

Unit D: Egg Production

Lesson 3: Incubation Management

Student Learning Objectives: Instruction in this lesson should result in students achieving the following objectives:

1. Describe the embryonic development of a chicken.
2. Discuss factors affecting hatchability of eggs.
3. Describe the ideal environment for incubating eggs artificially.
4. Prepare eggs for hatching and care for young birds during brooding.

Recommended Teaching Time: 5 hours

Recommended Resources: The following resources may be useful in teaching this lesson:

- A PowerPoint has also been developed for use with this lesson plan

List of Equipment, Tools, Supplies, and Facilities

Writing surface

PowerPoint Projector

PowerPoint Slides

Materials for Lab (Page 10 of this Lesson)

Candler (use the one from Unit D Lesson 2)

Terms: The following terms are presented in this lesson (shown in bold italics and on PowerPoint Slide # 2):

Allantois

Amnion

Brooding

Chorion

Egg candler

Fertility

Gastrulation

Hatchability

Hatcher

Setter

Interest Approach: Use an interest approach that will prepare the students for the lesson.

Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Make a copy of TM: D3-1. Cut out each individual day and the corresponding stage of development so you will have a pile of slips of paper with the days and a pile of slips of paper with the stage of development. Pass out the slips to the students until all of the slips have been passed out. Give the students 7 minutes to arrange the days and stages of development in the correct order. Once they have finished, rearrange anything that is out of place and show the students a copy of TM: D3-1.

Summary of Content and Teaching Strategies

Objective 1: Describe the embryonic development of a chicken.

(PowerPoint Slide #3)

- I. Cell division begins in the fertilized egg soon after fertilization.
 - A. The blastoderm spreads over the yolk.
 1. The blastoderm differentiates into two layers, known as the ectoderm and entoderm, by a process known as **gastrulation**.
 2. The ectoderm, forming first, creates the skin, feathers, beak, claws, nervous system, eye lens and retina, and linings of both mouth and vent.

(PowerPoint Slide #4)

3. The entoderm, forming second, creates the linings of the digestive tract, as well as the respiratory and secretory organs.
4. A third layer, the mesoderm, finally gives rise to bones, muscles, blood, and reproductive and excretory organs.

(PowerPoint Slide #5)

- B. Membranes cover the developing embryo for protection and aid in development.
 1. The **chorion** is a membrane that surrounds the yolk sac and amnion during chick development.

(PowerPoint Slide #6) This slide shows where the chorion is located in a developing embryo. If possible, dissect a developing egg to identify the chorion. If a live egg is not available slides will be shown at the end of this objective.

(PowerPoint Slide #7)

2. A transparent sac, known as the **amnion**, is full of colorless liquid that surrounds the embryo. The amnion serves as a cushion and provides protection for the developing embryo.

(PowerPoint Slide #8) This slide shows a picture of the amnion. Use a live egg to show the amnion or show in the picture at the end of this objective.

(PowerPoint Slide #9)

3. The **allantois** is a sac connected to the abdomen of the developing chick that makes respiration possible it stores excretions, absorbs albumen for food, and gets calcium from the shell for the structural needs of the embryo.

(PowerPoint Slide #10) This slide shows a picture of the allantois. Use a live egg to show the amnion or show in the picture at the end of this objective.

Show PowerPoint Slides #11 - 30 to the students. These show a developing chick every day from fertilization to hatching. Have the students identify the chorion, amnion, and allantois in the pictures where they are present.

Objective 2: Discuss factors affecting hatchability of eggs.

(PowerPoint Slide #31)

II. Hatchability refers to the percentage of fertilized eggs that hatch.

A. Factors that affect hatchability include:

1. Fertility, the capacity to reproduce, is affected by:
 - a. number of females mated to a single male.
 - b. age of breeding animals.
 - c. length of time between breedings.
 - d. management practices.

(PowerPoint Slide #32)

2. Genetics, or genetic makeup of the bird, is affected by:
 - a. inbreeding
 - b. crossbreeding
 - c. lethal genes
 - d. heritable traits (ex. egg production)

(PowerPoint Slide #33)

3. Nutrients, available to the developing chick, are affected by:
 - a. rations fed to breeding hens.
 - b. amount of vitamins and minerals in hen rations.

