yolk  
   b. The white  
   c. The germ spot  
   d. The chalaza

5. Why do eggs need to be turned during incubation?
   a. To warm the eggs evenly  
   b. To prevent the embryo from sticking to the side of the egg  
   c. To prevent embryo death and unhealthy hatches  
   d. Both b and c

6. What is the minimum number of times per day that incubating eggs need to be turned?
   a. 1  
   b. 3–5  
   c. 12  
   d. 24

7. When do you stop turning the eggs?
   a. Day 15 of incubation  
   b. Day 18 of incubation  
   c. Day 20 of incubation  
   d. Never

8. Why shouldn’t you use water to clean the eggs you are going to incubate?
   a. It can contaminate the egg  
   b. It can decrease hatchability  
   c. a and b  
   d. It is okay to wash eggs with water

9. How soon should eggs be incubated after they are laid?
   a. Within 1 day  
   b. Within 10 days  
   c. Within 21 days  
   d. Within 30 days

10. Should you store fertile eggs in a refrigerator?
    a. Yes, you need to keep them cold  
    b. No, that is too cold for them  
    c. No, they need to be stored at room temperature  
    d. No, they should be stored somewhere warm

11. Which end should be up when you place the eggs in an incubator?
    a. The small end  
    b. The large end  
    c. Either end

12. What does candling mean?
    a. Making candles  
    b. Using light to look in an egg  
    c. Cooking an egg with a candle  
    d. All of the above

13. How long should you leave a chick in the incubator after it has hatched?
    a. 10 minutes  
    b. 24 hours  
    c. 2–3 days  
    d. 1 week

14. When do chicks need food and water after they hatch?
    a. Immediately  
    b. In 2–3 days  
    c. In 4–5 days  
    d. In 1 week

15. What three environmental factors are important during incubation?
    a. Humidity, temperature, ventilation  
    b. Humidity, sound, temperature  
    c. Sound, temperature, ventilation  
    d. Humidity, light, sound,
16. What does pipping mean?
   a. Turning egg from side to side
   b. The chick breaking through the eggshell
   c. Putting an egg in the incubator
   d. Looking at the egg with a light

17. Can you have too much or too little humidity in an incubator?
   a. No, humidity is not important
   b. Yes, too much can kill the embryo
   c. Yes, too little can kill the embryo
   d. Both b and c

18. Should you wash your hands before touching eggs in the incubator?
   a. No, it doesn’t matter
   b. No, only after touching the eggs in the incubator
   c. Yes, germs on your hands could contaminate the egg
   d. Yes, but only if you have just eaten

19. What do the pores in an egg do?
   a. Allow the egg to breath
   b. Allow light into the egg
   c. Allow food into the egg
   d. Allow the egg to sweat

20. What is the purpose of the air cell in an egg?
   a. To give a cushion to the embryo
   b. To tell you what end is up on an egg
   c. To give the chick a place to breathe
   d. To help the chick hatch

21. What does hatchability mean?
   a. Percentage of eggs to hatch
   b. Number of eggs
   c. Percentage of eggs to pip
   d. None of the above

22. Why do chicks hatch at or around the same time?
   a. They talk to each other
   b. They are more likely to survive
   c. Both a and b
   d. They don’t, chicks hatch randomly

23. Why should you NOT open the incubator repeatedly?
   a. It alters the temperature
   b. It alters the humidity
   c. It can decrease hatchability
   d. All of the above

24. How long can it take a chick to hatch?
   a. 1 hour
   b. 5 hour
   c. 24 hours
   d. 48 hours

25. What does “setting” an egg mean?
   a. Turning it from side to side
   b. Placing it in the incubator
   c. Removing infertile or dead eggs
   d. Spinning the egg

26. What types of eggs might explode while being incubated?
   a. Dirty eggs
   b. Infertile eggs
   c. Both a and b
   d. Neither a nor b

27. What is the purpose of the egg yolk?
   a. It becomes the chick
   b. It serves no purpose
   c. It helps protect the chick
   d. It is the embryo’s food

28. Is an egg shell permeable?
   a. Yes
   b. No

29. Do eggs from different species of birds take different numbers of days to hatch?
   a. Yes
   b. No

30. What four factors control the hatching of an egg?
   a. Humidity, temperature, time, rotation
   b. Color, light, temperature, time
   c. Candling, food source, temperature, time
   d. Color, humidity, temperature, time