(PowerPoint Slide #34)

4. Diseases of breeding stock.
5. Egg Selection. Certain physical characteristics can affect hatchability.
 - a. Size. Extremely large or small eggs do not hatch well.
 - b. Shape. Unnaturally shaped eggs do not hatch well.
 - c. Shell quality. Strong shells hatch better than weak shells.
 - d. Interior quality. Upon candling, better interior quality eggs tend to hatch better.

(PowerPoint Slide #35)

6. Handling of fertilized eggs. Good management practices include:
 - a. Gathering eggs frequently.
 - b. Clean soiled eggs.
 - c. Sanitizing eggs.
 - d. Hold, or prolong start of incubation, for a minimum amount of time.

(PowerPoint Slide #36)

- e. Hold eggs at a temperature of 18.3° C.
- f. Keep eggs at a relative humidity of 75 to 80%.
- g. Position eggs with large end up.
- h. Turn eggs if they are held for more than 7 days.

Hold a discussion with the students about the various factors that impact hatchability. Ask them questions such as, "What problems do we have with hatchability in Afghanistan?" "Does a larger egg mean a larger bird?"

Objective 3: Describe the ideal environment for incubating eggs artificially.

(PowerPoint Slide #37)

- III. Fertile eggs will hatch if placed in an incubator with the correct environmental conditions.
 - A. Temperature.
 - 1. Optimum temperature for hatching chickens is between 37.2 to 37.8° C.

(PowerPoint Slide #38)

- B. Humidity.
 - 1. Eggs lose moisture during development and low humidity causes an increased loss.
 - 2. High humidity can prevent the correct evaporation of water.
 - 3. Humidity levels should be around 60% for the first 18 days, followed by 70% for the remaining days.

(PowerPoint Slide #39)

- C. Ventilation.
 - 1. Proper circulation is critical to assure a fresh supply of oxygen and removal of carbon dioxide.

(PowerPoint Slide #40)

- D. Position and turning of eggs.
 - 1. The head of the chick must face the large end of the egg for proper hatching.
 - 2. Eggs should be incubated large end up, and turned three to five times daily to prevent the developing embryo from attaching to the shell membrane.

(PowerPoint Slide #41) This slide shows an incubator with trays that tilt to prevent the developing bird from sticking to the inside of the shell.

Lead a lecture/discussion on the environmental conditions that are needed for proper hatching. Use this discussion to lead into LS: D3-1. Have students set up the incubator with the correct environmental conditions for hatching. Ask students questions while they are setting up the lab to check for understanding of concepts.

Objective 4: Prepare eggs for hatching and care for young birds during brooding.

(PowerPoint Slide #42)

- IV. Fertility of eggs can be determined by a process known as candling.
 - A. Eggs held up to an **egg candler**, a device for shining a light beam into an egg.
 - 1. Eggs will look different depending on fertilization or lack of fertilization.
 - 2. Fertile eggs will appear darker as the developing embryo begins to form.
 - 3. Infertile eggs can be detected after 15 to 18 hours of incubation.
 - 4. A second fertility test can be made 14 to 16 days after incubation.
 - B. A 75 watt bulb is recommended for use in an egg candler.
 - C. In commercial hatcheries, two separate incubators are used for hatching.
 - 1. Incubation of the chick from day 1 through day 19 is done in an incubator known as the **setter**. The setter has the environmental conditions discussed earlier.
 - 2. Days 19 through 21 are usually spent in an incubator known as the **hatcher**.
 - a. The hatchers have slightly lower temperatures (36.7° C) and have chick holding trays that cut down on the debris from hatching eggs that may cause disturbances to other eggs.
 - 3. Incubation times depend on the species of bird being hatched.

(PowerPoint Slide #44) This is an example of an incubator, or hatcher. There are numerous designs and sizes available to fit various growers' needs.

(PowerPoint Slide #45)

- D. **Brooding** refers to the care of young poultry from the time of hatching through eight to ten weeks of age.
 - 1. Certain environmental conditions are needed for proper brooding.
 - a. Temperature—When chicks are one day old, the temperature should be between 32.2 and 35 ° C.
 - i. The temperature is generally lowered five degrees per week until a temperature of 21.1 to 23.8°C is reached, or until the chicks are fully feathered.