31. If you incubate an egg from the grocery store, will a chick hatch?
   a. Yes
   b. No

32. As the embryo grows, does the egg gain or lose weight?
   a. The egg will weigh more
   b. The egg will weigh less
   c. The weight will not change

33. How does a chick get out of the egg?
   a. It kicks its way out
   b. It uses an egg tooth to peck its way out
   c. It grow until the egg cracks open
   d. The mother or a human cracks the egg for it
34. Should you help a chick break out of its shell?
   a. Yes
   b. No

35. Will all the eggs in an incubator hatch?
   a. Yes, if they are all fertile
   b. Yes, if the temperature is correct
   c. No, even some fertile eggs don’t hatch
   d. a and b

36. Why should you NOT incubate a cracked egg?
   a. It will not hatch
   b. It will contaminate the incubator
   c. It will contaminate the other eggs
   d. All of the above

37. When storing eggs, what should the relative humidity of the room be.
   a. 55–60%
   b. 10–20%
   c. 75–80%
   d. 30–40%

38. A chick begins to breathe air from the air cell on day 20 of incubation.
   a. True
   b. False

39. True or false: How you handle eggs before you incubate them will not affect hatchability.
   a. True
   b. False

40. In which kind of incubator will the temperature will fluctuate more?
   a. One with a fan to circulate air
   b. One without a fan to circulate air
   c. Neither, it will fluctuate the same amount with or without a fan

41. Can you incubate eggs of different species (ducks, chicken, quail, and geese) in the same incubator?
   a. Yes, an egg is an egg
   b. No, they will hatch at different times
   c. No, they require different temperatures during incubation
   d. Both b and c

42. What is a good way to increase the humidity in the incubator:
   a. Place a dish of water in it
   b. Place a damp sponge in it
   c. Open the incubator
   d. Both a and b

43. Best case scenario: What percentage of incubated eggs will hatch?
   a. 70–75%
   b. 80–90%
   c. 95–100%
   d. 50–65%

44. Which of the following is correct?
   a. Eggs stored less than 10 days should be stored with the large end up
   b. Eggs stored more than 10 days should be stored with the large end down
   c. Eggs should be incubated with the large end higher than the small end
   d. All of the above

45. What is the correct order, from shortest to longest, for the number of days to hatch?
   a. Pigeon, chicken, turkey, goose
   b. Chicken, pigeon, goose, turkey
   c. Turkey, chicken, pigeon, goose
   d. Chicken, pigeon, turkey, goose

46. Why do chicks hatch late?
   a. The eggs are large
   b. The eggs are old
   c. The temperature is too low
   d. The humidity is too low
   e. All of the above

47. Why do chicks hatch early?
   a. The eggs are small
   b. The temperature is too low
   c. The humidity is too low
   d. All of the above

48. What could cause chicks to die after pipping the shell?
   a. The eggs were not turned the first 2 weeks
   b. The humidity was too high during Days 1–19
   c. The humidity was too low during Days 19–21
   d. All of the above

49. When do chicks begin to breathe air?
   a. Day 1 of incubation
   b. Day 18 of incubation
   c. Day 20 of incubation
   d. The day they hatch

50. Chicks may hatch with malformed legs and toes due to:
   a. Improper temperature
   b. Improper humidity
   c. Eggs that are too small
   d. Both a and b
|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|1) c  | 11) b  | 21) a  | 31) b  | 41) d  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|2) c  | 12) b  | 22) c  | 32) b  | 42) d  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|3) b  | 13) b  | 23) d  | 33) b  | 43) b  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|4) c  | 14) b  | 24) c  | 34) b  | 44) d  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|5) d  | 15) a  | 25) b  | 35) c  | 45) a  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|6) b  | 16) b  | 26) c  | 36) d  | 46) e  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|7) b  | 17) d  | 27) d  | 37) c  | 47) d  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|8) c  | 18) c  | 28) a  | 38) a  | 48) d  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|9) b  | 19) a  | 29) a  | 39) b  | 49) c  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|10) b | 20) c  | 30) a  | 40) b  | 50) d  |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

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