(PowerPoint Slide #46)

- b. Ventilation—Proper ventilation provides fresh oxygen, removes carbon dioxide, carbon monoxide, ammonia, and keeps bedding dry.
- c. Moisture—50 to 60% relative humidity is recommended for good feathering.
- d. Space requirements—Each chick needs 17.8 to 25 centimeters of space under the brooder.
 - i. More brooder space may be required during colder weather.

(PowerPoint Slide #47) This slide shows a brooding area for chicks. Hanging from the ceiling is a heater. Located on the ground are feeders and there are waterers hanging from ceiling.

Use TM: D3-2 to show the differing incubation times for various bird species. Relate the discussion of environmental conditions needed for proper brooding to the environmental conditions needed for proper hatching. Discuss what equipment the chicken producer might need to achieve these environmental conditions. Have students discuss the impact improper conditions could have on hatching and brooding operations. If the chicks being hatched out as part of the lab are being kept for brooding, have student design and build a brooding environment for the baby chicks. Discuss ways to observe and record environmental conditions in a brooding environment

Review/Summary: Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used to determine which objectives need to be reviewed or re-taught with a different approach. Questions on PowerPoint Slide #48 can also be used.

Application: Invite a poultry producer into the classroom to discuss their operation and how they approach incubation. If this is not possible, continue observation of the incubation lab. Use different species of eggs and compare hatching.

Evaluation: Evaluation should focus on student achievement of this lesson's objectives. A sample written test is attached.

Answers to Sample Test:

Part One: Matching

1. g
2. a
3. h
4. b
5. c
6. e
7. d
8. f

Part Two: Completion

1. Humidity
2. Gastrulation
3. Carbon Dioxide (or Monoxide)

Part Three: Multiple Choice

1. a
2. d
3. c
4. c
5. a

Part Four: Short Answer

1. Fertility—capacity to reproduce
Genetics—genetic makeup of the animal
Nutrition—proper nutritional rations fed to hens
Diseases—healthy hens produce healthy eggs
Egg Selection—egg physical characteristics
Handling—care of fertile eggs before incubation
2. A proper brooder environment will have a temperature of 90 to 95° for new chicks, with temperature falling five degrees each week until chicks are fully feathered, relative humidity of 50% to 60%, proper ventilation to provide oxygen and remove harmful gases and waste fumes, and proper space requirements for growing chicks.

Sample Test

Name _____

Test

Unit D Lesson 3: Incubation Management

Part One: Matching

Instructions: Match the term with the correct response.

- | | | | |
|--------------|--------------|----------------|------------|
| a. allantois | b. fertility | c. incubation | d. amnion |
| e. setter | f. brooding | g. egg candler | h. chorion |

- _____ 1. A device to shine light into an egg to determine fertility.
- _____ 2. A sac connected to the chick abdomen to make respiration possible.
- _____ 3. A membrane surrounding the yolk sac and amnion.
- _____ 4. The capacity to reproduce.
- _____ 5. The process of bringing a fertilized egg to hatching.
- _____ 6. An incubator or incubating house used for the first 19 days.
- _____ 7. A transparent sac that surrounds the embryo and provides protection.
- _____ 8. The care of young poultry up to 8 to 10 weeks of age.

Part Two: Completion

Instructions: Provide the word or words to complete the following statements.

1. _____ refers to the amount of moisture in the air.
2. The entoderm and ectoderm separate by a process called _____.
3. Ventilation is needed to insure the removal of _____.

Part Three: Multiple Choice

Instructions: Circle the letter of the correct answer.

- _____ 1. Which of the following factors does not affect hatchability?
 - a. incubator size
 - b. ventilation
 - c. humidity
 - d. turning eggs
- _____ 2. The process of checking fertility of incubated eggs is called:
 - a. lighting
 - b. cradling
 - c. brooding
 - d. candling
- _____ 3. What factor is not required for successful brooding?
 - a. water
 - b. light
 - c. litter
 - d. humidity

- _____ 4. What is the optimum temperature for incubating chicken eggs?

 - a. 29.4-32.2° C
 - b. 32.2–35
 - c. 37.2-39.4
 - d. 105–108

_____ 5. What is the purpose of turning the eggs 3–5 times per day?

 - a. prevent germ spot from attaching to shell
 - b. increase fertility of egg
 - c. prevent carbon dioxide build up
 - d. allow light penetration to all sides of egg

Part Four: Short Answer

Instructions: Provide information to answer the following statements.

1. List and briefly describe four factors that will affect the hatchability of eggs.
 2. Describe the proper environment for brooding young poultry.

Daily Development of a Chicken Egg

Stage or Period	What Takes Place
Before egg laying	Fertilization, division, and growth of living cells, segregation of cells into groups of special function.
Between laying and incubation	No growth; stage of inactive embryonic life.
During incubation:	
First day:	
16 hours	First sign of resemblance to a chick embryo.
18 hours	Appearance of alimentary tract.
20 hours	Appearance of vertebral column.
21 hours	Beginning of formation of nervous system
22 hours	Beginning of formation of head.
23 hours	Appearance of blood islands—vitelline circulation.
24 hours	Beginning of formation of eye.
Second day:	
25 hours	Beginning of formation of heart.
35 hours	Beginning of formation of ear.
42 hours	Heart begins to beat.
Third day:	
50 hours	Beginning of formation of amnion.
60 hours	Beginning of formation of nasal structure.

Stage or Period	What Takes Place
62 hours	Beginning of formation of legs.
64 hours	Beginning of formation of wings.
70 hours	Beginning of formation of allantois.
Fourth day	Beginning of formation of tongue.
Fifth day	Beginning of formation of reproductive organs and differentiation of sex.
Sixth day	Beginning of formation of beak and egg-tooth.
Eighth day	Beginning of formation of feathers.
Tenth day	Beginning of hardening of beak.
Thirteenth day	Appearance of scales and claws.
Fourteenth day	Embryo turns its head toward the blunt end of egg.
Sixteenth day	Scales, claws, and beak becoming firm and horny.
Seventeenth day	Beak turns toward air cell.
Nineteenth day	Yolk sac begins to enter body cavity.
Twentieth day	Yolk sac completely drawn into body cavity; embryo occupies practically all the space within the egg except the air cell.
Twenty-first day	Hatching of chick.

Incubation Times for Various Bird Species

Common Name	Incubation Period in Days
Ducks	28
Geese	28-32
Turkeys	28
Chicken	21

Incubating Eggs

Teacher Information

Agricultural Applications and Practices

Modern incubators with capacities of more than 500,000 eggs have replaced the setting hen as nature's way of hatching eggs. Artificial incubation is a complex and highly technical process which requires proper control of temperature, humidity, ventilation, and positioning or turning of the eggs. Commercial hatcheries maintain specialized rooms for setting and hatching eggs. The optimum temperature for setting or incubating eggs is between 37.2° and 39.4°C. Overheating is more critical than underheating and can result in a lower percentage of hatchability. Humidity is maintained at 60 percent during incubation and 70 percent during hatching. Adequate ventilation is necessary to maintain optimum oxygen levels around the egg. Automatic egg turners rotate incubating eggs to keep the germ spot from attaching to the shell membrane. Finally, incubated eggs are sometimes checked for fertility by a process called candling on the first and fifteenth day of incubation. Newly hatched chicks rely on nutrients from the egg yolk for the first several hours of life. The yolk is drawn into the body of the chick on the nineteenth day of incubation and is used up during the first ten days of life. Brooding refers to the care of chicks from hatching to 8 to 10 weeks of age. In commercial operations, the environmental conditions of temperature, humidity and ventilation are controlled to promote optimum growth. Brooder houses with 50,000 or more birds are common. Adequate feed, water, litter, and light must be provided for successful brooding. Brooding chicks are vaccinated against diseases and strict sanitation is practiced to keep the birds healthy and growing. Science

Connections—Questions for Investigation

1. How is poultry reproduction different from the reproduction of mammals?
2. What factors are important in incubating eggs artificially?
3. What factors influence the hatchability of eggs?
4. What are the stages in development of a chick embryo?
5. What is brooding?

Purpose of Laboratory and Student Performance Objectives

The purpose of this experiment is to investigate the development of chick embryos by artificially incubating fertilized eggs. Through this laboratory exercise and related discussion, students will be able to:

1. describe the embryonic development of a chicken;
2. discuss factors affecting hatchability of eggs;
3. describe the ideal environment for incubating eggs artificially; and,
4. prepare eggs for hatching and care for young birds during brooding.

Materials and/or Equipment

- fertile chicken eggs
- incubator
- incubator thermometer
- egg candler (overhead projector can be used as a candler)
- baby chick feeder and feed
- baby chick waterer
- brooder pen
- warming lamp
- shavings for brooder

Procedure

Give each student or group of students a copy of the worksheet to perform the activity.

Helpful Hints

- The most important aspect of this laboratory exercise is proper environmental conditions for your incubator.
- Make sure that the incubator is set up and operating for at least a week ahead of placing eggs inside.
- Monitor conditions and make sure that proper conditions are held for the full time of incubation.
- Improper temperature by a few degrees will cause eggs not to hatch. Improper humidity will also cause eggs not to hatch, or hatching chicks to have a difficult time getting out of the shell.
- Resist the urge to open the incubator to look at the eggs. If opening is needed, make it very brief.
- Make sure to purchase your fertile chicken eggs from a reliable source to insure fertility. Many science catalogs sell guaranteed fertile chicken eggs by the dozen.

Data Summary and Analysis

- Student should record the operating conditions of the incubator in the chart provided.
- Students should also record observations from egg candling in the chart provided.

Anticipated Findings

After 21 days of development, the fertile eggs should hatch in the incubator.

Ideas for Other Experiments

The incubator can be used to hatch other species of birds. Quail eggs are usually available in the early spring for hatching.

Incubation of Fertile Chicken Eggs

Student Sheet

Incubator Preparation Check List

1. Wash it thoroughly with a damp cloth using a diluted chlorox (bleach) solution, then let it dry.
2. Set it away from drafts, direct sunlight, and traffic paths.
3. Regulate the temperature between 37.3° and 37.7° C two or three days before you begin incubation of fertile eggs.
4. Maintain room temperature between 21.1° and 23.8° C.
5. Make sure you have a reliable and accurate thermometer.
6. Be sure the thermometer is placed at egg level.
7. Fill rings in the bottom of incubator with distilled water and keep full.

Incubation and Hatching Check List

1. Wash hands thoroughly before setting eggs in the incubator.
2. Make sure the incubator water channels are full of water.
3. With a pencil mark an "X" on one side of the egg and an "O" on the other side.
4. The best day on which to set your eggs is a Tuesday or a Wednesday. (Hatching will then occur on a class day.)
5. Turn your fertile eggs three times a day until day 18 of incubation. Wash hands thoroughly before handling eggs. Keep a record of when you turn the eggs.
6. Eggs can be candled on days 7, 14, and 18 of the incubation period.
7. On the 18th day of incubation, place a thick layer of cheesecloth over the wire rack, then place the eggs on the cheesecloth.
8. Add wet sponges to the bottom of the incubator to increase moisture, and if your incubator has vent plugs, remove them if appropriate.
9. When chicks hatch, lower incubator temperature to 35° C.

Post-Hatch Check List

1. Set up a brooder box.
2. Acquire feed in advance of hatch.
3. Place fresh cat litter, cedar, or wood shavings in the bottom of the brooder box.
4. Regulate the temperature around 35° C.
5. Provide water and food for chicks after they are placed in the brooder box.
6. Decide in advance of hatch what you will do with the baby chicks.
7. After hatch, clean your incubator with diluted chlorox (bleach) solution.

(This check list information was adapted from material prepared by Gary S. Davis, North Carolina State University. Source: Eggciting Experiments: Chick Incubation and Embryology, K-6 Curriculum: Agricultural Concepts, Science Laboratory Exercise.)

Data Summary and Analysis

1. Record the operating conditions of the incubator in the chart provided.
2. Record observations from egg candling in the chart provided.

Student Data Sheet

Use this chart to record data about the incubating eggs. On a separate sheet of paper, make physical observations about the eggs and be sure to record which day the observations were taken.

Day	Time of Observation	Time Eggs Were Turned	Room Temperature	Incubator Temperature	Incubator Humidity
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					

Chick Hatch Prediction Chart

Egg Number	First candle	Second Candle	Third Candle	Did the egg hatch?
	Day ___ of Development?	Day ___ of Development?	Day ___ of Development?	
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				